CF-350
DUAL-CHANNEL
FFT ANALYZER

INSTRUCTION MANUAL

To ensure that you get the most from your new FFT analyzer, we recommend that you read and follow the instructions in this document carefully.

Before this analyzer was shipped from the factory, it was subjected to a severe series of inspections to verify that it operates properly. When unpacking the instrument, verify that no damage has occurred during transit and, after reading this document thoroughly, check the operation of the analyzer. Should damage have occurred or the unit not operate according to specifications, contact your nearest representative

Your new CF-350 is the export version, with certain normally optional items already built into the analyzer, these options being the following.

CF-0350	Plotter Interface Software
CF-0351	Frequency Zoom Software
CF-0352	Octave Analysis Software
CF-0353	3-Dimensional Display Software
CF-0354	Servo Analysis Software
CF-0355	Curve Fitting Software
CF-0380	Floppy Disk & Signal Generator Interface

Remember that these options are already provided in your analyzer, even though this instruction manual refers to all of the above as options. (Refer to Section 1.9 for details on options.)

TABLE OF CONTENTS

1. INTRODUCTION TO THE CF-350

1.1 CF-350 Specifications

(Items marked * are options)

1.1.1 Input Section

No. of input channels	2
Absolute maximum input	100 VAC rms for 1 minute (50 Hz)
Input configuration	Single ended
Input impedance	1 MΩ ±1%
Input capacitance	Between signal and ground: Approx. 110 pF (1kHz) (accessory cable: approx. 190 pF, 1 kHz)
Input coupling	DC and AC (0.5 Hz, −3 dB ±4%) (AC only for ±1 mV to 5 mV ranges)
Voltage ranges	±1 mV, ±2 mV, ±5 mV ±10 mV, ±20 mV, ±50 mV ±100 mV, ±200 mV, ±500 mV ±1 V ±2 V, ±5 V ±10 V, ±20 V, ±50 V and autoranging, for a total of 16 ranges
Maximum allowed input voltage	100 VAC rms for 1 minute (50 Hz)
Input level monitor	Red OVER LED
Internally generated test signals	Sinewave: 0 to 0.7 V (Ch A and Ch B same phase) Frequency is linked to the frequency range at ranges of 200 Hz and above (fundamental is 1/25 of the analysis frequency range). In the 100 Hz and lower ranges, the frequency is fixed at the 200-Hz frequency (i.e., fundamental of 8 Hz).
External trigger input	Absolute maximum input: 100 VAC rms for 1 minute (50 Hz) Input impedance: 100 kΩ ±2% Maximum sensitivity: 0.5 V_{p-p} Frequency response: 200 kHz or greater
External sampling input	Absolute maximum input: 100 VAC rms for 1 minute (50 Hz) Fan-in: 1 TTL load Input specifications: Sampling on transition edge from low to high Maximum input frequency: 102.4 kHz

1.1.2 Trigger Section

Trigger functions	Free-run, repeated, single and one-shot triggering
Trigger view function	Display of an external trigger signal
Trigger source	Internal (Ch A or Ch B) and external trigger signal
Trigger point	Pre-triggering and post-triggering Pre-triggering: Settable from −65,536 points before the trigger, in 1-point steps. Post-triggering: Settable to −65,536 points after the trigger, in 1-point steps.
Trigger level	Settable with a resolution equal to ± 1/128 of the full-scale voltage range (minimum: −95.5%, maximum: +95.3%) External trigger full scale: ±5V
Trigger slope	(+) and (−) (rising edge and falling edge)

1.1.3 Analysis Section

Frequency ranges	1, 2, 5, 10, 20, 50, 100, 200, 500 Hz, 1 , 2 , 5 , 10 , 20 , and 40 kHz

Data Capture Times and Frequency Resolution (Δf) for the Each Frequency Range

Frequency range	800 Lines (2048 points)		400 Lines (1024 points)	
	Data length (t)	Resolution (Δt)	Data length (t)	Resolution (Δf)
40kHz	20ms	50Hz	10ms	100Hz
20kHz	40ms	25Hz	20ms	50Hz
10kHz	80ms	12.5Hz	40ms	25Hz
5kHz	160ms	6.25Hz	80ms	12.5Hz
2kHz	0.4s	2.5Hz	0.2s	5Hz
1kHz	0.8s	1.25Hz	0.4s	2.5Hz
500Hz	1.6s	0.625Hz	0.8s	1.25Hz
200Hz	4s	0.25Hz	2s	0.5Hz
100Hz	8s	0.125Hz	4s	0.25Hz
50Hz	16s	62.5mHz	8s	0.125Hz
20Hz	40s	25mHz	20s	50mHz
10Hz	80s	12.5mHz	40s	25mHz
5Hz	160s	6.25mHz	80s	12.5mHz
2Hz	400s	2.5mHz	200s	5mHz
1Hz	800s	1.25mHz	400s	2.5mHz

Sampling speed	2.56 times the analysis range or governed by an external sampling clock
Frequency accuracy	±0.01% of full scale
No. of sampled points, frequency resolution and no. of spectral lines	See table.

No. of sampled points	1024-point mode	2048-point mode
Frequency resolution	1/400	1/800
No. of spectral lines	400	800

(The above does not apply to the servo mode.)

Anti-aliasing filter	Linked to the frequency range (digital filter at 100 Hz and lower ranges) 80-dB or greater attenuation at 1.56 times the frequency range full-scale frequency.
A/D converter	16 bits
Real-time analysis range	2 kHz (for 1-ch power spectrum display, normal FFT) 1 kHz (for other modes, normal FFT)
Overlap processing	Sampling overlap is settable. Setting values: 0%, 50% and max.
Window functions	Rectangular, Hanning, flattop, force, exponential and user-defined windows
Delay function	A delay can be introduced in the Ch B window with respect to Ch A before sampling (up to 65,536 points in 1-point steps).
Octave analysis*	1/3 octave analysis: 30 bands (conform to ANSI Class III specifications) 1/1 octave analysis: 10 bands A weighting can be applied when performing octave analysis.
Digital zoom*	Real-time zoom and record zoom from 2 to 64 times (binary steps)
Search enhance function	High-precision reading of amplitude and frequency using a Hanning window. X axis: Frequency precision improved 32 fold Y axis: ±0.1 dB precision
Averaging modes	Time domain: Summation averaging, exponential averaging, absolute-value averaging Amplitude domain: Summation averaging Frequency domain: Summation averaging, exponential averaging, peak hold, differential averaging, Fourier averaging, sweep averaging
No. of averages	1 to 8,192, set in binary steps 1 to 32,767 set as any value
Spectral density	Power spectrum density Energy spectrum density
4-Decade analysis*	1117-line, 4-decade analysis

Autoranging analysis*	Usable for 400-line and 4-decade analysis
High-precision FFT function	High-precision mode: 32-bit FFT Normal mode: 16-bit FFT

1.1.4 Analog Characteristics Setting Values

Dynamic range See table.

Noise Floor and Spurious Components

Range	1 to 200 Hz	200 Hz to 10 kHz	20 and 40 kHz
50 V 20 V 10 V 5 V 2 V 1 V 500 mV 200 mV 100 mV 50 mV	−80 dB min. with respect to fs	−78 dB min. with respect to fs	−76 dB min. with respect to fs
20 mV	−76 dB min. with respect to fs	−73 dB min. with respect to fs	−70 dB min. with respect to fs
10 mV	−72 dB min. with respect to fs	−68 dB min. with respect to fs	−64 dB min. with respect to fs
5 mV	−68 dB min. with respect to fs	−63 dB min. with respect to fs	−58 dB min. with respect to fs
2 mV	−60 dB min. with respect to fs	−55 dB min. with respect to fs	−50 dB min. with respect to fs
1mV	−55 dB min. with respect to fs	−50 dB min. with respect to fs	−45 dB min. with respect to fs

(Above applied for 16 averages, Hanning window, 50% or less overlap in the high-precision mode.)

Harmonic distortion	−74 dB with respect to full scale
Aliasing	−75 dB
Amplitude flatness	±0.3 dB
Channel-to-channel amplitude matching	±0.3 dB
Channel-to-channel phase matching	±3 deg (phase adjustment OFF, in the same sensitivity range) ±0.5 deg (phase adjustment ON, in the same sensitivity range)

1.1.5 Display Functions

Display type	7-inch raster-scan CRT
Displayed data	Time domain: Time-axis waveform, auto-correlation function, cross correlation function, impulse response, orbit (lissajous pattern) Frequency domain: Power spectrum, linear spectrum, phase spectrum, Fourier spectrum (real and imaginary), cross spectrum (gain, phase, real and imaginary), transfer function (gain, phase, real, and imaginary), Nyquist plot (Fourier spectrum, cross spectrum and transfer function), Cole-Cole plot, Nichols plot, Coherence function, S/N ratio, group delay, coherent output power, 1/3-octave analysis*, 1/1-octave analysis*, A weighting (narrowband and octave analysis) Amplitude domain Amplitude probability density function, amplitude probability distribution function Other data Cepstrum, list data, time-axis envelope, mass memory stored data, floppy disk stored data
Display modes	Single-frame display mode Any 1 frame displayed, including data from memory Dual-frame display mode Any 2 frames displayed, including data from memory (but not including Nyquist plots and lissajous displays) Overlaid display mode Overlaid display of any two frames of data of the same domain (but not including Nyquist plots and lissajous displays) 3-Dimensional display mode* 20-line mode ● 20 lines of any data (except for Nyquist plots and lissajous displays) plotted in 3 dimensions ● Specification of 3-dimensional display angle and amplitude (3 values) ● Scrolled display and specification of scrolling direction (up or down) 60- and 90-line modes ● 60- or 90-line 3-dimensional display of the power spectrum Nyquist plot mode Nyquist display of Fourier spectrum, cross spectrum and transfer function

Nichols plot mode

Nichols plot of transfer function

Cole-Cole plot mode

Cole-Cole plot of transfer function

Orbit display mode

Orbit plot of the waveforms input at Ch A and B. Display for any selected range is possible, as well as a perspective display with the vertical axis representing frequency.

Perspective display mode

Perspective display of Nyquist plot and orbit pattern.
The displayed region can be limited.

List display mode

- Listing of harmonics up to the 20th order with any spectrum component selected as the fundamental frequency, along with the harmonic distortion (up to 10th order only for dual-frame display).
- Listing of up to 20 specified points (up to 10th order only for dual-frame display). For a dual-frame display, the waveform is displayed at the bottom and the listing at the top of the screen.
- Listing of band numbers and spectral values for octave analysis.
- Listing of the largest 10spectral values (power spectrum only).
- Search enhance function and fitting functions can be combined.

Display inhibit mode

The screen display is held to shorten the calculation time.

Coherence blanking

Partial overall value display

Character display	Input attenuator range for each input channel, input coupling for each channel, Frequency range, averaging mode, number of set averages, number of executed averages, trigger level, trigger point, trigger source, trigger slope, window type, displayed data type, full-scale X and Y values, label, date (year, month & day), time, soft key functions.
Search functions	Display of X and Y values for search point. The search point can be jogged 1 point or 13 points at a time to any desired position on the display.

Maximum value display function	With the search function OFF, the maximum value and corresponding frequencies (X-axis values) are displayed. For time-axis waveforms, the maximum and minimum values in the single-frame mode are displayed.
Horizontal-axis units	Hz, CPM (cycles per minute), ORD (order), V, s, and EXT (when an external clock is used)
Vertical-axis units	V, Vrms, V^2, V^2rms, dBV, dBVrms, EU, dBEU, dB, %, deg, s For spectrum, PSD and ESD are possible.
Horizontal-axis scaling	Linear and logarithmic (baseband frequency axis) For linear scaling, expanded display is possible along the *f*, *t* and amplitude axes, over a specified region.
Vertical-axis scaling	Linear and logarithmic Linear: 1/10, 1/5, 1/2. ×1, ×2, ×5, ×10, ×20. ×50, ×100, ×200, ×500, ×1000 and ×2000 Log: 20, 30, 40, 50, 60, 70, 80, 90, 100, 120, 140, 160, 180 and 200 dB A reference level can be set.
Phase display	±10 to ±20 000° full scale (For unwrapped display, it is possible to display only negative or positive values.)
Grid display	Switchable ON and OFF
Label display	Two lines of up to 55 characters each, including alphanumeric characters and symbols can be displayed. The uppermost line can be stored.
Calculation functions	Arithmetic functions Addition, subtraction, multiplication and division (and combinations of these operations) are possible between data of the same domain. Equalization of a transfer function Reciprocal (1/H) Open-closed loop transformations Differentiation and integration First and second order differentiation/ single and double integration Differentiated/integrated display: Time-axis waveform Inverse Fourier transform Time-axis envelope calculation Hilbert transform Time envelope and its logarithmic display S/N calculation using coherence function Phase compensation using delay time Curve fitting* Group delay calculation

1.1.6 Memory Functions

Data memory capacity	RAM mass memory: 512 Kbytes 3.5-inch micro-floppy disk*: 300 frames CMOS memory*: 1 Mbyte
Mass memory	Time record storage in one of four mode: 255 Kwords (1 ch) 1 data 127 Kwords (2 ch) 1 data 31 Kwords (1 ch) 8 data 31 Kwords (2 ch) 4 data CMOS memory* (when installed) 768 Kwords (1 ch) 1 data 384 Kwords (2 ch) 1 data 255 Kwords (1 ch) 3 data 127 Kwords (2 ch) 3 data 31 Kwords (1 ch) 24 data 31 Kwords (2 ch) 12 data

Time Record Memory Time Lengths

	768k (1ch)	384k (2ch)	255k (1ch)	127k (2ch)	31k (2ch)
40kHz	7.68s	3.84s	2.55s	1.27s	0.31s
20kHz	15.36s	7.68s	5.10s	2.54s	0.62s
10kHz	30.72s	15.36s	10.20s	5.08s	1.24s
5kHz	61.44s (1m01s)	30.72s	20.40s	10.16s	2.48s
2kHz	153.6s (2m33s)	76.8s (1m16s)	51s	25.4s	6.2s
1kHz	307.2s (5m07s)	153.6s (2m33s)	102s (1m42s)	50.8s	12.4s
500Hz	614.4s (10m14s)	307.2s (5m07s)	204s (3m24s)	101.6s (1m41s)	24.8s
200Hz	1,536s (25m36s)	768s (12m48s)	510s (6m30s)	254s (4m14s)	62s (1m02s)
100Hz	3,072s (51m12s)	1,536s (25m36s)	1,020s (17m)	508s (8m28s)	124s (2m04s)
50Hz	6,144s (1h42m)	3,072s (51m12s)	2,040s (34m)	1,016s (16m56s)	248s (4m08s)
20Hz	15,360s (4h16m)	7,680s (2h08m)	5,100s (1h25m)	2,540s (42m20s)	620s (10m20s)
10Hz	30,720s (8h32m)	15,360s (4h16m)	10,200s (2h50m)	5,080s (1h24m)	1,240s (20m40s)
5Hz	61,440s (17h04m)	30,720s (8h32m)	20,400s (5h40m)	10,160s (2h49m)	2,480s (41m20s)
2Hz	153,600s (42h40m)	76,800s (21h20m)	51,000s (14h10m)	25,400s (7h03m)	6,200s (1h43m20s)
1Hz	307,200s (85h20m)	153,600s (42h40m)	102,000s (28h20m)	50,800s (14h06m)	12,400s (3h26m40s)

(All values above have been rounded to whole numbers.)

	CRT Block memory Storage capacity for 60 frames (540 frames of storage when CMOS memory* is installed)
Floppy disk*	Permanent storage for mass memory data Data stored onto floppy disk can be loaded into mass memory for playback. Storage capacity: 300 frames/disk Storage of panel condition memory contents, autosequence programs and signal sequence programs is also possible. Disk type: 3.5-in. double-sided, double-density micro-floppy disk No. of drives: 1 When CMOS memory* is installed, it can be used as a second drive.
Panel condition memory	Panel condition settings can be stored (four sets of conditions) in battery backed up (5 years min.) memory.
Autosequence memory	Autosequence programs and signal sequence programs can be stored.
Autorecall function	When power is switched ON, the contents of location 1 of the panel condition memory are automatically loaded and set.

1.1.7 Operating Functions

Autosequence function	Manual operating procedures are programmed for automatic execution of analysis. Auto mode: Continuous automatic analysis Stepped mode: Stepped operation by means of repeated pauses and starts Memory capacity: Two 63-step programs (One can be used as a subroutine.)
Signal sequence*	When the analyzer is used in combination with the optional signal output or the SG-450, it is possible to sequentially switch the output signal for each specified frequency range when determining the transfer function.
Misoperation display	When a misoperation is sensed, a long beeper sounds as a warning, as a message indicating the type of error or the corrective action required appears on the display.
Timer function	Clock and scheduler functions Time display: Date, hour and minute are displayed. Scheduler function: Analysis is performed at an interval set in the range 1 to 9999 s.

1.1.8 Output Section

Data bus	GPIB interface (conforms to IEEE-488 1978 standards)
Plotter output*	Output for HP-GL type plotters or Graphtec plotters (Personal mode) (HP-GL is the HP plotter command set.) Output modes: Hardcopy, annotationless, frameless and dataless output or specification of output of only annotation, data or frame. Autoplotting from mass memory or disk 3-Dimensional plotting (130 lines) of data from disk Plotter tracing Arbitrary setting of plotting size and position (P_1-P_2 mode and numerical setting mode)
Video signal output	Hardcopy of the display screen using a VP-035
X-Y recorder output*	Plotting of waveform only is possible. Tracking analysis is possible using the search point analog output.
Signal output*	Output waveforms: Sine, impulse, swept sine, periodic random, random, tone burst (pip), arbitrary waveform (A pink filter can be applied to the above signals.) Time-axis waveform display analog output: Analog output of the waveform displayed on the CRT screen Time record analog output: Analog output of 4 or 8 Kwords of data from the time record memory Sync pulse signal for above signals (except for random signals): Output level: TTL Output characteristics Frequency range: 0.0001 Hz to 40 kHz Maximum output: $5\ V_{0\text{-}p}$ (open circuit) Setting resolution: $1\ mV_{0\text{-}p}$ Impedance: Approx. 50 Ω Output connector type: BNC Output modes Continue: Continuous output Single: One cycle of the selected waveform (except for random signals) Burst: Set number of cycles of the selected waveform output every set time interval

Waveform characteristics

(1) Sine
Harmonic distortion:
−70 dB or lower at below 1 kHz
−58 dB or lower at 1 kHz to 10 kHz
−53 dB or lower at 10 kHz to 40 kHz
(at an amplitude of 1 $V_{0\text{-}p}$)
Accuracy:
40 kHz $\geqq f >$ 2 kHz:
±12.5 mHz ±50 ppm
2 kHz $\geqq f >$ 200 Hz:
±5 mHz ±50 ppm
200 Hz $\geqq f >$ 20 Hz:
±8 mHz ±50 ppm
20 Hz $\geqq f >$ 2 Hz:
±3.5 mHz ±50 ppm
2 Hz $\geqq f$: ±650 µHz ±50 ppm

(2) Impulse
Flatness: ±2 dB
Crest factor: 30 max.

(3) Swept sine
Flatness: +4 dB, −9 dB
Crest factor: 2 max.

(4) Periodic random
Flatness: ±1 dB
Crest factor: 4 max.

(5) Random
Flatness: ±2 dB (with 512 averages)

Other interfaces SG-450 interface*

1.1.9 General Specifications

Power requirements	90 to 264 Vac, 47 to 440 Hz (see note)
Power consumption	Approx. 100 VA
Operating temperature range	0 to +40°C (+5 to +35°C when using the floppy disk drive)
Humidity range	20 to 80%
Storage temperature range	−10 to +60°C
Outer dimensions	315 (W) × 199 (H) × 450 (D) mm
Weight	Approx. 13 kg

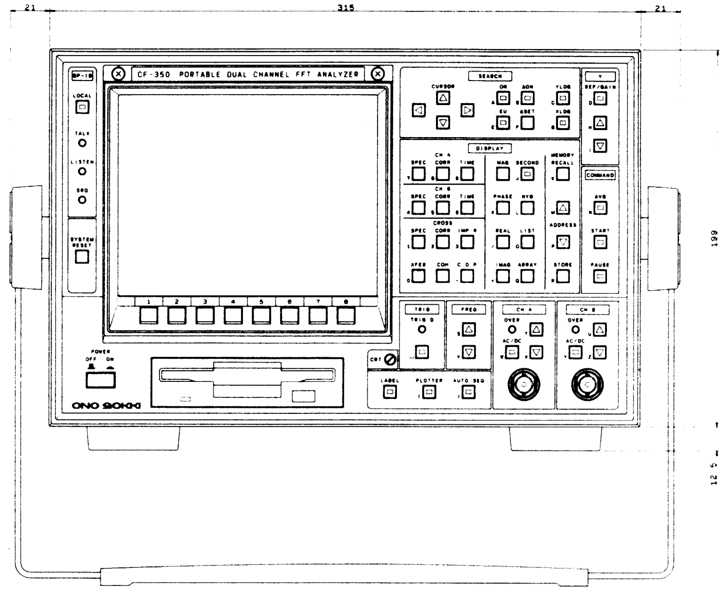
Note: The CF-350 is supplied with a 2-A line fuse. When powering the analyzer from a 180 to 264 V line, this must be changed to a EAWK 1-A fuse. Refer to Section 1.4 for further information on the power line.

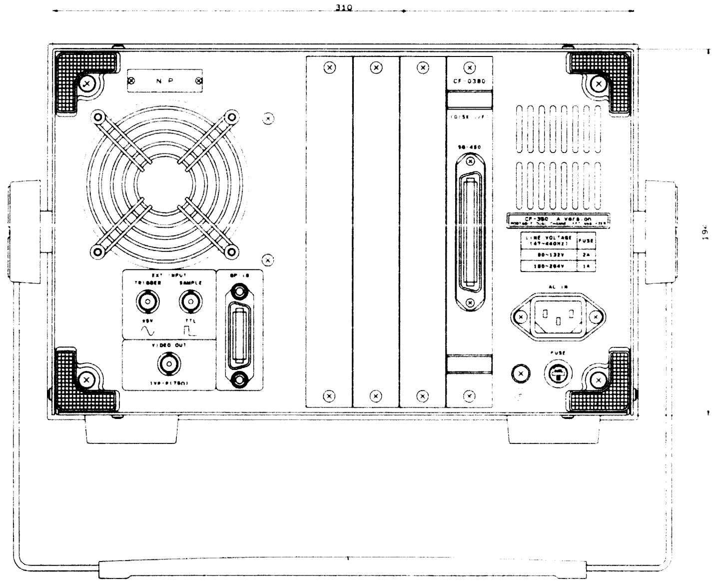
1.1.10 Accessories

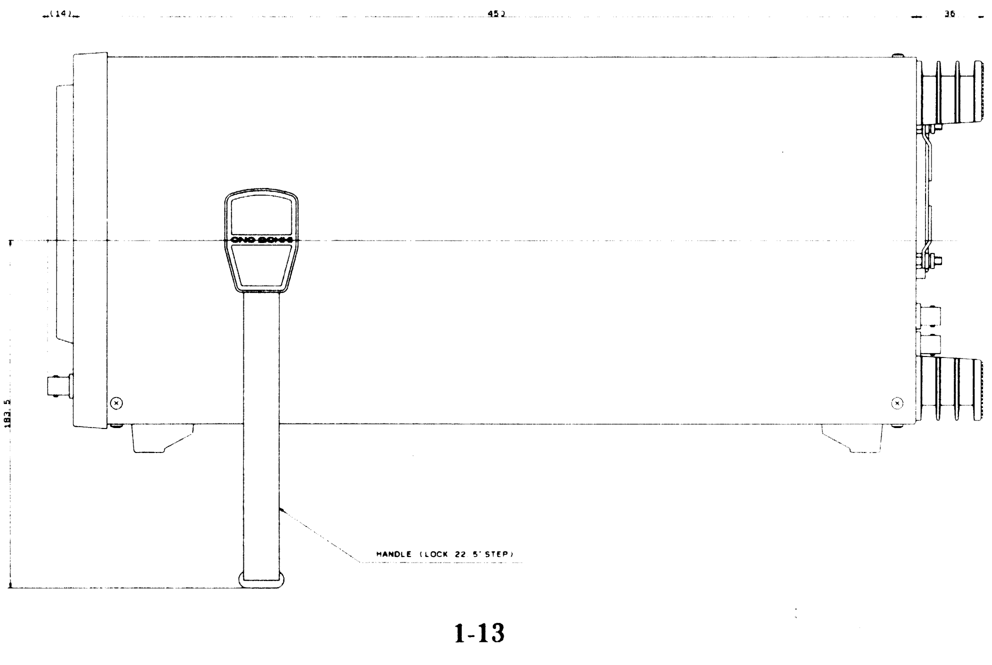
Power cord (AX-302)

BNC-alligator clip cables (2)

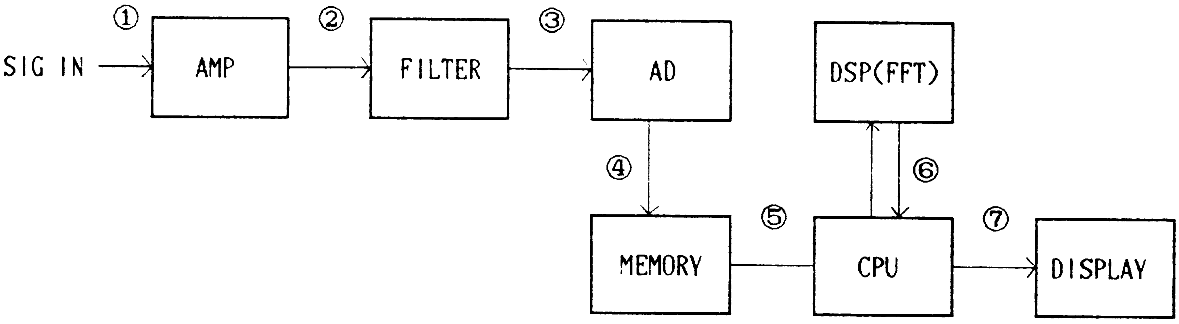
1.2 Outer Views







1.3 CF-350 Signal Flow

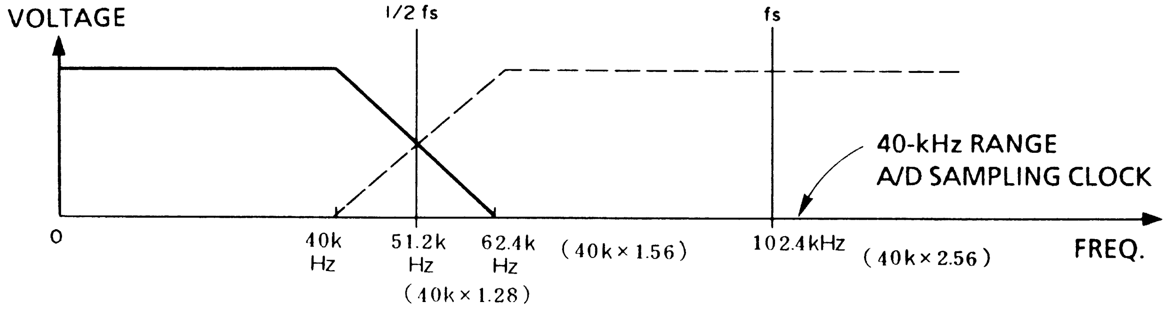


CF-350 Block Diagram

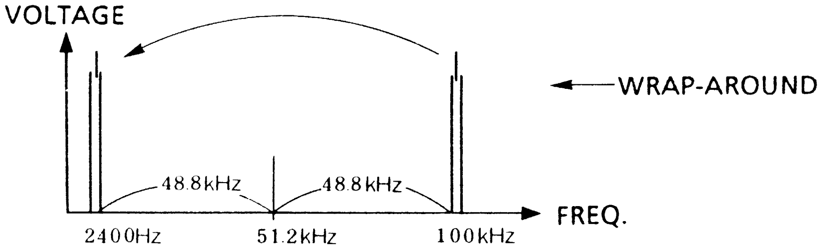
① The input signal is either AC or DC coupled and applied to a high-impedance (1 MΩ) input circuit. One side of both the Ch A and Ch B signals is grounded in common. For this reason, input signals having grounds with potential differences should be avoided.

② The signals are amplified or attenuated, according to the setting of the front panel voltage range.

③ To reduce errors caused by the wraparound phenomenon (aliasing) that can occur when A/D conversion is performed, the input signals are passed through a lowpass filter.



In the case of the 40-kHz range, the signal would exhibit wraparound a center frequency of 51.2 kHz (40 kHz × 2.56 /2). With the filter off, a 100-kHz signal would, therefore, be A/D converted as a 2400-Hz signal. (Signal components above 62.4 kHz would be wrapped around and appear on the CRT at "false" or alias positions.

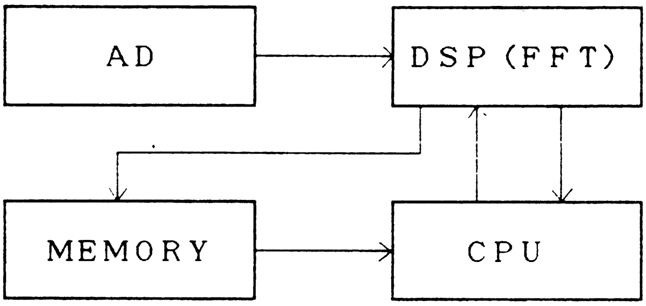


The CF-350 uses an 8th order filter to reduce aliasing error by attenuating signals greater than 1.56 times the analysis frequency range by at least 80 dB.

④ After passing through the filter, the signals are sampled and held and then A/D converted by a 16-bit successive approximation type A/D converter.

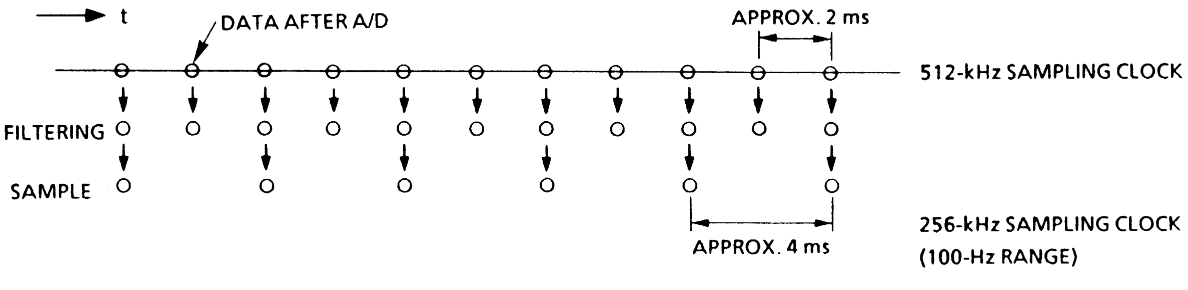
⑤ The A/D converted data is temporarily stored in memory. The memory always contains the latest captured data (without regard to the START or PAUSE conditions). The trigger condition and channel-to-channel delay and other settings control the transfer of CPU data into the storage memory.

⑥ CPU Time data is sent to a DSP (digital signal processor), at which it undergoes a fast Fourier transform. This processor performs such processing tasks as window application, FFT, IFFT and calculations such as the power and cross spectrum. The FFT calculation is normally performed with a fixed-point precision of 16 bits. However, a soft key selection of 32-bit precision can be made as well. The DSP also serves as a digital filter. In the 40 kHz to 200 Hz ranges, the cutoff frequency of an analog lowpass filter is switched. However, in the 100-Hz range and below, the filtering is performed by the DSP. The A/D converted data is input to the DSP, passed through the filter, resampled and finally sent to the memory.



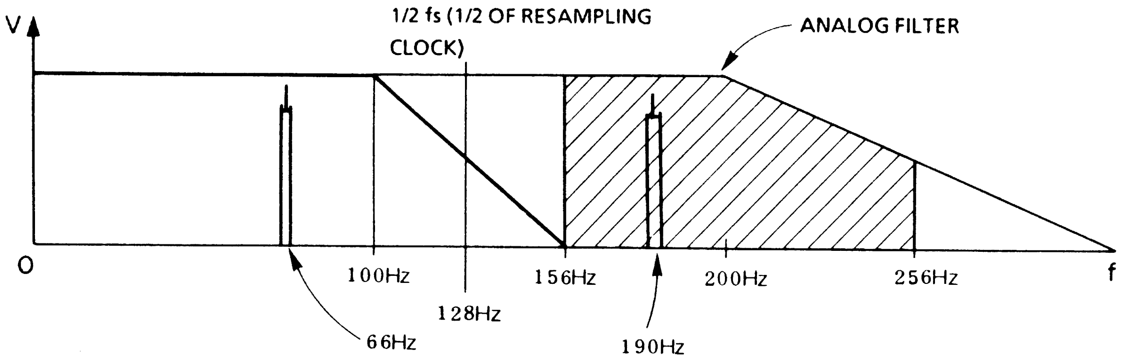
SIGNAL FLOW AT BELOW 100 Hz

For frequency zooming, the DSP performs processing tasks related to frequency shifting, digital filtering and resampling.



As shown above, data sampled at 512 kHz is filtered and sent to memory (1 time out of 2). This data is then the time data for the 100-Hz range. Below 100 Hz, combinations of 1/5 and 1/2 resampling are applied.

When data sampled by a 512-Hz clock and filtered with a cutoff frequency of 200 Hz are resampled by a sampling clock of 256 Hz and then FFT processed, signal components in the 156 to 256 Hz range are wrapped around. Digital filtering is used to prevent this wraparound.

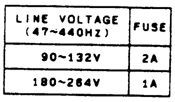


When digital filtering is not applied, the shaded section is wrapped around

⑦ After processing by the DSP, data is transferred to the CPU memory and displayed on the CRT.

1.4 AC Line Power

The CF-350 line voltage must be kept within specified limits. The line voltage is indicated on the rear panel. If the power is applied when the CF-350 is connected to a line of the incorrect voltage, damage can result to the instrument. Always take extreme care to avoid this danger.



LINE VOLTAGE (47~440HZ)	FUSE
90~132V	2A
180~264V	1A

WARNING !!

Although the CF-350 can be powered from an AC line in the voltage range 100 to 240 V by merely changing the fuse rating, the ratings of the power cord limit operation to the line voltage range of 100 to 125 V.

To power the unit from a line voltage greater than 125 V, it is necessary to change the plug and power cord. If this becomes necessary, consult your sales representative.

1.5 Grounding

- When the signal source ground and the cabinet are connected as shown in Fig. 1-1, a ground loop will be formed, causing susptibility to noise. For this reason, the signal source ground should be isolated from the cabinet as shown in Fig. 1-2.

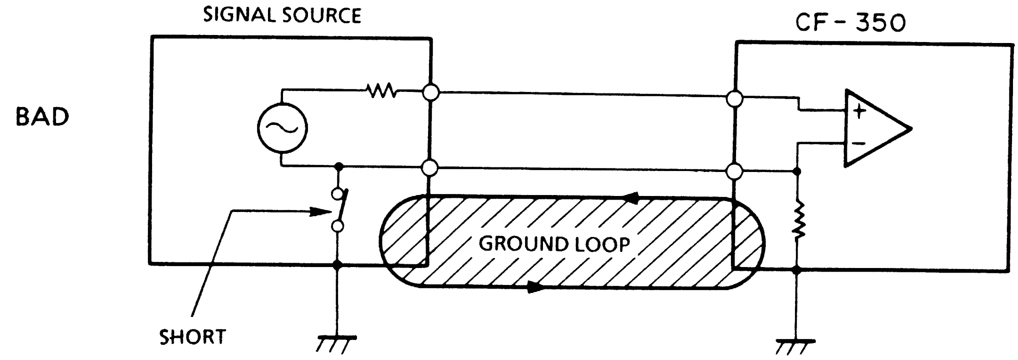


Fig. 1-1

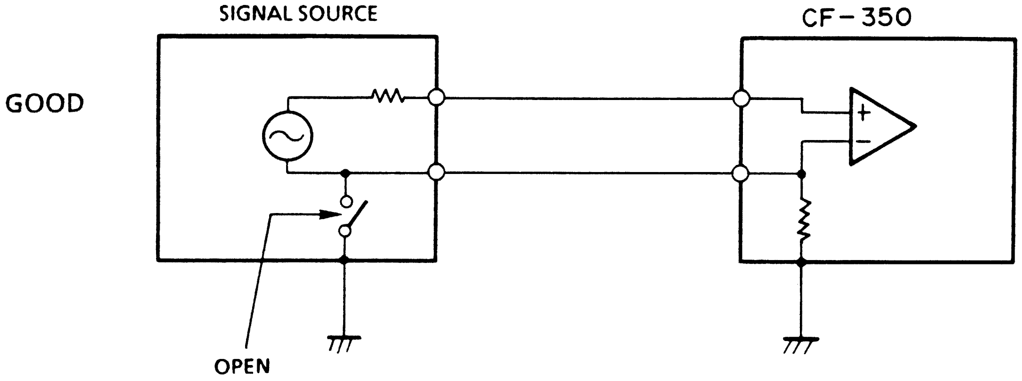
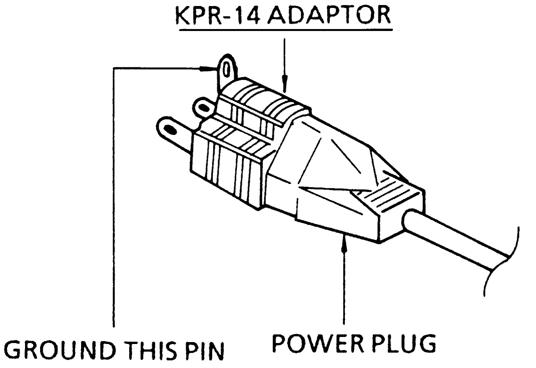


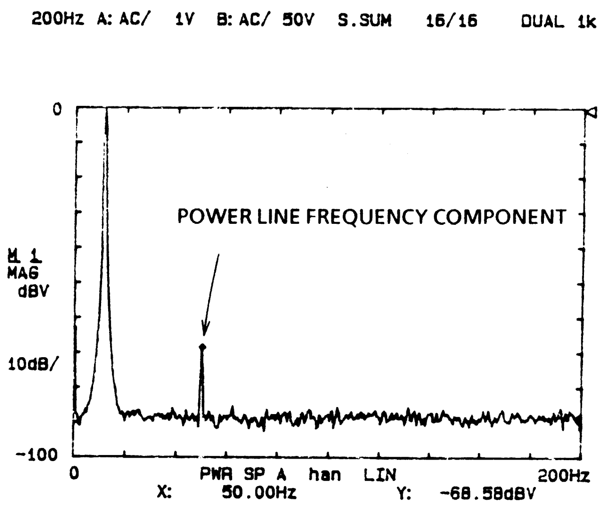
Fig. 1-2

CF-350 Grounding Method

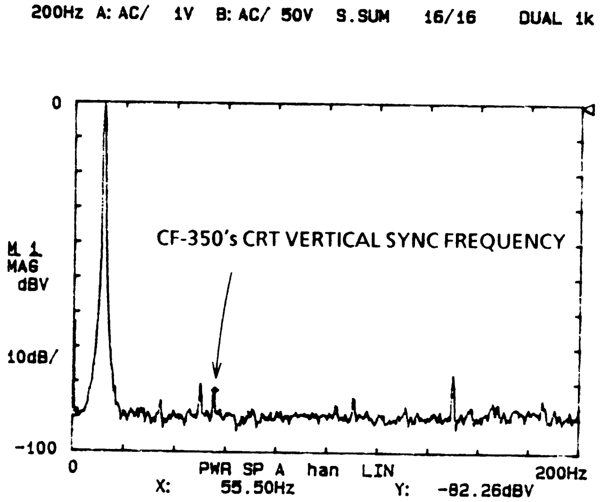
The cabinet of the CF-350 should be grounded, either at the ground terminal on the rear panel, or at the ground pin of the power plug. A three-pin power plug is provided on the power cord, the round center pin being the ground pin. When inserted into a 3-pin power outlet, the center pin is grounded. When using an adaptor on this plug to adapt it for 2-pin outlets, ground the terminal that protrudes from the side of the adaptor.



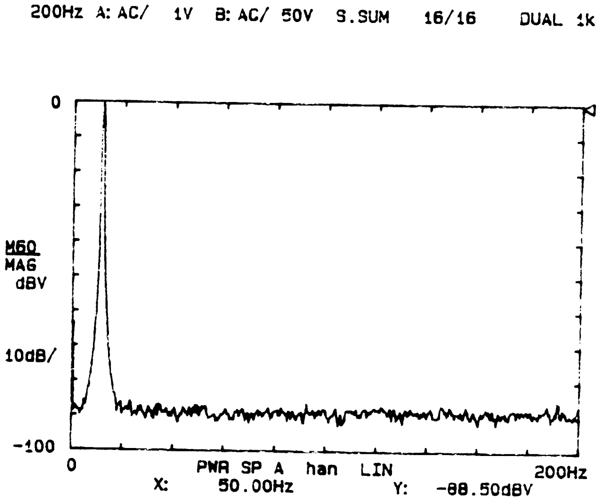
Data when the signal source is not grounded



Data with an improper ground

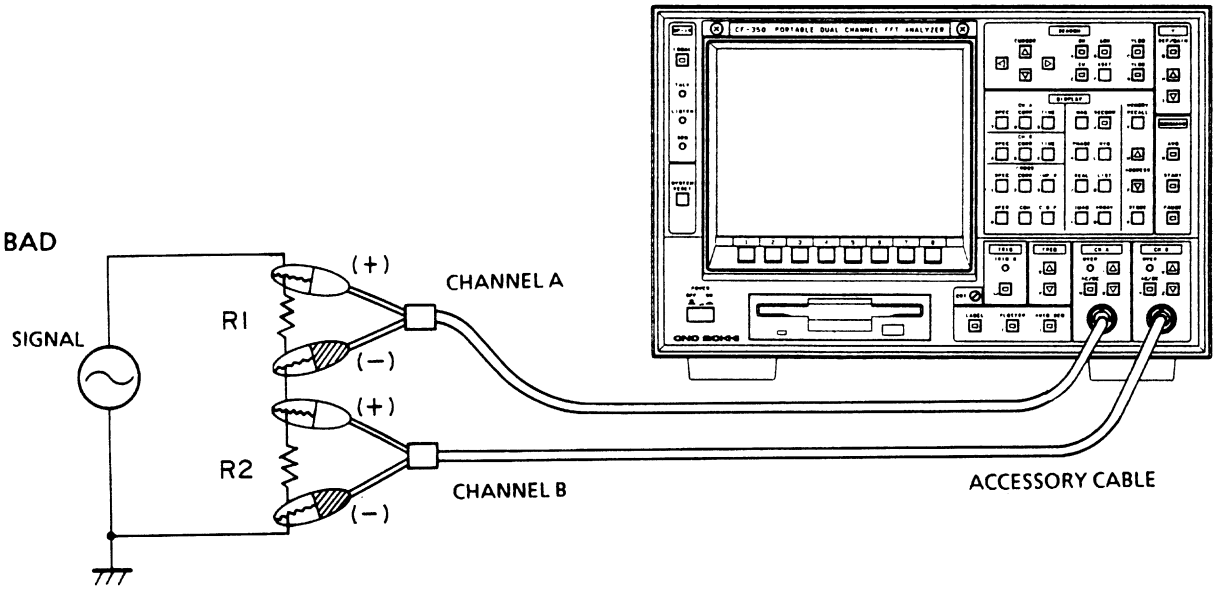


Data with a proper ground

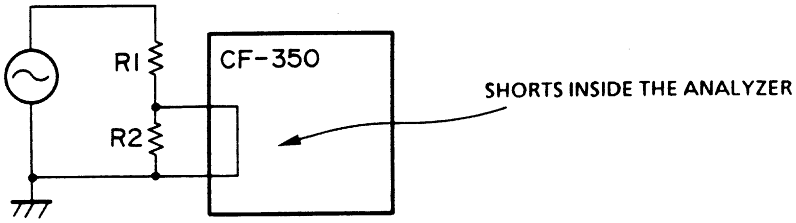


1.6 Measurement Precautions

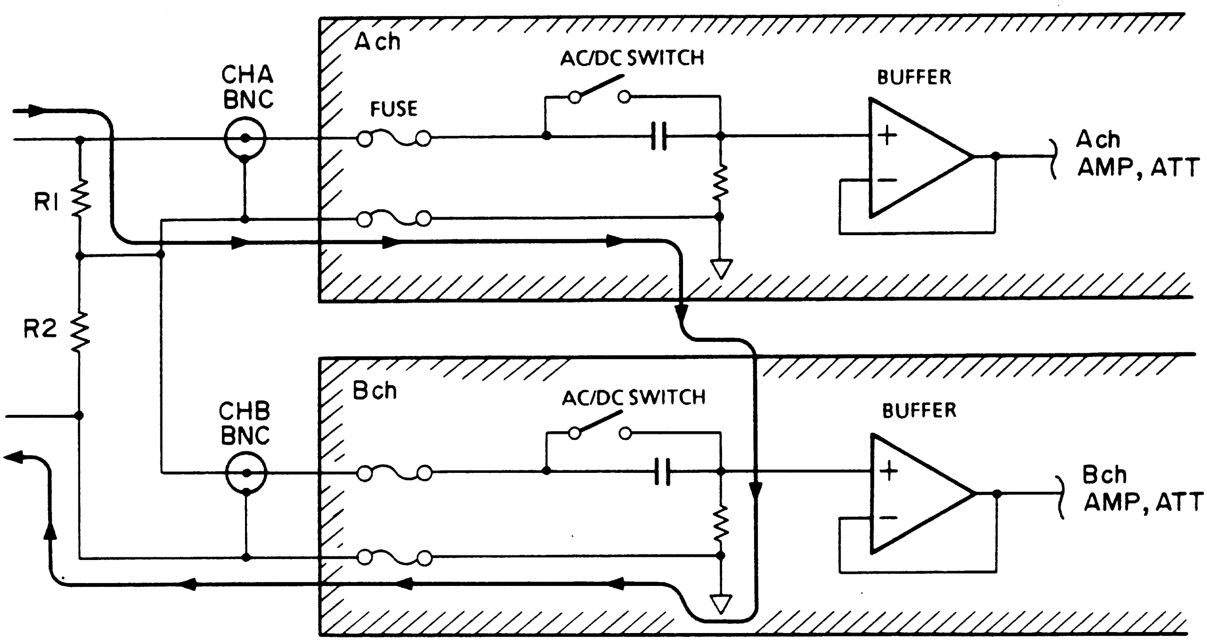
- Potential Difference Existing Between Channels A and B (−)



In the CF-350 input, the (−) sides of the two input channels are connected in common. Therefore, measurement connection method shown above cannot be used. That is, measurement is not possible if there is a potential difference between the (−) of channels A and B.



CF-350 Input Circuit



- Thick lines shown current flow direction.

In such cases, care is required as the protective input fuse might blow.

1.7 Connections to Peripheral Devices

① Potentials Developing Between Cabinets

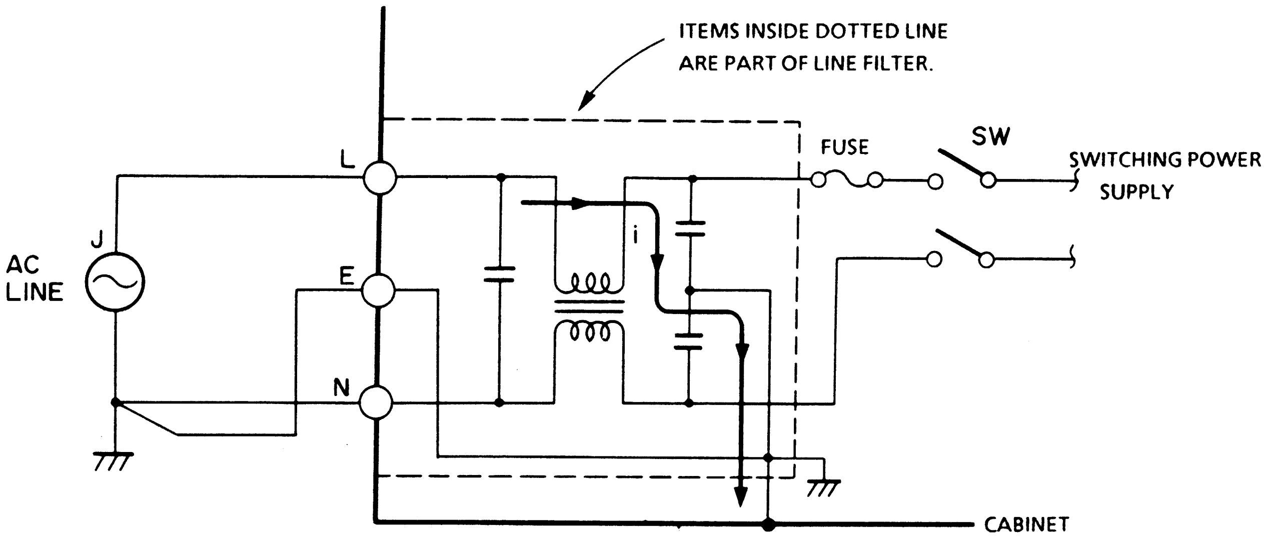


Fig. 1-3 CF-350 Power Supply Input Circuit

The CF-350 power supply has a line filter to eliminate noise and, as shown by the thick arrows in Fig. 1-6, a minute current flows in this filter, although not enough current to cause bodily harm. When using a 2-pin power cord, connections to other devices should be made as shown below.

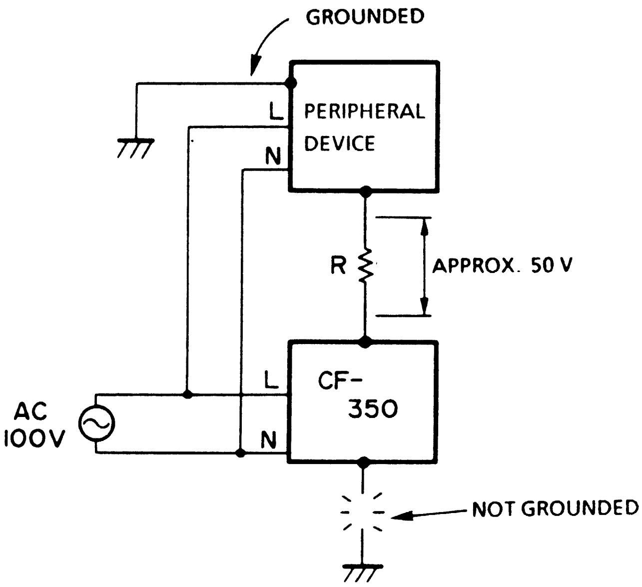
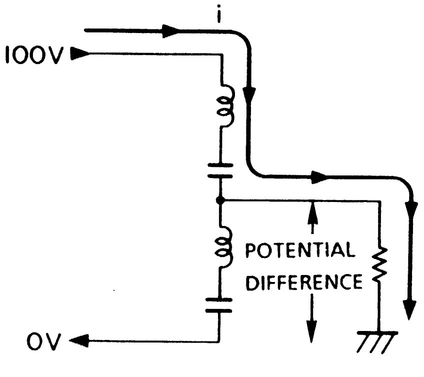


Fig. 1-4

As shown in Fig. 1-7, with the peripheral device grounded and the CF-350 left floating, a potential of approximately 50 V will develop between the cabinets.

Expressing this as an equivalent circuit, the current flows through the LC circuit of the filter and into a resistance, across which the potential develops.

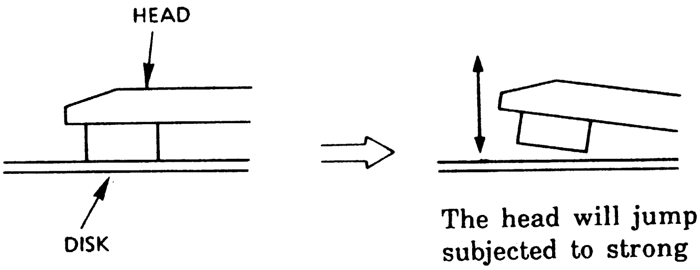


In the configuration shown in Fig. 1-7, grounding the equipment will result in damage to internal circuitry.

Therefore, when grounding peripheral devices, connect the ground before inserting the power cord into the power outlet, then insert the plug and set the POWER switch to ON.

1.8 Floppy Disk Precautions

Do not move the analyzer or transport it with a disk remaining in the disk drive, as this can cause damage to the head and disk.



The head will jump when subjected to strong vibration or shock.

1.9 Cleaning

- Cleaning the CRT Filter and Screen

  Wet a soft cloth with methyl alcohol and use it to wipe the surface of filter.

- Cleaning Panel Surfaces of Dirt and Dust

  Polish panel surfaces with silicone-treated cloth. If the panel surface is extremely dirty, wipe with a soft cloth wetted with methyl alcohol, taking care not to apply too much alcohol.

- Cleaning the Cooling Fan Filter

  (1) Remove the filter frame and remove dust from the metallic mesh and filter using a stiff brush. Remount by pushing in the frame, taking care to observe the proper attitude of the filter element.

  (2) Remove the four screws from the protective cover, remove the finger guards and remove the air filter. Remove dust from the metallic mesh and filter using a stiff brush.

  (3) Cleaning with a stiff brush will cause dust to be raised, even if there is not much dust in the filter. Choose the location for this cleaning task carefully.

- When cleaning the CF-350, always be sure to shut the power OFF first.

- Check with a screwdriver that no screws on the outside of the analyzer have been loosened.

- Because the CF-350 uses high-speed processing circuits, they generate some heat. While the cooling fan used has sufficient capacity to cool the unit, if the fan filter at the rear panel becomes clogged, cooling will not be sufficient, leading not only to a reduced lifetime for the analyzer, but to possible failures as well. Care should always be taken to make sure that the fan filter does not become clogged. Clean it periodically. Also, ensure that the air outlets are not blocked, as this will have the same effect.

1.10 Options

There are 6 software options (named in the format CF-035X) and 5 hardware options (named in the format CF-038X) for the CF-350.

Model	Option Name	Description	Version			
			A	B	C	V
CF-0350	Plotter Interface Software	Interface for GPIB plotters using the HP-GL command sets.	●	●	●	●
CF-0351	Frequency Zoom Software	Real-time zooming: 2 to 64 times Record zooming: 2 to 64 times		●	●	●
CF-0352	Octave Analysis Software	1/3-Octave analysis, 30/15 bands 1/1-Octave analysis, 10/5 bands	●	●	●	●
CF-0353	3-Dimensional Display Software	20-line display of waveforms with scroll function (switchable up/down). 60/90-linepower spectrum display. Provided with search function (% display)	●	●	●	●
CF-0354	Servo Analysis Software	4-decade analysis, autoranging analysis, signal sequencing		●	●	●
CF-0355	Curve Fitting Software	MDOF (multiple degree of freedom) curve fitting, list display of resonant frequencies and dampling factors.			●	●
CF-0380	Floppy Disk & Signal Generator Interface Card	Interface to connect to double-sided, double-density disk drive and SG-450 Signal Source (using AX-401).	●	●	●	●
CF-0381	CMOS Memory Card	1 Mbyte of RAM, battery backup, RAM disk/CRT block memory expansion/time record memory expansion.			●	
CF-0382	Tracking & X-Y Output Card	Division and multiplication of rotational sync signal, rpm tracking analysis on the CRT, X-Y recorder output, search point analog output.				
CF-0383	Signal Output Card	Sine, sine sweep, random, periodic random, swept sine and impulse signal output.		●	●	
CF-0384	Comparator Output Card	Spectrum comparator function and comparator output.				

● Indicates the option is provided as standard for that particular version

Marking of Versions

The version (A, B, C or V) is marked on a seal affixed to the rear panel.

Version V is the export version of the CF-350.

Option List

An option list can be displayed on the CF-350's CRT screen as a check of what options the analyzer includes. Options included are indicated as ON and those not included are indicated as OFF.

<Procedure>

<<<MENU B>>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

VIEW	LABEL	SET UP					RETURN

ON	OPTION						RETURN

```
OPTION LIST

                CF0380  DISK        ON
                CF0381  CMOS        OFF

                CF0382  TRACK       OFF
                CF0383  SIGOUT      OFF

                CF0384  COMP        OFF

                CF0350  PLOT I/F    ON
                CF0351  ZOOM        OFF

                CF0352  OCTAVE      ON
                CF0353  3D ARRAY    ON

                CF0354  SERVO       OFF
                CF0355  FIT         OFF
```

Operation of Options

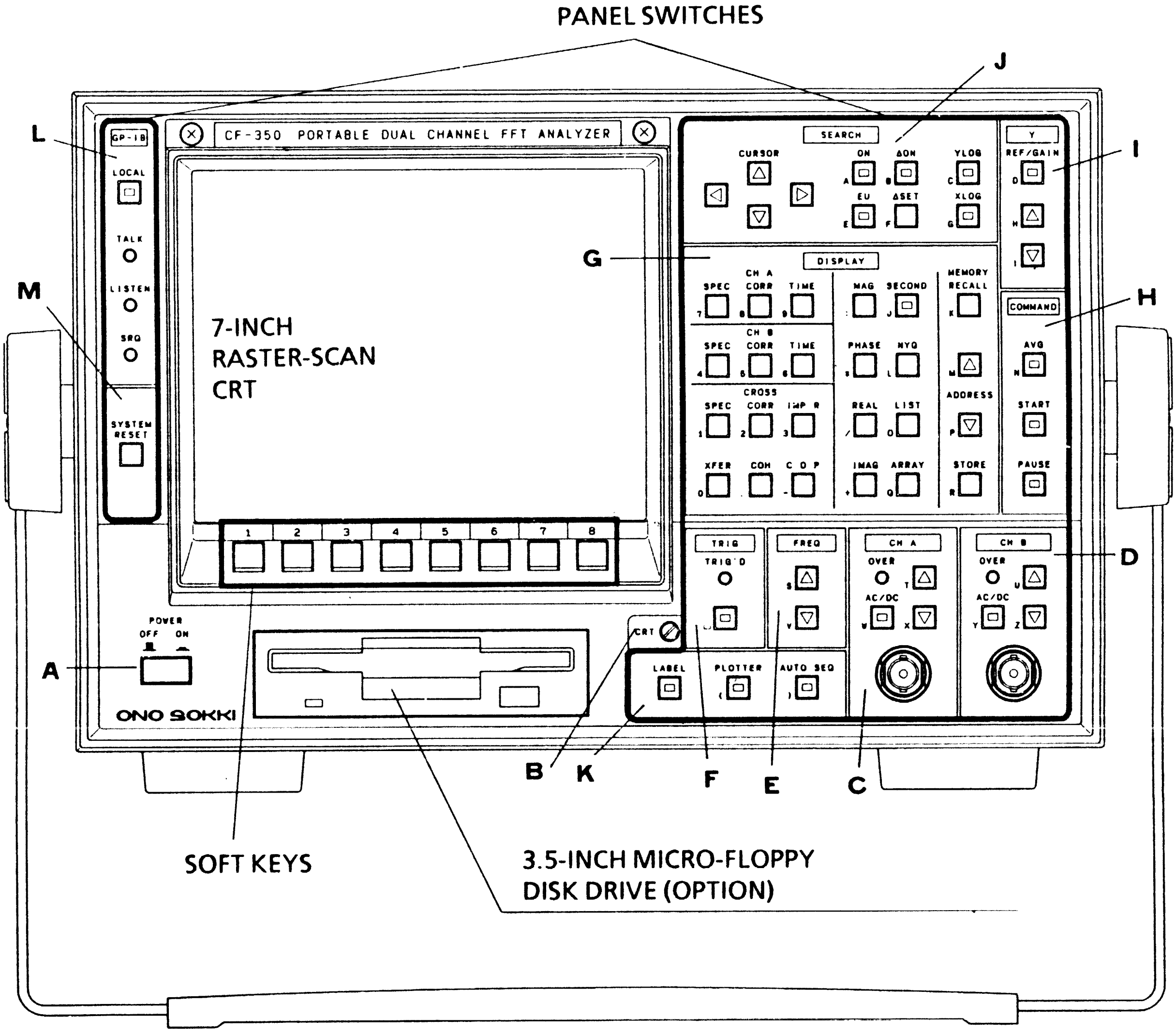
Optional functions are operated the same way as standardly provided functions by using front-panel switches and soft keys.

Adding Options

Up to 3 types of options CF-0381 thru CF-0384 can be fitted into the analyzer simultaneously. For details on adding options, contact your sales representative.

2. GENERAL DESCRIPTION

2.1 Panel Descriptions



Front-panel switches can be divided into panels switches and soft keys.

- Panel Switches
  - Each switch corresponds to one function.
  - When displaying a label, the panel switches are used to write the alphanumeric characters and symbols that are marked to the lower left of each switch. The group of switches with the numerals 0 thru 9 will be referred to as the *numeric keys*.
- Soft Keys
  - These keys are used for more complex settings of data capture conditions and analysis and can have more than one function, depending upon the display just above the keys at the bottom of the CRT screen.

PANEL SWITCH DESCRIPTIONS

A POWER

POWER OFF ON ▲ ▲ ☐	POWER switch

B INTENSITY ADJUSTMENT

CRT ⊘	CRT Intensity adjustment

C Channel A Input Group

◎	Signal input connector
AC/DC W ⊟	AC/DC coupling switch
OVER ○	A/D overload display LED
T △ X ▽	Input voltage range setting switches

D Channel B Input Group

◎	Signal input connector
AC/DC Y ⊟	AC/DC coupling switch
OVER ○	A/D overload display LED
U △ Z ▽	Input voltage range setting switches

E Frequency Range Setting Group

S △ V ▽	Frequency range setting switches

F Trigger Group

_ ⊟	Trigger execution switch
TRIG'D ○	Trigger execution display LED

G Display Function Group

CH A	Channel A group
SPEC 7 ☐	Spectrum display switch
CORR 8 ☐	Autocorrelation function display switch
TIME 9 ☐	Time-axis waveform display switch
CH B	Channel B group
SPEC 4 ☐	Spectrum display switch
CORR 5 ☐	Autocorrelation function display switch
TIME 6 ☐	Time-axis waveform display switch
CROSS SPEC 1 ☐	Cross spectrum display switch
CORR 2 ☐	Cross correlation function display switch
IMP R 3 ☐	Impulse response display switch
XFER 0 ☐	Transfer function display switch
COH ☐	Coherence function display switch
C O P - ☐	Coherent output power display switch
MAG : ☐	Amplitude display switch
PHASE * ☐	Phase display switch
REAL / ☐	Real-part display switch
IMAG + ☐	Imaginary-part display switch
SECOND J ⊟	Dual-frame mode display switch
NYQ L ☐	Polar coordinate display switch
LIST O ☐	List display switch
ARRAY Q ☐	3-Dimensional display switch
MEMORY RECALL K ☐	Memory recall switch
M △ ADDRESS P ▽	CRT block memory address-specification switches
STORE R ☐	Store switch

H COMMAND Group

AVG N ⊟	Averaging execution switch
START ⊟	Start switch
PAUSE ⊟	Pause switch

I Y-Axis Adjustment Group

REF/GAIN D ☐ Y-axis reference/gain selection switch

H △ Y-axis reference/gain magnification
I ▽ setting switches

J SEARCH Group

YLOG C ☐ Y-axis Log-Lin display selection switch

XLOG G ☐ X-axis Log-Lin display selection switch

ΔON B ☐ Delta function execution switch

ΔSET F ☐ Delta cursor setting switch

ON A ☐ Search function execution switch

EU E ☐ EU (engineering units) setting switch

CURSOR △ ◁ ▷ ▽ Search cursor movement keys.

K Group

LABEL ☐ Label display function switch

PLOTTER (☐ Plot execution switch

AUTO SEQ) ☐ Autosequence execution switch

L GPIB Group

LOCAL ☐ Local switch

TALK ○ Talk status LED

LISTEN ○ Listen status LED

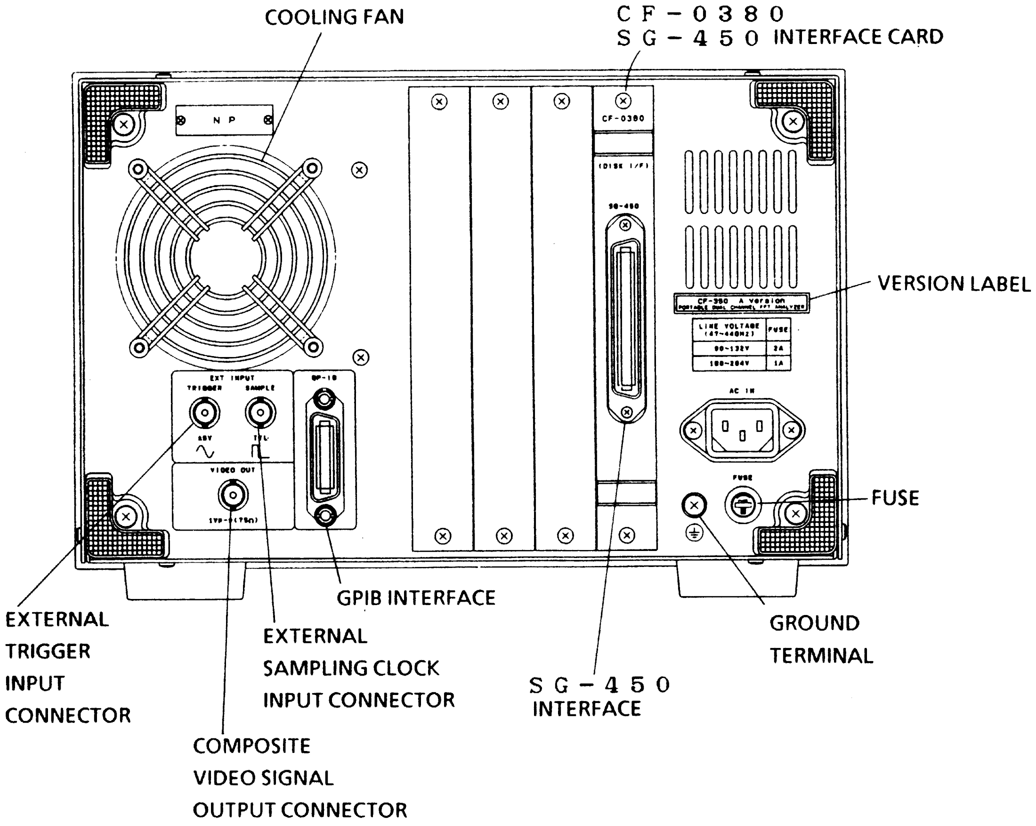
SRQ ○ Service request display LED

M Group

SYSTEM RESET ☐ System reset switch

Rear Panel Layout

Version V



(This page purposely left blank.)

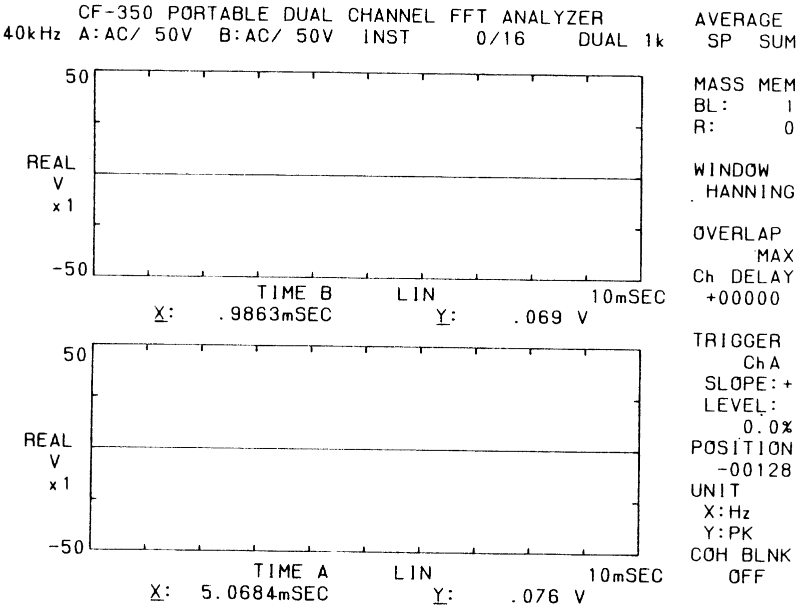
2.2 Powering ON the CF-350

Be sure that the line voltage supplied to the CF-350 matches the voltage marked on the rear panel (refer to Section 1.4).

LINE VOLTAGE (47~440HZ)	FUSE
90~132V	2A
180~264V	1A

Press the POWER switch to apply power to the analyzer.

After power is applied, initialization will be performed and, after 2 to 3 seconds have elapsed, the CRT will appear as shown below.



```
       CF-350 PORTABLE DUAL CHANNEL FFT ANALYZER         AVERAGE
40kHz A:AC/ 50V  B:AC/ 50V  INST      0/16    DUAL 1k    SP  SUM

  50                                                    MASS MEM
                                                        BL:     1
                                                        R:      0
REAL
 V                                                      WINDOW
 x1                                                      HANNING

                                                        OVERLAP
 -50                                                        MAX
             TIME B        LIN              10mSEC      Ch DELAY
    X:   .9863mSEC             Y:      .069 V            +00000

  50                                                    TRIGGER
                                                           ChA
                                                         SLOPE:+
                                                         LEVEL:
REAL                                                       0.0%
 V                                                      POSITION
 x1                                                       -00128
                                                        UNIT
                                                         X:Hz
 -50                                                     Y:PK
                                                        COH BLNK
             TIME A        LIN              10mSEC        OFF
    X:  5.0684mSEC             Y:      .076 V
```

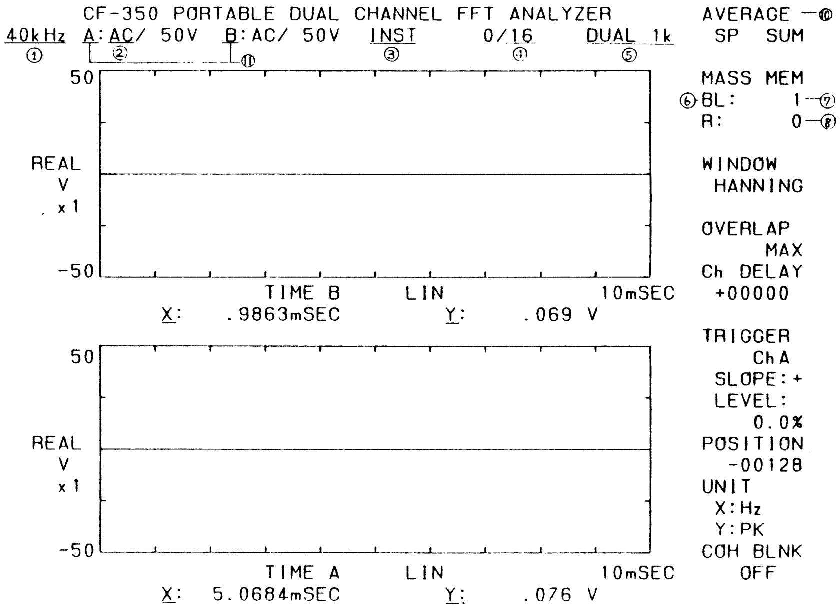
- Whenever the SYSTEM RESET reset switch is pressed, the same initialization is performed and the display appears as shown above. When a system reset is performed, however, the immediately previous analysis results and the contents of mass memory are all lost.

- When autorecall is in effect, the analysis conditions that were previously set at location 1 of the panel condition memory are loaded and automatically set.

<u>If the Display is Blank</u>

If nothing appears on the CRT display, adjust the INTENSITY knob at the lower right of the CRT to the right to increase the intensity of the CRT screen.

2.3 Display Description



```
            CF-350 PORTABLE DUAL CHANNEL FFT ANALYZER      AVERAGE
40kHz A:AC/ 50V B:AC/ 50V  INST      0/16     DUAL 1k       SP  SUM
      50                                                   MASS MEM
                                                           BL:     1
                                                           R:      0
    REAL                                                   WINDOW
     V                                                      HANNING
     x1
                                                           OVERLAP
                                                               MAX
     -50                                                   Ch DELAY
                 TIME B        LIN              10mSEC      +00000
        X:    .9863mSEC           Y:     .069  V
                                                           TRIGGER
      50                                                       ChA
                                                            SLOPE:+
                                                            LEVEL:
                                                               0.0%
    REAL                                                   POSITION
     V                                                       -00128
     x1                                                    UNIT
                                                            X:Hz
                                                            Y:PK
     -50                                                   COH BLNK
                 TIME A        LIN              10mSEC        OFF
        X:  5.0684mSEC            Y:     .076  V
```

Highlighted Display Items

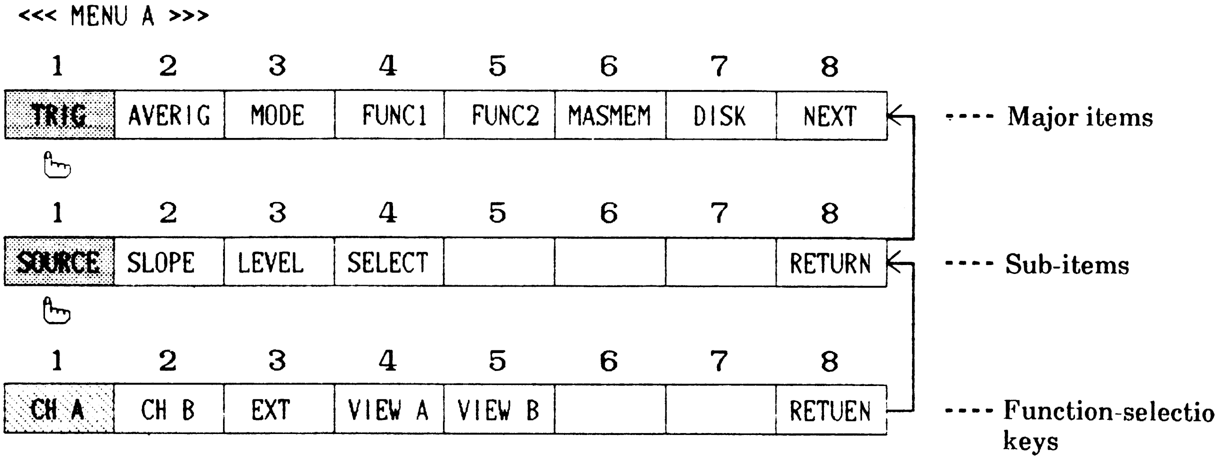
During normal operation, characters on the CRT will sometimes be highlighted.

When the characters ① through ⑨ in the figure above appear highlighted, they have the meanings shown in the table below.

	Character string	Item	Meaning
①	40 kHz	Frequency range	External sampling ON
②	AC	Coupling	DC cancel ON
③	INST	Calculation precision	High-precision mode
④	16	Number of averages	Display inhibit ON
⑤	DUAL 1K	Data length	Record memory playback in progress
⑥	BL	Store	Executing
⑦	1	CRT memory block	Storage completed
⑧	0	Record memory address	Storage completed
⑨	01/0187 15:38	Day/month/year Hour:minute	Time interval ON
⑩	AVERAGE	Analysis source	Disk data analysis mode
⑪	A, B	Polarity	Polarity reversed

2.4 Using the Soft Keys

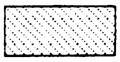
As an introduction to soft key operation, perform the following soft key sequence.



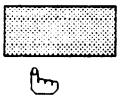
The highlighted box CH A (indicated by shading), shows that the trigger source is set to Channel A.

Now press soft key 2. Note that the CH B key is highlighted, indicating that the trigger source has been selected as Channel B.

The thing to remember in reading through this manual is that the software keys that are shaded are the ones that are set (activated). Additionally, the keys to press are indicated by a small hand symbol under the key.



Selected (activated)



Key to be pressed

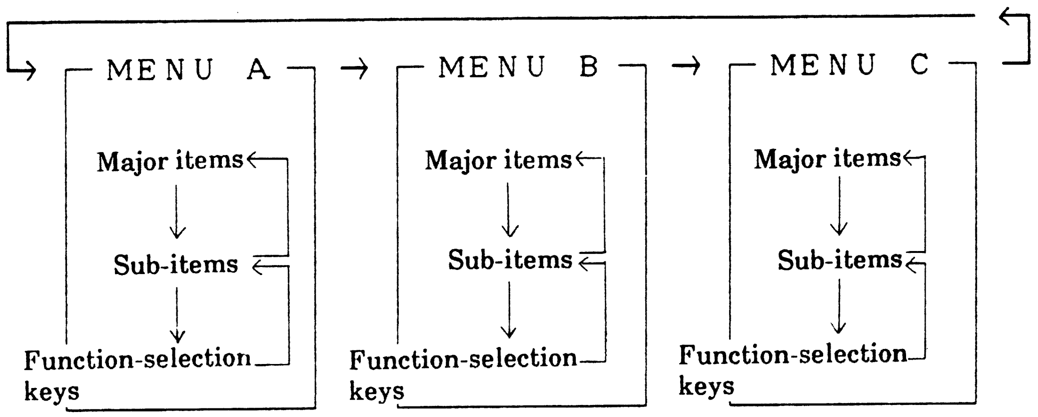
Press soft key 8. Note that the soft key menu returns to one level back, i.e., to the subitem level.

Now press soft key 8 again. Note that a return is made to yet one level back--to the major item level.

If you press the soft key 8 once again, you will note that you switch from MENU A to MENU B.

The overall sequence and structure are shown below.

By pressing soft key 8, the soft key level changes as shown here.



Soft Key Recall Function

When the LOCAL panel switch is pressed, it is possible recall up to 9 function-selection level soft key operations that have been made.

The recall sequence is exactly the reverse of the setting sequence. Note, however, that this function is not operative when GPIB is operating.

2.5 Operating Precautions and Conventions

Warning Beeper and Error Messages

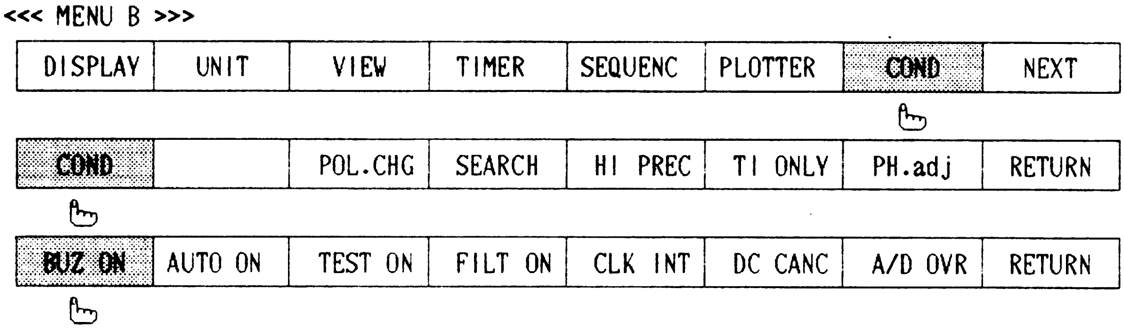
Press the MEMORY RECALL switch.

1. The long beeper will sound. This is a warning beeper.
2. The error message "NO STORE" will appear in the lower right part of the CRT.

This message indicates that an attempt was made to recall from memory when no data had been stored in mass memory.

In this manner, the CF-350 warns the operator of misoperation by means of a beeper and an error message. (When proper key operations are made, however, a normal short beeper will sound and no message will appear.)

* The beeper can be inhibited. The soft key sequence for this is as follows.



BUZ ON ----- Beeper OFF

▨ BUZ ON ------ Beeper ON

Note: The GPIB can be used to inhibit the short beeper only.

2.6 Data-Processing Condition Settings

2.6.1 Initialized Conditions

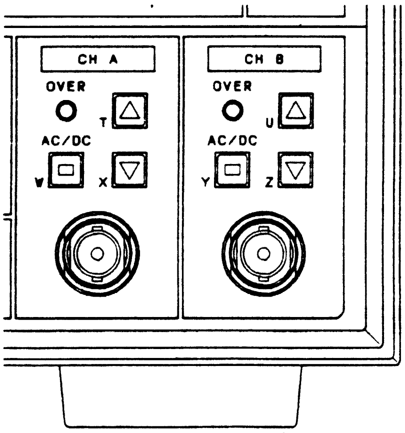
Immediately after applying power to the CF-350, the analyzer goes into what is called the *initialized state*. Since the CF-350 is designed to perform a wide range of complex analysis functions, there are a large number of settings which must be made properly. In the initialized state, it is set up in a most generally usable manner.

When the SYSTEM RESET switch is pressed, the CF-350 goes into the initialized state without having to be powered down and then up once again. This can be done when many settings have been changed and it is necessary to return most of this to the original settings and whenever the actual settings made are not known to bring the analyzer back to some known condition.

Note that when the SYSTEM RESET switch is pressed, the contents of the panel condition memory, autosequence memory and signal sequence memory, part of the plotting parameters and the date and time will not be changed.

2.6.2 Signal Input

Since the CF-350 is a dual-channel FFT analyzer, it has two signal input channels, which are accessed at two connectors located at the lower right of the front panel. The left channel is Channel A and the right channel is Channel B. These channels can be considered to be identical. When performing measurement of such functions as transfer function or coherence, the input to the system must be applied to Channel A and the output from the system connected to Channel B. In the initialized state, the trigger and other functions are set with respect to Channel A. For this reason, when using only one channel, it is best to adopt the convention of using Channel A.



2.6.3 Input Voltage Range Setting

The up and down switches located to the right of each of the input connectors are used to set the input voltage range. Pressing the up switch *increases the sensitivity*, thereby reducing the full-scale voltage down to a minimum of 1 mV. Similarly, the down switch *reduces the sensitivity*, thereby increasing the full-scale voltage up to 50 V.

If the input voltage exceeds the input voltage range setting, the input signal will become distorted, preventing faithful analysis of the true input signal. If this occurs, the OVER warning LED will light. When this happens, press the down (sensitivity) switch for the offending channel to increase the full-scale voltage range.

On the other hand, if the input signal is exceedingly low in level when compared with the input voltage range, measurement accuracy will be greatly reduced. Therefore, the best practice is to increase the sensitivity as much as possible without having the OVER indicator light. The following procedure can be used to determine the proper input voltage range.

① Input the signal to be analyzed.

↓

② Press the up sensitivity switch until the OVER LED lights.

↓

③ When the OVER LED lights, press the down sensitivity switch while observing the OVER LED for some time and stop pressing until the LED does not light any more.

The AC/DC switch located above each of the input connectors is used to select either AC or DC coupling on the input signal. When the input signal is DC coupled, the signal is fed to the analysis section as is. If there is a large DC component superimposed on the input signal, when compared with the varying component, however, this setting will result in reduced analysis accuracy. In such cases, selecting AC coupling will cut out components from DC to a extremely low frequency, resulting in improved accuracy over the normal frequency range, with only slight sacrifice in accuracy near the DC end of the frequency scale. In the initialized state, both channels are AC coupled.

2.6.4 Frequency Range Setting

The FREQ up and down switches located at the bottom part of the front panel are used to set the upper analysis frequency limit (frequency range). Pressing the up and down switches increase and decrease the range, respectively. Each time the up switch is pressed, the CF-350 up ranges, this continuing to a maximum frequency range of 40 kHz. Similarly, the down switch can be pressed to successively reduce the range to the minimum range of 1 Hz.

If a high frequency range is selected, the frequency resolution is reduced. The range should, therefore, be selected as slightly higher than the frequency band to be analyzed.

2.6.5 Test Signal Input

The CF-350 includes a signal-generation circuit that generates a signal used to check analyzer operation. The following describes its basic use. First, press the SYSTEM RESET switch at the left edge of the front panel to place the CF-350 in the initialized state.

To activate the analyzers signal-generation circuit the soft keys located just below the CRT display are used. The meanings (functions) of the eight keys are displayed in abbreviated form at the bottom of the CRT just above the corresponding soft key.

<<<MENU A>>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

Press soft key 8. This is the key under the NEXT in the CRT soft key menu. In this manual, we will refer to the abbreviated names of the keys as they appear in the soft key menu on the CRT. Note that the soft key menu changes. When it does, there should be a COND key indicated in the soft key menu above soft key 7.

<<<MENU B>>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND.	RETURN

Press this COND key. The functions will change again.

CONDIT		POL.CHG	SEARCH	HI PREC	TI ONLY	PH.adj	RETURN

Next, press CONDIT.

BUZ ON	AUTO ON	TEST ON	FILT ON	CLK INT	DC CANC	A/DOVER	RETURN

Note that TEST ON is displayed for soft key 3. Press this soft key; the soft key will be highlighted, indicating that the test signal generating circuit is operating.

In the initialized state, the input voltage range for both channels is set to 50 V. Since the test signal has an amplitude of below 1 V, the range must be lowered (i.e., the sensitivity increased). First, set the input voltage range of Ch A. While observing the screen, press the up sensitivity key for Ch A repeatedly. A squarewave will appear in the bottom half of the CRT display, increasing in apparent amplitude each time the up key is pressed. If the key is continued to be pressed, the waveform will eventually disappear out of the display frame and the OVER LED will light. This indicates excessive input sensitivity. If this occurs, press the down sensitivity switch. This completes the Ch A input voltage range setting. The setting for Ch B is made in the same manner.

In normal use, after this the frequency range would be set as well. In the case of the test signal input, however, the frequency of the test signal is automatically adjusted to suit the frequency that happens to be set at that time, making frequency range setting unnecessary. Since in the initialized state the frequency range setting is 40 kHz, we will proceed with the explanation assuming this setting was left unchanged.

Simple Functional Check Using the Test Signal

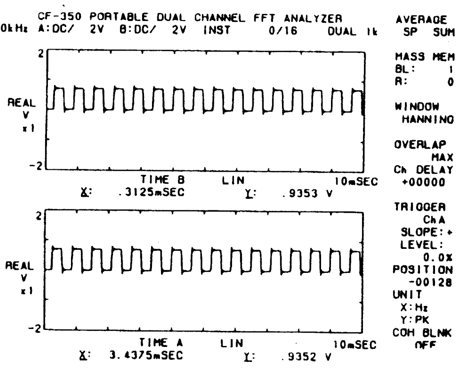
1. Place the analyzer into the initialized state (perform a system reset).
2. Input the test signal (as described above). The CRT will appear as shown below in Fig. 2-1.

Notes:
1. Select DC coupling for both channels A and B.
2. Press AUTO ON to turn autoranging ON.

3. Display the power spectrum (Fig. 2-2).
Make the following panel switch settings.

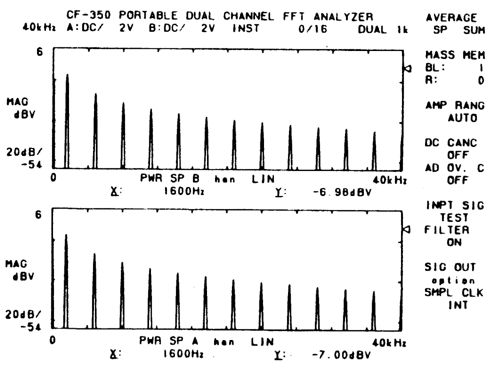
CH A SPEC → SECOND → CH B SPEC

Since the search function is OFF, the maximum Y-axis value and corresponding X-axis value will be displayed automatically.



```
      CF-350 PORTABLE DUAL CHANNEL FFT ANALYZER        AVERAGE
40kHz A:DC/  2V  B:DC/  2V  INST     0/16    DUAL 1k    SP  SUM
                                                      MASS MEM
                                                      BL:    1
                                                      R:     0
                                                      WINDOW
                                                       HANNING
                                                      OVERLAP
                                                           MAX
                                                      Ch DELAY
            TIME B      LIN              10mSEC        +00000
  X:   .3125mSEC             Y:   .9353 V
                                                      TRIGGER
                                                         ChA
                                                       SLOPE:+
                                                       LEVEL:
                                                          0.0%
                                                      POSITION
                                                        -00128
                                                      UNIT
                                                       X:Hz
                                                       Y:PK
                                                      COH BLNK
            TIME A      LIN              10mSEC          OFF
  X:  3.4375mSEC             Y:   .9352 V
```

Fig. 2-1



```
      CF-350 PORTABLE DUAL CHANNEL FFT ANALYZER        AVERAGE
40kHz A:DC/  2V  B:DC/  2V  INST     0/16    DUAL 1k    SP  SUM
                                                      MASS MEM
                                                      BL:    1
                                                      R:     0
                                                      AMP RANG
                                                          AUTO
                                                      DC CANC
                                                          OFF
                                                      AD OV. C
0            PWR SP B  han  LIN            40kHz          OFF
  X:     1600Hz            Y:   -6.98dBV
                                                      INPT SIG
                                                         TEST
                                                      FILTER
                                                           ON
                                                      SIG OUT
                                                        option
                                                      SMPL CLK
                                                          INT
0            PWR SP A  han  LIN            40kHz
  X:     1600Hz            Y:   -7.00dBV
```

Fig. 2-2

Check the Following:

1. The waveform should appear as shown in Fig. 2-1.
2. The Y-axis maximum value should be −7.0 dB ±0.2 dB (Fig. 2-2)
3. The Y-axis values should be as shown in the table below for the X-axis values given for each frequency range (Fig. 2-2).

If the above checks are successful, the FFT analyzer is operating normally. If the checks do not succeed, contact your sales representative.

Frequency range (Hz)	40k	20k	10k	5k	2k	1k	500	200	100~10
Fundamental frequency (Hz)	1600	800	400	200	80	40	20	8	8

After completing the checks, either set the test signal off or perform a system reset.

2.7 Processing Functions

2.7.1 Basic Analysis Functions

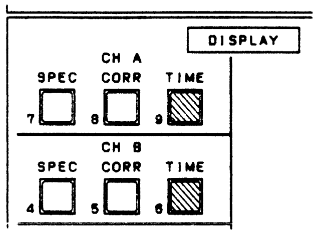
The front panel DISPLAY group has switches that control such basic analysis functions as time-axis waveform, spectrum and autocorrelation for channels A and B individually, cross spectrum and cross correlation of channels A and B together, and system transfer function, impulse response, coherence function and coherent output power (with Channel A is the input and Channel B the output of the system). These functions are assigned to the 12 keys of the left section of the DISPLAY group. For complex spectra and transfer functions, the center part of the DISPLAY group is used to select the format for the amplitude, phase and other displays.

We will input the test signal to exercise the various basic analysis functions.

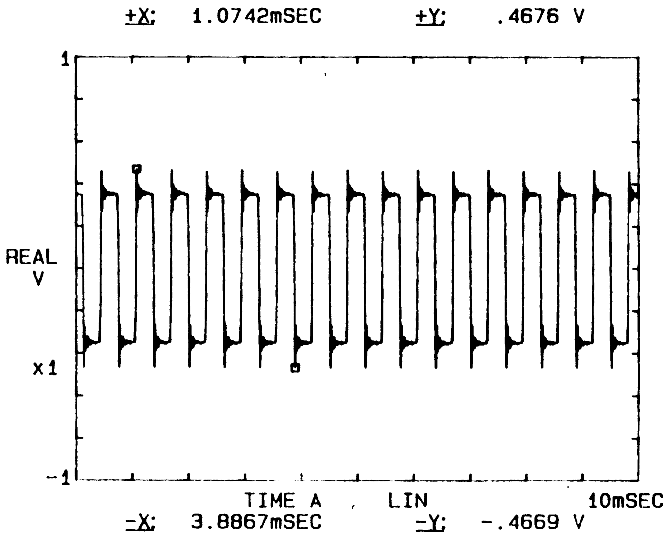
(For details on each of the functions, refer to Section 4 on processing functions.)

(a) Time Waveforms

In the upper-left part of the DISPLAY group, there are three keys each assigned to Ch A and Ch B. The switch marked TIME for each channel causes display of the raw time-axis waveform of the signal input at the corresponding channels. This display function can be likened to that of a digital oscilloscope with memory.



Press TIME of the CH A subgroup. A squarewave will appear and virtually fill the CRT screen. This is the time-axis waveform of the signal applied at Ch A. By pressing the TIME switch of the CH B group, the time-axis waveform of the signal applied at Ch B would be displayed in a similar manner.



Test Signal Time Waveform

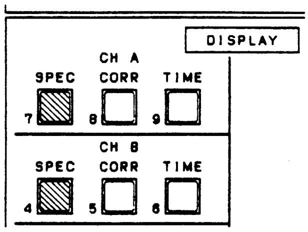
The full-scale value for the horizontal axis (time) of the displayed time-axis waveform depends upon the frequency range setting and is displayed to the lower right of the waveform display frame.

Since the current frequency range setting is 40 kHz, the full-scale value is 10 ms. Although the time waveform is moving horizontally and therefore difficult to observe, the display is showing precisely 16 cycles of the waveform. Therefore, the period of the test signal is 625 µs.

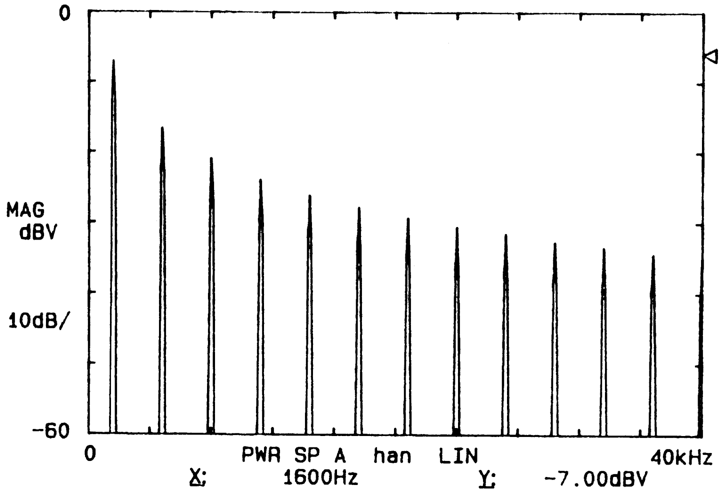
The full-scale value of the vertical axis (amplitude) of the time-axis waveform depends upon the input voltage range setting and a scale is displayed at the left edge of the display frame. Let's look at the amplitude of the test signal. By comparison with the display frame scales, the maximum and minimum points of the waveform appear to fall within the range ±300 to ±500mV. The front-panel Y GAIN up and down switches can be used to compress or expand the vertical axis on the display without changing the input voltage range setting. Before making this change, however, the YLOG switch at the right edge of the SEARCH group should be switched off.

(b) Spectrum

The switches marked SPEC in the CH A and CH B subgroups of the DISPLAY switch group are used to display the Fourier spectrum of the signal input at Ch A and Ch B, respectively. Since the Fourier spectrum is a complex spectrum (having a real and an imaginary part), it is possible to select one of four display formats--magnitude , phase, real part or imaginary part, using the MAG, PHASE, REAL and IMAG switches in the center subgroup of the DISPLAY switch group. Immediately after pressing the SPEC switch, the magnitude display will be selected. This display will be referred to simply as the spectrum display in this manual.



Press the SPEC switch of the CH A switch subgroup. The spectrum of the test signal previously displayed as a time-axis waveform will appear on the display.



Test Signal Spectrum

When Fourier analysis is performed on a squarewave signal, it is seen that the signal is composed of odd harmonics of the fundamental frequency (reciprocal of the period of the squarewave; in this case 1/625μs= 1600 Hz for the test signal generated with the 40-kHz frequency range selected), these components gradually decreasing in magnitude as their frequency increases. Let's now try out the PHASE, REAL, and IMAG display formats. In contrast to the spectrum display format, these displays are constantly changing. This is because the CF-350 is capturing the signal with timing that is not related to the period of the signal, so that there is no phase reference established.

The CF-350 can capture a signal by triggering on the period of the signal. This will be described in detail in the section of triggering.

For the spectrum, the horizontal axis is either divided evenly (linear scaling) or logarithmically (log scaling). This selection is made using the XLOG switch located at the right edge of the SEARCH group.

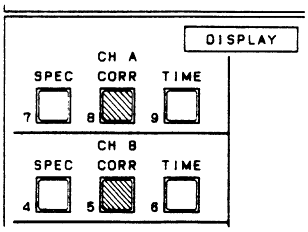
The vertical axis can be scaled either linearly or logarithmically, but only for the magnitude (MAG) display mode. This is selected by the YLOG switch of the SEARCH group, setting it ON for log scaling, thereby changing the displayed units from volts to dBV (dB display referenced to 1 V). The up and down switches of the Y GAIN group can be used to compress or expand the Y axis of the display. When the phase, real part or imaginary part are selected for display, the YLOG switch must be set to OFF before expanding or compressing the vertical axis.

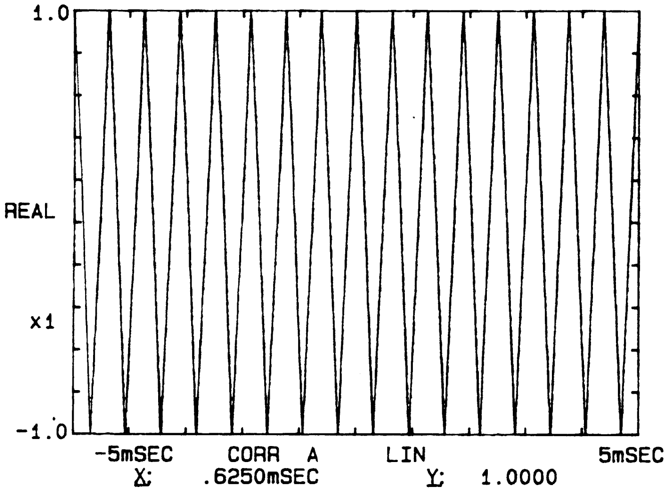
Note

The SPEC switch is used for power spectrum, complex Fourier spectrum and octave analysis.

(c) Auto-Correlation Function

The switches of the CH A and CH B subgroups marked CORR are used to determine the auto-correlation function of the signals applied to the Ch A and Ch B inputs, respectively. Press the CORR switch of the CH A subgroup. The auto-correlation function of the test signal will be displayed. The horizontal axis represents time delay, with zero at the center. The vertical axis represents the correlation value, with the correlation value (signal power) 1 for a delay of zero. If the YLOG switch of the SEARCH group is turned off first, the Y GAIN up and down switches can be used to expand or compress the display in the Y-axis direction.

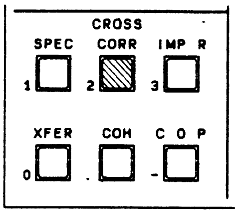


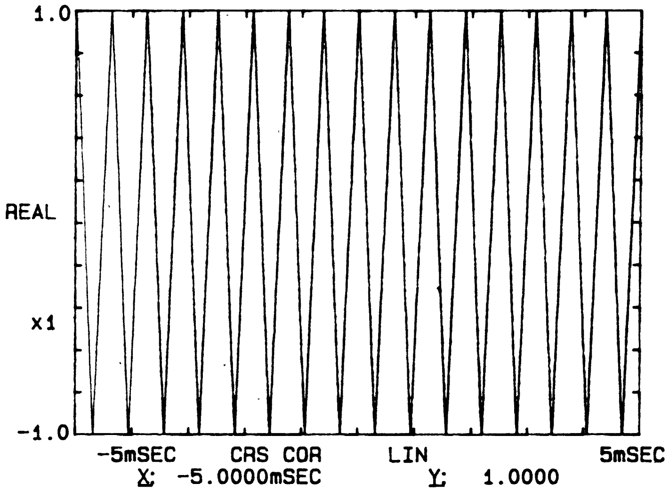


Test Signal Auto-Correlation

(d) Cross Correlation Function

The switch of the CROSS group marked CORR is used to display the cross correlation between the signals applied to Ch A and Ch B. Press the CORR switch of the CROSS group.





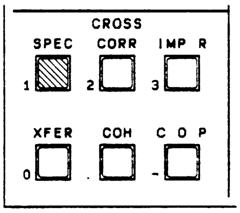
Test Signal Cross Correlation

The cross correlation of the test signals applied to channels A and B is displayed as shown above. The horizontal axis represents time delay, with the zero delay at the center. The vertical axis is the correlation value, normalized using the square root of the product of the auto-correlation values at the delay of zero for each of the signals. If the YLOG switch of the SEARCH group is turned off first, the Y GAIN up and down switches can be used to expand or compress the display in the Y-axis direction,

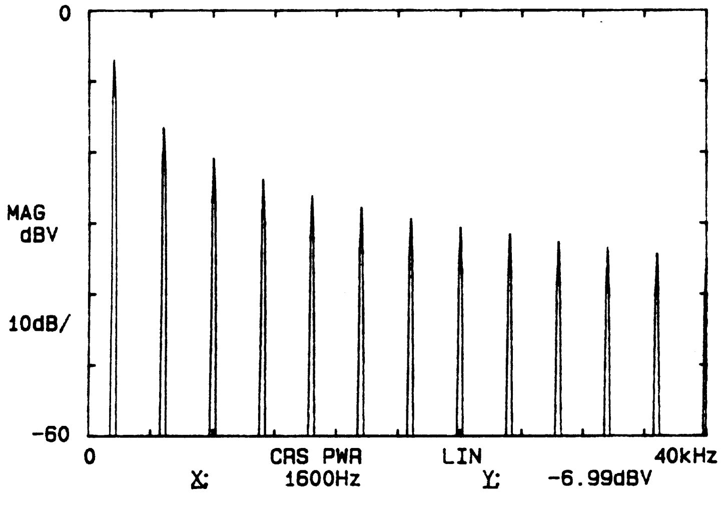
(e) Cross Spectrum

The switch of the CROSS group marked SPEC is used to determine the cross spectrum.

Since the cross spectrum is a complex spectrum, in addition to the MAG, PHASE, REAL and IMAG displays available as with the Fourier spectrum, it is possible to obtain a Nyquist plot (NYQ) of the spectrum, with the vertical axis representing the real part and the horizontal axis the imaginary part. Immediately after pressing the SPEC switch of the CROSS group, the magnitude display (MAG) is selected.



Press the SPEC switch of the CROSS group.



Test Signal Cross Spectrum

The cross spectrum of the test signals applied to channels A and B will be displayed as shown above.

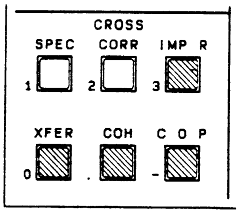
After obtaining the above-described cross spectrum display, let's try out the phase (PHASE), real part (REAL), imaginary part (IMAG) and Nyquist plot (NYQ) functions. In contrast with the Fourier spectrum, the display is fixed. The cross spectrum indicates the *relationship* between the signals input at the two channels, so that the timing of capture does not have to be synced to the signal period. This is because the *relationship* between the signals is constant.

For the cross spectrum, as is the case for the Fourier spectrum display, for all display formats (with the exception of the Nyquist plot), the horizontal axis can be scaled either linearly in uniform divisions, or logarithmically, this selection being made by using the XLOG switch at the right edge of the SEARCH group. When XLOG is ON, the horizontal axis is logarithmically scaled.

For the vertical axis, linear and log scaling are possible for only the magnitude display (MAG), log scaling being selected when the YLOG switch of the SEARCH group is ON, in which case the units are changed from volts to dBV. The up and down switches of the Y GAIN group at the upper right part of the front panel can be used to expand and compress the display in the vertical-axis direction (with the exception of the Nyquist plot mode). Before expanding or compressing the display, remember to turn the YLOG switch to OFF.

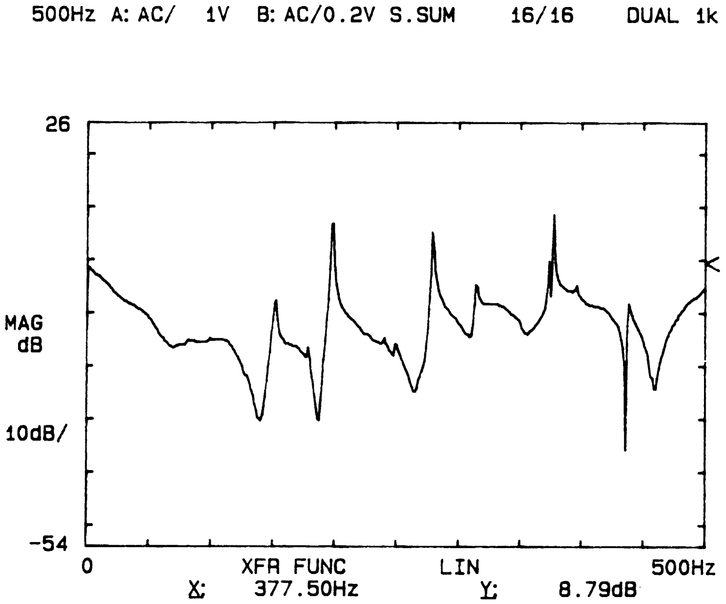
(f) Transfer Function, Impulse Response, Coherence and Coherent Power Output

The four switches marked XFER (transfer function), IMP R (impulse response), COH (coherence function) and COP (coherent output power) of the CROSS switch group are used to make transfer function measurements.



Normally, the input signal to the system-under-measurement is input at Ch A and the output from the system is input at Ch B.

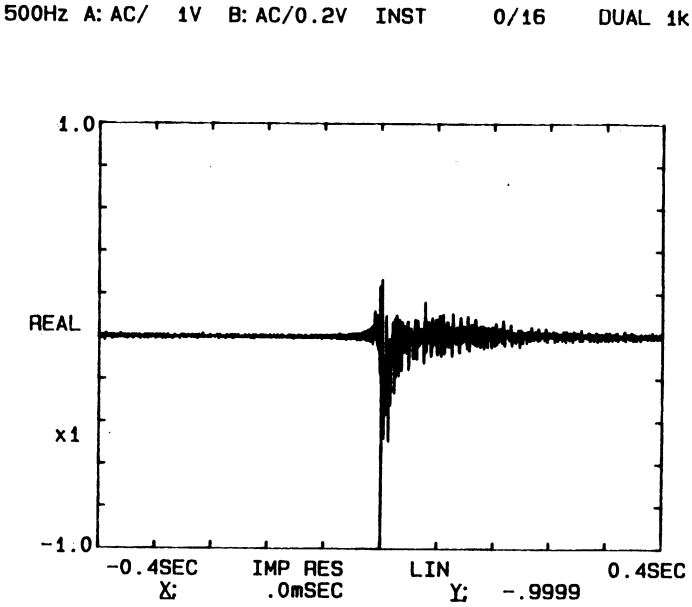
Press the XFER of this group.



Transfer Function Example

Since the test signal is being applied to the input of the analyzer, the waveform appearing on the CRT screen has no significance as a transfer function of a system, although it does provide a check of the operation of this function. The transfer function, similar to the cross spectrum, is a complex function that indicates the *relationship* between two signals, enabling selection of any of the five complex function display modes (magnitude, phase, real part, imaginary part, and Nyquist plot). Immediately after pressing the XFER switch, the magnitude display mode is selected. The XLOG and YLOG switches can be used to select horizontal- and vertical-axis log or linear scaling and the Y GAIN can be used for compression and expansion of the display in the vertical-axis direction in the exact same way as these are done for the cross spectrum.

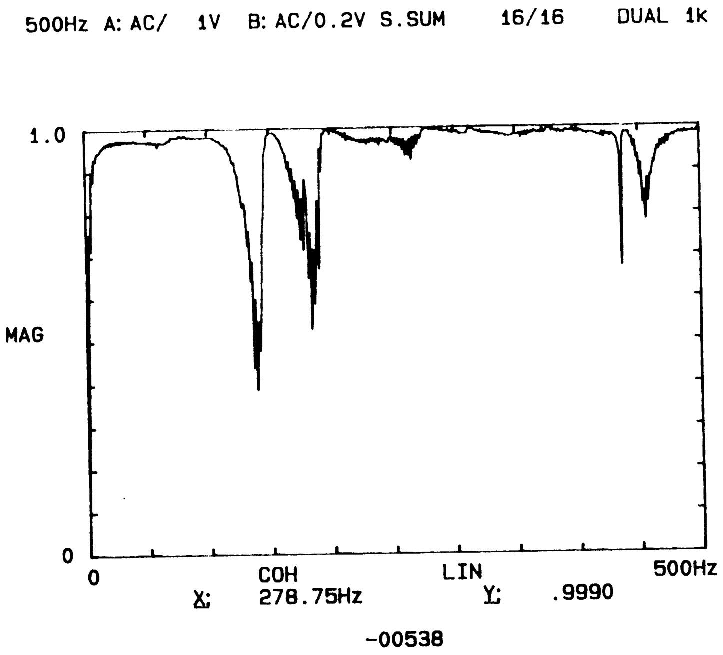
When the IMP R switch is pressed, the impulse response is displayed.



Impulse Response Example

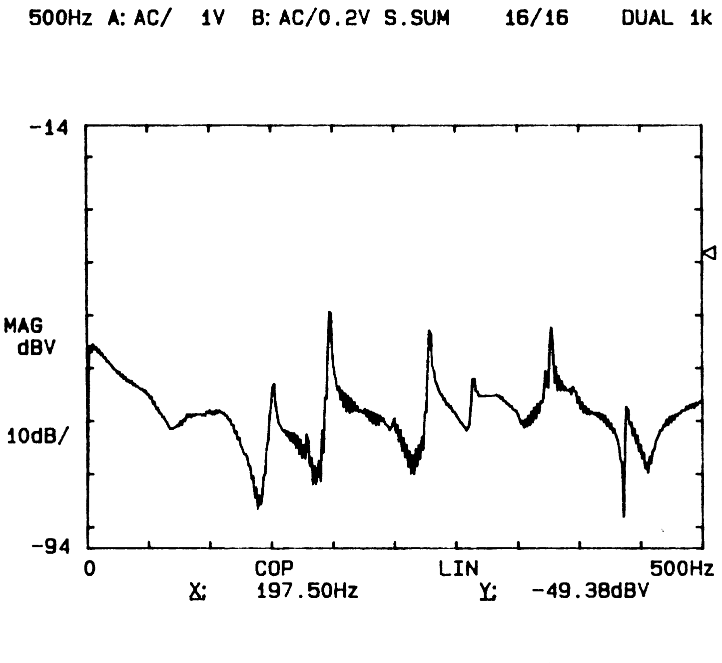
For the test signal input, this display is not significant as an impulse response. The horizontal axis represents time, with zero at the center. The vertical axis is unitless. As is the case for time waveforms, the auto-correlation function and cross correlation function, if the YLOG switch is turned OFF first, the Y GAIN up and down switches can be used to expand and compress the display in the vertical-axis direction. (The maximum value is normalized to the value of 1.)

When the COH switch is pressed, the coherence function is displayed. The coherence function has little significance unless the averaging function is being used. The coherence function display cannot be expanded or compressed.



Coherence Function Example

When the COP switch is pressed, the coherent output power is displayed. This function also has little significance unless the averaging function is being used. Vertical axis expansion and compression, and linear and log scaling are precisely the same as described for the spectrum magnitude display. For the coherent output power, there is no phase, real part or imaginary part display.



Coherent Output Power Example

2.7.2 Dual-Frame Display Function

Immediately after applying power to the analyzer to bring it into the initialized state, the time-axis waveforms of the Ch A signal and the Ch B signal are displayed simultaneously at the top and bottom of the CRT screen. The CF-350, it can be seen, is capable of displayed two analysis functions on the same display screen.

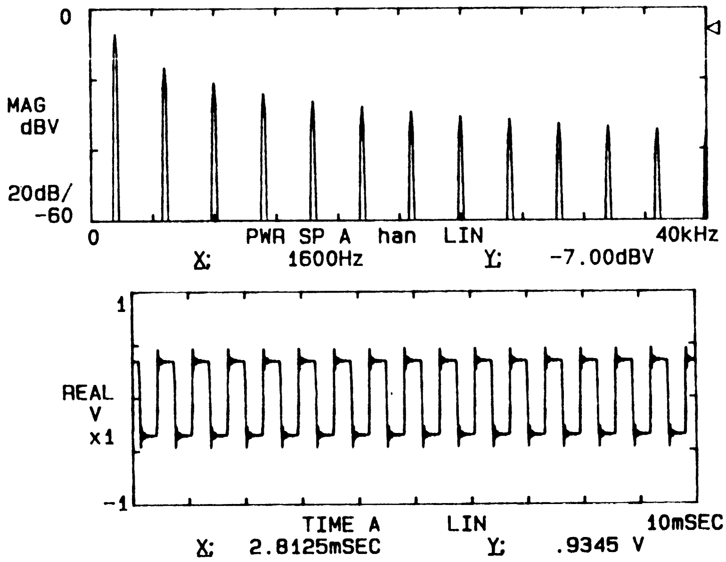
First, select the function to be displayed on the lower half of the screen to obtain a normal (single-frame) display of this function. Next, press the SECOND switch to light the associated LED. At this point, the display that had occupied the entire screen will move to the lower half of the screen. If another function is selected while the SECOND switch LED is lighted, this second function will be displayed on the upper half of the screen.

(Example)

Suppose we wish to display the Ch A time-axis waveform at the top of the screen and the Ch A spectrum at the bottom of the screen.

The sequence to do this is as follows:

TIME of CH A group → SECOND → SPEC of CH A group



Test Signal Time Waveform and Spectrum Display in Dual-Frame Mode

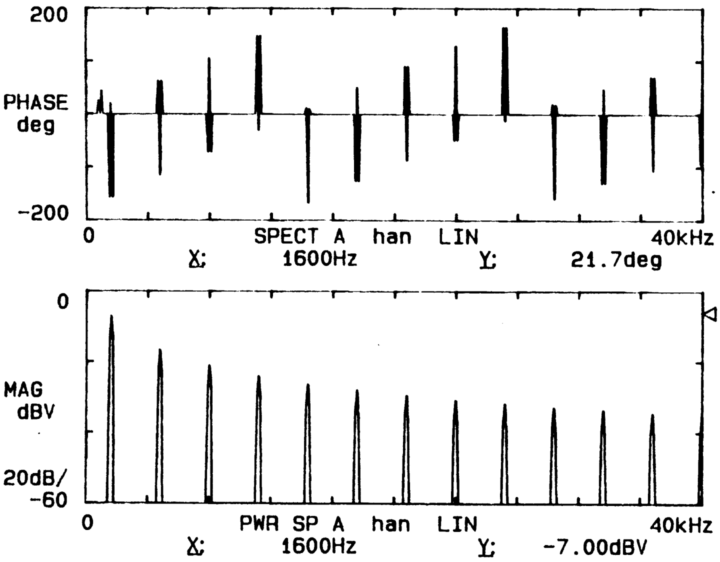
For functions such as the phase display of the Fourier spectrum, in which the display format must be selected after selection of the analysis function, refer to the following example.

(Example)

Suppose we wish to display the magnitude part of the Ch A signal Fourier spectrum at the bottom of the display and the corresponding phase spectrum at the top of the display.

The switch sequence to achieve this is as follows.

SPEC of CH A group → SECOND → PHASE



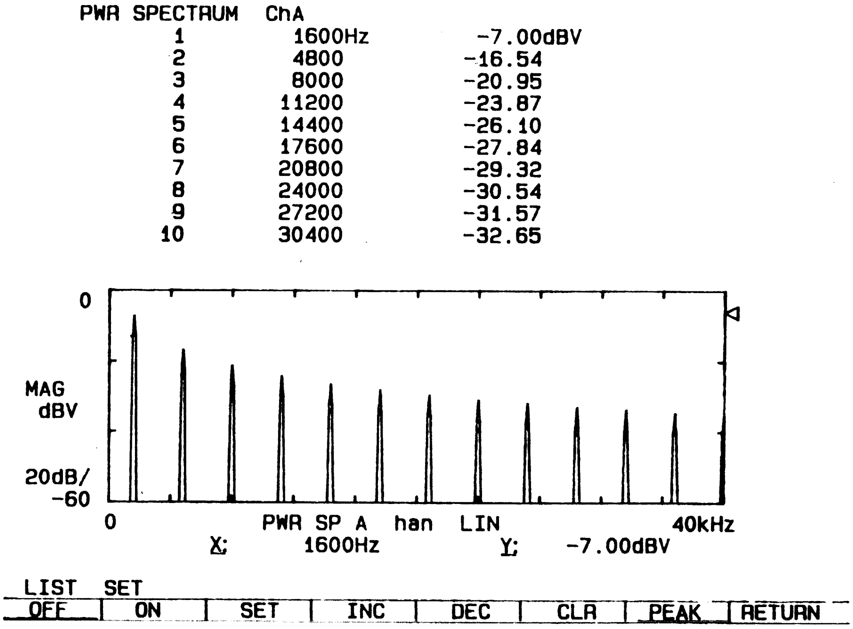
Test Signal Spectrum Magnitude and Phase in Dual-Frame Mode

By the very nature of the display format, the Nyquist plot cannot be displayed on a dual-frame screen.

(For details, refer to Section 6.4.)

2.7.3 List Display

A list display is possible for the results of any of the basic analysis functions. However, the display is limited to up to 20 peak values or specified points from the overall analysis results. (For the octave analysis function, a display is possible of the values for all bands.)



```
PWR SPECTRUM  ChA
          1     1600Hz      -7.00dBV
          2     4800       -16.54
          3     8000       -20.95
          4     11200      -23.87
          5     14400      -26.10
          6     17600      -27.84
          7     20800      -29.32
          8     24000      -30.54
          9     27200      -31.57
         10     30400      -32.65
```

Test Signal Spectrum List Display

After selecting an analysis function such as time-axis waveform or spectrum, the LIST switch of the DISPLAY group can be pressed to enable the list display mode. This alone, however, will only result in numbers displayed along the left side of the screen, with no actual analysis results displayed. To obtain a listing of analysis results, soft keys must be used.

(For. details, refer to Section 6.6.)

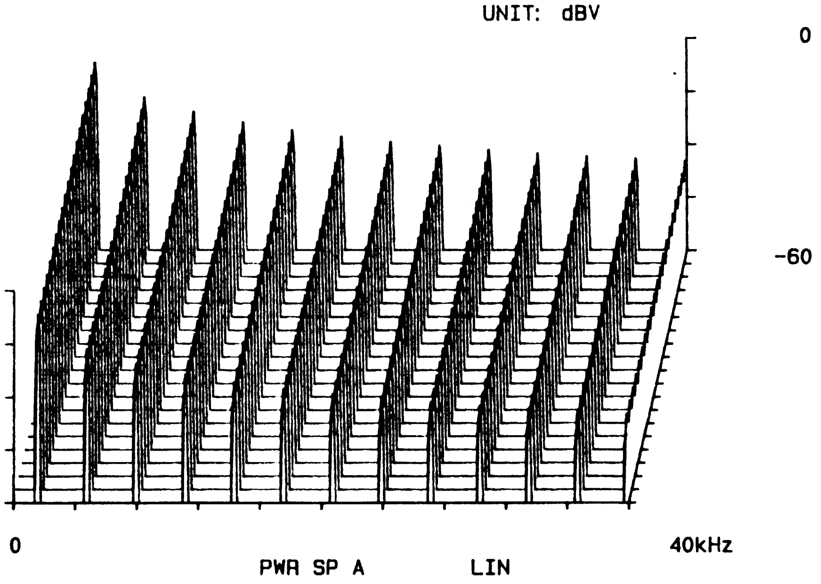
2.7.4 3-Dimensional Display (optional)

With the exception of the Nyquist plot display and list display, 3-dimensional display is possible of any basic analysis function, enabling the time variations to be observed easily on the display.

First, select the function to be displayed in 3-dimensional form. Next, press the ARRAY switch of the DISPLAY switch group. The vertical and horizontal axes will retain the same meaning it normally has, the depth (into the display) axis will be added and this axis will scroll towards the observer. This added depth axis does not strictly indicate time but rather the age of the waveform traces in terms of when they were obtained from the analysis process, with the very newest waveform in the rear and the traces becoming newer as towards the front.

The soft keys can be used to make changes in the 3-dimensional display format (e.g., inclination and scrolling on/off control).

(For details refer to Section 6.7.)



Test Signal 3-Dimensional Spectrum Display

2.7.5 Start and Pause Functions

The CF-350 normally performs the operation of signal capture, analysis and display in a continuously repeated cycle. Using the front-panel START and PAUSE switches of the COMMAND group, however, it is possible to inhibit the capture of new signals, thereby freezing the display, and possible to start the capture process once again.

Press the TIME switch of the CH A subgroup to display the time waveform for Ch A and then press PAUSE and observe what happens. The time waveform will stop on the display. When this switch is pressed, after the current capture operation is completed, display is made and further signal capture is stopped. This is a useful feature when details signal observation is required.

In the PAUSE condition, press either the SPEC or the CORR switch and observe the results. Note that it is possible to select the display function or expand and compress the display even in this PAUSE condition. However, changes made in such signal-capture related settings as input voltage range and frequency range will have no effect on the display in the PAUSE condition, these settings being disabled until the PAUSE condition is canceled.

To cancel the PAUSE condition, press the PAUSE switch once again or press the START switch; either operation will have the same effect. However, the START switch is used for functions other than this pause-canceling operation.

2.7.6 Search Function

The search function is a convenient function in accurately determining the voltage or time at a particular point on the displayed trace. When the ON switch in the center of the SEARCH switch group is pressed, this search function is activated, causing an intensified point to appear on the displayed waveform trace. We will call this the *search point.*

The vertical-axis and horizontal-axis values at the search point are displayed at the bottom of the screen after the X: and Y:, respectively. By pressing the left and right SEARCH group jogging switches, the search point can be moved to any desired horizontal position. The up and down jogging switches are also used to move the search point, but at a faster speed than the left and right switches.

The ΔSET and ΔON switches of the SEARCH group are used with the *delta cursor* function. The delta cursor function enables the display of the vertical- and horizontal-axis value differences between any two selected points on the display. To use it, first mover the search point to the point on the waveform to be used as the reference and press the ΔSET switch. At this point a broken-line cursor appears at the reference point to mark it. Next, press the ΔON switch, after which the differences in X and Y values between the search point and the broken-line (the reference point) are displayed after the ΔX: and ΔY:, respectively, which appear in the same position that the absolute value displays for the search point had been displayed previously. Press the left/right and up/down switches to move the search point and observe how the delta cursor function behaves. To cancel the delta cursor function, press the ΔON switch once again. The displayed ΔX: and ΔY: will return to the original X: and Y:, indicating that the normal search function is activated. The broken-line remaining on the screen indicates that the delta cursor reference point setting is still in effect. If the ON switch is pressed and search function disabled, and the ON switch is pressed again, the broken line will disappear and the reference point setting will be canceled.

The search function and the delta cursor function are operative regardless of the display format.

When the search function is off, in place of the search point vertical- and horizontal-axis values, the display will indicate the following, depending upon the displayed function.

- For time-axis waveforms:

  Maximum and minimum voltage values and corresponding times (for a dual-frame display, however, the difference between the maximum and minimum values and the time differences are displayed)

- For spectrum, cross spectrum and transfer function:

  Maximum value of magnitude, phase or other displayed quantity and the corresponding frequency.

- For auto-correlation function:

  Maximum correlation value (other than at zero delay) and the time delay at that point

- For cross correlation function:

  Maximum correlation value and the time delay at that point

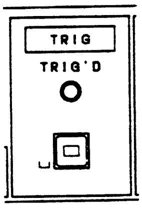
(For details, refer to Section 6.11)

2.7.7 Trigger Function

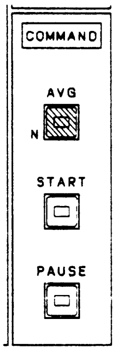
The cycle of signal capture, analysis and display is normally performed in an asynchronous fashion with respect to the input signal period, resulting in a time-axis waveform that appears to move horizontally. For the same reason, the phase part of the Fourier spectrum is a representation of the time relationship of each frequency component with respect to the left edge of the time waveform, so it is not stationary either. To observe a stationary time waveform or phase spectrum, it is necessary to sync the signal capture process to the input signal, using the CF-350's trigger function.

The CF-350 trigger function operates in much the same manner as the trigger of an oscilloscope. When the input signal exceeds a set voltage, the signal capture begins. However, the CF-350 trigger function offers many more combinations of settings than does the trigger function of a conventional oscilloscope. Details are covered in a later section.

The switch in the TRIGGER switch group located at the bottom of the front panel can be used to turn the trigger function on and off. When the trigger function is on, the LED marked TRIG'D flashes. If the function is on but the LED is not flashing, or is flashing irregularly, it indicates that the trigger settings have not been made properly, If so, refer to Section 3.10 on the trigger function for the setting method.



2.7.8 Averaging Function

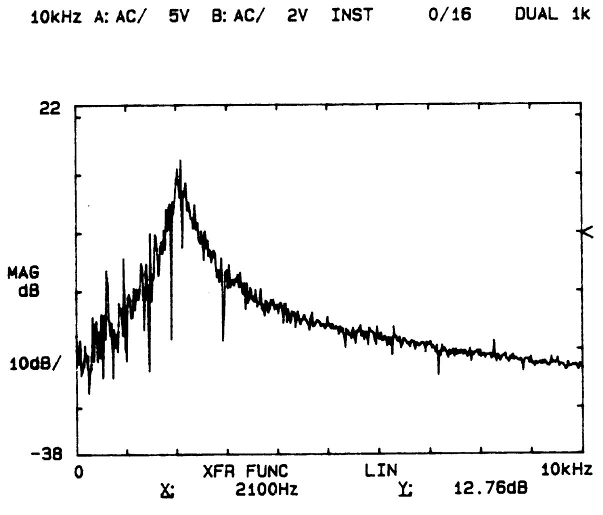


When the output of an actual sensor is input to the CF-350 for analysis, in addition to the desired signal, unwanted signals and noise will be input. In such cases, the fact that the characteristics of the desired signal are different from the unwanted signals are often used to eliminate the effects of the latter. One of these techniques is that of using the difference in statistical properties of the desired and unwanted signals.

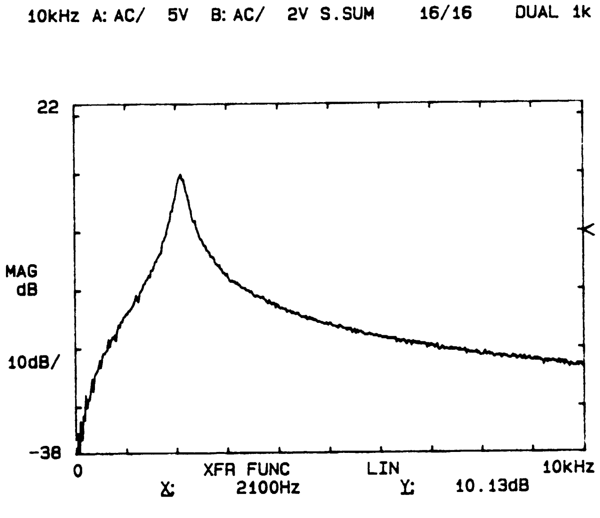
The CF-350 enables a number of different types of averaging, which can be selected as appropriate to signal types and conditions. In the initialized state, spectrum averaging is set, this being used to eliminate unwanted noise from a signal's power spectrum, a cross spectrum or from a transfer function.

The averaging function is activated by setting the AVG switch of the COMMAND group on. Simultaneous with enabling the averaging function, this places the CF-350 into the PAUSE condition. Press the START switch to start averaging. Since the number of averages is initially set to 16, signal capture will be performed 16 times, at which point the average will be calculated and the results displayed, the analyzer returning to the PAUSE condition. During the capture process, the number of averages already performed is indicated in the upper part of the display. To cancel the averaging function press the AVG switch once more.

For information on other averaging functions, refer to Section 5.1.



No Averaging

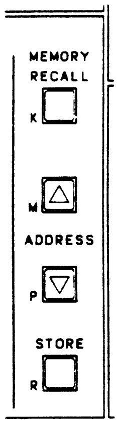


Power Spectrum with 16 Averages

2.8 Other Functions

2.8.1 Storage of Display Data into Mass Memory

The CF-350 has a large-capacity mass memory capable of holding up to 60 frames of display data for recall whenever desired. The four switches at the right side of the DISPLAY switch group are used to control this mass memory.



Addresses 1 through 60 are assigned to locations in mass memory, with each address corresponding to memory space for one frame of display. The address may be changed by using the ADDRESS up and down keys of the switch subgroup shown here. To store a waveform displayed on the CRT, press the STORE switch. In addition to storing the currently displayed waveform, the address will automatically be incremented by 1. However, if the STORE switch is pressed when a dual frame display is being observed, the lower display followed by the upper display (in this sequence) will be stored as individual frames, and the address will be incremented by 2.

For the transfer function, it is stored as a complex function, thus requiring two continuous frames of memory (i.e.. 2 addresses), with a resulting automatic increment in address of 2.

To recall data which has been stored in mass memory, after using the ADDRESS up and down switch to select the desired address, press the MEMORY RECALL switch.

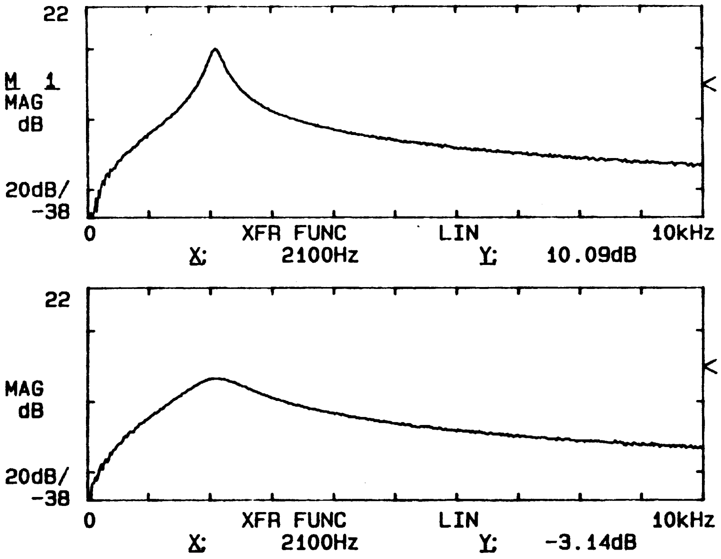
When the mass memory is used in combination with the dual-frame display, it is possible to compare the analysis results for two signals. First, input and analyze the first signal. Then press the STORE switch to store the analysis results in mass memory. Then input the second signal and analyze it in the same manner. Finally, return the mass memory address to the first address, press the SECOND switch and then press MEMORY RECALL, at which point the upper half of the screen will display the first signal analysis results and the lower half will display the results of analysis of the second signal, enabling easy comparison.

(Example)

Compare the frequency response of two filters.

First, connect Filter A to the CF-350, measure the transfer function and press the STORE switch to store analysis results into mass memory. Next, remove Filter A and connect Filter B, performing the same transfer function measurement. With the analyzer in this condition, the CRT screen is displaying the transfer function of Filter B. At this point, press the SECOND switch to move the Filter B transfer function to the lower half of the screen. Following this, press the *down* ADDRESS switch two time to return to the address of the Filter A transfer function (remembering that a transfer function storage requires two address locations) and then press MEMORY RECALL to recall the Filter A transfer function from memory to the upper half of the CRT screen.

(For details, refer to Section 7.1.)



Example of Comparing Frequency Responses Using the Mass Memory Function

2.8.2 Panel Condition Memory

This memory is used to store all panel-switch and soft-key analysis condition settings. It enables the storage of up to four sets of such conditions.

When a given set of voltage range, frequency range, processing function and other settings are used repeatedly, once these are made, they can be stored in the panel condition memory. The contents of this memory are held even when the power of the analyzer is switched off. This function eliminates the need to make complex condition settings each time the power is switched on.

(For details, see Section 8.1.)

2.8.3 Autosequence Function

The CF-350 provides the ability to execute automatic analysis sequences, following a preprogrammed sequence of analysis steps.

Once a sequence is stored, it can be recalled and executed quickly and without operator error.

The AUTO SEQ switch is the command switch used both to store and to execute such automatic analysis sequences.

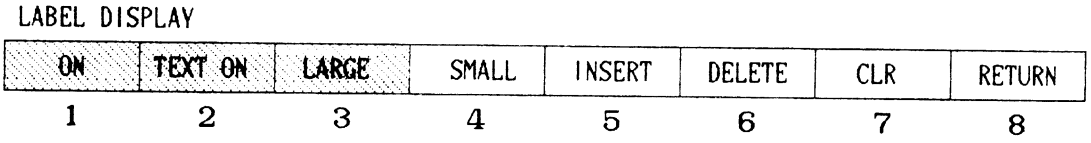
(For details, refer to Section 8.2.)

2.8.4 Label Function

Two lines of up to 55 characters each (alphanumerics and symbols) can be displayed on the CRT screen. This is a convenient way of adding comments and other vital data to analysis results when storing them onto disk or making hardcopies of them.

Press the LABEL switch.

A setting marker will appear at the beginning position for label entry and the soft keys will appear as follows.



1 .... Label upper line display (highlighted) and delete (normal)

2 .... Label entry condition (highlighted) and entry disabled (normal)

3 .... Upper-case character display

4 .... Lower-case character display

5 .... Insert 1 character

6 .... Delete 1 character

7 .... Delete character string

When displaying a label, use the label-entry keys of the front-panel switches.

Cursor movement is done by using the front-panel SEARCH group left and right keys.

(For details, refer to Section 6.10.4.)

2.8.5 GPIB Function

The GPIB (General-Purpose Interface Bus) is a standard bus developed to interface computers to measuring instruments for the purpose of data transfer and control. It was established by the Institute of Electrical and Electronic Engineers (US) in 1975.

Using the GPIB, it is possible to unify the interfacing of different instruments, and up to 15 instruments can be connected to any given bus in parallel fashion (daisy-chain connection).

This enables equipment of different manufacturers to be combined, ensuring reliable data transfer of data between the equipment. Many personal computers and measuring instruments have this interface capability, it being the most widely used today.

The LOCAL switch is used to place the GPIB interface in the local status.

When power is first applied and whenever a system reset is performed:

- If the LOCAL LED is lighted, the addressable condition has been enabled, making control from an external computer or other GPIB controller possible.
- If the LOCAL LED is not lighted, and the TALK LED only is lighted, the CF-350 is controlling a plotter via the GPIB (in the TALK ONLY mode) and should not be connected to a computer.

TALK LED lighted	CF-350 has been specified as a talker.
LISTEN LED lighted ...	CF-350 has been specified as a listener.
SRQ lighted	A service request has been issued.

Switching of the external computer mode and the plotter mode is performed using soft keys (this can be done at any time).

(For details, refer to Section 13.)

2.8.6 Floppy Disk Drive (Option)

When the optional floppy disk drive is installed in the CF-350, permanent storage of large amounts of data is possible. One disk is capable of storing up to 300 frames of display data or 255 Kwords of time waveform data.

The floppy disk can be used to store panel setting conditions and sequence programs as well. For details on this, refer to Section 6.4.

For general information on the floppy disk, refer to Section 7.3.

2.8.7 Hardcopy Function (Plotter Output is Optional)

By connecting a video printer to the CF-350 or connecting a plotter to the CF-350 via an optional plotter interface, it is possible to generate a hardcopy of the display screen. When a plotter is connected, the hardcopy can be generated by simply pressing the PLOTTER switch on the front panel. By setting the CF-350 plotting parameters appropriately, it is possible to create expanded plots, color plots and to perform continuous plotting as well.

(For details, refer to Section 9.)

3. SETTING DATA-CAPTURE CONDITIONS

3.1 Sampling

3.1.1 Sampling and the A/D Converter

To enable digital processing of a voltage signal that is varying continuously with respect to time, it is necessary to quantize instantaneous values of the signal by means of a process known as *sampling*. In this process, a waveform is sampled every fixed time interval (sampling interval), these samples being quantized to obtain a series of numerical values. This conversion of an analog signal to a digital signal is known as A/D conversion and the accuracy of the A/D converter used to perform the conversion (expressed in number of bits of resolution) determines the dynamic range. In the CF-350, this A/D conversion is performed with 16 bits of resolution.

3.1.2 Sampling Theorem

If the sampling interval is Δt (1 sample every Δt seconds), the sampling frequency is then the reciprocal of this or $(1/\Delta t)$ Hertz (i.e., $1/\Delta t$ points sampled every second).

The sampling theorem states that the sampling frequency has the limitation that it must be at least twice the frequency of the highest frequency component contained in the signal to be sampled. If the sampling frequency is not twice this maximum frequency, a phenomenon known as aliasing occurs, causing the appearance in the FFT spectrum of "false" component that does not actually exist in the original signal (refer to Section 3.8 which described the anti-aliasing filter).

3.1.3 Sampling in the CF-350

In the CF-350, the sampling frequency is automatically selected as 2.56 times the currently selected frequency range. For example, if the 40-kHz frequency range is selected, the sampling frequency is automatically set to 2.56 times this frequency--102.4 kHz (i.e., 102,400 samples each second).

Sampling Clock Selection

In the initialized state, the internal sampling clock is selected, in which case an internal quartz crystal oscillator within the CF-350 provides as sampling frequency of 2.56 times the selected frequency range. When using an externally applied signal as a sampling clock, the internal sampling clock is turned off.

<Procedure>

Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

CONDITION SET

CONDIT		POL.CHG	SEARCH	HI PREC	TI ONLY	PH.adj	RETURN

CONDITION

BUZ ON	AUTO ON	TEST ON	FILT ON	CLK INT	DC CANC	A/D OVR	RETURN

If the CLK INT key is activated, the internal sampling clock is selected, and if it is turned off, the external sampling signal applied to the external sampling clock input connector is enabled.

Note

Both channels are always sampled by the same clock.

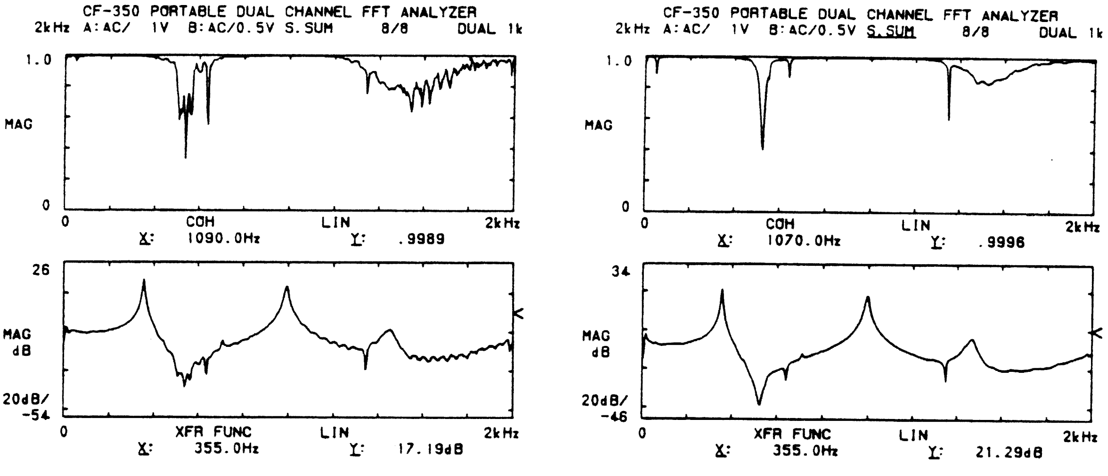
3.2 High-Precision Mode

In the CF-350, the FFT calculation is normally done using a fixed-point precision of 16 bits. This, however, can be changed to 32-bit fixed point precision by selection of the high-precision mode. In this mode, the dynamic range is 80 dB or greater (refer to Section 1.1.4 for a table of dynamic range values).

In using an impulse hammer to provide an acceleration stimulus, the high-precision mode can be employed to make full use of the high precision of the 16-bit A/D converter.

However, the high-precision mode requires longer calculation times than the normal mode.

Real-time range	Normal mode	2 kHz
	High-precision mode	200 Hz



(a) Normal Mode (b) High-Precision mode

Fig. 3-1 Transfer Function Measurement Using Impulse Stimulus
(Bottom: Gain, Top: Coherence)

<Procedure>

Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

CONDITION SET

CONDIT		POL.CHG	SEARCH	HI PREC	TI ONLY	PH. adj	RETURN

HIGH PRECISION

OFF	ON						RETURN

3.3 Autoranging Function

The voltage range (signal input sensitivity) can be made using front-panel switches. However, the CF-350 also has an autoranging function which automatically selects the optimum voltage range to suit the input signal voltage level. When the input signal causes overflow, the voltage range is switched one range upward, and when the input signal drops below 25% of the full-scale range value, the voltage range is switched one range down.

Using this function, each time 1024 points are captured, the voltage range is selected to suit the input signal level.

Note

When averaging is being executed and when triggered data capture is being performed, it is not possible to use the autoranging function.

<Procedure>

Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT
						☝	

CONDITION SET

CONDIT		POL.CHG	SEARCH	HI PREC	TI ONLY	PH. adj	RETURN
☝							

CONDITION

BUZ ON	AUTO ON	TEST ON	FILT ON	CLK INT	DC CANC	A/D OVR	RETURN
	☝						

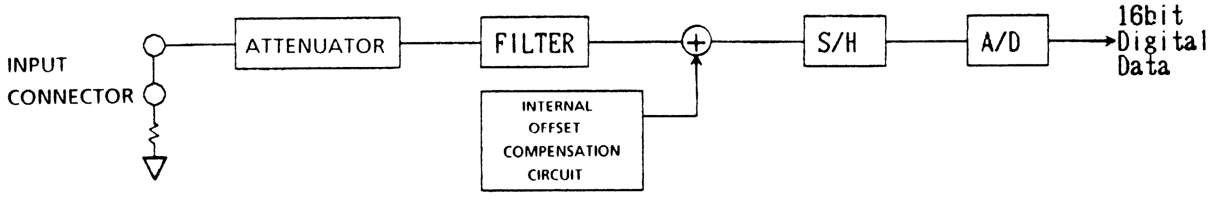
In addition to this function, the CF-0354 Servo Analysis Software has an autoranging function that sets the voltage range separately for each spectrum line.

3.4 Autozero Function

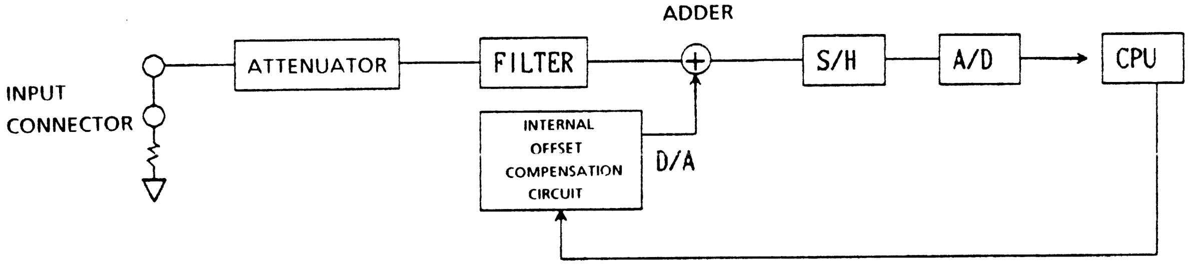
In the CF-350, a function is provided which automatically compensates for the DC offsets introduced by internal analog circuits (amplifiers and filters).

This circuit operates by having the CPU measure the A/D converted data with the input shorted and send a compensation value to an offset compensation circuit, which performs an A/D conversion of this value, which then gets added to the signal after passing through a filter.

- A relay is used to short the input of the A/D converter as follows.



- The CPU reads the resulting data and the compensation value is D/A converted and added to the signal output from the filter.



- After completion of compensation, the relay is reset, enabling normal measurement.

This function limits the CF-350's internal offset to ±5% of each voltage range (−60 dB) at maximum.

If the autozero function is on, the function operates each time the voltage range or frequency range setting is changed.

<Procedure>

Make the following soft key settings.

<<< MENU C >>>

SERVO	Y axis	DATAset	OTHERS			OPTION	NEXT

OTHERS CONTROL

P.COND	GP-IB	DISK	ANALOG				RETURN

ANALOG CONTROL

AT ZERO							RETURN

3.5 A/D Overflow Cancel Function

When the input signal exceeds the set voltage range, this function automatically ignores the captured signals and simultaneously sounds a beeper as a warning. In such measurements as using an impulse stimulus to determine the transfer function, this enables the cancellation of excessive inputs which cause the overflow condition.

Cancel Function

In addition to the A/D overflow cancel function, when using the trigger function *and* summation averaging, there is a cancel soft key that enables the cancellation of waveforms that cause A/D overflow and other waveforms that the operator may which to have ignored. Refer to Section 5.1.2 (a) for details.

<Procedure>

Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

CONDITION SET

CONDIT	SIG OUT	POL CHG	SEARCH	HI PREC	TI ONLY	PH.adj	RETURN

CONDITION

BUZ ON	AUTO ON	TEST ON	FILT ON	CLK INT	DC CANC	A/D OVR	RETURN

Press the A/D OVR key to activate this function.

When A/D OVR is activated, it is not possible to issue a service request to the GPIB.

3.6 DC Cancel Function

This function eliminates DC components by means of a digital calculation. Another function which eliminates DC components is AC coupling. Compared with the use of AC coupling, the DC cancel function offers the following features.

- It enables the elimination of DC components *after* a signal is captured using DC coupling.
- The attenuation in the low frequency region exhibited by AC coupling does not exist.

When performing integration with respect to time, the DC component can be reliably eliminated, thereby reducing overflow.

Note

When the DC cancel function is off, time integration will integrate starting with DC.

<Procedure>

Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

CONDITION SET

CONDIT	SIG OUT	POL CHG	SEARCH	HI PREC	TI ONLY	PH.adj	RETURN

CONDITION

BUZ ON	AUTO ON	TEST ON	FILT ON	CLK INT	DC CANC	AD OVR	RETURN

Press DC CANC to activate this function.

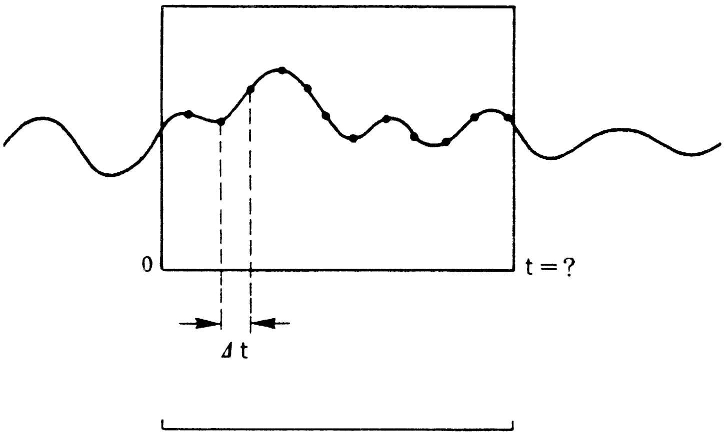
The Coupling characters at the top of the CRT will appear highlighted.

3.7 Analysis Data Length Setting and Resolution

3.7.1 Analysis Data Length

The data analysis length (frame length) is 1024 points (1 Kword) and with single channel capture only, it can be selected as either 1024 or 2048 points (2 Kwords). For time-axis waveforms, 1024 or 2048 points are displayed on a single frame, and the display is updated every 1024 or 2048 captured points. The FFT analysis is performed with respect to each frame, resulting in one spectrum.

The time length for one frame is related to the frequency range as follows.



1 FRAME = 1024 or 2048 PTS

If the frequency range is f_i (Hz), the sampling frequency is 2.56 f_i (Hz). The sampling interval Δt then is the reciprocal of this or $(1/2.56f_i)$ (s).

Therefore, the time length of 1024 points is $(1/2.56f_i) \times 1024$ (s) and for 2048 is $(1/2.56f_i) \times 2048$ (s).

From this relationship, it is clear that the analysis data length is linked to the frequency range setting.

3.7.2 Resolution

The frequency resolution of the CF-350 is 1/400 for an analysis data length of 1024 points and 1/800 for an analysis data length of 2048 points. For example, in the 1-kHz frequency range, the minimum frequency reading resolution would be (1000/400) = 2.5 Hz. The powers are the integrated values over each bandwidth.

- The CF-350 can determine the power spectrum per 1-Hz unit of frequency (power spectral density). Refer to Section 5.8.4 for information on this function.

- To improve resolution, the zoom function (CF-0351 Frequency Zoom Software) and 4-decade analysis function (CF-0354 Servo Analysis Software) which enhances transfer function resolution are available. For information on the zoom function, refer to Section 5.2 and for information of the 4-decade analysis function, refer to Section 11, which describes the servo analysis function.

  When using the Hanning window, the search enhance function provides a 32-fold increase in the line spectrum peak value resolution. Refer to Section 5.8.2.

The relationship of analysis data time length to frequency range and resolution is shown in the table below.

Frequency range	800 Lines (2048 points)		400 Lines (1024 points)	
	Data length (t)	Resolution (Δf)	Data length (t)	Resolution (Δf)
1Hz	800s	1.25mHz	400s	2.5mHz
2Hz	400s	2.5mHz	200s	5mHz
5Hz	160s	6.25mHz	80s	12.5mHz
10Hz	80s	12.5mHz	40s	25mHz
20Hz	40s	25mHz	20s	50mHz
50Hz	16s	62.5mHz	8s	0.125Hz
100Hz	8s	0.125Hz	4s	0.25Hz
200Hz	4s	0.25Hz	2s	0.5Hz
500Hz	1.6s	0.625Hz	0.8s	1.25Hz
1kHz	0.8s	1.25Hz	0.4s	2.5Hz
2kHz	0.4s	2.5Hz	0.2s	5Hz
5kHz	160ms	6.25Hz	80ms	12.5Hz
10kHz	80ms	12.5Hz	40ms	25Hz
20kHz	40ms	25Hz	20ms	50Hz
40kHz	20ms	50Hz	10ms	100Hz

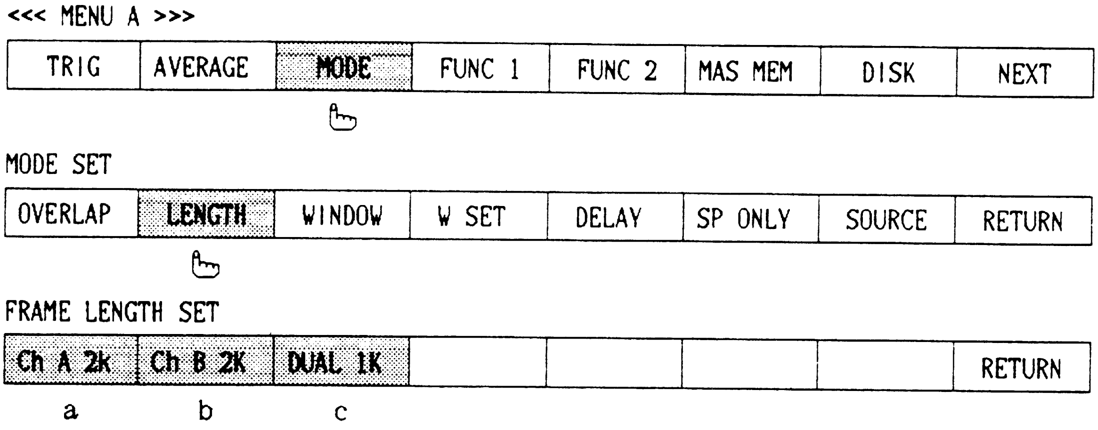
Table 3-1 Frequency Ranges and Analysis Data Lengths (units: s)

Analysis Data Length Setting

The initialized setting is 1024 points.

<Procedure>

Make the following soft key settings.



a	Ch A 2K	.....	For input from Channel A only, the analysis data length is selected as 2048 points.
b	Ch B 2K	.....	For input from Channel B only, the analysis data length is selected as 2048 points.
c	DUAL 1K	.....	The analysis data length is selected as 1024 points.

Note

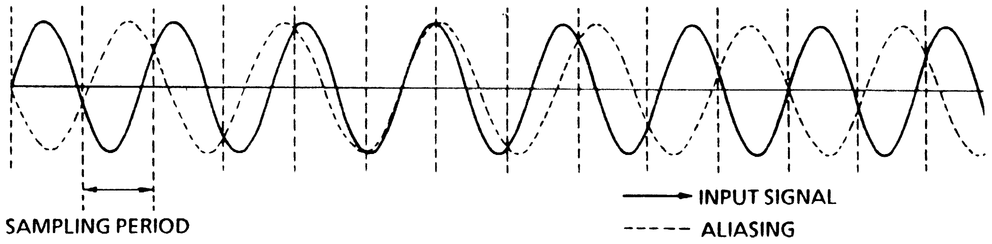
The playback analysis data length for time record data in memory can also be set using the mass memory soft keys. For information on this, refer to Section 7.2.2 (d).

3.8 Anti-Aliasing Filter

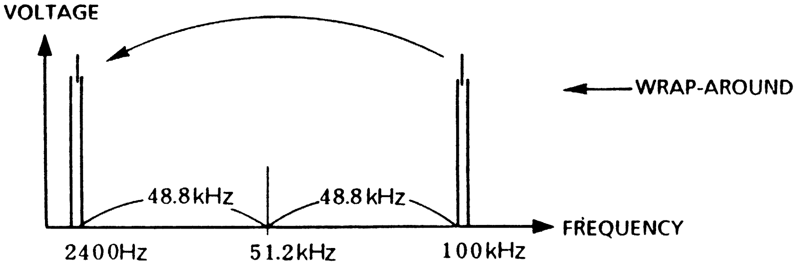
3.8.1 Aliasing

When a waveform is sampled, the sampling theorem dictates that the sampling frequency must be at least two times the frequency of the highest frequency component included in the signal to be sampled. Stated in terms of sampled points, there must be two points sampled for every period of the highest frequency component.

As shown in Fig. 3-2 (a), if the waveform to be sampled (solid line) is sampled with a frequency less than twice the high frequency component (i.e., at the intervals marked by the vertical lines), the sampling will result in the erroneous conclusion that the broken line waveform representing a low-frequency component which does not actually exist is included in the sampled waveform. This effect of making false low-frequency signals appear in the spectrum is known as the *aliasing* phenomenon or *wrap-around.*



(a) Time-Axis Waveform



(b) Frequency-Axis Representation

Fig. 3-2 Aliasing Phenomenon

3.8.2 Anti-Aliasing Filter

When the aliasing phenomenon is observed on the frequency axis, there appears a wrap-around of components higher than 1/2 of the sampling frequency about this frequency point. Thus, in the 40-kHz range, there would be wrap-around about the frequency of 51.2 kHz (40 kHz × 2.56/2). To prevent this aliasing, the normal approach in frequency analysis equipment is to pass the signal through a lowpass filter before sampling to eliminate any frequency components above the nominal analysis frequency upper limit. This filter is known, for this reason, as an anti-aliasing filter.

However, since an ideal filter having infinite attenuation outside its passband is impossible to actually implement, the CF-350 samples at not 2 times, but rather 2.56 times the frequency range, captures 1024 or 2048 points and then performs an FFT on this data. Of the thus derived spectral lines it leaves only 1/2.56 of the total (i.e., either 400 or 800 lines), discarding the 624 or 1248 lines that are susceptible to aliasing.

The CF-350 uses an 8th order cascaded Chebyshev anti-aliasing filter having characteristics as shown in Fig. 3-4, with an attenuation of approximately 80 dB at 1.56 times the frequency range. The cutoff frequency is linked to the selected frequency range and switched automatically. At ranges of 100 Hz and below, a digital filter is applied automatically.

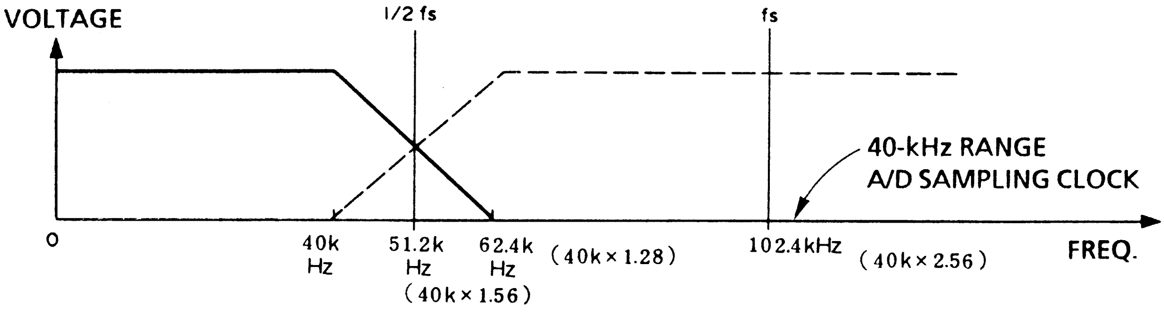


Fig. 3-3 Anti-Aliasing Filter

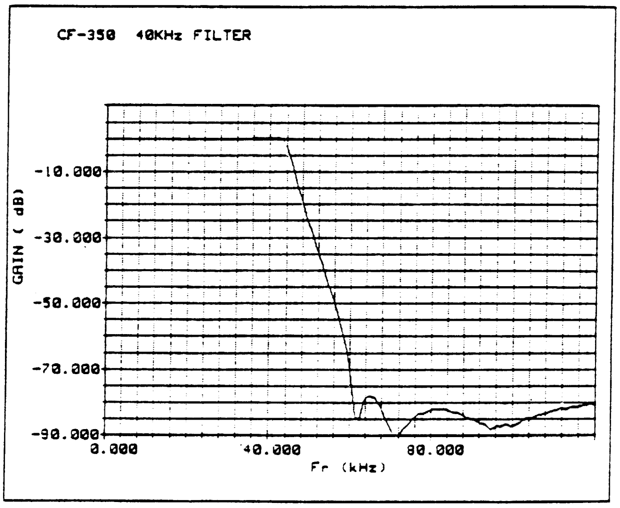


Fig. 3-4 CF-350 Filter Characteristics

Switching the Anti-Aliasing Filter On and Off

In the initialized state, the anti-aliasing filter is on. However, this can be switched off.

By applying anti-aliasing filtering, since frequencies above the frequency range are eliminated, the time-axis waveform might not be an accurate representation of the actual input waveform. By turning the anti-aliasing filter off, it is possible to observe a waveform that is very close to the original input signal.

For observation of frequency-domain characteristics, however, always keep the filter on.

<Procedure>

Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

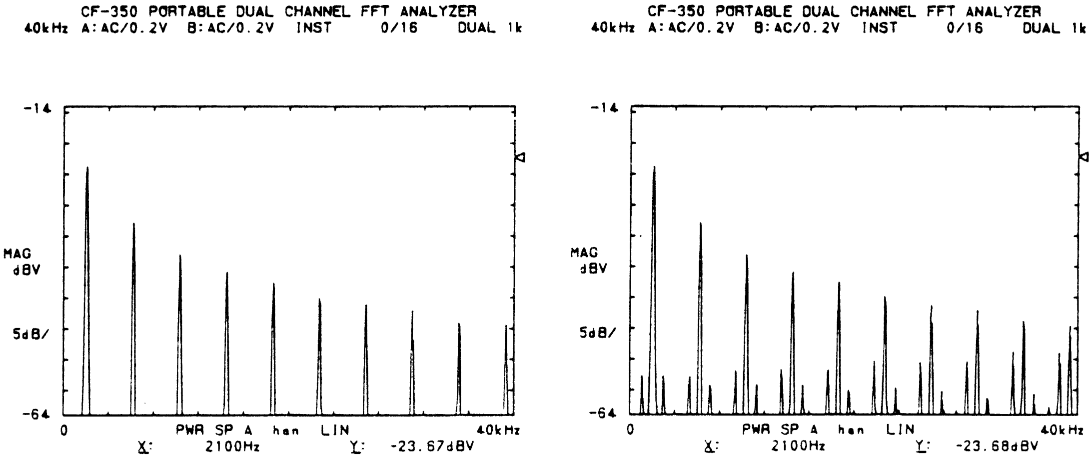
CONDITION SET

CONDIT		POL.CHG	SEARCH	HI PREC	TI ONLY	PH. adj	RETURN

CONDITION

BUZ ON	AUTO ON	TEST ON	FILT ON	CLK INT	DC CANC	A/D OVR	RETURN

Press the FILT ON key to deactivate it and turn off the anti-aliasing filter.



(a) Filter On

(b) Filter Off

Fig. 3-5 Squarewave Spectrum with and Without Anti-Aliasing Filtering

3.9 Window Setting

3.9.1 Windowing

FFT Processing is performed by selecting a portion of the sampled data for analysis (in the case of the CF-350, this is 1024 or 2048 points). The processing of truncating the signal to be analyzed is done by applying what is known as a window function to the signal.

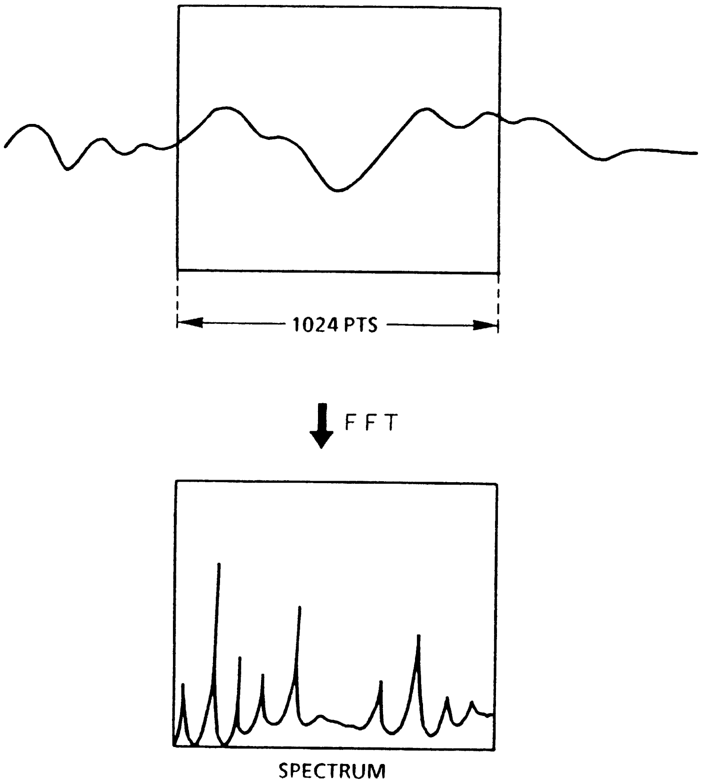
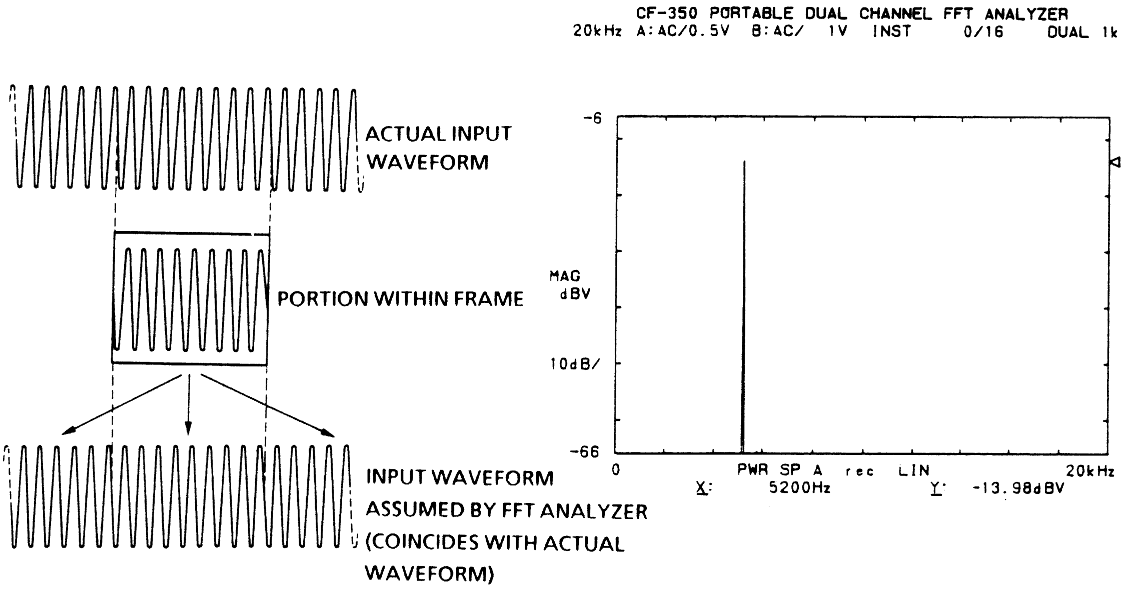


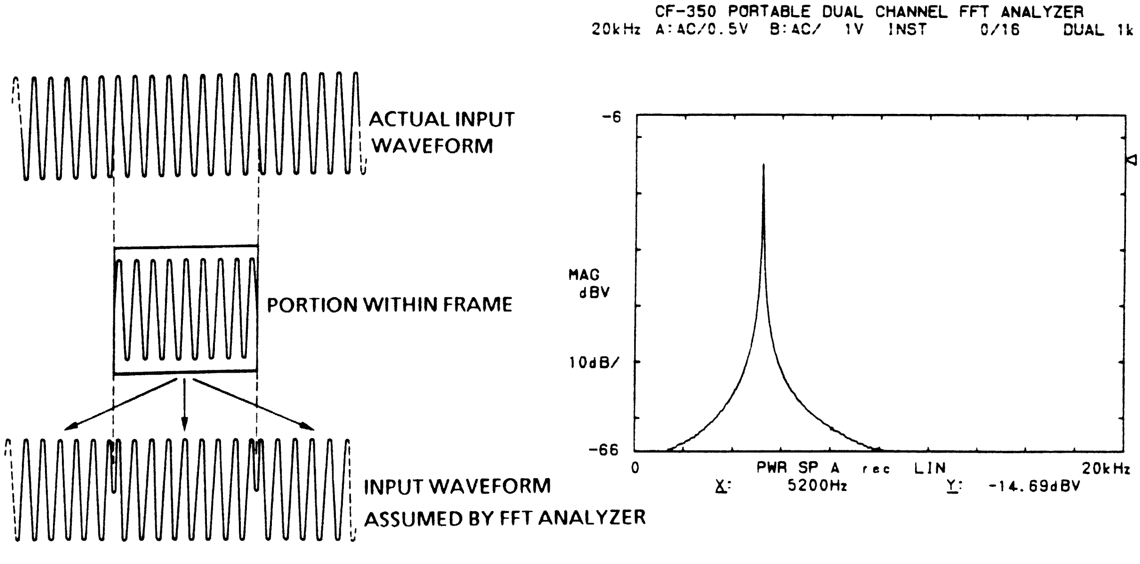
Fig. 3-6 Window

The Fourier transform is, strictly speaking, defined for data of an infinite length. This holds for the discrete Fourier transform as well, so that in the FFT analyzer, the truncated waveform is assumed to repeated infinitely. In performing the analysis, if the analysis data length (i.e., the window length) is an integral multiple of the periods of the frequency of the components thus truncated (as shown in Fig. 3-7 (a)), the assumed endlessly repeating waveform will coincide with the actual input waveform, and a single sine wave component will result in a clean, single-line spectrum. If however, the window is not an integral multiple of the sampled signal's period (as shown in Fig. 3-8 (a)), i.e., it does not correspond to one of the discrete frequency resolution points, there will be discontinuities when the window edges are brought around to meet each other. This results in a broadening of the spectrum as shown in Fig. 3-8(b). This broadening manifests itself as what is known as leakage error. In theory, to obtain a true line spectrum, an infinite data length is required. Since the FFT analyzer makes use of a finite length of data, however, the existence of this leakage error is inevitable.



(a) Time Waveform (b) Spectrum Synchronized to Data Length

Fig. 3-7 Input Signal with a Period of an Integral Multiple of the Analysis Data Length

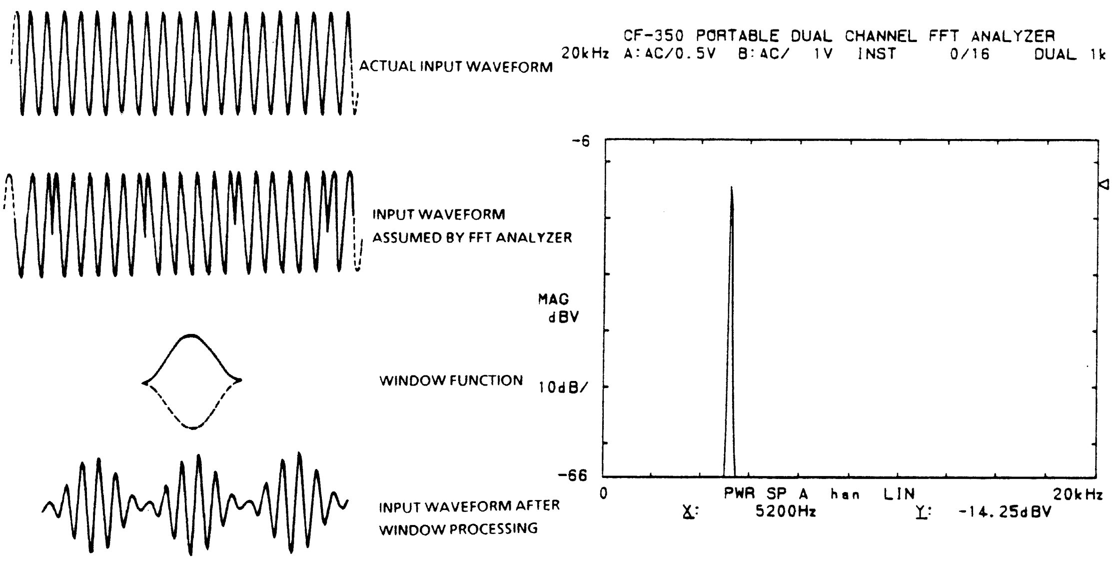


(a) Time Waveform (b) Spectrum not Synchronized to Data Length

Fig. 3-7 Input Signal with a Period not an Integral Multiple of the Analysis Data Length

Window processing can be used to prevent this leakage error. Fig. 3-9 (a) illustrates the concept of window processing. The input waveform shown has a period that is not an integral multiple of the analysis data length, i.e., it is not synced to the analysis data length. If we use this figure to consider leakage error, it can be seen that the problem exists because of the discontinuities existing at the edges of window when they are brought together (remembering that the FFT analyzer assumes an infinitely repeated series of signals. Thus, the leakage power can be eliminated by performing the analysis of the central section of the data only, the result being a single-line spectrum. If the signal is multiplied by a window function having the value of zero at both ends, this will have the effect of centralizing the FFT processing, the result being, as shown in Fig. 3-9 (b), that the spectrum approaches being a true line spectrum.

One commonly used window is called a Hanning window and other windows are used as well, depending upon the type of signal being analyzed.



(a) Window Function and Processing

(b) Reduction of Leakage by means of Window Processing

Fig. 3-9 Window Processing

In the CF-350 analyzer, the window weighting is applied, so that the window does not change a time waveform. However, it is possible to monitor the time-axis waveform which has had a window applied to it. Refer to Section 3.9.3 (d).

A waveform stored in the time record memory can be played back and FFT analyzed with a variety of window types, even after storage of the original waveform. It is also possible to change the window type when the mass memory is selected as the analysis signal source in analyzing CRT block memory time-axis waveforms. For information on the memory function, refer to Section 7.

3.9.2 Window Types

The CF-350 enables selection of the following window types.

Window type	Level accuracy	Equivalent noise bandwidth	Frequency resolution	Applications
Rectangular	-3.9 dB	1.0	Good	Transients such as impulse signals. Internally generated sine, swept sine and periodic signals.
Hanning	-1.42 dB	1.5	Fair	General FFT signal analysis, particularly continuous waveforms.
Flat-top	**±0.1 dB**	**3.1662**	**Poor**	**High-frequency analysis (e.g., THD) in which level accuracy is important.**
Force	————			Transient impulse signals such as from acceleration stimuli. Elimination of noise.
Exponential	————			Acceleration response. Naturally damped waveforms.
User defined	————			Processing using an arbitrarily defined window.

Table 3-2 Available Window Types

With the Hanning and Flat-top windows, spectrum peak and overall value compensation is performed.

(a) Rectangular Window

This is an rectangular window without weighting. It is described by the following relationship.

$$w(n\Delta t) = 1 \; (n=0, 1, \cdots N\text{-}1, N=1024, 2048)$$

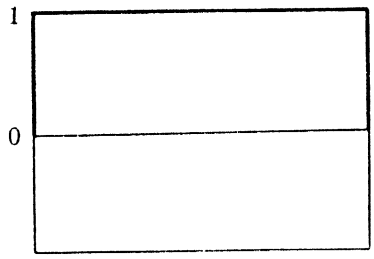


Fig. 3-10 Rectangular Window

Since this window is not weighted, levels and frequencies are determined with high accuracy. However, as described in Section 3.9.1, this is not suitable for the analysis of continuous waveforms, although it is effective for impulse waveforms and other waveforms that start and end within a single frame. Of the outputs provided by the CF-0383 Signal Output Card and the SG-450 Signal Source Unit, the sine, sine sweep, periodic random and pink periodic random signals are synced to the CF-350's sampling clock, so that the data length is an integral multiple of the signal period, making the rectangular window the proper choice.

(b) Hanning Window

This is a typical window that is used in applying weighting to continuous waveforms. It is defined by the following relationship.

$$w(n\Delta t) = \frac{1 - \cos \frac{2\pi n}{N} \Delta t}{2} \quad (n = 0 \rightarrow N - 1, N = 1024, 2048)$$

In analyzing continuous waveforms, the Hanning window can be used to reduce the effects of sidelobes (spectral broadening), this window being particularly effective with respect to high-frequency components.

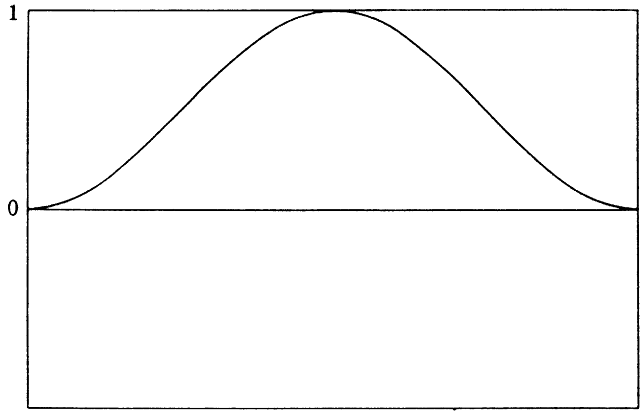


Fig. 3-11 Hanning Window

By using the Hanning window, the spectral power is reduced, although this is internally compensated for in the CF-350, so that true values are displayed.

(c) Flat-Top Window

This window is defined as follows.

$$w(n\Delta t) = \{a_0 + \sum_{k=1}^{4} a_k \cos(\frac{2\pi}{N} n\Delta t)\}$$

$$(n = 0, 1, \cdots N-1, N=1024, 2048)$$

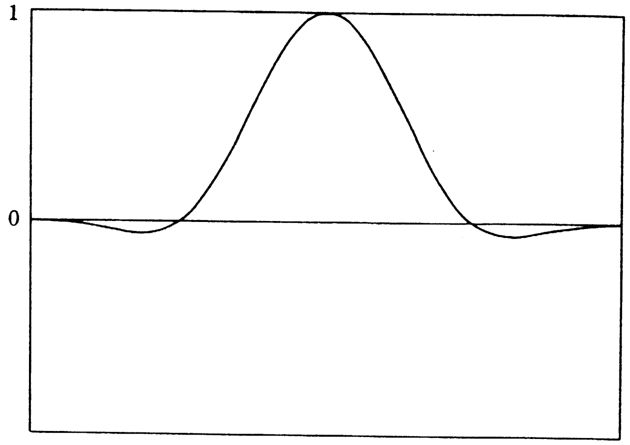
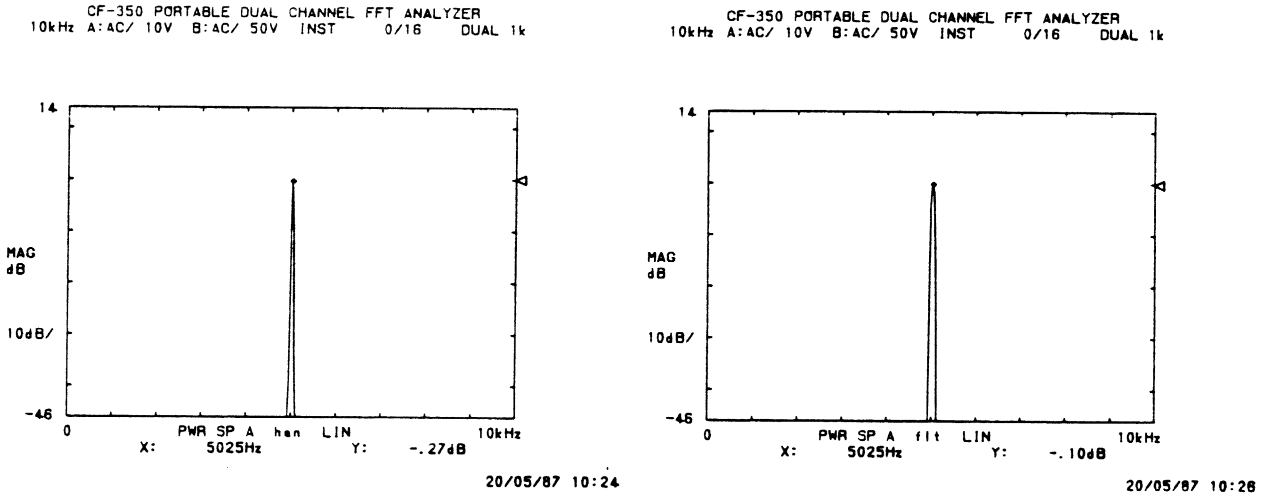


Fig. 3-12 Flat-Top Window

Compared to the Hanning window, the frequency resolution is lower, but the power does not drop, enabling accurate level measurements.



(a) Hanning Window (b) Flat-Top Window

Fig. 3-13 Window Level Accuracy for a 5020-Hz Sinewave of 0 dB level

By using the flat-top window, the power of the spectrum is reduced, but this is internally compensated to achieve a display of true values.

(d) Force Window

This is also a rectangular window, but provides a limited window span for analysis. The function is defined as follows.

$$w(n\Delta t) = \begin{cases} 1 \ (A \leqq n \leqq B) \\ 0 \ (n < A, n > B) \end{cases}$$

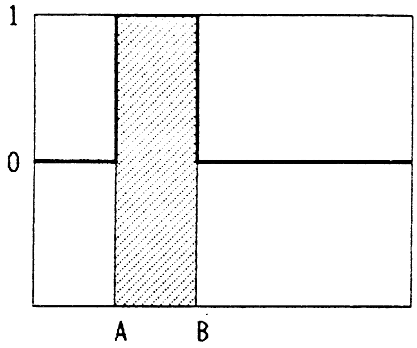


Fig. 3-14 Force Window

Only the portion of the waveform is processed (shaded portion in Fig. 3-14), with any portions falling outside the window set to zero. The force window is used in the following cases.

- For analysis of impulse waveforms, to eliminate noise components. For transfer function measurements using an impulse stimulus, the stimulus can be measured using the force window and the damped output waveform measured using an exponential window (described in the next section).

- When more than two periods of a waveform are included in a single frame, this window can be used to limit the FFT analysis to a single period of the waveform.

Note

By using the force window, it is possible to further limit the analysis to a portion of the actual data length. As is the case with the rectangular window, when the waveform is not zero at both edges of the window, sidelobe broadening of the spectrum will occur by virtue of a discontinuity. Also, since the waveform outside the window is set to zero, the spectrum levels are lower (there is no compensation for this provided).

(e) Exponential Window

When an object is stimulated by vibration, in general the response curve exhibits exponential attenuation (damping). If the waveform does not reach zero within the analysis window, however, the FFT analysis results will contain errors caused by a discontinuity, as described in Section 3.9.1. The exponential window can be used to change the exponential curve slope (by changing the damping factor), thereby causing the response curve to attenuate within the window.

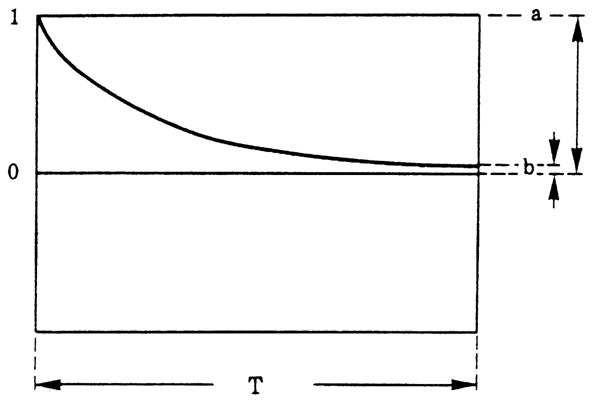


Fig. 3-15 Exponential Window

The setting of this window is made by establishing the ratio (b/a) between the positive starting level (a) and the final level (b) on the Y axis.

When using the exponential window, the damping factor changes, making compensation necessary to measure this parameter. Refer to Section 4.1.5 for the method of calculating the attenuation (damping).

- When the CF-0355 Curve Fitting Software is installed, the **attenuation factor can be internally calculated automatically.**

(f) User-Defined Windows

In addition to the above-described windows, it is possible to define the window arbitrarily. The shape of the window is displayed on the CRT as a 2048-point time waveform. A waveform generated by a computer can also be set, using the GPIB to input the data. Spectrum level compensation is not performed.

This function can be used to implement Hamming, Gaussian, triangular and virtually any other window type.

<Procedure>

The window is selected by means of soft keys, and the shape of the force, exponential and user-defined windows must be set up beforehand.

The set windows are stored in individual window buffer memories, so that the window can be reused even if a window type was changed midway, as long as the power is not turned off and a system reset is not performed. However, the exponential window and user-defined window use a common window buffer memory, preventing simultaneous use of these two window types.

Note

When using the output from the CF-0383 Signal Output Card, the following automatic window selections will be made, depending upon the signal type selected.

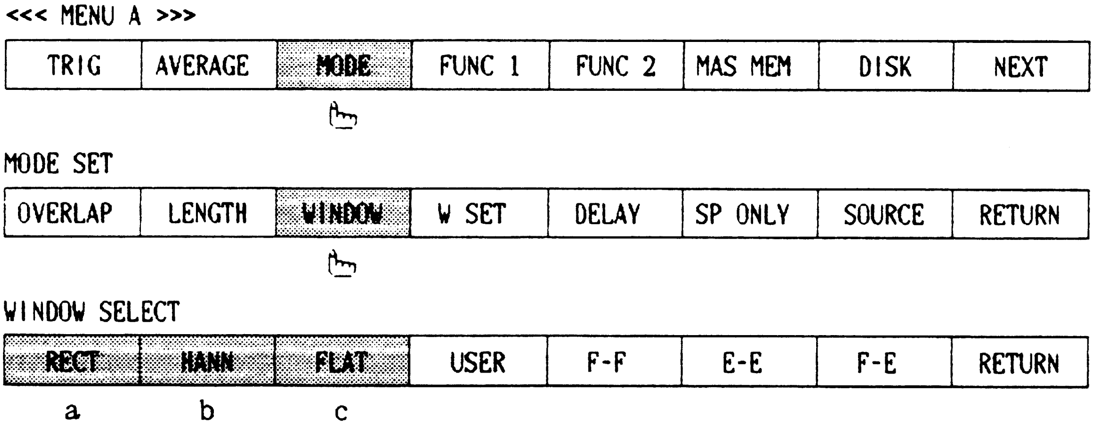
Swept sine, periodic random, impulse .... Rectangular window

Random .... Hanning window

(For information on the CF-0383, Refer to Section 10.)

(a) Selection of Rectangular, Hanning and Flat-Top Windows

Make the following soft key settings.



a RECT ..... Selects the rectangular window.

b HANN .... Selects the Hanning window.

c FLAT ..... Selects the Flat-Top window.

Note

These windows are selected simultaneously for Ch A and Ch B.

(b) Selection of the Force and Exponential Windows

(1) Force Window Setting and Selection

① Press the CH A TIME switch of the DISPLAY group to display the time axis waveform of Channel A.

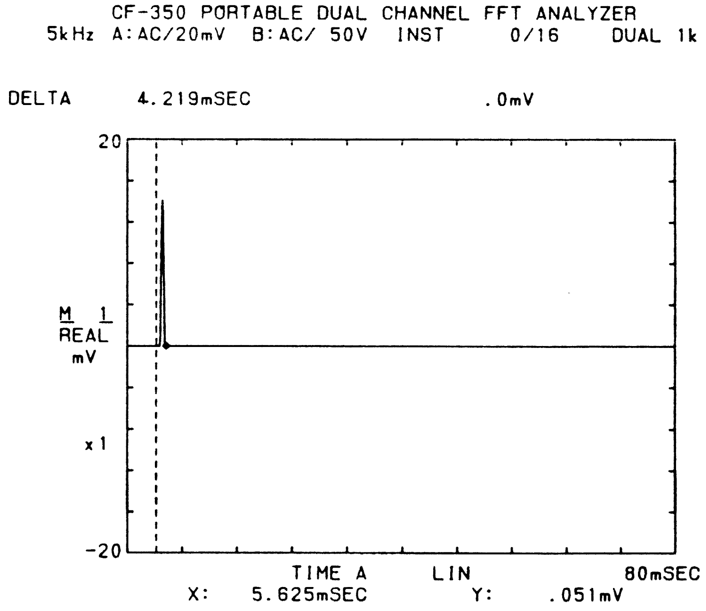
- Set up the trigger (refer to Section 3.10) so that the section of the waveform to be analyzed is displayed every time at the same position.

② Set the PAUSE switch of the COMMAND group to turn it on and enable the PAUSE condition.

③ Press the ON switch of the SEARCH group to turn it on and use the left and right switches to move the search point to the desired window starting point.

④ Press the ΔSET switch of the SEARCH group to turn it on, at which point the delta cursor will appear at the search point.

⑤ Move the search point to the desired window ending point.



```
        CF-350 PORTABLE DUAL CHANNEL FFT ANALYZER
5kHz  A:AC/20mV  B:AC/ 50V  INST     0/16    DUAL 1k

DELTA        4.219mSEC                    .0mV

                 X:   5.625mSEC          Y:    .051mV
```

Fig. 3-16 Force Window Setting

⑥ Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

MODE SET

OVERLAP	LENGTH	WINDOW	W SET	DELAY	SP ONLY	SOURCE	RETURN

WIND COEFF.SET

FORCE	EXP	USER			DISP	**SET**	RETURN

Press the sequence FORCE → SET.

⑦ Select the set force window. This is done by the following soft key settings.

WIND COEFF.SET

FORCE	EXP	USER			DISP	SET	**RETURN**

MODE SET

OVERLAP	LENGTH	**WINDOW**	W SET	DELAY	SP ONLY	SOURCE	RETURN

WINDOW SELECT

RECT	HANN	FLAT	USER	**F-F**	E-E	**F-E**	RETURN
				a		b	

a F-F ..... Applies the Force window to Ch A and Ch B.

b F-E ..... Applies the Force window to Ch A and the Exponential window to Ch B.

(2) Exponential Window Setting and Selection

① Press the CH A TIME switch of the DISPLAY group to display the time axis waveform of Channel A.

- Set up the trigger (refer to Section 3.10) so that the section of the waveform to be analyzed is displayed every time at the same position.

② Set the PAUSE switch of the COMMAND group to turn it on and enable the PAUSE condition.

③ Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	**MODE**	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

MODE SET

OVERLAP	LENGTH	WINDOW	**W SET**	DELAY	SP ONLY	SOURCE	RETURN

The characters ".0000E+0%" will appear in the lower part of the CRT display.

WIND COEFF.SET. .0000E+0%

FORCE	EXP	USER			DISP	SET	RETURN

When the EXP key is pressed, the number at the left edge will appear highlighted.

④ Input the window coefficient. This coefficient is input as the final value (b) as a percentage of the starting value (a).

The format of the display is .0000E+0%. Examples of the meaning of this format are as follows.

$.1000E+2 = 0.1 \times 10^2 = 10\%$

$.5000E-1 = 0.5 \times 10^{-1} = 0.05\%$

The maximum setting value is 100% and a setting of 0% will be automatically taken as the value 1%.

Input the string from the left using panel switches.

⑤ Window Coefficient Setting

⑤WIND COEFF.SET

FORCE	EXP	USER			DISPLAY	SET	RETURN

When the SET key is pressed, the message "BUSY" will appear flashing on the CRT and after the message disappears the set curve will appear on the CRT screen along with the flashing message "set complete."

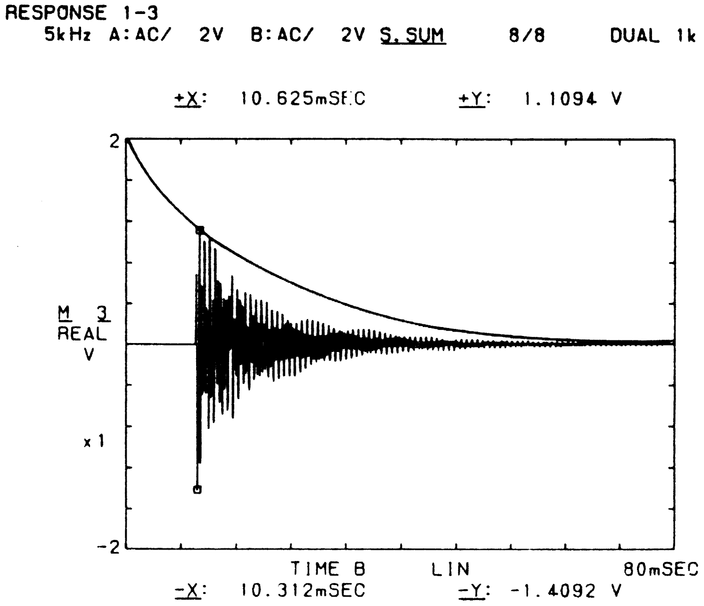


Fig. 3-17 Exponential Window Setting

Notes

1. The exponential window buffer memory is used also as the buffer memory for the user-defined window, so that if the user-defined window is set after setting the exponential window, the exponential window will be deleted. However, the coefficient will be held, enabling restoration of the exponential window by simply pressing the SET key.

2. Only the coefficient for the exponential window is stored in the panel condition memory. Therefore, to recall the window, recall and then press the SET key.

⑥ Select the set window by making the following soft key settings.

WIND COEFF.SET

FORCE	EXP	USER			DISPLAY	SET	RETURN

WINDOW SELECT

RECT	HANN	FLAT	USER	F-F	E-E	F-E	RETURN
					a	b	

a E-E ..... Applies the Exponential window to Ch A and Ch B.

b F-E ..... Applies the Force window to Ch A and the Exponential window to Ch B.

(c) Setting and Selection of a User-Defined Window

It is possible to define any 2048 points of time waveform on the display as a window. When using this function, the same window is applied when the 1024 point analysis data length is selected.

The defined and stored waveform is written into the window buffer memory, so that the window can be reused even if a window type was changed midway, as long as the power is not turned off and a system reset is not performed. However, the time axis waveform stored as a window cannot be displayed. This window buffer memory is used in common with the exponential window, so that selection of the exponential window causes deletion of the user-defined window. To store the user-defined window, it can be written onto floppy disk as a 2048-point time waveform. (For information of the floppy disk drive, refer to Section 7.3.)

① **Set the analysis data length to 2048 points.**

Press the START switch of the COMMAND group to turn it on and enable the START condition. Then make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

MODE SET

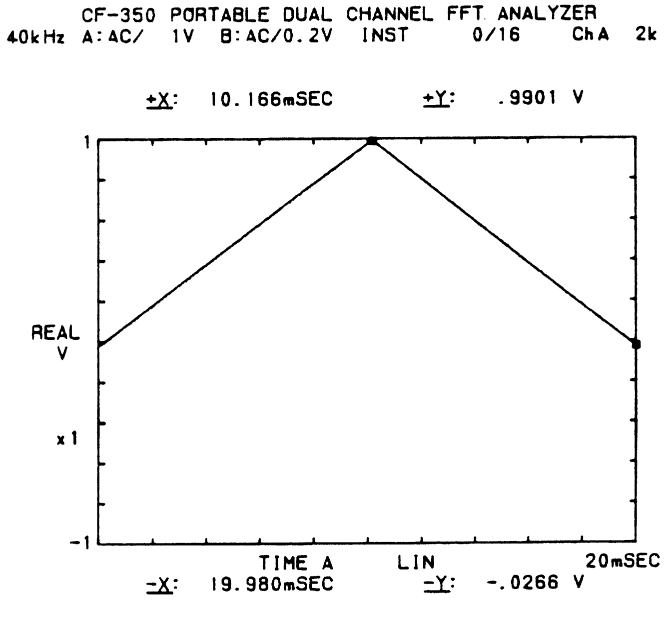
OVERLAP	LENGTH	WINDOW	W SET	DELAY	SP ONLY	SOURCE	RETURN

FRAME LENGTH SET

Ch A 2K	Ch B 2K	DUAL 1K					RETURN

Since the user-defined window is to be set on Ch A, select Ch A 2K.

② Press the CH A TIME switch of the DISPLAY group to display the Ch A time waveform, the waveform to be defined as a window.


```
        CF-350 PORTABLE DUAL CHANNEL FFT ANALYZER
40kHz  A:AC/  1V  B:AC/0.2V  INST     0/16    ChA  2k

          +X:  10.166mSEC        +Y:   .9901 V

          -X:  19.980mSEC        -Y:  -.0266 V
```

Fig. 3-18 User-Defined Window Setting

③ Set the displayed waveform as a window by making the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT
		☝					

MODE SET

OVERLAP	LENGTH	WINDOW	W SET	DELAY	SP ONLY	SOURCE	RETURN
			☝				

WIND COEFF.SET

FORCE	EXP	USER			DISP	SET	RETURN
		☝				☝	

Input the sequence USER → SET. The message "set complete" will appear on the CRT display.

④ Select the User-Defined Window

WIND COEFF.SET

FORCE	EXP	USER			DISP	SET	RETURN
							☝

MODE SET

OVERLAP	LENGTH	WINDOW	W SET	DELAY	SP ONLY	SOURCE	RETURN
		☝					

WINDOW SELECT

RECT	HANN	FLAT	USER	F-F	E-E	F-E	RETURN
			☝				

(d) Monitoring a Windowed Waveform

Make the following soft key settings.

WIND COEFF.SET

FORCE	EXP	USER			DISP	SET	RETURN
					☝		

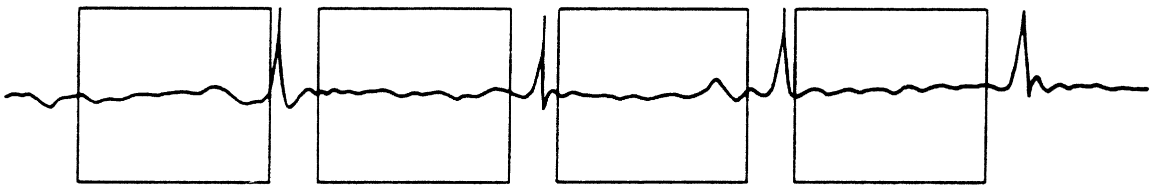
When the DISP key is on, and the time-axis waveform is displayed, the screen will show the waveform after application of the window.

3.10 Trigger Function

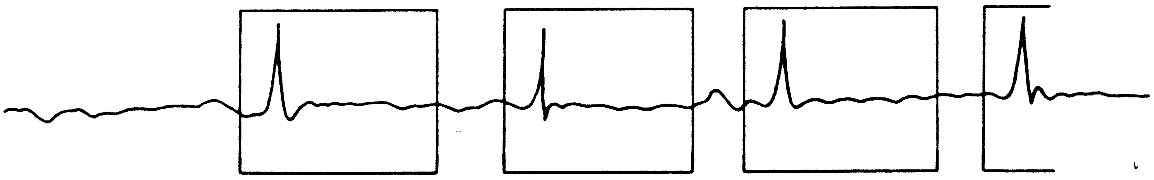
3.10.1 Trigger-Function Concept

The trigger function enables the sampling of a signal to be started at a desired point on the input signal or at the instant that an external signal is received. When the input signal itself is used to trigger the start of sampling, the triggering is known as *internal triggering,* in which the trigger is applied when the input signal reaches a set level. The other type of triggering--*external triggering* uses an externally applied signal to start the sampling.

This trigger function can be effectively employed to capture and analyze just the desired portion of signal and is additionally useful in syncing the signal on the screen when performing averaging.



(a) When the triggering function is not used, capture of one-time events is impossible



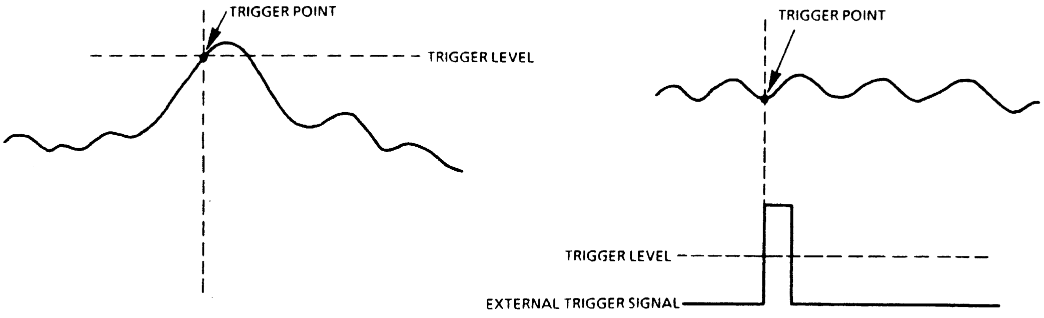
(b) By using the triggering function it is possible to sync at the desired position on the display.

Fig. 3-19 Trigger Function

3.10.2 Trigger Function Settings

Using the CF-350, the following trigger function settings are available.

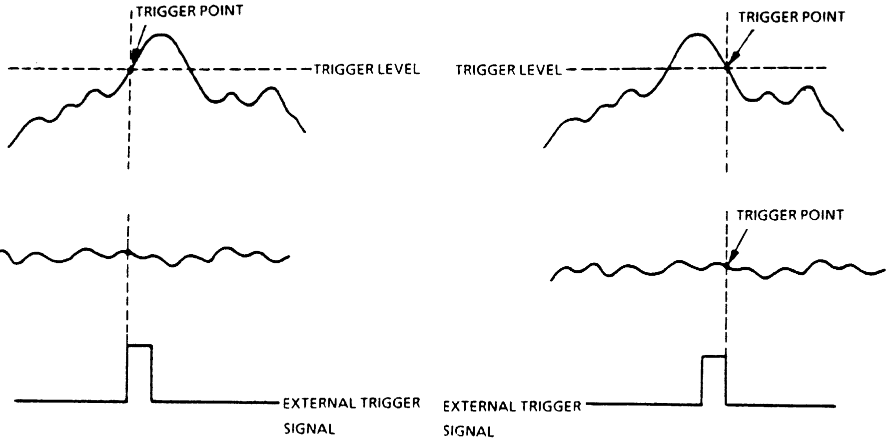
① Trigger Source ..... This is the selection of either internal or external triggering. With internal triggering, when either the Ch A or the Ch B input signal reaches a set voltage level, the trigger is applied and sampling is started. For external triggering, an external pulse signal applied at a rear-panel connector is used as the timing reference for the start of sampling. The external trigger signal can be monitored.



(a) Internal Triggering (b) External Triggering

Fig. 3-20 Trigger Signal Source

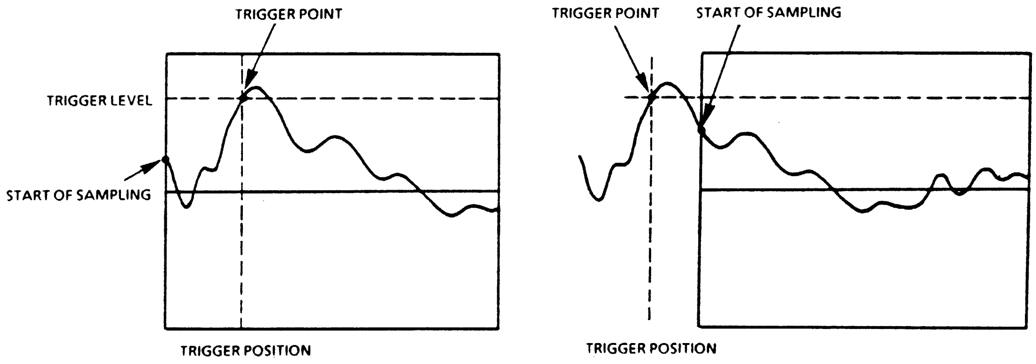
② Trigger Polarity ... This is the selection of triggering on either the rising edge (+) or the falling edge (–).



(a) Rising-Edge Triggering (b) Falling-Edge Triggering

Fig. 3-21 Trigger Polarity

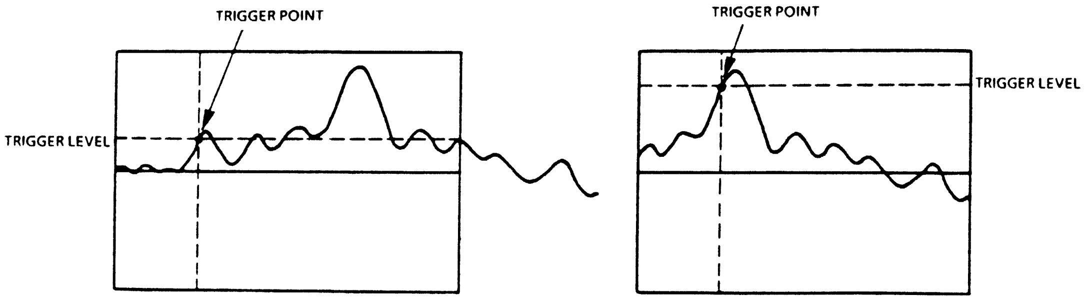
③ **Trigger Position** ... This is the setting of the start of sampling in terms of points before or after the trigger point. Starting the sampling before the trigger point is known as *pre-triggering* and starting the sampling after the trigger point is known as *post-triggering*. The distance before the trigger point can be set up to 65,536 (64 frames from the 1024 point of analysis data) in 1-step increments, and the distance after the trigger point can be similarly set up to 65,536 point in 1-step increments.



(a) Pre-Triggering (b) Post-Triggering

Fig. 3-22 Trigger Position

④ Trigger Level ...... This is the setting of the level at which the trigger is applied (i.e, at which the sampling starts). The setting can be made with a resolution of ± 1/128 of the voltage full-scale range value. For external triggering, with a full scale of ±5 V, the input sensitivity is 0.5 V_{p-p}.



(a) 25.0% Trigger Level Setting (b) 75.0% Trigger Level Setting

Fig. 3-23 Trigger Level

⑤ Trigger Type ...... Selection is possible of single, repeated or one-shot triggering. In the single trigger mode, the analyzer captures one frame when the trigger is applied and then goes into the waiting state. In the repeated triggering mode, each time the trigger is applied, 1 frame of data is captured and a trigger occurring during the sampling process is ignored. In the one-shot mode, when the trigger is applied, 1 frame of data is captured and the free trigger (non-triggered condition) is enabled.

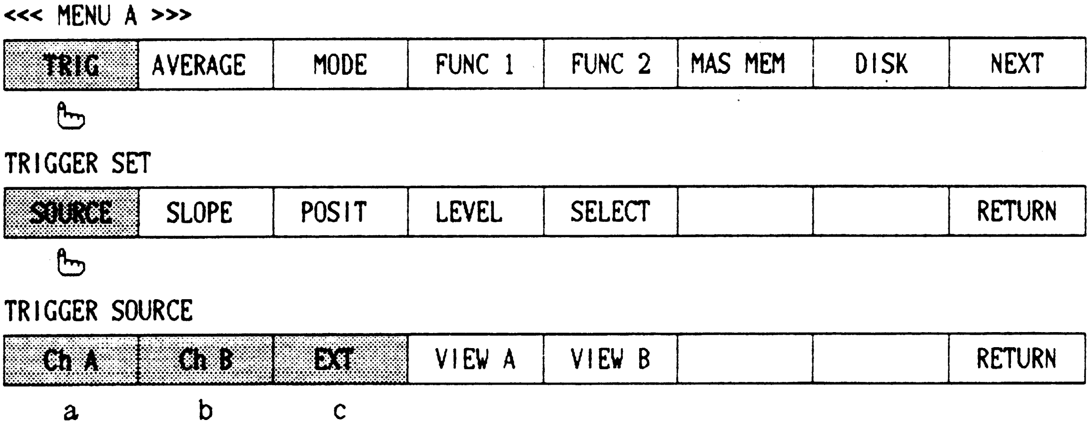
<Procedure>

(a) Selection of the Trigger Signal Source

The trigger signal source can be selected as the input signal applied to either Ch A or Ch B.

In the initialized state, Ch A is selected as the trigger signal source.

Make the following soft key settings.

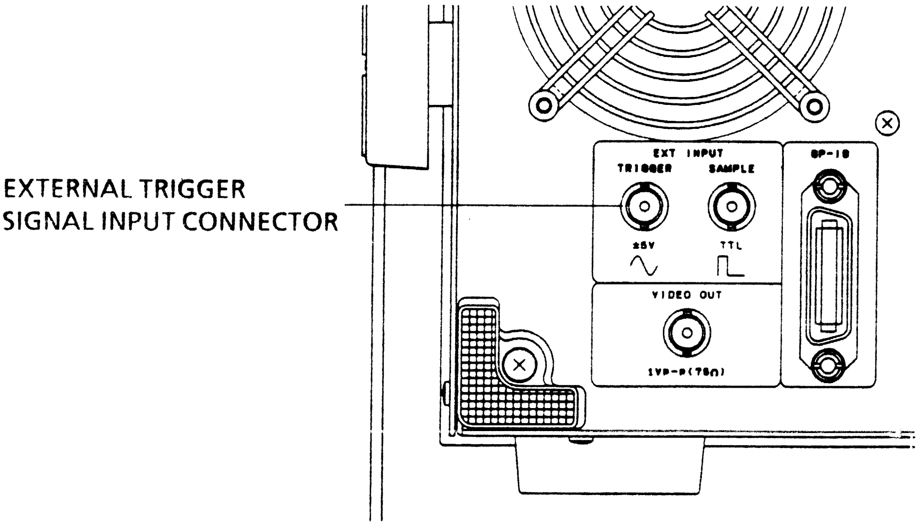


a	Ch A	Selects the Ch A input signal.
b	Ch B	Selects the Ch B input signal.
c	EXT	Selects external triggering using a signal applied at a rear-panel connector.

External Trigger Signal Input

① The external trigger signal is applied at a rear-panel BNC input connector provided for this purpose. The input specifications are as follows.

Maximum input frequency	100 kHz
Maximum sensitivity	0.5 V_{p-p}
Maximum trigger level	±5 V
Input impedance	Approx. 100 kΩ
Maximum allowable input voltage	100 V_{rms} for 1 minute


EXTERNAL TRIGGER SIGNAL INPUT CONNECTOR

② External Trigger Input Monitor

The waveform of the trigger signal applied at the external trigger input connector can be monitored on the CRT screen of the CF-350.

To do this, make the following soft key settings.

TRIGGER SOURCE

Ch A	Ch B	EXT	VIEW A	VIEW B			RETURN
			a	b			

a VIEW A ...... Monitors the external trigger signal on Ch A.

b VIEW B ...... Monitors the external trigger signal on Ch B.

Note

When the external trigger signal is being monitored, the internal test signal is automatically turned off.

(b) Selection of the Trigger Polarity

The trigger can be applied on the rising edge (+) or on the falling edge (−), as selected. In the initialized state, the setting is rising edge (+).

Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

TRIGGER SET

SORCE	SLOPE	POSIT	LEVEL	SELECT			RETURN

TRIGGER SLOPE

+	−						RETURN
a	b						

a + ... Selects rising edge.

b − .... Selects falling edge.

(c) Selection of Trigger Position

The starting point for sampling can be set as a position with respect to the trigger point. The setting is a value in the range −65,536 to + 65,536.

In the initialized state, the setting is −128 point (i.e., pre-triggering).

① Display the time waveform selected as the trigger source.

② Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

TRIGGER SET

SOURCE	SLOPE	POSIT	LEVEL	SELECT			RETURN

TRIGGER POSITION -00128

NUMERIC	SET						RETURN

The cursor will appear on the display. Make the setting as a value or using the cursor position. The methods are described below.

Numerical Setting Method

Press the NUMERIC key and then make the value input using the front-panel numeric keys.

Press the SET key to complete the setting. When this is done, the cursor will move to adjust its position to the setting.

Cursor Setting Method

Use the up and down switches of the SEARCH group to move the cursor. Press the up and down switches to move the cursor to the left and the right, respectively. The cursor position will be displayed numerically.

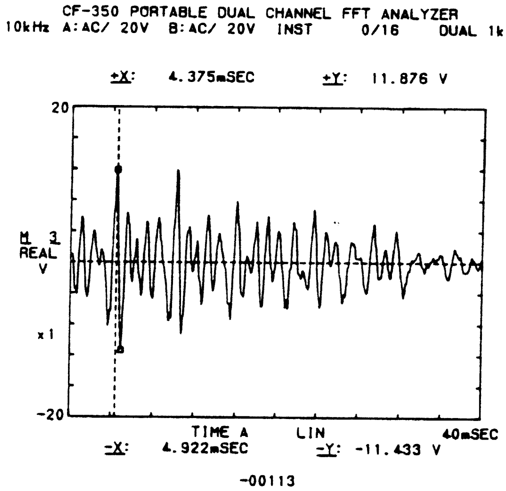


Fig. 3-24 Trigger Position Setting

(d) Setting of the Trigger Level

The trigger is set as a voltage level.

In the initialized state, the setting is 0.0%.

① Display the time waveform selected as the trigger source.

② Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

TRIGGER SET

SOURCE	SLOPE	POSIT	LEVEL	SELECT			RETURN

TRIGGER LEVEL

MAK SET							RETURN

The horizontal cursor will appear on the display.

③ The trigger level is indicated by the displayed horizontal cursor.

Use the up and down switches of the SEARCH group to move this cursor up and down while observing the waveform to set the proper trigger level.

To check the trigger level, use the LEVEL % that is displayed on the right edge of the screen.

Note

This cursor is not displayed if X-axis expansion is being used.

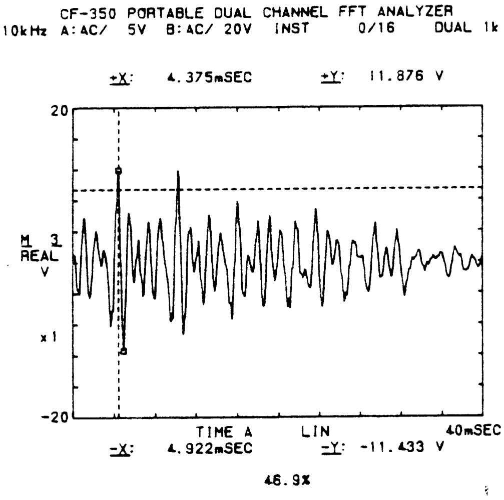


Fig. 3-25 Trigger Level Setting

(e) Selection of the Trigger Type

The trigger type can be selected as repeated, single or one-shot. In the initialized state, the repeated triggering mode is selected.

Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS.MEM	DISK	NEXT

TRIGGER SET

SOURCE	SLOPE	POSIT	LEVEL	SELECT			RETURN

TRIGGER SELECT

REPEAT	SINGLE	ONEshot		CANCEL			RETURN
a	b	c					

a REPEAT ..... Selects the repeated triggering mode.

b SINGLE ...... Selects the single triggering mode.

c ONE shot ..... Selects the one-shot triggering mode.

(f) Execution of the Triggering Function

Press the TRIG panel switch to turn it on.

When the trigger signal reaches the trigger level, the TRIG'D LED will light.

For the single triggering mode, each time the SINGLE key is pressed, the ready (waiting) condition will be enabled (thus *arming* the analyzer and ready it for a trigger).

In the one-shot triggering mode, when the trigger occurs, the free trigger condition is enabled and each time the ONE shot key is pressed, the ready condition is enabled.

3.11 Overlap Setting

3.11.1 Real-Time Analysis

In real-time analysis, data is continuously FFT analyzed with neither overlap of windows nor missed portions due to spacing between windows.

In the CF-350, when sampling of the signal's analysis data length (1024 or 2048 points) is performed, an FFT analysis then performed on the sampled data. During the analysis process, data is again captured, enabling immediate analysis after the first analysis is completed. Therefore, as can be seen from Fig. 3-26, real time analysis is performed when the time required for sampling is the same as the FFT analysis time (including the time required for display). However, if the sampling time is shorter than the analysis time, there will be missing portions of the signal, as shown in Fig. 3-27. If, on the other hand, the sampling time is longer than the analysis time, there will be overlap between neighboring windows, as shown in Fig. 3-28.

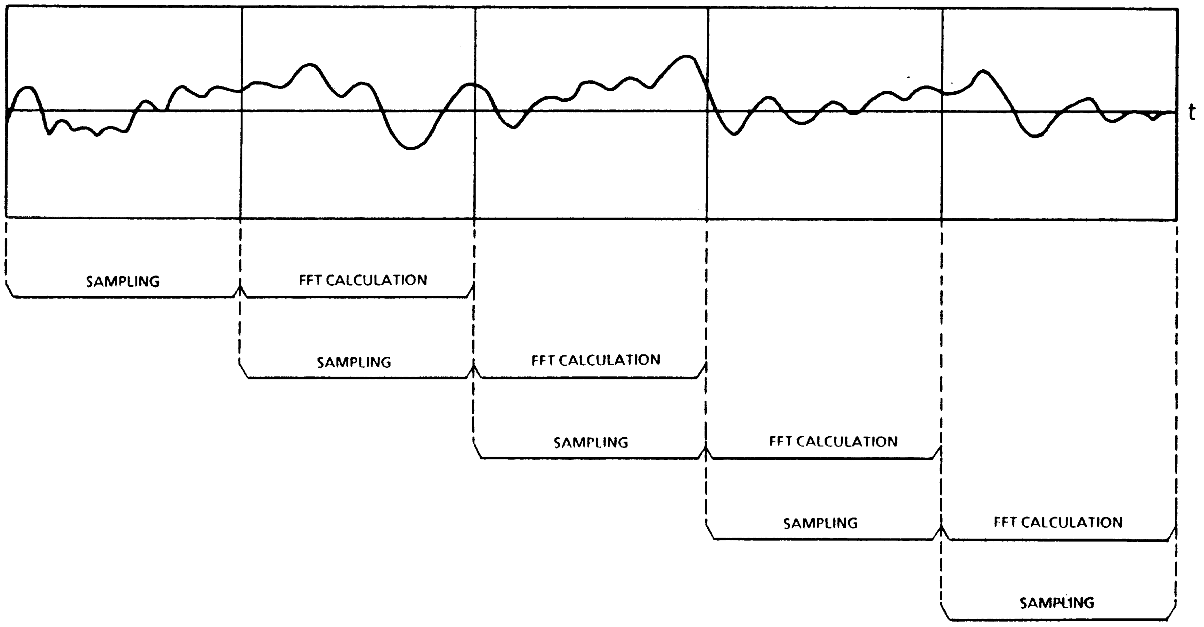


Fig. 3-26 Real-Time Analysis

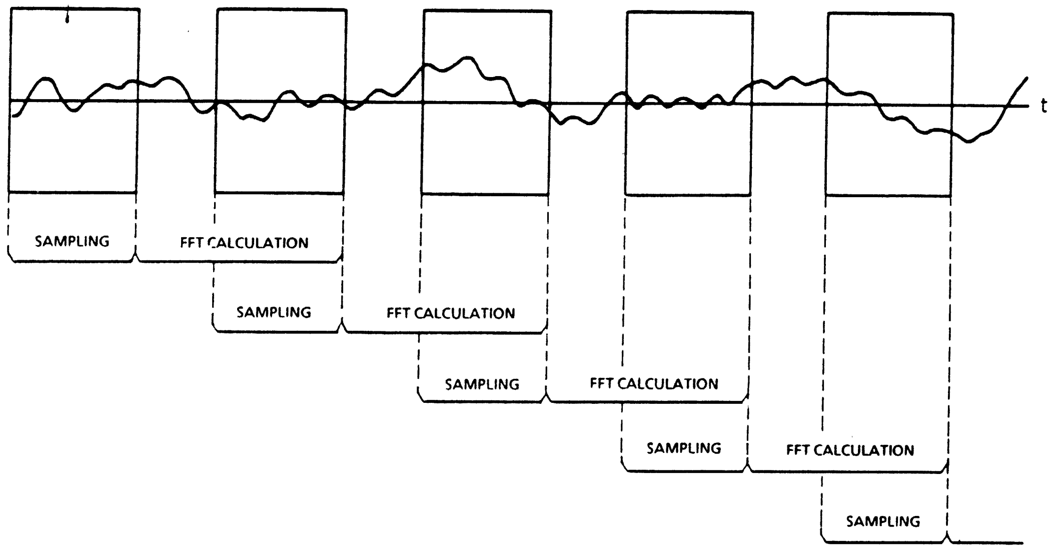


Fig. 3-27 Missing Data Portions Preventing Real-Time Analysis

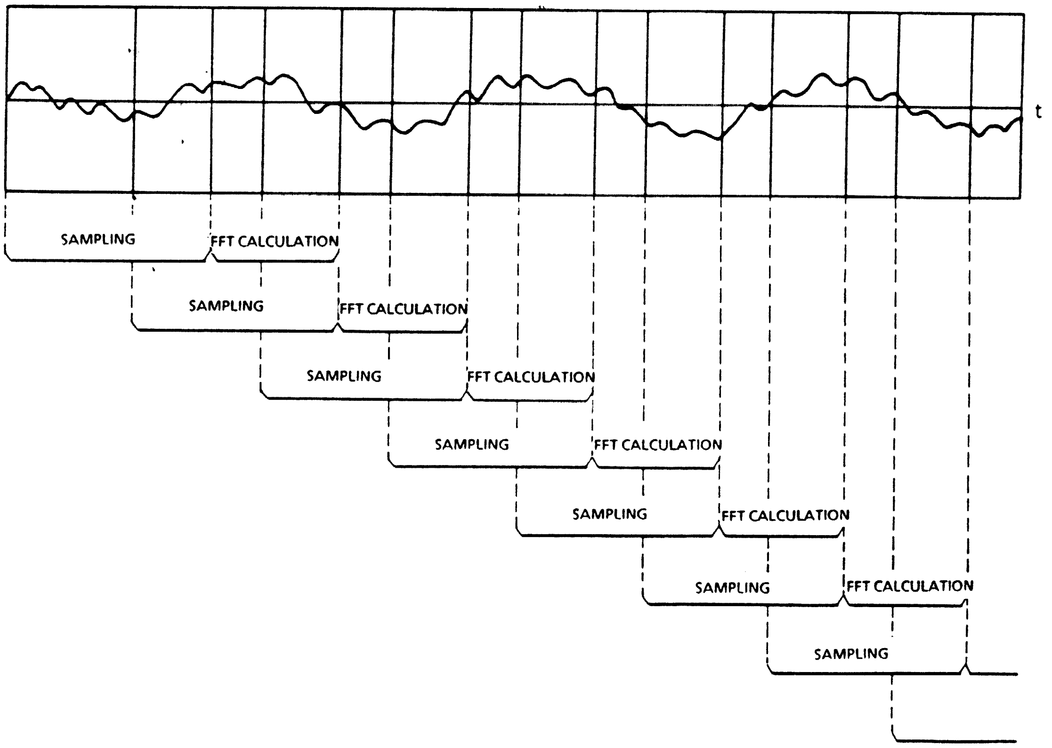


Fig. 3-28 Overlap Between Windows

In the CF-350, real-time analysis is performed in the 2-kHz range. At lower ranges, overlap processing occurs, and at 5-kHz and higher ranges data is missed between windows.

Note

To perform analysis of data at 5 kHz or higher without missing data portions, the data can be first stored in the time record memory and then played back for subsequent analysis.

3.11.2 Setting the Amount of Overlap

At frequency ranges of 2 kHz and lower, it is possible to adjust the amount of overlap between adjacent windows. The overlap can be set to maximum, 50% of the frame or absolutely no overlap.

Note

When the trigger function is being used, overlap processing is not possible. After 1 frame of data is analyzed, the wait condition is entered.

<Procedure>

In the initialized condition, the overlap setting is MAX.

Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

MODE SET

OVERLAP	LENGTH	WINDOW	W SET	DELAY	SP ONLY	SOURCE	RETURN

OVERLAP SET

MAX	50%	0%					RETURN
a	b	c					

a	MAX	....	Sets the maximum overlap.
b	50%	....	Sets the overlap to 50% of a frame.
c	0%	....	Sets the overlap to zero.

3.12 Reducing the Processing Time

By performing only a single processing function and inhibiting others, it is possible to shorten the processing time. This can shorten the averaging time, increase the real-time range and increase the speed of GPIB data transfer. There are three modes available, as described below.

3.12.1 Time-Only Mode

In this mode, only signal capture and time waveform display, with FFT and all other processing and display functions inhibited.

In this mode, the time waveform is stored into the CRT block memory using autostore, enabling continuous, high-speed storage. (Refer to Section 7.1.2 for information in this autostore operation.) The stored waveform can be FFT analyzed by specifying mass memory as the analysis signal source (Refer to Section 7.4). When using this in combination with the display-inhibit function, it is possible to perform continuous capture of time-axis waveforms up to the 20-kHz range without losing data. This mode also increases GPIB transfer speed.

3.12.2 Spectrum-Only Mode

In this mode, only time waveform display, FFT analysis and power spectrum display are performed.

3.12.3 Display-Inhibit Function

When averaging performed, this function inhibits the display of intermediate results, so that only every other result or just the final results are displayed. In addition, this function enables inhibit of the display for except whenever the PAUSE switch is pressed. For the operating procedure, refer to Section 6.9.

Table 3-3 shows the processing times with the time-only mode and display-inhibit function on and off.

No. of spectrum lines	Averaging	Spectrum-only mode	Display-inhibit function	Processing time(ms)	
				Normal mode	High-precision mode
400	OFF	OFF	OFF	198	1064
		OFF	ALL	197	940
		ON	OFF	185	853
		ON	ALL	184	727
	AVG SUM	OFF	OFF	328	1546
		OFF	ON	198	1408
		OFF	1/2	263	1477
		ON	OFF	253	1096
		ON	ON	186	963
		ON	1/2	220	1030
800	OFF		OFF	348	1194
			ALL	263	973
	AVG SUM		OFF	432	1428
			ON	264	1208
			1/2	348	1318

- * For single-frame display of the test signal.
- * 1 Average, SUM: summation average.
- * Display-inhibit function ALL: Inhibit all display update.
  - ON: Inhibit update during averaging
  - 1/2: Update every other pass (the processing time is the average of the processing times with the function on and off.)
- * For an 800-line resolution, cross modes such as the cross spectrum and transfer function are not performed, so that there is very little difference whether or not the spectrum-only mode is on or off.

Table 3-3 Processing Times with the Spectrum-Only Mode and Display-Inhibit Function On and Off

<Procedure>

(a) Time-Only Mode

Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	**COND**	NEXT

CONDITION SET

CONDIT		POL.CHG	SEARCH	HI PREC	**TI ONLY**	PH. adj	RETURN

TIME ONLY MODE

OFF	**ON**						RETURN

(b) Spectrum-Only Mode

Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	**MODE**	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

MODE SET

OVERLAP	LENGTH	WINDOW	W SET	DELAY	**SP ONLY**	SOURCE	RETURN

SPECTRUM ONLY

OFF	**ON**	A weight	V^2				RETURN

3.13 Delay Function

In performing transfer function measurements on mechanical and other systems, if the propagation time through the system is long, resulting in a time delay between the input and the output of the system, accurate transfer function measurement will not be possible. The delay function provides the ability to insert a delay between the two channels of the analyzer, thereby delaying Channel B with respect to Channel A to compensate for this delay.

The Channel B delay can be set up to 65,536 points from the sampling starting point, in 1-point steps.

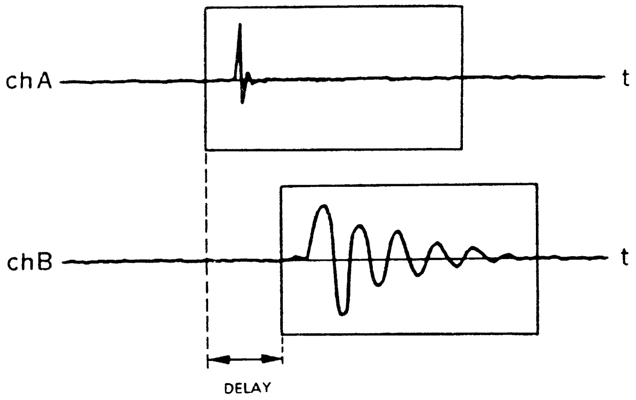


Fig. 3-29 Delay Time

In addition, the following functions are available.

Time Record Memory Playback Delay

It is possible to delay waveform data when playing it back from time record memory. When doing this, playback of Channel B starts first, followed by playback of Channel A after the set number of points. (Refer to Section 7.2.2 (c).)

Phase-Delay Compensation

For the transfer function of an already-captured signal, it is possible to delay Channel B with respect to Channel A by some time expressed in seconds. (Refer to Section 5.8.6.)

<Procedure>

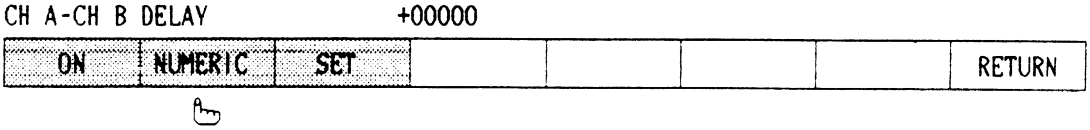
Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

MODE SET

OVERLAP	LENGTH	WINDOW	W SET	DELAY	SP ONLY	SOURCE	RETURN


CH A-CH B DELAY +00000

Press the NUMERIC key.

Use the front-panel numeric keys to set the number of points and then press the SET key to complete the setting procedure.

The phase-delay compensation function is enabled by activating the ON key.

3.14 Time-Interval Function

This function enables a time interval to be inserted between different processing functions. This delay can be set in the range 1 to 9999 seconds.

3.14.1 Interval Between 3-Dimensional Displays

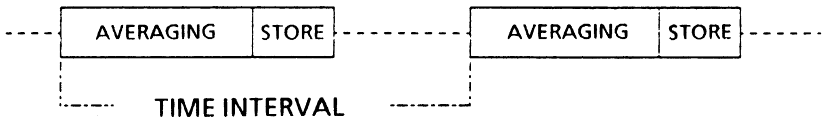
When generating a 3-dimensional display, if the time-interval function is turned on, a line will be displayed every set time interval.

3.14.2 Autostore Time Interval

When performing autostore to the CRT block memory or to the floppy disk drive, if the time-interval function is turned on, a frame will be stored every set time interval. For the autostore operation to the CRT block memory, refer to Section 7.1.2, and for information on autostore operation to floppy disk, refer to Section 7.3.3 (b).

Note

The set interval is the time between the *beginning* of one function and the *beginning* of the next function. For example, when performing averaging, the interval is the time between the beginning of one average (following by a stored) and the start of the next average. Therefore, if the time required for the averaging and storage is longer than the set interval, the interval is invalid and has no effect.



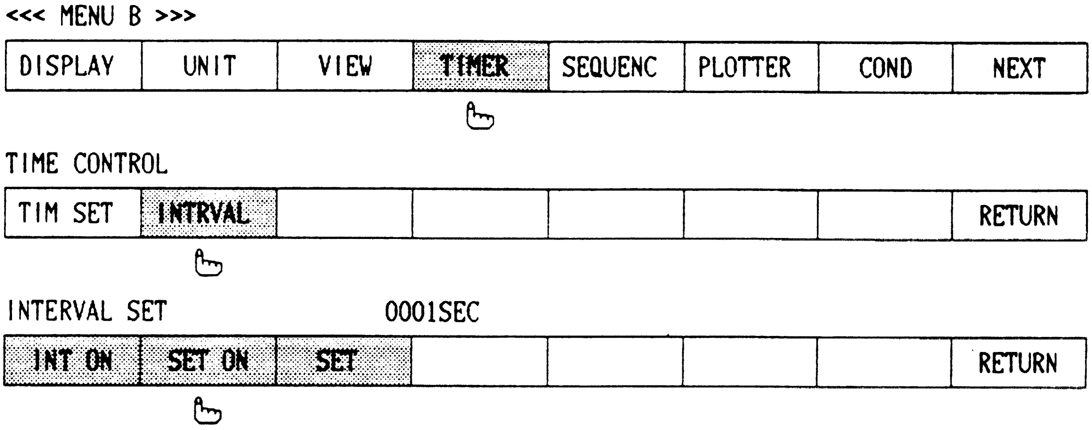
3.14.3 Autosequence Time Interval

If the time-interval function is used in combination with the autosequence function, it is possible to insert a time interval between autosequence steps. The interval can be inserted between all steps or between only selected steps. For the setting method, refer to Section 8.2.6 (c).

<Procedure>

First, place the analyzer into the PAUSE condition.

Then, make the following soft key settings.



Press the SET ON key.

Use the front-panel numeric keys to input the time interval.

Press the SET key to complete the setting.

When the INT ON key is activated, the interval will be inserted, in which case the clock display at the lower part of the CRT display will be highlighted.

3.15 Order Ratio Analysis

3.15.1 External Sampling Clock

In addition to the internal sampling clock of 2.56 the frequency range, the CF-350 can perform sampling of data using an externally applied pulse signal as the sampling clock.

<u>External Sampling Input Specifications</u>

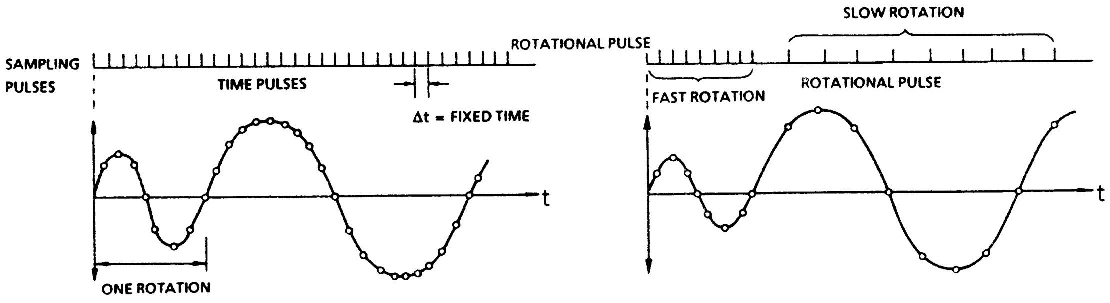
Input level	TTL level (low-to-high transition edge)
Fan-in	1 TTL load
Maximum input frequency	102.4 kHz
Maximum allowable input	100 Vac rms for 1 min. (at 50 Hz)

3.15.2 Order Ratio Analysis

When sampling with an external sampling clock, the spectrum obtained by performing an FFT analysis on the sampled data has an X axis that represents not frequency, but rather *order*. The order ratio analysis function is used chiefly in the analysis of vibration and noise characteristics in rotating machinery such as engines and motors.

(a) Rpm Order Ratio Analysis

Rpm order ratio analysis is a technique used in analysis of the vibration and noise characteristics of rotating machinery. It performed by using the pulse signal from a detector mounted to a rotating member as the external sampling clock.



(a) Internal Sampling Clock
(No. of pulses per
revolution depends
upon the rpm.)

(b) External Sampling Clock
(P samples per
revolution even if
the rpm changes.)

Fig. 3-30 Sampling Clocks

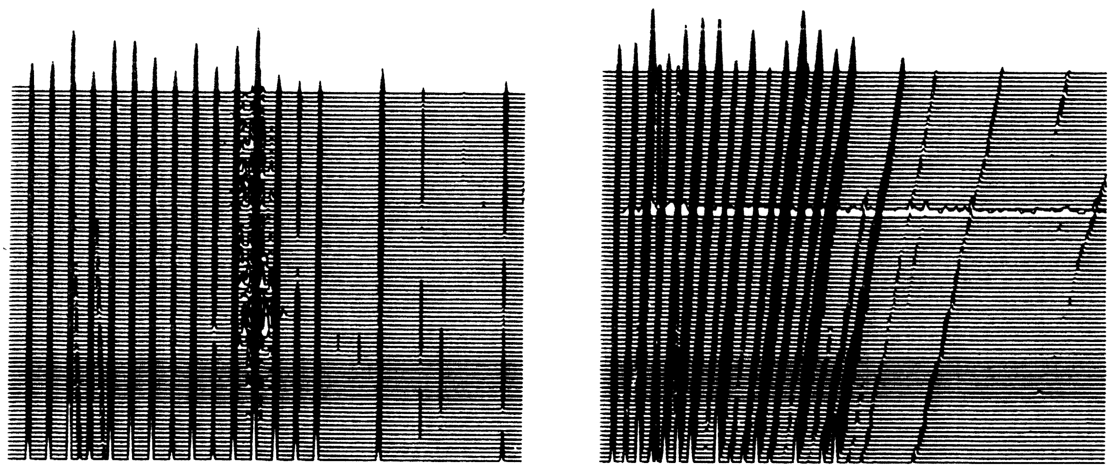
In performing frequency analysis, a 1-Hz component completes one cycle (period) in 1 second. In contrast to this, with rpm order ratio analysis, the 1st order refers to that component which goes through one period for each *revolution*. Similarly, the 2nd order component is the component which completes two periods for each *revolution*--two times the 1st order component. In order to establish the reference of *per revolution*, it is necessary to synchronize the data sampling to the rpm. As can be seen from Fig. 3-31, with the internal sampling clock as the rpm changes the number of sampled points per revolution changes. If sampling is synced to rpm, however, using a rotational pulse, the number of sampled points per revolution remains constant.

For example, for a body rotating at 600 rpm, the 1st order frequency is as follows.

$$\frac{600\,rpm}{60} = 10\,Hz$$

The 2nd order frequency would then be 20 Hz. If the rpm rises to 700 rpm, the 1st order frequency is 11.7 Hz and the 2nd order is 23.3 Hz.

Thus, while the frequency changes as the rpm changes, if normalization in terms of order is performed, the influence of changing rpm is eliminated, thereby facilitating the observation of individual components.



(a) Rpm Order Ratio Analysis (b) Frequency Analysis

Fig. 3-31 Rpm Order Ratio Analysis and Frequency Analysis

In Fig. 3-31 (b), as the rpm is increased, it can be seen that the frequency components in the 3-dimensional display also increase. In Fig. 3-31 (a), however, with normalization to order rather than frequency, the *order* remains constant as the rpm changes.

Rpm Tracking Analysis

One application of rpm order analysis is *rpm tracking analysis*. In rpm tracking analysis, the level variations of a given order component are traced, enabling determination of what components are related to resonances at given rpm speeds and determination of what multiples of rpm speeds (i.e., what orders) exhibit resonances.

When the CF-0382 Tracking & X-Y Output Card is installed in the CF-350, it is possible to execute and display rpm tracking analysis on the CRT display.

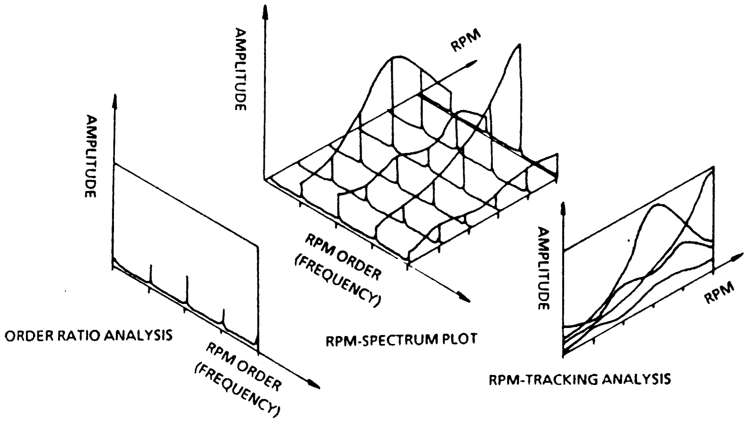


Fig. 3-32 Rpm Tracking Analysis Concept

(b) Maximum Analysis Order and Resolution

In normal frequency analysis with the CF-350, the sampling frequency is 2.56 times the frequency range. Similarly, in rpm order ratio analysis, a pulse signal having a number of pulses equal to 2.56 times the maximum order to be analyzed is input as the external sampling clock. For example, to analyze up to the 10th order, the external sampling clock applied input to the CF-350 should have 25.6 pulse per revolution of the rotating body being analyzed. Under these conditions, the X axis of the resulting spectrum has a full-scale value of 10th order. The spectral resolution is 1/400 for a analysis data length of 1024 points and 1/800 for an analysis data length of 2048 points, so that the 400th or 800th line corresponds to the 10th order. The 40th (or 80th line for 2048 points) line corresponds to the 1st order and the reading resolution is 0.025 order (or 0.0125 order for 2048 points).

When the CF-0382 Tracking & X-Y Output Card is installed in the CF-350, the rotational pulse signal is divided or multiplied as required to provide the proper sampling clock for the maximum order to be analyzed.

(c) Rpm Order Analysis and Aliasing

As is the case with normal frequency analysis, in rpm order ratio analysis the aliasing phenomenon occurs, making it necessary to use an anti-aliasing filter.

If the order to be analyzed is X and the rpm is N_m, the frequency f_x of the X-th order is given as follows.

$$f_x = X \cdot \frac{N_m}{60} \; [Hz]$$

For example, for X = 25th order and $N_m = 2000$ rpm, we have.

$$f_x = 25 \times \frac{2000}{60} = 833.3 \, [Hz]$$

Since the frequency to be analyzed is 833.3 Hz, aliasing can be eliminated by using a lowpass filter to cut out components higher than 833.3 Hz.

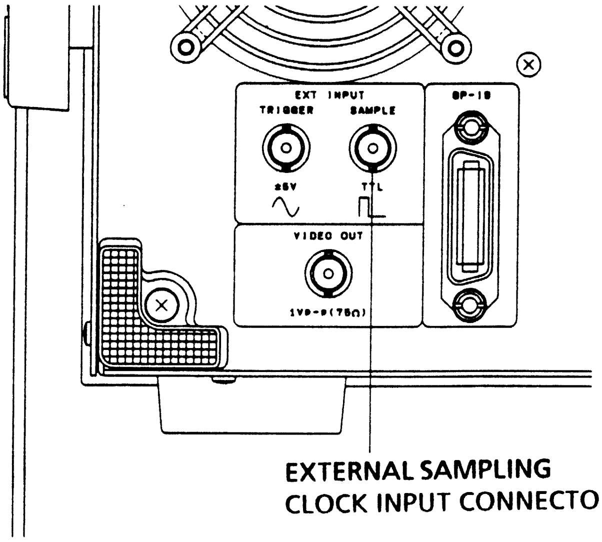
In the CF-350, even when an external sampling clock is used, the anti-aliasing filter is operative. In this example, if we set the frequency range to 1 kHz, components above 1 kHz will be eliminated.

However, in this case if the rpm increases to 1000 rpm, aliasing might occur. Since the 25th order frequency in this case is 416.7 Hz, the solution is to switch the frequency range setting to 500 Hz. If the frequency to be analyzed does not match one of the frequency range settings, or if analysis is to be performed while varying the rpm (such as in rpm tracking analysis), it will be necessary to use a separate tracking filter.

<Procedure>

(d) Input of the External Sampling Clock

Apply the pulse signal to the rear-panel external sampling clock input connector.



EXTERNAL SAMPLING
CLOCK INPUT CONNECTOR

(e) Selection of the External Sampling Clock

Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

CONDITION SET

CONDIT		POL.CHG	SEARCH	HI PREC	TI ONLY	PH. adj	RETURN

CONDITION

BUZ ON	AUTO ON	TEST ON	FILT ON	CLK INT	DC CANC	A/D OVR	RETURN

In the initialized condition, the internal sampling clock is selected, so that the CLK INT key is on.

If the CLK INT key is turned off, the external sampling clock is enabled and the input from the rear-panel connector described above will be used as the sampling clock.

4. PROCESSING FUNCTIONS

4.1 Time Domain

4.1.1 Time Waveform

The time waveforms of the signals input to Channel A and Channel B front-panel connectors are sampled at 1024 points (for 2-channel analysis) or either 1024 or 2048 points (for 1-channel analysis) and displayed on a single frame. The X axis represents time (in seconds) starting at zero and the Y axis represents voltage starting at zero and ranging to a peak voltage. The full-scale range of the X axis will depend upon the frequency range setting.

<Procedure>

Press the CH A or CH B TIME switch of the DISPLAY group.

X-Axis Units and Scaling

- The display can be expanded.
  - Place the analyzer in the PAUSE condition.

① Move the cursor to the left edge of the section of the display to be expanded.

② Press the ΔSET switch of the SEARCH group. A delta cursor will appear at the search point position.

③ Move the search point to the right edge of the section of the display to be expanded.

④ Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

DISPLAY

FORMAT	LIST	3-ARRAY	COH	NYQ.ORB	P.OV	INHIBIT	RETURN

FORMAT

SPLIT	OVERLAY	GRID ON	BODE ON	MAG LOG		X EXPAN	RETURN

Press the X EXPAN key to turn it off, thereby returning to the normal display.

Y-Axis Units and Scaling

- The units and reading values can be changed by using the EU function.

  For the setting method, refer to Section 6.2.

  To display the Y axis in the set engineering units, press the EU switch of the SEARCH group.

- The display position can be moved (i.e., the reference changed) and the display expanded (i.e,, the gain changed).

  Reference function display setting range: 3 times the full scale established by the range

  Gain function display setting range: 1/10 to 2000 times (1-2-5 steps)

When the REF/GAIN switch (of the Y group) LED is lighted, the reference function is set and when the LED is extinguished, the GAIN function is set. The up and down switches are used to make these settings.

Each time the REF/GAIN switch is pressed, the soft key menus corresponding to each of these functions appear. If the ON key is turned on, the reference function is enabled. The gain function is enabled by setting the YLOG switch of the SEARCH group off.

For information on soft key settings, refer to Section 6.1.4.

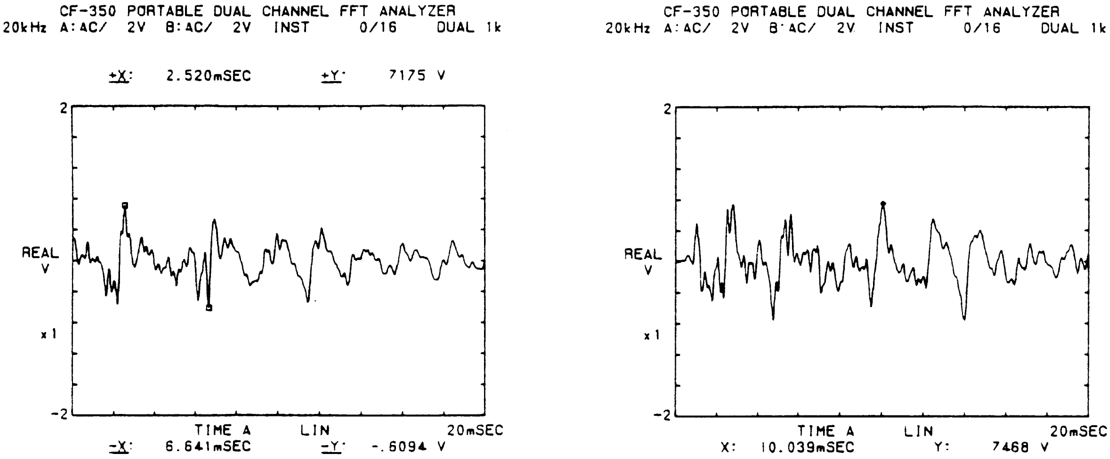
<u>Reading Values</u>

- With search point off

  In the upper part of the CRT, the time of the maximum value (+X) (from the beginning of the frame) and the corresponding voltage level (+Y) are displayed. Similarly, the bottom part of the CRT indicates the time of the minimum value (−X) and the corresponding voltage level value (−Y).
  For a dual-frame display, the difference (Y) between the maximum and minimum values and the time difference (X) between these two points are displayed

- With the search point on

  The time (X) and voltage level (Y) at the search point are displayed at the bottom of the screen.



(a) Search Point Off (b) Search Point On

Fig. 4-1 Time-Axis Waveform

4.1.2 Auto/Cross Correlation Functions

(a) Auto-Correlation Function

The auto-correlation function is defined by the following expression as a function of τ by using a waveform $x(t)$ that it shifted by an amount τ to form the waveform $x(t + \tau)$.

$$R_{xx}(\tau) = \lim_{T \to \infty} \frac{1}{T} \int_{-T/2}^{T/2} x(t)\, x(t+\tau)\, dt$$

The auto-correlation function is an effective means of determining the period of a waveform. Fig. 4-2 shows a 500-Hz sinewave and its auto-correlation function. When $\tau = 0$, the auto-correlation is at maximum and it takes the same maximum value every 2 milliseconds. Thus, the auto-correlation is maximum at a delay of zero--essentially the product of waveform with itself--and, if the waveform is periodic, the auto-correlation function will exhibit a peak having the same period.

With non-deterministic signals, for slowly changing signals, the value of the function increases with increasing τ and for signals that change fast, the value of the function is high for small values of τ. This can be used as a guide to the time variations of the original signal.

In the CF-350, the auto-correlation is determined from the inverse Fourier transform of the power spectrum.

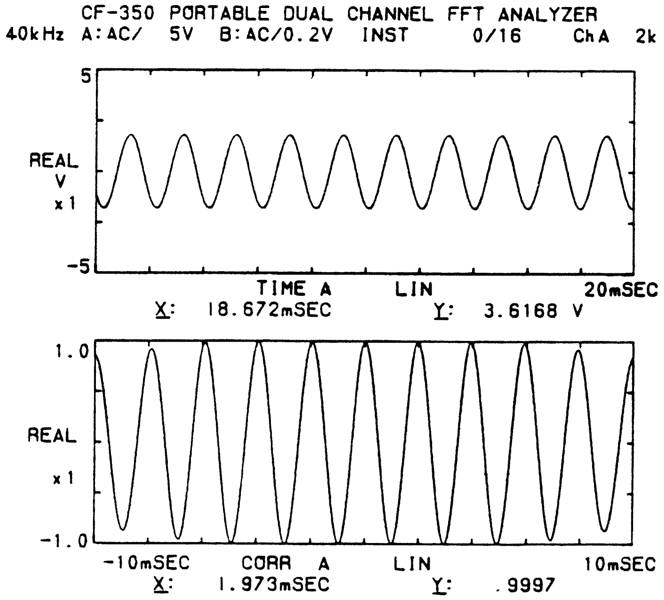


Fig. 4-2 500-Hz Sinewave Time-Axis Waveform (top) and Auto-Correlation Function (bottom)

<Procedure>

Press either the CH A or the CH B CORR switch of the DISPLAY group.

X-Axis Units and Scaling

- It is possible to expand the display. Refer to the procedure described at the beginning of this section.

Y-Axis Units and Scaling

- The display position can be moved (i.e., the reference changed) and the display expanded (i.e., the gain changed). Refer to the procedure described at the beginning of this section.

Reading Values

- With search point off

  The time (X) at the maximum value and the corresponding level (Y) will be displayed at the bottom of the CRT screen.

(b) Cross Correlation Function

The cross correlation function is defined as a function of τ that is determined by shifting one of two waveforms by an amount τ, according to the equation below.

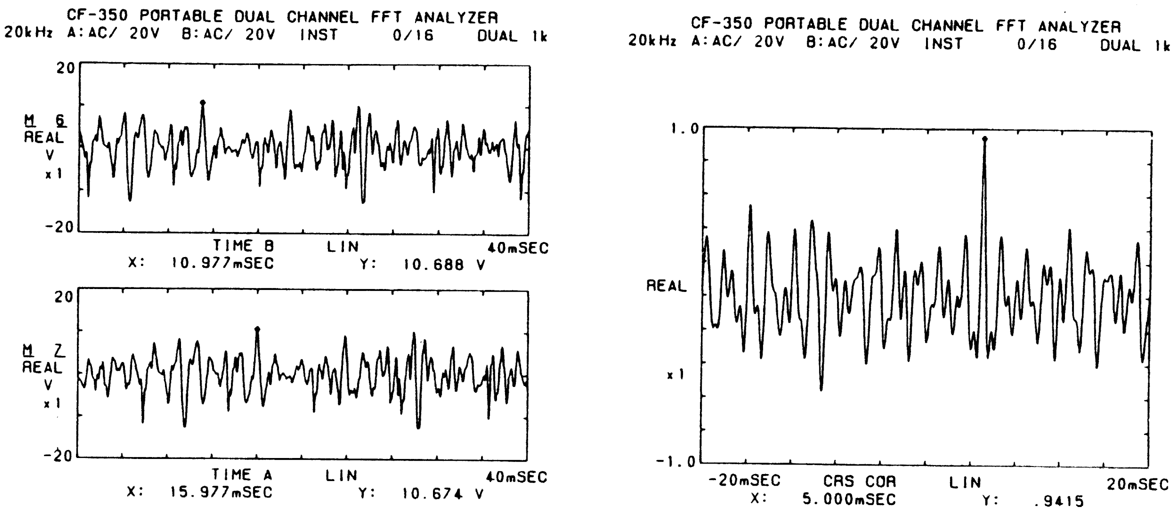
$$R_{xy}(\tau) = \lim_{T\to\infty} \frac{1}{T} \int_{-T/2}^{T/2} x(t)\,y(t+\tau)\,dt$$

The cross correlation is a measure of the similarity between two signals or the time shift between two signals. For two completely different signals, the value of the function would approach zero regardless of the value of τ. Fig. 4-3 shows an example of a measurement of the cross correlation of a waveform with the same waveform shifted by an amount γ. Note that the maximum value is observed when $\tau = \gamma$. The cross correlation function is also used between the input and output signals of a system to determine the time delay of the system, to detect elusive signals buried in noise and to determine signal propagation paths.

In the CF-350, the cross correlation is determined from the inverse Fourier transform of the cross spectrum.

Cross Correlation Function and Averaging

The cross correlation between unrelated noise signals is, in principal, zero. However, in practice, when performing calculations with finite values, this will not completely reach zero. The value can be made to approach zero, however, by performing a large number of averages.



(a) Waveform Before (top) and After 5-ms Delay (b) Cross Correlation

Fig. 4-3 Cross Correlation Function

<Display Method>

Press the CORR switch of the CROSS subsection of the DISPLAY group.

X-Axis Units and Scaling

- It is possible to expand the display. Refer to the procedure described in Section 4.1.1.

Y-Axis Units and Scaling

- The display position can be moved (i.e., the reference changed) and the display expanded (i.e., the gain changed). Refer to the procedure described in Section 4.1.1.

Reading Values

- With search point off

  The time (X) at the maximum value and the corresponding level (Y) will be displayed at the bottom of the CRT screen.

4.1.3 Impulse Response

The response of a system *h(t)* to a unit impulse stimulus *δ(t)* is known as the system's *impulse response*. The impulse response is an expression of the characteristics of the system in the time domain, as contrast to the transfer function, which expresses the system's characteristics in the frequency domain.

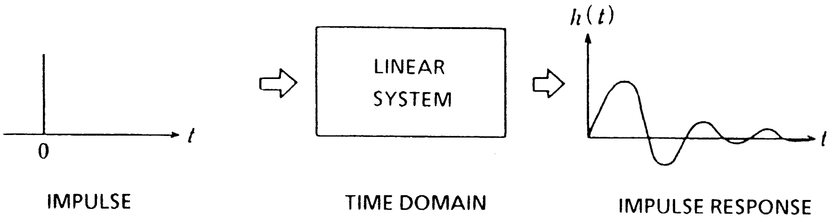


Fig. 4-4 Impulse Response

If the impulse response of a system is known, it is possible to determine the output *y(t)* of the system in response to an input of *x(t)* by means of a convolution calculation.

In the FFT analyzer, the impulse response is determined from the inverse Fourier transform of the current transfer function.

<Display Method>

The impulse response is calculated from the current transfer function. It is also possible to calculate the impulse response from the *1/H* of the transfer function and from an equalized transfer function.

- Displaying the transfer function

  Press the IMP R switch of the CROSS subgroup of the DISPLAY group.

The procedure described below is then used to calculate the impulse response from transfer function data after multiplications divisions or *jω* processing, or transfer function data recalled to the display from memory.

- Display the transfer function. For a dual-frame display, display it on the bottom part of the screen.

  Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

FUNCTION SET 2

IFFT	ENVELOP	LOOP	XFER	FITTING	ZOOM		RETURN

X FER

NICO	1/H	conv SV	CRT IMP				RETURN

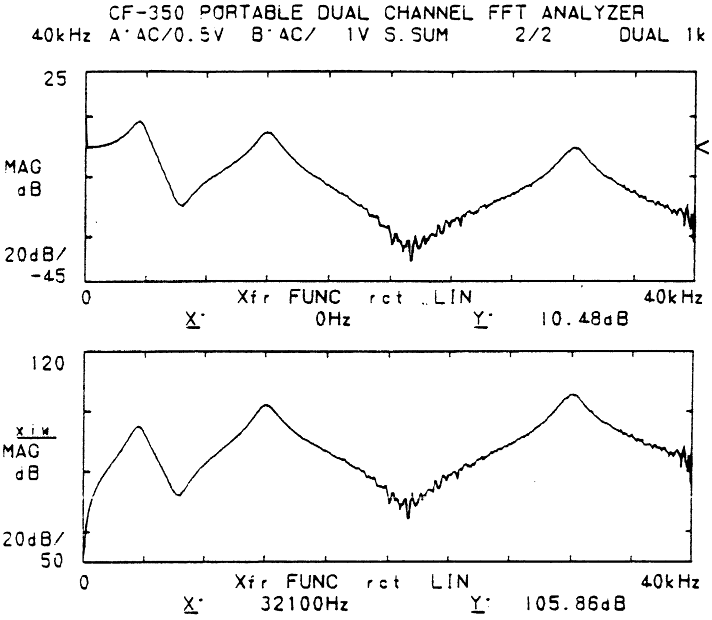
If the CRT IMP key was already on, turn it off and then on once again.

Press the IMP R switch of the CROSS subgroup of the DISPLAY group.

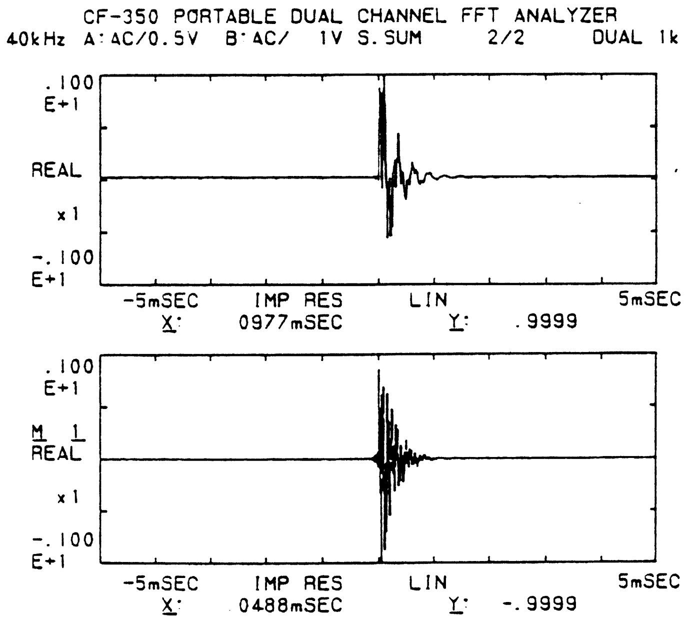
Notes

1. If the CRT IMP key is set to off and then turned on once again when a waveform other than the one from which the impulse response is to be determined is being displayed, the impulse response of the original data will be displayed.

2. It is not possible to determine the impulse response from a 4-decade transfer function.



(a) Transfer Function (top) and Same after jω Processing

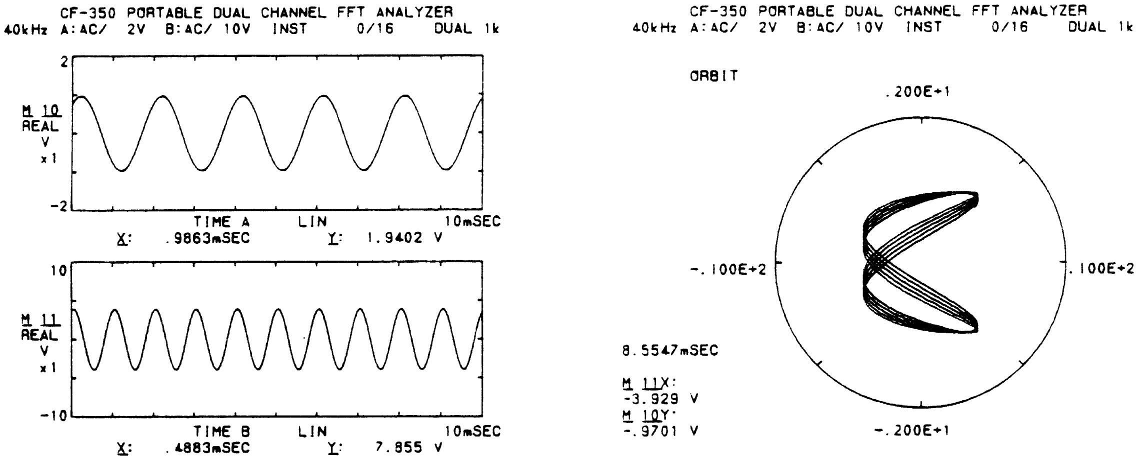


(b) Impulse Response of a Measured Transfer Function (top) and the Impulse Response after jω Processing (bottom)

Fig. 4-5 Impulse Response of Transfer Function after jω Processing

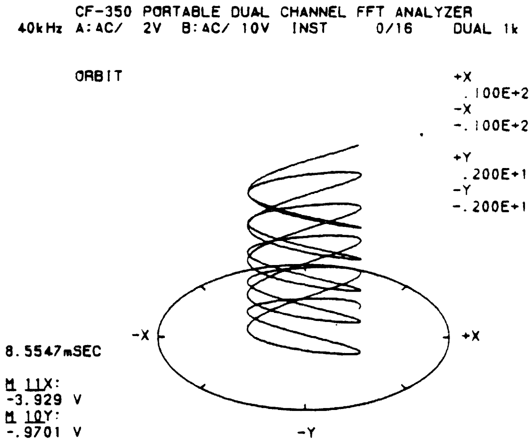
4.1.4 Orbit (Lissajous) Display

A display of a synthesized pattern on the X and Y axes that cross two signals is known as an orbit or lissajous pattern display. This provides a means of visualizing the amplitude, frequency and phase differences between the two signals. When the frequency ratio between the two signals is an integer, the pattern will return to the original point after a fixed period.



(a) Time-Axis Waveform

(b) Orbit



(c) Perspective Display

Fig. 4-6 Orbit Display

<Display Method>

Display the desired traces on a dual-frame display.

Press the NYQ switch of the DISPLAY group.

Orbit Perspective Display

Display the orbit pattern.

Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

DISPLAY

FORMAT	LIST	3-ARRAY	COH	NYQ.ORB	P.OV	INHIBIT	RETURN

NYQUIST

LIMIT	SET	3D	+ROTATE	-ROTATE	COLE	Xfr M-P	RETURN
		a	b	c			

a	3D	Selects a perspective display when turned on.
b	+ROTATE	Rotates the display 45° CW each time it is pressed.
c	−ROTATE	Rotates the display 45° CCW each time it is pressed.

Changing the Reference and Gain

It is possible to move the display position (i.e., to change the reference) and to expand the display (i.e., change the gain). For the method of doing this, refer to Section 6.1.4. However, it should be remembered that the reference function is activated when the LOW soft key is on and the gain function is activated when the YLOG switch of the SEARCH group is off *and* UP soft key is on.

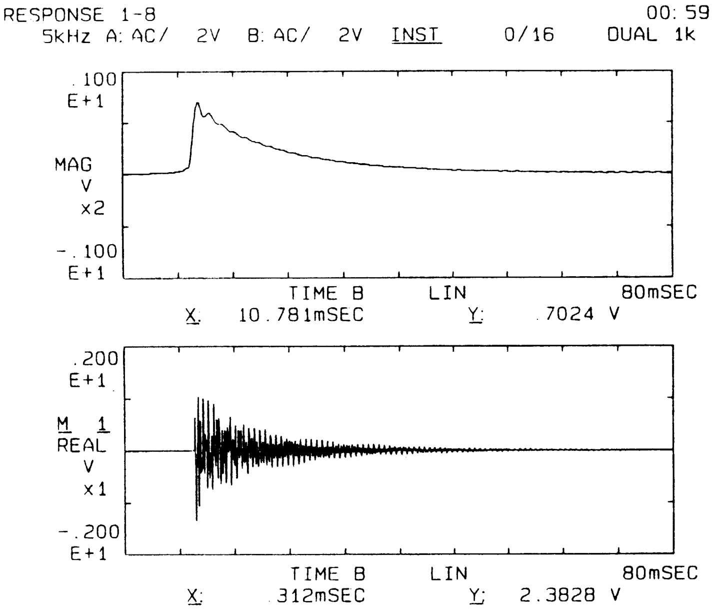
Reading Values

- With the search point off

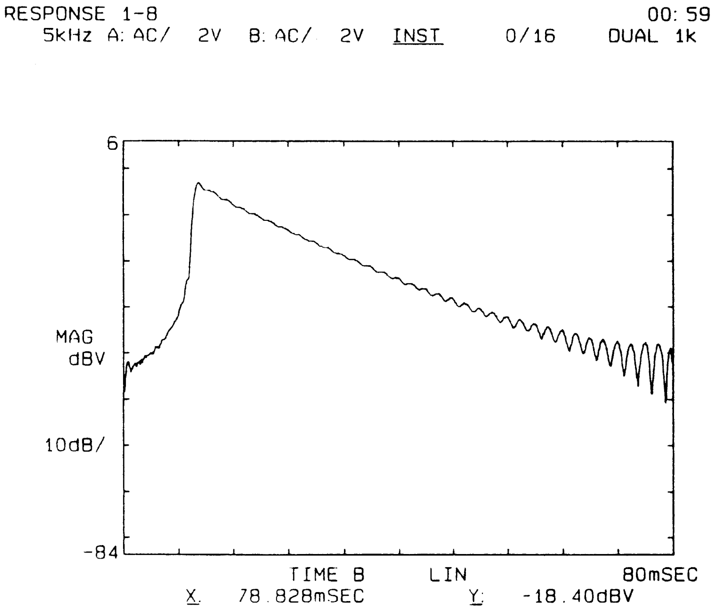
  The time at the maximum value (X) and corresponding level (Y) are displayed in the lower left of the CRT screen.

4.1.5 Time Envelope (Hilbert Transform)

In the CF-350, the Hilbert transform can be used to determine the time envelope. The real and imaginary parts determined by the Hilbert transform, the time envelope, the Nyquist plot obtained by plotting the imaginary part on the Y axis and the real part on the X axis, and a perspective Nyquist plot can be displayed. When performing the Hilbert transform, it is possible to limit the bandwidth on the frequency axis.



(a) Damped Waveform (bottom) and Corresponding Time Envelope with Linear Y axis (top)



(b) Display with Log Y Axis

Fig. 4-7 Time Envelope

Calculation of the Logarithmic Damping Factor Using the Hilbert Transform

① Display the time envelope with log scaling.

② Use the search function to read the ΔX and ΔY values from the displayed graph.

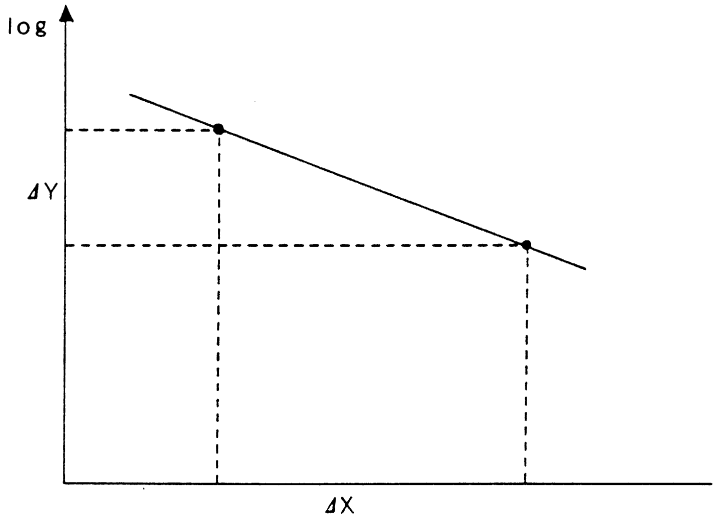


Fig. 4-8 Calculation of Logarithmic Damping Factor

③ Substitute the values read into the following equations and solve.

For the logarithmic damping factor δ:

$$\delta = \left| \frac{\Delta Y}{\Delta X} \right| \cdot \frac{ln\,10}{20} \cdot \frac{1}{f_n} = 0.1151 \cdot \left| \frac{\Delta Y}{\Delta X} \right| \cdot \frac{1}{f_n}$$

For the damping factor ξ:

$$\xi \simeq \frac{\delta}{2\pi} = 0.01832 \left| \frac{\Delta Y}{\Delta X} \right| \cdot \frac{1}{f_n}$$

In the above, f_n is the resonant frequency.

When an exponential window has been applied, the value of ξ determined above is compensated as follows.

$$\xi' = \xi - \lambda$$

$$\lambda = - \frac{ln\,(\frac{X}{100})}{\omega_n T}$$

X: Exponential window setting value (%)

ω_n: $2\pi f_n$ (rad/s)

T: Data frame length (s)

(For information on the exponential window, refer to Section 3.9.2 (e).)

<Procedure>

- Place the analyzer in the START condition.

- Select a rectangular window. For any other type of window, the shape of the window will have an influence.

- If signals are being input on both Channel A and Channel B, perform a Hilbert transform on both channels.

① Set the bandlimiting.

Display the spectrum of Ch A or Ch B and make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

FUNCTION SET 2

IFFT	ENVELOP	LOOP	XFER	FITTING	ZOOM		RETURN

ENVELOPE CONT

OFF	ON	MAG	LOG	BAND	SET		RETURN
	c	d	e	a	b		

Move the search point to the lower edge of the range for bandlimiting and press the ΔSET switch, at which point the delta cursor will appear.

Next, move the search point to the upper edge of the range for bandlimiting and press the sequence BAND → SET . The message "complete" will appear on the CRT.

② Obtain a dual-frame display of the time-axis waveform and the auto-correlation function.

③ When the ON key is pressed, the Hilbert transform will be executed.

Note The CF-350 must be in the START condition.

The relationship of switches and the display is as follows.

TIME switch ..... Real part

CORR switch .... Imaginary part

Note

For a dual-frame display, the TIME switch displays the real part of the complex signal. For a single-frame display, the original time waveform without the influence of bandlimiting and the window is displayed.

The CORR switch displays the imaginary part of a complex signal for both display modes, so that the auto-correlation cannot be displayed.

However, if after executing the Hilbert transform the PAUSE condition is enabled, the TIME switch will display the real part even for a single-frame display.

When the MAG key is pressed, the time envelope will be displayed on the screen corresponding to the CORR switch.

④ When the LOG key is pressed, the vertical axis of the time envelope display is logarithmically scaled.

Nyquist Display Of the Time Envelope

Obtain a dual-frame display of TIME and CORR and display the time envelope. This is done by pressing the NYQ switch of the DISPLAY group.

For information on the perspective display, refer to Section 4.1.4.

4.2 Amplitude Domain

4.2.1 Amplitude Probability Density Function

The amplitude probability density function is a measure of the probability that a signal will exist a given amplitude, with the horizontal axis representing amplitudes (V) and the vertical axis representing probability, normalized to a maximum value of 1. In the CF-350, the amplitude levels are obtained by dividing the voltage range into 256 levels. From the amplitude probability density function it is possible to determine the extent of variations in signal level and the shape of the function can be used in making go/no-go comparisons.

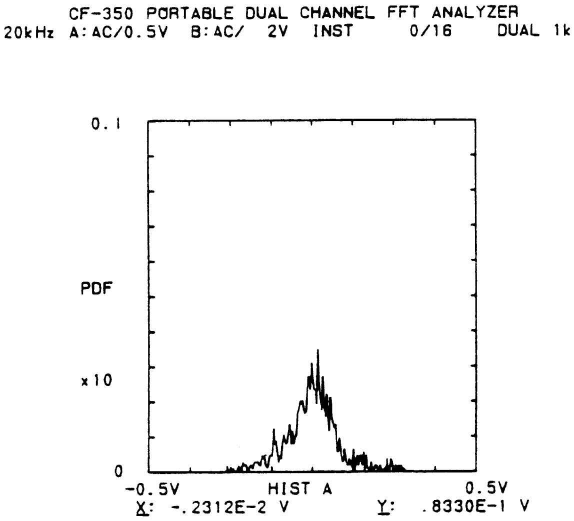


Fig. 4-9 Amplitude Probability Density Function

<Procedure>

Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

AVERAGE SET

PWR SP	TIME	HIST	FOURIER	MAXoval	DISPLAY	CONTROL	RETURN

HISTOGRAM AVG

SUM		HIST A	HIST B		INC	DEC	RETURN
		a	b				

a	HIST A	Displays the amplitude probability density function of the Ch A signal.
a	HIST B	Displays the amplitude probability density function of the Ch B signal.

The notation FDF will be displayed on the left of the CRT.

X-axis Units and Scaling

- The display can be expanded.

  For the procedure, refer to Section 4.1.1.

- The units and reading values can be changed by using the EU function. Refer to Section 6.2 for the setting method.

Y-Axis Units and Scaling

- The display may be expanded by changing the gain. Refer to Section 6.1.4 for the procedure to do this. However, remember that this will work only if the YLOG switch of the SEARCH group is off.

Reading Values

- With search point off

  The average value (X) and the standard deviation (Y) are displayed at the bottom of the CRT screen.

4.2.2 Amplitude Probability Distribution Function

This function expresses the probability that an instantaneously changing time-axis signal will, at any given instant, be below a given level. It is determined by integrating the amplitude probability density function.

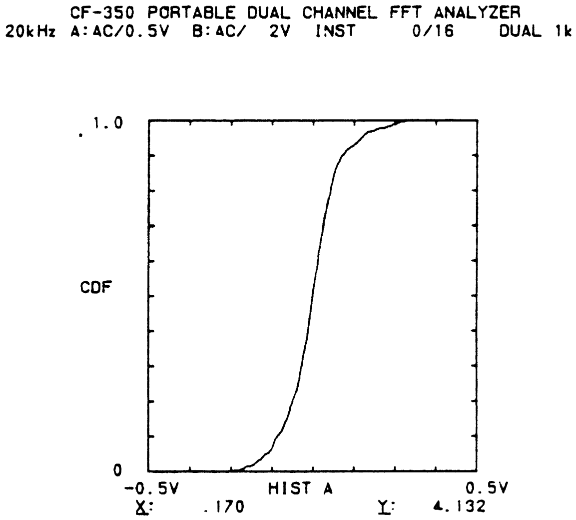


Fig. 4-10 Amplitude Probability Distribution Function

(c) Kurtosis

The kurtosis is the 4th moment about the mean normalized by σ^4, and this is used as an index of the peakiness about the mean value.

It is determined by the following relationship.

$$K = (\sum_{i=0}^{255} (x_i - \mu)^4 P(x_i))/\sigma^4$$

< Display Method >

Display the amplitude probability distribution function and turn the search point off. The kurtosis value will be displayed after Y: at the bottom of the CRT screen.

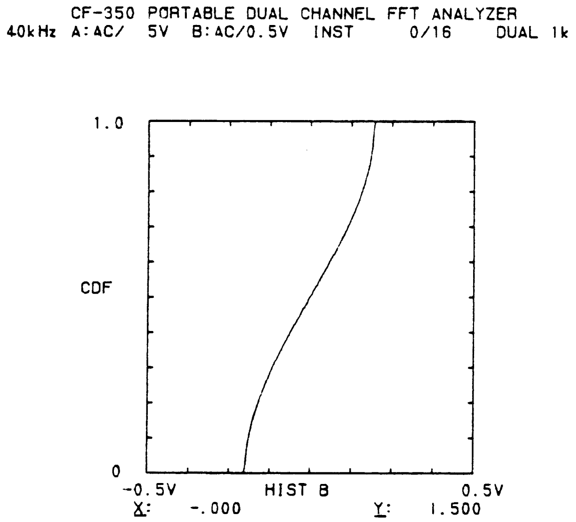


Fig. 4-12 Skewness (X) and Kurtosis (Y)

4.3 Frequency Domain

4.3.1 Power Spectrum

The power spectrum is determined by dividing the analyzed frequency range into even parts and determining the power included in each division. The power spectrum function is expressed in units of V^2 (the square of the amplitude).

In an FFT analyzer, the Fourier transform calculates a frequency-domain waveform from a time-axis waveform. The Fourier transform of a time function *x(t)* is expressed as follows.

$$X(f) = \int_{0}^{\infty} x(t)\, e^{-j2\pi ft}\, dt \quad (Fourier\ Transform)$$

$$x(t) = \int_{-\infty}^{\infty} X(f)\, e^{j2\pi ft}\, dt \quad (Inverse\ Fourier\ Transform)$$

The complex function *X(f)* is the Fourier spectrum of the time function *x(t)*. As shown in the relationships above, if the Fourier spectrum is known, it is possible to determine the original time-axis waveform.

In actual practice, since the transform is determined from a finite number of samples, the resulting transform is a *Discrete Fourier Transform*. The fast Fourier transform determined in the FFT analyzer is, then, a high-speed version of this DFT.

The dimension of the power spectrum is V^2. In the CF-350, this is $\sqrt{V^2}$ for linear scaling display. Therefore, this coincides with the single-ended amplitude value of the time waveform for each frequency. The V^2 display is also possible using soft keys.

In the initialized state, the X axis represents frequency and the Y axis is logarithmic, with 0 dB corresponding to 1 V.

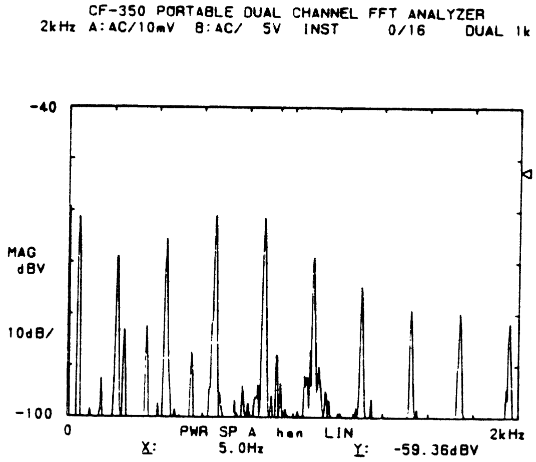


Fig. 4-13 Power Spectrum

<Display Method>

(a) Power Spectrum Display

Channel A .... Press the CH A SPEC switch of the DISPLAY group.

Channel B .... Press the CH B SPEC switch

(b) Fourier Spectrum Display

First, display the power spectrum of either Channel A or Channel B.

Real part	Press the REAL switch of the DISPLAY group.
Imaginary part	Press the IMAG switch.

X-Axis Units and Scaling

In the initialized state, the units are set to Hz, and this can be changed to CPM, Order or seconds.

● CPM (cycles per minute)	Displays the number of cycles per minute (60 times the frequency in Hz).
● ORDER (harmonic order)	Displays the harmonic order with respect to a frequency selected as the fundamental. For the fundamental frequency setting method, refer to Section 6.6.1.
● sec (period)	Indicates the period (reciprocal of Hz).

Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

UNIT SET

UNIT X	UNIT Y	Ch A EU	Ch B EU	HARMNIC			RETURN

UNIT X

Hz	CPM	ORDER	SEC				RETURN
a	b	c	d				

Press keys *a* thru *d* to make the desired selection.

- Logarithmic scaling is possible by pressing the XLOG switch of the SEARCH group.
- The display can be expanded. Refer to Section 4.1.1 for the procedure for this.

Y-Axis Units and Scaling

- Rms value display is possible. Refer to Section 6.2.4 for the procedure.
- The units and reading values can be changed by using the EU function. Refer to Section 6.2 for the procedure. To display the Y-axis in the set EU values, press the EU switch of the SEARCH group.
- In the initialized state, the $\sqrt{V^2}$ is logarithmically scaled. This can be changed to linear scaling, V^2 display or MAG LOG display.

- Linear Scaling

Set the the YLOG switch of the SEARCH group to off. The linear power spectrum amplitude values correspond to the zero-to-peak values for the time waveform of each of the frequency components.

- V^2 Display

Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

MODE SET

OVERLAP	LENGTH	WINDOW	W SET	DELAY	SP ONLY	SOURCE	RETURN

SPECTRUM ONLY

OFF	ON	Aweight	V^2	OA DISP			RETURN

If the V^2 key is switched on with linear scaling in effect, a linear representation of the power spectrum is displayed.

- MAG LOG Display

With a log scaled display, reading values are expressed as linear V and V^2 values.

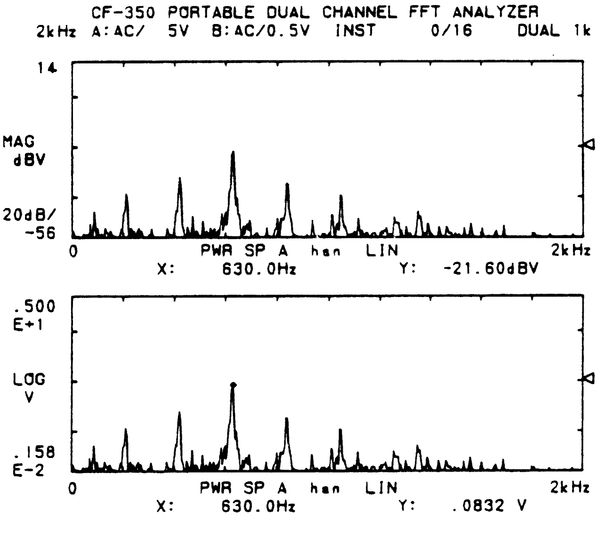


Fig. 4-14 MAG LOG (bottom)

Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

DISPLAY

FORMAT	LIST	3-ARRAY	COH	NYQ.ORB	P.OV	INHIBIT	RETURN

FORMAT

SPLIT	OVERLAY	GRID ON	BODE ON	MAG LOG		X EXPAN	RETURN

- It is possible to move the display position (i.e., to change the reference) and the expand the display (i.e., to change the gain).

Reference function display setting range

Log scaling	200 to −200 dB
Linear scaling	3 times the full scale established by the gain

Gain function display setting range

Log scaling	20 to 200 dB full scale (10-dB steps)
Linear scaling	1/10 to 2000 times (1-2-5 steps)

When the REF/GAIN switch (of the Y group) LED is lighted, the reference function is set and when the LED is extinguished, the GAIN function is set. The up and down switches are used to make these settings.

Each time the REF/GAIN switch is pressed, the soft key menus corresponding to each of these functions appear. If the ON key is turn on, the reference function is enabled. The gain function is enabled by setting the YLOG switch of the SEARCH group off.

For information on soft key settings, refer to Section 6.1.4.

Reading Values

- With search point off

  The frequency (X) and level (Y) at the maximum value are displayed at the bottom of the screen.

- With the search point on

  The frequency (X) and level (Y) at the search point are displayed at the bottom of the screen.

Power Spectrum Auditory Weighting Compensation

In the CF-350, when performing octave analysis and even when performing narrowband spectrum analysis, it is possible to apply (or not apply, as desired) auditory weighting compensation.

Note

This function is usable only in the 1, 2, 5, 10 and 20-kHz ranges.

<Procedure>

Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

MODE SET

OVERLAP	LENGTH	WINDOW	W SET	DELAY	SP ONLY	SOURCE	RETURN

SPECTRUM ONLY

OFF	ON	Aweight	V^2	OA DISP			RETURN

4.3.2 Octave Analysis

In contrast to the power spectrum, which represents the power contained in each of a number of evenly divided section of frequency band, analog-type frequency analysis equipment has traditionally employed a logarithmic frequency axis with even divisions on *this* axis obtained by passing the signal through a series of filters having geometrically incremented passbands (i.e., uniform *ratios* between top and bottom ends of the filter passbands). Commonly used passbands are 1/3 octave and 1 octave, with this type of analysis being known as *octave analysis*, a widely used measurement technique in the field of acoustics.

In general, if f_2 is double the frequency of f_1 on the frequency axis, the span between these two frequencies is called *one octave*. The center frequency is given by $\sqrt{f_1 f_2} = \sqrt{2}\, f_1 = f_2/\sqrt{2}$. The 1/3 octave bands split the octave further into 3 equal sub-bands. In this scheme f_2 is $2^{1/3}$ times f_1 and the center frequency is $2^{1/6} f_1 = f_2/2^{1/6}$.

ANSI Class III standards establish the octave band center frequencies and filter characteristics to which analog frequency analysis equipment conforms. In the FFT analyzer, the power spectrum is first determined and then 1/3 and 1 octave band analysis is performed, although the results in the CF-350 (30-band 1/3-octave analysis and part of the 15-band 1/3-octave analysis) conform to ANSI Class III standards . As can be seen from Fig. 4-15, the filter characteristics also conform to ANSI Class III standards. However, the uppermost band of a frequency range, e.g. the 20-kHz band for 20 kHz does not have any leakage from the next highest (in this example 25-kHz) band. The apparent filter characteristics have been made to conform to ANSI Class III MIN standards. This means that grouping into octaves is possible without having to consider the leakage from other bands (SHARP soft key).

In the CF-350, the following types of octave analysis are possible.

- 30-band 1/3-octave analysis
- 15-band 1/3-octave analysis
- 1/1-octave analysis
- Auditory weighting of the above types of analysis
- List display

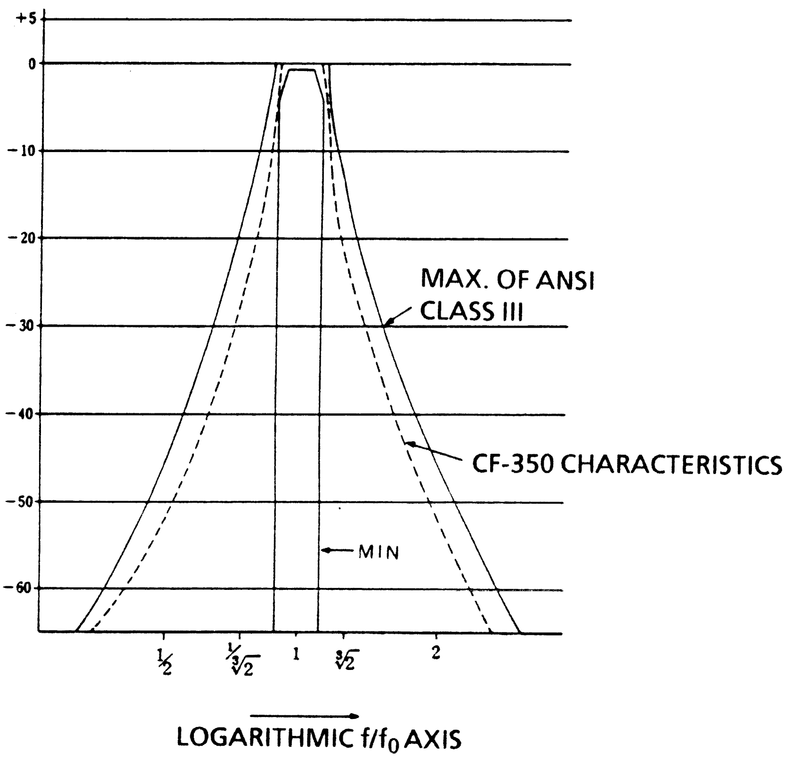


Fig. 4-15 1/3-Octave Filter Characteristics

The center frequencies of the 1/3-octave bands are actually established as

$$f_n = 1000 \times 10^{\frac{n-30}{10}}, \qquad \text{where n = band number.}$$

For example, for a nominal center frequency of 2 kHz, the actual center frequency is

$$f_{33} = 1000 \times 10^{\frac{3}{10}} = 1995.262\,[Hz].$$

The cutoff frequencies are established as follows.

Lower frequency limit of band: $f_{Un} = f_n / \sqrt{2} = 0.8909\, f_n$

Upper frequency limit of band: $f_{Ln} = f_n \times \sqrt{2} = 1.1225\, f_n$

Therefore, there is a difference between the upper limit of f_n and the lower limit of f_{n+1}. In the CF-350, the average value of these two values is taken as the common cutoff frequency, so that the cutoff frequency between f_n and f_{n+1} is

$$\frac{f_{Un} + f_{L(n+1)}}{2}.$$

The attenuation at this point is 3 dB ± 1 dB.

(a) 30-Band 1/3-Octave Analysis

In the CF-350, 30-band 1/3-octave analysis is performed on 2 channels simultaneously. It is also possible to perform 1/3-octave analysis on data stored in time record memory.

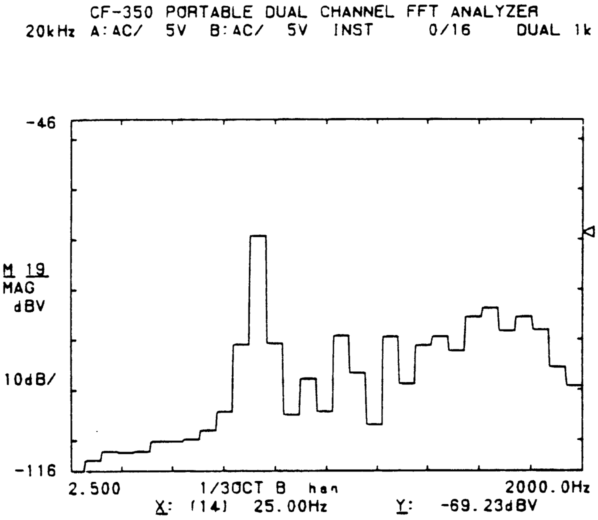


Fig. 4-16 30-Band, 1/3-Octave Analysis

The setting frequency ranges, bands which can be analyzed within these ranges and the corresponding center frequencies are given in the table below.

Frequency range (Hz)		(K/1) Ratio	Center frequency range (Hz)	ANSI Class III 1/3 Octave Band number	Analysis time (s)
Analysis range	Pair range				
500	20	25/1	0 63~ 500	-2~27	Approx43.0
1k	50	20/1	1.25~1000	1~30	18.0
2k	100	20/1	2.5 ~2000	4~33	10.1
5k	200	25/1	6.3 ~5000	8~37	5.7
10k	500	20/1	12.5 ~ 10k	11~40	3.1
20k	1k	20/1	25.0 ~ 20k	14~43	2.2
40k	2k	20/1	50.0 ~ 40k	17~46	1.8

Table 4-1 30-band, 1/3-Octave Analysis Ranges and Pair Ranges

In the CF-350, when performing 30-band, 1/3-octave analysis, the analysis range is changed two times. The ratio of the analysis range and the pair range is, as shown in Table 4-1, K:1 (K=20, 25). For example, for the CF-350's 20-kHz analysis range, the calculation is made for the 20-kHz and 1-kHz ranges (pair range). The analysis data length is 2048 for each range. Essentially, the analysis procedure is as follows.

① 2048 points sampled in the 20-kHz range.

② Determination is made of 43 values from band number 30.

③ 2048 points sampled in the 1-kHz range.

④ Determination is made of 29 values from band number 14.

⑤ From the data of ② and ④, auditory weighting compensations and display is performed from band number 14 to band number 43. The analysis times are shown in Table 3-1.

Analysis of Time Record Data

The ratio between the analysis range and the pair range is K:1, so that the time waveform required for the calculation is K times the pair range. The time record memory data is played back and the 30-band, 1/3-octave analysis is performed as follows.

Calculation for analysis range ..	A 2048-point FFT analysis is performed K times and averaged. The time waveform must have 2048 × K points.
Calculation for pair range	Digital filtering is applied to (2048 × K points) of time waveform, the waveform is 1/K sampled to extract 2048 points and an FFT analysis is performed on this data (so that the frequency range is divided by K).

Essentially, the result is that the calculation is made on the same number of points (2048 × K points) for both the analysis range and the pair range. The method of transforming a power spectrum to 1/3-octave results is precisely the same as for current data analysis.

Notes

1. Since this calculation necessitates processing a large amount of data, the processing time is as follows, and is not related to the frequency range.

2-channel analysis	Approx. 2 min. 30 s
1-channel analysis	Approx. 1 min. 15 s

2. The playback gap (shift) is changed from the set gap and is as follows.

Setting	Actual gap	Setting	Actual gap	Setting	Actual gap
1	5120	32	30720	1024	56320
2	10240	64	35840	2048	61440
4	15360	128	40960	4096	66560
8	20480	256	46080		
16	25600	512	51200		

For example, when analyzing in the 1-kHz range, as described above, one analysis is performed on 2048 × 20 = 40,960 points. If the gap is set as 1, the next analysis is performed on the 40,960 points starting at the 5120th point.

3. The time waveform displayed will be the first 1024 points of the 2048 × K points.

4. With 30 Kwords of data, since there is insufficient data, the calculation is not possible. In other modes also, when the data is insufficient, the calculation is terminated.

5. For analysis of transient waveforms, the rectangular window should be used.

	Freq. range (Hz)	40K	20K	10K	5K	2K	1K	500
	Pair range (Hz)	2K	1K	500	200	100	50	20
Band no.	Center freq. (Hz)							
-2	0.63							-2
-1	0.80							
0	1.00							
1	1.25						1	
2	1.60							
3	2.00							
4	2.50					4		
5	3.15							
6	4.00							
7	5.00							
8	6.30				8			
9	8.00							
10	10.00							
11	12.50			11				
12	16.00							12
13	20.00							13
14	25.00		14					
15	31.50							
16	40.00						16	
17	50.00	17					17	
18	63.00							
19	80.00					19		
20	100.00					20		
21	125.00							
22	160.00				22			
23	200.00				23			
24	250.00							
25	315.00							
26	400.00			26				
27	500.00			27				27
28	630.00							
29	800.00		29					
30	1000.00		30				30	
31	1250.00							
32	1600.00	32						
33	2000.00	33				33		
34	2500.00							
35	3150.00							
36	4000.00							
37	5000.00				37			
38	6300.00							
39	8000.00							
40	10000.00			40				
41	12500.00							
42	16000.00							
43	20000.00		43					
44	25000.00							
45	31500.00							
46	40000.00	46						

←----→ indicates pair ranges.

Table 4-2 30-Band, 1/3-Octave Analysis Frequency Ranges and Band Numbers that can be Analyzed

(b) 15-Band, 1/3-Octave Analysis

15-Band, 1/3-octave analysis is derived by grouping the results of normal analysis (i.e., a 400-line or 800-line spectrum) into 15 bands. When doing this, it is possible to return the analysis results to the narrowband power spectrum format, and the analysis can be performed on data from time record memory as well. As shown in Table 4-3, although bands outside the range of 15 bands are determined, only the bands in parentheses conform to the ANSI Class III standards. This analysis mode is limited to ranges of 20 Hz and above. For an analysis data length of 1024 points, the cross spectrum can be converted to a 1/3-octave analysis result in the same manner.

Analysis range (Hz)	2048 Points		1024 Points	
	Band no.	Center freq. (Hz)	Band no.	Center freq. (Hz)
20	-2~13 (-2~12)	0.63~20 (0.63~16)	-2~13 (-1~12)	0.63~ 20 (0.8 ~ 16)
50	1~17 (1~16)	1.25~50 (1.25~40)	1~17 (2~16)	1.25~ 50 (1.6 ~ 40)
100	4~20 (4~19)	2.5~100 (2.5~ 80)	4~20 (5~19)	2.5 ~100 (3.15~ 80)
200	8~23 (8~22)	6.3~200 (6.3~160)	8~23 (9~22)	6.3 ~200 (8.0 ~160)
500	10~27 (11~26)	10.0~500 (12.5~400)	11~27 (12~26)	12.5 ~500 (16.0 ~400)
1k	13~30 (14~29)	20.0~ 1k (25.0~800)	14~30 (15~29)	25.0 ~ 1k (31.5 ~800)
2k	16~33 (17~32)	40.0~ 2k (50.0~ 1.6k)	17~33 (18~32)	50.0 ~ 2k (63.0 ~ 1.6k)
5k	20~37 (21~36)	100 ~ 5k (125 ~ 4k)	21~37 (22~36)	125 ~ 5k (160 ~ 4k)
10k	23~40 (24~39)	200 ~10k (250 ~ 8k)	24~40 (25~39)	250 ~10k (315 ~ 8k)
20k	26~43 (27~42)	400 ~20k (500 ~16k)	27~43 (28~42)	500 ~20k (630 ~16k)
40k	29~46 (30~45)	800 ~40k (1k ~31.5k)	30~46 (31~45)	1k ~40k (1.25k ~31.5k)

Table 4-3 15-Band, 1/3-Octave Analysis Frequency Ranges and Band Numbers that can be Analyzed

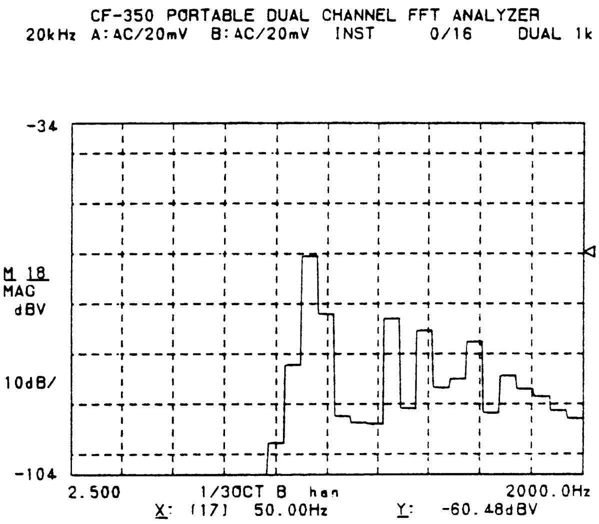


Fig. 4-17 15-Band, 1/3-Octave Analysis (Grid Display)

(c) 1/1-Octave Analysis

The CF-350 is capable of 10-band and 5-band 1/1-octave analysis. In 10-band analysis, grouping of three bands each is made of the 30-band, 1/3-octave results and in 5-band analysis a similar grouping is made of the 15-band, 1/3-octave analysis results. Therefore, in 5-band, 1/1-octave analysis, it is possible to return to the power spectrum display, but it is necessary to switch off first for the 10-band, 1/1-octave analysis. Both analysis modes are usable with data from time record memory. Except for the 20-kHz, 10-kHz and 5-kHz ranges, the center frequencies do not conform to ANSI Class II standards.

Band no.	Center freq. (Hz)	Freq. range (Hz)			Band no.	Center freq. (Hz)	Freq. range (Hz)			
		20 500	50 1k	100 2k			200 5k	10k	20k	40k
-1	0.8	-1			9	8	9			
2	1.6	↑	2		12	16	↑	12		
5	3.15		↑	5	15	31.5		↑	15	
8	6.3			↑	18	63			↑	18
11	12.5				21	125				↑
14	25				24	250				
17	50				27	500				
20	100				30	1k				
23	200	↓			33	2k	↓			
26	400	26	↓		36	4k	36	↓		
29	800		29	↓	39	8k		39	↓	
32	1.6k			32	42	16k			42	↓
					45	31.5k				45

Table 4-4 1/1-Octave Analysis Frequency Ranges and Band Numbers that can be Analyzed

(d) A Weighting Compensation

In general, analog analysis equipment performs 1/3-octave analysis after applying compensation for auditory sensitivity characteristics. In the CF-350 this compensation can be selected or turned off when performing octave analysis. The characteristics are as shown in Table 4-5.

Center freq. (Hz)	Band no.	A weighting (dB)	Center freq. (Hz)	Band no.	A weighting (dB)
0.63	-2	-∞	200.00	23	-10.9
0.80	-1	-∞	250.00	24	-8.6
1.00	0	-∞	315.00	25	-6.6
1.25	1	-∞	400.00	26	-4.8
1.60	2	-∞	500.00	27	-3.2
2.00	3	-∞	630.00	28	-1.9
2.50	4	-∞	800.00	29	-0.8
3.15	5	-∞	1000.00	30	0.0
4.00	6	-∞	1250.00	31	0.6
5.00	7	-∞	1600.00	32	1.0
6.30	8	-78.0	2000.00	33	1.2
8.00	9	-75.0	2500.00	34	1.3
10.00	10	-70.4	3150.00	35	1.2
12.50	11	-63.4	4000.00	36	1.0
16.00	12	-56.7	5000.00	37	0.5
20.00	13	-50.5	6300.00	38	-0.1
25.00	14	-44.7	8000.00	39	-1.1
31.50	15	-39.4	10000.00	40	-2.5
40.00	16	-34.6	12500.00	41	-4.3
50.00	17	-30.2	16000.00	42	-6.6
63.00	18	-26.2	20000.00	43	-9.3
80.00	19	-22.5	25000.00	44	-∞
100.00	20	-19.5	31500.00	45	-∞
125.00	21	-16.1	40000.00	46	-∞
160.00	22	-13.4			

Table 4-5 A Weighting Compensation Filter at
1/3-Octave Band Center Frequencies

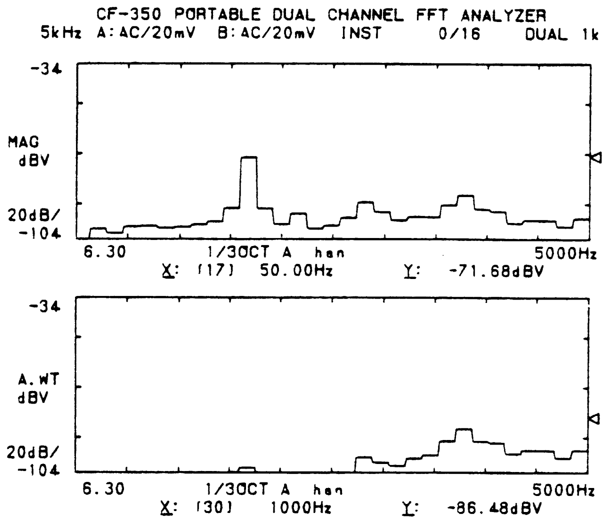
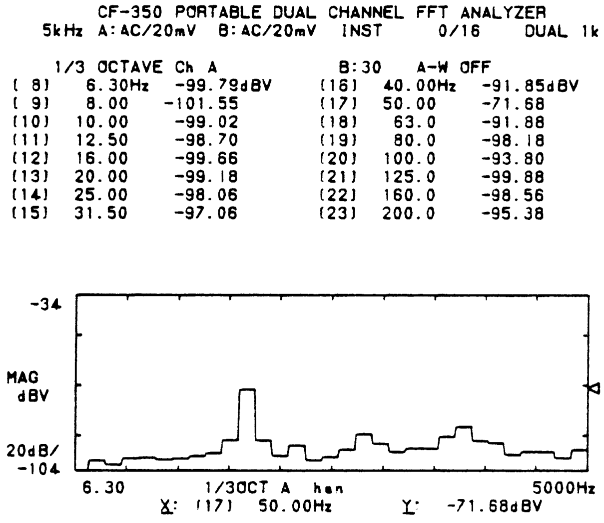


Fig. 4-18 Waveform Without A Weighting (top) and with A Weighting (bottom)

(e) List Display

When performing octave analysis, a list of center frequencies and corresponding levels can be output to the display screen.



```
      CF-350 PORTABLE DUAL CHANNEL FFT ANALYZER
  5kHz A:AC/20mV  B:AC/20mV  INST    0/16    DUAL 1k

    1/3 OCTAVE Ch A            B:30   A-W OFF
[ 8]   6.30Hz  -99.79dBV     [16]  40.00Hz  -91.85dBV
[ 9]   8.00   -101.55        [17]  50.00    -71.68
[10]  10.00    -99.02        [18]   63.0    -91.88
[11]  12.50    -98.70        [19]   80.0    -98.18
[12]  16.00    -99.66        [20]  100.0    -93.80
[13]  20.00    -99.18        [21]  125.0    -99.88
[14]  25.00    -98.06        [22]  160.0    -98.56
[15]  31.50    -97.06        [23]  200.0    -95.38
```

Fig. 4-19 30-Band, 1/3-Octave Analysis Results (bottom) and List Display (top)

<Procedure>

Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

FUNCTION SET 1

EQULIZE	CALC	∫dt,/dt	jω	OCTAVE	DENSITY	CEPSTRM	RETURN

OCTAVE SET

OFF	30	15	1/3 OCT	1/1 OCT	Aweight	SHARP	RETURN
	a	b	c	d	e	f	

(1) 30-Band, 1/3-Octave Analysis

Place the CF-350 into the PAUSE condition.

Press the 30 key and the 1/3 OCT key to turn them on.

Press the START switch to turn it on and enable the START condition.

To turn off, press the PAUSE switch and then press the OFF soft key.

(2) 15-Band, 1/3-Octave Analysis

Press the 15 key and the 1/3 OCT key to turn them on.

(3) 10-Band, 1/1-Octave Analysis

Place the CF-350 into the PAUSE condition.

Press the 30 key and the 1/1 OCT key to turn them on.

Press the START switch to turn it on and enable the START condition.

To turn off, press the PAUSE switch and then press the OFF soft key.

(4) 5-Band, 1/1-Octave Analysis

Press the 15 key and the 1/1 OCT key to turn them on.

(5) Analysis of Time Record Data

Playback data from the time record memory (PLAYBACK ON), and perform the above operations.

(6) A Weighting

Set the A weight key to on to apply auditory weighting.

(7) MIN Characteristics Octave Filter

When the SHARP key is turned on, octaves are grouped without consideration to the the octave filter response (leakage from other bands). This conforms to ANSI Class III filter characteristics standards.

(8) List Display

Execute octave analysis and press the LIST switch of the DISPLAY group.

4.3.3 Cross Spectrum

If the Fourier transform of the the two signals $x(t)$ and $y(t)$ are $X(f)$ and $Y(f)$, and the complex conjugate of $X(f)$ is $X^*(f)$, the cross spectrum $W_{XY}(f)$ is defined as follows.

$$W_{XY}(f) = \overline{X^*(f)\,Y(f)}$$

The cross spectrum is the result of a multiplying and averaging given frequency components of two different signals, with the X axis representing frequency and the Y axis expressed in units of V^2. The cross spectrum has a high value at certain frequencies because the correlation between the two signals at these frequencies is high. This being true, the components of both signals are also large values at these frequencies. The cross spectrum is used in calculation of the cross correlation function, transfer function and coherence function.

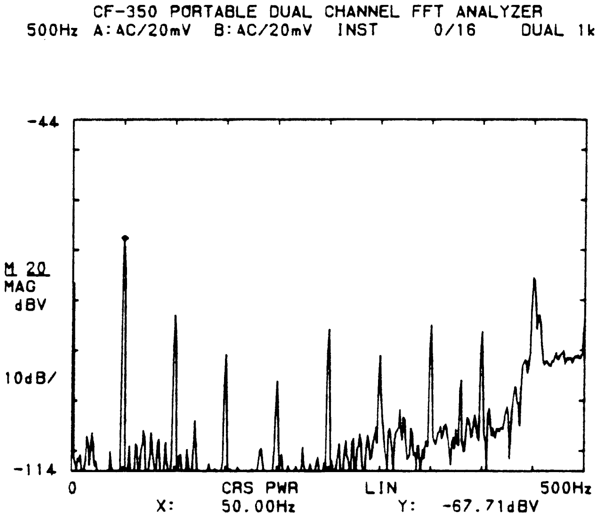


Fig. 4-20 Cross Spectrum

<Display Method>

Press the SPEC switch of the CROSS subgroup of the DISPLAY group.

X-Axis Units and Scaling

- The units are initially set to Hz, but can be changed to CPM, Order or seconds. The method is the same as for the power spectrum. Refer to Section 4.3.1.
- The display can be expanded. For method, refer to Section 4.1.1.

Y-Axis Units and Scaling

- The units or reading vlalues can be changed by using the EU function. Refer to Section 6.2 for the procedure.

- In the initialized state, the display is logarithmically scaled, with 0 dB corresponding to 1 V. This can be changed to linear scaling, rms value display and MAG LOG display. When the YLOG switch of the SEARCH switch is set to off, linear scaling is selected.

  For the rms value display, refer to Section 6.2.4.

  For the MAG LOG display, with a log scaled display, reading values are expressed as linear values V^2. For the procedure, refer to the Section 4.3.1 subsection on MAG LOG.

- The display position can be moved (i.e., the reference changed) and the display expanded (i.e., the gain changed). For the procedure, refer to Section 6.1.4.

Reading Values

- With search point off

  The frequency (X) and level (Y) at the maximum point are displayed at the bottom of the screen.

4.3.4 Phase Spectrum

The spectrum obtained from the FFT analysis includes a phase spectrum which represents the phase of each of the frequency components. It is expressed as follows.

$$\Phi(f) = tan^{-1} \frac{X_I(f)}{X_R(f)}$$

In the CF-350, the phase is expressed with respect to the 0 deg reference of a cosine wave starting at precisely the beginning of the data frame. The phase of each frequency component has a great influence on the waveform and even if the waveform shape does not change, a lag or lead on the time axis result in a phase rotation that is proportional to the frequency.

To measure the phase of one signal, an external trigger or other means is used to establish a phase reference for observation of phase lead or lag. In the phase characteristics of the transfer function, the phase spectrum enables observation of whether there is a lead or lag in the phase of the output of a system with respect to the input.

In the CF-350, digital compensation of up to ±0.5° is possible for the channel-to-channel phase difference inherent in the analog circuitry.

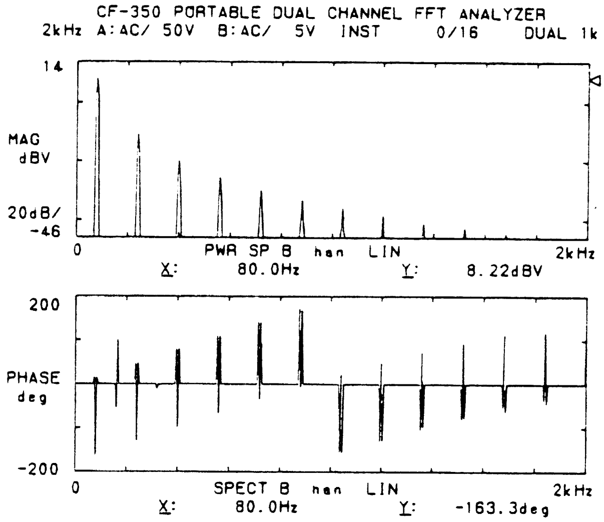


Fig. 4-21 Phase Display

<Procedure>

(a) Display Method

First, display the function for which the phase spectrum is to be determined (power spectrum or transfer function). Then press the PHASE switch of the DISPLAY group.

X-Axis Units and Scaling

- The units are set to Hz in the initialized state, but this can be changed to CPM, Order or seconds. For the procedure, refer to Section 4.3.1 describing this for the power spectrum .
- The display can be expanded. For the procedure, refer to Section 4.1.1.

Y-Axis Units and Scaling

- In the initialized state, the full scale is ±200°, but this can be changed to any range from ±10° to ±20,000°.

  Set the YLOG switch of the SEARCH group to off.

  Set the REF/GAIN switch of the Y group to off.

  Use the up and down switches of the Y group to change the full-scale value.

  It is possible to display only the positive or only the negative phase range. For the procedure, refer to Section 6.1.5.

Reading Values

- With search point off
- The frequency at the maximum value of the power spectrum is displayed as X and the corresponding phase is displayed as Y.

(b) Phase Adjustment

This is an adjustment of the phase mismatch between channels introduced by analog circuitry.

First, place the analyzer into the PAUSE condition.

Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

CONDITION SET

CONDIT		POL.CHG	SEARCH	HI PREC	TI ONLY	PH. adj	RETURN

PHASE ADJUST

SET							RETURN

When the frequency range is switched, this is turned off. Whenever the frequency range is switched, the setting should be made once again.

Phase-Delay Compensation

When displaying the transfer function, it is possible to compensate for the phase delay time between the two channels. This is set in units of seconds. For the procedure, refer to Section 5.8.6.

4.3.5 Group Delay

The group delay is obtained by differentiating the phase data of the transfer function. It is measure of the phase distortion caused by changing phase with respect to frequency and provides the means of gaining an understanding of the phase versus frequency characteristics of the transfer function.

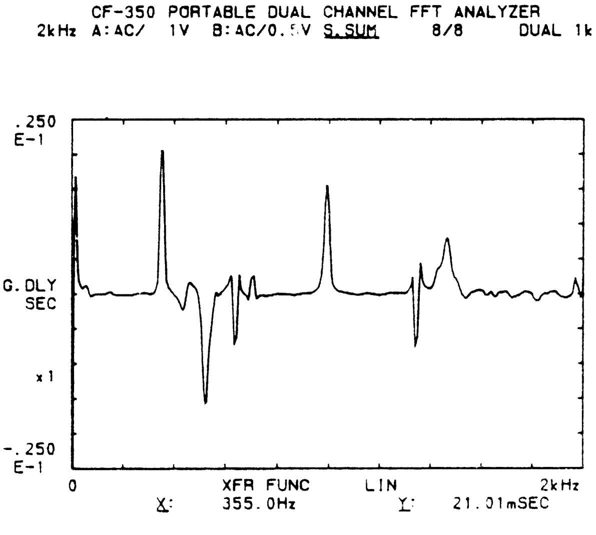


Fig. 4-22 Group Delay

<Display Method>

First, display the phase spectrum.

Make the following soft key settings.

<<< MENU C >>>

SERVO	Y axis	DATAset	OTHERS			OPTION	NEXT

DISPLAY Y ax

REF SET	GAIN	PHASE					RETURN

PHASE CONTROL

FORMAT1	FORMAT2	FORMAT3	G-DLY	DLY.adj	SET ON	SET	RETURN

4.3.6 Transfer Function

The transfer function is the representation of the relationship of the input and output of an electrical system or structure or other system stimulated by vibration. It is the ratio between the Fourier spectrum of the input, $X(f)$, and that of the output, $Y(f)$.

The transfer function $H(f)$ is, thus, expressed as

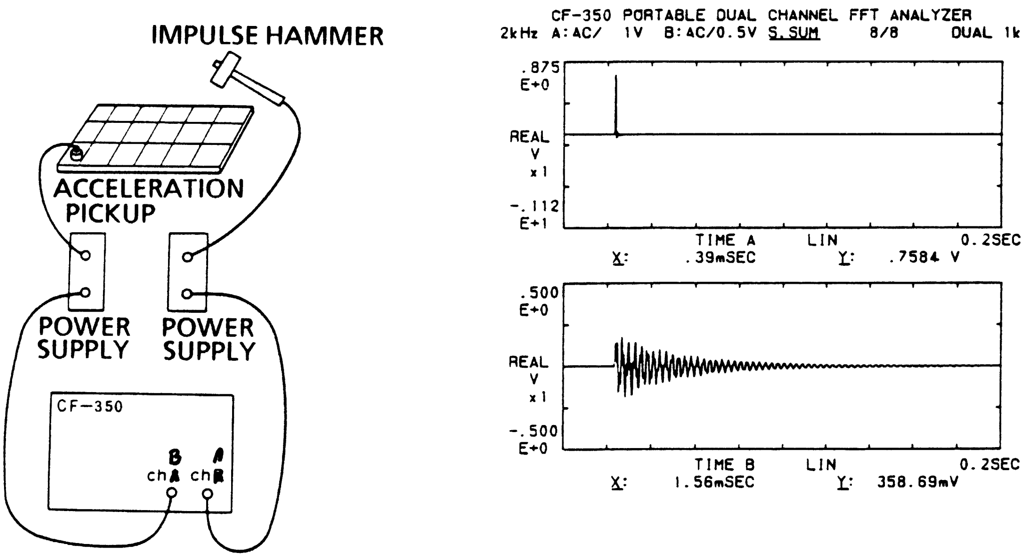
$$H(f) = \frac{Y(f)}{X(f)} .$$

In the CF-350, both the numerator and the denominator of the right side above are multiplied by the complex conjugate of the input Fourier spectrum, $X^*(f)$, and the calculation made as follows.

$$H(f) = \frac{Y(f) \times X^*(f)}{X(f) \times X^*(f)}$$

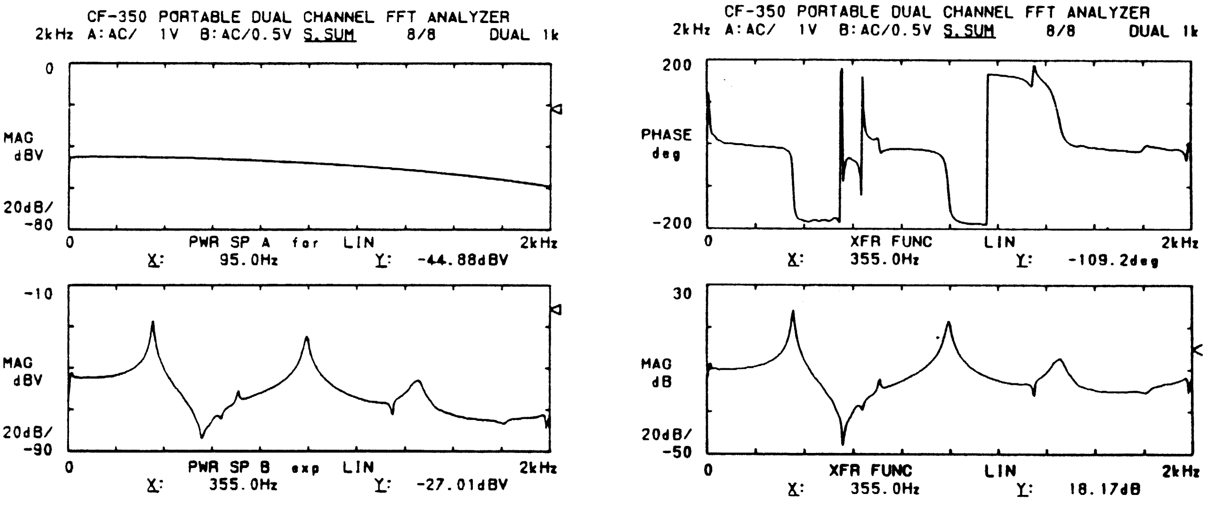
The denominator $X(f) \times X^*(f)$ is the power spectrum of $X(f)$ and the numerator $Y(f) \times X^*(f)$ is the cross spectrum of $X(f)$ and $Y(f)$. From this relationship, it is possible to determine the transfer function $H(f)$ by dividing the input-to-output cross spectrum by the power spectrum of the input.

The transfer function is expressed as gain and phase characteristics. The gain characteristics indicate how the amplitude of a signal changes as it passes through a system, with the X axis representing frequency and the vertical axis representing gain in decibels (ratio of output to input) by the relationship $20 \log_{10} H(f)$. The phase characteristics indicate the phase lead and lag of the output with respect to the input, the X axis again representing frequency and the Y axis representing phase in degrees or radians.



(a) Measurement System

(b) Input Signal (top) and Output Signal (bottom)



(c) Input Signal (top) and Output Signal (bottom) Power Spectrum

(d) Transfer Function Gain (bottom) and Phase (top)

Fig. 4-23 Vibration Transfer Function Measurement on a Structure

Applications to Machinery

Assume the following assignments.

x: Displacement
F: External force
a: Acceleration
v: Velocity

With these variables, the following definitions apply.

Mechanical impedance .... Z = F/v
Mobility .... M = v/F
Compliance .... C = x/F
Stiffness .... S = F/x
Inertance .... I = a/F
Apparent mass .... A = F/a

To make these measurements, apply the signal representing the denominator to Channel A and the signal representing the numerator to Channel B. For example, to measure mechanical impedance, input the velocity signal, *v*, to Channel A and the external force signal, *F*, to Channel B. In the CF-350, the reciprocal of the transfer function, *1/H*, can also be determined. This enables $M = v/F$ to be calculated from $Z = F/v$.

By performing differentiation and integration on the transfer function, it is possible to input force *F* to Channel A and acceleration *a* to Channel B, making the calculations shown in Table 4-6.

		X(jω)	X(jω)2	X(1/jω)	X(1/jω)2
H	$\frac{a}{F}$ **(Inertance)**			$\frac{v}{F}$ **(Mobility)**	$\frac{x}{F}$ **(Compliance)**
1/H	$\frac{F}{a}$ **(Apparent mass)**	$\frac{F}{V}$ **(Mechanical impedance)**	$\frac{F}{X}$ **(Stiffness)**		

Table 4-6 Transfer function and Related Differentiations and Integrations

<Procedure>

When the XFER switch of the CROSS subgroup of the DISPLAY group is pressed, the gain part of the transfer function is displayed.

With the transfer function displayed, pressing the PHASE switch displays the phase part of the transfer function.

Real part .... With the transfer function displayed, press the REAL switch of the DISPLAY group.

Imaginary part .. With the transfer function displayed, press the IMAG switch of the DISPLAY group.

X-Axis Units and Scaling

- The units are set to Hz in the initialized state, but this can be changed to CPM, Order or seconds. For the procedure, refer to Section 4.3.1 describing this for the power spectrum .
- The display can be expanded. For the procedure, refer to Section 4.1.1.

Y-Axis Units and Scaling

- In the initialized state, the display is logarithmically scaled. This can be changed to linear scaling or MAG LOG display.

  When the YLOG switch of the SEARCH group is off, linear scaling is selected.

  For the MAG LOG display, with a log scaled display, reading values are expressed as linear values (V^2). For the procedure, refer to the Section 4.3.1 subsection on MAG LOG.
- The display position can be moved (i.e., the reference changed) and the display expanded (i.e,, the gain changed). For the procedure, refer to Section 6.1.4.

Reading Values

- With search point off

  The frequency (X) and level (Y) at the maximum point are displayed at the bottom of the screen.

Method of displaying the phase, refer to Section 4.3.4.

For the transfer function, calculation is possible to the reciprocal, *1/H*, and the equalization function can be executed. For information on the reciprocal calculation, refer Section 5.9.2, and for the equalization function, refer to Section 5.9.1.

There are several other display formats for the transfer function, the ones listed below being available on the CF-350.

- Co-quad plot
- Bode plot
- Nyquist plot
- Nichols plot

(a) Co-Quad Plot

The co-quad plot is a plot of the real and imaginary parts of the transfer function against the frequency axis, plotted on the top and bottom of the same display. This can be used in the prediction of natural frequencies.

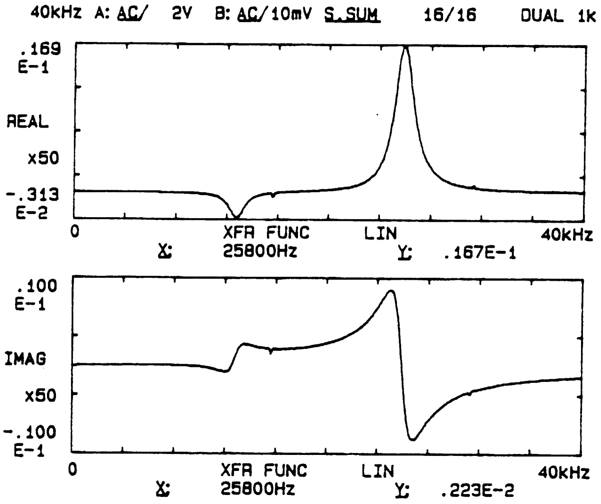


Fig. 4-24 Co-Quad Plot

<Display Method>

First display the transfer function.

The, press the IMAG switch of he DISPLAY group.

Press the SECOND switch.

When the REAL switch is pressed, the imaginary part of the transfer function moves to the bottom of the screen and the real part appears at the top of the screen in the dual-frame display mode.

(b) Bode Plot

The Bode plot is a pair of plots, one representing the gain and one representing the phase of the transfer function *H(f)* as plotted against frequency. The gain plot vertical axis is expressed in decibels by the relationship $20 \log_{10} H(f)$. The phase plot is in units of degrees or radians. The frequency axis for both parts is logarithmically scaled.

In the CF-350, the phase and gain are displayed on the top and bottom of the screen with a size (height) ratio of 1:3. This display format simplifies the task of reading the gain and phase margins which are used as stability criteria for control systems.

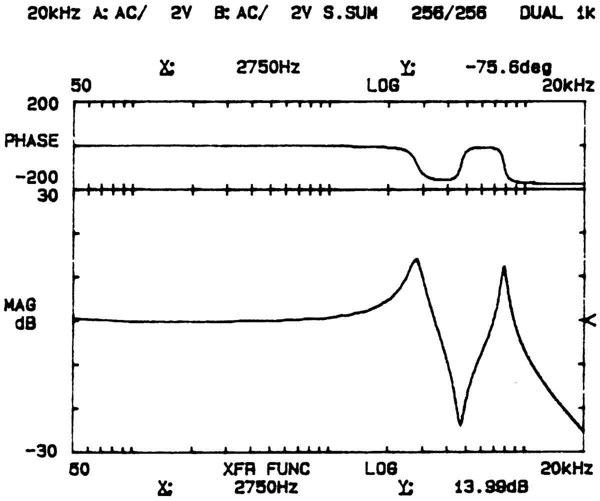


Fig. 4-25 Bode Plot

<Display Method>

First, display the transfer function, gain at the bottom and phase at the top, in a dual-frame display mode.

Next, make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

DISPLAY

FORMAT	LIST	3-ARRAY	COH	NYQ.ORB	P.OV	INHIBIT	RETURN

FORMAT

SPLIT	OVERLAY	GRID ON	**BODE ON**	MAG LOG		X EXPAN	RETURN

(c) Nyquist Plot

If the real part of the transfer function is plotted against the horizontal axis and the imaginary part is plotted against the vertical axis, the result is what is known as the *Nyquist plot.* In the CF-350, the Nyquist plot can be bandlimited and can be displayed in perspective.

This plot is used in the evaluation of control system stability criteria.

In measurements of chemical impedance, the Nyquist plot is usually turned upside-down, with the top of the plot representing negative values, and the Cole-Cole display of this is also possible.

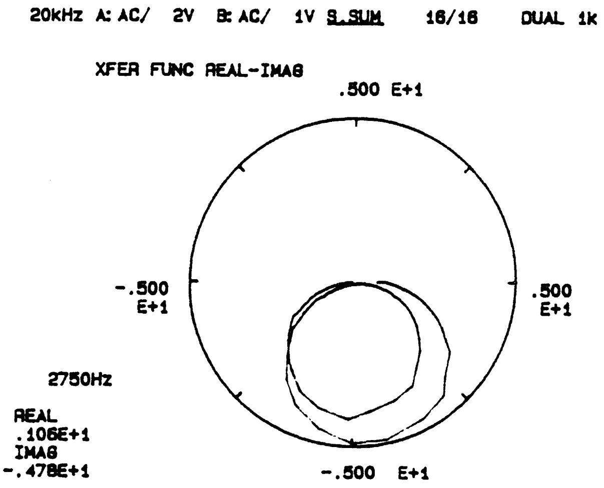


Fig. 4-26 Nyquist Plot

<Display Method>

First, display the transfer function.

Then, press the NYQ switch of the DISPLAY group.

<u>Changing the Display Method</u>

First, display the Nyquist plot, and then make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

DISPLAY

FORMAT	LIST	3-ARRAY	COH	NYQ.ORB	P.OV	INHIBIT	RETURN

NYQUIST

LIMIT	SET	3D	+ROTATE	-ROTATE	COLE	Xfr M-P	RETURN

① Perspective Display and Rotation of the Display

NYQUIST

LIMIT	SET	3D	+ROTATE	-ROTATE	COLE	Xfr M-P	RETURN
		a	b	c			

a	3D	Selects a perspective display when turned on.
b	+ROTATE	Rotates the display 45° CW each time it is pressed.
c	−ROTATE	Rotates the display 45° CCW each time it is pressed.

② Bandlimiting

First, display the gain of the transfer function.

Move the delta cursor to the lower edge of the range for bandlimiting and the search point to the upper edge of the range for bandlimiting.

NYQUIST

LIMIT	SET	3D	+ROTATE	-ROTATE	COLE	Xfr M-P	RETURN
☞	☞						

Press the SET key to make the setting.

Press the LIMIT key to activate the set bandlimiting.

③ Cole-Cole Plot

First, display the normal Nyquist plot.

NYQUIST

LIMIT	SET	3D	+ROTATE	-ROTATE	COLE	Xfr M-P	RETURN
					☞		

<u>Changing Units and Scaling</u>

The reading values are displayed in the lower left part of the CRT screen and the full-scale values are displayed at the upper right. In the initialized state, the units are set to Hz, but this can be changed to CPM, Order or seconds. For the procedure, refer to Section 4.3.1 which describes this for the power spectrum.

Changing the Reference and Gain

- The display position (reference) can be changed, and the display can be expanded.

  When the REF/GAIN switch (of the Y group) LED is lighted, the reference function is set and when the LED is extinguished, the GAIN function is set.

  Each time the REF/GAIN switch is pressed, the soft key menus corresponding to the reference and gain functions appear. This is operative if the ON and LOW soft keys are on. The gain function is enabled by setting the YLOG switch of the SEARCH group off and the UP soft key on.

  The up and down CURSOR keys of the SEARCH group are used to make these settings.

Reading Values

- With search point off

  The real and imaginary part values at the frequency of maximum gain value are displayed in the lower left of the CRT screen.

- With the Nyquist plot on the screen, it is possible to display the gain and phase values.

NYQUIST

LIMIT	SET	3D	+ROTATE	-ROTATE	COLE	Xfr M-P	RETURN

(d) Nichols Plot

In this plot, the vertical axis represents the gain and the horizontal axis represents the phase of the transfer function.

In the CF-350, bandlimiting may be applied to the Nichols plot as well.

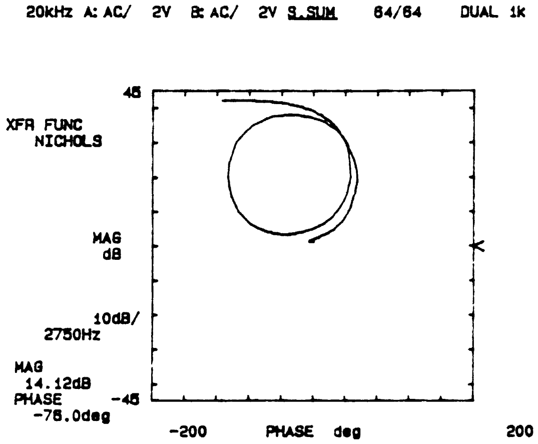


Fig. 4-27 Nichols Plot

<Display Method>

First, display the Nyquist plot of the transfer function and then make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

FUNCTION SET 2

IFFT	ENVELOP	LOOP	XFER	FITTING	ZOOM		RETURN

XFER

NICO	1/H	conv SV	CRT IMP				RETURN

For the method of applying bandlimiting, refer to Section (c) ② above, which describes this for the Nyquist plot.

Changing the Units and Scaling

The reading values are displayed in the lower left part of the CRT screen and the full-scale values are displayed at the upper right. In the initialized state, the units are set to Hz, but this can be changed to CPM, Order or seconds. For the procedure, refer to Section 4.3.1 which describes this for the power spectrum.

Changing the Gain

- The display can be expanded (i.e., the gain can be changed).

  Set the REF/GAIN switch (of the Y group) to off.

  When the YLOG switch of the SEARCH group is on, the X-axis (gain) gain is changed and when the YLOG switch is off, the Y-axis (phase) gain is changed.

  The up and down CURSOR keys of the SEARCH group are used to make these settings.

Reading Values

- With search point off

  The gain and phase values at the frequency of maximum gain are displayed in the lower left of the CRT screen.

4.3.7 Coherence Function

The coherence function γ^2 indicates the degree of causal relationship between the input and the output of a system. The value of the function γ^2 ranges from 0 to 1, with 1 indicating, for a particular frequency, that the output is entirely "caused" by the input, and a value of 0 indicating that at that frequency, the output is entirely unrelated to the input. When $0<\gamma 2(f)<1$, it is an indication that, to some degree, signals, internally generated noise, non-linearities and the time delay in the system are disturbing the measurement, although they are not the measured quantities.

$$\gamma^2 = \frac{W_{XY} \cdot W^*_{XY}}{W_{XX} \cdot W_{YY}} = \frac{|W_{XY}|^2}{W_{XX} \cdot W_{YY}}$$

The value of W_{XY} is the cross spectrum, W_{XX} and W_{YY} are the power spectra of x and y, and γ^2 is then the square of the absolute value of the cross spectrum, divided by the product of the power spectra.

The coherence function is inherently meaningless unless averaging is performed. Therefore averaging must be executed if the coherence function is to be used.

<Display Method>

First, display the transfer function.

The, press the COH switch of the CROSS subgroup of the DISPLAY group.

X-Axis Units and Scaling

- The units are set to Hz in the initialized state, but this can be changed to CPM, Order or seconds. For the procedure, refer to Section 4.3.1 describing this for the power spectrum .
- Logarithmic scaling is possible.

  To select this, set the XLOG switch of the SEARCH group to on.
- The display can be expanded. For the procedure, refer to Section 4.1.1.

Reading Values

- With search point off

  The frequency (X) and level (Y) at the maximum value are displayed at the bottom of the CRT screen.

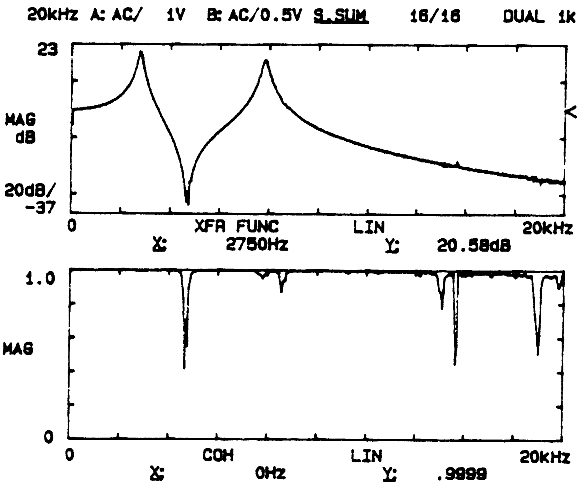


Fig. 4-28 Transfer Function Gain (top) and Coherence Function (bottom)

In the CF-350, the following functions can be executed or calculated using the coherence function.

- Coherent blanking function
- SN ratio calculation
- Coherent output power

(a) Coherent Blanking

If the coherence function $\gamma^2(f)$ of the analysis results between two measured channels is a small value, it indicates that the measurement results are not accurate. The coherent blanking function can be invoked to inhibit display of such inaccurate measurements, leaving only measurement results that can be trusted to be accurate. Using this function, if the value of $\gamma^2(f)$ for a given frequency component is lower than a set threshold value of $\gamma^2(f)$, that component is eliminated from the transfer function.

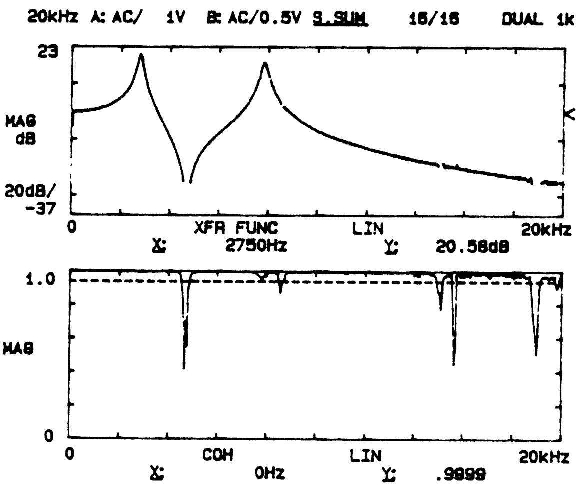


Fig. 4-29 Coherence Blanking

<Procedure>

Display the coherence function.

Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT
☞							

DISPLAY

FORMAT	LIST	3-ARRAY	COH	NYQ.ORB	P.OV	INHIBIT	RETURN
			☞				

COHERENCE

OFF	BLNK ON	SET	S/N				RETURN
	☞	☞					

When the BLNK ON key is turned on, a horizontal cursor appears in the display. Components that have a coherence value lower than the cursor will be eliminated from the transfer function display.

Use the up and down CURSOR switches of the SEARCH group to move the cursor to the desired position.

Press the SET key to make the setting; the "set complete" message will appear on the CRT screen.

When the BLNK ON key is on, if the transfer function is being displayed, the coherence blanking function will be executed.

To turn the function off, press the OFF key.

(b) SN Ratio Calculation

From the coherence function $\gamma^2(f)$ it is possible to determine the SN (signal-to-noise) ratio, using the equation given below, providing yet another means of evaluating the measurement.

$$\frac{S(f)}{N(f)} = \frac{\gamma^2(f)}{1 - \gamma^2(f)}$$

If the coherence function $\gamma^2(f) = 1$, it indicates that the output of the system is entirely determined by the input and that there is no noise present. Therefore, the term $1 - \gamma^2(f)$ can be considered to be the non-signal, i.e., noise component.

Since one reason for a low SN ratio is an insufficient number of averages, one solution would be to increase the number of averages setting.

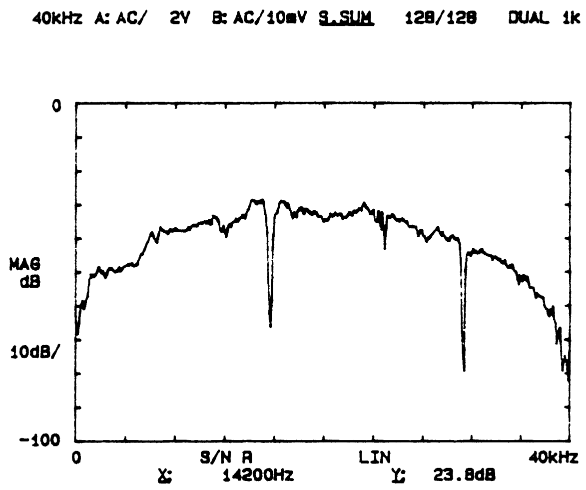


Fig. 4-30 SN Ratio Calculation

<Display Method>

First, display the coherence function.

Then, make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

DISPLAY

FORMAT	LIST	3-ARRAY	COH	NYQ.ORB	P.OV	INHIBIT	RETURN

COHERENCE

OFF	BLNK ON	SET	S/N				RETURN

X-Axis Units and Scaling

- The display can be expanded. For the procedure, refer to Section 4.1.1.

Y-Axis Units and Scaling

- In the initialized state, the Y axis is logarithmically scaled, but this can be changed to linear scaling.

  Set the YLOG switch of the SEARCH group to off.

- The display position can be moved (i.e., the reference changed) and the display can be expanded (i.e., the gain changed). For the procedure, refer to Section 6.1.4.

(c) Coherent Output Power

The coherent output power (COP) is the product of the coherence function and the auto power spectrum.

$$COP = \gamma^2(f) \cdot W_{VV}(f)$$

The COP represents that part of the auto power spectrum of the output that is caused by the measured input.

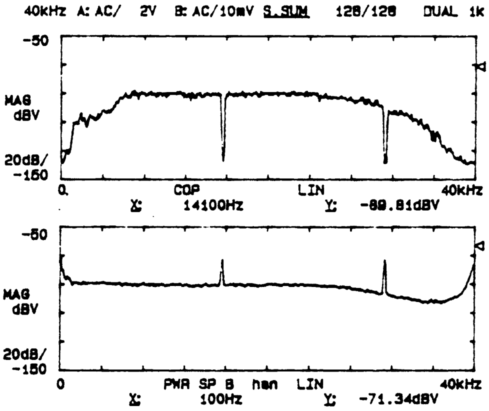


Fig. 4-31 Power Spectrum (bottom) and Coherent Output Power (top)

<Display Method>

Press the COP switch of the CROSS subgroup of the DISPLAY group.

<u>X-Axis Units and Scaling</u>

- The units can be changed to CPM, Order or seconds. For the procedure, refer to Section 4.3.1, which describes this for the power spectrum.
- Logarithmic scaling is possible.

  To select this, set the YLOG switch of the SEARCH group to on.
- Expansion of the display is possible. For the procedure, refer to Section 4.1.1, where this is described for time waveforms.

<u>Y-Axis Units and Scaling</u>

- The units and reading values can be changed by using the EU function. Refer to Section 6.2 for the setting method.
- The display can be read in rms (effective) values. For the procedure, refer to Section 6.2.4.
- In the initialized state, logarithmic scaling is selected, but this can be changed to linear scaling.

  Set the YLOG switch of the SEARCH group to off.
- The display position can be moved (i.e., the reference changed) and the display expanded (i.e., the gain changed). For the procedure, refer to Section 6.1.4.

4.4 Other Domains

Cepstrum and Liftered Envelope

The cepstrum is obtained by performing a Fourier transform on the logarithmically scaled results of a first Fourier transform. The horizontal axis takes on values of *quefrency*, which are a dimension of time.

When an input to a system exhibits a periodicity, if the period is long, this will manifest itself as a line cepstrum at the long-quefrency end and can be extracted as a basic periodicity. In the short-quefrency end, information which represents the transfer characteristics of the system is concentrated, enabling the inverse Fourier transform of this portion of the cepstrum to be used in extracting the power spectrum envelope. This envelope is characteristic of the system and is not dependent on the input signal.

An application of this is the extraction of basic periodicities and spectral envelopes from speech and biological waveforms.

<Procedure>

First, display the power spectrum.

Place the analyzer into the PAUSE condition.

Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT
			☝				

FUNCTION SET 1

EQULIZE	CALC	$\int$dt,/dt	jω	OCTAVE	DENSITY	CEPSTRM	RETURN
						☝	

CEPSTRUM

OFF	ON	REAL	MAG	ENVELOP	LIFTER		RETURN
	a	b	c				

With the ON and the REAL keys on, the cepstrum will be displayed.

With the ON and the MAG keys on, the absolute value of the cepstrum will be displayed.

X-Axis Units and Scaling

- The display can be expanded. For the procedure, refer to Section 4.1.1, in which it is described for time waveforms.

Y-Axis Units and Scaling

- The units and reading values can be changed by using the EU function. Refer to Section 6.2 for the setting method.
- In the initialized state, logarithmic scaling is selected, but the MAG sbsolute-value display can be changed to linear scaling.

  Set the YLOG switch of the SEARCH group to off.
- The display position can be moved (i.e., the reference changed) and the display expanded (i.e., the gain changed). For the procedure, refer to Section 6.1.4.

Spectral Envelope Extraction

First, display the cepstrum.

Move the delta cursor to the first point and the search point to the last point of the range to be liftered to make the setting.

CEPSTRUM

OFF	ON	REAL	**MAG**	**ENVELOP**	**LIFTER**		RETURN

When the LIFTER key is pressed, liftering is executed and the "set complete" message appears on the display.

If the keys ENVELOP and MAG are turned on in this sequence, the spectral envelope will be displayed.

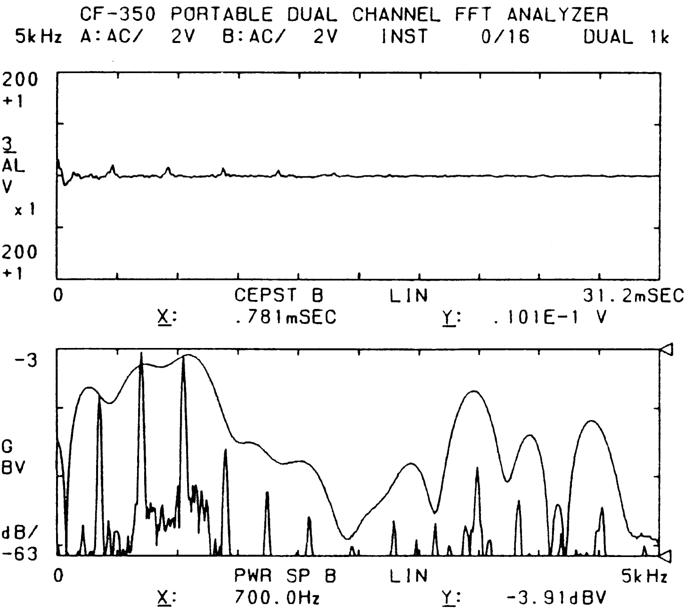


Fig. 4-32 Cepstrum (top) and Overlaid Display of Power Spectrum and Spectral Envelope (bottom)

5. DATA PROCESSING

5.1 Averaging

Averaging is performed in the CF-350 for the time, frequency, and amplitude domains.

- Averaging mode

Time domain	SUM	Summation averaging
	EXP	Exponential averaging
	ABS	Absolute-value averaging
Frequency domain	SUM	Summation averaging
	EXP	Exponential averaging
	PEAK	Peak hold
	DIFF	Differential averaging
	SWEEP	Sweep averaging
Amplitude domain	SUM	Summation averaging

- Number of averages

  The number of averages can be set in binary steps or at any desired arbitrary number.

  1 to 8192 averages can be set in binary steps or averages can be set at any arbitrary number up to 32767 (except in the EXP and SWEEP modes).

  The number of averages in the EXP mode can only be set in the range 2 to 16.

  Averaging in the SWEEP mode is set in terms of number of lines.

- Maximum overall function

  This function stores and displays the maximum power spectrum as the maximum overall value when averaging in the peak-hold mode.

- Cancel function

  When the trigger function is used for summation averaging in such cases as when impulse stimulus is applied, averaging is performed while observing each individual summation waveform (input signal or spectrum). This function makes it possible to eliminate excessive inputs and any other inputs the operator judges to be invalid (e.g., improper excitation) from the averaging process .

- Instant display function

  The instant power spectrum and cross spectrum of the signal currently being input are displayed during averaging. These can be switched between the upper and lower frames in dual-frame display according to the setting.

* Averaging cannot be performed simultaneously in different domains. For this reason the domain and mode must be clearly selected.

<Procedure>

Here is the averaging setting procedure for the CF-350.

1. Set the averaging mode (domain and type) and the number of averages.
2. Execute the averaging mode: decide whether the set averaging mode will be executed or not.

Setting and execution are operated separately.

1. Setting — Values for the various parameters are input at the soft keys.
2. Execution — Turn averaging on or off at the AVG panel switch.
   a. Start — Averaging starts from number one.

      Execution is initiated by pressing the START switch in the COMMAND group on the front panel.

      (The AVG switch in the COMMAND group is on at this time.)

   b. Termination

      Execution can be suspended when the specified number of averages has been performed or after any number of averages.

      Execution is suspended by pressing the PAUSE switch in the COMMAND group. The PAUSE condition is entered automatically when the specified number of averages has been taken.

   c. Continuation

      After averaging is completed, it can be resumed from the previous averaging result.

      Averaging can be continued after execution is suspended before the set number of averages is reached or after all the averages have been taken.

   (1) Press the PAUSE switch on the front panel to restart after execution is suspended before the set number of averages has been completed.

(2) When the set number of averages has been completed:

① The average control function is executed. Make the following the soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

AVERAGE SET

PWR SP	TIME	HIST	FOURIER	MAXoval	DISPLAY	CONTROL	RETURN

AVERAGE CONTROL

CONTINU	SUM NUM						RETURN

② Reset the number of averages to a value greater than the current setting.

③ Now press the PAUSE switch to resume execution.

5.1.1 Time Domain

Averaging in the time domain is performed as a series of synchronous summations using the trigger function.

Synchronous summation is effective because it separates the analysis signal synchronized with a trigger including the input from random noise.

(a) Summation average (SUMmation)

Time waveform normalized summation averaging is performed.

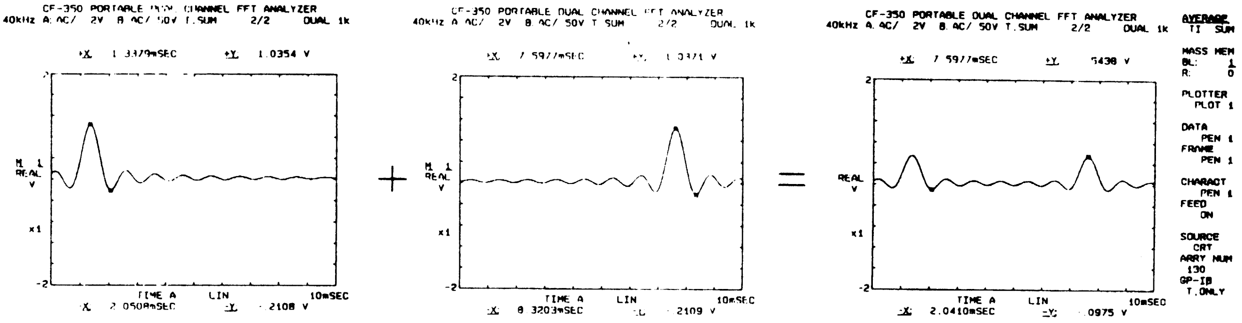


Fig. 5-1 Time-Axis Average

[Equations]

Example: Summation averaging, $n = 100$

S_i is the ith calculated (and displayed) summation average, and

T_i is the ith input time waveform.

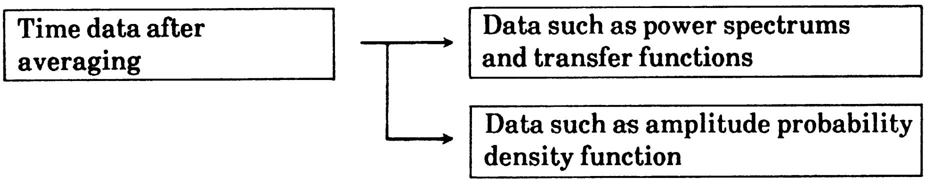
Summation averaging start	CRT display
↓	
First average	$S_1 = T_1$
Second average	$S_2 = (1/2)(T_1 + T_2)$
Third average	$S_3 = (1/3)(T_1 + T_2 + T_3)$
Fourth average	$S_4 = (1/4)(T_1 + T_2 + T_3 + T_4)$
:	:
mth average	$S_m = (1/m) \sum_{k=1}^{m} T_k$
:	:
100th average	$S_{100} = (1/100) \sum_{k=1}^{100} T_k$

After producing the average for $n = 100$ the CF-350 automatically enters the PAUSE condition and the averaging result is displayed.

- When averaging in the time domain (SUM, EXP, ABS), in the pause state the power spectrum is calculated and all the numerical functions of the frequency and amplitude domains are executed using the current average S_i.

  Thus, even if the PAUSE switch is pressed, suspending averaging before the specified number of averages is reached, all the data for each of the domains can be obtained for the average at which execution stopped.

Time-Domain Averaging



- * Phase data is included in the average in the time domain, so the sampling time has to be specified. This is done in the CF-350 using the trigger function. Even if the trigger function is not used (in free run), averaging in the time domain (SUM, EXP, ABS) is performed, but the phase is random, and averaging becomes meaningless. Thus, the operator must make absolutely sure the trigger function is used. (See Section 3.10.1 for the trigger function)

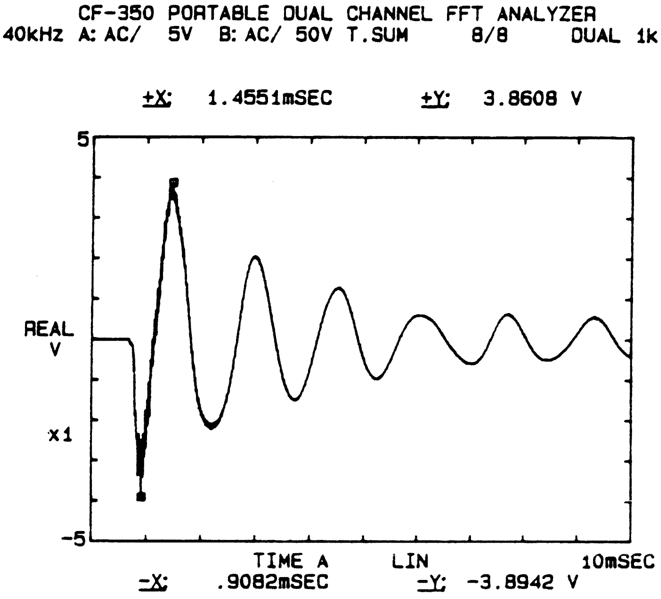


Fig. 5-2 Time-Axis Summation Averaging

(b) Exponential averaging (EXPonential)

Exponential averaging is performed on time waveforms. 2 to 16averages can be made in binary steps and the set number of averages indicates the weighting of the latest waveform. The set number of averages corresponds to the analog RC filter time constant.

[Equations]

Example Exponential averaging, $n = 4$

E_i is the ith calculated (and displayed) exponential average, and

T_i is the ith input time waveform.

Exponential averaging start	CRT display
↓	
First average	$E_1 = T_1$
Second average	$E_2 = (3/4)\,E_1 + (1/4)\,T_2$
Third average	$E_3 = (3/4)\,E_2 + (1/4)\,T_3$
:	:
nth average	$E_n = (3/4)\,E_{n-1} + (1/4)\,T_n$
↓	
Pause (averaging finished)	

The nth (calculation) result displayed is $E_n = [(n\text{-}1)/n]E_{n-1} + (1/n)T_n$ $(n = 2, 4, 8, 16)$

That is, the $(n-1)$th result is multiplied by $(n\text{-}1)/n$ and added to the latest captured waveform multiplied by $(1/n)$. This calculation is repeated. If the PAUSE condition is not entered, averaging will be continued indefinitely.

The set number of exponential averages (2 to 16) indicates the weighting of the most recent data. If the waveform varies with time, variation in displaced results will be larger the smaller the value of n (fast display variation), and smaller the larger the value of n (slow display variation).

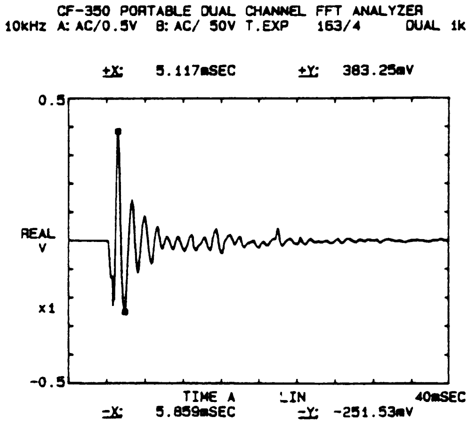


Fig 5-3 Time-Axis Exponential Averaging

(c) Absolute-Value Averaging (ABSolute)

Summation averaging of time signals is performed after the signals are subjected to absolute-value processing (negative voltage signal components are converted to positive voltages). The process of addition is the same as that in summation averaging.

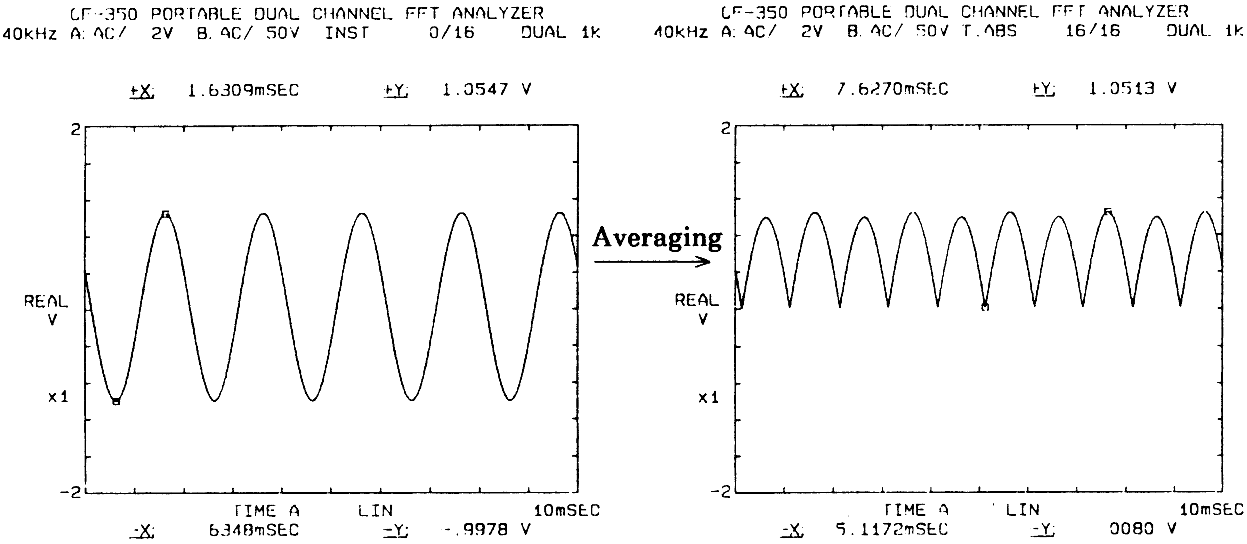


Fig. 5-4 Time-Axis Absolute-Value Averaging

<Procedure>

Time domain (summation, exponential, and absolute-value averaging)

① The trigger function is used in averaging in the time domain, so the trigger function setting must be made in advance.

② Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

AVERAGE SET

PWR SP	TIME	HIST	FOURIER	MAXoval	DISPLAY	CONTROL	RETURN

TIME AVG

SUM	EXP	ABS			INC	DEC	RETURN
a	b	c					

a SUM .. Selects summation averaging.

b EXP ... Selects exponential averaging.

c ABS .. Selects absolute-value averaging.

③ The number of averages can be set in one of the following ways:

a. Binary step setting 1, 2, 4, 8,..., 8192

b. Arbitrary setting 1 to 32,767.

a. Binary Step Setting

TIME AVG

SUM	EXP	ABS			INC	DEC	RETURN

The number of averages can be set by using either the INC or DEC switches. The value is displayed on the CRT screen.

b. Arbitrary Numerical Setting

1. Make the following soft key settings.

AVERAGE SET

PWR SP	TIME	HIST	FOURIER	MAXoval	DISPLAY	CONTROL	RETURN

AVERAGE CONTROL

CONTINU	SUM NUM						RETURN

2. The numerical input parameter appears in the lower five columns of the data frame, Use the numeric keys on the front panel to set the number of averages.

3. Press the SUM NUM switch once again to complete setting of the number of averages. This value is then displayed in the annotation section at the top of the CRT screen.

④ Press the AVG panel switch in the COMMAND group to light its LED.

⑤ Press the START panel switch in the COMMAND group to execute the specified averaging.

⑥ Except for exponential averaging, the PAUSE condition is entered automatically as soon as the specified number of averages is completed. Averaging can be suspended before the specified number of averages is completed by pressing the PAUSE switch. The PAUSE switch must be used to stop exponential averaging.

* Press the AVG switch to light its LED indicating that the averaging mode is on. If this switch is off, the instant mode, not the averaging mode, is enabled.

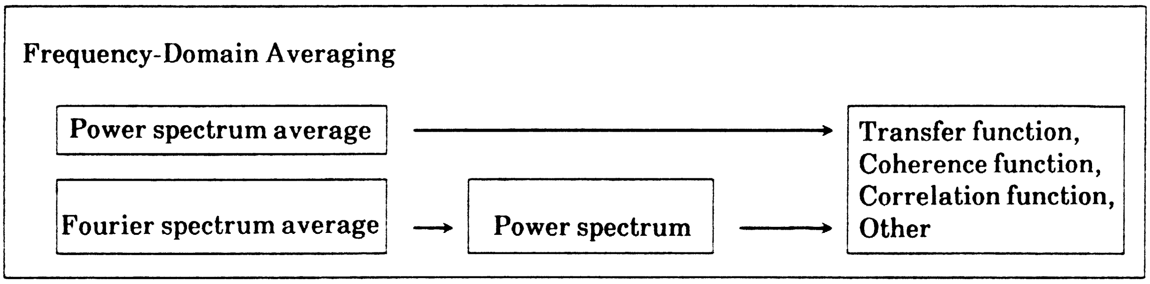
* Continuing averaging

If the PAUSE switch is pressed to suspend averaging, it is possible to resume averaging again. (See Section 5.1.2 (a))

5.1.2 Frequency Domain Averaging

Frequency domain averaging includes power spectrum and Fourier spectrum averaging. Power spectrum averages are produced from the power spectrum so phase data is not included (though phase data between the two channels A and B is included). For this reason the trigger function is not required. However, phase data is included in Fourier spectrum averages, just as in the time domain averages, so the trigger function has to be used to establish timing.

- After the power spectrum and Fourier spectrum averages have been produced in frequency domain averaging, various other frequency domain data, such as the transfer function, are also obtained. These averaging results are displayed as the most recent waveform and have no relation to the time waveform or amplitude domain data.



(a) Summation averaging (SUMmation)

Normalized summation averaging of power and Fourier spectrums is performed.

[Equations]

Example: Summation averaging, $n = 64$

S_i is the ith calculated (and displayed) summation average, and

P_i is the ith power or Fourier spectrum.

Summation averaging start	CRT display
↓	
First average	$S_1 = P_1$
Second average	$S_2 = 1/2(P_1 + P_2)$
Third average	$S_3 = 1/3(P_1 + P_2 + P_3)$
mth average	$S_m = (1/m) \sum_{k=1}^{m} P_k$
:	:
*64*th average	$S_{64} = (1/64) \sum_{k=1}^{64} P_k$

After producing the average for $n = 64$ the CF-350 automatically enters the PAUSE condition and the average results are displayed.

(a) Power Spectrum Summation Averaging

① Make the following soft key settings.

<<< MENU A >>>

TRIG	**AVERAGE**	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT
	☞						

AVERAGE SET

PWR SP	TIME	HIST	FOURIER	MAXoval	DISPLAY	CONTROL	RETURN
☞							

SPECTRUM AVG

SUM	EXP	PEAK	SWEEP	DIFF	INC	DEC	RETURN
☞							

② Set the number of averages in one of the following ways:

a. Binary step setting	1, 2, 4, 8,..., 8192
b. Arbitrary setting	1 to 32767.

a. Binary Step Setting

SPECTRUM AVG

SUM	EXP	PEAK	SWEEP	DIFF	**INC**	**DEC**	RETURN
					☞	☞	

The number of averages can be set by using the INC and DEC switches.

b. Arbitrary Numerical Setting

1. Make the following soft key settings.

AVERAGE SET

PWR SP	TIME	HIST	FOURIER	MAXoval	DISPLAY	**CONTROL**	RETURN
						☞	

AVERAGE CONTROL

CONTINU	**SUM NUM**						RETURN
	☞						

2. The numerical input parameter appears in the lower five columns of the data frame. Use the front panel numeric keys to set the number of averages.

3. Press the SUM NUM switch once again to complete setting of the number of averages. This value is then displayed in the annotation section of the upper section of the CRT screen.

③ Press the AVG panel switch in the COMMAND group to light the LED.

④ Press the START panel switch in the COMMAND group to execute the specified averaging.

⑤ The PAUSE condition is entered automatically when the specified number of averages is completed. Averaging can be suspended before this by pressing the PAUSE switch.

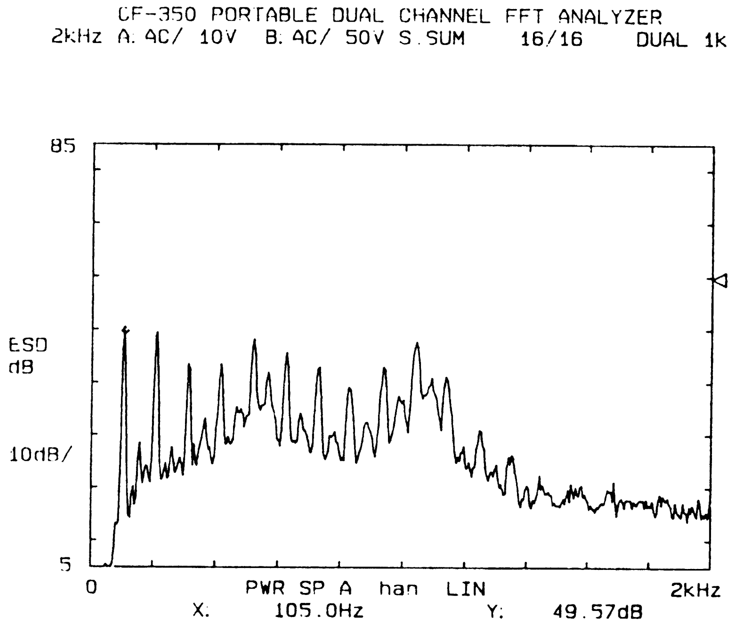


Fig. 5-5 Power Spectrum Summation Averaging

- **Continuing Averaging**

1. If the PAUSE switch is pressed to suspend averaging, press it again to resume operation.

2. If the specified number of averages has been completed:

(1) Make the following soft key setting.

AVERAGE CONTROL

CONTINU	SUM NUM						RETURN

(2) Reset the number of averages to a value greater than the current value. This can be done either binary steps or as an arbitrary numerical setting.

(3) Press the PAUSE switch again.

- The power and cross spectrums of the instant Channels A and B for which averaging is being performed can be displayed during execution. This is achieved using the function allowing single-frame and dual-frame display of the power and cross spectrums in the instant mode. For example, in dual-frame display the averaged waveform can be observed in the upper frame of the display and the instant waveform in the lower.

1. Make the following soft key settings.

AVERAGE SET

PWR SP	TIME	HIST	FOURIER	MAXoval	DISPLAY	CONTROL	RETURN

2. Display the spectrum (power or cross spectrum of Ch A or Ch B) to be displayed in the instant mode in single- or dual-frame display.

3. Make the following soft key setting to set the instant mode for the entire screen in single-frame display or the lower frame of the screen in dual-frame display.

INSTANT DISPLAY

LOW	UP						RETURN

Make the following soft key setting to set the upper frame of the screen to instant mode for dual-frame display.

INSTANT DISPLAY

LOW	UP						RETURN

The function display name in the lower part of the data frame will change as the instant display mode is entered.

Ch A power spectrum	PWR SP A	→	SPECT A
Ch B power spectrum	PWR SP B	→	SPECT B
Cross spectrum	CRS PWR	→	CRS SPEC

* Cancel function

When summation averaging is being performed using repeated triggering, input overflow signals and other data, such as signals with high errors, not to be included in the summation are eliminated before averaging is continued.

<Procedure>

① Use the repeated triggering function.

② Set power spectrum summation averaging.

③ Set the number of averages.

④ Press panel switch AVG.

⑤ Make the following soft key settings

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

TRIGGER SET

SORCE	SLOPE	POSIT	LEVEL	SELECT			RETURN

TRIGGER SELECT

REPEAT	SINGLE	ONEshot		CANCEL			RETURN

The TRIG switch LED will flash when the above settings have been made.

⑥ Press the START panel switch in the COMMAND group to initiate averaging while operating the cancel function.

⑦ When data to be deleted is captured during summation, make the following soft key setting before the next trigger capture to cancel the data and ensure that it is not included in the summation. This stores the instruction as to whether the preceding data is to be canceled or not before the trigger is applied and the next signal is captured.

TRIGGER SELECT

REPEAT	SINGLE	ONEshot		CANCEL			RETURN

If this CANCEL switch setting is not made, the preceding data will be taken into the summation when the next trigger is applied. This cancel switch must be used to ensure deletion of the data before the next trigger is input.

For example, if the data captured as the tenth summed waveform is to be canceled, the next data will be taken as the tenth in the series.

* If the cancel function is used during summation, the PAUSE condition is not entered when the set number of averages has been completed (on the CRT screen, the number of averages actually executed will become the set number of averages). This is because the last data has been put on "cancel hold", and the last data will only be summed when the PAUSE switch is pressed.

(b) Exponential averaging (EXPonential)

Power and Fourier spectrum exponential averaging is performed. The set number of averages (2 to 16) indicates the weighting of the latest data.

[Equations]

Example Exponential averaging, $n = 8$

E_i is the ith exponential average (display), and

P_i is the ith power or Fourier spectrum.

Averaging start

↓

First average $E_1 = P_1$

Second average $E_2 = (7/8)E_1 + (1/8)P_2$

Third average $E_3 = (7/8)E_2 + (1/8)P_3$

: :

nth average $E_n = (7/8)E_{n-1} + (1/8)P_n$

↓

Pause (averaging finished)

The nth result displayed (calculated) is $E_n = [(n-1)/n]E_{n-1} + (1/n)P_n$ $(n = 2, 4, 8, 16)$.

(1) The Fourier spectrum average is calculated by applying the above equations to the real and imaginary parts separately.

(2) Power spectrum exponential averaging

① Make the following soft key settings.

<<< MENU A >>>

TRIG	**AVERAGE**	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

AVERAGE SET

PWR SP	TIME	HIST	FOURIER	MAXoval	DISPLAY	CONTROL	RETURN

SPECTRUM AVG

SUM	**EXP**	PEAK	SWEEP	DIFF	INC	DEC	RETURN

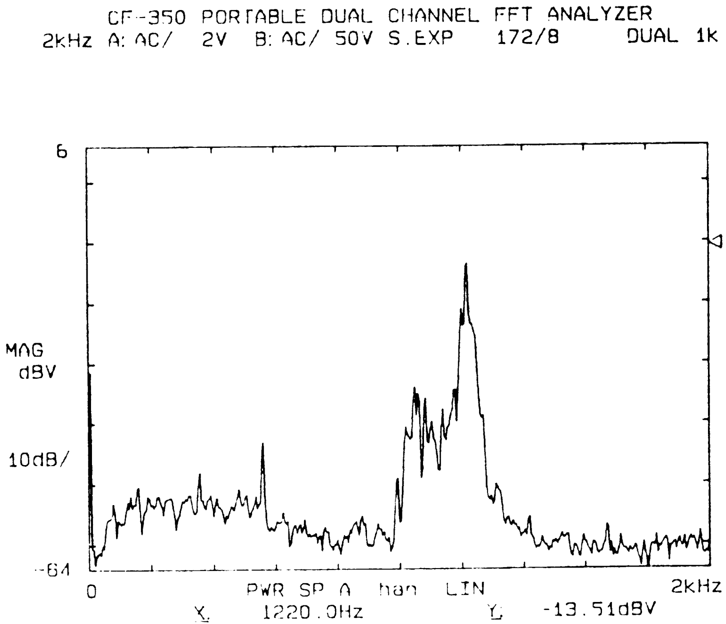
② Set the number of averages. This value is taken as the weighting during exponential averaging.

2, 4, 8, or 16 exponential averages can be produced.

③ Press the AVG switch in the COMMAND group to light its LED.

④ Press the START switch in the COMMAND group to execute averaging.

⑤ Exponential averaging does not stop automatically, but continues averaging processing, so the PAUSE panel switch has to be pressed to stop averaging. Press the PAUSE switch once again to resume averaging.



CF-350 PORTABLE DUAL CHANNEL FFT ANALYZER

2kHz A: AC/ 2V B: AC/ 50V S.EXP 172/8 DUAL 1k

PWR SP A han LIN

X 1220.0Hz Y -13.51dBV

Fig. 5-6 Power Spectrum Exponential Averaging

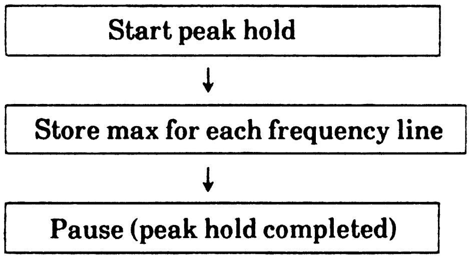
(c) Peak hold (PEAK hold)

This function holds (saves) the maximum value of each spectrum line of the power spectrum from the time peak hold is initiated until the PAUSE condition is entered.

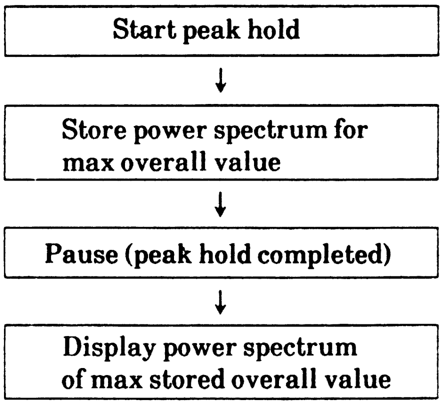
A maximum overall function is also available for use with this peak hold function. This can be thought of as the overall peak hold function, since it saves the power spectrum at the point of the overall maximum value.

There is no provision for setting the number of averages in this peak hold mode. So both start and pause (stop) operations have to be performed in this averaging mode. If the number of averages has been previously set, it does not affect the peak hold function. The number of CRT executions increases when the peak hold function is used. This indicates the number of executions of FFT analysis.

- Peak hold flowchart



- Maximum overall value function flowchart



- The overall value for this peak hold mode power spectrum is calculated as the overall value of the display.
- Calculations over two channels and other functions cannot be executed in the peak hold mode, so the following functions cannot be displayed.

  Cross spectrum, transfer function, coherence function, coherent output power, and impulse response.

<Procedure>

① Make the following soft key settings

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

AVERAGE SET

PWR SP	TIME	HIST	FOURIER	MAXoval	DISPLAY	CONTROL	RETURN

SPECTRUM AVG

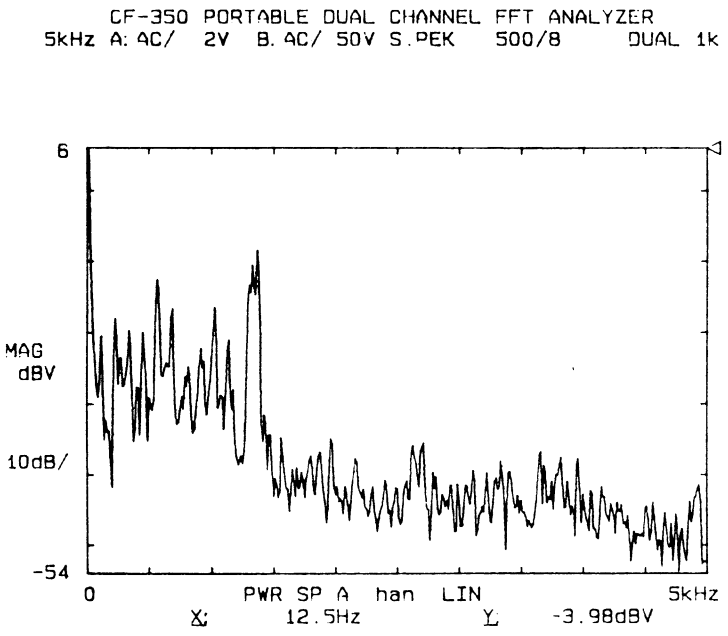
SUM	EXP	PEAK	SWEEP	DIFF	INC	DEC	RETURN

② Press the AVG switch of the COMMAND group to light its LED.

③ Press the START switch of the COMMAND group to initiate peak hold.

* The number of averages does not have to be set in the peak hold mode.

Peak hold is performed from the time the START switch is pressed until the PAUSE switch is pressed.



CF-350 PORTABLE DUAL CHANNEL FFT ANALYZER
5kHz A: AC/ 2V B. AC/ 50V S.PEK 500/8 DUAL 1k

PWR SP A han LIN
X: 12.5Hz Y: -3.98dBV

Fig. 5--7 Peak Hold

* Maximum overall function

The maximum overall function operates during execution of the peak hold mode. It produces the power spectrum at the point when the power spectrum reaches overall maximum in the time between initiation of peak hold and when the pause switch is pressed.

<Procedure>

① Set the peak hold mode.

② Make the following soft key settings.

AVERAGE SET

PWR SP	TIME	HIST	FOURIER	MAXoval	DISPLAY	CONTROL	RETURN

MAX OVERALL

OFF	ON						RETURN

③ Press the START switch of the COMMAND group to initiate peak-hold averaging and execution of the maximum overall function.

④ Press the PAUSE switch to stop execution. The power spectrum when the overall value is maximum is displayed.

(d) Differential average (DIFFerential)

The power-spectrum differential average function enables subtraction of a power spectrum from another while the latter is being averaged.

[Equations]

Example Differential average, $n = 20$

S_i is the ith calculated (and displayed) differential average,

S is the power spectrum to be subtracted, and

P_i is the ith power spectrum.

Differential averaging start	CRT display
↓	
First average	$S_1 = S - (1/20)P_1$
Second average	$S_2 = S_1 - (1/20)P_2$
Third average	$S_3 = S_2 - (1/20)P_3$
:	:
20th average	$S_{20} = S_{19} + (1/20)P_{20}$

Once 20 averages have been calculated, the CF-350 enters the PAUSE condition automatically and the averaging result is displayed.

<Procedure>

① Display the power spectrum after summation averaging or the instant power spectrum.

② Make the following soft key settings.

<<< MENU A >>>

TRIG	**AVERAGE**	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

AVERAGE SET

PWR SP	TIME	HIST	FOURIER	MAXoval	DISPLAY	CONTROL	RETURN

SPECTRUM AVG

SUM	EXP	PEAK	SWEEP	**DIFF**	INC	DEC	RETURN

③ Set the number of averages.

④ Press the AVG switch in the COMMAND group to light its LED.

⑤ Press the START switch in the COMMAND group to start averaging.

* Differential averaging can be continued.

* Memory data cannot be averaged.

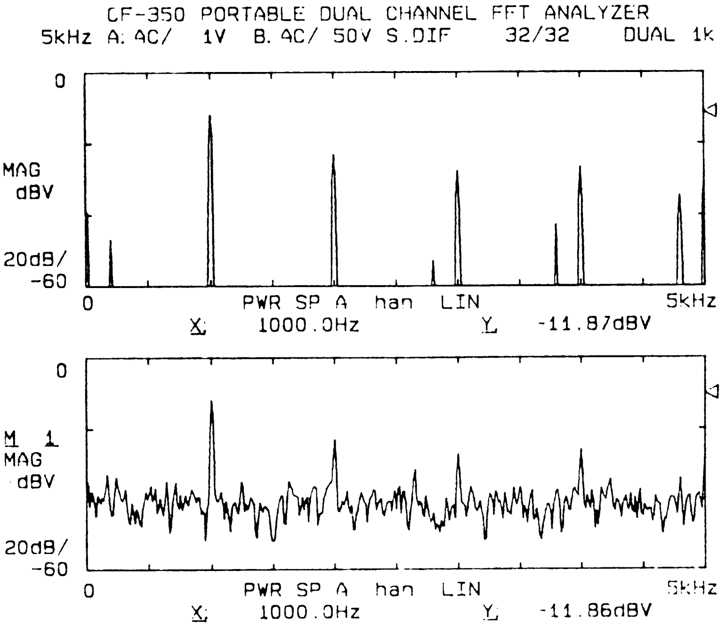


Fig. 5-8 Power Spectrum Differential Averaging

(e) Sweep averaging (SWEEP)

The optional sine-sweep signal output can be used to perform sinewave frequency sweep and power-spectrum sweep averaging.

Once the operator has set the sweep starting and ending frequencies, the CF-350 performs sinewave sweep synchronously with data capture and FFT analysis.

- The sweep frequency changes by one line for each data capture.
- The latest instant spectrum can be simultaneously monitored at any time during power spectrum averaging. (See Section 5.1.2 for the instant display function.)
- It is also possible to perform sweep averaging using the sweep signal from an external generator.

  Note that when a signal generator is employed, if the sweep speed of the external sweep is faster than the processing speed of the CF-350 some spectrum lines will be missed.

<Procedure>

When an external generator is used

① Make the connections as follows.

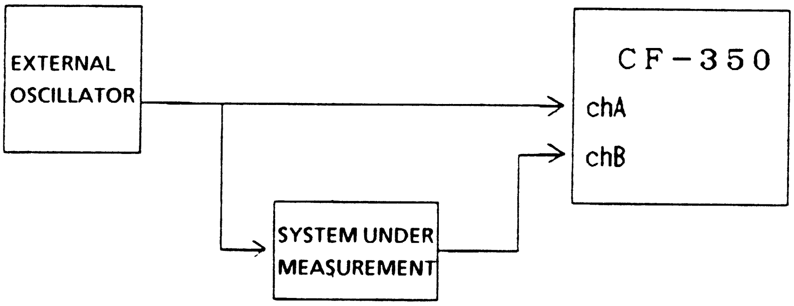


Fig. 5-9 Connections For Sweep Averaging

② Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

AVERAGE SET

PWR SP	TIME	HIST	FOURIER	MAXoval	DISPLAY	CONTROL	RETURN

SPECTRUM AVG

SUM	EXP	PEAK	SWEEP	DIFF	INC	DEC	RETURN

③ Press the AVG switch in the COMMAND group to light its LED.

④ Press the START switch in the COMMAND group to start averaging.

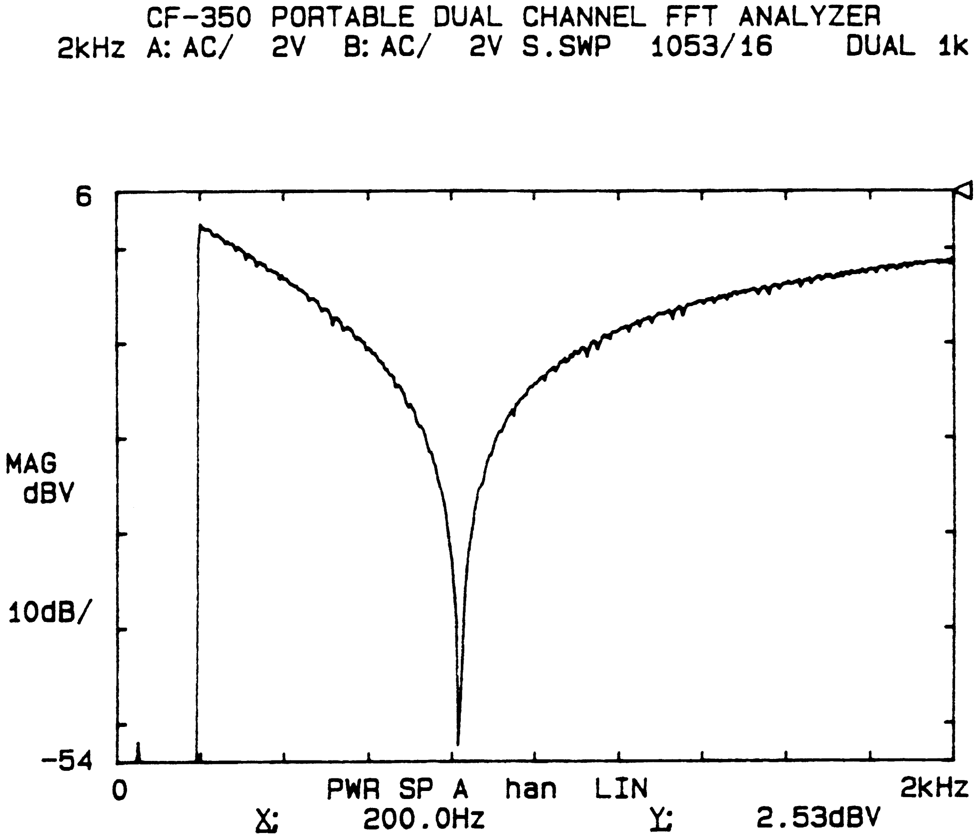


Fig. 5-10 Sweep Averaging

Notes

1. Since for sweep averaging only the maximum spectrum is displayed, when an external signal source is used, if sweep averaging is performed and the signal source has a high level of harmonic distortion, there may be cases in which sweep averaging is not possible at the frequency of interest.

2. Sweep frequency detection is performed on channel A, so that the sweep signal source must always be connected to this channel and the response signal connected to channel B.

5.1.3 Amplitude Domain

Summation Averaging (SUMmation)

Normalized summation averaging of probability density functions is performed.

[Equations]

Example Summation averaging, $n = 32$

S_i is the ith summation averaging result (display)

P_i is the ith probability density function

Summation averaging start	CRT display
↓	
First average	$S_1 = P_1$
Second average	$S_2 = 1/2(P_1 + P_2)$
Third average	$S_3 = 1/3(P_1 + P_2 + P_3)$
:	:
mth average	$S_m = 1/m \sum_{k=1}^{m} P_k$
:	:
32nd average	$S_{100} = 1/100 \sum_{k=1}^{32} P_k$

After 32 averages have been calculated, the CF-350 enters the PAUSE condition automatically and displays the averaging result.

<Procedure>

(1) Amplitude probability density function summation averaging

① Make the following soft key settings

<<< MENU A >>>

TRIG	**AVERAGE**	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

AVERAGE SET

PWR SP	TIME	**HIST**	FOURIER	MAXoval	DISPLAY	CONTROL	RETURN

HISTOGRAM AVG

SUM		**HIST A**	**HIST B**		INC	DEC	RETURN
		a	b				

Set amplitude-domain averaging. Press *a* or *b* to display the respective histogram.

② Set the number of averages in one of the following ways:

a. Binary step setting	1, 2, 4, 8,...,8192
b. Arbitrary setting	1 to 32767.

a. Binary Step Setting

HISTOGRAM AVG

SUM		HIST A	HIST B		INC	DEC	RETURN

The number of averages can be set by using either the INC or DEC switches. The value is displayed on the CRT screen.

b. Arbitrary Numerical Setting

1. Make the following soft key settings.

AVERAGE SET

PWR SP	TIME	HIST	FOURIER	MAXoval	DISPLAY	CONTROL	RETURN

AVERAGE CONTROL

CONTINU	SUM NUM						RETURN

2. The numerical input parameters appear in the lower five columns of the data frame. Use the numeric keys to set the number of averages.

3. Press the SUM NUM switch once again to complete setting of the number of averages. This value is then displayed in the annotation section at the top of the CRT screen.

③ Press the AVG panel switch in the COMMAND group to light its LED.

④ Press the START panel switch in the COMMAND group to execute the specified averaging.

⑤ The PAUSE condition is entered automatically as soon as the specified number of averages is completed. Averaging can be suspended before this by pressing the PAUSE switch.

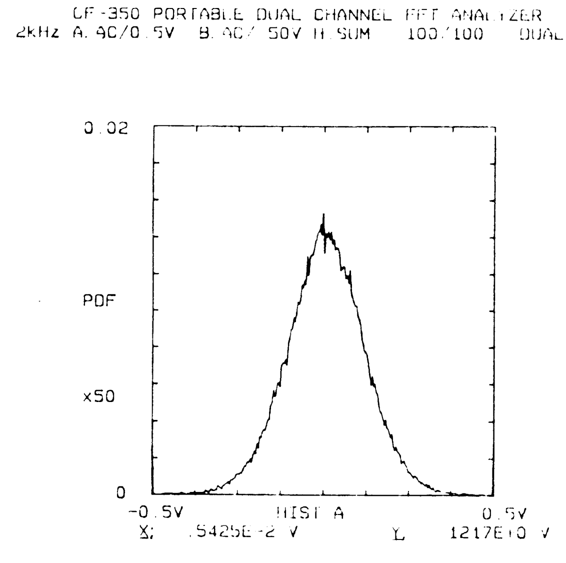


Fig. 5-11 Amplitude Probability Density Function Summation Averaging

(2) Amplitude Probability Distribution Function Summation Averaging

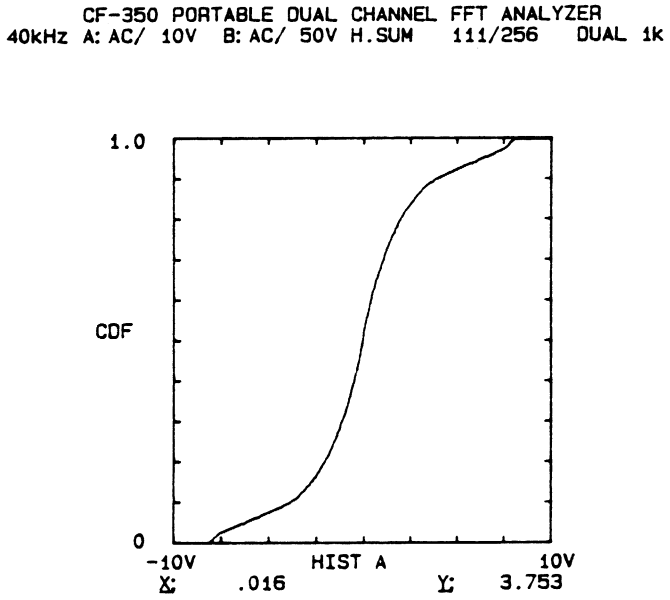
The amplitude probability distribution function can be displayed after the amplitude probability density function is averaged.

① Display the amplitude probability distribution function.

② Perform averaging.

③ Press the IMAG switch of the DISPLAY group.

The amplitude probability distribution function is calculated from the averaged amplitude probability density function and displayed.



```
          CF-350 PORTABLE DUAL CHANNEL FFT ANALYZER
40kHz  A: AC/ 10V   B: AC/ 50V  H.SUM    111/256    DUAL 1k
```

```
X:     .016            Y:   3.753
```

Fig. 5-12 Amplitude Probability Distribution Function Averaging Display

- Averaging Modes and Display Functions

Display Function Averaging Mode			TIME	CORR	IMP RESP	FOURIE SPECT	PWR SPECT	CROSS SPECT	XFER COH COP	INST POWER CROSS SPECT	HIST
Time Domain		Summation Averaging	◎	○	○	○	○	○	○	○	○
		Exponential Averaging	◎	○	○	○	○	○	○	○	○
		Absolute-Value Averaging	◎	○	○	○	○	○	○	○	○
Frequency Domain	Power	Summation Averaging	–	○	○	–	◎	◎	○	–	–
		Exponential Averaging	–	○	○	–	◎	◎	○	–	–
		Peak Hold	–	×	×	–	◎	×	×	–	–
		Differential Averaging	–	×	×	–	◎	×	×	–	–
		Sweep Averaging	–	○	○	–	◎	◎	○	–	–
	Fourier	Summation Averaging	–	○	○	◎	○	○	○	○	–
		Exponential Averaging	–	○	○	◎	○	○	○	○	–
Amplitude		Summation Averaging	–	×	×	×	×	×	×	×	◎

↑ Amplitude Domain

◎: Average processing
○: Calculation of waveform after averaging
×: Not possible
–: Not related (e.g., display latest waveform not averaged)

Table 5-1 Averaging Modes and Display Functions

5.2 Zoom Function (Option CF-0351)

Zoom analysis up to 64 times is possible on the CF-350. Realtime zoom and record zoom are available at multipliers in the range 2 to 64.

5.2.1 Real-Time Zoom

Input signals are zoomed in realtime. Zooming increases the frequency resolution, but this requires increasing the sampling time (window time length),

Example 1 kHz range,400-line mode

Zoom	Magn.	Frequency Resolution	Window Length
OFF	F	2.5 Hz	0.4 s
ON	Twice	1.25 Hz	0.8 s
	Times 4	0.625 Hz	1.6 s
	:	:	:
	Times 64	0.039 Hz	25.6 s

Table 5-2 Frequency Resolution and Window Length

The length of the window increases in inverse proportion to the multiplier, that is to the frequency resolution. The zoom analysis range is 200 lines either side of the set center frequency.

Example 1 kHz range, 400-line mode, 500 Hz center frequency, multiplier is 16.

F_L *(Minimum analysis frequency)* $= 500 - (1000/400) \times 200 \times 1/16 = 468.75$ *Hz*

F_U *(Minimum analysis frequency)* $= 500 + (1000/400) \times 200 \times 1/16 = 531.25$ *Hz*

<Procedure>

① Power spectra and other frequency-domain data are displayed in single-frame display or in the lower frame in dual-frame display.

② Turn the search point on and move it to the point set to the center frequency.

③ Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

FUNCTION SET 2

IFFT	ENVELOP	LOOP	XFER	FITTING	ZOOM		RETURN

④ Setting the center frequency

FREQUENCY ZOOM

ON	SET	INC	DEC				RETURN

The center frequency is established by this setting.

⑤ Executing zoom

FREQUENCY ZOOM

ON	SET	INC	DEC				RETURN

Zoom analysis is executed by this setting. Magnification is set to twice at initialization unless previously set to another value.

⑥ Changing magnification setting using the soft keys

FREQUENCY ZOOM

ON	SET	INC	DEC				RETURN
		a	b				

a INC is used to increase magnification.

b DEC is used to decrease magnification.

The magnification is displayed at the bottom of the frame.

* Repeat calculation times when zooming in the CF-350 are listed below.

×2	Approx. 0.4 s
×4	Approx. 0.65 s
×8	Approx. 1.0 s
×16	Approx. 1.8 s
×32	Approx. 3.5 s
×64	Approx. 6.7 s

* Zoom is not executed in the 2K mode, nor in the high-precision mode.

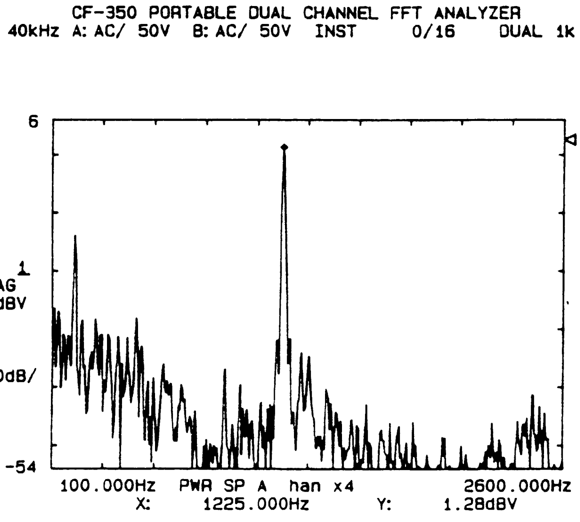


Fig. 5-13 Real-Time Zoom

5.2.2 Record Zooming

Record zoom differs from real-time zoom in that zooming is performed on the time data stored in the CF-350 built-in time-record memory. This makes it possible to store the time data for waveforms that are difficult to read, such as the analysis timings and frequencies of transient phenomena, change the center frequency and magnification to appropriate values, and then perform zoom analysis repeatedly.

The window length, analysis frequency range, and other parameters are the same for record zooming as for realtime zooming.

* Zooming can be performed up to a maximum magnification of 16 in the 30-Kword mode.

- Record zooming is initiated by setting the center frequency and magnification, and by starting it. Zooming is performed by skipping through data for each gap.

Example The gap is 1024, 16 averages are taken, and processing starts from address 1000.

Record zooming is performed at twice magnification, and the addresses of the zoomed data are as follows.

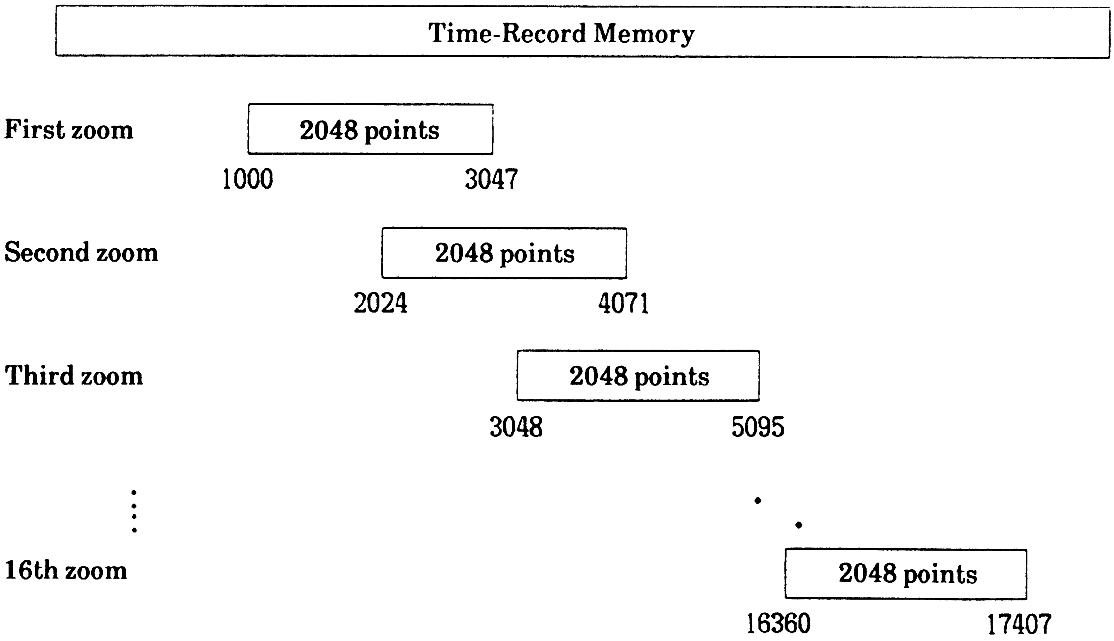


Fig. 5-14 Record Zooming and Addresses

<Procedure>

① Store time-record data in the built-in mass memory.

② Play back the time-record data.

③ Display frequency-domain data in single-frame display or in the lower section of dual-frame display.

④ Press the PAUSE panel switch in the COMMAND group

⑤ Move the search point to the center frequency point.

⑥ Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	**MAS MEM**	DISK	NEXT

MASS MEMORY

RECORD	PLYBACK	PB.LENG	**PB.ZOOM**	PB.DISP	CRT LD	CRT MEM	RETURN

PLAYBACK ZOOM

ON	FACTOR	**CF SET**	SINGLE				RETURN

The center frequency is now set.

PLAYBACK ZOOM

ON	FACTOR	CF SET	SINGLE				RETURN

⑦ Press the START panel switch in the COMMAND group.

Zooming is now performed from the address at which the PAUSE condition was entered. The magnification is displayed in the VIEW section on the right side of the frame.

⑧ The magnification can be changed by pressing the FACTOR switch.

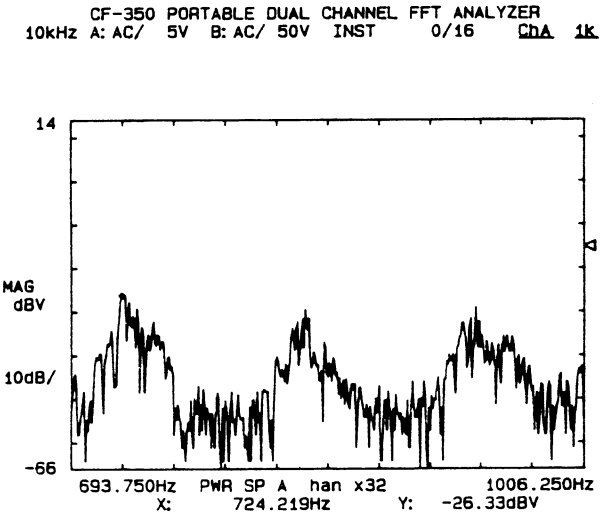
PLAYBACK ZOOM

ON	**FACTOR**	CF SET	SINGLE				RETURN

⑨ Zooming is performed just once from that address by pressing the SINGLE switch.

PLAYBACK ZOOM

ON	FACTOR	CF SET	**SINGLE**				RETURN



```
          CF-350 PORTABLE DUAL CHANNEL FFT ANALYZER
10kHz A: AC/  5V  B: AC/ 50V  INST    0/16    ChA  1k
```

```
X:      724.219Hz       Y:   -26.33dBV
```

Fig. 5-15 Record Zooming

5.3 Arithmetic Operations

The arithmetic operations can be performed on the data in the upper and lower frames in dual-frame display. (This is also possible in superimposed display.)

Addition	(+)	(Lower frame)	+	(Upper frame)
Subtraction	(−)	(Lower frame)	−	(Upper frame)
Multiplication	(×)	(Lower frame)	×	(Upper frame)
Division	(÷)	(Lower frame)	÷	(Upper frame)

The following combinations of the same type of data can be made for the arithmetic operations.

○: Available; −: Not available

	Addition (+)	Subtraction (−)	Multiplication (×)	Division (÷)
Time-axis data	○ (*)	○ (*)	○	−
Correlation function	○	○	−	−
Spectrum	○	○	−	○
Transfer function	○	○	○ (★)	○ (★)
Coherent output power	○	○	−	○
Impulse response	○	○	−	−
Histogram	○	○	−	−
Cepstrum	○	○	−	−
IFFT data	○ (*)	○ (*)	○	−
Hilbert transform	○	○	○	−

* Computation results can be stored either in the CRT block memory or on disk.

★ Transfer-function computation (multiplication and division) in the servo-analysis mode can be stored either int he CRT block memory or on disk.

The computation results of transfer-function data in the other modes can also be stored by first converting it to servo-analysis-mode data. (See Section 11.3)

<Procedure>

① Display the data (functions) to be operated on in the upper and lower frames of dual-frame display.

② Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

FUNCTION SET 1

EQULIZE	CALC	∫dt,/dt	jω	OCTAVE	DENSITY	CEPSTRM	RETURN

CALCULATION

ON	+	−	×	/			RETURN
	a	b	c	d			

Select an operation by pressing one of the keys *a* to *d*.

a	+	Addition.
b	−	Subtraction.
c	×	Multiplication.
d	÷	Division.

③ Execute the operation.

CALCULATION

ON	+	−	×	/			RETURN

Setting CALCULATION on initiates the specified arithmetic operation on the data in the upper and lower frames of the display.

* Make sure to perform the computation with the same frequency and the same conditions for the data int he upper and lower frames.

For example, if addition or subtraction are performed on data for different voltage ranges in the different frames, errors will occur because the function assumes that the same conditions apply to the data in the two frames.

* For subtraction, if the data on the upper part of the screen is greater than that on the lower part of the screen, the results of the subtraction will be negative and will not be displayed. In such cases, reverse the top and bottom parts of the display and perform the subtraction to obtain a positive result.

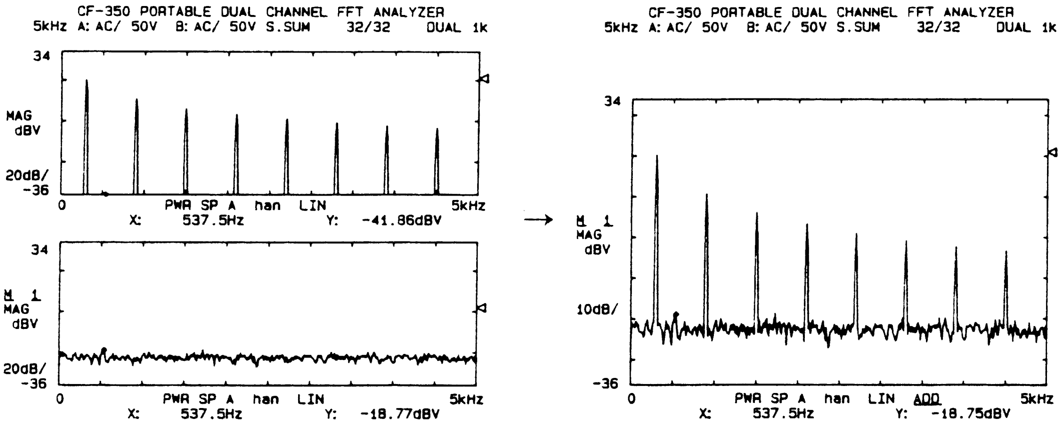


Fig. 5-16 Addition

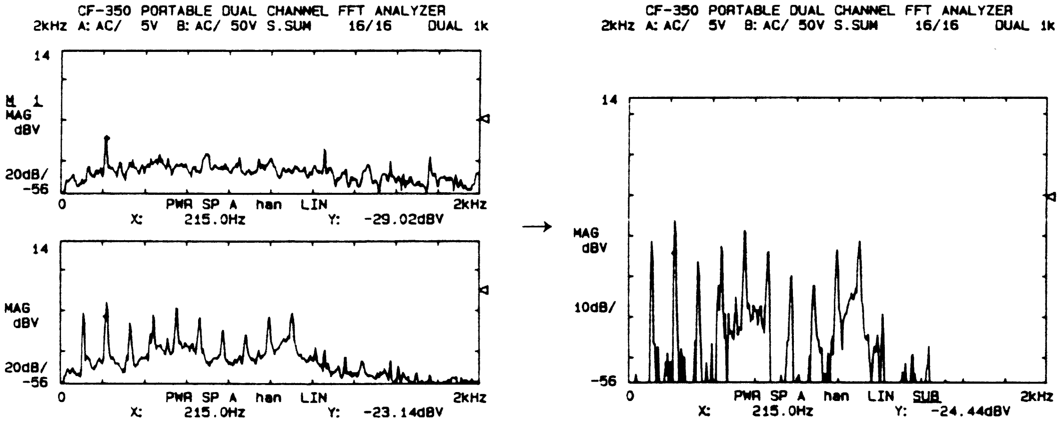


Fig. 5-17 Subtraction

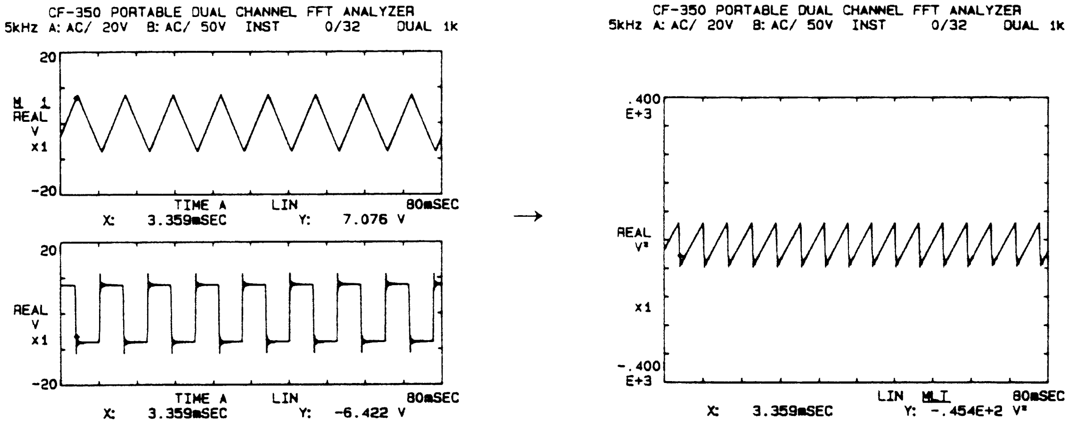


Fig. 5-18 Multiplication

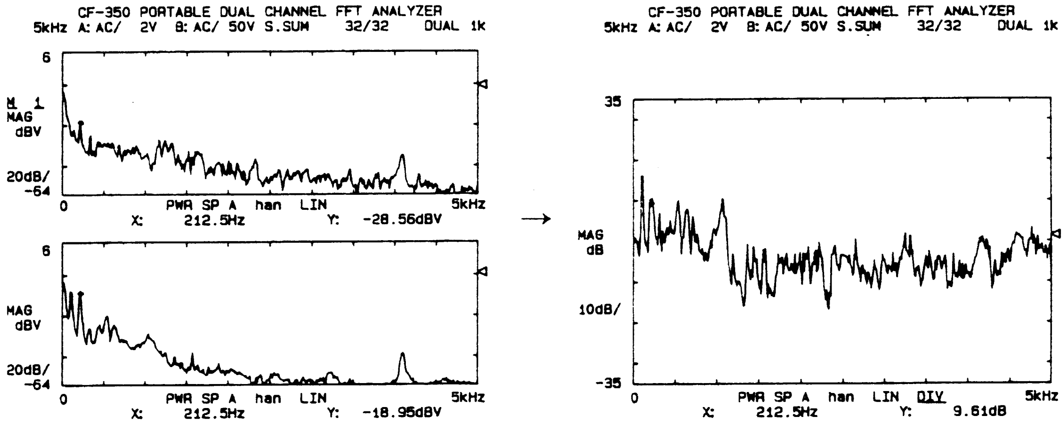


Fig. 5-19 Division

5.4 Differentiation and Integration Functions

The CF-350 calculates first and second order derivatives and single and double integrals in the time-axis and frequency-axis domains.

	Differentiation		Integration	
Domain	1st derivative	2nd derivative	Single integral	Second integral
Time-Axis Domain	d/dt	$(d/dt)^2$	$\int dt$	$(\int dt)^2$
Frequency-Axis Domain	$\times \ j\omega$	$\times (j\omega)^2$	$1/j\omega$	$(1/j\omega)^2$

Table 5-3 Differentiation and Integration

- Time-Axis-Domain Differentiation and Integration

  Sampled time data (1024 or 2048 points) is differentiated or integrated to give the respective time data. Subsequently, normal FFT analysis and other functions are performed, making it possible to obtain power spectra and other data. Differentiation and integration on Ch-B data only is also possible.

- Frequency-Axis-Domain Differentiation and Integration

  Differentiation and integration on on frequency-domain data such as power spectrums, cross spectra, and transfer functions is performed after FFT analysis.

5.4.1 Time-Axis Differentiation

(a) Calculation Method

The following equations are used to perform time-axis differentiation in the CF-350.

$$\frac{dX(T)}{dt} = \frac{X(T-2)-8X(T-1)+8X(T+1)-X(T+2)}{12}$$

$$\frac{dX(T)}{dt} = \frac{d^2X(T)}{d^2} = \frac{Y(T-2)-8Y(T-1)+8Y(T+1)-Y(T+2)}{12}$$

$$X(t) = \textit{Sampling data at time } T$$

$$Y(T) = \frac{dX(t)}{dt} = \textit{First order derivative at time } T$$

$$\frac{dY(T)}{dt} = \frac{d^2X(T)}{dt^2} = \textit{Second order derivative at time } T$$

(b) Read Value Calibration

The values (search points) obtained using the above equations have to be multiplied by the sampling frequency to calibrate them to physical quantities.

Calibration value $= A \times EU \times (f_{max} \times 2.56)^k$

A: Search point value for first or second order derivative after computation (voltage)

EU: Physical quantities per 1 V (e.g., 10.4 mm/V)

f_{max}: Frequency range

k: 1 (first derivative) or 2 (second derivative)

Example Derive first derivative in 1-kHz range for a 10.4 mm/V input signal.

When the search point value is 0.0043 V, the speed V is

$$V = 0.0043 \times 10.4 \times (1000 \times 2.56)$$
$$= 114.5 \text{ mm/s.}$$

- * Computation using equations like those above is necessary for calibration of time-axis differentiation or integration, so these equations must be considered when setting the engineering units to enable direct reading of the search points.

- * In the above example, the setting value [EU] when the fact that differentiation is performed is considered is as follows.

$$[EU] = 10.4 \times (fmax \times 2.56) = 10.4 \times 2560$$
$$= 0.2662 \times 10^5 \, EU/V$$

<Procedure>

① Press the START switch in the COMMAND group to put the CF-350 in the starting condition.

② Display Channel A and Channel B time-axis data on the CRT. (Other data can also be displayed.)

③ Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	**FUNC 1**	FUNC 2	MAS MEM	DISK	NEXT
			☞				

FUNCTION SET 1

EQULIZE	CALC	**∫dt,/dt**	jω	OCTAVE	DENSITY	CEPSTRM	RETURN
		☞					

④ Select first or second order differentiation.

a. Make the following settings for first order differentiation.

TIME INTE & DIFF

ON	**d/dt**	d/dt^2	∫dt	∫dt^2	B only	DC CANC	RETURN
	☞						

TIME INTE & DIFF

ON	d/dt	d/dt^2	∫dt	∫dt^2	B only	DC CANC	RETURN
☞							

* To compute the derivative from Ch B data only:

TIME INTE & DIFF

ON	d/dt	d/dt^2	∫dt	∫dt^2	**B only**	DC CANC	RETURN
					☞		

* Time-axis integration and differentiation are executed in the start condition. Note that they cannot be executed in the pause state. (The same applies to what follows.)

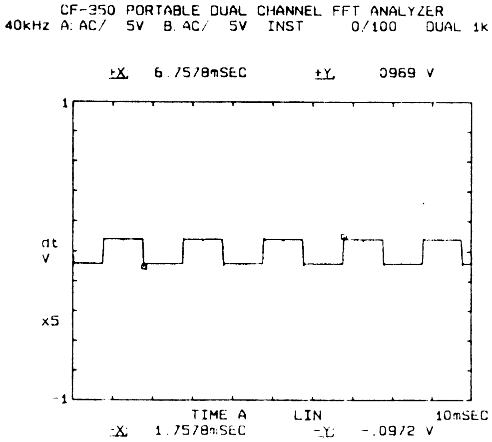
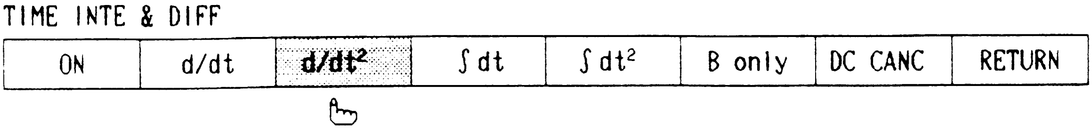
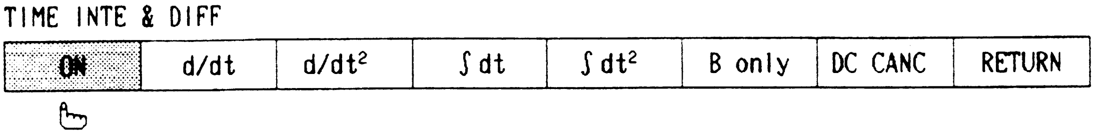


Fig. 5-20 Time-Axis First Order Differential

b. Make the following settings to execute time-axis second order differentiation.





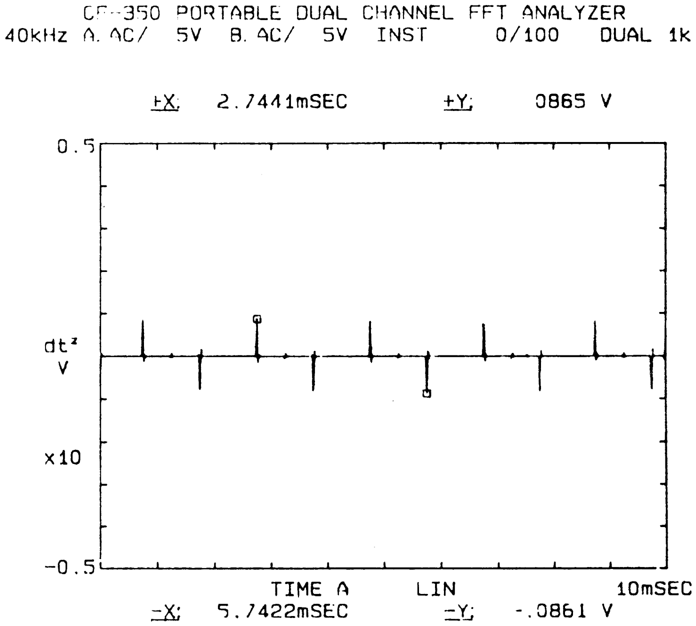


Fig. 5-21 Time-Axis Second Order Differentiation

5.4.2 Time-Axis Integration

(a) Calculation Method

The following equations are used to perform time-axis integration in the CF-350.

$$Y(k\Delta t) = \frac{1}{16} \sum_{i=0}^{k} \{X(i\Delta t - X\} \quad (K=0,1,2,3,\ldots,N-1)$$

$$X = \frac{1}{N} \sum_{i=0}^{N-1} X(i\Delta t) \quad (X=0 \textit{ when DC cancel is off.})$$

$$Z(k\Delta t) = \frac{1}{16} \sum_{i=0}^{k} \{Y(i\Delta t) - Y\} \quad (K=0,1,2,3,\ldots,N-1)$$

$$Y = \frac{1}{N} \sum_{i=0}^{N-1} Y(i\Delta t) \quad (Y=0 \textit{ when DC cancel is off.})$$

$X(n\Delta t)$	Data sampled in time nΔt
$Y(n\Delta t)$	Single integral in time nΔt
$Z(n\Delta t)$	Double integral in time nΔt
N	Sampled data length, 1024 or 2048
1/16	Display gain factor (constant)

(b) Calibrating Reading Values

The values (search points) obtained using the above equations have to be multiplied by the sampling frequency to calibrate them to physical quantities.

$$\textit{Calibration value} = A \times EU \times \left(\frac{16}{Fmax \times 2.56}\right)^{k}$$

A: Search point value for single/double integral after calculation (voltage)

EU: Physical quantities per 1 V (e.g., 1.1 g/V)

f_{max}: Frequency range

k: 1 (single integral) or 2 (double integral)

Example Derive the double integral in 5-kHz range for a 0.91 g/V input signal.

When the search point value is 1.18 V, the displacement X is

$$X = 1.18 \times \frac{9800}{0.91} \times \left(\frac{16}{5000 \times 2.56}\right)^{2}$$

$$= 0.02\ mm \qquad 1\ g = 9800\ mm/s^{2}.$$

* The EU setting value when the fact that the integral is being taken is considered is as follows.

$$[EU] = 9800 \times 1.1 \times \left(\frac{16}{5000 \times 2.56}\right)^{2} = 0.1684 \times 10^{-1}$$

<Procedure>

① Put the CF-350 in the starting condition, just as for time-axis differentiation.

② Display the time-axis data on the CRT.

③ Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

FUNCTION SET 1

EQULIZE	CALC	$\int dt$,/dt	jω	OCTAVE	DENSITY	CEPSTRM	RETURN

④ Select single or double integration.

a. Make the following settings for single integration.

TIME INTE & DIFF

ON	d/dt	d/dt^2	$\int dt$	$\int dt^2$	B only	DC CANC	RETURN

TIME INTE & DIFF

ON	d/dt	d/dt^2	$\int dt$	$\int dt^2$	B only	DC CANC	RETURN

* At this point, if there is a DC component (positive and negative DC voltage component) in the time-axis data integrated, the resulting time-axis integral will overshoot the scale. The following measures must be taken to deal with this.

1. AC-couple the input, or

2. Turn the DC cancel function on.

TIME INTE & DIFF

ON	d/dt	d/dt^2	$\int dt$	$\int dt^2$	B only	DC CANC	RETURN

This will eliminate the DC component. (This cancel function is the same as described in the Section 3.6 describing the DC cancel function.)

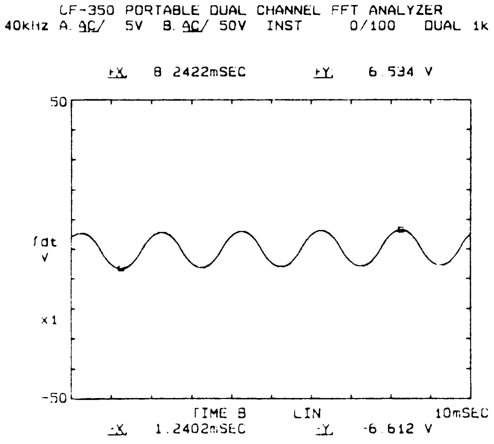
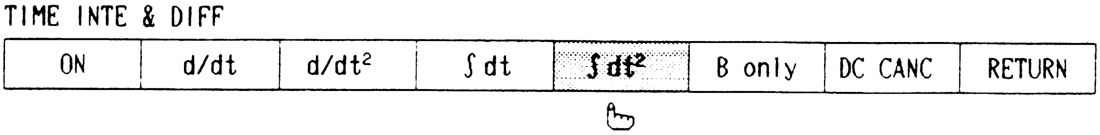
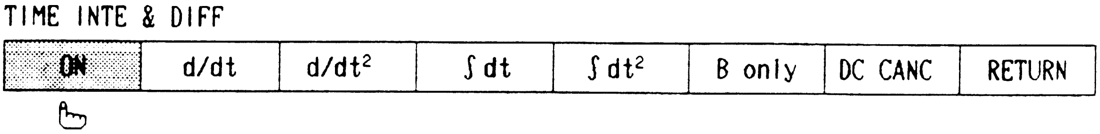


Fig. 5-22 Time-Axis Single Integral

b. Make the following settings to execute time-axis double integration.





* Just as for the single integral, either make AC coupling or use the DC cancel function.

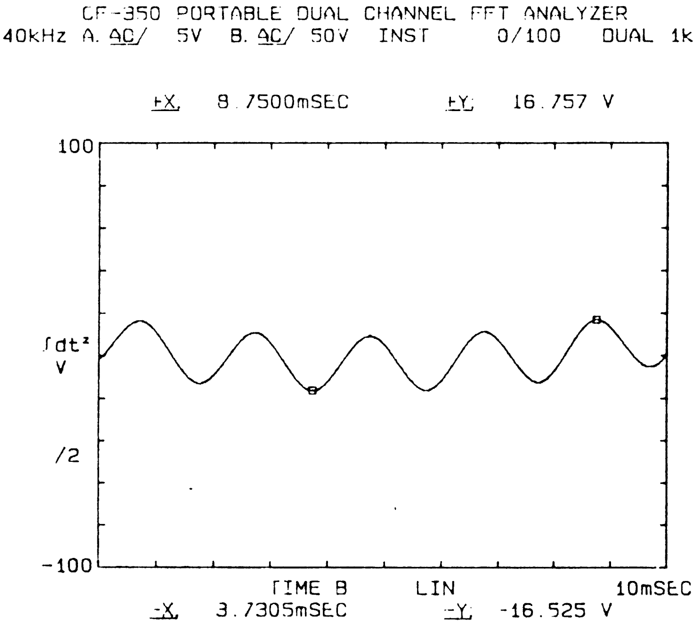


Fig. 5-23 Time-Axis Double Integration

5.4.3 Frequency-Axis Differentiation

(a) Calculation Method

The CF-350 performs differentiation with respect to frequency by multiplying the power spectrum by $(j\omega)^n$.

$$G_1(\omega) = F(\omega) \times (j\omega)$$

$$G_2(\omega) = F(\omega) \times (j\omega)^2$$

$F(\omega)$: Frequency function value for power spectrum etc. at frequency ω.

$G_1(\omega)$: First derivative at frequency ω.

$G_2(\omega)$: Second derivative at frequency ω.

(b) Calibrating Reading Value

The values of $F(\omega)$, $G_1(\omega)$, and $G_2(\omega)$ are all given in the respective units for the search-point reading value. For example, to calculate the speed (mm/s) and acceleration (mm/s^2) for an input signal from a displacement sensor and display these values, the respective calibration values for 1 mm voltage value (V/EU) and 1 V displacement value (EU/V) have to be set for $F(\omega)$ prior to differentiation. This makes it possible to read the values of for speed (mm/s) and acceleration (mm/s^2) directly for the respective data. It is not necessary to calculate the calibration values as for differentiation and integration with respect to time.

Example: Obtain the acceleration by differentiating the signals from a 1 mm = 5 V displacement sensor twice.

Set the engineering unit to 5 V (5 V/EU) using the EU function.

After differentiating twice with respect to frequency, 1 EU = 1 mm/s.

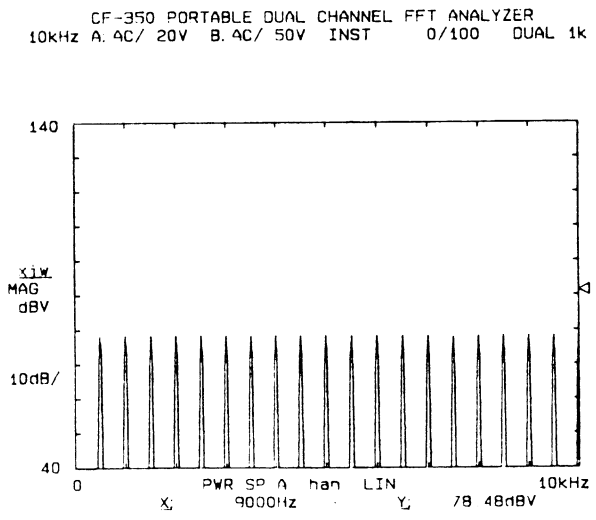


Fig. 5-24 First Derivative with respect to Frequency

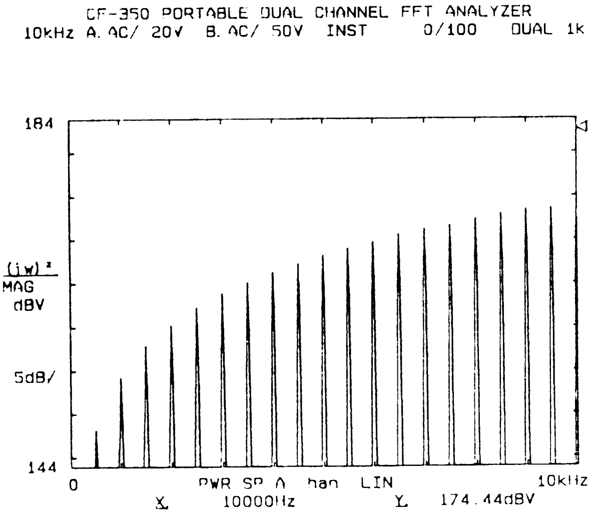


Fig.25 Second Derivative with respect to Frequency

5.4.4 Frequency-Axis Integration

(a) Calculation Method

The CF-350 performs differentiation with respect to frequency by multiplying the power spectrum by $(1/j\omega)^n$.

$$I_1(\omega) = F(\omega) \times (1/j\omega)$$

$$I_2(\omega) = F(\omega) \times (1/j\omega)^2$$

$F(\omega)$:	Frequency function value for power spectrum etc. at frequency ω.
$I_1(\omega)$:	Single integral at frequency ω.
$I_2(\omega)$:	Double integral at frequency ω.

(b) Calibrating Reading Value

As for differentiation with respect frequency, in order to be able to read the values of $F(\omega)$, $I_1(\omega)$, and $I_2(\omega)$ in their respective units, i.e., to display the speed in mm/s and acceleration in mm/s^2, the calibration values for 1 mm/s^2 voltage value (V/EU) and 1 V acceleration value (EU/V) have to be set for $F(\omega)$ prior to integration.

Example	Obtain the double integral of the signal from a 10 mV/g acceleration sensor.
	Set the engineering unit to 0.01 V/9800 mm/s^2 using the EU function.
	After integrating twice with respect to frequency, 1 EU = 1 mm.

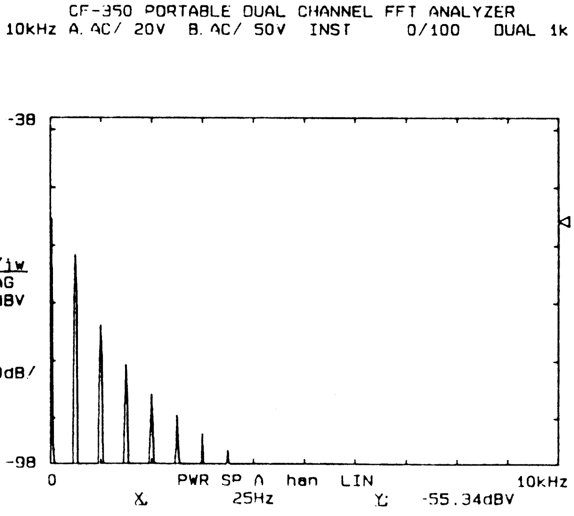


Fig. 5-26 Single Integration with respect to Frequency

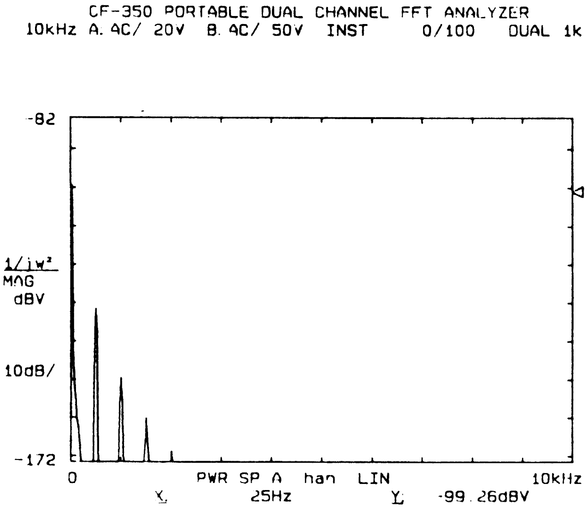


Fig. 5-27 Single Integration with respect to Frequency

<Procedure>

① Make the following soft key settings

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

FUNCTION SET 1

EQULIZE	CALC	∫dt,/dt	jω	OCTAVE	DENSITY	CEPSTRM	RETURN

INTEG & DIFF

ON	× jω	$\times(j\omega)^2$	1/jω	$1/(j\omega)^2$	REF UP	REF DW	RETURN
a	b	c	d	e	f	g	

a	ON	Initiates execution after selection has been made from switches *b* to *e*.
b	$\times(j\omega)$	Selects first order differentiation with respect to frequency.
c	$\times(j\omega)^2$	Selects second order differentiation with respect to frequency.
d	$1/j\omega$	Selects single integration with respect to frequency.
e	$1/(j\omega)^2$	Selects double integration with respect to frequency.
f	REF UP	Increases the display reference.
g	REF DW	Decreases the display reference.

- Calculation Using the Transfer Function

For the transfer function, differentiating or integrating with respect to frequency corresponds to the following operations.

	First Order Derivative $\times (j\omega)$	Second Order Derivative $\times (j\omega)^2$	Single Integral $\times (1/j\omega)$	Double Integral $\times (1/j\omega)^2$
H	Ch B first order derivative, or Ch A single integral	Ch B second order derivative, or Ch A double integral	Ch B single integral, or Ch A first order derivative	Ch B double integral, or Ch A second order derivative
$\frac{1}{H}$	Ch A first order derivative, or Ch B single integral	Ch A second order derivative, or Ch B double integral	Ch A single integral, or Ch B first order derivative	Ch A double integral, or Ch B second order derivative

H = Ch B/ChA $1/H$ = Ch A/Ch B

Table 5-4 Transfer-Function Differentiation and Integration

For example, if power *(F)* is input to Ch A and acceleration *(A)* is input to Ch B, the following results are obtained.

		Differentiation and Integration			
		$\times (j\omega)$	$\times (j\omega)^2$	$\times (1/j\omega)$	$\times (1/j\omega)^2$
H	A / F Inertance			V / F Mobility	X / F Compliance
1 / H	F / A Apparent Mass	F / V Mechanical Impedance	F / X Stiffness		

F:	Power	V:	Speed
A:	Acceleration	X:	Displacement

Table 5-5 *1/H* Function and Differentiation and Integration

5.5 Calibration (EU) Function

Analysis data can be read directly in the units of the input signal on the CF-350 using its engineering unit (EU) function. The following settings can be made.

EU/V: Physical quantity of input signal corresponding to an input of 1 $V_{0\text{-}P}$

V/EU: Voltage (zero-peak value) for one unit of input-signal physical quantity.

S.P/EU: Current search-point level is set to 1 unit of the physical quantity.

dB/S.P: Current search-point level is set to any desired dB value.

[Usage]

EU/V: Displacement sensor with an output of 0.38 g per 1 V. Input as 0.38.

V/EU: Acceleration sensor with output 10.5 m V per 1 g. No numerical setting.

S.P/EU: Current search point (e.g., 1 kHz) is set to 1 g. of the physical quantity.

This applies when using the calibration signal of an amplitude meter.

dB/S.P: Current overall value is set to 124 dB. Input as 124.

This applies when using the calibration signal of a noise meter.

Numerical setting using this EU function the search-point reading value, the list display, and Y-axis scale are set to units of physical quantities. Up to three alphanumeric or symbol. characters can be used for the display characters (usually "EU"). For example, "g", "dB", or "mm" can be set on the CRT display.

The following exponent format is used for calibration input setting (for EU/V and V/EU) in the CF-350.

$A \times 10^{8}$ (A: mantissa, B: exponent)

A and B can be set in the following ranges.

A: .0001 to .9999
B: ±0 to ±9.

For example, the following settings all result in the same value for 0.025,

0.25×10^{-1}
0.025×10^{0}
$0.0025 \times 10^{+1}$

- In the dB/S.P. setting mode, the search point can be set to any arbitrary value within ±250 dB.

  The search value for the calibration value set in the dB/S.P. mode, and the calibration value calculated after switching to another setting method (EU/V, V/EU, or S.P./EU) using the soft keys may overflow.

- The + and – signs have to be used in setting the calibration value.

- 1 EU = 1 V is the setting when the CF-350 is initialized.

<Procedure>

① Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

- To set Ch A:

UNIT SET

UNIT X	UNIT Y	Ch A EU	Ch B EU	HARMNIC			RETURN

- To set Ch B

UNIT SET

UNIT X	UNIT Y	Ch A EU	Ch B EU	HARMNIC			RETURN

② Press the soft key to select one of the four setting modes.

EU/V	V/EU	S.P/EU	dB/S.P	EU=	SET ChA	SET	RETURN
a	b	c	d				

a	EU/V	Sets the physical quantity per 1 $V_{0\text{-}P}$
b	V/EU	Set the voltage per unit of the physical quantity
c	S.P./EU	Set the current search-point voltage to one unit of the physical quantity.
d	dB/S.P.	Set the current search-point voltage to an arbitrary dB value.

③ If EU/V or V/EU is selected:

Ch A EU SET

EU/V	V/EU	S.P/EU	dB/S.P	EU=	SET ChA	SET	RETURN

Input the setting using the numeric keys of the DISPLAY group on the front panel. Using the exponent format:

.1000E+1 $(= 0.1 \times 10^1)$

To input, the sequence is mantissa, sign (+ or −), and exponent.

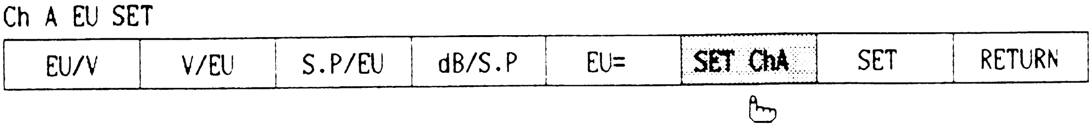
Ch A EU SET

EU/V	V/EU	S.P/EU	dB/S.P	EU=	SET ChA	SET	RETURN

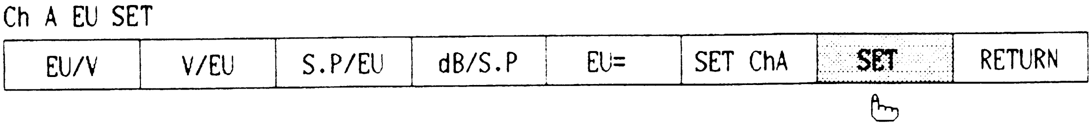
The EU value is now set.

④ If S.P./EU is selected, the search point is used so the power spectrum is displayed. Now move the search point to the setting point.

④-1



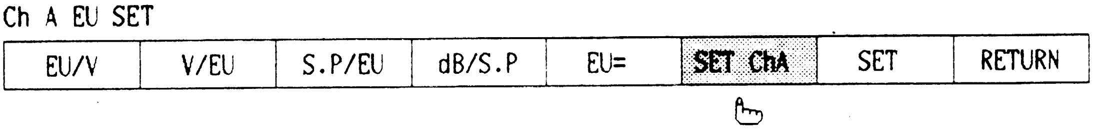
④-2



The S.P./EU value is not set.

⑤ If dB/S.P. is selected, again the power spectrum is displayed, so the search point has to be moved to the setting point.

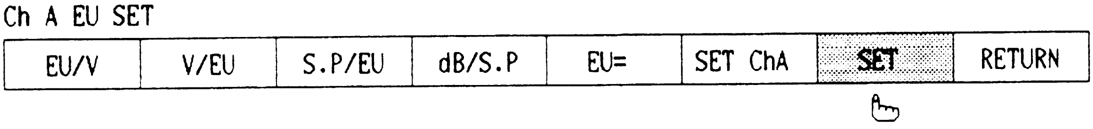
⑤-1



⑤-2 Input the dB setting value. For example, input the sign (+ or −) and then the numerical value thus:

+124.00 dBEU (= 124 dB).

⑤-3



The dB/S.P. value is now set.

- Executing EU Function

Press the EU switch in the SEARCH group to turn its LED on and initiate execution of the EU value as set up above.

Once the EU function is executed, the Y-axis reading value is given by the following table.

Power Spectrum		EU Function Off	EU Function On
Y-Axis Scaling	Logarithmic	dBV	dBEU
	Linear	V	EU

Table 5-6 Relation Between the EU Function and Y-Axis Value

The EU characters in the display can be changed to units such as dB, g, or mm.

- Changing EU Characters

The display unit characters are set to EU at initialization, but they can be changed to any desired characters. (The following describes the procedure for Ch A; that for Ch B is the same.)

① Make the following soft key settings.

<<< MENU B >>>

DISPLAY	**UNIT**	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

UNIT SET

UNIT X	UNIT Y	**Ch A EU**	Ch B EU	HARMNIC			RETURN

Ch A EU SET

EU/V	V/EU	S.P/EU	dB/S.P	**EU=**	SET ChA	SET	RETURN

Ch A EU SET

EU/V	V/EU	S.P/EU	dB/S.P	EU=	**SET ChA**	SET	RETURN

② Use the keys labeled with white alphanumerics and symbols of the switches on the front panel. Letters can be input in upper or lower case.

> The PAUSE switch of the COMMAND group toggles between upper and lower letters.

③ Make the following soft key setting.

Ch A EU SET

EU/V	V/EU	S.P/EU	dB/S.P	EU=	SET ChA	**SET**	RETURN

This complete the procedure for setting the display unit characters.

* When the display characters are dB, if the Y-axis is a logarithmic scale it will already be labeled dB, so the EU can be deleted simply by inputting a space.

* When functions such as differentiation or integration are used in the time domain, if the input-signal units are set using this EU function, the waveform resulting after differentiation or integration cannot be directly read. This situation can be dealt with either by calculating back from the result, or by setting the EU value prior to computation taking this conversion value into consideration.

5.6 Inverse Fourier Transform

The inverse Fourier transform is calculated from the Fourier spectrum to obtain a time signal.

The following two functions can be selected.

1. Bandlimiting Function

   When an inverse Fourier transform is performed, this function enables bandlimiting on the frequency axis and converts the spectrum to the time axis.

2. Adjustment Function

   This function performs compensation when an inverse Fourier transform is performed to eliminate Hanning window time data distortion.

   (This is not possible on about the first and last 10% of the data.)

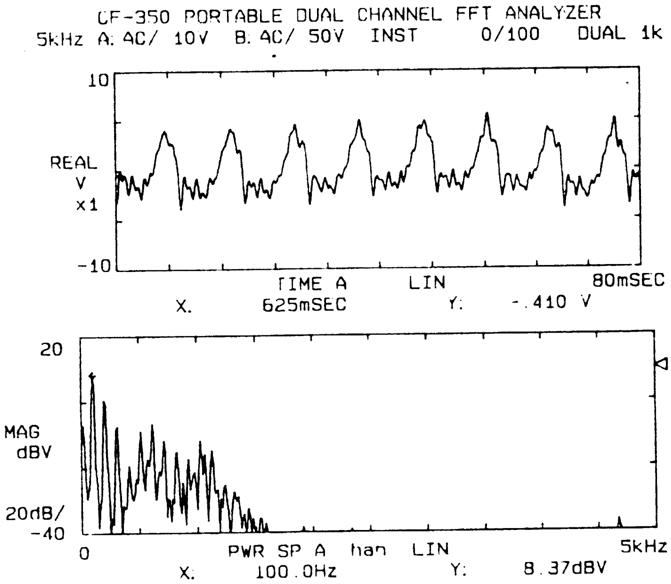


Fig. 5-28 Inverse Fourier Transform

<Procedure>

1. When an inverse Fourier transform is performed on the entire analysis-frequency-range band:

   ① Display the power or Fourier spectrum on the CRT.

   If the inverse Fourier transform is to be applied to disk or block memory data, the Fourier spectrum should be stored in advance.

   ② Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

FUNCTION SET 2

IFFT	ENVELOP	LOOP	XFER	FITTING	ZOOM		RETURN

INVERSE FFT CONT

IFFT	BAND	ADJUST	MULT H	ST.FS			RETURN

③ Perform the inverse Fourier transform; COMPLETE will be displayed on the CRT.

④ Press the TIME panel switch. The result of the inverse Fourier transform is now written into the time-axis data memory.

* Thus, e.g., when performing an inverse Fourier transform on CRT block memory data, the current input signal time data from the execution is deleted, and the result of the inverse Fourier transform is written in.

2. When bandlimiting is performed:

① Display the power or Fourier spectrum on the CRT screen as in 1. above.

Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	**FUNC 2**	MAS MEM	DISK	NEXT

FUNCTION SET 2

IFFT	ENVELOP	LOOP	XFER	FITTING	ZOOM		RETURN

② Move the search point to the minimum frequency for bandlimiting (inverse Fourier transform only over the set frequency range).

③ Press the ΔSET switch in the SEARCH group to display the delta-cursor.

④ Move the search point to the maximum bandlimiting frequency.

⑤ Make the following soft key settings

INVERSE FFT CONT

IFFT	**BAND**	ADJUST	MULT H	ST.FS			RETURN

INVERSE FFT CONT

IFFT	BAND	ADJUST	MULT H	ST.FS			RETURN

A bandlimited inverse Fourier transform will now be performed from the delta-cursor to the search point (including the bounding frequencies).

*1 An inverse Fourier transform can be performed on a single frequency line by placing the Δ-cursor on top of the search point.

*2 To perform an inverse Fourier transform that excludes a specific band (band rejection), set the delta-cursor to the maximum frequency of the band and move the search point to its minimum frequency.

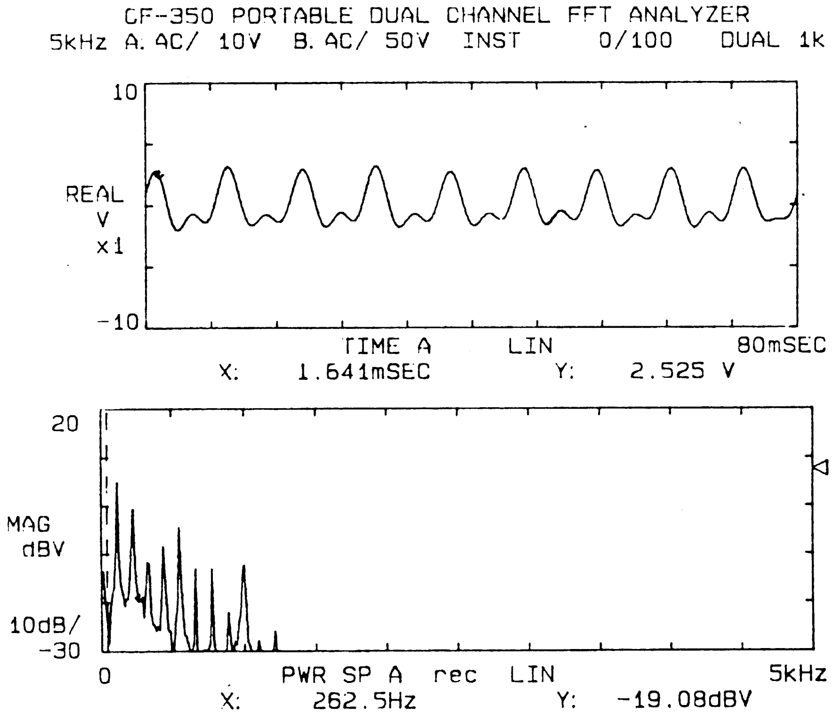


Fig. 5-29 Bandlimited Inverse Fourier Transform

3. Adjustment Function

Hanning-window compensation is performed. The adjustment function is executed before an inverse Fourier transform is performed and independently of bandlimiting.

INVERSE FFT CONT

IFFT	BAND	**ADJUST**	MULT H	ST.FS			RETURN

INVERSE FFT CONT

IFFT	BAND	ADJUST	MULT H	ST.FS			RETURN

Hanning window compensation followed by an inverse Fourier transform are now performed.

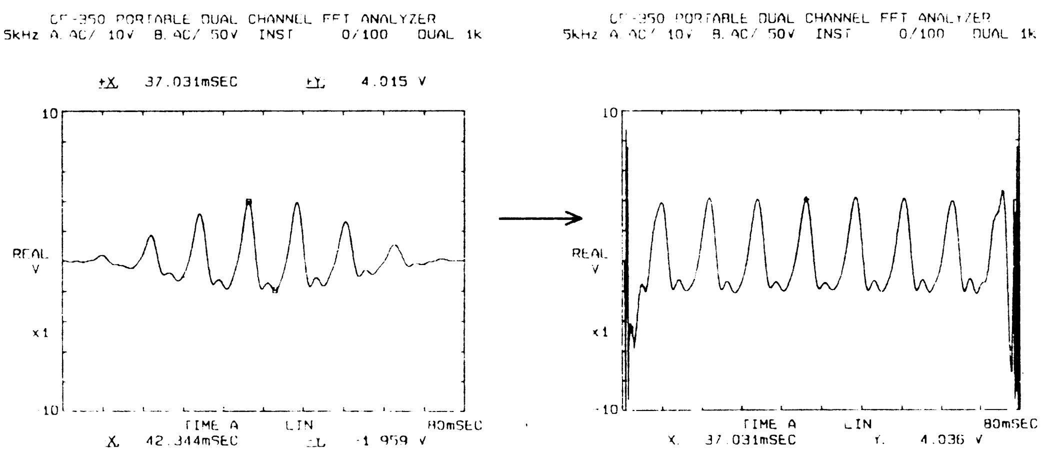


Fig. 5-30 Adjustment Function

* MULT H Key

With the MULT H key set to on, if the IFFT key is pressed to execute an inverse Fourier transform, compensation will be performed based on the transfer functions stored in CRT block memory locations 59 and 60. Essentially, multiplication of the Fourier spectrum (real and imaginary parts) and this transfer function will be performed and the result will be inverse Fourier transformed.

When using this function, the transfer fuction used for compensation (normally the reciprocal of the transfer fuctnion [1/H]) is stored in CRT block memory location 59 and the MULT H key set to on.

5.7 Time Domain Polarity Inversion

The polarity of the data-sampled digital time waveform is inverted and the result stored in memory. Positive voltages are converted to negative voltages and vice versa, and the results are stored. However, the capture conditions of triggers, etc., must be set to those of the input signal. The A and B displays of the CRT annotation-part second line are inverted.

<Procedure>

① Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

CONDITION SET

CONDIT		POL.CHG	SEARCH	HI PREC	TI ONLY	PH. adj	RETURN

POLARITY CHANGE

OFF	Ch A	Ch B					RETURN

The polarity of the signal on the channel selected is inverted.

② The signals on both Ch A and Ch B are deleted by pressing the OFF switch.

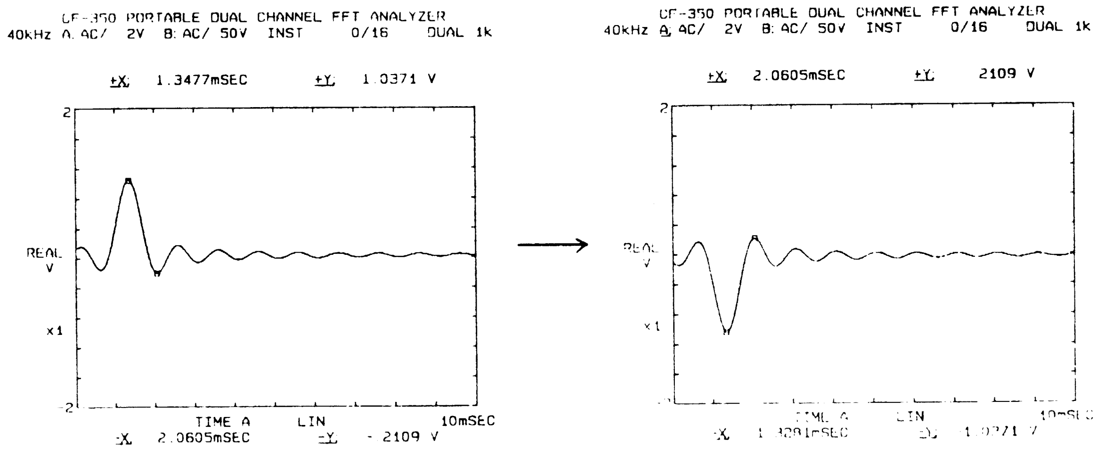


Fig. 5-31 Time-Axis Signal Polarity Inversion

5.8 Frequency Domain Functions

5.8.1 Changing X- or Y-Axis Scaling

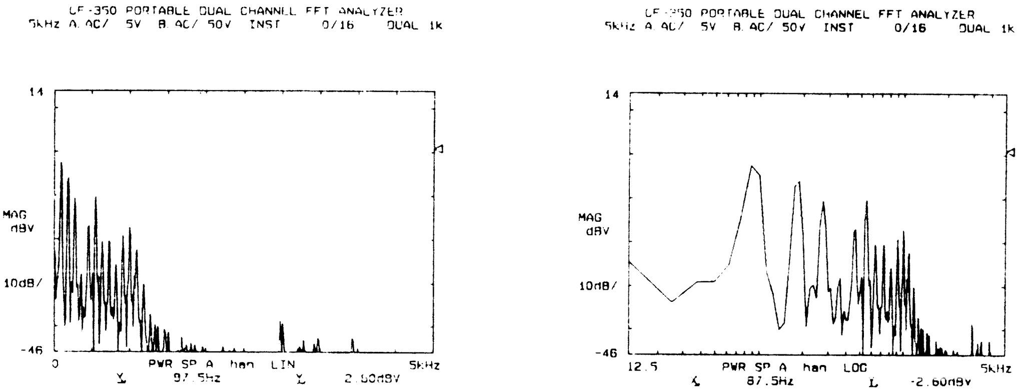
The frequency-domain data X- and Y-axis scaling can be changed from linear to logarithmic scales.

(a) X-Axis Scale Change

Press the SEARCH group XLOG switch to set linear or logarithmic scaling.

When switch LED lights:	Logarithmic scaling on X-axis
When switch LED is extinguished:	Linear scaling on X-axis

XLOG is not effective for time-axis and data other than frequency-domain data.



X-Axis Linear Scaling X-Axis Logarithmic Scaling

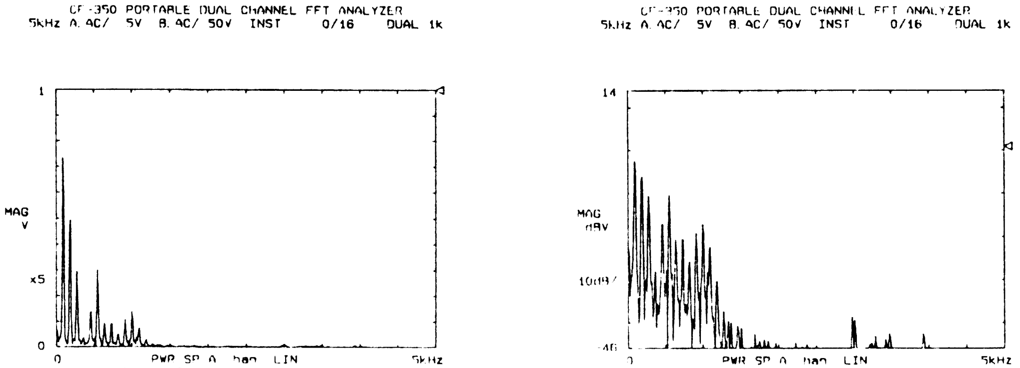
Fig. 5-32 X-Axis Scaling

(b) Y-Axis Scaling Change

Press the SEARCH group YLOG switch to set linear or logarithmic scale.

When switch LED lights:	Logarithmic scaling on Y-axis
When switch LED is extinguished:	Linear scaling on Y-axis

Note that, just as for the X-axis scaling, this switch is not effective for time-axis and data other than frequency-domain data.



Y-Axis Linear Scaling Y-Axis Logarithmic Scaling

Fig. 5-33 Y-Axis Scale

5.8.2 Search Enhance Function

When the Hanning window is selected, the line spectrum peak can be read

on the X axis: at 32 times normal resolution,

on the Y axis: with an accuracy of ±0.1 dB.

<Procedure>

① Select the Hanning window and display the power spectrum.

② Use the horizontal CURSOR switches in the SEARCH group to move the search point to the peak of the spectrum to be enhanced.

③ Make the following soft key settings

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

CONDITION SET

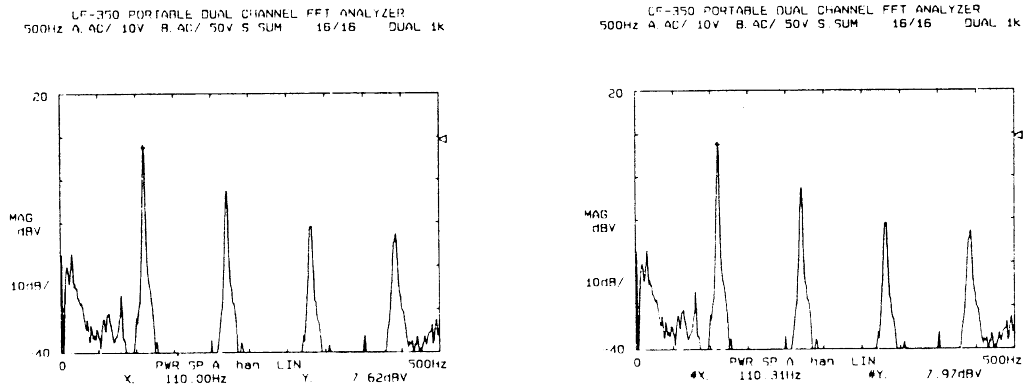
CONDIT		POL.CHG	SEARCH	HI PREC	TI ONLY	PH. adj	RETURN

SEARCH CONTROL

PEAK	delta Y	NEXT PK	P-P	UP-move	ENHANCE	S CUSOR	RETURN

A # symbol is attached to the X- and Y-axis display coordinates (#X and #Y) of the search point to indicate that it has been enhanced.

* This search enhance function can only be used with the Hanning window to read the spectrum peak with high accuracy.



Search Enhance Off

Search Enhance On

Fig. 5-34 Search Enhance Function

5.8.3 Overall Value

This function calculates the overall total in the analysis frequency range when a power spectrum or the coherent output power (C.O.P.) is being produced. The overall value is indicated by a mark on the right line of the frame, and the value can be read by placing the search point on this mark.

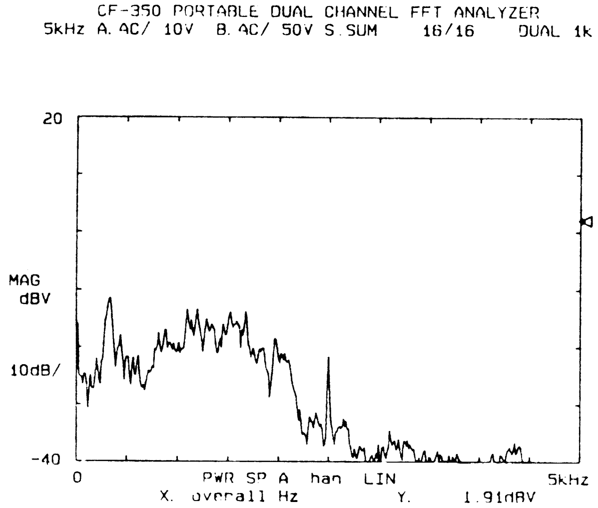


Fig. 5-35 Overall Value Display

The overall value is calculated using the following equations.

$$\text{If the input signal } s(t) = a_0 + \sum_{n=1}^{k} (a_n \cos n\omega t + b_n \sin n\omega t)$$

$$\text{The overall value} = 2a_0^2 + \sum_{n=1}^{k} (a_n^2 + b_n^2)$$

$$= 2\{a_0^2 + \frac{1}{2} \sum_{n=1}^{k} (a_n^2 + b_n^2)$$

$$= 2\ \overline{x(t)^2}$$

$k =$ 400 for 400 lines, or 800 for 800 lines

a_0: DC component

a_n: line n Fourier spectrum real part

b_n: line n Fourier spectrum imaginary part

x(t): Mean of the averages of the input signal

When the Y-axis is linearly scaled:

$$(OA)_{LIN} = (Overall) = \sqrt{2\ \overline{x(t)^2}}$$

$$= \sqrt{2} \times x(t) = \text{Effective value}$$

When the Y-axis is set to logarithmic scale

$$(OA)_{LOG} = 10\ log_{10}(overall\ value)$$

$$= 10\ log_{10}\ 2\ \overline{x(t)^2}$$

$$= 10\ log_{10}\ \overline{x(t)^2}\ + 3.01$$

$$= x(t),\ the\ effective\ value + 3\ dB$$

That is, in Vrms display on the CF-350, the overall value is equal to the mean of the squares (effective value) of the input time signal.

The actual overall value is calculated in the following way.

$$(OA) = (2P_0 + \sum_{i=1}^{N} P_i) \cdot H_r$$

Where,

P_0: DC component
P_i: the ith power spectrum obtained
N: 400, or 800
H_r: Window compensation value: 0.66 for Hanning
0.316 for flat-top
1 for any others

- Partial Overall Value

The overall value can be calculated for an arbitrary interval.

The partial overall value function is only valid for the following functions:

Power spectrum, cross spectrum, coherent output power, transfer function (sum of amplitude ratios), cepstrum, time waveform (sum of absolute values), time-envelope waveform (sum of absolute values).

Up to 20 points of partial overall values from a specified point can be displayed in list display.

<Procedure>

1. Partial Overall Display

① Display the waveform requiring the partial overall values.

② Set the search point of the SEARCH group of panel switches on.

③ Move the search point to the initial point of the partial overall value points using the cursor switches.

④ Press the ΔSET switch to display the delta cursor.

⑤ Move the search point to the final partial overall value point using the cursor switches.

⑥ Make the following soft key settings

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

DISPLAY

FORMAT	LIST	3-ARRAY	COH	NYQ.ORB	P.OV	INHIBIT	RETURN

PARTIAL OVERALL

ON							RETURN

The search point reading value is given at PY: , and the Y-axis value is the partial overall value.

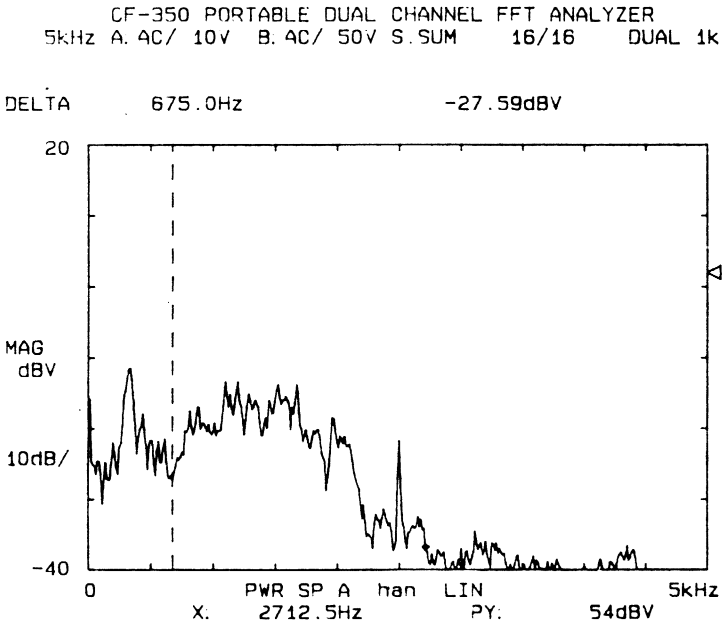


Fig. 5-36 Partial Overall Display

- If the search point is moved in this state, the initial point will not change, and only the final point will change.

- The partial overall value includes the values at the initial and final points.

* The initial point for the partial overall value is set using the delta cursor (low-frequency side, left side of time display), and the search point is used to set the final point (high-frequency side, right side of time display). If these are reversed, the correct value will not be obtained resulting in a display like PY: dBV, or PY: .000E+0V.

2. Partial Overall List Display

① Display the partial overall values in the same way as above and make the following soft key settings.

PARTIAL OVERALL

ON							RETURN

PARTIAL OVERALL

ON							RETURN

DISPLAY

FORMAT	LIST	3-ARRAY	COH	NYQ.ORB	P.OV	INHIBIT	RETURN

② Press the SECOND switch of the DISPLAY group.

③ Press the LIST switch of the DISPLAY group.

④ Turn the LIST SET soft key on.

LIST SET

OFF	ON	SET	INC	DEC	CLR	PEAK	RETURN

The first character at the top of the list display will be highlighted indicated the partial overall value set holding state.

⑤ The search point is not moved to display the first current partial overall value, instead use the soft keys.

LIST SET

OFF	ON	SET	INC	DEC	CLR	PEAK	RETURN

The frequency of the final point of the partial overall value is displayed at the top of the list display in the first position, and the partial overall value is displayed. Then the second position in the list is highlighted as it enters the set holding state.

⑥ Move the search point to the next final point, and make the same settings as in ⑤. The final point can be set up to 20 points.

⑦ Turn the LIST SET switch off when the settings have been completed.

LIST SET

OFF	ON	SET	INC	DEC	CLR	PEAK	RETURN

⑧ Press the LIST switch in the DISPLAY group to display a list of up to 20 points in single-frame display mode.

* Make the following settings to change the list setting.

LIST SET

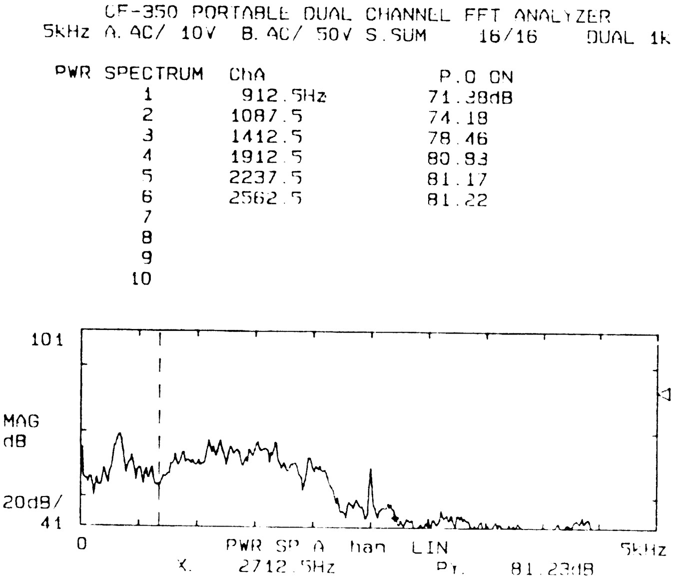
OFF	ON	SET	INC	DEC	CLR	PEAK	RETURN
a	b	c	d	e	f	g	

INC and DEC are used to invert the point at which value are changed and reset.

The CLR switch does not have to be used.

a	OFF	Used when list setting is completed
b	ON	Executes list setting
c	SET	Sets the search point position
d	INC	Increments list setting number and display. Note that in the single-frame display mode, this only increments the list setting number.
e	DEC	The reverse of INC, decrements list setting number and display.
f	CLR	Clears the frequency setting (in this case the partial overall value final point frequency)
g	PEAK	Used for displaying the peak list. This is not effective for partial overall values.

* Partial overall values with different initial-point frequencies cannot be listed on the display. It is only possible to list partial overall values to points from the frequency of one specified initial point.



```
      CF-350 PORTABLE DUAL CHANNEL FFT ANALYZER
5kHz A. AC/ 10V  B. AC/ 50V S.SUM     16/16    DUAL 1k

 PWR SPECTRUM  ChA               P.O ON
       1        912.5Hz         71.28dB
       2       1087.5           74.18
       3       1412.5           78.46
       4       1912.5           80.93
       5       2237.5           81.17
       6       2562.5           81.22
       7
       8
       9
      10
```

Fig. 5-37 Partial Overall List Display

5.8.4 Power Spectrum Density and Energy Spectrum Density

Power and energy spectrum densities are calculated and displayed.

(a) Power Spectrum Density (PSD)

Band widths (Δf) in digital FFT analyzers differ according to the analysis frequency ranges. For example, in the case of a resolution of 1/400, in the 20-kHz range, this band width corresponds to 20 kHz/400 = 50 Hz.

If signals distributed over a wide band, such as white noise, are subjected to frequency analysis, their power can be calculated as the integral for each band width. Thus, if the analysis range is varied, this value will change and the different values cannot be compared. For this reason, the power spectrum per unit frequency (1 Hz) is calculated below. Note, however, that this is not valid for line spectrums.

The power spectrum density is calculated as follows.

$$P_D(k\Delta f) = \frac{P(k\Delta f)}{W_f} \quad [V^2/Hz]$$

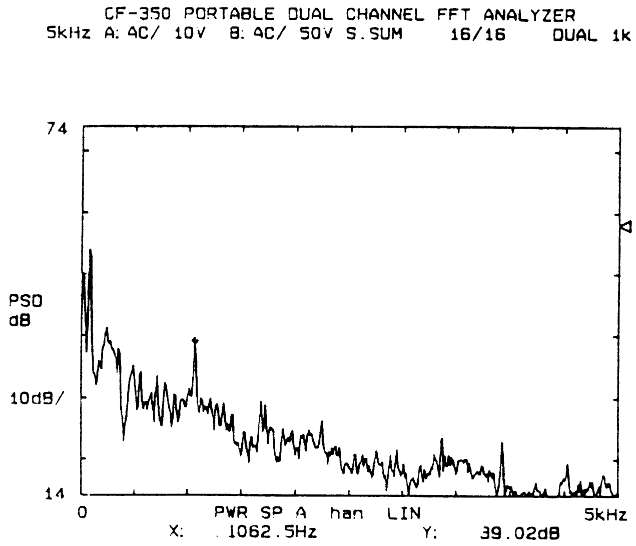
Where,
$P(k\Delta f)$: Calculated power spectrum
Δf: Frequency resolution
W_f: Window compensation factor
= 1 (rectangular)
= 1.5 (Hanning)
= 3.166 (flat-top)

The power spectrums obtained using the bandwidths corresponding to each window are normalized. If possible, measurement should be performed using a Hanning or rectangular window to calculate the power spectrum density.

Reading Values When Executing the PSD

For a high frequency range and a low input signal level, or low frequency range and a high input signal level, if the PSD is executed and the Y-axis linear scaling is used to display in units of V^2 (i.e., the V^2 key is switched to on), the PSD may cause the reading range (0.0001 mV/$\sqrt{\text{Hz}}$ to 9999.99 V/$\sqrt{\text{Hz}}$) to be exceeded.

If this occurs, set the EU value to 1 and set the EU switch of the SEARCH group to on to obtain an EU display. This will express reading values exponentially, so that even overange values as described above can be read.



CF-350 PORTABLE DUAL CHANNEL FFT ANALYZER
5kHz A: AC/ 10V B: AC/ 50V S.SUM 16/16 DUAL 1k

PWR SP A han LIN
X: 1062.5Hz Y: 39.02dB

Fig. 5-38 Power Spectrum Density

(b) Energy Spectrum Density (ESD)

The energy spectrum density of an impulse-type limited energy, produced by a method such as the impact method, is normalized and displayed.

The ESD is calculated be applying an even longer capture time (window length $T = 1/\Delta f$) than for the power spectrum density.

<Procedure>

① Display the power spectrum for Ch A or Ch B on the CRT screen.

② Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

FUNCTION SET 1

EQULIZE	CALC	∫dt,/dt	jω	OCTAVE	DENSITY	CEPSTRM	RETURN

DENSITY

OFF	PSD	ESD					RETURN
	a	b					

a	PSD	selects the power spectrum density display, and
b	ESD	selects the energy spectrum density display.

With these settings the Y-axis scale and the search point indicate the power or energy spectrum density.

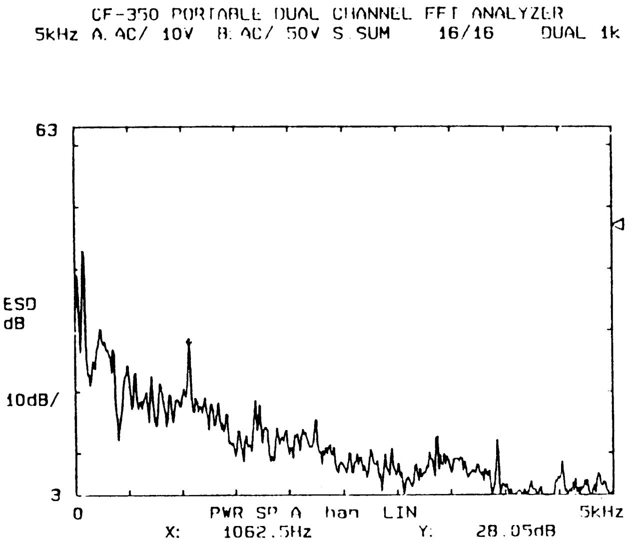


Fig. 5-39 Energy Spectrum Density

* The units for the power spectrum density (PSD) and energy spectrum density (ESD) are as follows. (However, it should be remebered that the unit display cannot be changed at the CF-350.) Also, since the PSD and ESD are normally displayed as rms values, the Y-axis units should be set to rms.

	Power spectrum dB display	Power spectrum linear display (V^2)	Linear spectrum display
Power spectrum density (PSD)	dBVrms/Hz	V^2rms/Hz	Vrms/$\sqrt{Hz}$
Energy spectrum density (ESD)	dBVrms·sec/Hz	V^2rms·sec/Hz	Vrms·$\sqrt{sec}$/$\sqrt{Hz}$

5.8.5 A-Weighting Compensation

A-weighting compensation is applied to the power spectrum. This function is used during octave analysis (1/1 octave, 1/3 octave) and narrow-band analysis (400 lines, 800 lines).

<Procedure>

1. For Octave Analysis:

   ① Display the octave waveform on the CRT screen.

   ② Make the following soft key settings.

<<< MENU A >>>

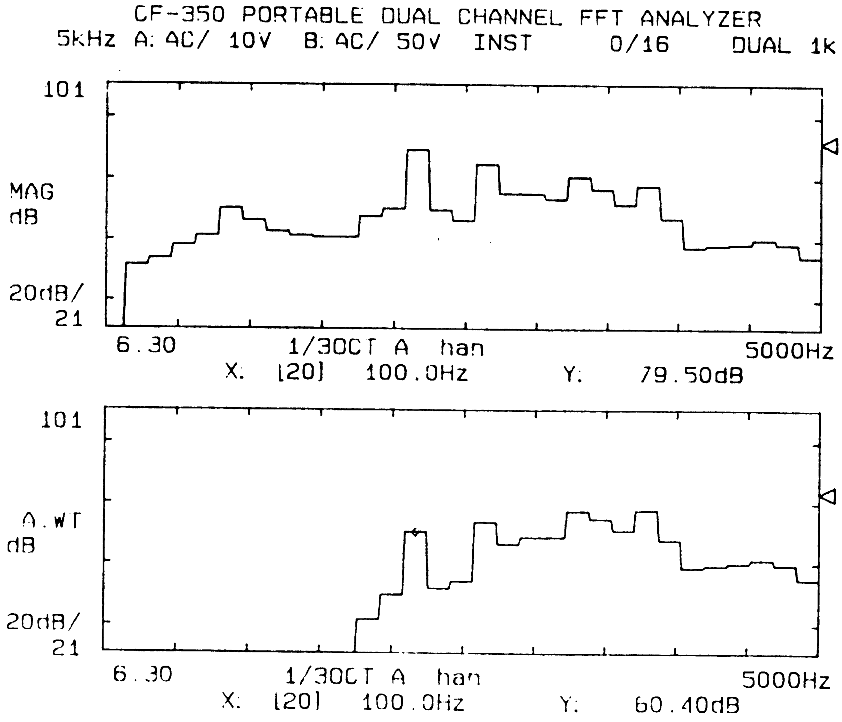
TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

FUNCTION SET 1

EQULIZE	CALC	∫dt,/dt	jω	OCTAVE	DENSITY	CEPSTRM	RETURN

OCTAVE SET

OFF	30	15	1/3 OCT	1/1 OCT	Aweight	SHARP	RETURN



CF-350 PORTABLE DUAL CHANNEL FFT ANALYZER
5kHz A: AC/ 10V B: AC/ 50V INST 0/16 DUAL 1k

X: [20] 100.0Hz Y: 79.50dB

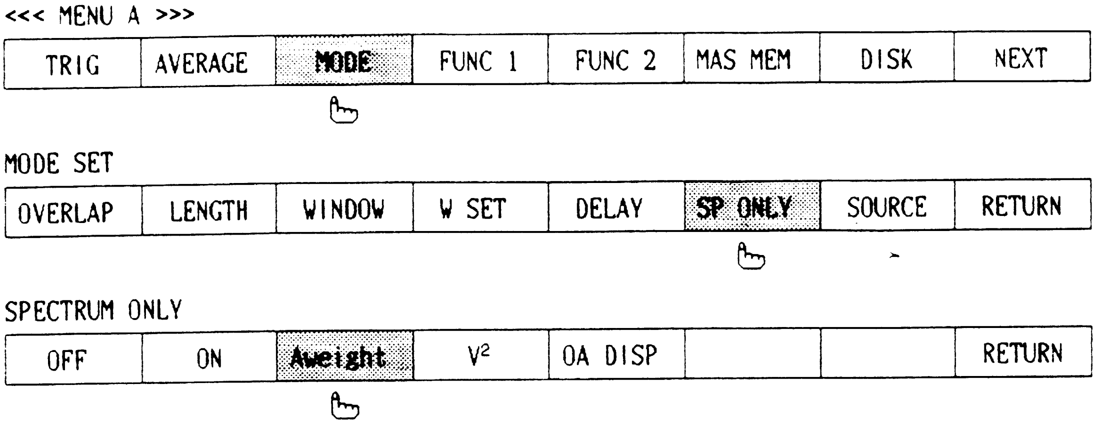
X: [20] 100.0Hz Y: 60.40dB

Fig. 5-40 A-Weighting Compensation (in Octave Analysis) Lower Frame

2. For Narrow Band Analysis:

① Display the power spectrum on the CRT screen.

② Make the following soft key settings.



* A-weighting compensation is only effective in the five ranges 1 kHz, 2 kHz, 5 kHz, 10 kHz, and 20 kHz for narrowband analysis.

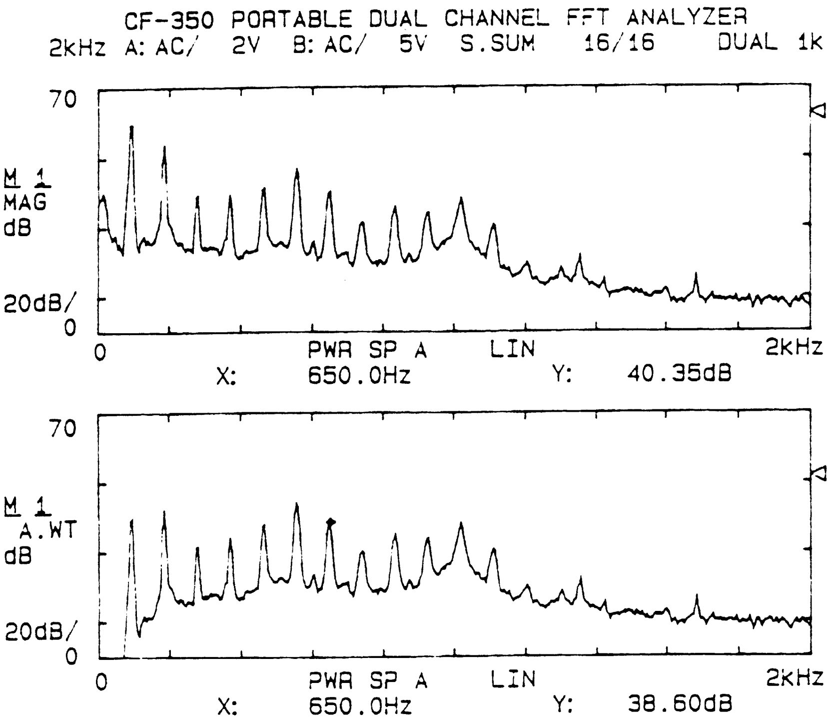


Fig. 5-41 A-Weighting Compensation
(in Narrow-Band Analysis) Lower Frame

5.8.6 Phase-Lag Compensation

Phase lag due to time between sound transmission on two channels A and B can be compensated for by setting time difference and calculating the transfer function.

For example, in measuring the transmission characteristics of speakers, the phase shift can be compensated for by adjusting the distance of the microphone.

<Procedure>

① Display the transfer function.

② Make the following soft key settings.

<<< MENU C >>>

SERVO ·	Y axis	DATAset	OTHERS			OPTION	NEXT

DISPLAY Y ax

REF SET	GAIN	PHASE					RETURN

PHASE CONTROL

FORMAT1	FORMAT2	FORMAT3	G-DLY	DLY.adj	SET ON	SET	RETURN

③ Set the compensation time using the numeric keys. Input the time in seconds in the exponent format, O.OOOE + O.

④ Make the following soft key setting.

PHASE CONTROL

FORMAT1	FORMAT2	FORMAT3	G-DLY	DLY.adj	SET ON	SET	RETURN

This completes setting the compensation time.

⑤ Make the following setting to execute phase compensation.

PHASE CONTROL

FORMAT1	FORMAT2	FORMAT3	G-DLY	DLY.adj	SET ON	SET	RETURN

Phase compensation is now executed and the phase display of the transfer function will be compensated.

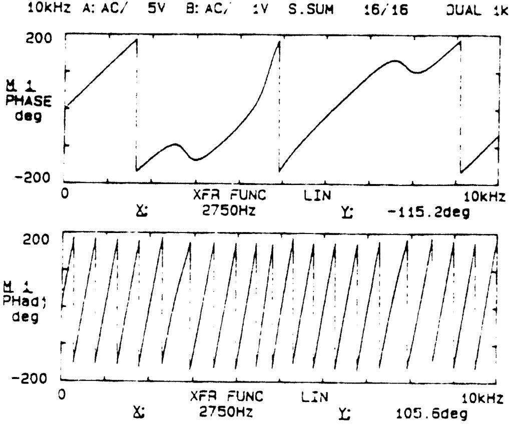


Fig. 5-42 Phase-Lag Compensation (Upper Frame)

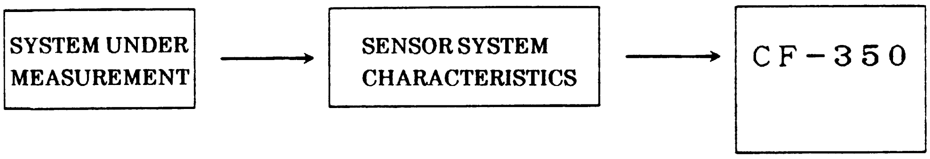
5.9 Transfer Function

5.9.1 Equalization Function

Transfer functions stored in memory can be used to compensate (equalize) other transfer functions and power spectrums. The equalization function compensates characteristics which affect transfer functions and power spectrums to be measured for sensor characteristic compensation to produce the true values.

Example Equalizing a sensor system

The equalization function is used to compensate the characteristics of a sensor system consisting of a sensor, amplifier and other components.



When a sensor is used for measurement, the characteristics of the sensor, amplifier and other components affect the data obtained. The characteristic (transfer function) of the sensor system is measured in advance, and the equalization function is used to compensate the characteristic of the sensor system.

<Procedure>

1. Equalizing the Transfer Function

① Display the transfer function to be measured (the characteristic to be compensated).

Display the transfer function in the single-frame mode, or in the lower frame if dual-frame display is used.

This can only be done in Mag display.

② Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

FUNCTION SET 1

EQULIZE	CALC	∫dt,/dt	jω	OCTAVE	DENSITY	CEPSTRM	RETURN

EQUALIZE

OFF	ON	SET	PWR SP				RETURN

The parameters for compensation have now been stored in memory.

③ Now display the equalized (compensated) transfer function.

④ Make the following soft key setting.

EQUALIZE

OFF	ON	SET	PWR SP				RETURN

The EQU display appears indicating that equalization has been executed. (The transfer function displayed at ③ is the compensated version of the transfer function displayed at ①.)

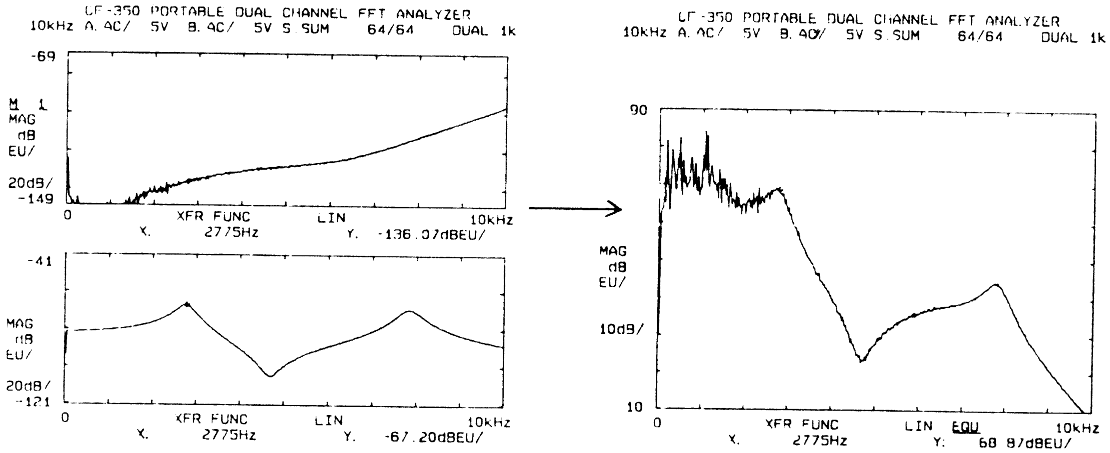


Fig. 5-43 Transfer Function Equalization

2. Equalizing the Power Spectrum

① Display the transfer function to be measured (the characteristic to be compensated). Make the same settings as in 1. ① and ②.

② Display the power spectrum.

③ Make the following soft key settings.

EQUALIZE

OFF	ON	SET	PWR SP				RETURN

EQUALIZE

OFF	ON	SET	PWR SP				RETURN

EQU display is entered and equalization is executed.

(Power spectrum of ② is compensated by the transfer function of ①.)

* When the power spectrum is displayed in dual-frame mode, the equalized power spectrum is shown in the lower frame.

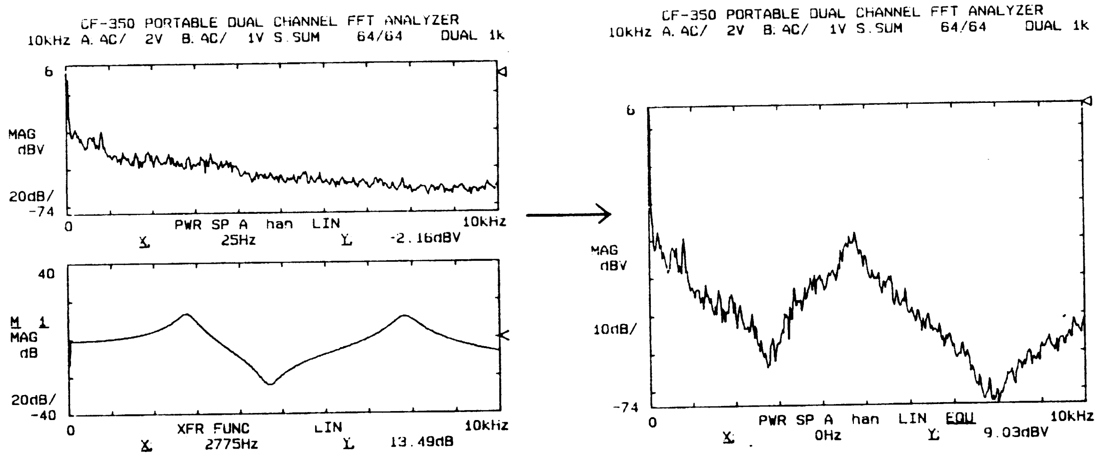


Fig. 5-34 Power Spectrum Equalization

5.9.2 Calculating the Reciprocal of Transfer Function *(1/H)*

The reciprocal of transfer functions can be calculated. The equation for calculating the transfer function is $H = B\ (Ch)/A\ (Ch)$. For the reciprocal of the transfer function it is, $1/H = A\ (Ch)/B\ (Ch)$, and this is stored in memory as a transfer function.

In gain display, the sign of the numerical value is reversed, and in phase display, the relation between lag and lead is reversed.

- Applications
  - This function is used together with the differentiation and integration functions when calculating mechanical impedance, inertance, compliance,and other parameters using power or acceleration sensors.
  - This function is also used to compensate measurement waveforms by inverse characteristics when executing the optional excitation control function.

<Procedure>

① Display the transfer function on the CRT screen.

② Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	**FUNC 2**	MAS MEM	DISK	NEXT

FUNCTION SET 1

IFFT	ENVELOP	LOOP	**XFER**	FITTING	ZOOM		RETURN

XFER

NICO	**1/H**	conv SV	CRT IMP				RETURN

The reciprocal of the transfer function will now be calculated.

* Note that reciprocal calculation cannot be performed on transfer function stored in the block memory, so the reciprocal *1/H* should be stored in the block memory in advance.

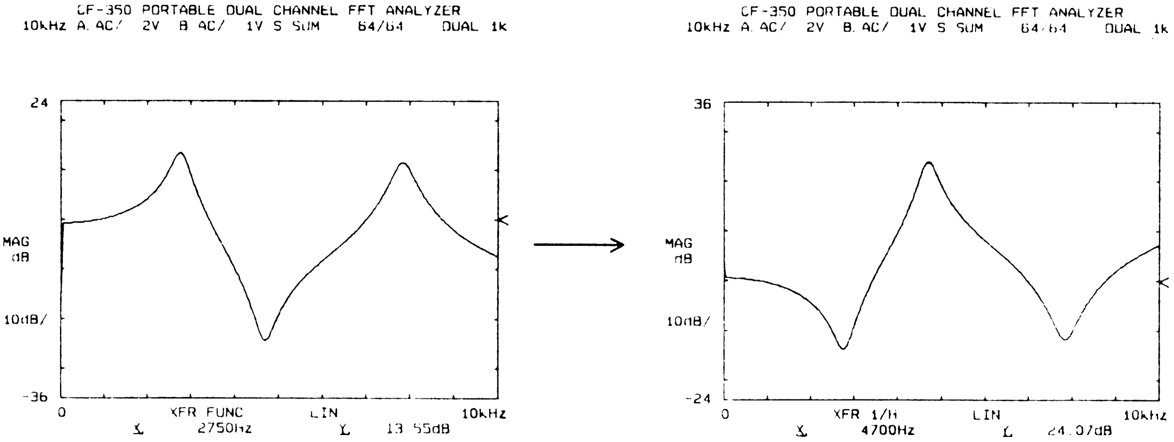
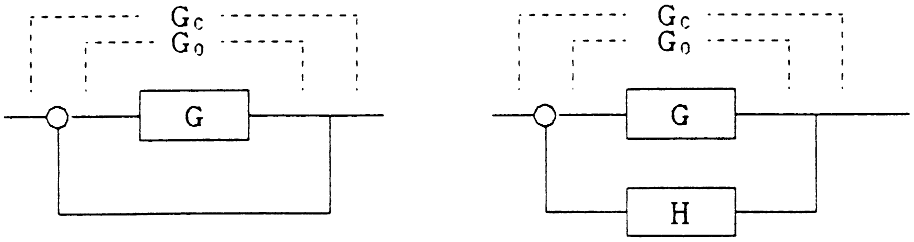


Fig. 5-45 Transfer Function Reciprocal Calculation (*1/H*)

5.9.3 Open-Loop/Closed-Loop Transfer Function Cross Calculation

Closed-loop and open-loop transfer functions are calculated from measured open-loop and closed-loop transfer functions, respectively. When feedback elements exist, transfer function feedback elements can be set up.



Coupled feedback system ($H = 1$)
Closed-loop transfer function

$$G_C = \frac{G_0}{1 + G_0}$$

Open-loop transfer function

$$G_0 = \frac{G_C}{1 - G_C}$$

When feedback elements exist
Closed-loop transfer function

$$G_C = \frac{G_0}{1 + G_0 H}$$

Open-loop transfer function

$$G_0 = \frac{G_C}{1 - G_C H}$$

Fig. 5-46

<Procedure>

- Unity feedback system ($H = 1$)

① Display the transfer function.

② Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

FUNCTION SET 2

IFFT	ENVELOP	LOOP	XFER	FITTING	ZOOM		RETURN

LOOP ANALYSIS

OFF	ON	OPEN	CLOSE	H= 1	H SET		RETURN
	a	b	c	d			

b	OPEN	Selects conversion from closed loop to open loop.
c	CLOSE	Selects conversion from open loop to closed loop.

③ Press H = 1.

④ Press ON.

Cross calculation is now enabled.

- When feedback elements exist

① Display the transfer function.

② Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

FUNCTION SET 2

IFFT	ENVELOP	LOOP	XFER	FITTING	ZOOM		RETURN

LOOP ANALYSIS

OFF	ON	OPEN	CLOSE	H= 1	H SET		RETURN
	a	b	c		d		

b OPEN Selects conversion from closed loop to open loop.

c CLOSE Selects conversion from open loop to closed loop.

③ Display feedback element *H* (transfer function) on the CRT screen.

④ Press H SET.

⑤ Display the transfer function to be cross calculated.

⑥ Press ON.

Cross calculation is now enabled.

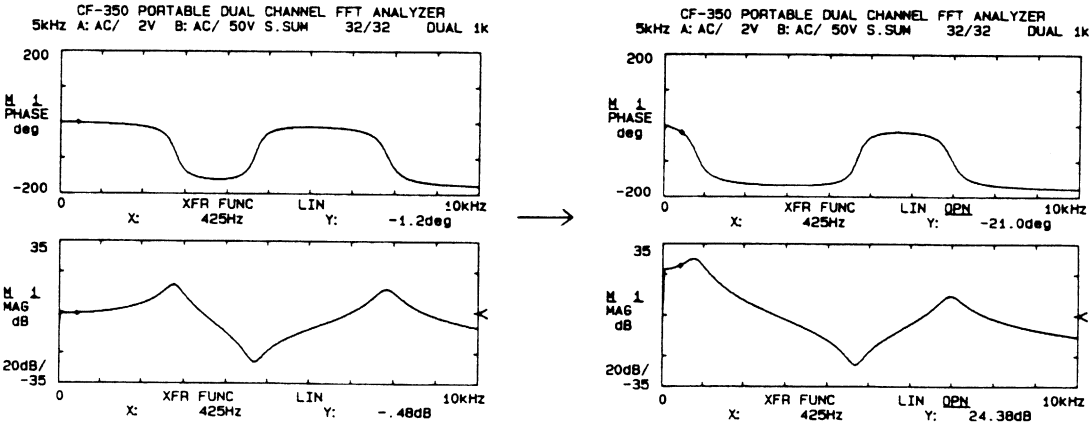


Fig. 5-47 Closed-/Open-Loop Cross Calculation

5.10 Curve Fitting

The CF-0355 curve fitting software can be loaded on the CF-350 to enable curve fitting of transfer functions.

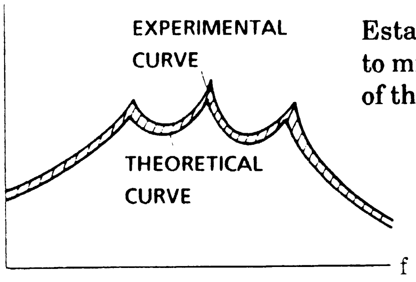
Curve fitting refers to the theoretical transfer function that includes unknown parameters useful in explaining a system, in contrast to the effective values of the transfer function of the real system. This methods enables separate analysis for multiple-point modes possessing peaks approaching the frequency axis, and derivation of the characteristic frequencies, damping factors, and other parameters with respect to each of these modes.

5.10.1 Basic Principles of Curve Fitting

Curve fitting in the CF-350, the model system assumes that an impulse response is displayed in the form of superimposed attenuation sinewaves, i.e., in a linear, non-time-varying system. An impulse response, or its Fourier-transformed frequency response, is one phenomenon handled as this type of linear, non-time-varying system. The quantities that can be measured using an FFT analyzer are not perfect impulse responses, but rather frequency responses cut off within a limited frequency band, and thus only a part of the frequency response. Frequency responses obtained in experiments in fact include noise and components external to the linear and time constant components of the system described above added to the frequency response of a system considered as a linear, non-time-varying system (referred to below as the true frequency response).

Curve fitting is designed to produce the true frequency response from imperfect measurement data, at least in the observable waveband, using equations estimated from the theoretical model. It is also designed to facilitate construction of these kind of systems.

The purpose of curve fittings is thus to enable production of equations which are as simple as possible, and which explain the system frequency response. The basic idea of curve fitting is to express the impulse response and frequency response of the model of the system to be identified in functions of unknown parameters, the properties of which are known, minimizing the difference between the impulse and frequency responses obtained experimentally and from the theoretical equations, in order to estimate the unknown parameters. The difference of two squares is normally used for this difference (error).



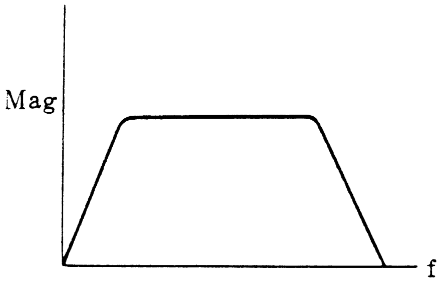
Establish the unknown parameters to minimize the sum of the squares of these differences.

5.10.2 Characteristics of Curve Fitting Method

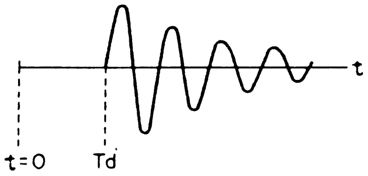
(a) Time Waveform to be Estimated

As the time waveform to be estimated, the impulse response is given in the form of superimposed attenuation sinewaves starting from $t = 0$, assuming a linear, non-time-varying system. Applications include resonance characteristics and torsional vibration of elastic bodies for which the stimulus point and vibration measurement point of the vibrating body are not excessively far apart, and resonance circuits composed of passive elements.

In fact, just like the vibration characteristic of a vibrating body, the time waveform appears as a pair of complex frequency poles, but the kind of odd-order elements arising in the case of RC circuits are not handled. In general, curve fitting cannot be applied to amplifiers with the following type of frequency characteristics.

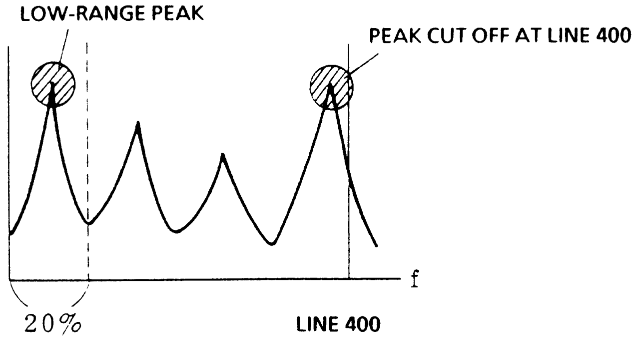


Impulse responses cannot be curve fitted if the rising edge follows a time lag $Td(\neq 0)$.



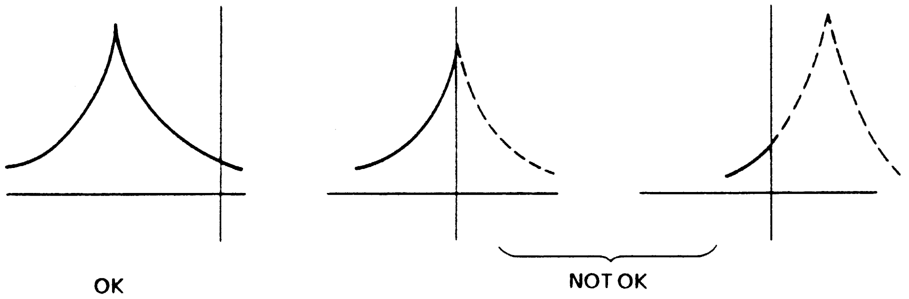
Also, if the system non-linearity appears in the frequency response, curve fitting deteriorates the greater the non-linear.

(b) Estimation Accuracy

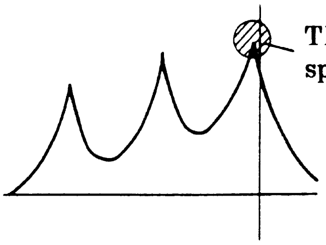


The estimation accuracy decreases slightly if there exist peaks in the low frequency band of the measurement range, but this problem can be solved by inputting a greater number of peaks than might be expected when performing curve fitting. This increases calculation time, so the best way to deal with this problem is to switch the frequency range so that peaks do not occur in the low-frequency band.

In the CF-350, data is cut off at the 400th frequency line . The accuracy decreases the greater the amount of peak occurring at this line frequency is that is cut off. If more than one third of the peak is cut off, the estimation parameter for that peak is invalid.



Despite the fact that the poor estimation accuracy of this cut peak implies that that of other peaks is good, there are cases when the entire synthesized fitting looks bad. There is not much broadening of the spectrum skirts in vibrating bodies with low damping, so this influence is not much felt.

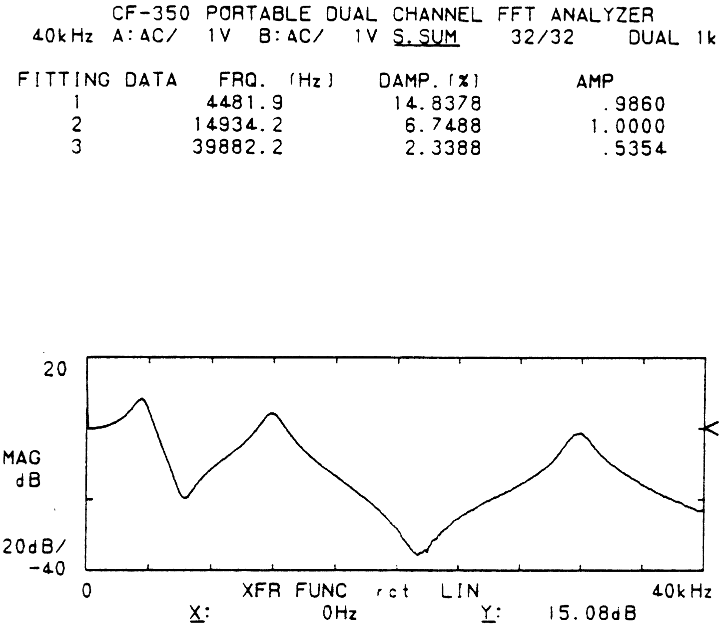


The effect of this makes the entire spectrum paaear high.

5.10.3 Executing Curve Fitting

(a) Executing Curve Fitting

The display when curve fitting is executed is as follows.



```
            CF-350 PORTABLE DUAL CHANNEL FFT ANALYZER
  40kHz  A:AC/   1V   B:AC/   1V S.SUM     32/32      DUAL 1k

FITTING DATA     FRQ. [Hz]       DAMP.[%]          AMP
     1            4481.9          14.8378          .9860
     2           14934.2           6.7488         1.0000
     3           39882.2           2.3388          .5354
```

```
                 XFR FUNC  rct   LIN
          X:         0Hz          Y:    15.08dB
```

Fig. 5-48 Curve Fitting

Where, FRQ. [Hz]:	Characteristic frequency
DAMP. [%]:	Damping factor
AMP:	Measure of other peaks against maximum peak taken as 1.0.

<Procedure>

- Perform measurements for the transfer function to be calculated, ensuring as much as possible that coherence is increased and measurement accuracy is maintained. Particular care should be taken in setting the window, averaging, etc.
- Display the transfer function in the lower frame and a listing in the upper frame in dual-frame display mode.
- Turn the PAUSE switch in the COMMAND group on to enter the PAUSE condition.

① Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

FUNCTION SET 2

IFFT	ENVELOP	LOOP	XFER	FITTING	ZOOM		RETURN

CURVE FITTING

ON	LIST	SYNTH	STORE		NUM SET	SET	RETURN

② Input the number of peaks to be fitted.

Estimate the number of peaks from the displayed waveform, double it, and input this as the number of peaks. The maximum number that can be input is 20.

Press the NUMBER key. 1 will be displayed above the soft key.

Use the vertical CURSOR switches in the SEARCH group to change numbers. The upward cursor increments the number by one, and the downward cursor decrements the values by one.

Press the SET key to set the values.

③ Press the LIST key and then the ON key to initiate execution of the function on. Curve fitting will now be executed. The time required until the results are displayed depending on the number of peaks.

Note

In curve fitting calculations on the CF-350, as outlined above, peaks within the bottom 20% of the frequency range, or peaks cut off at the 400th line will reduce the damping factor estimation accuracy. In this case, select the frequency range so that the frequencies of the peaks to be estimated do not fall within it, and perform measurement again. Another way to deal with this situation is to multiply the estimated number of peaks by three or four, not just two, to determine the input value, and then execute curve fitting again.

In rare cases, the position of the peak of the actual measured value of the parameters such as the estimated characteristic frequency will be listed as completely different. This is because numerical calculation falls into the "ill-condition" state. When this happens, set the number of peaks before and after, and execute curve fitting again.

(b) Transfer Function Synthesis

The transfer function is synthesized from the calculated curve fitting data, and then written over the measured transfer function.

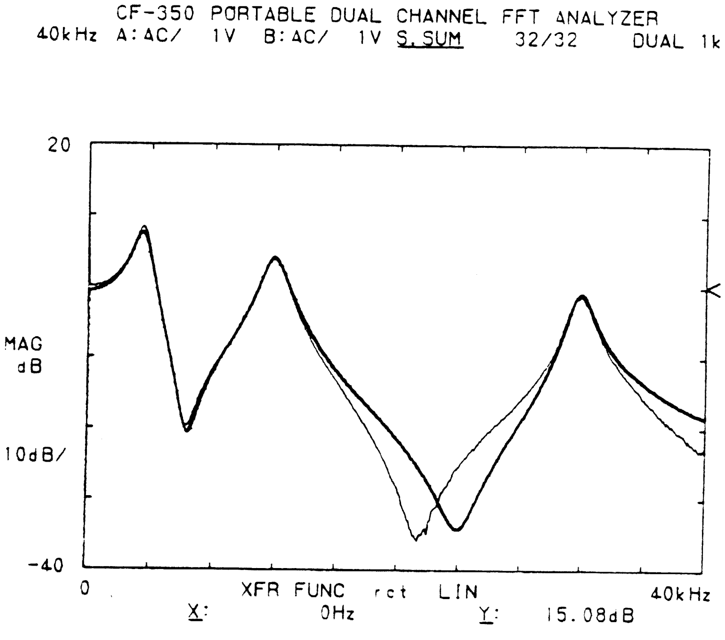


Fig. 5-49 Synthesis

<Procedure>

CURVE FITTING

ON	LIST	SYNTH	STORE		NUM SET	SET	RETURN

Turn the SYNTH key on.

It takes about ten seconds to produce a result.

If the data is not appropriate, change the number of peaks and execute curve fitting again.

(c) Storing Fitting Data

The synthesized data can be stored in the CRT block memory.

<Procedure>

- Execute synthesis and display the transfer function in single-frame mode.

CURVE FITTING

ON	LIST	SYNTH	STORE		NUM SET	SET	RETURN

The synthesized waveform will now be stored in the specified block.

Note

This operation does not store the measured transfer function, which has to be stored separately.

6. DISPLAY FUNCTIONS

6.1 Y-Axis Units and Scaling

The CF-350 Y-axis display units are as follows.

V, V^2, V_{rms}, V^2_{rms}, EU, $(EU)^2$, dB, dBV, dBV_{rms}, dBEU, dB $(EU)^2$, deg, PSD, ESD, magnification, ratio, and arbitrarily set units.

PSD: V^2/Hz, $V/\sqrt{Hz}$, dBV/Hz, $(EU)^2/Hz$, $EU/\sqrt{Hz}$, dBEU/Hz

ESD: $V^2 \cdot s/Hz$, $V \cdot \sqrt{s}/\sqrt{Hz}$, $dBV \cdot s/Hz$, $(EU)^2\, s/Hz$, $EU \cdot \sqrt{s}/\sqrt{Hz}$, $dBEU \cdot s/Hz$

For the power spectrum, cross spectrum and similar functions, the Y-axis units in the frequency domain are defined as follows.

1 V:	Indicates a single-ended peak value of 1 V.
1 V_{rms}:	Indicates a single-ended effective value of 1 V.

$0\,dBV = 1\,V_{0\text{-}p}$

$0\,dBV_{rms} = 1\,V_{rms} = \sqrt{2}\,V_{0\text{-}p}$

V	Single-ended peak value
V^2	When V^2 switch (refer to Section 6.1.2) is off, cross spectrum only. When V^2 switch is on: Power spectrum of Ch A and Ch B and coherent power output (COP).
V_{rms}	Single-ended effective (rms) value
V^2_{rms}	Used for the above V^2 when the Y-axis units are set to rms.
EU	Engineering units; used to perform calibration for sensors or detectors.
Magnification ...	Indicates the gain of a transfer function; Ch B amplitude ratio with respect to Ch A.
dB	Log expression of transfer function gain; also used for amplitude ratio between two spectra that were divided.
dBV	Log expression of amplitude with respect to a 1-V reference.
dBV_{rms}	Log expression of amplitude with respect to a 1-V_{rms} reference.
dBEU	Log expression of amplitude with respect to 1-EU reference.
dB $(EU)^2$	Log expression of the Ch A and Ch B cross spectrum set using the EU function; 0 dB $(EU)^2$ for 1 $(EU)^2$.
Ratio	0 to 1

6.1.1 Y-Axis Scaling

The Y-axis scaling can be set to either linear or logarithmic. With linear scaling, the scale is divided evenly. This is operative for time, frequency and amplitude domains.

With logarithmic scaling, the scale divisions intervals have equal differences. This is chiefly used for the display of frequency-domain data. It enables simultaneous display of extremely wide ranges of signal levels. Frequency-domain data is often displayed with log scaling.

Data Domain	Y-Axis Scaling	
	Linear	Logarithmic
Time domain	○	×*
Frequency domain	○	○
Amplitude domain	○	×

* Except for Envelope MAG

Table 6-1 Y-Axis Scaling

	Y-Axis Scaling		Unit
	Linear	Logarithmic	
TIME A	○	×	V or EU
TIME B	○	×	V or EU
AUTO CORR A	○	×	Ratio
AUTO CORR B	○	×	Ratio
CROSS CORR	○	×	Ratio
IMP RESP	○	×	Ratio

Table 6-2 Time-Domain Data Y-Axis Scaling

- Amplitude-Domain Data

For only REAL displays, the YLOG switch is ignored.

	Y-Axis Scaling	
	Linear	Logarithmic
HIST A (PDF)	○	×
HIST A (CDF)	○	×
HIST B (PDF)	○	×
HIST B (CDF)	○	×

Table 6-3 Amplitude-Domain Data Y-Axis Scaling

- Frequency-Domain Data

		Y LOG OFF			Y LOG ON				
		Scaling	UNIT		Scaling	UNIT			
						MAG LOG OFF		MAG LOG ON	
			V^2 OFF	V^2 ON		V^2 OFF	V^2 ON	V^2 OFF	V^2 ON
SPECT A,B	MAG	LIN	V, EU	V^2,(EU)^2	LOG	dBV, dBEU		EU,V	V^2,(EU)^2
	PHASE		deg		LIN	deg			
	REAL		V, EU			V, EU			
	IMAG		V, EU			V, EU			
CROSS SPECT	MAG	LIN	V^2, (EU)^2		LOG	dBV, dBEU		V^2, (EU)^2	
	PHASE		deg		LIN	deg			
	REAL		V^2, (EU)^2			V^2, (EU)^2			
	IMAG		V^2, (EU)^2			V^2, (EU)^2			
XFER	MAG	LIN	RATIO		LOG	dB		RATIO	
	PHASE		deg		LIN	deg			
	REAL		NO unit			NO unit			
	IMAG		NO unit			NO unit			
COH	MAG	LIN	NO unit		LIN	NO unit			
	PHASE								
	REAL								
	IMAG								
C.O.P	MAG	LIN	V,EU	V^2,(EU)^2	LOG	dBV, dBEU		V,EU	V^2,(EU)^2
	PHASE		deg		LIN	deg			
	REAL		V, EU			V, EU			
	IMAG		V, EU			V, EU			

Table 6-4 Frequency-Domain Data Y-Axis Scaling

6.1.2 V^2 Function

The V^2 function is operative for the SPEC A, SPEC B and COP MAG displays. The displayed waveform and search point reading values are in units of V^2.

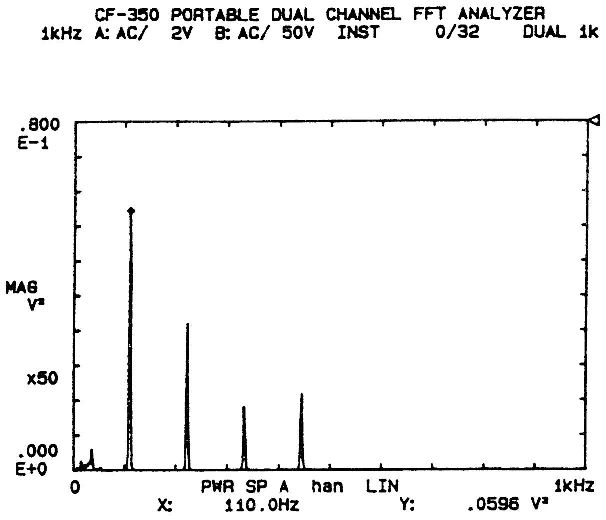


Fig. 6-1 V^2 Function

6.1.3 MAG LOG Display

In the CF-350, the search point value can normally be read in units of V, V^2 and ratio for a linear Y axis and in values of dBV, dBV^2 and dB for a log scaled Y axis.

The MAG LOG display function enables reading of the search point value in linear units such as V and V^2 when the Y axis is log scaled.

This MAG LOG display is only operative for the Y-axis log scale when the frequency-domain data MAG display.

The MAG LOG display function is operative the following cases.

	V^2 OFF	V^2 ON
SPECT A	V, EU	V^2, $(EU)^2$
SPECT B		
CROSS SPECT		
XFER	RATIO	
COH	×	
C.O.P	V, EU	V^2, $(EU)^2$

Table 6-5 MAG LOG Display

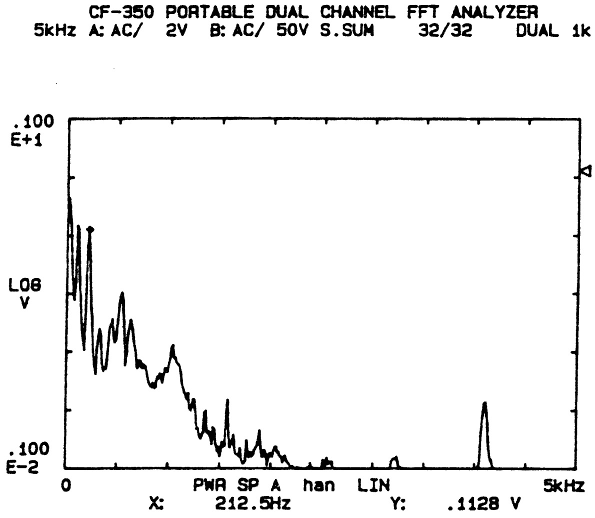


Fig. 6-2 MAG LOG Display

6.1.4 Reference and Gain

The reference function enables the displayed data to be moved in the Y-axis direction. The gain function enables expansion of the displayed data on the Y axis.

		Reference	Gain
TIME A, TIME B		○	Expand about zero *
AUTO CORR A, B			
CROSS CORR			
IMP RESP			
HIST A, B (PDF)		×	
HIST A, B (CDF)			
COH			×
SPECT A, B CROSS SPEC XFER C.O.P.	MAG	○	○
	PHASE	×	Expand about zero deg *
	REAL	○	Expand about zero *
	IMAG		

* With Y LOG set to off.

Table 6-6 The Reference and Gain Functions Used on Various Displayed Functions

<Procedure>

Each time the REF/GAIN switch of the Y group is pressed, the reference function and gain function are switched alternately. When the LED is lighted, the reference gain is selected, and when the LED is extinguished, the gain function is selected. The actual settings are made using the up and down switches.

Also, each time the REF/GAIN switch is pressed, the items corresponding to the reference and gain functions, respectively, are displayed as soft keys.

- Reference Function Display Setting Range

Y-axis LOG:	−200 dB to +200 dB
Y-axis LIN:	3 times the full-scale value established by GAIN

- Gain-Function Display Setting Range

Y-axis LOG:	20 dB to 200 dB full scale (in 10-dB steps)
Y-axis LIN:	1/10 to 2000 times (in 1-2-5 steps)

- Reference Function Procedure

① Press the REF/GAIN switch of the Y group to light the associated LED. When the LED is lighted, the soft key menu appears as follows.

DISPLAY REF SET

ON	LOW	UP	STEP 10	0 SET			RETURN
a	b	c	d	e			

a	ON	Sets reference function on and off.
b	LOW	The reference function is active for a single-frame display or for the lower part of a dual-frame display.
c	UP	The reference function is active for the upper part of a dual-frame display.
d	STEP 10	Movement width setting.
e	0 SET	Resets the set reference value.

② Press ON to set the reference function to on.

③ Use the LOW and UP keys to select the area of the display for the reference function.

④ Use the up and down switches of the Y group to set the reference value.

- The STEP 10 switch changes the reference value as follows.

		STEP 10 Key	
		ON	OFF
LOG		10-dB steps	1-dB steps
LIN	Spectrum	1/32 of input range	1/320 of input range
	Time axis	1/16 of input range	1/160 of input range

Table 6-7 STEP 10 Switch and the Reference Function

- For the Nyquist plot display and Nichols plot display, the reference function is as follows.

	Y-axis scaling	Soft keys
Nyquist plot	LIN/LOG	Effective for LOW only
Nichols plot	LIN/LOG	Effective for LOW only

Table 6-8 Nyquist/Nichols Plot and the Reference Function

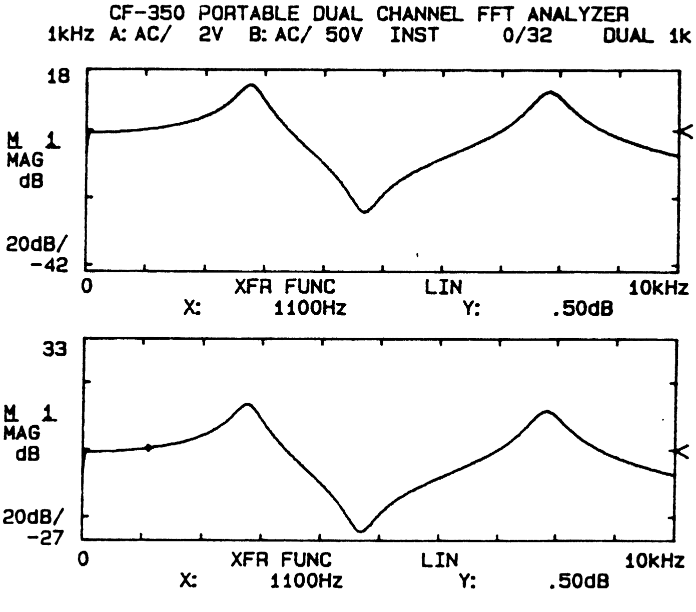


Fig. 6-3 Reference Function

- Gain Function Procedure

  ① Press the REF/GAIN switch of the Y group to extinguish the associated LED. With the LED extinguished, the soft key menu appears as follows.

DISPLAY REF SET

LOW	UP	×1 SET					RETURN
a	b	c					

a	LOW	Activates the gain function for a single-frame display or the lower part of a dual-frame display.
b	UP	Activates the gain function for the upper part of a dual-frame display.
c	×1 SET	Sets the gain to 1.

  ② Use the LOW and UP keys to select the part of the display on which the gain function is to be used.

  ③ Use the up and down switches of the Y group to set the gain.

- For the Nyquist plot and Nichols plot displays, the gain function is as follows.

	Y-axis scaling	Soft keys	Changed value
Nyquist plot	LIN/LOG	Only UP is valid	Gain
Nichols plot	LIN	Only UP is valid	Horizontal axis (gain)
	LOG		Vertical axis (phase)

Table 6-9 Nyquist/Nichols Plot and the Gain Function

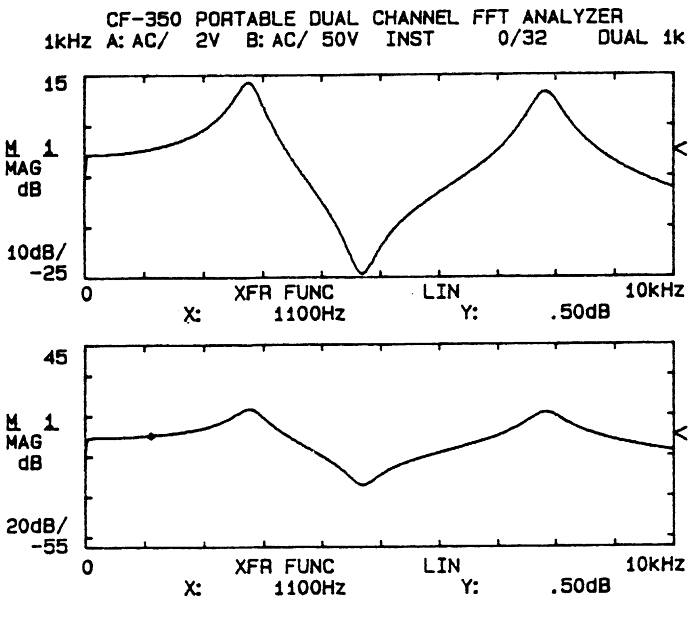


Fig. 6-4 Gain Function

6.1.5 Phase Unwrapping

When displaying the phase of frequency-domain data, for phase angles grater than ±200 deg, the phase information may be difficult to interpret. In such cases, the display GAIN function can be used to provide a full-scale display up to ±20000 deg, thereby facilitating interpretation of phase relationships.

To display phase information nearer the 0 deg region, it is possible to change the full-scale value down to ±10 deg, thereby facilitating the display of minute phase variations.

<Procedure>

① Display the phase data.

② Press the YLOG switch of the SEARCH group to extinguish its LED.

③ Press the REF/GAIN switch of the Y group to extinguish its LED.

④ Make the following soft key settings.

<<< MENU C >>>

SERVO	Y axis	DATAset	OTHERS			OPTION	NEXT

DISPLAY Yax

REF SET	GAIN	PHASE					RETURN

⑤ Select the phase unwrapped display format.

PHASE CONTROL

FORMAT1	FORMAT2	FORMAT3	G-DLY	DLY.adj	SET ON	SET	RETURN
a	b	c					

a	FORMAT 1	Changes the full-scale value in the sequence ±10, ±20, ±50, ±100, ±180, ±200, ±360, ±500, ±720, ±1000, ±2000, ±5000, ±10000, ±20000 deg.
b	FORMAT 2	Changes the full-scale value in the sequence ±10, ±20, ±50, ±100, ±180, ±200, 0 to 360, 0 to 500, 0 to 720, 0 to 1000, 0 to 2000, 0 to 5000, 0 to 10000, 0 to 20000 deg.
c	FORMAT 3	Changes the full-scale value in the sequence ±10, ±20, ±50, ±100, ±180, ±200, 0 to −360, 0 to −500, 0 to −720, 0 to −1000, 0 to −2000, 0 to −5000, 0 to −10000, 0 to −20000 deg.

⑥ Use the up and down switches of the Y group to change the actual full-scale phase display value.

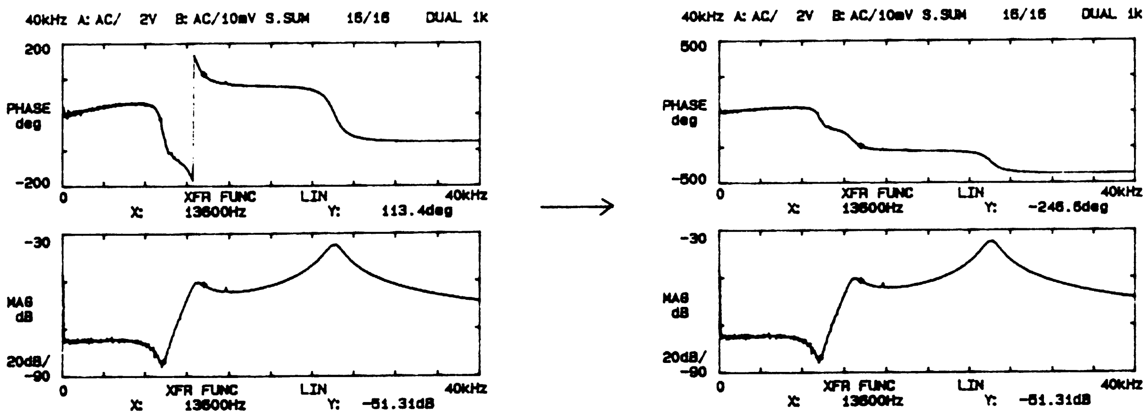


Fig. 6-5 Phase Unwrapped Display

6.2 EU Function

In the CF-350, the EU function can be used to perform calibration with respect to the input signal, enabling direct reading and calibration of the Y axis in meaningful physical units.

The following display units can be set.

1. An arbitrary voltage value can be set to 1 EU (0 dBEU) and 1 V can be set to an arbitrary number of EU (dBEU).
2. An arbitrary search point value can be set to 1 EU (0 dBEU).
3. An arbitrary search point value can be set to an arbitrary dB value.
4. Display can be made in terms rms (effective) values.
5. The Y-axis display units can be indicated as a variety of character strings.

- The CF-350 enables setting of input calibration (for EU/V and V/EU) by the following formula.

  $A \times 10^B$ (A: Mantissa, B: exponent)

  The setting ranges are.

  A (Mantissa): .0001 to .9999

  B (exponent): ± 0 to ± 9

  For example, to set 0.025, any of the following settings are possible.

  0.25 $\times 10^{-1}$

  0.025 $\times 10^{0}$

  0.0025 $\times 10^{+1}$

- In the dB/S.P setting mode, when setting the search-point to an an arbitrary dB value, the setting range is ±250 dB.

  When doing this, the dB/S.P setting calibration value remains the same and after using soft keys for other setting methods (EU/V, V/EU, S.P/EU), the calibration value is converted, so that the search value might exhibit an overflow.

- The calibration value numerical setting requires that a sign (+ or −) be used.

- In the CF-350, the initialized state sets the condition 1 EU = 1 V.

6.2.1 Setting a Voltage to 1 EU (0 dBEU) or 1 V to an EU (dBEU) Value

(a) Setting an Arbitrary Voltage Value to 1 EU (0 dBEU)

This procedure sets the voltage value (zero-to-peak value) of the input signal corresponding to one physical unit.

<Procedure>

① Make the following soft key settings.

<<< MENU B >>>

DISPLAY	**UNIT**	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

1. To set Ch A, make the following setting.

UNIT SET

UNIT X	UNIT Y	**Ch A EU**	Ch B EU	HARMNIC			RETURN

2. To set Ch B, make the following setting.

UNIT SET

UNIT X	UNIT Y	Ch A EU	**Ch B EU**	HARMNIC			RETURN

② As an example, calibrate Ch A for a 150 mmV/g acceleration sensor.

Ch A EU SET

EU/V	**V/EU**	S.P/EU	dB/S.P	EU=	SET ChA	SET	RETURN

Ch A EU SET

EU/V	V/EU	S.P/EU	dB/S.P	EU=	**SET ChA**	SET	RETURN

③ Use the numeric keys of the DISPLAY group to input the setting value. This is made in the following format.

.1500E+0 $(=0.15\times10^{0})$

Note that the sequence is Mantissa → sign (+ or −) → exponent.

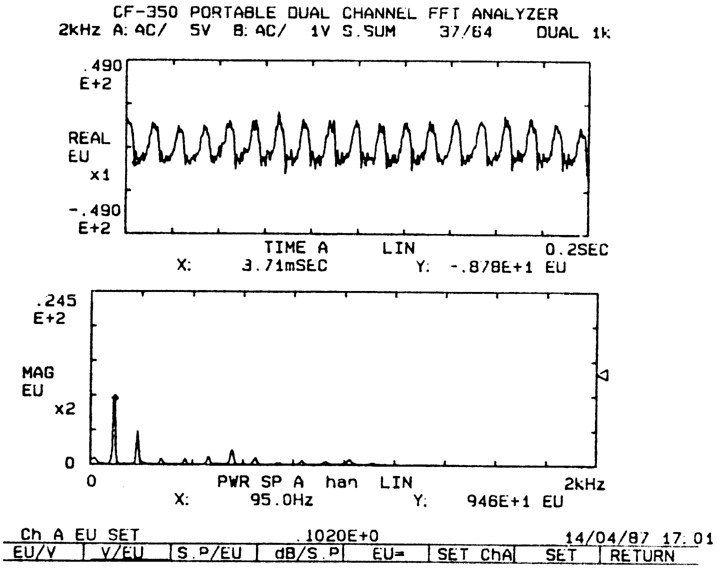
④ Make the actual setting as follows.

Ch A EU SET

EU/V	V/EU	S.P/EU	dB/S.P	EU=	SET ChA	**SET**	RETURN

The above operations made the setting of 150 mmV = 1 EU.

⑤ To actually execute set EU function, press the EU switch of the SEARCH group. This will make the Y axis read in EU units.


CF-350 PORTABLE DUAL CHANNEL FFT ANALYZER
2kHz A: AC/ 5V B: AC/ 1V S.SUM 37/64 DUAL 1k

X: 3.71mSEC Y: -.878E+1 EU

X: 95.0Hz Y: 946E+1 EU

Ch A EU SET .1020E+0 14/04/87 17:01

Fig. 6-6 EU Function V/EU Setting

(b) Setting 1 V to an Arbitrary EU (dBEU) Value

This procedure sets the input signal physical units equivalent to 1 $V_{0\text{-}p}$.

<Procedure>

① Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

1. For Ch A, make the following setting.

UNIT SET

UNIT X	UNIT Y	Ch A EU	Ch B EU	HARMNIC			RETURN

2. For Ch B, make the following setting.

UNIT SET

UNIT X	UNIT Y	Ch A EU	Ch B EU	HARMNIC			RETURN

② As an example, calibrate Ch A for a 4.00 mm/V displacement sensor.

Ch A EU SET

EU/V	V/EU	S.P/EU	dB/S.P	EU=	SET ChA	SET	RETURN

Ch A EU SET

EU/V	V/EU	S.P/EU	dB/S.P	EU=	SET ChA	SET	RETURN

③ Use the numeric keys of the DISPLAY group to input the setting value. This is done in the following format.

.4000 E+1 $(=0.40\times10^1)$

Note that the input sequence is Mantissa → sign (+ or −) → exponent.

④ Make the actual setting as follows.

Ch A EU SET

EU/V	V/EU	S.P/EU	dB/S.P	EU=	SET ChA	SET	RETURN

The above operation sets the EU value to 4.00 mm = 1 EU.

⑤ To actually execute set EU function, press the EU switch of the SEARCH group. this will make the Y axis read in EU units.

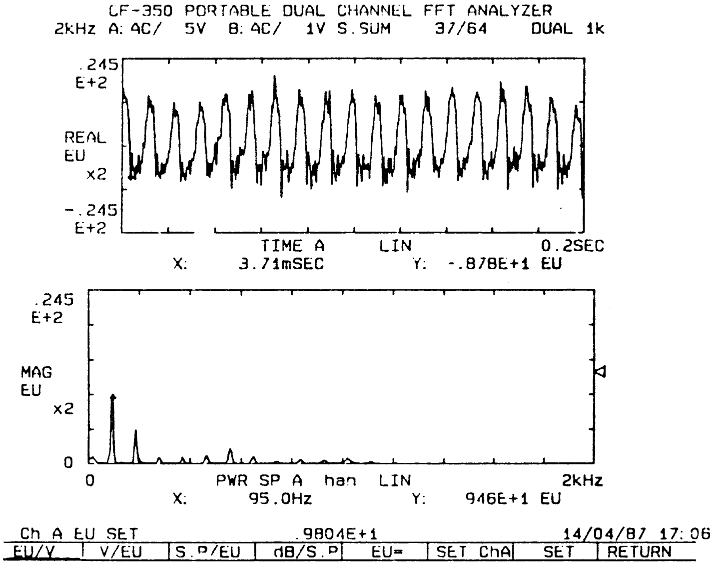


Fig. 6-7 EU Function EU/V Setting

6.2.2 Setting a Search Point Value to 1 EU (0 dBEU)

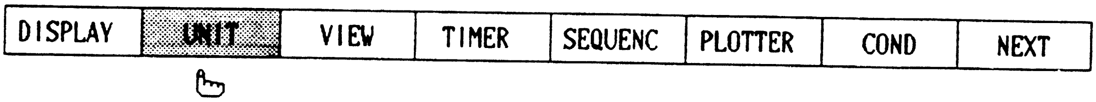
This setting sets up the current search point value as one physical unit.

<Procedure>

① Move the search point to the position of the desired setting.

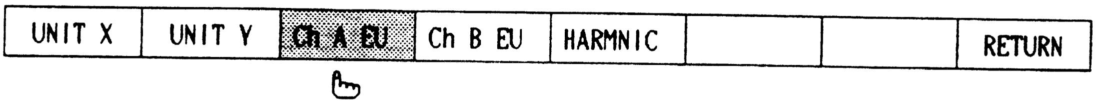
② Make the following soft key settings.

<<< MENU B >>>



1. To set Ch A, make the following setting.

UNIT SET

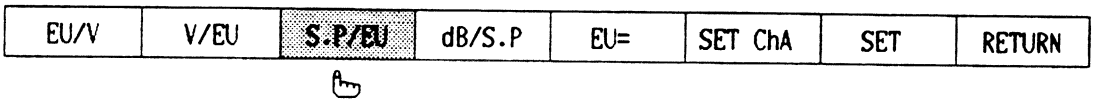


2. To set Ch B, make the following setting.

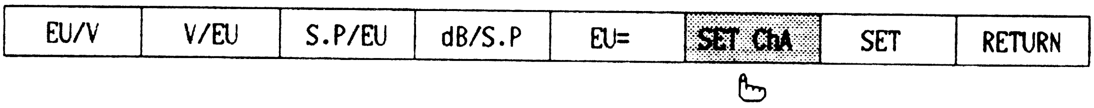
UNIT SET

③ Make the actual setting as follows.

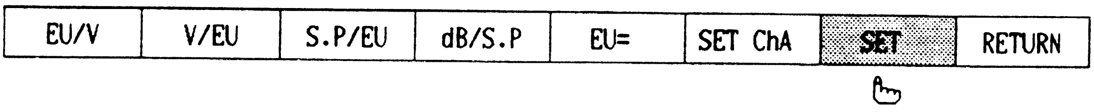
Ch A EU SET



Ch A EU SET



Ch A EU SET



The above operations establish the search point value as one physical unit.

④ To actually execute set EU function, press the EU switch of the SEARCH group. This will make the Y axis read in EU units.

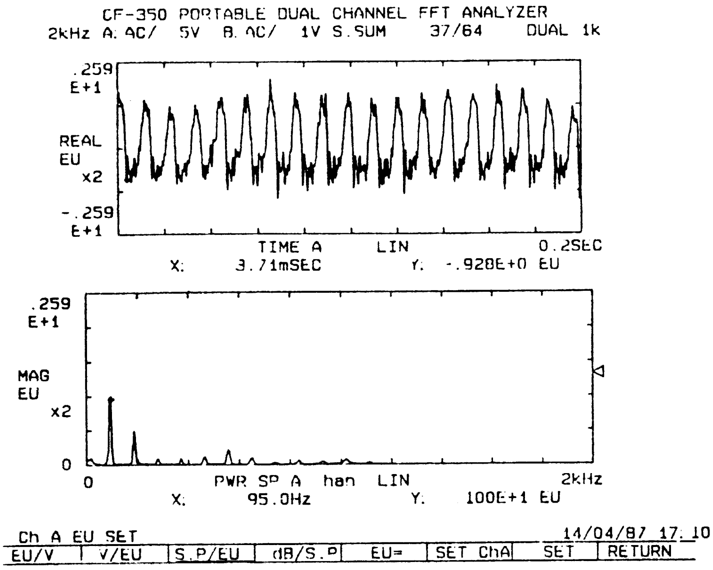


Fig. 6-8 EU Function S.P/EU Setting

6.2.3 Setting the Search Point Value as an Arbitrary dB Value

This setting establishes the current search point level as an arbitrary dB value.

<Procedure>

① Move the search point to the position of the desired setting.

② Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

1. To set Ch A, make the following setting.

UNIT SET

UNIT X	UNIT Y	Ch A EU	Ch B EU	HARMNIC			RETURN

2. To set Ch B, make the following setting.

UNIT SET

UNIT X	UNIT Y	Ch A EU	Ch B EU	HARMNIC			RETURN

③ As an example, set the Ch A search point to 124 dB.

Ch A EU SET

EU/V	V/EU	S.P/EU	dB/S.P	EU=	SET ChA	SET	RETURN

Ch A EU SET

EU/V	V/EU	S.P/EU	dB/S.P	EU=	SET ChA	SET	RETURN

④ Use the numeric keys of the DISPLAY group to input the setting value in the following format.

+124.00 dBEU

Remember that the sequence is sign (+ or −), and numerical value.

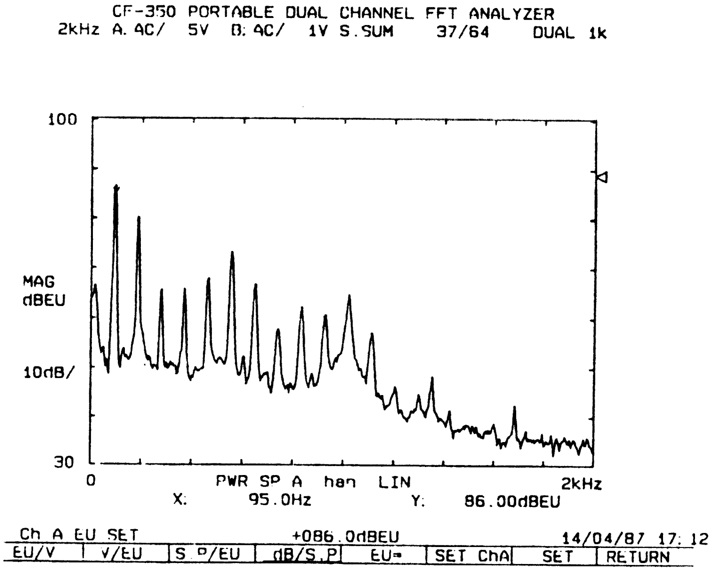
⑤ Make the actual setting as follows.

Ch A EU SET

EU/V	V/EU	S.P/EU	dB/S.P	EU=	SET ChA	SET	RETURN

The above operation sets the EU value to 124 dB.

⑥ To actually execute set EU function, press the EU switch of the SEARCH group. this will make the Y axis read in EU units.



```
CF-350 PORTABLE DUAL CHANNEL FFT ANALYZER
2kHz A. AC/  5V  B: AC/  1V S.SUM    37/64    DUAL 1k
```

```
PWR SP A  han  LIN
X:    95.0Hz          Y:   86.00dBEU
Ch A EU SET             +086.0dBEU            14/04/87 17: 12
EU/V | V/EU |S P/EU | dB/S.P| EU= |SET ChA| SET |RETURN
```

Fig. 6-9 EU Function dB/S.P Setting

- Since most noise meters output a voltage which is proportional to the display magnitude (needle deflection), for the measurement of the same noise, the output voltage will depend upon the range setting.

- The calibration with respect to a noise meter is performed using a pistonphone and the 124-dB calibration is normally performed in the 120 dB range. However, since measurement is performed in ranges such as 80 dB, the EU calibration value will change. For this reason, the read values from a noise meter using the CF-350, the following should be done.

1. The difference in ranges between the time of calibration and the time of actual measurement should be added to or subtracted from the reading. For example, if calibration is performed in the 120-dB range and measurement is made in the 80-dB range, for a CF-350 reading value of 112 dB, the calculation is as follows.

   $$112-(120-80)=72\ (\text{dB})$$

   This will result in the actual magnitude.

2. Another method is setting the EU value considering the 80 dB range. For a 124-dB pistonphone, the EU value when calibrating into 120-dB range should not be 124 dB but should be $124-(120-80)=84$ (dB). This will enable direct reading for measurements in the 80-dB range.

   Using the EU Function (When Executing PSD)

   For a high frequency range and a low input signal level, or low frequency range and a high input signal level, if the PSD is executed and the Y-axis linear scaling is used to display in units of V^2 (i.e., the V^2 key is switched to on), the PSD may cause the reading range ($0.0001\ \text{mV}/\sqrt{\text{Hz}}$ to $9999.99\ \text{V}/\sqrt{\text{Hz}}$) to be exceeded.

   If this occurs, set the EU value to 1 and set the EU switch of the SEARCH group to on to obtain an EU display. This will express reading values exponentially, so that even overange values as described above can be read.

6.2.4 Rms (Effective) Value Display

The CF-350 can provide the following two types of rms value displays.

1. Rms display of voltage values
2. Rms display of Eu setting values.

These modes are performed by making the following operations.

< Procedure >

Make for following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

UNIT SET

UNIT X	UNIT Y	Ch A EU	Ch B EU	HARMNIC			RETURN

UNIT Y

rms							RETURN

The above operations cause a display of the Y-axis in terms of rms (effective) values. The display will be in rms units such as Vr or dBr.

* Care is required so as not to confuse the EU converted values with this function on and off.

* The DC line (0 Hz) reading value for a Vrms display is as follows.

For a power spectrum dB display:	– 3 dB with respect to voltmeter reading
For a power spectrum linear (V^2) display:	1/2 of voltmeter reading
For a linear spectrum (V) display:	$1/\sqrt{2}$ of voltmeter reading

Because of this, the DC line should be read from a $V_{0\text{-}p}$.

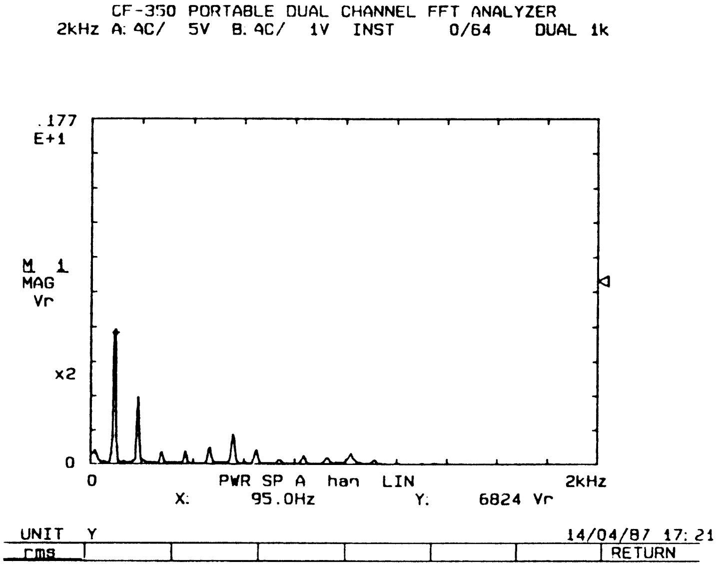


Fig. 6-10 EU Function Rms Display

6.3 X-Axis Scaling and Units

6.3.1 X-Axis Units

The CF-350 X-axis units are seconds for the time domain, volts for the amplitude domain and Hz, CPM, Order and seconds for the frequency domain.

Data domain	X-axis units
Time-domain data	seconds
Amplitude-domain data	Volt
Frequency-domain data	Hz, CPM, Order, seconds

Table 6-10 X-Axis Units

In the above, Order refers to the harmonic order with respect to a set fundamental frequency.

6.3.2 X-Axis Scaling

In the CF-350, the X-axis scaling is normally set to linear or logarithmic scaling. In addition to these types of scaling, as a variation of logarithmic scaling, 1/1 or 1/3 octave and 4-decade scaling are also available.

For the time-domain and amplitude-domain data displays, only linear X-axis scaling is available. However, for frequency-domain data, log scaling can be selected.

Data domain	X-axis scaling			
	Linear	Log	Octave	4-decade
Time-domain data	Settable	Settable	Settable	Settable(*)
Amplitude-domain data	Settable	×	×	×
Frequency-domain data	Settable	×	×	×

(*) For 4-decade analysis, the CF-0354 option is required.

Table 6-11 X-Axis Scaling

- X-Axis Expansion

In the CF-350, arbitrary expansion in the X-axis direction is possible of the displayed waveform. The area bounded by the delta cursor and the search point is expanded and this can be performed on all data domains.

<Procedure>

① Set the search function to on to display the search point on the CRT screen.

② Move the search point to the left side of the region to be expanded.

③ Press the ΔSET switch of the SEARCH group to display the delta cursor.

④ Move the search point to the right side of the area to be expanded.

⑤ Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

DISPLAY

FORMAT	LIST	3-ARRAY	COH	NVQ.ORB	P.OV	INHIBIT	RETURN

FORMAT

SPLIT	OVERLAY	GRID ON	BODE ON	MAG LOG		X EXPAN	RETURN

The above operations cause an expanded display of the area bounded by the delta cursor and search point.

⑥ When the X EXPAN key is pressed once again, the expansion is canceled.

* The setting of the area for expansion should be made with the delta cursor for the left edge and the search point with the right edge, not in the reverse order.

* For a logarithmically scaled X axis, this function is invalid.

* The grid does not align properly with the expanded X axis.

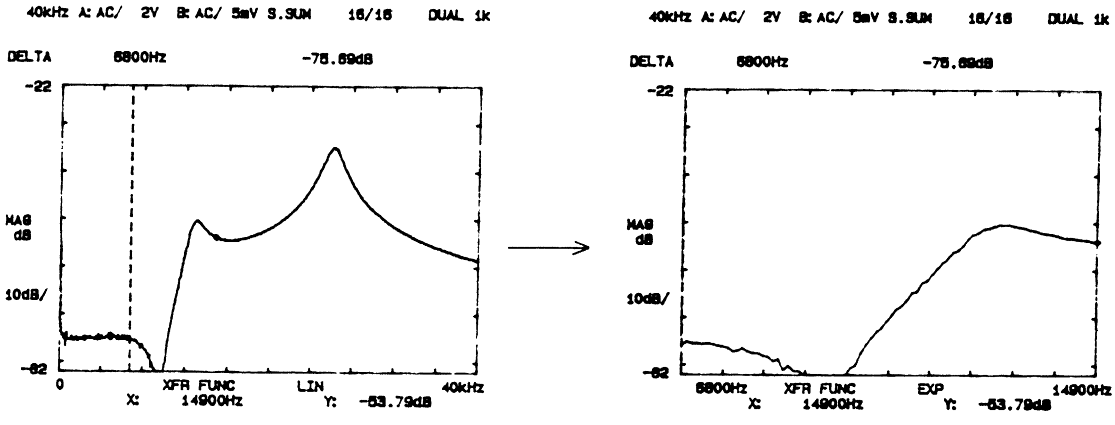


Fig. 6-12 X-Axis Expansion

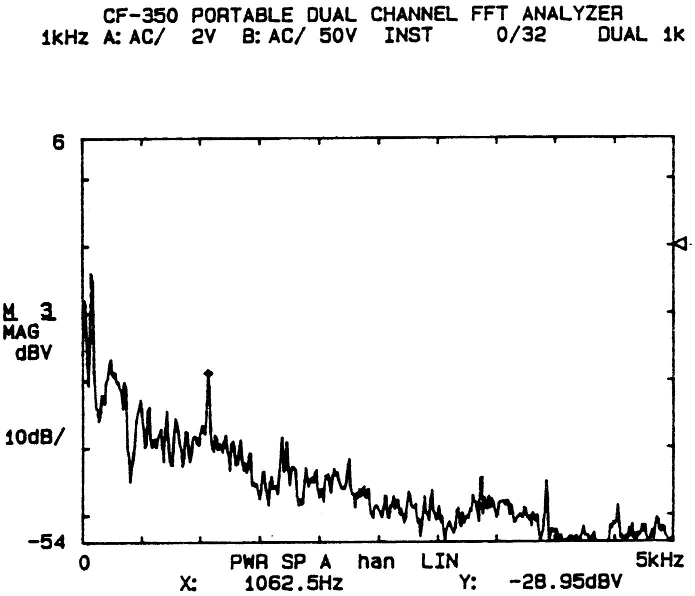
6.4 Single-Frame/Dual-Frame Display and Overlaid Display

The CF-350 data display formates can be selected as follows.

1. Single-frame display
2. Dual-frame display
3. Overlaid display

6.4.1 Single-Frame Display Mode

When the function switches of the DISPLAY group are pressed, a single-frame display is obtained.



```
           CF-350 PORTABLE DUAL CHANNEL FFT ANALYZER
1kHz A: AC/  2V  B: AC/ 50V  INST     0/32     DUAL 1k
```

```
X:   1062.5Hz              Y:   -28.95dBV
```

Fig. 6-13 Single-Frame Display

6.4.2 Dual-Frame Display Mode

In this mode, two functions or data sets are displayed, one on the top part of the screen and one on the bottom part.

<Procedure>

① When a function switch of the DISPLAY group is pressed, the data to be displayed at the bottom of the screen is selected (single-frame display).

② At this point if the SECOND switch of the DISPLAY group is pressed, the function or data selected at step ① will move to the bottom part of the screen.

③ Now the data to be displayed at the top part can be selected by pressing the corresponding switch to enable the full dual-frame display.

* To return to the single-frame display, press the function switch for the single-frame display. The dual-frame mode will be canceled, returning to the single-frame mode.

* To change the data at the bottom of the dual-frame display mode screen, return to a single-frame display.

- * To change the data at the top of the dual-frame display screen, do the following.

  1. Press the SECOND switch once again.
  2. Press the switch for the function to displayed at the top of the screen.

- * To display the transfer function gain and phase on a dual-frame display screen, do the following.

  1. Press the XFER switch to obtain a single-frame display of the transfer function gain.
  2. Press the SECOND switch.
  3. Press the PHASE switch to display the phase at the top and the gain at the bottom of the screen.

- * To display the phase spectrum for Ch A and Ch B on a dual-frame display screen, do the following.

  1. Press the SPEC B switch to display the power spectrum amplitude of Ch B.
  2. Press the PHASE switch to display the power spectrum phase of Ch B.
  3. Press the SECOND switch to move this to the lower part of the screen.
  4. Press the SPEC A to display the power spectrum amplitude for Ch A at the top of the screen.
  5. Press the SECOND switch.
  6. Press the PHASE switch to obtain a dual-frame phase display.

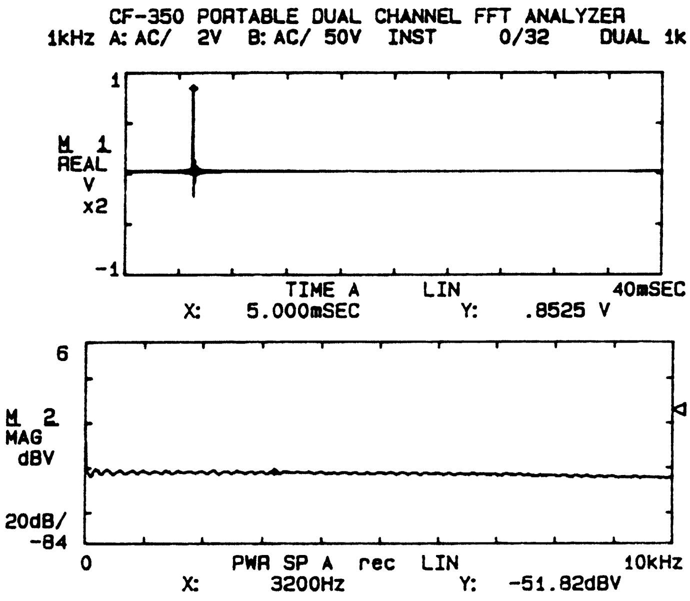


Fig. 6-14 Dual-Frame Display

6.4.3 Overlaid Display Mode

In this display mode, an overlaid display of data from the same domain is obtained.

< Procedure >

① Obtain a dual-frame display of data from the same domain.

② Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

DISPLAY

FORMAT	LIST	3-ARRAY	COH	NYQ.ORB	P.OV	INHIBIT	RETURN

FORMAT

SPLIT	OVERLAY	GRID ON	BODE ON	MAG LOG		X EXPAN	RETURN

The above operation enables the overlaid display mode.

* To return to a dual-frame display, press the SPLIT key.

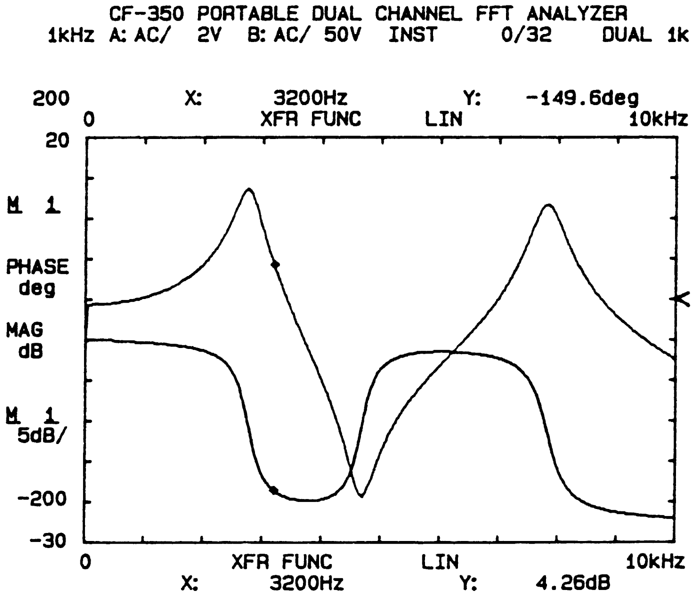


Fig. 6-15 Overlaid Display

6.5 Grid Display

In the CF-350, to enhance the readability of displayed waveforms, a grid is displayed on the CRT screen which matches the selected scaling.

<Procedure>

Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

DISPLAY

FORMAT	LIST	3-ARRAY	COH	NYQ.ORB	P.OV	INHIBIT	RETURN

FORMAT

SPLIT	OVERLAY	GRID ON	BODE ON	MAG LOG		X EXPAN	RETURN

The above settings display the grid.

- * To cancel the grid-display mode, press the GRID ON switch once again.
- * When recording on a plotter, the grid is normally plotted in broken lines. However, a setting can be made to plot the grid in solid lines (refer to Section 9).

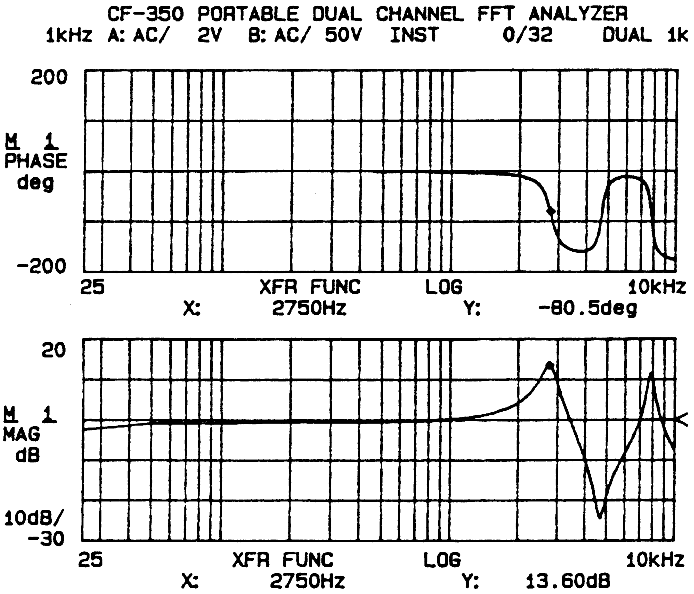


Fig. 6-16 Grid Display

6.6 List Display

In addition to waveform displays, the CF-350 can make a listing of up to 20 (or 10) X-axis and Y-axis values for any desired points or harmonics up to the 20th (or 10th) harmonic. There are 3 list-display, as follows.

1. Harmonic list
2. Arbitrary point list
3. Peak-value 10-point list

6.6.1 Harmonic List

This is a listing of harmonics with respect to a fundamental frequency (i.e. the first order frequency).

<Procedure>

① First, display a spectrum.

② Use the left and right switches of the SEARCH group to move the search point to the desired fundamental frequency (first order component).

③ Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

UNIT SET

UNIT X	UNIT Y	Ch A EU	Ch B EU	HARMNIC			RETURN

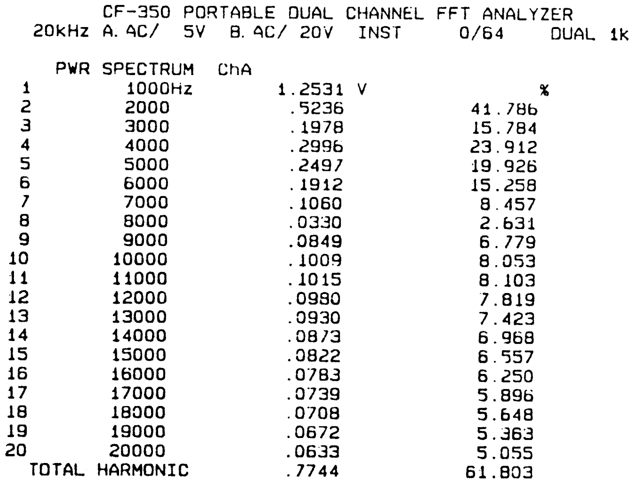
HARMONIC

ON	SET	LIST UP	LIST DW	FIT			RETURN
a	b	c	d	e			

④ Press SET to set the fundamental frequency.

⑤ Press ON to execute the list display.

a	ON	Executes a list display.
b	SET	Sets the fundamental frequency.
c	LIST UP	Scrolls the list for a dual-frame display.
d	LIST DW	Scrolls the list for a dual-frame display.
e	FIT	Uses the fit function when the frequency for components not falling precisely at frequency-resolution points to search for a peak near a harmonic frequency and treat this as the harmonic.



```
          CF-350 PORTABLE DUAL CHANNEL FFT ANALYZER
20kHz A. AC/  5V  B. AC/ 20V  INST     0/64    DUAL 1k

   PWR SPECTRUM  ChA
1        1000Hz       1.2531 V              %
2        2000          .5236           41.786
3        3000          .1978           15.784
4        4000          .2996           23.912
5        5000          .2497           19.926
6        6000          .1912           15.258
7        7000          .1060            8.457
8        8000          .0330            2.631
9        9000          .0849            6.779
10       10000         .1009            8.053
11       11000         .1015            8.103
12       12000         .0980            7.819
13       13000         .0930            7.423
14       14000         .0873            6.968
15       15000         .0822            6.557
16       16000         .0783            6.250
17       17000         .0739            5.896
18       18000         .0708            5.648
19       19000         .0672            5.363
20       20000         .0633            5.055
  TOTAL HARMONIC       .7744           61.803
```

Fig. 6-17 List Display

⑥ For an order display, make the following settings.

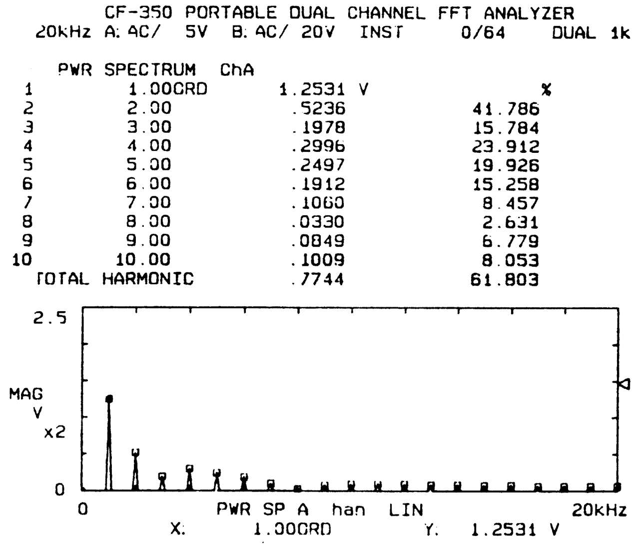
UNIT SET

UNIT X	UNIT Y	Ch A EU	Ch B EU	HARMNIC			RETURN

UNIT X

Hz	CPM	ORDER	SEC				RETURN

This will obtain an Order display.



```
          CF-350 PORTABLE DUAL CHANNEL FFT ANALYZER
20kHz A: AC/  5V  B: AC/ 20V  INST     0/64    DUAL 1k

   PWR SPECTRUM  ChA
1        1.00ORD      1.2531 V              %
2        2.00          .5236           41.786
3        3.00          .1978           15.784
4        4.00          .2996           23.912
5        5.00          .2497           19.926
6        6.00          .1912           15.258
7        7.00          .1060            8.457
8        8.00          .0330            2.631
9        9.00          .0849            6.779
10       10.00         .1009            8.053
  TOTAL HARMONIC       .7744           61.803
```

Fig. 6-18 Order List Display

6.6.2 List of Arbitrary Points

A list display can be had of arbitrary point of any function.

<Procedure>

① Display the function to be listed.

② Press the SECOND switch of the DISPLAY group.

③ Press the LIST switch of the DISPLAY group to obtain a dual-frame display.

④ Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

DISPLAY

FORMAT	LIST	3-ARRAY	COH	NYQ.ORB	P.OV	INHIBIT	RETURN

LIST SET

OFF	ON	SET	INC	DEC	CLR	PEAK	RETURN
		a	b	c	d		

⑤ Use the left and right switches of the SEARCH group to move the search point to the point to be listed.

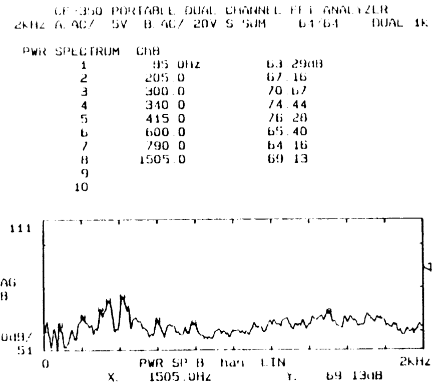
⑥ Press the SET switch to set that point. When doing this, the highlighted list No in the upper part of the list area is set. When this is set, the next number is automatically highlighted.

⑦ When 11 or more points are set, the list display of the upper part of the screen is automatically scrolled.

- * To move the position of the highlighted No, use the INC and DEC switches.
- * To clear set points or correct them, move to the highlighted No and press the CLR switch.

⑧ After setting is completed, press the OFF switch to cancel the setting mode.

- * To obtain a single-frame list of 20 orders, press the LIST switch of the DISPLAY group.



```
     CF-350  PORTABLE  DUAL  CHANNEL  FFT  ANALYZER
2KHz  A. AC/  5V  B. AC/  20V  S  SUM      64/64      DUAL  1K

PWR  SPECTRUM    ChB
         1           85  0Hz          63 29dB
         2          205 0             67 16
         3          300 0             70 67
         4          340  0            74 44
         5          415  0            76  28
         6          600 0             65 40
         7          790  0            64  16
         8         1505 0             69  13
         9
        10
```

Fig. 6-19 Arbitrary Point List Display

6.6.3 Peak-Value 10-Point List

This mode provides a listing of the 10 peak points of a spectrum in descending order.

<Procedure>

① Display the function for peak listing. (As is the case for an arbitrary-point listing, this will be a dual-frame display with the function at the bottom and the list at the top.)

② Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

DISPLAY

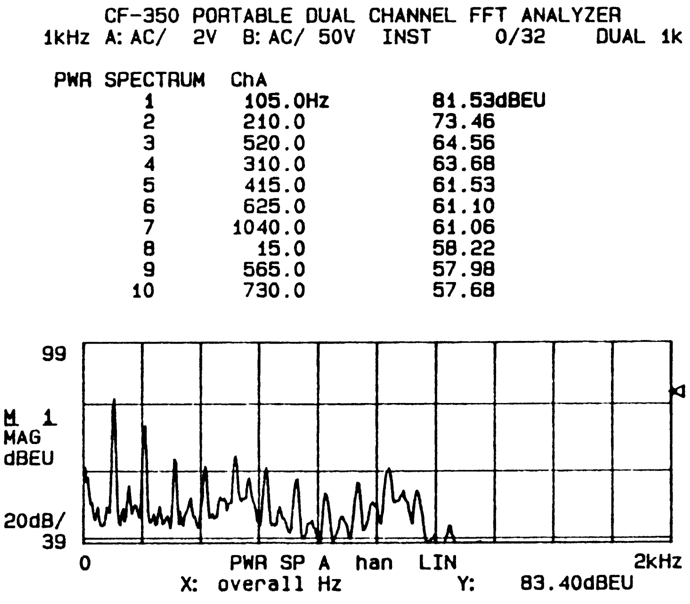
FORMAT	LIST	3-ARRAY	COH	NYQ.ORB	P.OV	INHIBIT	RETURN

LIST SET

OFF	ON	SET	INC	DEC	CLR	PEAK	RETURN

The above operations make a list of 10 points in order of descending Y-axis value.

* At this point, to change the sequence of listing to list points in increasing frequency sequence, press the CLR key. To return to the original sequence, press the CLR key again.



```
          CF-350 PORTABLE DUAL CHANNEL FFT ANALYZER
1kHz A: AC/  2V  B: AC/ 50V  INST     0/32    DUAL 1k

 PWR SPECTRUM  ChA
        1       105.0Hz         81.53dBEU
        2       210.0           73.46
        3       520.0           64.56
        4       310.0           63.68
        5       415.0           61.53
        6       625.0           61.10
        7      1040.0           61.06
        8        15.0           58.22
        9       565.0           57.98
       10       730.0           57.68
```

Fig. 6-20 Peak List Display

6.7 3-Dimensional Display (Option CF-0353)

The CF-350 can product 3-dimensional displays from all waveforms and data except those listed here.

Nyquist plots, Nichols plots, Cole-Cole plots, orbit, list display, dual-frame displays and overlaid displays, waveforms after arithmetic operations, coherence blanking waveforms and phase displays. The following formats are available for 3-dimension display.

1. 20-line scrolled 3-dimensional display
2. Scroll function on/off switching and scroll-direction selection
3. Display angle and gain selection
4. 60- and 90-line 3-dimensional display (possible only for power spectrum)

6.7.1 20-Line Scrolled 3-Dimensional Display

This function creates a 3-dimensional display with 20 lines.

<Procedure>

① Display the function to be displayed in 3 dimensions on a single-frame display screen.

② Press the ARRAY switch of the DISPLAY group.

③ Press the START switch of the COMMAND group.

* The above operations will cause a 3-dimensional display. However, if this display is to be combined with other functions (e.g., averaging and triggering), the following settings are required after ① above.

6.7.2 Turning the Scrolling Function On and Off and Selecting the Scrolling Direction

Scroll can be turned on and off and the direction of scrolling set as follows.

<Procedure>

① Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

DISPLAY

FORMAT	LIST	3-ARRAY	COH	NYQ.ORB	P.OV	INHIBIT	RETURN

3D ARRAY

SCROLL	DOWN	20 LINE	60 LINE	90 LINE	degree	Height	RETURN
a	b						

a	SCROLL	Sets the scroll function on and off. The key is highlighted when the function is on.
b	DOWN	Sets the scroll direction.

6.7.3 Selection of Display Angle and Gain

The angle and gain of the 3-dimensional display can be set as follows.

<Procedure>

Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

DISPLAY

FORMAT	LIST	3-ARRAY	COH	NYQ.ORB	P.OV	INHIBIT	RETURN

3D ARRAY

SCROLL	DOWN	20 LINE	60 LINE	90 LINE	degree	Height	RETURN
					a	b	

a	degree	Changes the 3-dimensional display angle each time it is pressed. There are 3 angles that can be selected.
b	Height	Changes the gain of the display. There are 3 gains that can be selected.

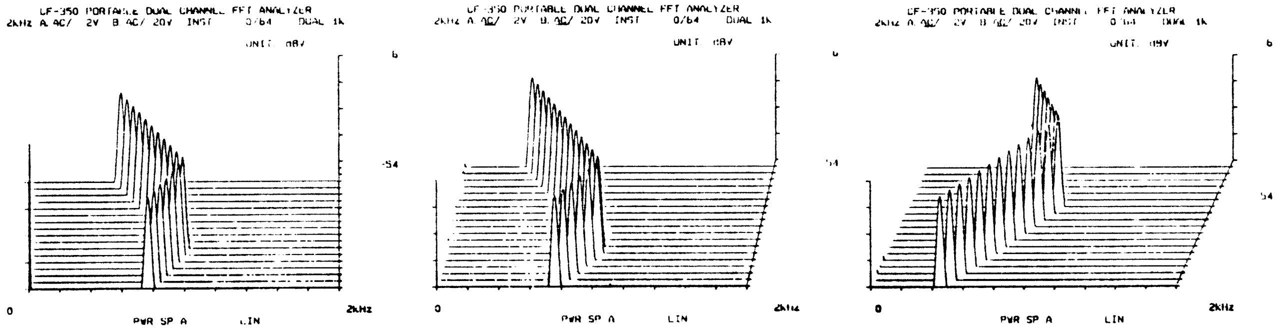


Fig. 6-21 3-Dimensional Display Angle Changing Function

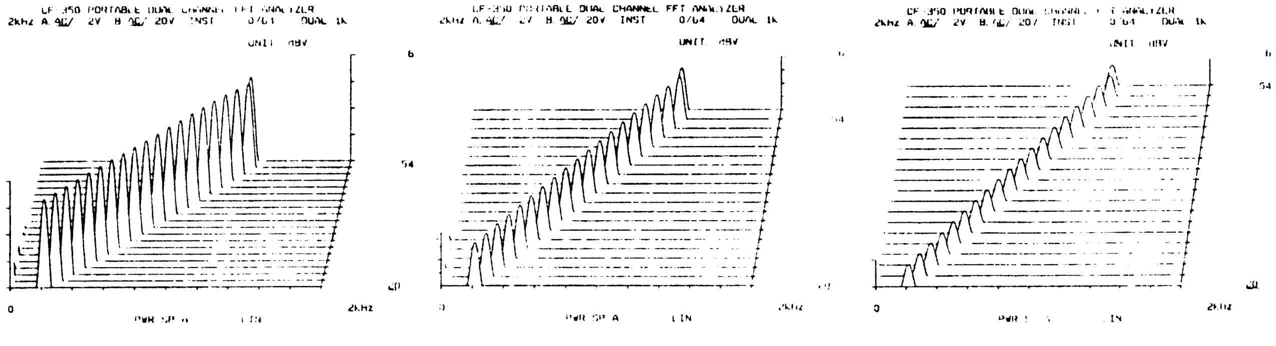


Fig. 6-22 3-Dimensional Display Gain Changing Function

6.7.4 60- and 90-Line 3-Dimensional Display (Power Spectrum Only)

This function creates a 60-line or 90-line 3-dimensional display of the power spectrum.

<Procedure>

Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

DISPLAY

FORMAT	LIST	3-ARRAY	COH	NYQ.ORB	P.OV	INHIBIT	RETURN

3D ARRAY

SCROLL	DOWN	20 LINE	60 LINE	90 LINE	degree	Height	RETURN
			a	b			

a	60 LINE	Selects a 60-line 3-dimensional display.
b	90 LINE	Selects a 90-line 3-dimensional display.

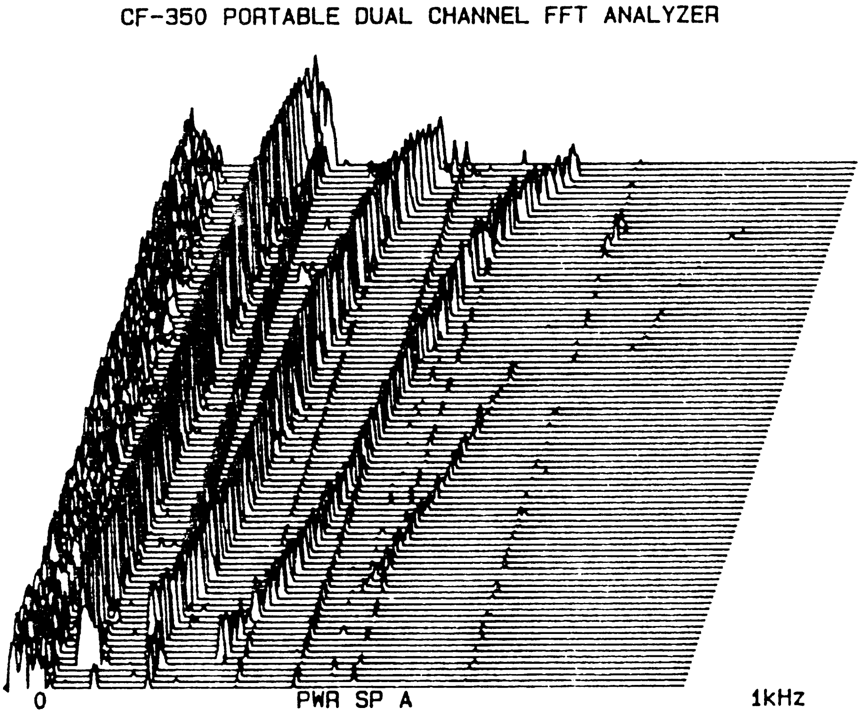
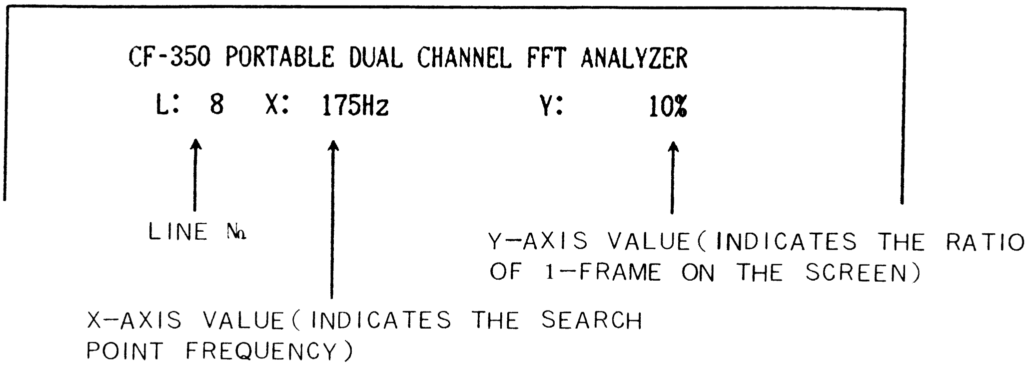


Fig. 6-23 90-Line 3-Dimensional Drawing

* The search function can be used on a 60-line or 90-line 3-dimensional display.

Use the up/down and left/right switches of the SEARCH group to move the search point. The display will be formatted as shown below.



* For the 60-line and 90-line displays, selection is possible from two degree (display angle) settings, although the Height (display gain) cannot be changed.

6.8 Nyquist Display

For the Nyquist display, a perspective display, rotation and display bandlimiting are possible.

1. Nyquist display prospective view and display rotation
2. Nyquist display bandlimiting

These two functions are also possible for a lissajous display. For the Nichols plot and Cole-Cole plot, display bandlimiting is possible.

6.8.1 Nyquist Display Perspective View and Display Rotation

It is possible to obtain a perspective-view display of and rotate the display of Nyquist plots and lissajous displays.

<Procedure>

① Display the desired Nyquist plot or lissajous pattern.

② Make the following soft key setting.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

DISPLAY

FORMAT	LIST	3-ARRAY	COH	NYQ.ORB	P.OV	INHIBIT	RETURN

NYQUIST

LIMIT	SET	3D	+ROTATE	-ROTATE	COLE	Xfr M-P	RETURN
		a	b	c			

a	3D	Selects the perspective display.
b	+ROTATE	Rotates the display +45°.
c	−ROTATE	Rotates the display −45°.

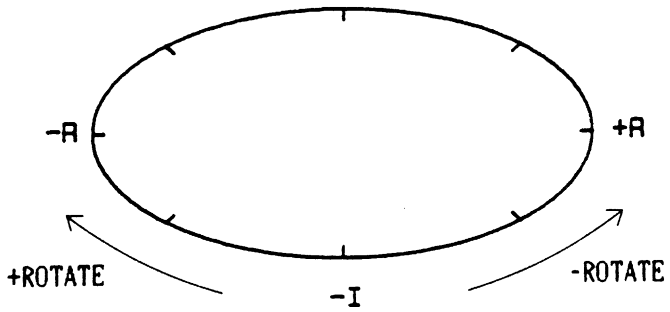
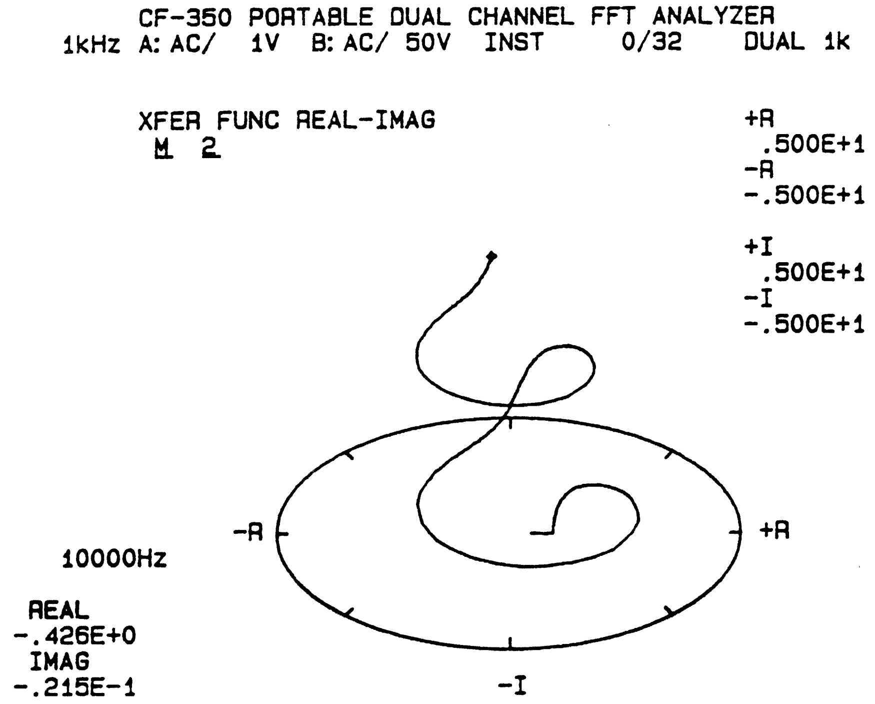


Fig. 6-24 Rotation



```
    CF-350 PORTABLE DUAL CHANNEL FFT ANALYZER
1kHz A: AC/  1V  B: AC/ 50V  INST    0/32   DUAL 1k

    XFER FUNC REAL-IMAG                      +R
     M  2                                     .500E+1
                                             -R
                                             -.500E+1

                                             +I
                                              .500E+1
                                             -I
                                             -.500E+1

10000Hz

 REAL
-.426E+0
 IMAG
-.215E-1
```

Fig. 6-25 Nyquist Perspective Display

6.8.2 Nyquist Display Bandlimiting

Bandlimiting can be applied to the Nyquist, lissajous, Nichols and Cole-Cole plot displays.

<Procedure>

① Display the desired Nyquist or lissajous plot.

② Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

DISPLAY

FORMAT	LIST	3-ARRAY	COH	NYQ.ORB	P.OV	INHIBIT	RETURN

③ Turn the search point on using the ON switch of the SEARCH group.

④ Move the search point to the starting point of bandlimiting.

⑤ Press the ΔSET switch of the SEARCH group to cause the delta cursor to be displayed.

⑥ Move the search point to the ending point of the bandlimiting region.

⑦ Make soft key settings to set bandlimiting region.

NYQUIST

LIMIT	SET	3D	+ROTATE	-ROTATE	COLE	Xfr M-P	RETURN

⑧ Execute bandlimiting.

NYQUIST

LIMIT	SET	3D	+ROTATE	-ROTATE	COLE	Xfr M-P	RETURN

* When making a bandlimited display of a Nichols plot or a Cole-Cole plot, the setting is made with the Nyquist plot and the Nichols and Cole-Cole plot displays will be bandlimited.

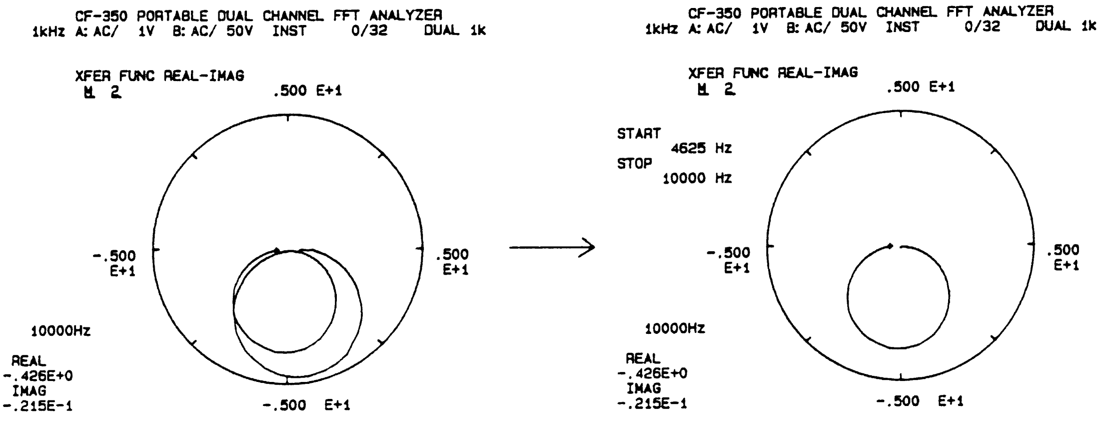


Fig. 6-26 Nyquist Display Bandlimiting

6.9 Display-Inhibit Function

By using this function, it is possible to increase the execution speed of the averaging process. The CF-350 data-processing time is approximately equal to the sum of the display processing time and calculation time. By inhibiting the display, therefore, it is possible to shorten the data-processing time and thereby shorten the effective averaging time. However, this function is not usable when triggering is executed.

The following three types of display-inhibit function can be used.

1. During averaging, the update of the display is inhibited and after the averaging is completed or when the PAUSE switch is pressed, the averaging is inhibited and the results displayed.
2. Inhibiting of all displays. However, display is made when the PAUSE switch is pressed.
3. Update of the display for every other data during the averaging process.

<Procedure>

Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

DISPLAY

FORMAT	LIST	3-ARRAY	COH	NYQ.ORB	P.OV	INHIBIT	RETURN

DISPLAY INHIBIT

ON	ALL F.	1/2					RETURN
a	b	c					

a	ON	**Executes the display-inhibit function listed above as 1.**
b	ALL F.	When *a* is pressed, the display-inhibit function described above as 2. is executed.
c	1/2	When *a* is pressed, the display-inhibit function described above as 3. is executed.

* The ALL F. function has priority over the 1/2 function. Therefore, if *a*, *b*, *c* are all on, the 1/2 function will not be executed.

* During execution of the display-inhibit function, the set number of averages displayed on the CRT will appear highlighted.

* For display-inhibit function 3. (display updated every other data), the calculation time will be the average of the time when the display-inhibit function is on and when it is off.

* For processing times when executing the display-inhibit function, refer to Section 3.12.

6.10 Display of Setting Conditions and Labels

6.10.1 View Function

The CF-350 has a view function which displays setting conditions at the right edge of the screen. This displays the current setting conditions in one of eight formats. The following soft key operations are used to change the contents displayed by this function.

<Procedure>

Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

VIEW

VIEW	LABEL	SETUP					RETURN

VIEW SET

OFF	NextINC	NextDEC	COND	XCHG	Fix		RETURN
a	b	c					

a	OFF	Sets the view function off when pressed so that display is not made.
b	NextINC	Sets the view function on and moves to the next VIEW display.
c	NextDEC	Changes to a different VIEW display.

* This view display automatically changes when settings are made.

* When making output to a plotter, if the view displayed information is not required, it can be set to OFF to reduce the plotting time (refer to Section 9).

VIEW 1

AVERAGE	AVERAGING MODE
SP SUM	FREQUENCY SUMMATION AVERAGING
MASS MEM	MASS MEMORY
BL: 1	CRT BLOCK MEMORY ADDRESS 1
R: 0	TIME RECORD MEMORY ADDRESS 0
WINDOW	WINDOW
HANNING	HANNING
OVERLAP	OVERLAP
MAX	MAX
Ch DELAY	CHANNEL-TO-CHANNEL DELAY
+00000	0
TRIGGER	TRIGGER FUNCTION
ChA	TRIGGER SOURCE: CHANNEL A
SLOPE:+	POLARITY +
LEVEL	LEVEL
0.0%	0.0%
POSITION	POSITION
-00128	PRETRIGGER: 128 POINTS
UNIT	UNITS (EU FUNCTION)
X:Hz	X AXIS: Hz
Y:PK	Y AXIS: PEAK VALUE (V)
COH BLINK	COHERENCE BLANKING FUNCTION
OFF	OFF

VIEW 2

AVERAGE	AVERAGING MODE
SP SUM	FREQUENCY SUMMATION AVERAGE
MASS MEM	MASS MEMORY
BL: 10	CRT BLOCK MEMORY ADDRESS 10
R: 0	TIME RECORD MEMORY ADDRESS 0
AMP RANG	AUTORANGING FUNCTION
MANUAL	OFF (MANUAL)
DC CANC	DC CANCELLATION FUNCTION
OFF	OFF
AD OV. C	A/D OVERFLOW CANCEL FUNCTION
OFF	OFF
INPT SIG	INPUT SIGNAL
MEASURE	MEASUREMENT MODE
FILTER	ANTI-ALIASING FILTER
ON	ON
SIG OUT	SIGNAL OUTPUT (OPTION)
RANDOM	RANDOM SIGNAL
SAMPL CLK	SAMPLING CLOCK
INT	INTERNAL SAMPLING

Fig. 6-27 View Display (1)

VIEW 3

AVERAGE SP SUM	AVERAGING MODE FREQUENCY SUMMATION AVERAGING
MASS MEM BL: 1 R: 1000	MASS MEMORY CRT BLOCK MEMORY ADDRESS 1 TIME RECORD MEMORY ADDRESS 1000
DENSITY OFF	POWER SPECTRUM DENSITY OFF
CALCULAT OFF	ARITHMETIC CALCULATION FUNCTION OFF
∫dt OFF	TIME-AXIS DIFFERENTIATION/INTEGRATION FUNCTION OFF
jω OFF	FREQUENCY-AXIS DIFFERENTIATION/INTEGRATION FUNCTION OFF
EQUALIZE OFF	EQUALIZATION FUNCTION OFF
OCTAVE 1/3	OCTAVE ANALYSIS 1/3 OCTAVE
BAND 30	OCTAVE BANDS 30 BANDS
A-WEIGHT OFF	A-WEIGHTING COMPENSATION FUNCTION OFF

VIEW 4

AVERAGE SP SUM	AVERAGING MODE FREQUENCY SUMMATION AVERAGING
MASS MEM BL: 1 R: 0	MASS MEMORY CRT BLOCK MEMORY ADDRESS 1 TIME RECORD MEMORY ADDRESS 0
EU SET Ch A	EU FUNCTION CHANNEL A
EU= g	EU CHARACTERS SET TO g
1V= .1010-1	1 V =0.0101 EU
Ch B	EU FUNCTION CHANNEL B
EU=EU	EU CHARACTERS SET TO EU
1V= .1000+1	1 V = 1 EU
UNIT X:Hz Y:PK	UNITS (EU FUNCTION) X AXIS: Hz Y AXIS: PEAK VALUE (V)
COH BLNK OFF	COHERENCE BLANKING FUNCTION OFF

Fig. 6-28 View Display (2)

VIEW 5

AVERAGE SP SUM	AVERAGING MODE FREQUENCY SUMMATION AVERAGING
MASS MEM BL: 1 R: 0	MASS MEMORY CRT BLOCK MEMORY ADDRESS 1 TIME RECORD MEMORY ADDRESS 0
REC MODE SINGLE	TIME RECORD CAPTURE MODE SINGLE MODE
LENGTH 128K	TIME RECORD MEMORY SIZE 128 KWORDS
SOURCE Ch A&B	TIME RECORD CAPTURE CHANNEL CHANNELS A & B
PLAYBACK UP	TIME RECORD PLAYBACK DIRECTION FORWARD
ZOOM OFF	RECORD ZOOM FUNCTION OFF
GAP 2	PLAYBACK GAP 2
LENGTH 1024	DATA FRAME LENGTH 1024 POINTS
ChB DELY 0	PLAYBACK CHANNEL-TO-CHANNEL DELAY 0 (DELAY OFF)

VIEW 6

AVERAGE SP SUM	AVERAGING MODE FREQUENCY SUMMATION AVERAGING
MASS MEM BL: 1 R: 0	MASS MEMORY CRT BLOCK MEMORY ADDRESS 1 CRT TIME RECORD MEMORY ADDRESS 0
PLOTTER PLOT 1	PLOTTER DEVICE PLOT 1
DATA PEN 1	DATA (WAVEFORM) RECORDING PEN SPECIFICATION RECORD WITH PEN 1
FRAME PEN 2	FRAME (WAVEFORM) RECORDING PEN SPECIFICATION RECORD WITH PEN 2
CHARACT PEN 3	CHARACTERS (ANNOTATION) RECORDING PEN SPECIFICATION RECORD WITH PEN 3
FEED ON	FEED FUNCTION ON
SOURCE CRT	PLOTTING SOURCE CRT DISPLAYED WAVEFORM
ARRY NUM 130	NUMBER OF LINES FOR 3-DIMENSIONAL PLOT OF DISK DATA 130
GP-IB T.ONLY	GPIB INTERFACE TALK ONLY MODE

Fig. 6-29 View Display (3)

VIEW 7

AVERAGE SP SUM	AVERAGING MODE FREQUENCY SUMMATION AVERAGING
MASS MEM BL: 1 R: 0	MASS MEMORY CRT BLOCK MEMORY ADDRESS 1 TIME RECORD MEMORY ADDRESS 0
REFER OFF	REFERENCE FUNCTION OFF
GAIN UP ON	GAIN FUNCTION (UPPER DISPLAY) ON
GAIN LOW ON	GAIN FUNCTION (LOWER DISPLAY) ON
PHASE - / +	PHASE DISPLAY FORMAT PLUS AND MINUS DISPLAYS
G-DELAY OFF	GROUP DELAY FUNCTION OFF
PH ADJ. OFF	PHASE ADJUSTMENT FUNCTION OFF

VIEW 8

AVERAGE SP SUM	AVERAGING MODE FREQUENCY SUMMATION AVERAGING
MASS MEM BL: 1 R: 0	MASS MEMORY CRT BLOCK MEMORY ADDRESS 1 TIME RECORD MEMORY ADDRESS 0
SIG SEQ No. 1	SIGNAL SEQUENCE FUNCTION (OPTION) No.1
START fr 1	STARTING FREQUENCY LINE 1
STOP fr 400	STOPPING FREQUENCY LINE 400
RANGE ALL	RANGE (FOR 4-DECADE ANALYSIS) ENTIRE RANGE
SIG KIND SINE	OUTPUT SIGNAL TYPE SINE
DELAY 0	ANALYSIS DELAY TIME 0
SW WIDTH 0	SWEEP WIDTH SWEPT SINE 0
SW DIREC 0	SWEEP DIRECTION INCREASING FREQUENCY
AVG No. 2	NUMBER OF AVERAGES 2
SWEEP 0	SWEEP MODE LINEAR SWEEP

Fig. 6-30 View Display (4)

6.10.2 Setup View Function

The setup view function can be used to display the soft key settings in the following sequence.

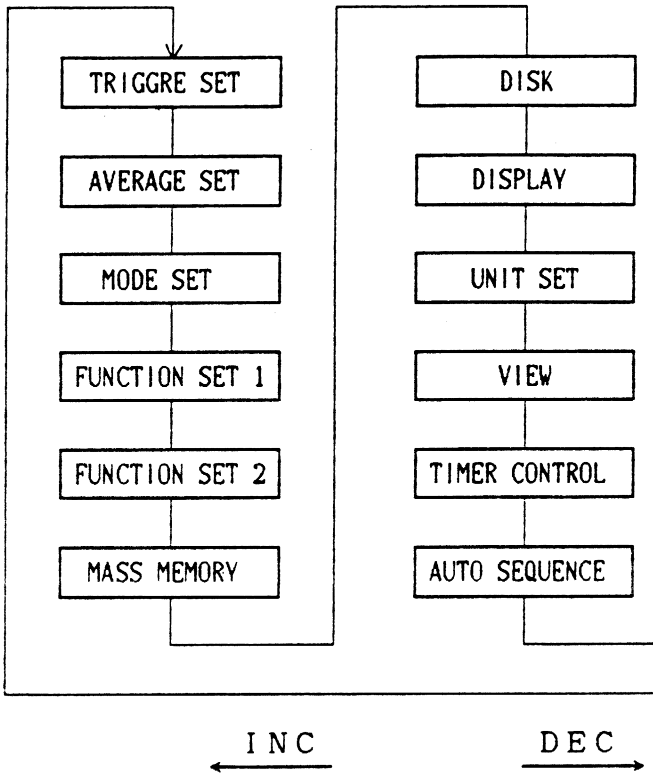


Fig. 6-31 Setup View

<Procedure>

Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

VIEW

VIEW	LABEL	SETUP					RETURN

SETUP VIEW

ON	OPTION				INC	DEC	RETURN
a					b	c	

a	ON	Sets the setup view function to on when pressed.
b	INC	Changes to the next setup view display.
c	DEC	Changes to the previous setup view display.

6.10.3 Option Setup Display Function

This function provides a display of the option functions installed in the CF-350.

<Procedure>

Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

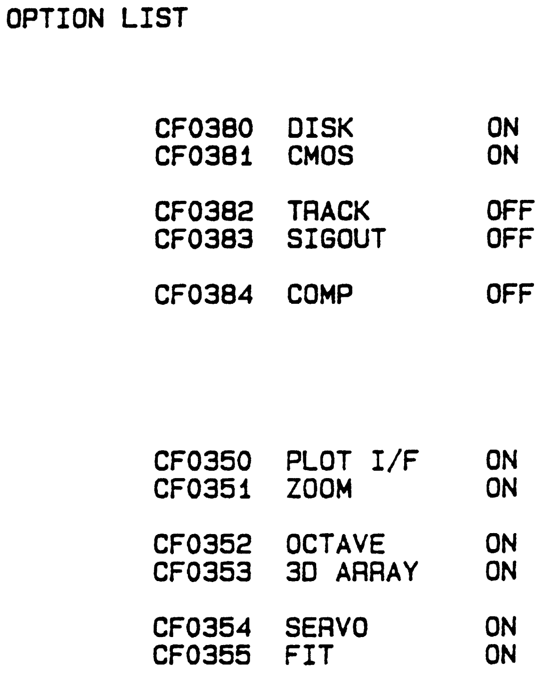
VIEW

VIEW	LABEL	SETUP					RETURN

SETUP VIEW

ON	OPTION				INC	DEC	RETURN

The CF-350 option list can be switched ON and OFF.



```
        OPTION LIST


                  CF0380  DISK       ON
                  CF0381  CMOS       ON

                  CF0382  TRACK      OFF
                  CF0383  SIGOUT     OFF

                  CF0384  COMP       OFF




                  CF0350  PLOT I/F   ON
                  CF0351  ZOOM       ON

                  CF0352  OCTAVE     ON
                  CF0353  3D ARRAY   ON

                  CF0354  SERVO      ON
                  CF0355  FIT        ON
```

Fig. 6-32 Option Setup Display

6.10.4 Label Function

In the initialized condition, the top of CF-350 CRT display appears as follows.

These two lines can each be made up of 55 characters, including alphanumeric characters and symbols which serve as labels. Characters are input by pressing front-panel switches according to the white characters that are assigned to and marked at the switches. In the label-input mode, these switches all correspond to characters.

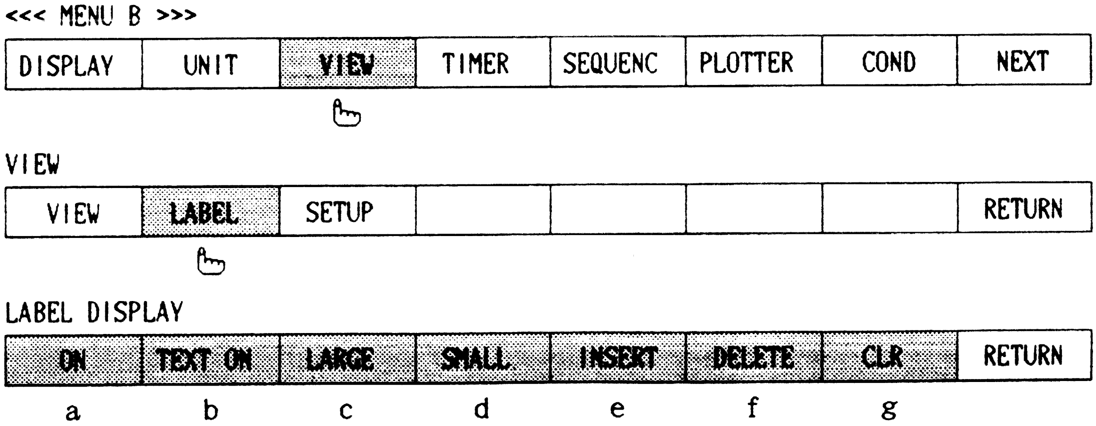
- * The top line of the label is stored together with data when storage is performed into the block memory or on to disk and appears in the listing of disk contents. Therefore, the essential comment information should be put on the top line.

- * **When using a 2-line label, the setting is made from the bottom line up.**

<Procedure>

- Upper-Line Label

① Press the LABEL switch or make the following soft key settings.



<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

VIEW

VIEW	LABEL	SETUP					RETURN

LABEL DISPLAY

ON	TEXT ON	LARGE	SMALL	INSERT	DELETE	CLR	RETURN
a	b	c	d	e	f	g	

② Press the TEXT ON key. If the LABEL key had been pressed, it will already have been on and need not be pressed, however.

③ A setting marker will appear at the left corner of the top of the CRT screen, indicating that the label will be written starting from this point.

④ Use the left and right switches to move the setting marker to the desired position.

⑤ If a switch having a white character market next to it is pressed, the character will be written into the label.

⑥ Both upper- and lower-case letters may be input, by pressing LARGE and SMALL, respectively.

INSERT	Inserts a character between the setting marker and the previous character when set to ON.
DELETE	Deletes a character at the set marker each time it is pressed.
CLR	Deletes all characters to the right of the set marker.

⑦ When the character input has been completed, press TEXT ON to complete the setting procedure.

* To set the label function to off (and thereby disable the display), press ON. If this is pressed once again, the label function will be switched to on once again.

- Lower (Second Line) Label

The lower label line is set by copying from the upper label line. The characters are set on the top line. Care is required, since the lower label line is not stored in memory.

<Procedure>

① Input a label on the upper line that is to be copied into the lower line.

② Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

VIEW

VIEW	LABEL	SETUP					RETURN

VIEW SET

OFF	NextINC	NextDEC	COND	XCHG			RETURN
			a	b			

③ When the XCHG switch is pressed, the upper label line is copies into the lower (second) label line.

④ After this, the upper label line can be set.

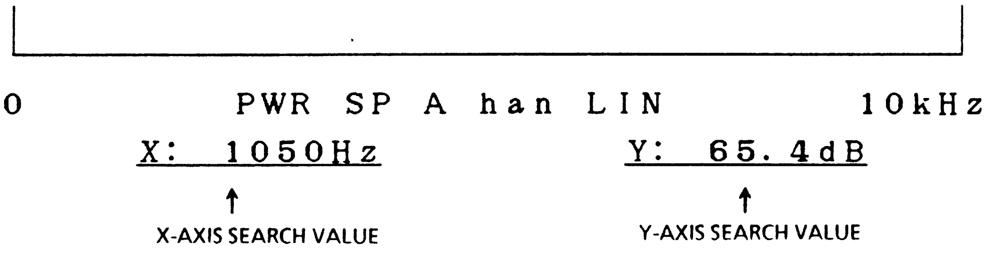
* When the COND switch is pressed, the second line is displayed as it was initially.

6.11 Search Function

The CF-350 has the following search function.

1. Maximum-value display
2. Arbitrary search point value display
3. Delta cursor X- and Y-axis value display (single-frame display)

The search values are displayed below the waveform as shown here.



```
0          PWR  SP  A  han  LIN        10kHz
      X:  1050Hz              Y:  65.4dB
```

Fig. 6-33 Search Function

6.11.1 Maximum-Value Display

When the search point is off, the maximum-value or other display is enabled for the following functions.

Displayed function	Indicated values	
Time-axis waveform	Single-frame display:	X and Y values at the maximum value and the minimum value
	Dual-frame display:	Difference between maximum and minimum values and the time difference
Spectrum	Maximum value and corresponding frequency	
Auto-correlation function	Maximum peak and lag time other than the point $\tau = 0$	
Cross-correlation function	Maximum value and corresponding lag time.	
Amplitude probability density function	Mean value and standard deviation	
Amplitude probability distribution function	Skewness and kurtosis	

Table 6-12 Displays When Search Point Function is Switched Off

- Functions When The Search Point is Off

Make the following soft key settings

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

CONDITION SET

CONDIT		POL.CHG	SEARCH	HI PREC	TI ONLY	PH. adj	RETURN

SEARCH CONTROL

PEAK	delta Y	NEXT PK	P-P	UP-move	ENHANCE	S CUSOR	RETURN
a	b	c	d	e	f	g	

PEAK	When the peak function is set to on from the off condition, the search point is moved to the peak point.
delta Y	The delta function displays not the delta value for the X axis but rather the normal X-axis value.
NEXT PK	Pressing the up and down switches moves to the next in the display.
P-P	See below *
UP-move	For a dual-frame display, the left and right switches move the search point on the upper display. The lower frame search point can be moved at any time.
ENHANCE	Enables the search enhance function.
S CUSOR	Changes the search point to a cursor.

* With respect to the time waveform, as follows.

	P-P Function	
	Off	On
Single-frame display	X (time) and Y (amplitude) coordinates for the maximum value and minimum value waveform are displayed.	The maximum and minimum values are displayed for the point of maximum amplitude over one period.
Dual-frame display	The maximum value, minimum value and difference between the two points are displayed for the upper part of the screen.	The maximum value, minimum value and difference between the two points are displayed for the upper part of the screen.

Table 6-13 Time-Axis Waveform P-P Function

6.11.2 Arbitrary Search Point Value Display

If the search point is set to on, it is possible read the X and Y values for any point.

<Procedure>

① Press the ON switch of the SEARCH group.

② Use the up/down and left/right switches of the SEARCH group to move the search point, as follows.

Left/right switches:	Moves the search point one point at a time to the left and right, respectively.
Up/down switches:	Moves the search point 13 points at a time left and right respectively.

③ The X and Y values at the search point are displayed at the bottom of the waveform.

6.11.3 Delta Cursor Display (Single-Frame Display Mode)

The delta function can be used to calculate and display the X- and Y-axis differences from an arbitrary starting point.

<Procedure>

① Set the search point function to on and move the point to the desired reference point.

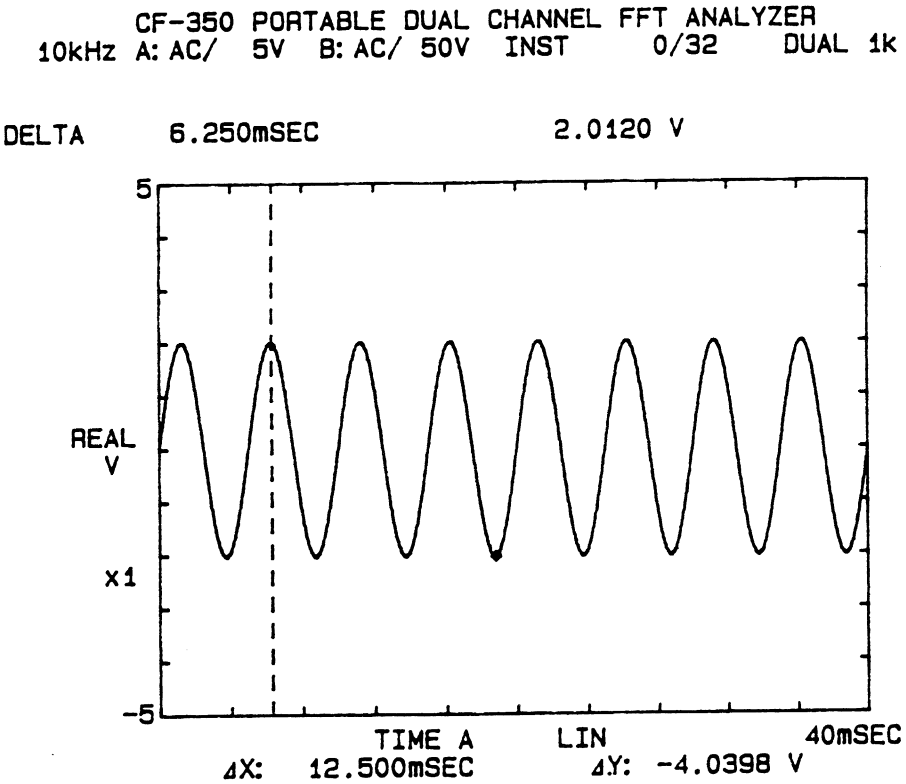
② Press the ΔSET switch of the SEARCH group.

③ Move the search point to the point at which the deviation is to be calculated.

④ Press the ΔON switch of the SEARCH group.

The deviation from the reference point will be displayed at the ΔX: and ΔY: which are displayed beneath the waveform.

* It is also possible to use the delta function with the Y axis only (refer to Section 6.11.1).



CF-350 PORTABLE DUAL CHANNEL FFT ANALYZER
10kHz A: AC/ 5V B: AC/ 50V INST 0/32 DUAL 1k

DELTA 6.250mSEC 2.0120 V

ΔX: 12.500mSEC ΔY: -4.0398 V

Fig. 6-34 Delta Cursor Display Function

6.12 Date/Time Function

In the CF-350, an internal clock is used to display the year, month, day, hour and minute on the CRT screen. This clock is set as follows.

The clock display is made in the following format at the lower right part of the CRT.

20/	4/	87	14:00
day	month	year	

To set the clock, perform the following operations.

① Place the analyzer into the PAUSE condition.

② Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT
			👆				

TIMER CONTROL

TIM SET	INTRVAL						RETURN
👆							

TIMER SET

ON	SET		←	→			RETURN
👆	a		b	c			

The above soft key settings cause the clock setting cursor to be displayed on the CRT.

③ Use the [←] and [→] keys to move the setting cursor to the location to be modified.

④ Use the numeric keys of the front panel to input the desired value.

⑤ Press the SET key to complete the setting procedure.

* This clock function is backed up by battery power.

6.13 Using the SECOND Switch

The CF-350 SECOND switch is used as follows.

6.13.1 Inhibiting the Upper Part of the Display

The SECOND front-panel switch can be used as follows.

① It can be used to move data to the lower part of the screen in preparation for a dual-frame display (see Section 2.7.2).

② It can be used to change only the data at the top of a dual-frame display. In addition to the above purposes, it can be used to inhibit the top part of a dual-frame display.

- Inhibiting the Top Part of a Dual-Frame Display

  By using this function, it is possible to obtain a dual-frame display (top/bottom) of waveforms which have and which have not been processed using a secondary processing function (e.g., differentiation or A weighting compensation).

<Procedure>

In this example, we will display on a dual-frame display a spectrum after frequency differentiation (jω) and before differentiation.

① Press the SPEC switch of the CH A subgroup.

② Press the SECOND switch.

③ Press the SPEC switch of the CH A subgroup.

The above operations will cause a dual-frame display of the channel A spectrum.

④ Press the SECOND switch.

⑤ Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

FUNCTION SET 1

EQULIZE	CALC	∫dt,/dt	jω	OCTAVE	DENSITY	CEPSTRM	RETURN

INTEG & DIFF

ON	X jω	X(jω)^2	1/jω	1/(jω)^2	REF UP	REF DW	RETURN

The above operations will display the spectrum after jω processing on the bottom of the display and the spectrum before such processing at the top of the display.

If, on the other hand, you desire to display the spectrum after jω processing on the top of the screen and the spectrum before processing on the bottom of the screen, do the following.

1. Before executing the operation of step ④ above, perform the key operations of ⑤ to obtain a jω processed waveform on both top and bottom of the screen.

2. Press the SECOND switch.

3. Turn the jω processing off.

The above operations can be used to obtain a dual-frame display of a function with and without other processing functions as well. This can also be used to produce the corresponding hardcopy.

* It should be noted, however, that since the upper CRT display is disabled, a variety of functions will not operate.

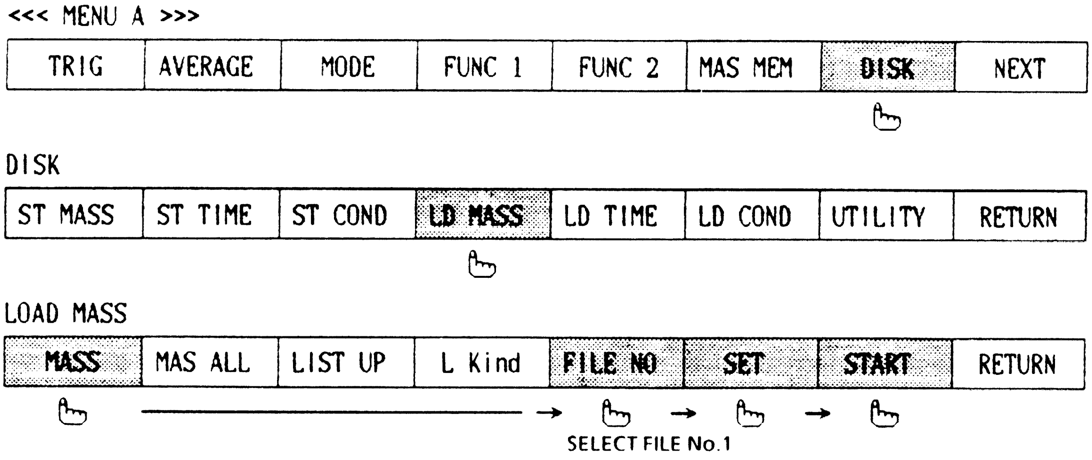
6.13.2 Dual-Frame Display of Disk Data

To display data from disk in the dual-frame display mode, the data is first stored into CRT block memory and then recalled to the top and bottom part of the screen by the following procedure. Other aspects of this operation are the same, however, as the normal single-frame display.

<Procedure>

In this example, we will recall data from disk file No.1 and No.2 to form a dual-frame display.

① Make the following soft key settings.



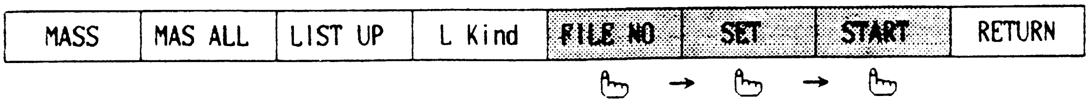
The data from file No.1 will be displayed on a single-frame screen.

② Press the SECOND switch.

③ Change the memory address using the CRT block memory address-specifications switch.

④ Operate the soft keys to change the disk file number and load the data.

LOAD MASS



SELECT FILE No.2

The above operations create a dual-frame display of disk data (data from file No.2 on the top and data from file No.1 on the bottom part of the CRT).

The CF-350 has 12K bytes of data memory and the following memory functions are available.

(1) Display waveform storage and playback (CRT block memory)

(2) Time-axis waveform storage and playback (time record memory)

Function (1) can be used to store up to a maximum of 60 frames of data. It also enables automatic continuous storage, as well as storage in response to external timing signals.

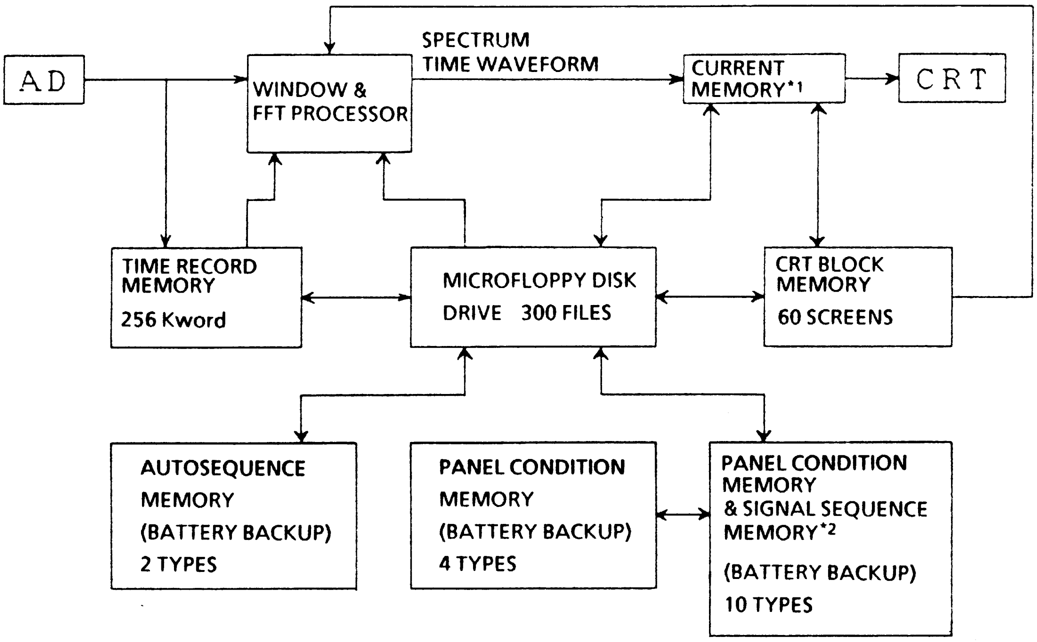
Function (2) enables storage of data with no missed data at 255K words/1 channel,127K words/2 channels, or 31K words × 8 data records. During playback, the same kind of analysis is possible as with normal analog inputs. Playback zooming up to 32 times is also possible.

The CF-0381 CMOS memory card enables mass memory expansion. The CMOS memory card has 1M bytes of RAM which is backed up by battery, so the data is not lost when the power is turned off. Selection can be made between (1) CRT block memory, (2) time record memory, and (3) RAM disk. If CRT block memory is selected, combined with the standardly provided CRT block memory, up to 540 frames can be stored. If time record memory is the selected, this enables storage of up to 768K words (1 channel) of data when combined with the standardly provided time record memory.

If the CF-0380 Floppy Disk and Signal Generator interface card is installed, the contents of the built-in memory can be stored on disk. The microfloppy disk drive takes double-sided, double-density disks with a storage capacity of 300 files/disk, so the contents of the CRT block memory or the time record memory can be stored. The contents of the panel condition, autosequencing, and signal sequence memories can also be stored. The battery backup for the CF-0381 CMOS memory card means that it can be used as a second disk drive and used in exactly the same way as the microfloppy disk drive.

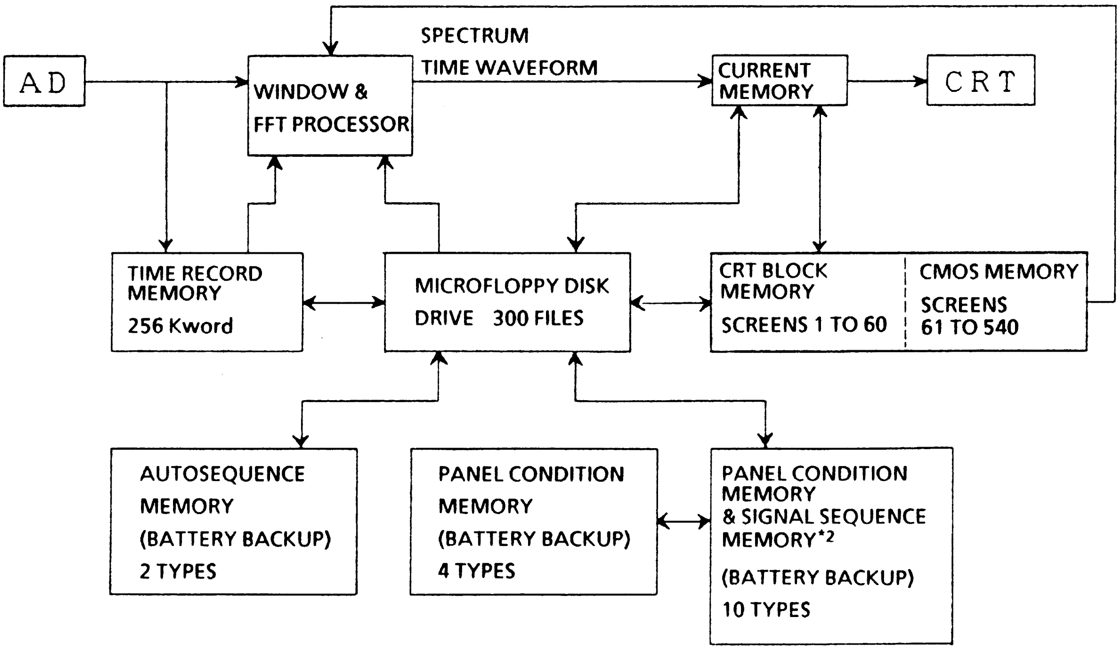
Memory Diagrams

<Standard>

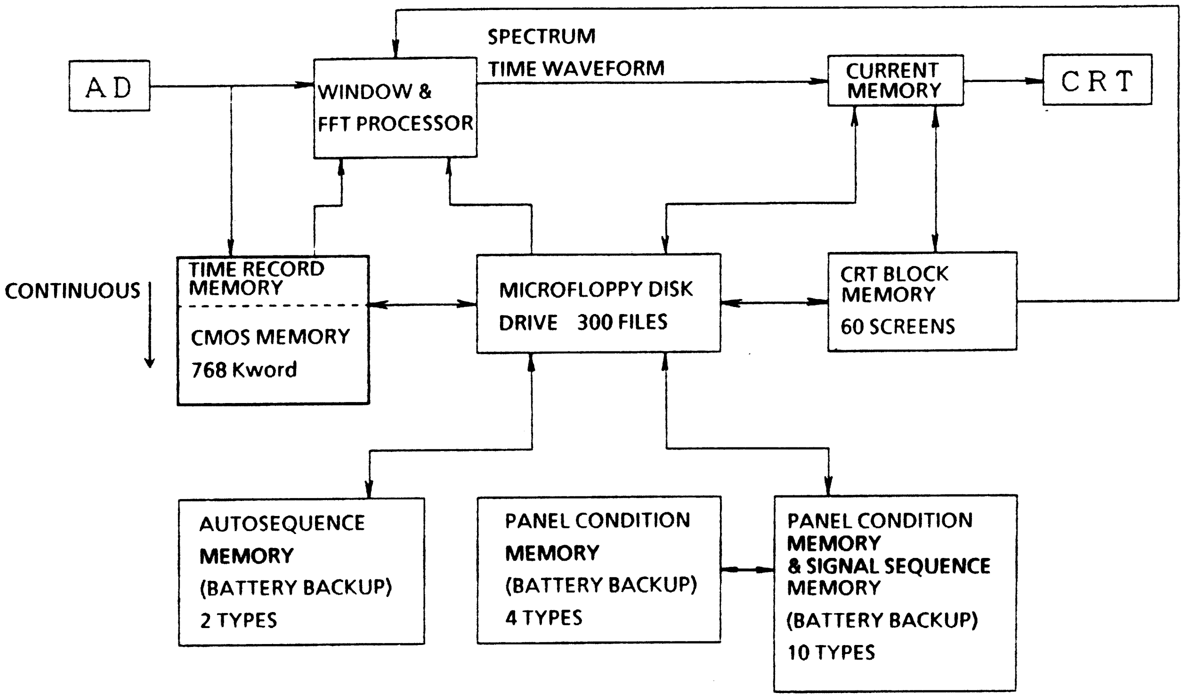


*1) Display memory for functions operated by panel switches
*2) See Chapter 11 on the Servo Analysis Function

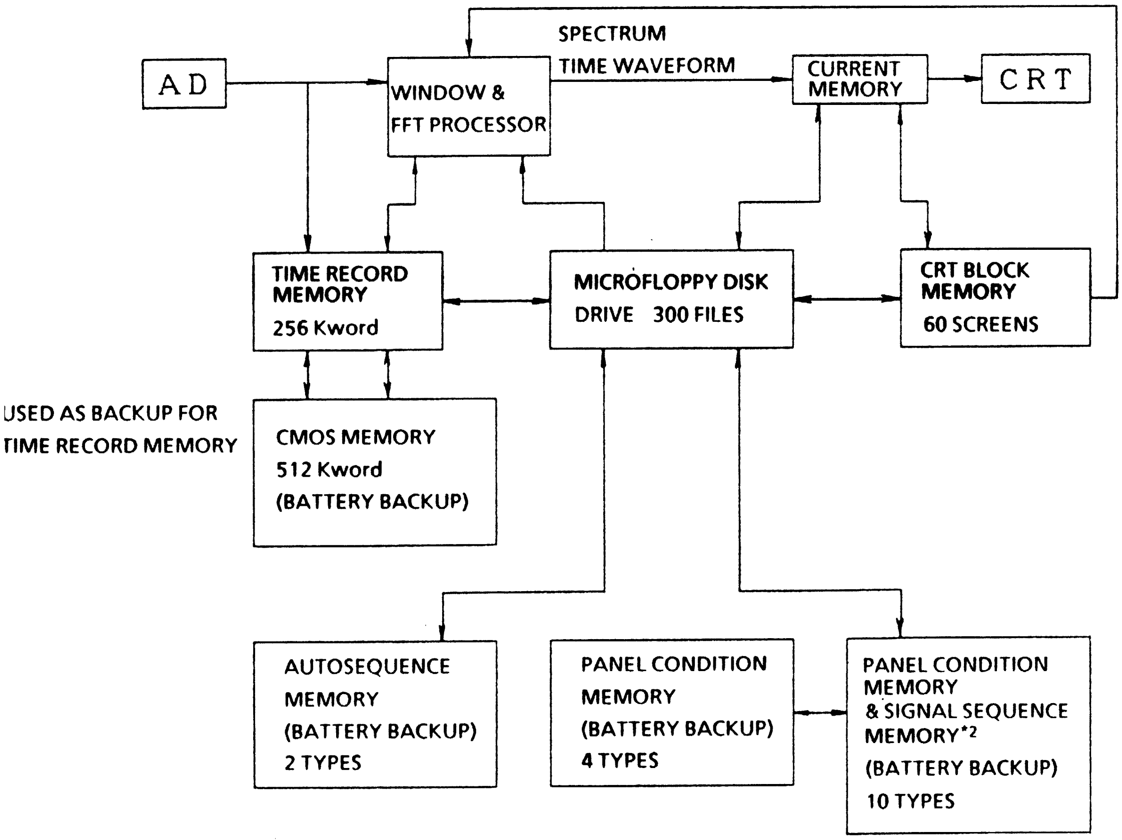
<CMOS Memory Card and CRT Block Memory Selection>



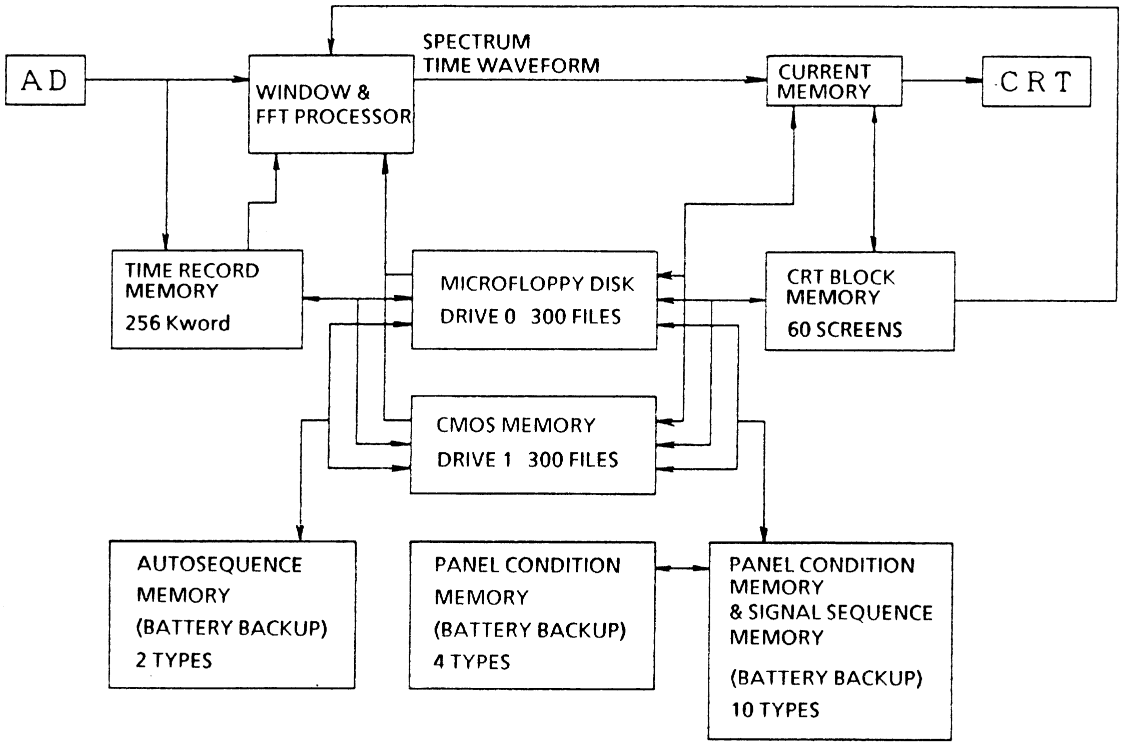
<CMOS Memory Card and Time Record Memory Selection, 768-Kword Mode>


AD
WINDOW &
FFT PROCESSOR
SPECTRUM
TIME WAVEFORM
CURRENT MEMORY
CRT
CONTINUOUS
TIME RECORD MEMORY
CMOS MEMORY
768 Kword
MICROFLOPPY DISK
DRIVE 300 FILES
CRT BLOCK MEMORY
60 SCREENS
AUTOSEQUENCE
MEMORY
(BATTERY BACKUP)
2 TYPES
PANEL CONDITION
MEMORY
(BATTERY BACKUP)
4 TYPES
PANEL CONDITION
MEMORY
& SIGNAL SEQUENCE
MEMORY
(BATTERY BACKUP)
10 TYPES

<CMOS Memory Card and Time Record Memory Selection, 256K/30-Kword Mode>


AD
WINDOW &
FFT PROCESSOR
SPECTRUM
TIME WAVEFORM
CURRENT MEMORY
CRT
TIME RECORD MEMORY
256 Kword
MICROFLOPPY DISK
DRIVE 300 FILES
CRT BLOCK MEMORY
60 SCREENS
USED AS BACKUP FOR
TIME RECORD MEMORY
CMOS MEMORY
512 Kword
(BATTERY BACKUP)
AUTOSEQUENCE
MEMORY
(BATTERY BACKUP)
2 TYPES
PANEL CONDITION
MEMORY
(BATTERY BACKUP)
4 TYPES
PANEL CONDITION
MEMORY
& SIGNAL SEQUENCE
MEMORY*2
(BATTERY BACKUP)
10 TYPES

<CMOS Memory Card Used as Second Disk>


AD
WINDOW & FFT PROCESSOR
SPECTRUM
TIME WAVEFORM
CURRENT MEMORY
CRT
TIME RECORD MEMORY
256 Kword
MICROFLOPPY DISK
DRIVE 0 300 FILES
CRT BLOCK MEMORY
60 SCREENS
CMOS MEMORY
DRIVE 1 300 FILES
AUTOSEQUENCE MEMORY
(BATTERY BACKUP)
2 TYPES
PANEL CONDITION MEMORY
(BATTERY BACKUP)
4 TYPES
PANEL CONDITION MEMORY
& SIGNAL SEQUENCE MEMORY
(BATTERY BACKUP)
10 TYPES

7. MEMORY

7.1 CRT Block Memory--Storage and Playback of Display Frames

The CF-350 provides the following functions for storage and playback of display frames.

1. Up to 60 frames can be stored and played back.
2. Automatic continuous storage of waveforms as they are analyzed, and automatic continuous storage of averaging results.
3. The interval function can also be used to store data intermittently.
4. Frames can be stored in response to external timing signals. (When the CF-0384 comparator-out card is installed.)
5. Three-dimensional display of stored data. (When the CF-0353 three-dimensional display software is installed.)
6. FFT analysis can be performed on stored time data

If the CF-0381 CMOS Memory Card is installed for use as a 480-block CRT block memory, there are a total of 540 block of storage. If this is done, blocks 61 to 540 on the CMOS memory card are supported by battery back-up power. Basically, one block of memory should be sufficient for one waveform, but in some cases two, or even up to six, blocks may be required.

Functions using two blocks

800-line power spectrum

800-line Fourier spectrum

Time-axis waveforms with 2-Kword data length

Auto-correlation function with 2-Kword data length

Cross spectrum

Transfer function

Functions using six blocks

4-Decade analysis function

All other waveforms require only one block of memory.

7.1.1 Display Frame Storage and Playback

<Procedure>

(a) Storage

Waveforms can be stored in either the PAUSE or START conditions.

① Display the waveform to be stored.

② The first block number in which waveforms can be stored is displayed in the annotation section at the right of the screen. Set the number of the block for the displayed waveform using the vertical increment and decrement keys of the ADDRESS switch of the DISPLAY group.

③ The waveform on the screen will be stored when the STORE switch of the DISPLAY group is pressed.

The block number is incremented each time a waveform is stored. If it reaches 60, when the next waveform is stored, the block number will return to 1.

Notes

1. If a waveform is stored in a block that already contains a waveform, the latter will be deleted and the new waveform stored in the block. The write-protect function can be used to avoid this situation. (See Section 7.1.4 (f) on the write-protect function.)

2. In dual-frame display, the contents of both frames cannot be stored in a single block. Store the waveform in the lower frame first, and then that in the upper frame.

Make the following soft key settings to enable input of the block number.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

MASS MEMORY

RECORD	PLYBACK	PB.LENG	PB.ZOOM	PB.DISP	CRT LD	CRT MEM	RETURN

CRT DISPLAY COND BLK No. 001

LOAD	L. COPY	LABEL	BLK No.	LIST UP	INSERT	DELETE	RETURN

The block number will be displayed above the keys when the BLK No. key is pressed.

Input the block number using the numerical keys on the front panel while the BLK No. key is on.

Turn the BLK No. key off to set the block number.

(b) Playback

① The block number will now be one greater than the number of frames stored up to this point. (If 10 frames have been stored, the block number will now be 11.)

Use the increment and decrement keys of the ADDRESS switch of the DISPLAY group to set the number of the block containing the waveform to be played back.

The selected address will then be displayed and highlighted.

② Press the MEMORY RECALL switch of the DISPLAY group.

The waveform will be displayed on the screen with the block number highlighted at the left of the screen in the format "M1".

③ The block number can be automatically incremented to the next data each time a waveform is played back.

Make the following soft key settings to enable this.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT
					👆		

MAS MEMORY

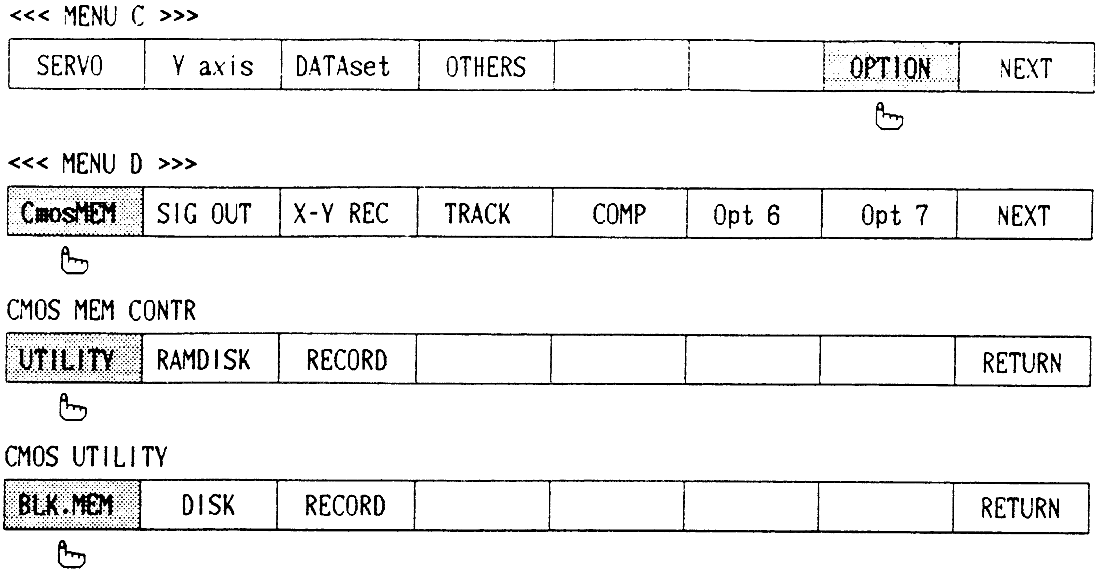
RECORD	PLYBACK	PB.LENG	PB.ZOOM	PB.DISP	CRT LD	CRT MEM	RETURN
						👆	

CRT DATA RECORD

MANU	AUTO	EXTERNL	DATE ON	TIME ON	PROTECT	ALL CLR	RETURN
	👆						

With the AUTO key on, the block number will be incremented automatically each time the MEMORY RECALL switch is pressed.

Make the following soft key settings when the CF-0381 CMOS Memory Card is used as CRT block memory.



When the BLK.MEM key is turned on, up to 540 block of CRT block memory storage is available.

Block 1 to block 60 is the standard memory, and block 61 to block 540 is the CMOS memory card.

Note

When the power is turned off, the contents of blocks 1 to 60 will be erased, but those of blocks 61 to 540 are supported by battery backup, and are not erased.

7.1.2 Automatic Continuous Storage of Display Frames

Waveforms of captured signals can be stored automatically, each time the FFT analysis is performed and the display changes, or each time an average is completed.

<Procedure>

Set the START condition.

① Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	**MAS MEM**	DISK	NEXT

MAS MEMORY

RECORD	PLYBACK	PB.LENG	PB.ZOOM	PB.DISP	CRT LD	**CRT MEM**	RETURN

CRT DATA RECORD

MANU	**AUTO**	EXTERNL	DATE ON	TIME ON	PROTECT	ALL CLR	RETURN

② Press the STORE switch of the DISPLAY group. BL: in the annotation section at the right of the screen will be highlighted during continuous storage.

The contents of the screen will be automatically stored each time the screen changes from the time the STORE switch was pressed. Continuous storage stops when block 60 is reached (or when block 540 is reached if the CMOS memory card is used).

③ Press the STORE switch again to suspended automatic storage.

During Averaging:

Data is stored each time an averaging operation is completed, and averaging is restarted.

Turn the AVG switch of the COMMAND group on, and the PAUSE condition will be entered.

Press the START switch to restart averaging.

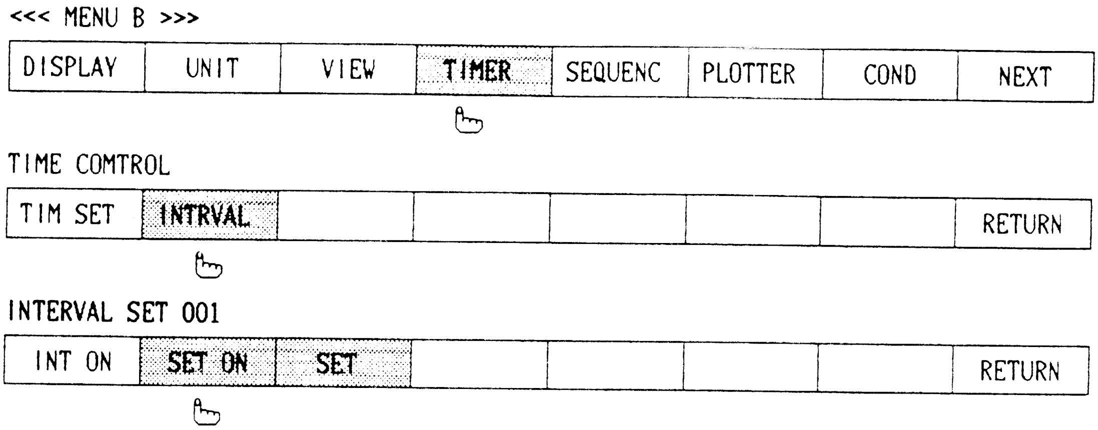
Press the STORE switch of the DISPLAY group before the set number of averages has been completed.

Using the Interval Function with Automatic Continuous Storage

The interval function enables automatic storage at intervals set in the range 1 to 9999 s.

① Make the same soft key settings given at the beginning of this procedure to turn the AUTO key on and enable the PAUSE condition.

② Make the following soft key settings.



Input the interval in the range 1 to 9999 s using the numeric keys.

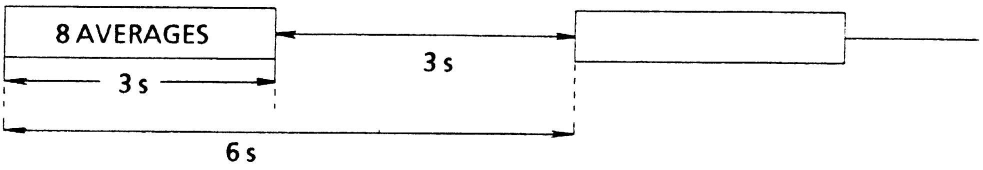
Press the SET key to set the interval value.

Once the interval has been set, press the INT ON key to turn the interval function on. The clock at the bottom right of the CRT screen will now be highlighted.

③ Press the START switch in the COMMAND group to enter the START condition.

④ A frame will be stored after each time interval set above when the STORE key is pressed and storage begins.

(Example) **Execute averaging eight times approximately every 3 s, and store the results.**



If the time required for averaging is about 3 s, set the interval to 6 s. The result is stored when averaging is finished, and averaging resumes about 3 s later.

7.1.3 Three-Dimensional Display of Stored Data

If the CF-0353 3-Dimensional Display software is installed, stored waveforms can be played back and displayed in 3-dimensional format.

<Procedure>

① Set the number of the block from which play back is to begin using the ADDRESS switch or the BLK No. soft key.

② Press the MEMORY RECALL, ARRAY, and START switches in that order.

Waveforms will now be continuously played back and displayed in 3-dimensional format. The block numbers of the waveforms played back are displayed consecutively at the bottom right of the CRT screen.

Notes

1. If a block is encountered which does not contain data, the function stops at the block before it.
2. The function stops when block 60 (or block 540 if the CMOS memory card is used) is reached even if the scroll function is on.
3. If waveforms of different types are stored in the CRT block memory, this function will display only waveforms of the same type as that displayed when execution of the function was initiated.

7.1.4 Other Functions

The soft keys can be used to execute the following CRT block-memory functions also.

(1) Display mode playback

(2) Label selection

(3) Storage data listing

(4) Block insertion and deletion

(5) Date and time storage

(6) Write protection

(7) Erase all storage data

<Procedure>

Make the following soft key settings for function (1) to (4).

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

MASS MEMORY

RECORD	PLYBACK	PB.LENG	PB.ZOOM	PB.DISP	CRT LD	CRT MEM	RETURN

CRT DISPLAY COND

LOAD	L.COPY	LABEL	BLK No.	LIST UP	INSERT	DELETE	RETURN

(a) Playback of Data in Same Display Mode as When Stored

Waveforms can be played back in the same display mode as when storage was performed in the display mode that enables changing the X- or Y-axis scaling, logarithmic/linear scaling, EU value, or other features.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

MASS MEMORY

RECORD	PLYBACK	PB.LENG	PB.ZOOM	PB.DISP	CRT LD	CRT MEM	RETURN

CRT DISPLAY COND

LOAD	L.COPY	LABEL	BLK No.	LIST UP	INSERT	DELETE	RETURN

If playback is now performed with the LOAD key on, the data will be displayed in the same mode as when it was stored.

(b) Label Selection

Either of the following two selections can be made when playing back stored data on the screen:

① Set the label to the label of the stored frame and display it.
② Set the label to the current label.

If selection ① is made, stored labels will be displayed each time data is played back.

If any other display switch other than MEMORY RECALL is pressed, it will return to the current label. With this selection it is also possible to replace (copy) the current label with the stored label.

CRT DISPLAY

LOAD	L.COPY	LABEL	BLK No.	LIST UP	INSERT	DELETE	RETURN
	b	a					

a LABEL ..... **When this key is on, the label stored at playback is** displayed. If it is off, the label display does not change even when data is played back.

b L.COPY .... The stored label is copied to the current label. Thus, if this key is turned on while the stored label is displayed, the label will not change when any of the switches are pressed except MEMORY RECALL.

(c) Listing Stored Data

CRT DISPLAY COND

LOAD	L.COPY	LABEL	BLK No.	LIST UP	INSERT	DELETE	RETURN

- Enter the PAUSE condition.

  Press the LIST UP key.

  The data type of the data stored in the CRT block memory is listed on the display together with the first 40 characters of the labels.

(d) Inserting and Deleting Blocks

CRT DISPLAY COND

LOAD	L.COPY	LABEL	BLK No.	LIST UP	INSERT	DELETE	RETURN
					a	b	

a INSERT .... When this key is pressed, one empty block is inserted in front of the block whose number is currently displayed in the annotation section at the right of the screen. The result is that block numbers of subsequent data will be increased by 1.

b DELETE .... When this key is pressed, the block whose number is currently displayed in the annotation section at the right of the screen is deleted. The result is that block numbers of subsequent data will be reduced by 1.

Make the following soft key settings for functions (5) to (7).

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

MASS MEMORY

RECORD	PLYBACK	PB.LENG	PB.ZOOM	PB.DISP	CRT LD	CRT MEM	RETURN

CRT DATE RECORD

MANU	AUTO		DATE ON	TIME ON	PROTECT	ALL CLR	RETURN

(e) Storing Date and Time

CRT DATE RECORD

MANU	AUTO		DATE ON	TIME ON	PROTECT	ALL CLR	RETURN
			a	b			

a	DATE ON	If this key is on, the date is added to the right half of the label and stored simultaneously.
b	TIME ON	If this key is on, the time is added to the right half of the label and stored simultaneously.

If *a* and *b* are on, both the date and time are stored.

Note

The date and time are written over the contents of the right half of the label, so the 14 characters of the right half are erased.

(f) Write Protect

This prevents data being written over data already stored in a block.

CRT DATE RECORD

MANU	AUTO		DATE ON	TIME ON	PROTECT	ALL CLR	RETURN

If the PROTECT key is turned on, a "MEMORY PROTECT" error message will be returned when an attempt is made to store data in a block that already contains data.

(g) Erasing All Stored Data

CRT DATA RECORD

MANU	AUTO		DATE ON	TIME ON	PROTECT	ALL CLR	RETURN

The entire contents of the CRT block memory will be erased if the ALL CLR key is pressed.

7.2 Time Record Memory--Time Waveform Storage and Playback

The CF-350 has a 255-Kword time record memory and can store time waveforms without missing time data.

If the CF-0381 CMOS Memory Card is installed, it can also be used as a time record memory, extending capacity to a maximum of 768K words.

All the functions can be used for numerical and other processing on stored waveforms. (However, when only one channel is stored, transfer functions and other cross-mode analysis cannot be executed.)

Numerical calculations and other processing can be performed on stored waveforms while they are being played back using the panel switches and soft keys, just as for the usual analysis functions.

All of the following functions can be executed on data in the time record memory.

1. Storage of time signals on Channels A and B.
2. An shfit can be specified in the range 0 to 4096 points for analysis and display of stored time waveforms.
3. A delay can be applied between the stored time waveforms for Channels A and B.
4. The entire stored time waveform can be displayed, or it can be broken up into eight blocks, and each block displayed separately.
5. The analysis data length of stored time waveforms can be changed.
6. Stored time waveforms can be FFT analyzed and frequency zoomed.
7. Stored time waveforms can be written to and played back from disk.

** See Section 1.1.6 for the time length of data that can be stored in the time record memory.

7.2.1 Time Waveform Storage

Memory can be divided in the following ways for storage of time waveforms.

① 255-Kword Mode

All 255 words can be used to store a signal on either of Channels A or B, or 127K words can be used to store signals on the two channels simultaneously.

② 30-Kword Mode

31-Kword data is stored in eight data sets for a signal on one channel. 31 Kwords each in four data sets are used for simultaneous storage of signals on two channels.

③ 255-Kword and 30-Kword Ring Modes

Data is stored continuously after the end of the memory capacity on through the start address erasing the previous contents. Storage stops at some point of the the 1024 points (for two channels) or 2048 points (for 1 channel) before and after the time when the PAUSE switch is turned on, and the 255 Kwords or 31 Kwords of data are stored.

The timing for stopping storage is determined by the timing at which the PAUSE switch is turned on and the internal processing timing.

When the CF-0381 CMOS memory card is used for time record memory:

The CMOS memory card capacity should be divided in the following ways when it is used for time record memory.

① 768-Kword Mode

a. Store a signal on either Channels A or B in 768 Kwords.

b. Signals on both Channels A and B can be simultaneously stored in 384 Kwords each.

② 255-Kword Mode

a. Store a signal on one of the channels in 255 Kwords in three data sets.

b. Store signals on two channels in 127 Kwords each in three data sets.

③ 30-Kword Mode

Store 31-Kword signals in 24 data sets. If the signal is on one channel, store it in 24 data sets; for signals on two channels, store them simultaneously in 12 data sets.

Waveforms stored in the CMOS memory card in two data sets in the 255-Kword mode, or in 8 data sets (or four data sets each for two channels) in the 30-Kword mode, are protected by battery backup.

If data is previously stored in time record memory, the storage mode cannot be changed. Erase the contents of the time record memory and then change the mode.

<Procedure>

(a) 255-Kword Mode

Press the PAUSE switch of the COMMAND group to enter the PAUSE condition.

① Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

MASS MEMORY

RECORD	PLYBACK	PB.LENG	PB.ZOOM	PB.DISP	CRT LD	CRT MEM	RETURN

RECORD MODE

ON	RING		Ch A&B	Ch A	Ch B	CLEAR	RETURN
			a	b	c		

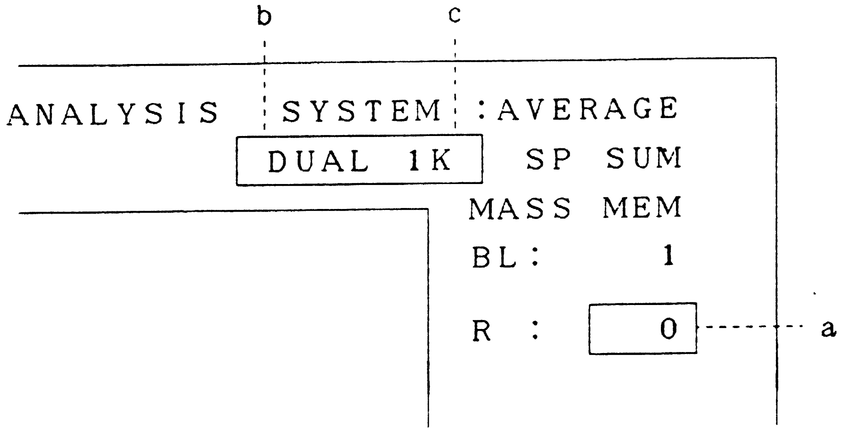
a	Ch A&B ...	Stores A-Channel and B-Channel signals simultaneously in 127 Kwords each.
b	Ch A	Stores the A-Channel signal in 255 Kwords.
c	Ch B	Stores the B-Channel signal in 255 Kwords.

Select *a*, *b*, or *c*.

Now press the ON key.

② Storage starts when the START switch of the COMMAND group is pressed.

When storage is finished, a long beep tone is issued, and the following information is shown in the annotation section of the display.



Where *a* and *b* are as follows.

a. R:0 (RECORD address)

i) When the value displayed here is 0k, 1k, 2k, etc., this means that data is being captured in the record mode.

ii) When this value is highlighted, this indicates that data has already been stored in the record memory.

Thus, when data capture is completed, the highlighted address 0 is displayed automatically. Highlighted values other than 0 indicate the playback address.

b.

DUAL	Storage in 127 Kwords for both Channels A and B.
Ch A	Storage in 255 Kwords for Channel A.
Ch B	Storage in 255 Kwords for Channel B.
1K	Playback of a data length of 1024 points.
2K	Playback of a data length of 2048 points.

The characters in *b*. are displayed highlighted during playback.

Note

BL:1 (BLOCK address)

This indicates the CRT block memory address.

This has no relation to the time record memory.

* The address displayed during playback indicates the starting point of the frame. The last displayed value for a data length of 1024 points in the 255 Kwords mode for 1-channel storage is 260096 ($255 \times 1024 - 1024$), and for 2-channel storage is 129024 ($127 \times 1024 - 1024$). When the overlap and analysis data length are changed, the playback may stop before this point is reached.

(b) 30-Kword Mode

① Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

MASS MEMORY

RECORD	PLYBACK	PB.LENG	PB.ZOOM	PB.DISP	CRT LD	CRT MEM	RETURN

DATA LENGTH

2048	1024		BLOCK	INC	DEC	AD CLR	RETURN

The 30-Kword mode is entered when the BLOCK key is pressed.

The number of the block in which 30-Kword data is to be stored is displayed in the annotation section at the right of the screen in the format R:I.

31-Kword data can be stored in 8 data sets, so blocks 1 to 8 can be set.

Set the number of the storage block using the INC and DEC keys.

② Use the procedure in (a) of this section to store the data.

Notes

1. When signals from two channels are being stored simultaneously (with each 31 Kwords occupying 2 blocks), the block numbers are 1 and 2, 3 and 4, 5 and 6, etc. The block numbers cannot be set as 2 and 3, 4 and 5, etc. If two-channel storage is initiated with an even number set as the block number, storage will actually start automatically from the block immediately prior to the setting. During playback, the (odd) number of the block containing the data for Channel A is displayed in the annotation section on the right of the screen.

2. If the time record memory already contains data, it is not possible to switch modes from 255-Kword mode to 30-Kword mode.

   See (d) below in this section for the procedure for erasing data from memory.

(c) **Ring Mode**

Make the soft key settings given in (a) above in this section to display the following menu.

RECORD MODE

ON	**RING**		Ch A&B	Ch A	Ch B	CLEAR	RETURN

Press the RING key on to start storing data.

To complete storage, press the PAUSE switch at the last data point to be captured.

(d) Erasing Time record-Memory Data

Data can be erased from the time record memory. Make the same soft key settings as for storage, and again the following menu will be displayed.

RECORD MODE

ON	RING		Ch A&B	Ch A	Ch B	**CLEAR**	RETURN

When the CLEAR key is pressed, a "MEM CLEAR OK?" message will be displayed, so press the CLEAR key once more.

Note

When the CMOS Memory Card is used for time record memory, these operations can be used to erase data from the CMOS memory.

When the CMOS memory card is used as time record memory:

① Select time record memory.

Make the following soft key settings.

<<< MENU C >>>

SERVO	Y axis	DATAset	OTHERS			**OPTION**	NEXT

<<< MENU D >>>

CmosMEM	SIG OUT	X-Y REC	TRACK	COMP	Opt 6	Opt 7	NEXT

CMOS MEM CONTROL

UTILITY	RAMDISK	RECORD					RETURN

CMOS UTILITY

BLK.MEM	DISK	**RECORD**					RETURN

② Make the following soft key settings.

CMOS UTILITY

BLK.MEM	DISK	RECORD					**RETURN**

CMOS MEM CONTROL

UTILITY	RAMDISK	**RECORD**					RETURN

RECORD CONTROL

768K		XCHG1	XCHG2	F- 256	M- 256	L- 256	RETURN

(1) 768-Kword Mode

Set the PAUSE condition.

RECORD CONTROL

768K		XCHG1	XCHG2	F- 256	M- 256	L- 256	RETURN

Press the 768K key and use the procedure in (a) above in this section to store the data.

The address in the annotation section at the right of the screen during storage goes through the range 0 to 256k three times.

Notes

1. If there is already data in the time record memory when this operation is initiated, it is not possible to switch to other modes (768-, 255-, or 30-Kword mode). See (d) above in this section to erase data from the time record memory.

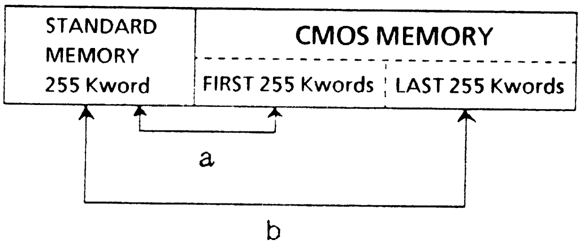
2. Data already stored in the CMOS memory (CRT block memory, time record memory, or RAM disk) will be erased.

(2) 255-Kword Mode ×3 Data Sets

Data which was stored in the 255-Kword mode in the standard memory can be transferred to the CMOS memory.

RECORD CONTROL

768K		XCHG1	XCHG2	F- 256	M- 256	L- 256	RETURN
		a	b				



a	XCHG1 ...	Replace the 255-Kword data in the top half of the CMOS memory with the 255-Kword data in the standard memory, and vice versa.
b	XCHG2 ...	Replace the 255-Kword data in the bottom half of the CMOS memory with the 255-Kword data in the standard memory, and vice versa.

(3) 30-Kword Mode × 24 Data Sets

8-data-set data stored in 30-Kword mode in standard memory can be transferred to CMOS memory all in one.

RECORD CONTROL

768K		XCHG1	XCHG2	F- 256	M- 256	L- 256	RETURN
		a	b				

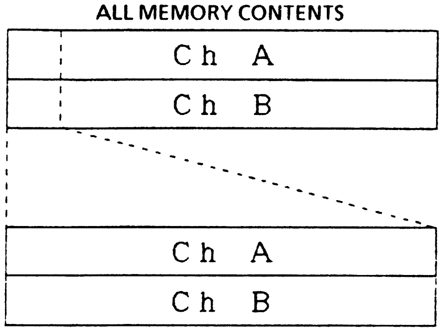
a	XCHG1 ...	Replace the 31-Kword data ×8 data sets in the top half of the CMOS memory with the 31-Kword data ×8 data sets in the standard memory, and vice versa.
b	XCHG2 ...	Replace the 31-Kword data ×8 data sets in the bottom half of the CMOS memory with the 31-Kword data ×8 data sets in the standard memory, and vice versa.

7.2.2 Time Waveform Playback

The following methods can be selected for playback from the time record memory.

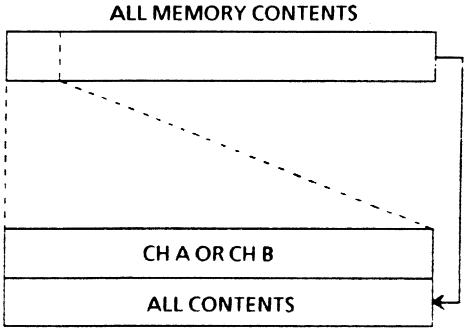
① Normal Display

After each specified gap in points, 1024 or 2048 points are displayed.



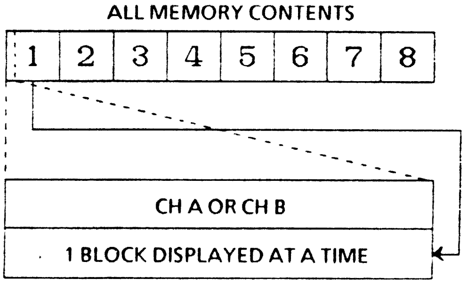
② Display Entire Memory Contents

The entire contents of memory, 127 or 255 Kwords, is displayed in the lower frame of the screen. Any desired data from within that can also be displayed in the upper frame same time.



③ Display of Each Block

The contents of the 127- or 255-Kword memory is divided into eight blocks, and one of those blocks is displayed in the lower frame of the screen, while any desired data from within that is displayed at the same time in the upper frame.



The waveforms have to be from the same channel in both frames in ② and ③.

** In the 30-Kword mode, block display ③ displays all 31 Kwords of memory.

** Both block display and display of the entire contents of memory are available for 768-Kword mode data with the CMOS Memory Card. Note, however, that the 768-Kword mode data is divided into 24 blocks for block display.

- The following functions can also be executed.

  Playback with a delay applied to the signal on Channel B

  Playback with frequency zooming (if the CF-0351 Frequency Zooming software is installed)

<Procedure>

① Make the following soft key settings

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

MASS MEMORY

RECORD	PLYBACK	PB.LENG	PB.ZOOM	PB.DISP	CRT LD	CRT MEM	RETURN

PLAYBACK MODE

ON	DOWN	GAP INC	GAP DEC	ADDRESS	ChB DLY	SET	RETURN

The ON key is turned on automatically when storage is completed.

② Press the START switch of the command GROUP to start playback.

③ When the DOWN key is set to on, playback is performed in the reverse direction.

(a) Changing the Gap

Only the number of data frames given by the specified gap are skipped and the next frame is played back. The gap can be specified at any power of 2 in the range 0 to 4096 points. The value is displayed in the annotation section at the right of the screen and marked GAP. (The gap is set 2 points at initialization.)

PLAYBACK MODE

ON	DOWN	GAP INC	GAP DEC	ADDRESS	ChB DLY	SET	RETURN
		a	b				

Press the GAP INC key to increase the gap setting, or GAP DEC to reduce it.

(b) Specifying Point to Start Playback

The data starting point can be set in units of 1 point.

Press the PAUSE switch of the COMMAND group to enter the PAUSE condition.

When the ADDRESS key is pressed, a 6-digit value is displayed above the soft keys

PLAYBACK MODE 000000

ON	DOWN	GAP INC	GAP DEC	ADDRESS	ChB DLY	SET	RETURN

Input the playback start point using the numeric keys on the front panel, and then press the SET key to set the value. The set address will then be displayed in the annotation section at the right of the CRT screen in the format R:OOOOOO.

The last address to be displayed is as follows, and higher numbers cannot be set.

For the 255 Kword-mode:

For 1-channel playback data length of 1024 points:
260096 (255 × 1024 − 1024)
For 1-channel playback data length of 2048 points:
259072 (255 × 1024 − 1024)
For 2-channel playback:
129024 (127 × 1024 − 1024)

Make the following soft key settings to return the address to zero.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

MASS MEMORY

RECORD	PLYBACK	PB.LENG	PB.ZOOM	PB.DISP	CRT LD	CRT MEM	RETURN

DATA LENGTH

2048	1024		BLOCK	INC	DEC	ADS CLR	RETURN

Press the ADS CLR key to set the address to 0.

(c) Playback with Time Delay Between Channels A and B

In the CF-350, it is possible to start playback of the data from Channel B a specified number of points before playback of the data for Channel A is played back.

Press the PAUSE switch of the COMMAND group to enter the PAUSE condition.

The number of points of the delay will be displayed in the following format when the Ch B DLY key is pressed.

PLAYBACK MODE 000000

ON	DOWN	GAP INC	GAP DEC	ADDRESS	ChB DLY	SET	RETURN

At this point, input the number of points of delay using the numeric keys, and then press the SET key to set the value.

The delay value will then be displayed on the right of the CRT screen in the VIEW section in the format ChB DELY OOOOO.

If the delay setting is n and the time recorded sampling interval is Δt, a delay of $n\Delta t$ only is applied to Channel B.

(d) Analysis Data Length Selection

When data from only one channel is stored, time-waveform playback can be displayed in either 2048 or 1024 points.

When the frequency resolution is 2048 points, this is 1/800, and when 1024 points, it is 1/400.

The 1024 key goes on automatically when storage is completed.

MASS MEMORY

RECORD	PLYBACK	PB.LENG	PB.ZOOM	PB.DISP	CRT LD	CRT MEM	RETURN

DATA LENGTH.

2048	1024					AD CLR	RETURN
a	b						

a	2048	.....	Sets the number of display points at 2048.
b	1024	.....	Sets the number of display points at 1024.

(e) Frequency Zooming

This is enabled when the CF-0351 Frequency Zooming software is installed.

Frequency zooming can be performed while playing back waveforms stored in the time record memory.

Play back the waveform as described in the beginning of Section 7.2.2 and display the power spectrum for the start of zooming.

Press the PAUSE switch of the COMMAND group to enter the PAUSE condition.

① Press the ON switch of the SEARCH group and use the CURSOR switches to move the search point to the frequency desired as the center of magnification.

② **Make the following soft key settings.**

MASS MEMORY

RECORD	PLYBACK	PB.LENG	PB.ZOOM	PB.DISP	CRT LD	CRT MEM	RETURN

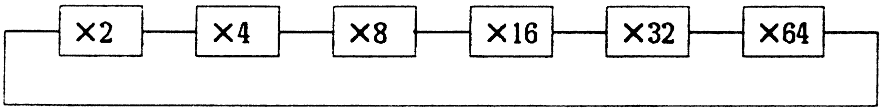
PLAYBACK ZOOM

ON	FACTOR	CF SET	SINGLE				RETURN
a	b	c	d				

a The other keys are enabled when the ON key is pressed.

b FACTOR is the zoom magnification key.

Pressing this key changes the magnification (ZOOM) displayed in the annotation section at the right of the screen varies through the following loop.



The maximum magnification in the 30-Kword mode is ×16.

c The specified frequency is set to center frequency by pressing the CF SET key.

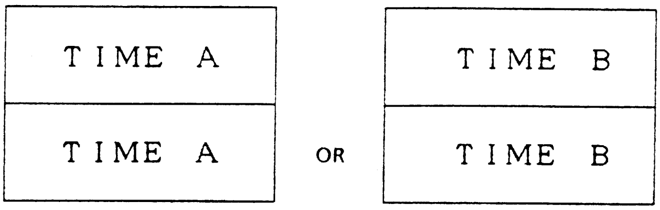
③ Perform the operations in either a. or b. below to execute zooming.

a. To zoom only the waveform currently displayed on the screen, press the SINGLE key to zoom once only. The address will return to zero automatically when zooming is turned off and playback is resumed.

b. Press the START switch of the COMMAND group in the ZOOM ON condition to initiate execution of continuous zooming at the specified magnification.

(f) Total Display or Block Display

① Display one of the following two dual-frame screens.



② Make the following soft key settings

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

MASS MEMORY

RECORD	PLYBACK	PB.LENG	PB.ZOOM	PB.DISP	CRT LD	CRT MEM	RETURN

PLAYBACK DISPLAY

OFF	ALL	BLOCK					RETURN
	a	b					

a	ALL	All the stored waveforms are displayed (255 or 127 Kwords).
b	BLOCK ...	The stored waveforms are divided into eight blocks, and one block is displayed at a time. All 30 Kwords of data is displayed.

Press the ALL key to display all the data, and the BLOCK key to display the data in eight blocks.

③ **Press the START switch of the COMMAND group.**

Display will start about 10 s after pressing START in case of ALL, or about 35 after pressing START in case of BLOCK.

One frame of a waveform is displayed in the upper display frame from the position of the cursor in the lower display frame.

In the case of block display, once the waveform of block 1 has been fully played back, the waveforms of block 2 and then the other blocks are displayed in sequence.

The block number is displayed at the bottom of the lower display frame in the format BK:1.

- 768-Kword Mode

Press the START switch and display will start about 30 s later. The 768 Kwords are divided into 24 blocks for block display.

7.3 Microfloppy Disk Drive

If the CF-0380 Floppy Disk and Signal Generator Interface Card is installed, the contents of the CRT block memory, the time record memory, panel condition memory, and the autosequencing memory can be stored on disk for permanent storage.

If the CF-0381 CMOS Memory Card is installed for use as a second disk it can be used in exactly the same way as the microfloppy disk drive.

The microfloppy disk drive takes double-sided, double-density 3.5-inch disks with a storage capacity of 1 Mbyte.

In CF-350 requires that disk files have the following format.

File Address at which data is to be stored. Or one unit of storage.
One file corresponds to 2 Kbytes.
Files No. 1 to No. 300 can be used for storage.

Note that the required number of files varies for the different functions being stored.

1. For Screen Storage (Same as for CRT block memory)

Data Length (Resolution)	Screen Type	Capacity Used for Storing 1 Screen
2048 points (1/800)	All, except histogram	2 files
1024 points (1/400)	Cross spectrum, transfer function, and other cross-mode functions	2 files
	Other	1 file
	4-decade transfer function	**6 files**

Note

Nyquist plots, orbit displays, Nichols plots, and listing displays cannot be stored exactly as is. Store time-axis waveforms, power spectrums, transfer functions, and other waveforms, then play them back, and then convert them.

2. For Time record Memory Data

①	255-Kword mode	256 files
②	30-Kword mode	32 files

3. For Panel condition and Autosequencing Programs

①	One type of specified panel conditions and 10 types of signal sequences	1 file
②	**Two types of autosequence programs**	**1 file**

- **Interchangeability of CF-350 and CF-900 Series Microfloppy Disks**

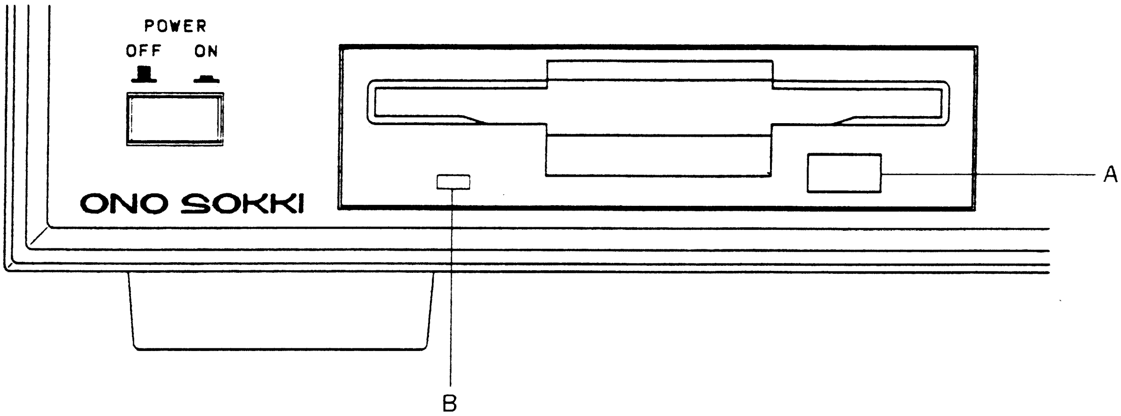
Among the CF-900 series models, the disks of the CF-910 and -920 are single-sided, double-density disks, while those of the CF-930 and -940 are, like those of the CF-350, double-sided, double-density disks. The disks of the CF-350 and CF-930 and 940 are interchangeable, so files on the disks can be processed by either system. The disks of the CF-910 and -920, though single-sided, double-density, can be handled by the CF-350 by switching with the SINGLE soft key, making it possible to read CRT block-memory data in the data on the CF-910 or -920 microfloppy disks. However, time record memory data cannot be correctly read because the storage capacities of the CF-910 and -920 disks differs from that of the CF-350 disks. (See Section 7.3.3 (d) on playback from CF-910 and -920 disks.)

The CF-350 copy function can be used to copy files from CF-910 and -920 disks onto double-sided, double-density disks. (See Section 7.3.8 (c) on copying microfloppy disks.)

Note that if an attempt is made to read CF-920 or -940 50- or 100-kHz-range data on the CF-350, or conversely to read CF-350 40-kHz-range data on either of the CF-920 or -940, a DEVICE MISMATCH error message is displayed.

Panel conditions and autosequence programs are not compatible between CF-350 and CF-900 Series disks

7.3.1 Inserting the Microfloppy Disk



The microfloppy disk drive uses automatic shuttering. The disk must be inserted with the label facing upwards all the way in until the clicking sound is heard, and then the shutter must be closed.

Press A to remove the disk from the drive.

* Use double-sided, double-density 3.5-inch disks (Ono Sokki format CF-0902).

Notes

1. Do not remove the disk or turn the instrument on or off while the lamp B is lighted.
2. **Make sure to format disks before using them. (See Section 7.3.2 below on formatting disks.)**

7.3.2 Formatting Disks

Note

Disks containing data must not be formatted.

< Procedure >

- Press the PAUSE switch of the COMMAND group to enter the PAUSE condition.

① Insert an unused disk into the drive carefully, as described above.

② Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	**DISK**	NEXT

DISK

ST MASS	ST TIME	ST COND	LD MASS	LD TIME	LD COND	**UTILITY**	RETURN

DISK UTILITY

DRIVE 0	RAM DSK	PROTECT	PURGE	COPY	**FORMAT**	**START**	RETURN

Press the FORMAT key and then the START key in that order.

Note

Once formatting has been started, it cannot be suspended before completion.

Formatting will now begin, and the LED will light. A number will be displayed above the soft keys sequentially from 1 to 76 during formatting.

When formatting is finished, a "complete" message will be displayed at the bottom right of the CRT screen, and the LED will be extinguished. Under no circumstances remove the disk from the drive until the complete message is displayed and the LED has gone out.

If formatting cannot be completed, a "FORMAT ERROR" message will be displayed. Start the process again from the beginning.

This formatting routine creates files numbered 1 to 300 on the disk.

7.3.3 Direct Storage to and Playback from Disk of Screen Data/Storage to and Playback from Disk of CRT Block Memory Data

The following functions can be executed.

(1) Display screens can be written directly to disk.

(2) Display screens can be written directly to disk automatically and continuously.

(3) Data stored in the CRT block memory can be written to disk.

(4) Data stored on disk can be played back to the screen or to the CRT block memory.

<Procedure>

Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

DISK

ST MASS	ST TIME	ST COND	LD MASS	LD TIME	LD COND	UTILITY	RETURN

CRT DATA STORE FILE No.001

CRT	AUTO	MASS	MAS ALL	FILE NO	SET	START	RETURN

(a) Writing Display Screens Directly to Disk

CRT DATA STORE

CRT	AUTO	MASS	MAS ALL	FILE NO	SET	START	RETURN
a				b	c	d	

① Press the CRT key. (CRT is set on at initialization.)

Press the FILE NO key to set the files to be written to disk.

② Input the file number using the numeric keys on the front panel. Press the SET key to set the value.

③ Press the START key. The contents of the screen will now be transferred to disk. The LED lights while data transfer is underway, and goes out when it is completed.

In the case of dual-frame display, both frames cannot be stored in the same file. The lower frame and then the upper frame will be automatically written to separate files.

Notes

1. If screen data is written to files already containing data, the previous contents will be erased. Use the write-protect function to ensure that screen data is not written to files containing data mistakenly. (See Section 7.3.8 (a) on the write-protect function.)

2. When storage is completed, the file number will be incremeted by 1. For example, when storage to No. 1 is completed, No. 2 will be displayed. Do not misinterpret this as indicating that storage was made into No. 2.

   However, for autoplotting, this is different (see Section 9.1). Also, while the plotter is operating, if data is loaded from the floppy disk, the file number may not be incremeted in this manner.

(b) Automatic Continuous Storage of Display Screens to Disk

Data can be automatically, and continuously, written to disk as screens change with signal capture or FFT analysis, or as averaging finished.

CRT DATA STORE

CRT	AUTO	MASS	MAS ALL	FILE NO	SET	START	RETURN

Press the AUTO key.

Set the number of the file at which storage is to begin.

Press the START key, and storage will commence immediately.

When averaging is being performed, averaging is resumed immediately storage is completed.

(c) Writing CRT Block Memory Data to Disk

CRT DATA STORE FILE NO 001

CRT	AUTO	MASS	MAS ALL	FILE NO	SET	START	RETURN
		a	b				

a MASS ..... The contents of the currently specified block (the number of which is displayed in the annotation section on the right of the screen at BL:) is written to disk.

b MAS ALL .... The data from the currently specified block to the last block containing CRT block-memory data is continuously written to disk.

Select either the MASS key or the MAS ALL key.

If necessary, set the number of the file to which data is to be written.

Now press the START key to start writing the CRT block-memory data to the specified file on the disk.

Note

Once data transfer has been started using the MAS ALL key, it cannot be suspended until it is completed.

- When using CMOS memory as CRT block memory, 300 of the 540 block of screen data can be stored on disk.

(d) Playing Back Data from Disk

① Press the PAUSE switch of the COMMAND group to enter the PAUSE condition.

② Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

DISK

ST MASS	ST TIME	ST COND	LD MASS	LD TIME	LD COND	UTILITY	RETURN

CRT DATA LOAD FILE NO 001

MASS	MAS ALL	LIST UP	L Kind	FILE NO	SET	START	RETURN
a	b						

a	MASS	The contents of the specified file is played back to the specified block of CRT block memory, and simultaneously displayed on the screen.
b	MAS ALL	Data is played back from the specified file to the last file containing CRT block-memory, or until the CRT block memory reaches block 60 (or 540 if the CMOS memory card is being used.)

If the MASS key is selected, one file at a time is read out to the CRT block memory.

If the MAS ALL key is selected, 60 files are read out.

Now press the START key to start playback, or set the number of the file at which playback is to commence and then press the START key to start playback.

Note

Once data transfer has been initiated using the MAS ALL key, it cannot be suspended until it is completed.

If the MASS key is selected, the display condition enabling changing the X- or Y-axis scaling, logarithmic/linear scaling, EU value, or the parameters from the back can be brought up on the CRT screen in the same state used for storage. Perform playback after turning the LOAD key on by making the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

MASS MEMORY

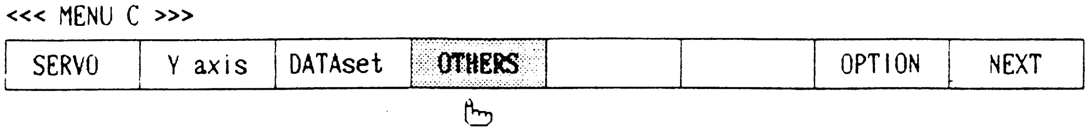
RECORD	PLYBACK	PB.LENG	PB.ZOOM	PB.DISP	CRT LD	CRT MEM	RETURN

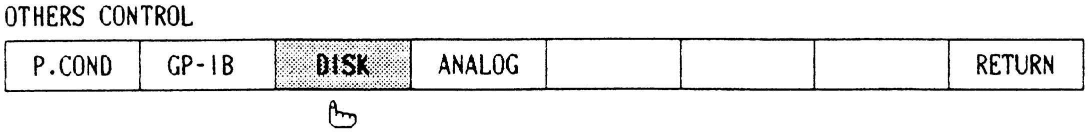
CRT DISPLAY COND

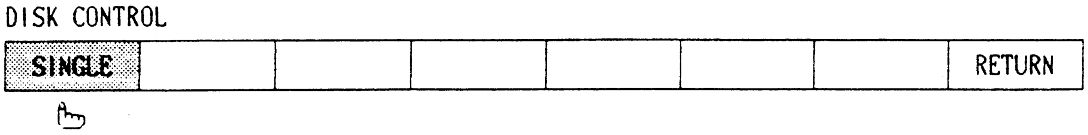
LOAD	L.COPY	LABEL	BLK No.	LIST UP	INSERT	DELETE	RETURN

Playback from CF-910/920 Disks

Make the following soft key settings.







Press the SINGLE key to initiate execution.

Only one side of the disk is read and written into the CF-350 when the SINGLE key is turned on.

Notes

1. This procedure can be used to read CRT block-memory data, but time record memory data cannot be correctly read, because the memory capacities of the CF-910/920 and the CF-350 are different.

2. If a double-sided, double-density disk is used in this procedure, in this state only files 1 and 2, 5 and 6, 9 and 10, skipping two files in between, will be read out and written to the CF-350.

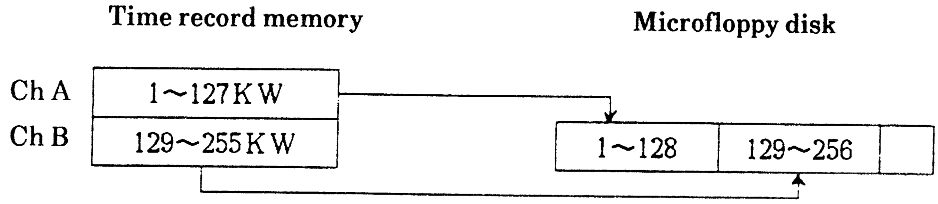
CF-350 Display	Actual File No.
No. 1	No. 1
No. 2	No. 2
No. 3	No. 5
No. 4	No. 6
No. 5	No. 9
No. 6	No. 10
:	:

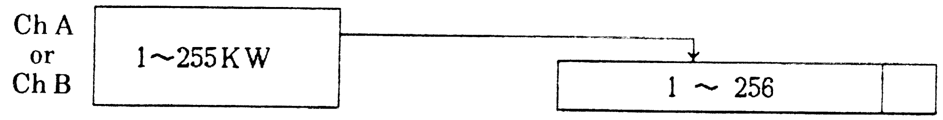
7.3.4 Storage to and Playback from Disk of Time Record-Memory Data

Use the following procedure for data transfer between the time record memory and disk.

[KW: kiloword]
[1 KW: 1024 points]

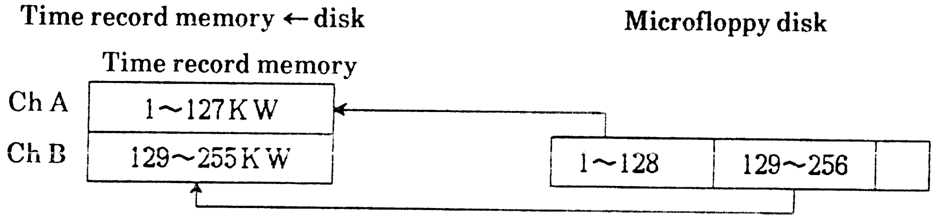
Time record memory → disk

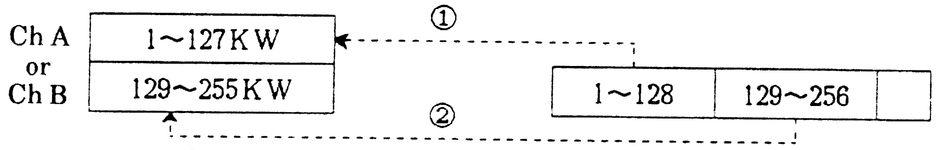




When writing two channels simultaneously, the A-Channel data is stored in the first half of the disk and B-Channel data on the second half.

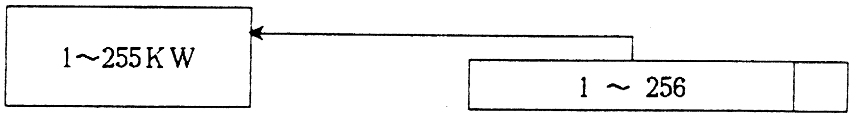
Time record memory ← disk





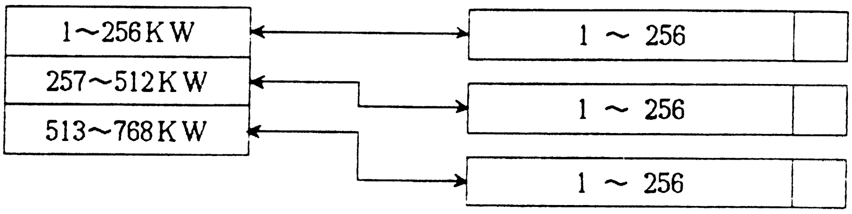
Select ① or ②, or enter separately.

Data from either one of Channel A or B can be played back to the time record memory.



* The conditions are stored in the 128th or 256th Kword.

(When the CMOS memory card is used as time record memory.)



Use three disks

<Procedure>

(a) Writing Time record-Memory Data to Disk

- This operation requires 256 empty files on one disk. Thus, a newly formatted, otherwise unused, disk should be inserted into the disk drive.
- Press the PAUSE switch of the COMMAND group to enter the PAUSE condition.

Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

DISK

ST MASS	ST TIME	ST COND	LD MASS	LD TIME	LD COND	UTILITY	RETURN

TIME REC STORE

TIME				FILE NO	SET	START	RETURN
				a	b	c	

Select the FILE NO key to set the number of the file to which data is to be written.

Input the file number using the numeric keys on the front panel.

Press the SET key to set the value.

Press the START key to initiate writing of the time waveform stored in the time record memory to the disk.

* Files numbered 1 to 128 are used to store waveforms from Channel A and files 129 to 256 for those from Channel B in the case of 127 Kword × 2 Ch data storage.

Notes

1. Once data transfer has begun it cannot be suspended.
2. Disks containing time record memory data from the CF-350 are not interchangeable with data disks of the DM-100 Digital Data Freezer.

(b) Playing Back Data from Disk to Time record Memory

- Press the PAUSE switch of the COMMAND group to enter the PAUSE condition.

Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

DISK

ST MASS	ST TIME	ST COND	LD MASS	LD TIME	LD COND	UTILITY	RETURN

TIME DATA LOAD

ALL	PRE 128	POS 128		FILE NO	SET	START	RETURN
a	b	c					

a	ALL	**All 256 files of time record-memory data stored on disk are played back to the time record memory.**
b	PRE 128	128 files of data starting with the specified file number are played back to the first 128 Kwords of time record memory. These correspond to Ch A data.
c	POS 128	128 files of data starting with the specified file number are played back to the last 128 Kwords of time record memory. These correspond to Ch B data.

Select *a*, *b*, or *c*.

Set the file number and then press the START key.

A "COMPLETE" message will be displayed when playback is finished.

Storage to and Playback from Disk of 768-Kword Data

768-Kword data is stored on three disks, 256 Kwords at a time. Thus, the first, center or last third of 768-Kword can be selected for playback.

<Procedure>

Make the following soft key settings.

<<< MENU C >>>

SERVO	Y axis	DATAset	OTHERS			OPTION	NEXT
						☝	

<<< MENU D >>>

CmosMEM	SIG OUT	X-Y REC	TRACK	COMP	Opt 6	Opt 7	RETURN
☝							

CMOS MEM CONTROL

UTILITY	RAMDISK	RECORD					RETURN
		☝					

RECORD CONTROL

768K		XCHG1	XCHG2	F- 256	M- 256	L- 256	RETURN
				a	b	c	

a	F-256	....	The 256 Kwords of time record memory data are stored on one disk. Playback from the disk is performed by transferring it to the first 256 Kwords of the 768-Kword mode meory.
b	M-256	....	In the same way, the central 256 Kwords of 768-Kword mode data are stored on disk, and these are played back to the central 256 Kwords of time record memory.
c	L-256	....	In the same way, the last 256 Kwords of 768-Kword mode data are stored on disk, and again, these are played back to the last 256 Kwords of time record memory.

Select one of F-256, M-256, or L-256, to execute storage or playback.

7.3.5 Storage to and Playback from Disk of Panel condition-Memory Data

Panel condition memory data can be written to disk. Data from panel condition memories 1 to 4 can be recorded separately on the disk.

<Procedure>

(a) Writing to Disk

- Press the PAUSE switch of the COMMAND group to enter the PAUSE condition.

  Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

Letop Disk/utility/protect uitzetten

DISK

ST MASS	ST TIME	ST COND	LD MASS	LD TIME	LD COND	UTILITY	RETURN

P.COND.SEQ STORE FILE No. 001 P1

P.COND	SEQUENC	P.No DW	P.No UP	FILE NO	SET	START	RETURN

Set the number of the panel condition memory from which data is to be written to disk at P1 to P4, to the right of the file number above the soft keys.

Decrement the panel condition memory number in the sequence P1 → P4 → P3 → P2 → P1 ... using the P.NO DW key. Increment it through the reverse sequence with the P.NO UP key.

Next set the number of the disk file to which data is to be written. Press the FILE NO key and input the file number using the numeric keys on the front panel. Press the SET key to set the value.

Press the START key.

Now the contents of one of the panel condition memories will be written to the specified disk file.

(b) Playback to Panel condition Memory

- Press the PAUSE switch of the COMMAND group to enter the PAUSE condition.

Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT
						☝	

DISK

ST MASS	ST TIME	ST COND	LD MASS	LD TIME	LD COND	UTILITY	RETURN
					☝		

P.COND,SEQ LOAD FILE No. 001 P1

P.COND	SEQUENC	P.No DW	P.No UP	FILE NO	SET	START	RETURN
☝							

Set the number of the panel condition memory to which data is to be played back using the P.NO DW and P.NO UP keys.

Next set the number of the file containing the panel conditions.

Press the START key to initiate playback to the panel condition memory.

7.3.6 Storage to and Playback from Disk of Autosequence Programs

Both autosequence programs 1 and 2 are stored in the same file, and they are played back simultaneously also.

<Procedure>

(a) Writing to Disk

- Press the PAUSE switch of the COMMAND group to enter the PAUSE condition.

Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

DISK

ST MASS	ST TIME	ST COND	LD MASS	LD TIME	LD COND	UTILITY	RETURN

P.COND,SEQ STORE FILE No. 001 P1

P.COND	SEQUENC	P.No DW	P.No UP	FILE NO	SET	START	RETURN

Press the FILE NO key, input the file number with the numeric keys, and the press the SET key to set the file number.

Once the file number has been set, press the START key to initiate writing to the disk.

(b) Playback to Autosequence Memory

- Press the PAUSE switch of the COMMAND group to enter the PAUSE condition.

Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

DISK

ST MASS	ST TIME	ST COND	LD MASS	LD TIME	LD COND	UTILITY	RETURN

P.COND,SEQ LOAD FILE No. 001 P1

P.COND	SEQUENC	P.No DW	P.No UP	FILE NO	SET	START	RETURN

At this point, set the number of the file containing the autosequence program and press the START key to initiate playback.

7.3.7 Listing Files

File directories can be listed on the CRT screen to check the files on the disk.

- Insert the disk in the drive.
- Press the PAUSE switch of the COMMAND group to enter the PAUSE condition.

  Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT
						☝	

DISK

ST MASS	ST TIME	ST COND	LD MASS	LD TIME	LD COND	UTILITY	RETURN
			☝				

DISK UTILITY

MASS	MAS ALL	LIST UP	L Kind	FILE NO	SET	START	RETURN
		☝				☝	

Press the LIST UP key and then the START key.

Press the FILE NO key and then input the file number using the numeric keys on the front panel, and finally press the SET key to set the file number.

This procedure enables listing on the CRT screen of the data types and the first 40 characters of the labels of 20 files starting with the specified file.

The listing stops after the data for 20 fields has been displayed. Press the START key again to continue the listing.

If the L Kind key is turned on and then the START key is pressed, the labels are not shown, an instead the data types of 60 files are listed.

7.3.8 Utility Functions

The following utility functions are available for use with the microfloppy disk drive.

(1) Write-protect function

(2) Purge (erase) function

(3) Disk copy (backup) function

<Procedure>

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

DISK

T MASS	ST TIME	ST COND	LD MASS	LD TIME	LD COND	UTILITY	RETURN

DISK UTILITY FILE No. 001

Let op ! Bij store paneelknop naar di
uitzette

DRIVE 0	RAM DSK	PROTECT	PURGE	COPY	FORMAT	START	RETURN
		(1)	(2)	(3)			

(a) Write-Protect Function

This function prevents screen data from being written over files which already contain screen data (CRT block-memory data).

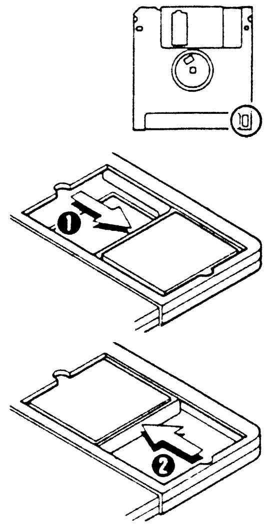
Press the PROTECT key.

A "WRITE PROTECT" error message is returned when an attempt is made to write screen data to a write-protected file already containing screen data.

Note

The write-protect function is not valid for time record-memory data.

- Micro-floppy Disk Write Protect



A tab is attached to the disk to prevent erasing data in error. The tab should be moved all the way back in the direction of arrow ① in the illustration to prevent writing to the disk.

Push the tab back all the way forwards in the direction of arrow ② to enable writing to the disk.

(b) Purge (Erase) Function

The function enable erasing the contents of one specified file.

First, specify the number of the file to be purged.

Press the PURGE key and then the START key.The contents of the specified file are now erased, and the file is left empty.

(c) Disk Copy (Backup) Function

In the interests of safety, it is recommended that a backup copy of disks to which data has been written be made.

This copy function can also be used to copy data from CF-910/920 single-sided, double-density disk onto double-sided, double-density disks.

- Be careful to copy data with this function only to formatted disks.

Note

Copying the entire contents of the disk requires mass memory (time record and CRT block memories). Data in mass memory is erased when this function is used to copy a disk in. For this reason, any data in mass memory that has to be saved must be written to a disk before the copy function is executed.

- Press the PAUSE switch of the COMMAND group to enter the PAUSE condition.

① Insert the disk to be copied in the disk drive.

② Press the COPY key and then the START key.

The entire contents of the disk will now be written into mass memory.

A "MOUNT New DISK" message will be displayed on the CRT screen when data transfer is finished.

③ Insert the disk to which the data is to be copied.

④ Press the START key. All the data is now transferred from mass memory to the disk.

This completes the procedure for copying disks.

Note

Once data transfer has started, it cannot be suspended until completion.

When Using CF-0381 CMOS Memory Card as RAM Disk

The CMOS memory card is supported by battery backup power, so the data in it is not lost when the power is turned off. It can therefore be used as a second disk drive in exactly the same way as the real disk drive.

<Procedure>

① Set the CMOS memory card application to disk.

Make the following soft key settings.

<<< MENU C >>>

SERVO	Y axis	DATAset	OTHERS			OPTION	NEXT
						☝	

<<< MENU D >>>

CmosMEM	SIG OUT	X-Y REC	TRACK	COMP	Opt 6	Opt 7	NEXT
☝							

CMOS MEM CONTROL

UTILITY	RAMDISK	RECORD					RETURN
☝							

CMOS UTILITY

BLK.MEM	DISK	RECORD					RETURN
	☝						

② Select RAM disk for the disk drive.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT
						☝	

DISK

ST MASS	ST TIME	ST COND	LD MASS	LD TIME	LD COND	UTILITY	RETURN
						☝	

DISK UTILITY FILE No. 001

DRIVE 0	RAM DSK	PROTECT	PURGE	COPY	FORMAT	START	RETURN
	☝						

③ **Storage and playback can be performed using exactly the same operations as for the real disk drive.**

However, the copy function of the utilities is operated in the following way.

CMOS UTILITY

BLK.MEM	DISK	RECORD					EXIT
	☞						

If DISK is selected for the CMOS memory application, data is transferred between the disk (DRIVE 0) and the RAM disk (RAM DSK).

If DISK is not selected, a copy is made of the disk to another disk.

If DISK is selected, either a copying the disk (DRIVE 0) to the RAM disk, or copying the RAM disk to the disk can be executed.

(a) Copying Disk to RAM Disk

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT
						☞	

DISK

T MASS	ST TIME	ST COND	LD MASS	LD TIME	LD COND	UTILITY	RETURN
						☞	

DISK UTILITY FILE No. 001

DRIVE 0	RAM DSK	PROTECT	PURGE	COPY	FORMAT	START	RETURN
☞				☞		☞	

Turn the DRIVE 0 key on.

Press the COPY key and then the START key.

(b) Copying RAM Disk to Disk

DISK UTILITY FILE No. 001

DRIVE 0	RAM DSK	PROTECT	PURGE	COPY	FORMAT	START	RETURN
	☞			☞		☞	

Turn the RAM DSK key on.

Press the COPY key and then the START key.

The following utility functions are also available.

(1) Delete (file erase) function

(2) Insert function

(3) Purge (erase contents) function

<<< MENU C >>>

SERVO	Y axis	DATAset	OTHERS			OPTION	NEXT

<<< MENU D >>>

CmosMEM	SIG OUT	X-Y REC	TRACK	COMP	Opt 6	Opt 7	NEXT

CMOS MEM CONTROL

UTILITY	RAMDISK	RECORD					RETURN

RAMDISK CONTROL

DELETE	INSERT	PURGE		FILE NO	SET	START	RETURN
(1)	(2)	(3)					

(1) Delete (File Erase) Function

The specified file is erased and the subsequent files are moved up.

Set the number of the file to be erased.

Press the DELETE key and then the START key.

(2) Insert Function

An empty file is inserted in front of the specified file.

Set the number of the file at which the empty file is to be inserted.

Press the INSERT key and then the START key.

(3) Purge (Erase-Contents) Function

The contents of the specified file are deleted. The file is left empty.

Set the number of the file to be emptied.

Press the PURGE key and then the START key.

* This is the same as using the PURGE disk-soft key of the UTILITY group. (See Section 7.3.8 on the utility functions.)

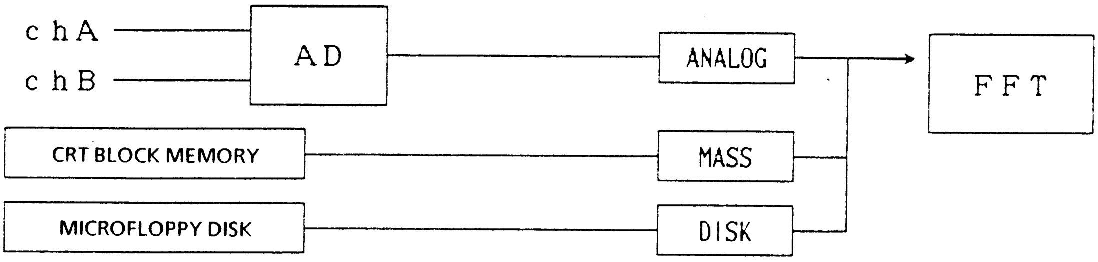
7.4 Analyzing Memory Data

The CF-350 enables analysis of analog signals input at the signal-input connector on the front panel as well as the following analysis functions on data stored in memory.

1. FFT analysis on time-axis waveforms stored in CRT block memory.
2. FFT analysis on time-axis waveforms stored on disk as CRT-screen data.
3. The results of functions 1 and 2 above is averaged and the transfer function between the data can be obtained.

Thus, if only time signals are stored, they can all be subjected to analysis.

In this case, data from memory (rather than A/D-converted analog signals) is input for analysis.



These functions can be used to enable combining stored time-axis waveforms which cannot be captured simultaneously, to facilitate computation of functions between these signals.

It is also possible to apply different windows to the same time signal for FFT analysis.

Note

These functions are effective time-axis waveforms are stored in the CRT block memory or on disk as screen data. (Spectrum waveform data cannot be played back and subjected to functional computation.)

<Procedure>

- Enter the PAUSE condition.

Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

MODE SET

OVERLAP	LENGTH	WINDOW	W SET	DELAY	SP ONLY	SOURCE	RETURN

ANALYSIS

ANALOG	MASS	DISK	CONTINU	FILE NO	BLK NO	DUAL	RETURN
	a	b	c			d	

a MASS ..... Sets analysis of data stored in CRT block memory.

b DISK ..... Sets analysis of data stored on disk.

Select either the MASS or DISK keys.

c CONTINUE .. If this key is off, analysis is performed and then the PAUSE condition is entered each time it is pressed, and the block number increases by one. When it is on, data is analyzed continuously, and the block or file number is incremented automatically. This is used for average processing. Analysis is continued until the specified number of averages is completed, or the data runs out, or until the PAUSE switch is pressed.

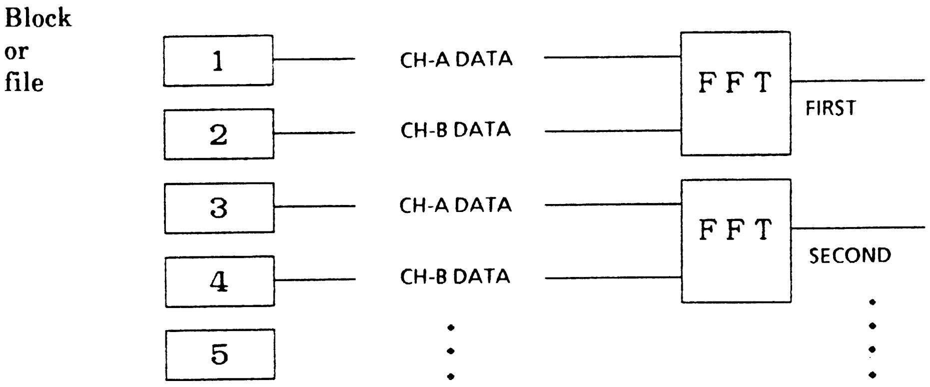
d DUAL ..... When this key is on, data is analyzed continuously in two groups (e.g., No. 1 and No. 2), with the first group taken as Channel-A data and the second group as Channel-B data. Thus, Channel-A and Channel-B data must be alternately stored in memory. If the transfer function is displayed at this time, this will actually be the transfer function between Channel-A and Channel-B data.

When this key is off, one data set is analyzed. In this case, Channel-A and Channel-B data are the same.

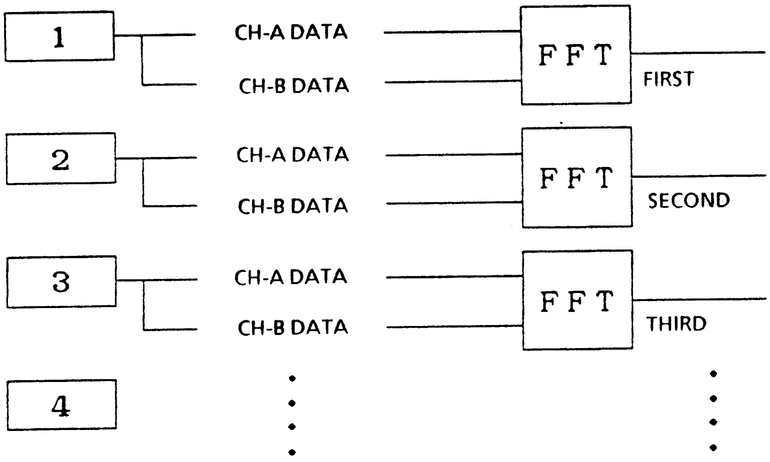
Set the number of the block or file at which analysis is to begin.

Press the START switch of the COMMAND group to initiate analysis.

When the DUAL key is on



When the DUAL key is off



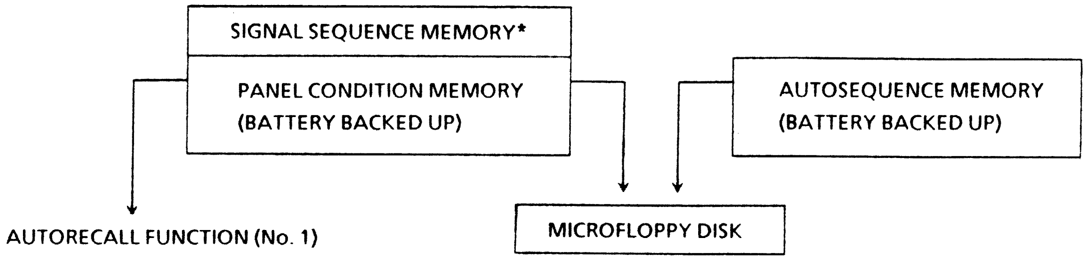
** The currently specified window is applied. The window can be changed and these operations performed again to compare analysis on the same data.

Note

A "CONDITION DISAGREE" error message will be displayed if the data length of the time signal stored in memory differs from the currently specified data length. With the DUAL key on, if the frequency ranges of the data in the 2 files do not agree, the frequency range of the data in the lower-numbered file will be set.

Memory Diagram

The CF-350 contains the following memories for storing measurement conditions and other parameters



* See Chapter 11 Servo Analysis Function

As the figure shows, the panel condition and autosequence memories are supported by lithium battery backup power, so their contents are not lost when the power is turned off.

When the autorecall function is used, the parameters stored in panel conditon memory No. 1 are automatically loaded and set when power is switched on. Use this function for all the parameters described up to the last chapter.

Two types of autosequence memory (63 steps × 2) are supported by battery backup power, so it is no longer necessary to read them in from disk, as in the previous models.

The data of these memories can be stored on disk and a program library organized to speed up measurement and improve its efficiency.

8. PANEL CONDITION MEMORY AND AUTOSEQUENCE FUNCTION

The battery backed-up panel condition memory of the CF-350 stores the values of the analysis parameters (conditions) set using the panel switches and soft keys.

Four different groups of conditions can be stored in the CF-350. They can also be stored on disk.

8.1.1 Storing Data in Panel Condition Memory

<Procedure>

- Press the PAUSE switch of the COMMAND group to enter the PAUSE condition.

① Make the following soft key settings.

<<< MENU C >>>

SERVO	Y axis	DATA set	ANG OUT	OTHERS			NEXT

OTHERS CONTROL

P.COND	GP-IB	DISK	ANALOG				RETURN

PANEL CONDITION

AT recal	MEM 1	MEM 2	MEM 3	MEM 4	STORE		RETURN
	a	b	c	d	e		

Press the STORE key to highlight it.

There are four panel condition memories, numbered 1 to 4.

Select the panel condition memory in which data is to be stored by pressing one of MEM 1, 2, 3, or 4. The selected key will be highlighted.

Press the STORE key to turn off highlighting.

Data will now be stored in the selected panel condition memory.

Notes

1. It also possible to store servo analysis signal sequences (see Section 11.4), arbitrary plotting size specifications (see Section 9.1) and tracking conditions into the panel condition memory.

2. When playing back and displaying memory data, it is not possible to store panel conditions.

8.1.2 Playback from Panel Condition Memory

<Procedure>

- Enter the PAUSE condition.

① Make the following soft key setting.

PANEL CONDITION

AT recal	MEM 1	MEM 2	MEM 3	MEM 4	STORE		RETURN
	a	b	c	d			

Press one of MEM 1, 2, 3, or 4 to select the number of the panel condition memory from which is data is to be played back.

8.1.3 Autorecall Function

This function automatically sets the measurement parameters stored in panel condition memory 1 when the power is turned on or at system reset.

<Procedure>

① Make the following soft key settings.

<<< MEMU C >>>

SERVO	Y axis	DATA SET	ANG OUT	OTHERS		OPTION	NEXT

OTHERS CONTROL

P.COND							RETURN

PANEL CONDITION

AT recal	MEM 1	MEM 2	MEM 3	MEM 4	STORE		RETURN

Once the AT recal switch is turned on, the contents of panel condition memory 1 are automatically recalled and set whenever the power is turned on or the system is reset from that time on.

8.1.4 Storage to and Playback from Disk of Panel Condition Memory Contents

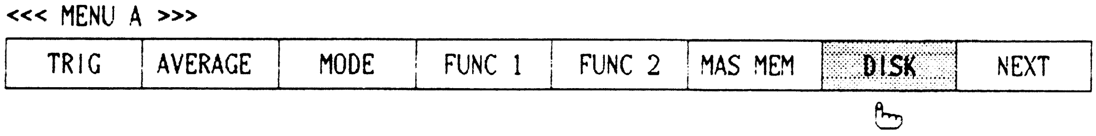
The contents of the panel condition memory can be stored on disk. The contents of each memory 1 to 4 are stored in separate files.

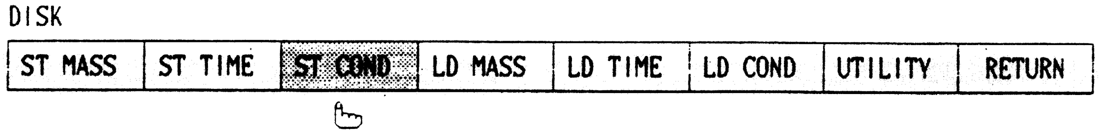
(a) Storage to Disk

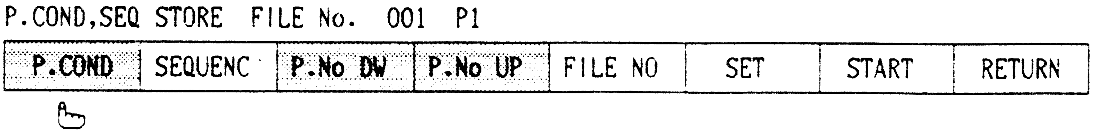
<Procedure>

- Enter the PAUSE condition.

① Make the following soft key settings.



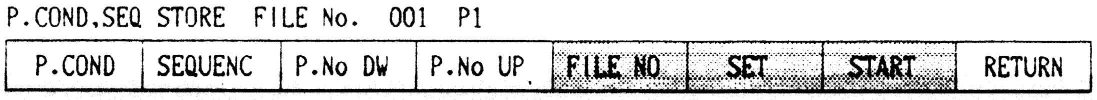




Press the P.COND key.

② Use the P.No DW and P.No UP keys to set the number of the panel condition memory to be stored on the disk. The panel condition memory number is displayed as P1, P2, P3, or P4 to the right of FILE No. above the soft keys.

③ Set the number of the file on disk which is to hold the data.



Press the FILE No key.

Input the file number using the numeric keys on the front panel.

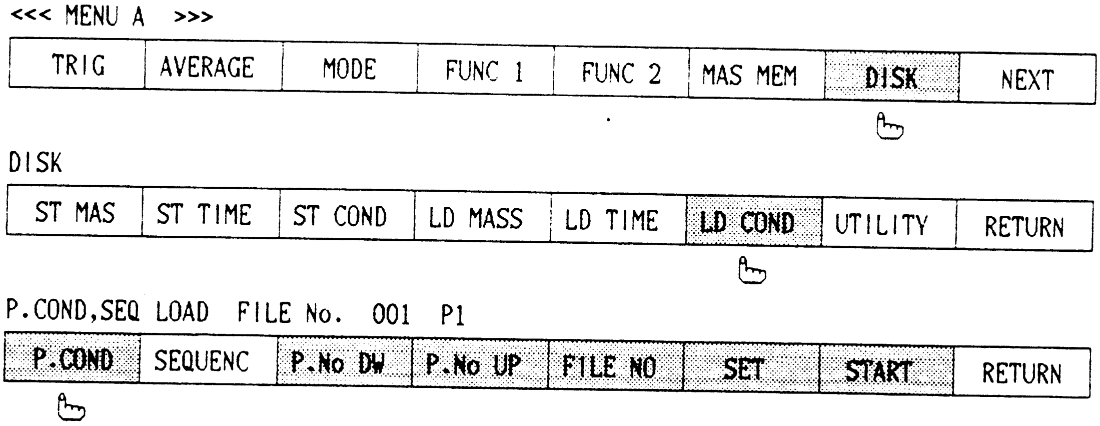
Press the SET key.

④ Press the START key to initiate storage of data to the disk.

(b) Playback to Panel Condition Memory

- Enter the PAUSE condition

① Make the following soft key settings.



Press the P.COND key.

② Set the number of the disk file containing the panel conditions to be played back.

Press the FILE No key.

Input the file number using the numeric keys on the front panel.

Press the SET key.

③ Use the P.No DW and P.No UP keys to set the number of the panel condition memory to which the data on the disk is to be loaded.

④ When the START key is pressed, the contents of the panel condition memory stored on disk will be loaded into the panel condition memory of the CF-350.

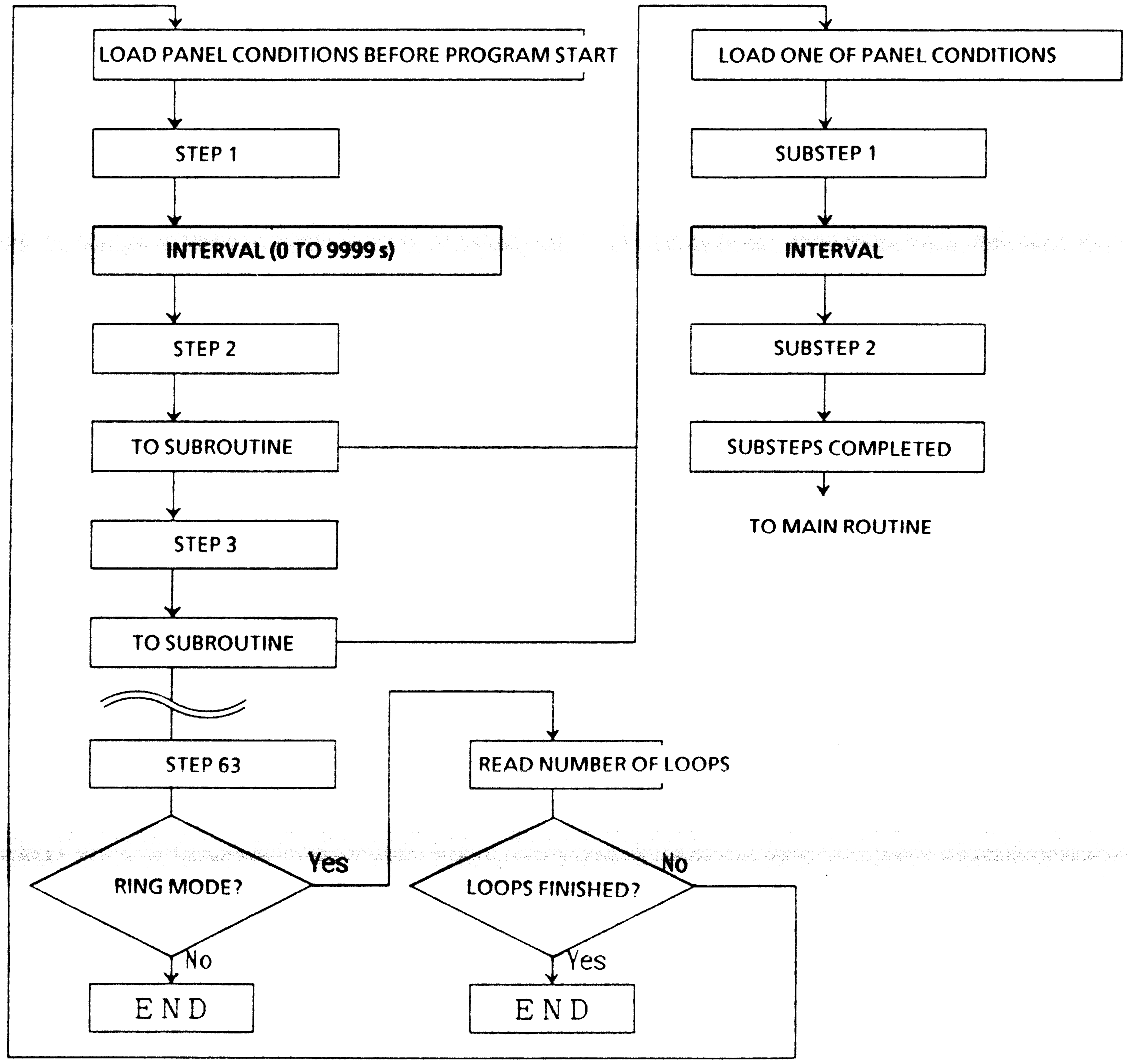
** **See Section 7.3 for details on disk formatting, contents check, and other aspects of disk usage.**

8.2 Autosequence Function

This function enables the CF-350 to learn any analysis procedure developed by the operator to execute analysis automatically.

Two 63-step sequence programs can be written and stored in the CF-350. The programs are stored in battery backed-up memory, so they are not lost when the power is turned off.

The following types of programming are possible on the CF-350.



Notes

1. Use sequence memory 2 for substeps.
2. Panel condition loading, ring mode, and number of loops are set at execution time.
3. The interval is set using the time-interval function.
4. **The following operations cannot be programmed.**

   Store panel conditions, soft key setup view, autosequence.

8.2.1 Writing Autosequence Programs

This section explains how to write simple programs of about five steps.

Problem 1	Take 32 averages of the power spectrum of the signal on Channel A, display the resulting power spectrum waveform and list of 10 peak values on a dual-frame display, and output the plot.

- Set the following parameters in advance.

  Dual-frame display for the Channel-A power spectrum and listing.

  32 summation averages of the power spectrum.

  Set the list mode to peak listing.

  Set the AVG switch of the COMMAND group to on.

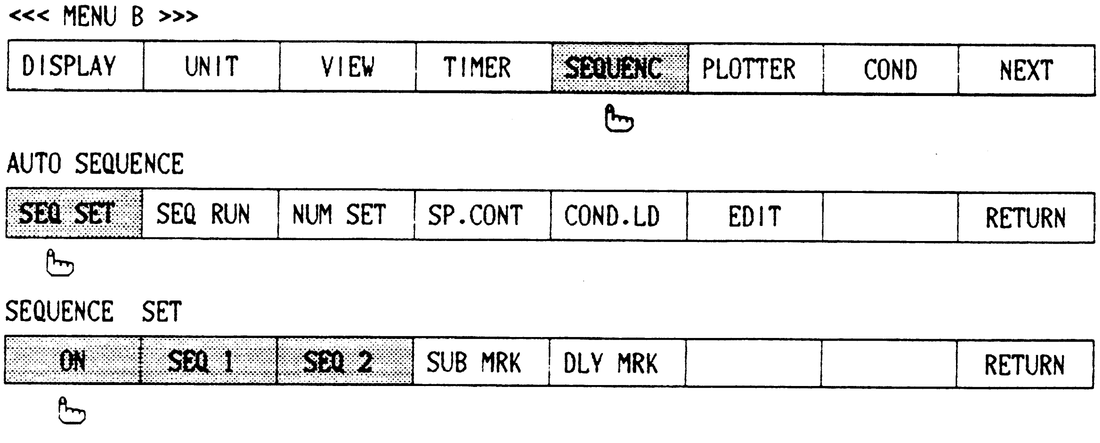
Note

When writing a program, as many of the basic parameters, such as frequency range, should be set in advance. This is one of the keys to keeping the number of program steps down to a minimum. Set the calibration value in advance also.

<Procedure>

- Press the PAUSE switch of the COMMAND group to enter the PAUSE condition.

① Make the following soft key settings.



Select one of SEQ 1 or SEQ 2, and turn the ON key on.

SEQ 1 is used for storing data in autosequence memory 1, and SEQ 2, for autosequence memory 2. (SEQ 1 is selected at initialization.)

② Press the AUTO SEQ switch at the bottom of the front panel. The CF-350 will now learn operations specified from this point on.

③ **Apart from the parameters that have already been set, the instrument also has to be taught to start analysis, and to start plotting when analysis has ended.**

- Set the START switch of the COMMAND group to on.

Once averaging is finished:

- Set the PLOTTER switch at the bottom of the front panel to on.

The number of steps performed will be displayed to the left of the clock at the bottom right of the CRT screen when these operations have been executed.

In this case, the display should be 2.

④ Turn the AUTO SEQ switch at the bottom of the front panel off. A "complete" message will now flash at the bottom of the CRT screen. These operations have now been learned by the instrument and stored in battery backed-up memory.

8.2.2 Executing Autosequences

Here is the procedure for executing the program written in Section 8.2.1 above.

<Procedure>

- Enter the PAUSE condition.

① Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

AUTO SEQUENCE

SEQ SET	SEQ RUN	NUMBER	SP.CONT	COND.LD	EDIT		RETURN
	c	b		a			

a COND.LD . . . Loads panel conditions.

The following menu will appear when the COND.LD key is pressed.

INIT CONDITION

LOAD ON							RETURN

The LOAD ON key is used to select whether or not the panel conditions set before autosequence writing will be loaded before autosequence is executed.

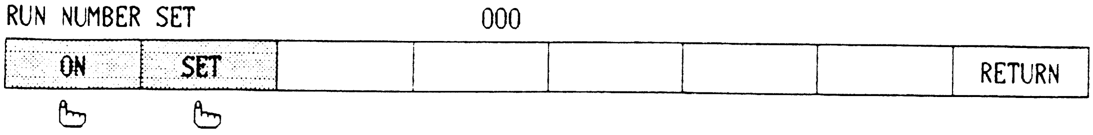
This key is turned on at initialization, so this operation does not have to be defined for problem 1.

Press the key to turn it off.

When the LOAD ON key is off, autosequence is executed using the currently set panel conditions.

b NUMBER . . . Sets the number of loops.

The following menu will appear when the NUMBER key is pressed.



RUN NUMBER SET 000

Press the ON key.

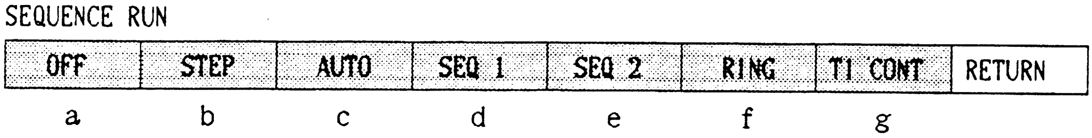
Use the numeric keys on the front panel to input the value in the range 1 to 999.

Press the SET key to set the value.

This operation is not required for Problem 1.

c SEQ RUN . . . Executes autosequence.

The following menu appears when the SEQ RUN key is pressed.



SEQUENCE RUN

The correspond to the following functions.

a OFF ...... Suspends autosequence.

b STEP ...... Enables operator to execute autosequence one step at a time.

c AUTO ...... Executes entire autosequence automatically.

d SEQ 1 ...... Executes autosequence 1.

e SEQ 2 ...... Executes autosequence 2.

f RING ...... **Enables continuous endless execution of** autosequence, or execution a specified number of times.

g TI CONT ..... Applies an interval between all the steps of the autosequence, or between specified steps, by a method described below. (This is not used in the solution to Problem 1.)

The execution procedure is described next.

Note

During autosequence execution, all keys other than the OFF and STEP soft keys and the AUTO SEQ switch are inoperative.

(a) Operator Execution One Step at a Time

SEQUENCE RUN

OFF	STEP	AUTO	SEQ 1	SEQ 2	RING	TI CONT	RETURN
a	b	c	d	e	f	g	

Press the RING key to execute the autosequence continuously an unlimited number of times, or a specified number of times.

Press the STEP key. The screen will now show the autosequence in the state in which storage began. The AUTO SEQ switch LED at the bottom of the front panel will now light, and an "AUTO SEQUENCE" message will be displayed.

Press the AUTO SEQ switch to execute each step. The number of the step currently being executed is shown at the bottom right of the CRT screen. If the RING soft key is off at this point, the procedure will terminate when the last step has been executed, and a "SEQUENCE end" message will be displayed.

If the RING key is on, execution will begin again with the first step after the last step is executed. Press the OFF key to suspend execution.

If the specified number of executions of the autosequence are completed, the soft key automatically goes off, and the AUTO SEQ switch LED also goes off.

(b) Automatic Execution of All Steps

SEQUENCE RUN

OFF	STEP	AUTO	SEQ 1	SEQ 2	RING	TI CONT	RETURN
a	b	c	d	e	f	g	

Press the RING key to execute the autosequence continuously an unlimited number of times, or a specified number of times.

Press the AUTO SEQ switch to execute the autosequence. Its LED will light, and the autosequence will be executed automatically. The number of the step currently being executed is shown at the bottom right of the CRT screen.

If the RING soft key is off at this point, the AUTO SEQ switch LED goes off and the soft key goes OFF when the last step has been executed, and a "SEQUENCE end" message will be displayed at the bottom of the CRT screen.

If the RING key is on, execution will begin again with the first step after the last step is executed. Execution will be suspended when the specified number of loops has been performed.

Press the AUTO SEQ switch (turning it off) to suspend the autosequence during execution, or press the OFF key.

8.2.3 Interval Function

Analysis timing can be set to any desired value by using the CF-350 time interval function with the autosequence function.

The two following setting modes can be used for this function.

a. The same time interval can be applied between specified steps.
b. The same time interval can be applied between all the steps.

The interval-function settings can be made before the autosequence settings or at execution time. Turn the panel-condiiton-load LOAD ON key on to make the interval function settings before the autosequence settings. Turn the LOAD ON key off to make the settings at execution time, and execute the autosequence immediately after. (See Section 8.2.2.)

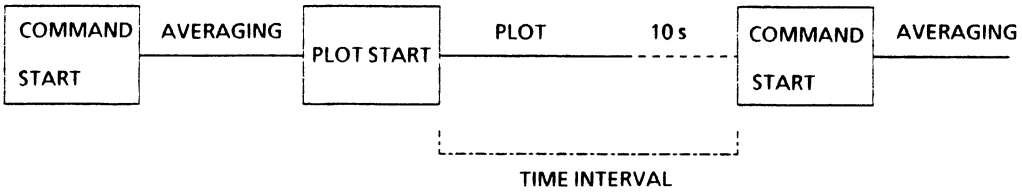
The interval time can be changed at any point prior to execution.

Note

The interval time is not stored in the autosequence memory, so it must be set before execution.

Problem 2	Execute the program in Problem 1, Section 8.2.1, repeatedly at intervals of 10 s.

The time interval specified on the CF-350 is the time from the point when a given operation is begun until execution moves to the next operation, as shown in the figure below.

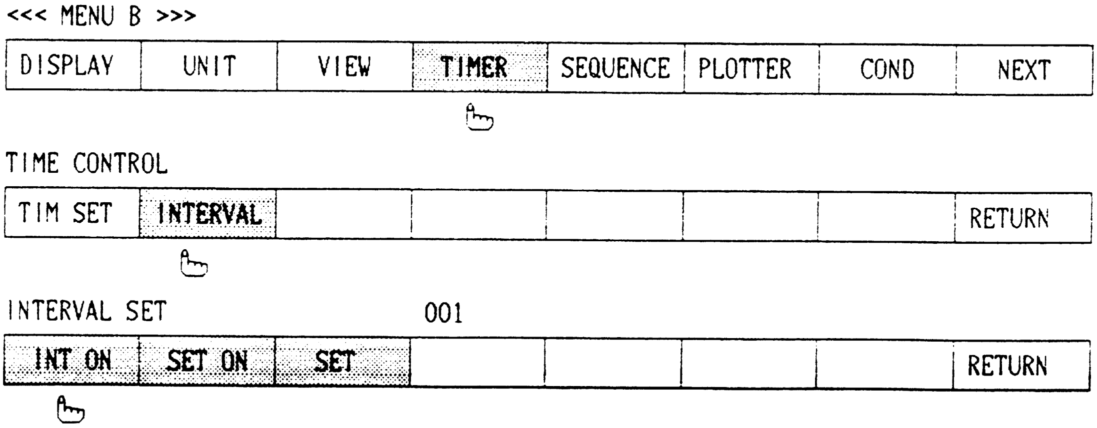


Thus, if in this example an interval of 60 s is applied to plotting, the interval has to be set at 70 s to resume averaging 10 s after plotting has finished.

(a) Time Interval Function Setting

Enter the PAUSE condition.

Make the following soft key settings.



Turn the SET ON key on and use the numeric keys on the front panel to input the value of the interval in seconds in the range 1 to 9999.

Press the SET key to set the interval.

Now press the INT ON key to turn the interval function on, and the clock at the bottom right of the CRT screen will be highlighted.

(b) Interval Function Execution

- To apply an interval between specified steps:

This is the method used in the solution to Problem 2.

SEQUENCE SET

ON	SEQ 1	SEQ 2	SUB MRK	DLY MRK			RETURN

Press the DLY MRK key when writing the autosequence program at the step **to which an interval is to be applied.**

Note

The DLY MRK operation takes up one step in the sequence.

For Problem 2.

SEQUENCE SET

ON	SEQ 1	SEQ 2	SUB MRK	DLY MRK			RETURN

Press the DLY MRK key at the final step in the sequence (start averaging → start plotting).

The interval will now be applied between executions of the program.

SEQUENCE RUN

OFF	STEP	AUTO	SEQ 1	SEQ 2	RING	TI CONT	RETURN

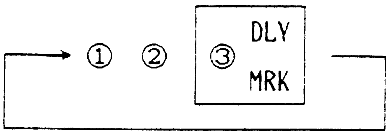
Turn the TI CONT key on when executing autosequence.

①	②	③	④	⑤ DLY MRK	⑥	⑦	⑧	⑨ DLY MRK	⑩

The interval specified at the DLY MRK points (between ④ and ⑥, and ⑨ and ⑩) is applied (with the DLY MRK operations counted in the number of steps). No interval is applied between other steps in the sequence.

Turn both the RING and TI CONT keys on to perform repeated execution in Problem 2.

The setting is made in the following way for the solution of Problem 2.

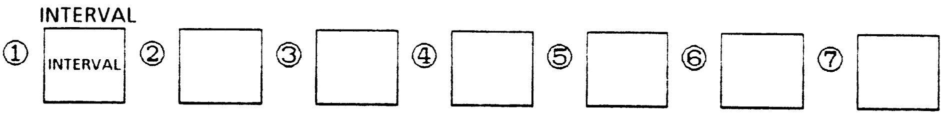


Interval applied between step ② and step ① of the next execution.

- To apply an interval between all steps in the sequence:

Set the TI CONT key to off.

The DLY MRK is disabled and the interval is applied between all steps in the sequence.

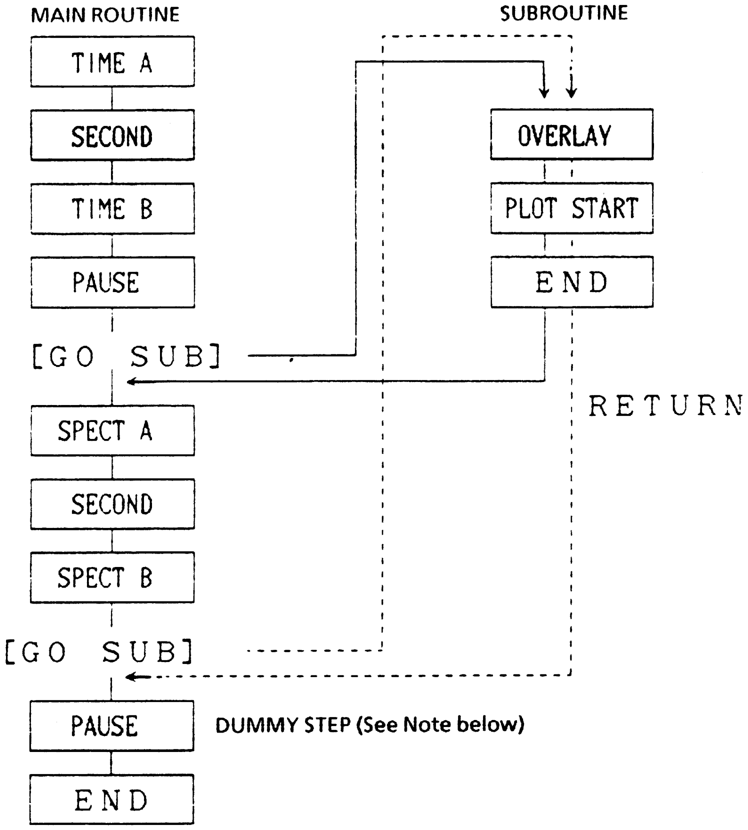


8.2.4 Programs With Subroutines

Repeatedly used routines can be defined as subroutines and called within the program reducing the number of steps in the main routine.

Problem 3 Display the time waveforms and spectra of signals on Channels A and B superimposed on the screen, and plot them.

- The solution to Problem 3 is diagrammed in the following flowchart.



DUMMY STEP (See Note below)

The main routine (left line) is stored with SEQ 1, and the subroutines (right line) are stored as SEQ 2. Use the procedure described in Section 8.2.1 on autosequence programming to store SEQ 1 and then SEQ2.

* The OVERLAY key is in the <<<MENU B>>> → DISPLAY → FORMAT soft key menu. The others, except for [GO SUB], are panel-switch commands.

Make the following soft key settings when moving from the program in SEQ 1 at the [GO SUB] step to the subroutine in SEQ 2.

SEQUENCE SET

ON	SEQ 1	SEQ 2	SUB MRK	DLY MRK			RETURN

That is, for Problem 3, after the PAUSE switch of the COMMAND-group is set to on, and after the SPEC switch for CH B is pressed, the SUB MRK key is pressed.

At execution, select SEQ 1, then follow the procedure in Section 8.2.2 to execute the autosequence.

The number of steps is displayed at the bottom right of the CRT screen as S1, S2, etc., when subroutine steps are being executed.

Notes

1. It is recommended that a flowchart be drawn up first before the program is written.

2. SUB MRK cannot be inserted as the last step.

If it is desired to make the last step of the subroutine a jump, insert a dummy step after SUB MRK, just as in Problem 3.

8.2.5 Search Point Control

The following search point control functions are provided in the CF-350 for use with the autosequence function while programs are being executed.

(1) Search-point position can be specified for each step when the sequence is defined.

(2) The search-point position can be set to the same point for the entire sequence at execution.

This function ensures that as execution proceeds through the steps, even if a function different from the initial function is displayed, and even if the scaling is changed, the search point will be displayed at the specified positions, or at the same position throughout, as desired.

(a) **To specify the position of the search point for each step when writing the** sequence:

① Move the search point to the desired position as each function is displayed while setting up the autosequence.

② Make the following soft key settings to execute the autosequence.

AUTO SEQUENCE

SEQ SET	SEQ RUN	NUM.SET	SP.CONT	COND.LD	EDIT		RETURN
			👆				

SEARCH P.CONTROL

OFF	ON	MEM	SET				RETURN
	👆						

When the ON key is turned on, during execution the search point appears at the position specified when the sequence was set up.

* The autosequence edit function, described below, can be used to specify the search-point position by number of points.

(b) To set the search point at the same position for the entire execution:

Perform the following operations when executing the autosequence.

① Move the search point to the desired point.

② Press the RETURN key to bring up the following soft key menu.

AUTO SEQUENCE

SEQ SET	SEQ RUN	NUM.SET	SP.CONT	COND.LD	EDIT		RETURN
			👆				

SEARCH P.CONTROL

OFF	ON	MEM	SET				RETURN
		👆	👆				

Press the MEM key and then the SET key. The position of the search point is now stored.

③ When the MEM key is turned on, the search point will stay at the stored position when the autosequence is executed.

* The OFF key can be used to turn these functions off.

8.2.6 Editing Autosequence Program

The CF-350 has the following editing functions for autosequence programs.

(1) Program listing display.
(2) Insertion, deletion and erasure of programs.
(3) Edit functions can be used in writing autosequence programs.

(a) Program Listing Display

- Enter the PAUSE condition.

Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

AUTO SEQUENCE

SEQ SET	SEQ RUN	NUM SET	SP.CONT	CONT.LD	EDIT		RETURN

SEQUENCE EDIT

OFF	SEQ 1	SEQ 2	EDIT ON	INSERT	DELETE	CLEAR	RETURN

When SEQ 1 or SEQ 2 is pressed, the contents of sequence memory 1 or 2, respectively, is listed on the CRT screen.

Example of Program Listing

Sequence Memory Display ↓

Current Search Point Position ↓

```
SEQUENCE 1 LIST UP                    16      16

 1  Spect A
 2  Second
 3  Spect B

 4  Spect AXB
 5  Avg on
 6  Com.start
 7  Plot start

 8   wait
 9  Spect A
10  Second
11  Time  A

12  Com.pause
13  Plot start
14   wait
15  Xfer

16  Second
17  Phase
18  Com.start
19  Plot start

20     END
```

↑ **When editing the program,** indicates position to which search point is set for the command indicated by the cursor.

8 wait → Indicates DLY MRK key that an interval is applied by.

Note

When written on an X-Y plotter, this will be different from the CRT display, in that there will be intervals between the lines of the listing shown above. If output to a video printer, however, the printout will be exactly the same as the CRT display.

If there is nothing stored for the program, only the last line, 1 END, will be displayed.

(b) Program Step Insertion, Deletion and Clear

① Display the program listing with the procedure in (a) above.

② Make the following soft key settings.

SEQUENCE EDIT

OFF	SEQ 1	SEQ 2	EDIT ON	INSERT	DELETE	CLEAR	RETURN
			☞	a	b	c	

If the EDIT ON key is pressed, the cursor will appear above the listing.

This cursor is moved using the vertical keys of the CURSOR switch of the SEARCH group.

a INSERT ... A line will be inserted just before the listing number (see below) indicated by the cursor, and a "wait" message will be displayed when this key is pressed.
When the EDIT ON key is off, one line is inserted at the first line of the program. An interval is applied at the step when the "wait" message is displayed. If operations are performed at this point, the operation commands will be input at the step when the "wait" message is shown.

```
SEQUENCE 2 LIST UP

 1  wait
 2 Spect A
 3 Second

 4 Spect B
 5 Spect AXB
 6 Avg on
 7 Com.start

 8 Plot start
 9  wait
10 Spect A
```

b **DELETE .. When the EDIT ON key is on, the line indicated by the cursor key in the listing can be deleted by pressing this key.**

c CLEAR .... The entire contents of the program listing are erased when this key is pressed. This is only effective when the EDIT ON key is on.

(c) Writing Autosequence Programs Using the Edit Functions

The CF-350 edit functions can be used in writing programs while checking the listing on the CRT screen.

SEQUENCE EDIT

OFF	SEQ 1	SEQ 2	EDIT ON	INSERT	DELETE	CLEAR	RETURN

Turn the EDIT ON key on.

The panel switches or soft keys can be operated from this point, and the functions indicated will be included in the listing.

The search point control functions described in Section 8.2.5 for the following procedure.

① Display the program listing, and turn the EDIT ON key on.

② Use the vertical cursor keys of the CURSOR switch of the SEARCH group to set the search-point position to the desired step.

③ Keeping an eye on the number (current search-point position) at the left side of the top right of the CRT screen, change this number using the CURSOR switch vertical cursor keys. (If it is kept depressed, the number will change continuously.) The number indicates the number of points the search point is from the left.

④ When the change is completed, input the step again.

Now, the number to the right at the top right of the CRT screen, and this indicates that setting is complete.

As stated in Section 8.2.5, if the ON key is turned on, when the autosequence is executed the search point will be set to the point specified here.

This also makes it possible to check the positions of the search point for each step in the autosequence by listing the program on the CRT screen.

8.2.7 Storage to and Playback from Disk of Autosequence Programs

Both autosequence programs, 1 and 2, are stored in the same disk file, and both are played back simultaneously.

(a) Storage Method

- Enter the PAUSE condition.

① Make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	**DISK**	NEXT

DISK

ST MAS	ST TIME	**ST COND**	LD MASS	LD TIME	LD COND	UTILITY	RETURN

P.COND,SEQ STORE FILE No. 001 P1

P.COND	**SEQUENC**	P.NO DW	P.NO UP	FILE NO	SET	**START**	RETURN

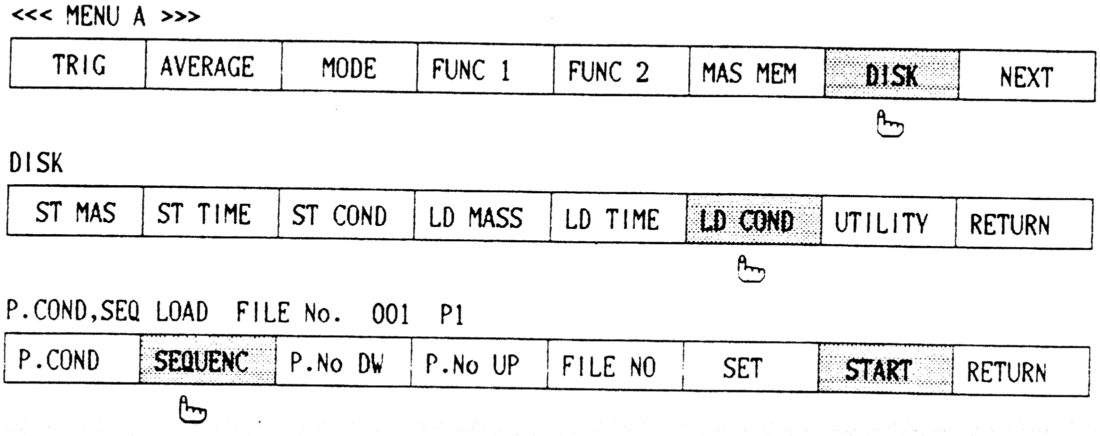
② To set the disk file number, press the FILE NO key, then input the file number using the numeric keys on the front panel, and finally press the SET key to set the value.

③ Press the START key to start storage (transfer).

(b) **Playback Method**

- Enter the PAUSE condition.

① Make the following soft key settings.



<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

DISK

ST MAS	ST TIME	ST COND	LD MASS	LD TIME	LD COND	UTILITY	RETURN

P.COND,SEQ LOAD FILE No. 001 P1

P.COND	SEQUENC	P.No DW	P.No UP	FILE NO	SET	START	RETURN

② To set the number of the disk file containing the autosequence programs, press the FILE NO key, then input the number using the numeric keys on the front panel, and finally press the SET key to set the value.

③ Press the START key to initiate program playback.

** See Section 7.3 on the microfloppy disk drive for details on formatting, contents check, and other aspects of using the disks.

9. HARD COPY FUNCTION

9.1 Connection to Plotter

If the CF-0350 plotter interface software is installed in the CF-350, various kinds of plots can be produced using the GPIB.

Here is a list of the plotters that can be used with the CF-350.

(1) Plotters using the HP-GL commands:

CX-335

CX-338

The following Hewlett-Packard plotters

HP7550A

HP7470A

HP7475A

HP9872C/T

HP7225B

HP7440A

The Graphtec plotter MS8603 (Rastercorder)

Note

HP-GL is a graphics language for plotters used by Hewlett-Packard.

(2) Plotters using the commands of the Graphtec personal plotter series:

The Graphtec plotters:

WX4731

WX4636

FP5301

MP2000

MP3000 and others

9.1.1 Plotting Method

In the CF-350, hard copies can be made in either of the following modes. The modes are switched by selecting a GPIB address with the soft keys.

① Plotter (talk-only) Mode

This mode is used when an external controller (CPU) is not connected. Set the plotter to Listen Only for this mode.

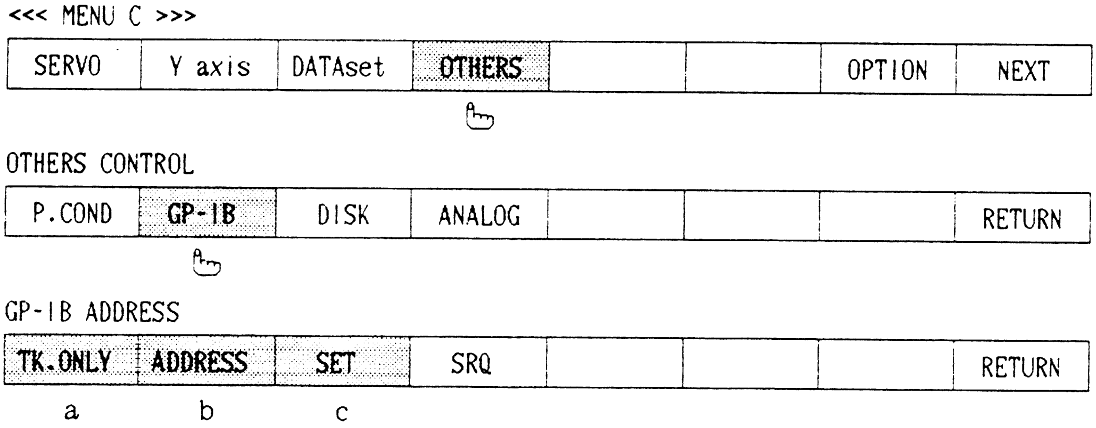
② Addressable Mode

This mode is used when an external controller (CPU) is connected. The GPIB address has to be specified for this mode.

Normally, an external CPU is not used, and the CF-350 is connected directly to the plotter. Mode ① is used to with manual start.

For information on the addressable mode, refer to Section 9.1.3, which describes GPIB control and gives a sample program.

(a) Switching the CF-350 Modes



a TK.ONLY .... Sets the talk only mode.

b ADDRESS .... Sets the addressable mode.

c SET .... Sets the address.

(b) Switching Plotter Modes

- Setting the CX-338 to Listen Only

  Set GPIB address DIP switch position 6 to on. (This switch is set on prior to shipping.)

- Setting the CX-335, HP7470A, 7475A, and 7440A to Listen Only

  Set all five GPIB address DIP switches to 1 (on) and apply power. (The CX-335 switches are set on prior to shipping.)

- Using the HP7550A

  Setting Listen Only

  Press the ENTER switch and then the NEXT DISPLAY switch, to enable the HP-IB mode.

  Pressing the HP-IB switch sets the address mode.

  The initial value is 05, so hold the switch down until Listen Only is set. Press the ENTER switch now to store this in backup memory. Subsequently, the Listen Only condition will be maintained even when the power is turned off.

  Feed

  The CF-350 can output the feed command after plotting is finished.

  Press the AUTO FEED switch on the 7550A initially, and then press the LOAD key to set the paper.

  If the AUTO FEED switch is left on, paper will be fed automatically once plotting is completed, and new paper will be loaded.

** Consult the instruction manuals for the other plotter models.

(c) Plotting Method

Put the CF-350 in the PAUSE condition.

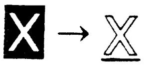
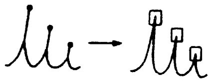
Press the PLOTTER switch at the bottom of the front panel. (Its LED will light.) Plotting will start immediately.

When plotting is finished, the PLOTTER switch LED will go out. Press the PLOTTER switch and turn it off to suspend plotting. (Continuous start is not available.)

The CF-350 has a large-capacity buffer for use with the plotter, enabling the instrument to move on to the next analysis approximately 1 s after initiating transfer of screen data to the plotter.

Note

The following differences exist between screen images and plotting data.

Item	Screen	Plot	Example
Highlighted characters	Highlighted	Underlined	
Search point	Point	□	
X-axis logarithmic scale Display-time grid	Display only for odd-numbered frequencies	Display of both even- and odd-numbered frequencies	

9.1.2 Setting Plot Parameters

Initial Parameters

The following parameter settings are made for the plot functions before the CF-350 is shipped. The parameter values are changed using the soft keys.

Function	Parameter
Plotter model	PLOT 1
Pen to plot waveform	Pen 1
Superimposed display plotting method	Superimposed waveforms plotted in full lines
Pen to plot frame	Pen 1
Grid plotting method	Broken lines
Pen to plot characters	Pen 1
Soft keys plotted or not?	Not plotted
Function to plot only character at search point	Off
Paper feed control	On
Objects to be plotted	CRT screens
Plotter trace	Off
Plot format	A4
Plot position	–

(a) Setting the Recorder

Select a plotter using the HP-GL commands or a Graphtec plotter using the GPIB interface (personal plotter series commands). (PLOT 1 is set at initialization.)

Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

PLOTTER

DEVICE	DATA	FRAME	CHARACT	FEED	SOURCE	FORMAT	RETURN

DEVICE SELECT

PLOT 1	PLOT 2				P1-P2	NUMERIC	RETURN
a	b						

a	PLOT 1	...	Select this key when the CF-350 is connected to an HP-GL-command plotter (CX-338, etc.).
b	PLOT 2	...	Select this key when the CF-350 is connected to a Graphtec plotter (with the personal plot series commands) using the GPIB interface (such as the WX4731 or FP5301).

(b) Pen and Plotting Method Specification

In the CF-350, any of pens 1 to 4 can be specified for waveform, frame, or character (display character) plotting.

It is also possible to leave the pen number unspecified and not to perform any of the three types of plotting.

Besides these, the following settings can also be made.

- Broken-line plotting of the waveform in the lower frame when two waveforms are displayed superimposed. (Set to full line plotting at initialization.)
- Full-line grid plotting. (Set to broken-line plotting at initialization.)
- Plotting soft keys. (Turned off at initialization.)
- Plotting only the character indicated by the search point in a group of characters, and the scaling.

Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

PLOTTER

DEVICE	DATA	FRAME	CHARACT	FEED	SOURCE	FORMAT	RETURN
	a	b	c				

a	DATA	....	Select to make settings for waveform plot.
b	FRAME	....	Select to make settings for frame plot.
c	CHARACT	....	Select to make settings for (display) character plot.

Note

Pens are specified in here by the pen-stock number, 1 to 4. Thus, colors are not specified directly.

① Settings for Waveform Plot

PLOTTER

DEVICE	DATA	FRAME	CHARACT	FEED	SOURCE	FORMAT	RETURN

PEN SEL. SIGNAL

PEN 1	PEN 2	PEN 3	PEN 4	OFF	BODE	DOTT L	RETURN
a	b	c	d	e	f	g	

Press keys *a* to *e* to select the pen for plotting waveforms, and to turn waveform plot on or off.

a	PEN 1	Plot waveforms with pen 1.
b	PEN 2	Plot waveforms with pen 2.
c	PEN 3	Plot waveforms with pen 3.
d	PEN 4	Plot waveforms with pen 4.
e	OFF	Plot no waveforms.

Select keys *f* and *g* for the following settings.

f	BODE	When a transfer function Bode plot is displayed, this is normally plotted with the upper-frame phase to lower-frame gain size ratio at 1:3, but they can be plotted at any desired ratio. This is explained below in Subsection (d) in this section, E. Method for Plotting Transfer Function Bode Plot at Arbitrary Size.
g	DOTT L ...	When plotting two frames superimposed, select this key to **plot the lower-frame waveform in broken line.** (When this key is off, the waveforms in both frames are plotted in full lines.)

② Settings for Frame Plot

PLOTTER

DEVICE	DATA	FRAME	CHARACT	FEED	SOURCE	FORMAT	RETURN

PEN SEL. FRAME

PEN 1	PEN 2	PEN 3	PEN 4	OFF	G.LINE		RETURN
a	b	c	d	e	f		

Select the pen for plotting frames by pressing key PEN 1, 2, 3, or 4.

Frames are not plotted when the OFF key is on.

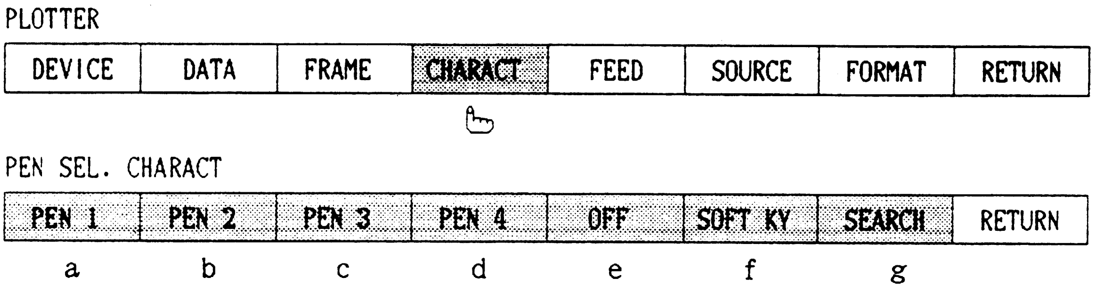
f G.LINE .. **When a grid is displayed in the upper frame, select this key to** plot the grid in full line.
(The grid is plotted in broken line when this key is off.)

Notes

1. Grids are not plotted when the OFF key is on.

2. If a grid is displayed when a frequency-axis waveform is displayed with logarithmic scaling on the X-axis, only odd-numbered frequencies 1, 3, 5, 7, 9, 10, 30 ... Hz are displayed on the CRT screen, while even numbered frequencies are included in the plot thus, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20, 30 ... Hz.

③ Settings for Character (and Display Character) Plot



PLOTTER

DEVICE	DATA	FRAME	CHARACT	FEED	SOURCE	FORMAT	RETURN

PEN SEL. CHARACT

PEN 1	PEN 2	PEN 3	PEN 4	OFF	SOFT KY	SEARCH	RETURN
a	b	c	d	e	f	g	

Press keys *a* to *d* to specify the number of the pen for character plotting.

When the OFF key is set to on, the label, condition, the view value on the right, the scaling value, and other display characters at the top of the screen are not plotted.

f SOFT KY ... Plot soft keys. (Soft keys are not plotted when this key is off.)

g SEARCH ... Only the search value, scaling value, and date and time are plotted as characters.

Note

The SFT KY and SEARCH plot functions cannot be executed when the OFF key is on.

(c) Specifying Plot Format

In the CF-350, the following plot formats can be selected using the soft keys for the various plotters.

①	Plot size	FORMAT 1	A4
		FORMAT 2	A6
		FORMAT 3	A5

Note

Format 3 is not available on certain plotters (e.g., the FP5301).

② Plot Position

LOCATION 1	LOCATION 3
LOCATION 2	LOCATION 4

<For A6 size>

↓

Corresponds to Format 2

LOCATION 1or3
LOCATION 2or4

<For A5 size>

↓

Corresponds to Format 3

If plotting is performed with the feed function on at this point, in Format 2, feed is performed when plotting of Location 4 is completed, and in Format 3, feed is performed when plotting of Location 2 or 4 is completed.

Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

PLOTTER

DEVICE	DATA	FRAME	CHARACT	FEED	SOURCE	FORMAT	RETURN

PLOT FORMAT

FORMAT1	FORMAT2	FORMAT3	LOCAT1	LOCAT2	LOCAT3	LOCAT4	RETURN

The sizes and positions indicated by the figure above are set by pressing the respective soft keys in this menu.

However, if the FORMAT1 key (A4) is pressed, Location setting is ineffective.

WX4731

When the WX4731 plotter is used, it has to be switched to A3 mode for plotting in Format 3. To perform switching, turn the power off, then turn it on again while holding down the FEED switch on the plotter operation panel. To return the plotter to the original condition, turn the power off and then on again.

(d) Setting Plot Size and Position

Plotting can be performed at any desired size and position by changing the plotter scaling point.

A. P1 and P2 ...	Sets the positions of P1 and P2 at the plotter for HP-GL-type plotters.
B. Numeric	Sets the numeric value on the CF-350.
C. Normal (1 and 2 are both off)	Plots using the format specifications explained in Subsection (c) above.

The following settings are also possible.

D. Amount of feed setting.

E. Arbitrary settings for ratio of heights of upper-frame (phase) and lower-frame (gain) for Bode plot.

F. Rotation of plot through 90°, changing vertical and horizontal axes.

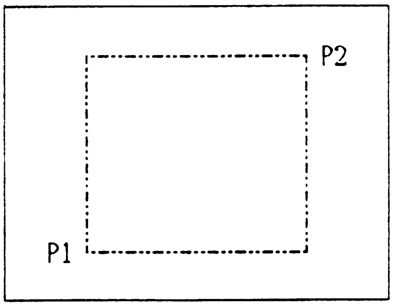
A. P1 and P2

Set P1 and P2 at the plotter for HP-GL-type plotters. The rectangle established by the scaling points P1 and P2 on the plotter form the frame of the waveform. This is a very useful function (with single-frame display) when plotting on paper with the frame already printed on it.

Note

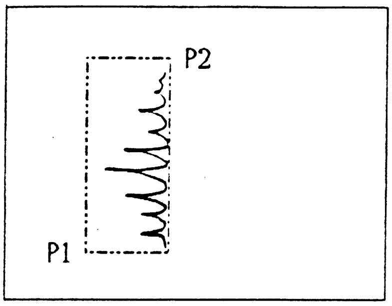
The P1 and P2 functions cannot be used with dual-frame display. (The plot position is aligned with P1 at the bottom left of the lower frame, but it is higher than that of P2 at the top right of the upper frame.)

① Set the P1 and P2 positions at the plotter. The positions of P1 and P2 are shown in the figure below. P1 is at the bottom left of the frame, and P2 at the top right. Refer to the plotter instruction manual for details on the method of setting the positions of P1 and P2. (The method for setting them in the CX-338, CX-335 and the HP7475A is explained below.)

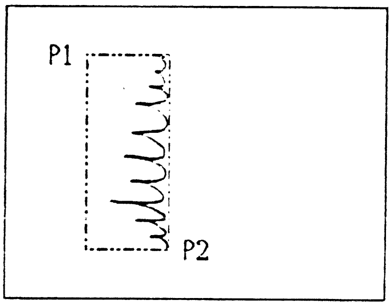


Note

As the figure below shows, when plotting at 90° rotation (see Subsection (d) F. below), P1 is at the top left of the frame and P2 at the bottom right.



P1 and P2 have the following positions when set up for plotting at 90° rotation on the CX-335 (see P1 and P2 Settings on the CX-335 below).



Setting P1 and P2 on the CX-338

Press the REMOTE/LOCAL switch to set the LOCAL condition. (The REMOTE lamp goes out.)

Press the POSITION/PEN SELECT switch, and move the pen to the position to which P1 is to be set.

Press the ENTER switch, and the PROMPT lamp will flash.

Press the P1 switch. The PROMPT lamp will now go out.

This completes the procedure for setting P1.

Now, in the same way, move the pen to the position to which P2 is to be set.

Press the ENTER switch, and the PROMPT lamp will flash.

Press the P2 switch. The PROMPT lamp will go out, indicating that the position of P2 is now set.

Check that the pen moves to the set positions by pressing the P1 and P2 switches.

Press the REMOTE/LOCAL switch to return to the REMOTE condition. (The REMOTE lamp lights.)

Setting P1 and P2 on the CX-335

Use the horizontal and vertical cursor keys to move the pen to the position to which P1 is to be set.

Press the FAST switch simultaneously to increase the speed of moving the pen.

With the ENTER switch depressed, press the P1 switch. P1 is now set.

Move the pen to the position to which P2 is to be set.

With the ENTER switch depressed, press the P2 switch. P2 is now set.

Check that the pen moves to the set positions by pressing the P1 and P2 switches.

** In the CX-335, the following settings can also be made using the switches.

- Plot rotated 90°

With the ENTER switch depressed, press the FAST switch.

- Return all functions to the condition at power application

With the ENTER switch depressed, press the VIEW switch.

Setting P1 and P2 on the HP7475A

Use the horizontal and vertical cursor keys to move the pen to the position to which P1 is to be set.

With the ENTER switch depressed, press the P1 switch.

In the same way, move the pen to the position to which P2 is to be set, and, with the ENTER switch depressed, press the P2 switch.

② **Make the following soft key settings.**

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

PLOTTER

DEVICE	DATA	FRAME	CHARACT	FEED	SOURCE	FORMAT	RETURN

DEVICE SELECT

PLOT 1	PLOT 2				P1-P2	NUMERIC	RETURN

These operations complete the procedure for setting the desired plot position and size at the plotter.

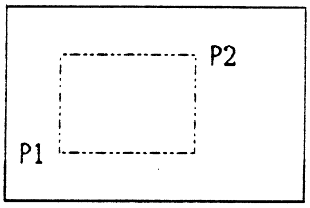
Notes

1. If the the plot size is set to Format 3, as described in Subsection (c) above, plotting in the P1-P2 mode is not possible.

2. If the settings of P1 and P2 are changed, even if the P1 and P2 keys are turned off, the plot does not return to the usual size. In this case, turn the power to the plotter off and then on again to re-initialize P1 and P2.

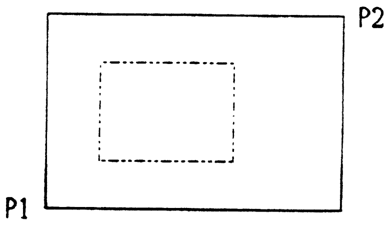
   The settings for P1 and P2 are as follows.

Soft key P1-P2 is on



P1-P2 form frame

Soft key P1-P2 is off



P1-P2 form plot region

B. Numeric

The plot size and position is set on the CF-350 in numerical values.

① HP-GL-Command Plotter (PLOT1)

Set the positions of P1 and P2.

② Plotter using GPIB interface (personal-plot system commands) (PLOT2)

Set the plot position at offset, and the plot size at magnification.

- Set the PAUSE switch of the COMMAND group to on to enter the PAUSE condition.

① Make the following soft key settings.

<<< MENU C >>>

SERVO	Y axis	DATAset	OTHERS			OPTION	NEXT

DATA INPUT

PLOT							RETURN

PLOT SIZE DATA

ON	ENTER			CLR			RETURN

If the ON key is set to on, the following menu will be displayed on the CRT screen.

The setting values are as follows.

X MIN POINT P1x	PLOT1	Sets P1 X coordinate.	Set for PLOT1
X MAX POINT P2x	PLOT1	Sets P2 X coordinate.	
Y MIN POINT P1y	PLOT1	Sets P1 Y coordinate.	
Y MAX POINT P2y	PLOT1	Sets P2 Y coordinate.	
X offset	PLOT2	Sets X-axis offset value.	Set for PLOT2
Y offset	PLOT2	Sets Y-axis offset value.	
FACTOR p	PLOT2		
FACTOR q	PLOT2	Sets X-axis magnification.	
FACTOR r	PLOT2	Sets Y-axis magnification.	
FEED LENGTH (0.1 mm)		Sets the amount of paper feed.	
BODE LOWER DISPLAY TOP		Sets the top position of the lower frame for Bode plot.	
BODE UPPER DISPLAY BOTTOM		Sets the bottom position of the upper frame for Bode plot.	
BODE UPPER DISPLAY TOP		Sets the top position of the upper frame for Bode plot.	
X-Y ROTATION [ON(1), OFF(0)]		Rotates plot direction by 90°.	

② In this menu, use the vertical keys of the CURSOR switch of the SEARCH group to move the cursor to each parameter. Use the numeric keys on the front panel to input the values, and press the ENTER key to set them.

When the values are input with the numeric keys, the CLR key can be used to delete the values.

The numerical values input in this way are stored in battery backed-up memory, so they are not lost when the power is turned off.

③ Once the parameters have been set up, make the following soft keys settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	**PLOTTER**	COND	NEXT

PLOTTER

DEVICE	DATA	FRAME	CHARACT	FEED	SOURCE	FORMAT	RETURN

DEVICE SELECT

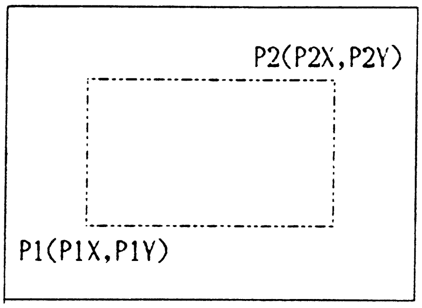
PLOT 1	PLOT 2				P1-P2	**NUMERIC**	RETURN

The NUMERIC key is set to on to perform plotting at the size and position specified by the numerical values of the parameters. If this key is turned off, plotting is performed as described in Subsection (c) above.

- Setting Numerical Values

① HP-GL-Command Plotter (PLOT1)

Set the coordinates of P1 and P2 as follows.



The numerical values set at

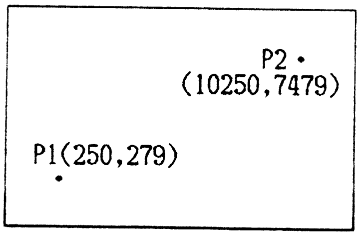
X axis	Frame point 0	P1X
X axis	**Frame full-scale point**	**P2X**
Y axis	Frame point 0	P1Y
Y axis	Frame full-scale point	P2Y

Specify the positions of P1 and P2.

The units of the numerical values are 1 = 0.025 mm for the CX-338, and are given as coordinates from the origin at the bottom left of the effective plot range.

The initial settings for P1 and P2 for the CX-338 are

P1X	250
P1Y	279
P2X	10250
P2Y	7479



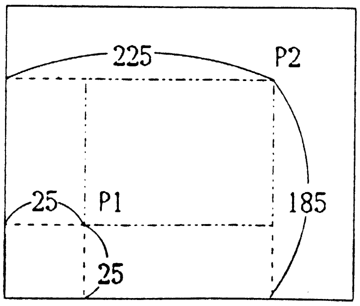
For the CX-335

P1X	603
P1Y	440
P2X	10603
P2Y	7640

Note

When it is desired to plot at the positions and size at right the values are as follows

P1X	1000 (25 ÷ 0.025)
P1Y	1000 (25 ÷ 0.025)
P2Y	9000 (225 ÷ 0.025)
P2Y	**7400 (185 ÷ 0.025)**



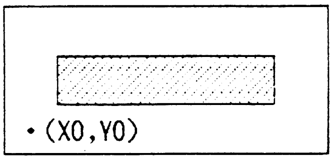
② GPIB-interface-type plotters (using Graphtec "personal plotter" series commands) (PLOT2)

The position at the bottom left of the plot region is set in offset, and the size in magnification.

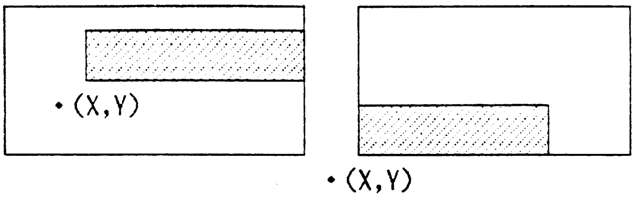
Offset Setting

X OFFSET and Y OFFSET are the setting parameters.

(X,Y) are specified in numerical values at $1 = 0.1$ in coordinates from the origin at the bottom left of the paper at initialization.



1: Plot region before offset



2: Plot region after offset

The numerical values can be set in the following ranges.

$-16383 \leqq X, Y \leqq 16383.$ *and*

$-16383 \leqq X + XO \leqq 16383$

$-16383 \leqq Y + YO \leqq 16383$

X0:	X coordinate prior to application of offset.
Y0:	Y coordinate prior to application of offset.

Note

The offset value does not affect the Factor value.

Magnification Setting

The setting parameters are Factor p, Factor q, and Factor r. The magnifications p/r and q/r are multiplied by the length and character size. They do not effect the offset value.

p, r, and q are set in the following way.

p/r:	X-axis magnification (set to 1 at initialization)
q/r:	Y-axis magnification (set to 1 at initialization)

Numerical values can be assigned to these parameters in the following ranges.

$0 < p, q, r \leqq 32767$

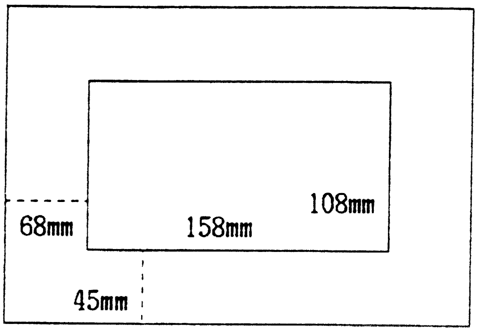
$1/4096 < p/r$

$q/r < 8$, and

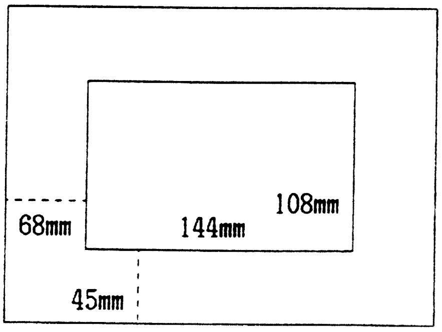
Coordinate prior to multiplying by Factor $\times$ $(p/r, q/r) \leqq 16383$

C. Normal Plotting

For example, on the CX-338, plot size and position are initialized to the following values (for A4 and single-frame display)



Spectrum



Time-Axis Waveform

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

PLOTTER

DEVICE	DATA	FRAME	CHARACT	FEED	SOURCE	FORMAT	RETURN

DEVICE SELECT

PLOT 1	PLOT 2				P1-P2	NUMERIC	RETURN

Turn both the P1-P2 and NUMERIC keys off.

If the settings for P1 and P2 have been changed from the initial values at the plotter, even when these keys are off, the system will not return to plotting at the normal size. In this case, turn the power to the plotter off and then on **again, because the values of P1 and P2 have to be returned to the initial** settings.

D. Setting the Feed Quantity

For plotters like the WX4731 which use roll paper, the quantity of paper feed either before or after plotting can be set .

This value is set as a numerical value using the FEED LENGTH key, and the unit is 1 = 0.1 mm.

The setting at initialization is as follows.

2100 (2100 × 0.1 mm = 210 mm)

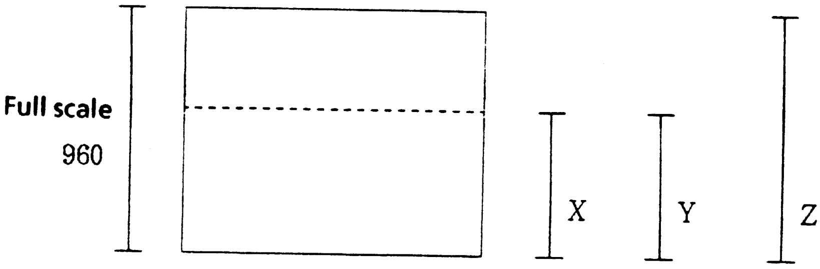
E. Plotting Transfer-Function Bode Plots at Arbitrary Size

When the transfer-function Bode plot is displayed, plotting is usually performed with the ratio between the height of the upper-frame (phase) and lower-frame (gain) plots at 1:3, but this can be changed to any desired ratio.

If the setting parameters are

BODE LOWER DISPLAY TOP	X,
BODE UPPER DISPLAY BOTTOM	Y, and
BODE UPPER DISPLAY TOP	Z,

then they are all specified from the bottom with the full scale at 960.



That is,

X specifies the position of the lower-frame span,

Y, that of the upper-frame zero, and

Z, that of the upper-frame span.

For example, the settings for 4:1 are

X = 768,

Y = 768, and

Z = 960.

To plot the gain full scale and the phase at 1/3, they are as follows.

X = 960,

Y = 720, and

Z = 960.

Thus, if X is set greater than Y, a part of the upper and lower frames will be superimposed, while if X < Y, there will be a gap between the plots of the upper and lower frames.

After the parameters have been set up, make the following soft key settings.

PLOTTER

DEVICE	DATA	FRAME	CHARACT	FEED	SOURCE	FORMAT	RETURN

PEN SEL.SIGNAL

PEN 1	PEN 2	PEN 3	PEN 4	OFF	BODE	DOTT L	RETURN

When the BODE key is pressed, plotting will be performed at the specified size. When this key is turned off, the ratio of the heights of the lower frame (gain) and the upper frame (phase) will return to 3:1.

Note

Characters (displayed characters) cannot be plotted in this way. Be sure to **turn character plotting off.**

F. Rotating Plot Direction 90°

The plot direction is rotated 90° by setting ON(1) on at X-Y ROTATION[ON(1), OFF(0)].

the plot position and size are set up by specifying values for P1 and P2. See Subsection A above.

G. A3 Plotting with the CX-335

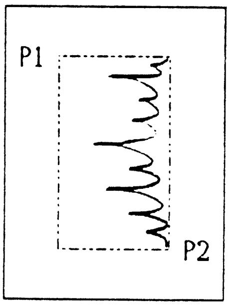
A3-sized plots can be produced on the CX-335 Minicolor Plotter.

① The paper size is set to A3 mode at the DIP switches on the CX-335.

Set DIP switch 1 position 1 (left side) to 1, and position 2 and 3 to 0.

② Mount the A3 paper vertically.

Plotting is standardly performed with the long side of the paper taken as the X-axis, and positions of P1 and P2 as shown below.



Note

When plotting in A3 size, be sure to attach the chart guides (front and back) provided.

(e) Paper Feed Control and Superimposed Plotting

The following paper-feed control functions are available in the CF-350.

Paper feed on and off

Manual feed using soft keys

Selection of feed before or after plotting

On the CX-338, selection of feed backwards or forwards.

Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

PLOTTER

DEVICE	DATA	FRAME	CHARACT	FEED	SOURCE	FORMAT	RETURN

FEED CONTROL

ON	MANU	BEFORE	FRONT				RETURN
a	b	c	d				

In this menu, the following functions are associated with the keys.

a ON .... Turns paper feed function on and off.

b MANU ..... The paper is fed the amount specified according to the procedure in (d) D above each time this key is pressed.

c BEFORE ... When this key is turned on, the paper is fed before plotting is performed. Turn this function on when using the HP-7550A or the Graphtec Rastercorder.

d FRONT ..... Paper is fed in the forward direction when this key is turned on when using the CX-338.

** If paper feed is turned off, and specification of the the pen for frame and character plotting (see (b) above) is turned off also, superimposed waveforms can be plotted.

(f) Specifying Plot Source Data

The following selections can be made on the CF-350 for plot source data.

① CRT .... Plot CRT display data.

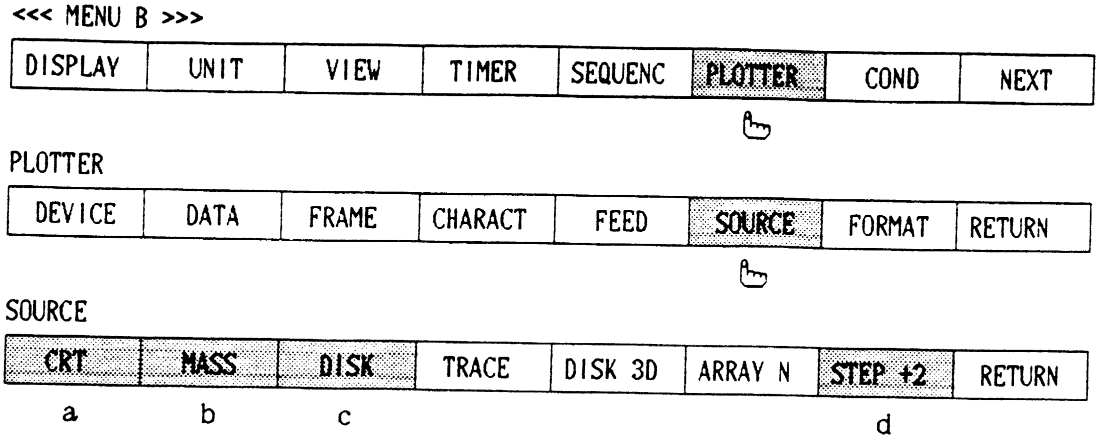
② MASS ...... Plot CRT block-memory data — Autoplot

③ DISK .... Plot disk data (screen data) — Autoplot

If either MASS or DISK are selected, the autoplot function is used to plot screen data stored in CRT block memory or on disk automatically and continuously. Disk data can also be used to produce a 3-dimensional plot.

- Set the PAUSE condition.

  Make the following soft key settings.



<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

PLOTTER

DEVICE	DATA	FRAME	CHARACT	FEED	SOURCE	FORMAT	RETURN

SOURCE

CRT	MASS	DISK	TRACE	DISK 3D	ARRAY N	STEP +2	RETURN

a	CRT	Plot frame displayed on CRT screen.
b	MASS	Plot screen data stored in mass memory (CRT block-memory) continuously.
c	DISK	Plot screen data stored on disk continuously.
d	STEP +2	When this key is on, every other file, or every other block of memory, is plotted.

Press the PLOTTER switch on the front panel to initiate plotting.

Notes

1. The autoplot function can be operated using the MASS or DISK keys when plotter like the CX-338 with automatic feed functions, or plotters using paper rolls are used. It is important to check that the remaining number of sheets, or length of paper, are sufficient.

2. Plotting is performed from the specified block in the CRT block memory, and stops at address 60. However, if there is a part which is not stored in a CRT block memory address, plotting will halt at that address.

   In the case of data on disk, plotting is performed from the specified file number, and if there exists a file in the plotting sequence with no data, plotting stops at that file.

   Waveforms stored in time record memory on disk cannot be plotted. (These waveforms should be plotted by calling each frame individually and plotting then in turn.) If there exists a file in the plot sequence containing time record memory data, plotting will stop at that file.

3. When DISK is selected, the disk file numbers will differ from the normal numbers, and the number of the file in which data is written will be displayed.

3-Dimensional Plotting of Disk Data

If the same type of data is stored on disk consecutively, the data stored on disk can be plotted in 3 dimensions. If a different type of data is encountered in the plot sequence, plotting will stop at that point.

Set the PAUSE condition.

Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	**PLOTTER**	COND	NEXT
					☞		

PLOTTER

DEVICE	DATA	FRAME	CHARACT	FEED	**SOURCE**	FORMAT	RETURN
					☞		

SOURCE

CRT	MASS	DISK	TRACE	**DISK 3D**	**ARRAY N**	**STEP +2**	RETURN
				a	b	c	

The DISK 3D and ARRAY N keys are highlighted when DISK 3D is pressed, and 3-dimensional display plotting can be performed. Turn the START switch on to initiate plotting.

Select the number of the 3-dimensional data using the ARRAY N key. The number will then be displayed in the annotation section at the right of the CRT screen at the ARRY NUM position. The ARRY NUM display moves through the sequence 130 → 90 → 60 → 30 →130 as the ARRAY N switch is pressed.

Every other file is plotted when the STEP + 2 switch is on.

The height of the Y-axis is specified using the Height soft key, just as when displaying waveforms in 3-dimensional mode on the CRT screen. (See Section 6.7 on 3-dimensional display.) That is, the settings change through the following sequence.

Height 1 → Height 2 → Height 3
Height 1 → 1/2 → 1/4

In fact, if Format 2 is selected, only Height 2 and Height 3 can be selected.

If Height1 is selected, Height2 is set.

The inclination of the 3-dimensional display can be selected using the DEGREE key.

The label written in the plot frame, as well as the X- and Y-axis scaling data form the contents of the first data file plotted.

Notes

1. It is not possible to produce a plot with a logarithmic scale on the X-axis.
2. Disk data is transferred to the plotter after first being displayed on the CRT screen, so use blocks 1 and 2 of the CRT block memory.
3. Plotting cannot be performed if waveform and frame plotting are turned off.

** See Section 7.3 for details on the correct way to handle the microfloppy disks.

(g) Plotting Search Point Trace

The CF-350 can produce traces of up to 256 search points continuously.

There are two modes for producing traces. Data from the time record memory is played back, and then traced, for time record memory trace. It is also possible to produce real-time traces while capturing data. When the search point is on, the value of the frequency to which the search point is set can be traced. When the search point is off, the values of the peak frequencies for each power spectrum are plotted.

The time on the horizontal axis is given by the playback gap for time record memory trace, and by the analysis frequency for real-time trace.

The full-scale time for time record memory trace is

$$\frac{1}{2.56 \times f} \times \mathit{playback\ gap} \times 256$$

$$= (100/f) \times \mathit{playback\ gap}$$

where f: analysis frequency, and

Playback gap: 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096

E.g., if the analysis range is 20 kHz, and the playback gap is 16, the full-scale time is

$$100 \div 20{,}000 \times 16 = 0.085\ s = 85\ ms$$

Set the gap carefully for the amount of data to be traced.

Set display to single-frame mode, and enter the PAUSE condition.

① Display the power spectrum of the data to be traced, and set the search point to the frequency to be traced. Turn the search point off if peak values are to be traced.

② Make the following soft key settings.

<<< MENU B >>>

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

PLOTTER

DEVICE	DATA	FRAME	CHARACT	FEED	SOURCE	FORMAT	RETURN

SOURCE

CRT	MASS	DISK	TRACE	DISK 3D	ARRY N	STEP+2	RETURN

③ Turn the START switch of the COMMAND group on, and then turn the PLOTTER switch on.

This will initiate output.

Plotting stops when the last time record memory address is reached, or when 256 points have been output, or when the PLOTTER switch is pressed.

If plotting is stopped by pressing the PLOTTER switch, tracing is stopped, but the axes and characters are output.

Notes

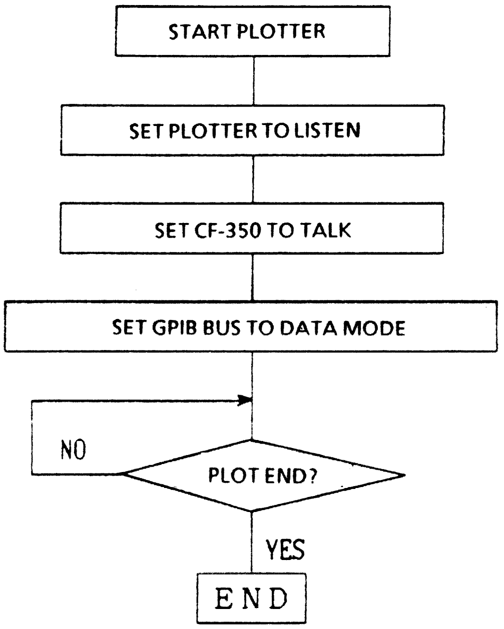
1. For real-time trace, time can be scheduled on the horizontal axis by using the time-interval function.
2. The trace function is effective when time-axis waveforms are displayed. However, if the display inhibit function is used, but trace is only effective when power spectrum is displayed on the screen. Processing speed can be increased by using the display inhibit function. See Section 6.9 for the display inhibit function.
3. If the search function is off when a power spectrum is displayed, the value of the peak frequency is traced. The previous search point value is output for all other displays.

9.1.3 GPIB Control and Sample Programs

Examples are given below of operation when an external controller (CPU) is connected.

Refer to Section 9.1.1 (a) on switching CF-350 modes, and set the addressable mode.

Flowchart



[Send PST command to CF-350.]

[Set ANT signal to High]

[SRQ is output from CF-350 when plot ends.]

SAMPLE 1

```
1       !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
2       !   CF350 & PLOTTER controlled by CPU    !
3       !    CPU = HP9816S                       !
5       !    device #of CF350 = 9                !
6       !    device #of PLOTTER = 5              !
7       !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
10      D=709
20      ON INTR 7 GOSUB Service
30      ENABLE INTR 7;2                  ! interrupt on !!!
40      P=0
50      OUTPUT D;"SMS1"                  ! request service set
60      OUTPUT D;"PDV1"                  ! plotter device
70      OUTPUT D;"PST"                   ! plotter start
80      SEND 7;UNL LISTEN 5 TALK 9 DATA  ! address set
90       !!!  other process !!!
100      IF P=0 THEN 100
110     GOTO Pend
120 Service:!
130          P=SPOLL(D)
140          ENABL INTR 7;2
150          RETURN
160 Pend:    END
```

SAMPLE 2

```
10 ''''''''''''''''''''''''''''''''''''''
20 ' CF350  plotter out                 '
30 '   controller =PC9801               '
50 ''''''''''''''''''''''''''''''''''''''
60  CF=9:PLOTTER=7                ' DEVICE # SET
70  ISET IFC:ISET REN             ' GP-IB initialize
80  ON SRQ GOSUB *SERVICE :SRQ ON ' service request set
90  PRINT@CF;"SMS1"               ' plotter end SRQ on
100 PRINT@CF;"PDV2PST"            ' plotter start
110 WBYTE &H3F,&H20+PLOTTER,&H40+CF;  'CF350 TALK,plotter =LISTEN
120 P= 0
130 ' !!! other process !!
140 IF P=0 THEN 140               ' if plotter end then end
150 END
500 *SERVICE
510   POLL CF,P
520   SRQ ON
530  RETURN
```

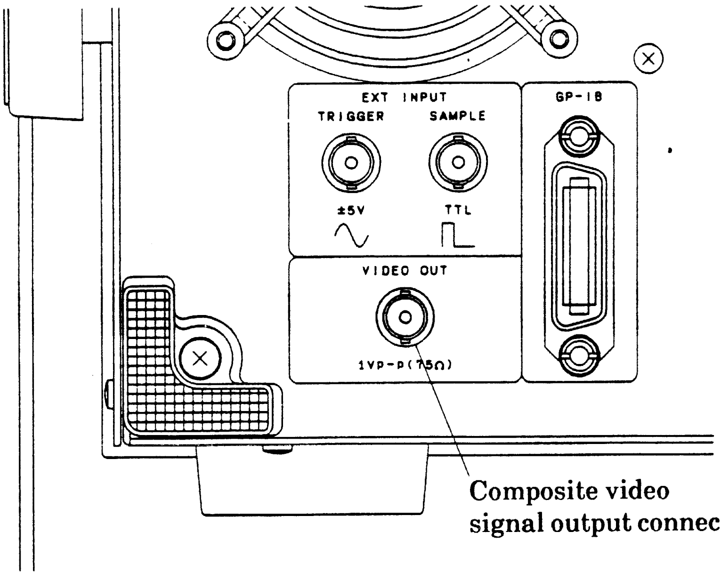
9.2 Connecting Video Printer

A composite video signal output is provided in the CF-350.

The VP-035 Video Printer can be connected for high-speed hardcopies of screens.

The standard speed is 16.7 s/screen.

The signals are output from the BNC connector on the rear panel.



Composite video signal output connector

9.2.1 Composite Video Signal Specifications

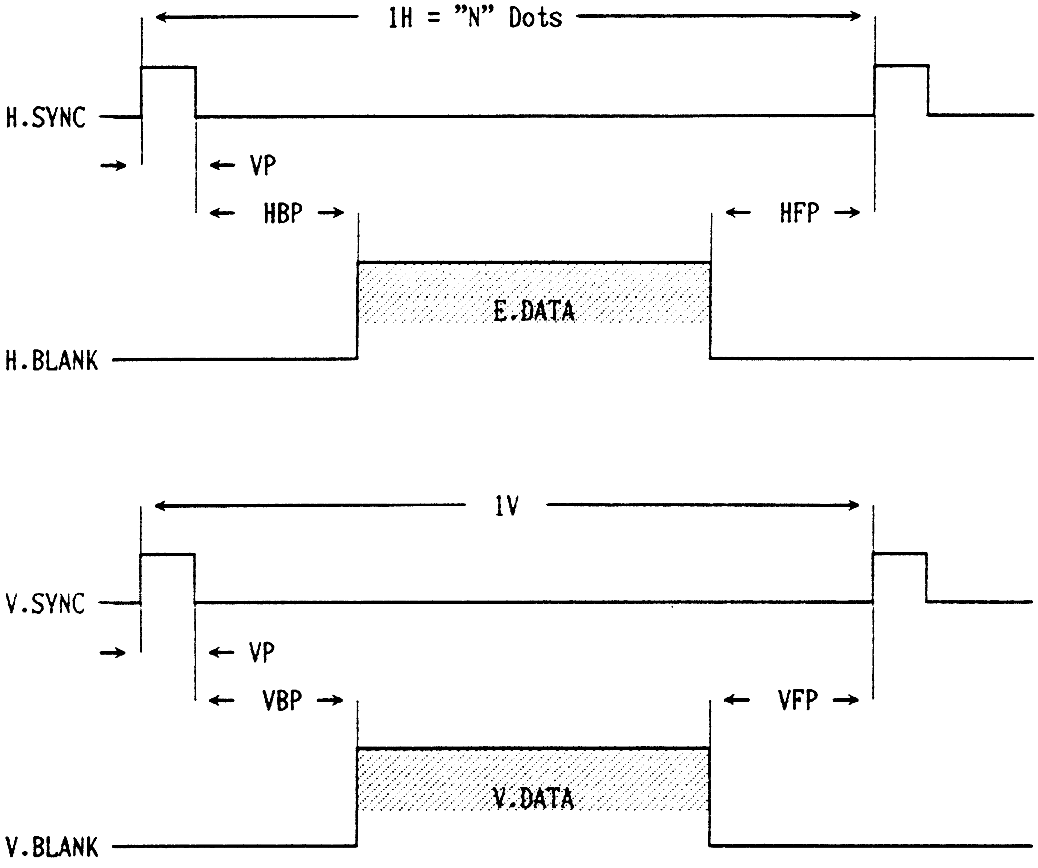
Number of horizontal picture dots	N = 759 dots
Horizontal sync frequency	Fh = 15.5 kHz
Vertical sync frequency	Fv = 55.3 Hz
Clock frequency	F = 11.776 MHz

Parameters

H. parameters	1) H P = 120 dots	2) HBP = 72 dot
	3) H.DATA = 512 dots	4) HFP = 56 dots
V. parameters	5) V P = 9H	6) VBP = 7H
	7) V.DATA = 256H	8) VFP = 24H

- **Scan Interlacing**

[TYPICAL TIMING CHART]



"N" = (HP) + (HBP) +(H.DATA) + (HFP) • • • • • • • Dots

"F" = ("Fh" × 1000 × "N") / 1000000 • • • • • MHz

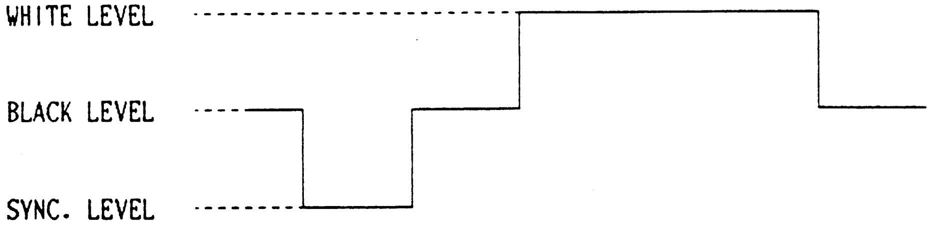
- **Signal Levels**

  White level = 0.7 V

  Black level = 0.4 V

  Sync level = 0 V

[COMPOSIT VIDEO SIGNAL]



9.2.2 Plotting Method

① Use a BNC coaxial cable to connect the VP-035 from its input connector to the composite-video signal output connector on the rear panel of the CF-350.

② Press the print key on the video printer to start printing.

** If the printout is not good, refer to the video printer instruction manual to adjust the printer.

If the CF-0383 Signal Output Card is installed in the CF-350, the following analog signals can be output.

- Sinewave
- Sine sweep
- Swept sine
- Random noise
- Periodic random noise
- Impulse
- Tone burst (pip)

It is possible to apply pink filtering to the above signals and obtain a burst output (with the exception of random noise).

With the exception of random noise, it is also possible to output a signal which is synchronized to the window frame (i.e., the resolution points). This signal can be used as the input signal to a system in performing high-accuracy transfer function measurements.

In addition, it is possible to output one frame of time-axis waveform displayed on the CRT or 8 Kwords of data from the time record memory as an analog signal.

10. SIGNAL OUTPUTS

10.1 Output Waveforms

There are seven types of signal outputs.

10.1.1 Sinewave

This is a sinewave output at a frequency set on the power spectrum.

10.1.2 Sine Sweep

This is a sweep of a set frequency band. By performing a sweep average, a waveform synchronized to the window frame can be converted to one line of frequency each time a frame is captured.

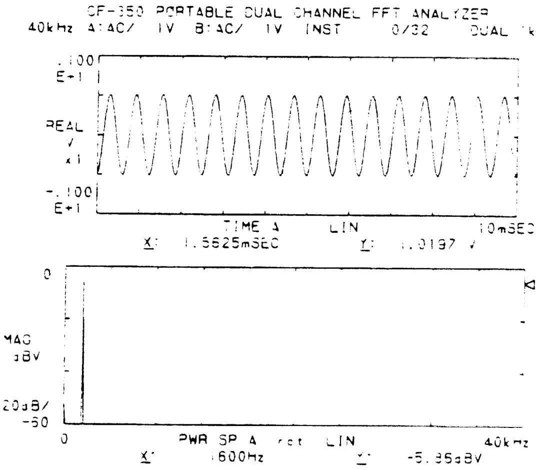


Fig. 10-1 Sinewave: Time-Axis Waveform (Top) and Power Spectrum (Bottom)

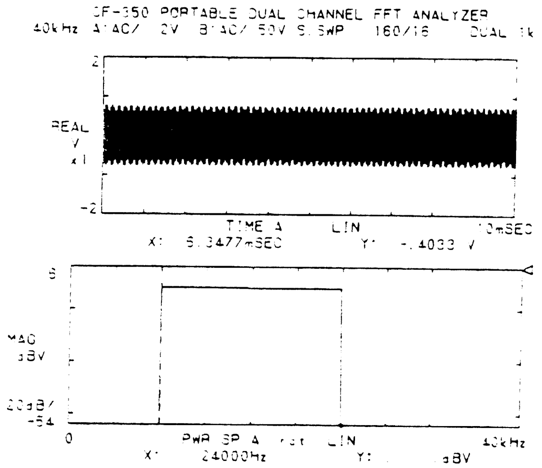


Fig. 10-2 Sinewave: Time-Axis Waveform (Top) and Power Spectrum After Sine Sweep (Bottom)

10.1.3 Swept Sine

This is a single-frame sweep over a set frequency band. It is synchronized to the window frame.

10.1.4 Random

This is a white random signal with no periodicities. The output frequency band is 40 kHz, regardless of the frequency range setting.

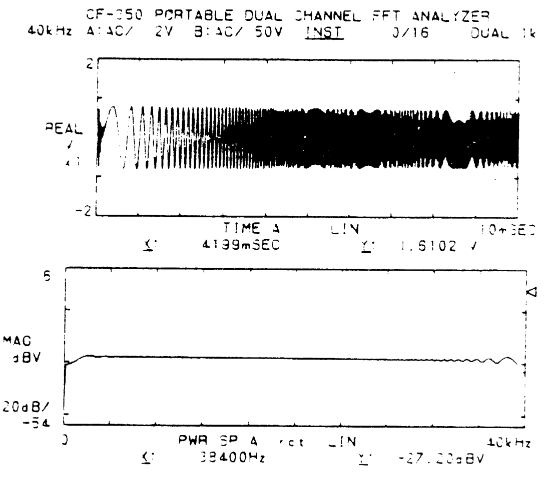


Fig. 10-3 Swept Sine: Time-Axis Waveform (Top) and Power Spectrum (Bottom)

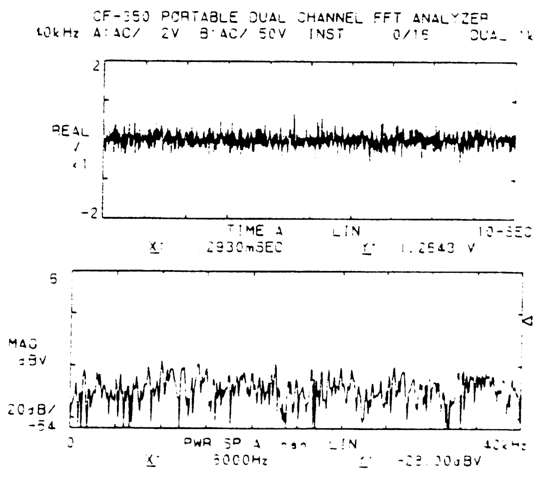


Fig. 10-4 Random: Time-Axis Waveform (Top) and Power Spectrum (Bottom)

10.1.5 Periodic Random

This is a random signal of constant spectral amplitude which consists of a waveform synchronized to the window frame. The output frequency band is linked to the frequency range.

10.1.6 Impulse

This is an impulse-type waveform consisting of waveforms synchronized to the window frame. It has a constant spectral amplitude.

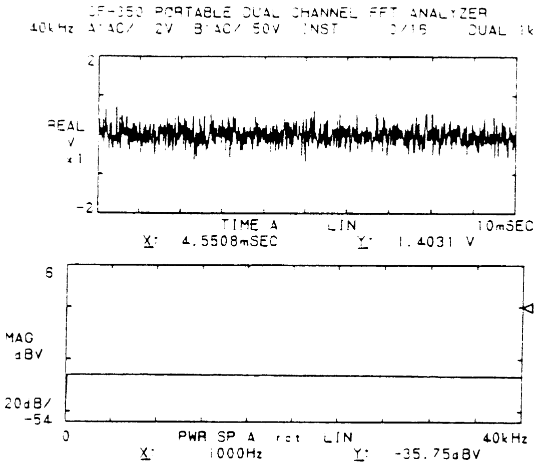


Fig. 10-5 Periodic Random: Time-Axis Waveform (Top) and Power Spectrum (Bottom)

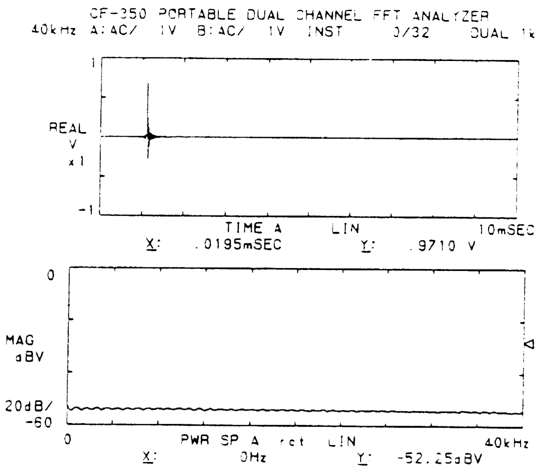


Fig. 10-6 Impulse: Time-Axis Waveform (Top) and Power Spectrum (Bottom)

10.1.7 Tone Burst (Pip)

This is a signal consisting of six sinewave cycles weighted with a Hamming window having a time length equivalent to the burst period. The bandwidth at the –3 dB points with respect to the level at the center frequency is 1/3 octave (refer to Section 10.2 on indoor acoustic measurements).

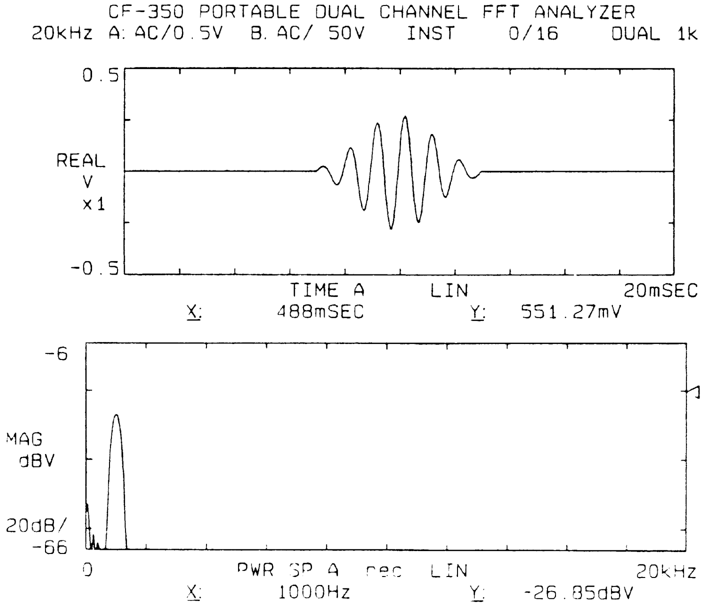


Fig. 10.7 Pip Waveform: Time-Axis Waveform (Top) and Power Spectrum (Bottom)

* For output signal characteristics, refer to section 1.1.8.

It is possible to apply a pink filter to the above waveforms when required. With pink filtering the level will have as the frequency is doubled (i.e., as the frequency is increased to one octave above the original frequency), this representing a −3 dB change in level. When a random or periodic random signal is linearly scaled with respect to frequency, the power spectrum level will be approximately constant. In contrast to this, pink random and pink periodic random signals will exhibit nearly constant level when they are processed using octave analysis.

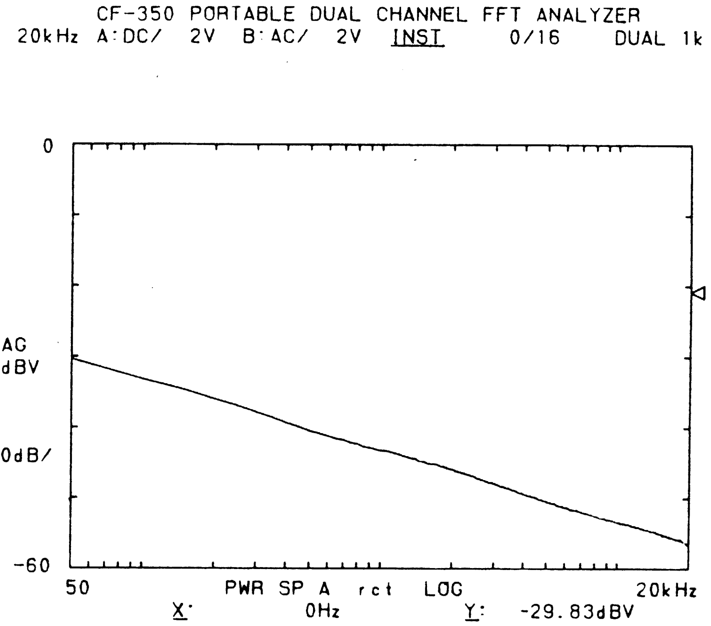


Fig. 10-8 Pink Periodic Random: Power Spectrum (Logarithmic X Axis)

It is possible to repeat a single frame of the output waveform or output a single frame and then stop output.

In addition, it is possible to set the number of cycles and the time interval to obtain a burst output.

A pulse signal is output which is synchronized to the output waveform, this output being usable as a trigger signal.

The following two types of time waveform analog outputs are available. The maximum output voltage in both cases is 5 V, and the ± full scale value at capture time corresponds to ±5 V.

① Time Waveform Display Analog Output

A 1024-point or 2048-point time-axis waveform displayed on the CRT can be output as an analog signal one time or repeatedly.

② Time Record Analog Output

Of the data stored in time record memory, 4 Kwords or 8 Kwords starting at a set address can be output as an analog signal one time or repeatedly. However, only 4 Kwords of output is possible in the 1-Hz range.

In addition to these output, it is possible to repeatedly output from the SG-450 Signal Source Unit a time-axis waveform displayed on the CRT.

10.2 Indoor Acoustic Measurements

White noise, pink noise, a warble-tone, shock noise, tone bursts and other signals have been used as test signals in performing indoor acoustic measurements. These can be classified in terms of characteristics as follows.

Spectrum Type		Continuous Sound	Short Sound
Uniform spectrum		White noise Pink noise	Impulse
Band spectrum	Low spectrum levels outside bandwidth	Band noise	Pip waveform
	High spectrum outside bandwidth	Warble tome	Tone burst

For continuous sound, since the signal is output at all times, it is easy to obtain a high signal level and noise immunity is improved. However, large variation in the signal spectrum require that time averaging be performed.

In contrast to this short sounds enable a single measurement to be used in determining a variety of characteristics. However, since the signal is only output for a short period of time, the actual signal level is diminished and noise immunity suffers, so that a shock-type sound having a sound pressure level high enough with respect to noise is required.

For signals having a band spectrum, a tone burst or similar waveform can be used. However, although it provides noise immunity, it has the disadvantages of having high spectral components outside the band and not having a concentration of energy in the desired band. The pip waveform was devised because of this. It can be used to measure reverberation time, impulse transfer characteristics, echo time patterns and D (see Note) values, making it usable in measuring virtually all characteristics required to characterize playback acoustic fields.

Note

D (Definition) Value

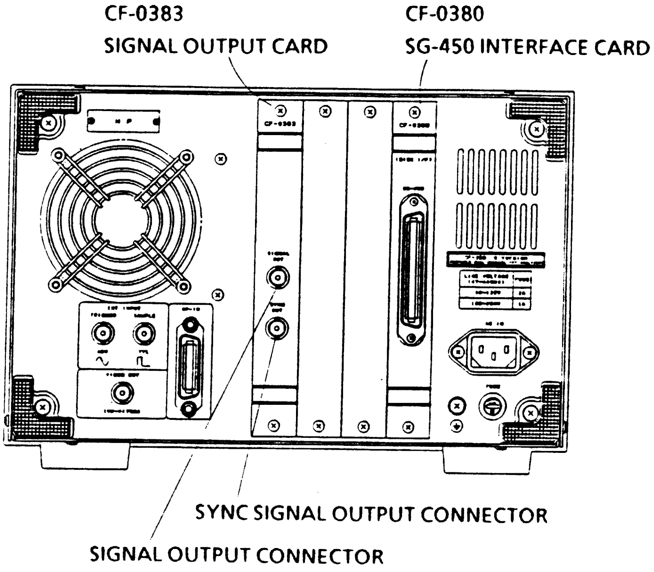
Reflected sound for the 50 ms after the arrival of the directly received sound reinforces the directly received sound and thereby increases definition. One method of evaluating the impulse response quantitatively is the D value which is defined as the portion of the total energy represented in the first 50 ms after the reception of the direct sound. This can be expressed as an equation as follows.

$$\text{D value} = \frac{\int_0^{50\,\text{msec}} p^2(t)\,dt}{\int_0^{\infty} p^2(t)\,dt}$$

10.3 Output Method

10.3.1 Output Connectors

The CF-0383 Signal Output Card is installed at the CF-350 rear panel.



The output signal is accessed at the SIGNAL OUT connector (BNC). In addition, a pulse signal synced to the signal output is available at the SYNC OUT connector (BNC).

10.3.2 Output Waveform Setting

Selection is possible of a sinewave, sine sweep, swept sine, periodic random, random, impulse or pip waveform.

<Procedure>

Make the following soft key settings.

<<< MENU C >>>

SERVO	Y axis	DATAset	OTHERS			OPTION	NEXT

<<< MENU D >>>

CmosMEM	SIG OUT	X-Y REC	TRACK	COMP	Opt 6	Opt 7	NEXT

SIGNAL OUT

FRQ SET	SELECT	AMPLITD	MEM OUT	OUTcont			RETURN

(a) Output Waveform Selection

In the initialized condition, random is selected.

<Procedure>

Make the following soft key setting.

SIGNAL OUT

FRQ SET	**SELECT**	AMPLITD	MEM OUT	OUTcont			RETURN

SIGNAL SELECT

SIN	**SWEPT.S**	**PERIOD**	**RANDOM**	**IMPULSE**	**PIP**		RETURN
a	b	c	d	e	f		

a	SIN	Selects sinewave
b	SWEPT.S	Selects swept sine. The window is automatically set to a rectangular window.
c	PERIOD	Selects a periodic random signal. The window is automatically set to a rectangular window.
d	RANDOM	Selects a random signal. The window is automatically set as a Hanning window.
e	IMPULSE	Selects an impulse signal. The window is automatically set as a rectangular window.
f	PIP	Selects a pip (toneburst) signal.

Press the key corresponding to the desired signal.

(b) Output Frequency Setting

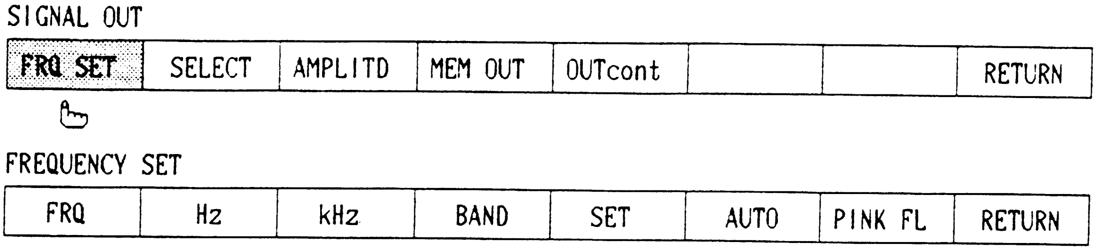
Setting is made at the sinewave output frequency, pip waveform center frequency, or sine sweep and swept sine frequency band. The setting is made using the delta cursor, and setting by numerical input is also possible for the sinewave and pip signals.

In addition, when the frequency range is switched, the output frequency is automatically switched appropriately.

In the initialized condition, the sinewave and pip frequencies (16th line) are set the 1600 Hz and the bandwidth is set to DC to 40 kHz (full scale). When the frequency range is changed, these will change (AUTO key on).

<Procedure>

Make the following soft key settings.



A. Single Frequency Setting (Sinewave and Pip)

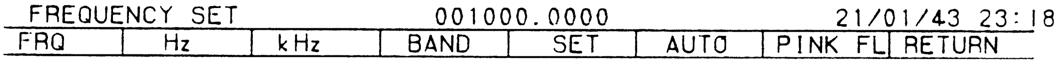
When making numerical settings, the setting resolution is 0.0001 Hz.

Numerical Setting 1: Numerical Input Using the Numeric Keys.

① In the initialized setting, the AUTO key is on. Set this to off.

② Set the FRQ key to on. One character will appear highlighted over the soft keys. Use the front-panel numeric keys to input the desired value. The format is 000000.0000. After the value, press the Hz or kHz key to input the units. The set value will be displayed.

For example, if 1 is input and kHz is pressed, the display will be "001000.0000".



③ When the FRQ key is pressed once again, the leftmost digit of the value will be highlighted, enabling this digit to be changed by means of further numerical input.

④ When the FRQ key is pressed once again, the setting value disappears and return is made to the condition where one character is highlighted in the display.

Numeric Input 2 Using CURSOR Switches.

① Set the FRQ key to on.

② Press any of the up/down or left/right CURSOR switches of the SEARCH group. "000000.0000" will appear above the soft keys and the leftmost digit will be highlighted.

③ Use the up/down and left/right switches to set the value.

The up switch increments the highlighted digit by 1.

The down switch decrements the highlighted digit by 1.

The left switch moves the highlighted digit to the left.

The right switch moves the highlighted digit to the right.

④ Press the Hz key to complete the setting.

Setting Using the Delta Cursor

- Display the power spectrum. For a dual-frame display, display the power spectrum at the bottom of the screen.

① Set the On switch of the SEARCH group to on to display the search point.

Use the CURSOR up/down and left/right switches to move the search point to the desired output frequency.

Press the ΔSET switch. The delta cursor will appear at the search point.

② Press the SET key to complete the setting of the output frequency.

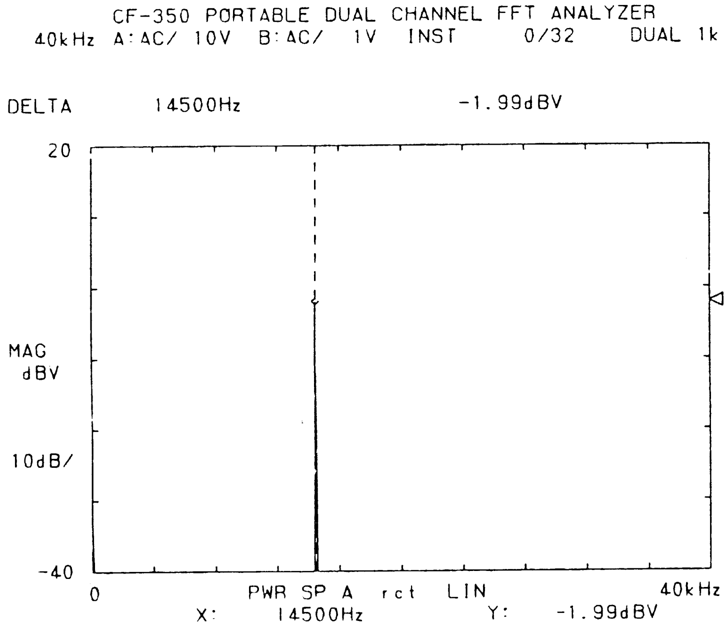


Fig. 10-9 Delta Cursor Setting of the Sinewave

B. Frequency Band Setting (For Sine Sweep and Swept Sine)

The setting is made with the delta cursor and search point.

- Use the procedure described in Section 10.3.2 (a) to select either the sinewave or swept sine.

- Display the power spectrum. For a dual-frame display, display the power spectrum at the bottom of the screen.

① Set the ON switch of the SEARCH group to on to display the search point.

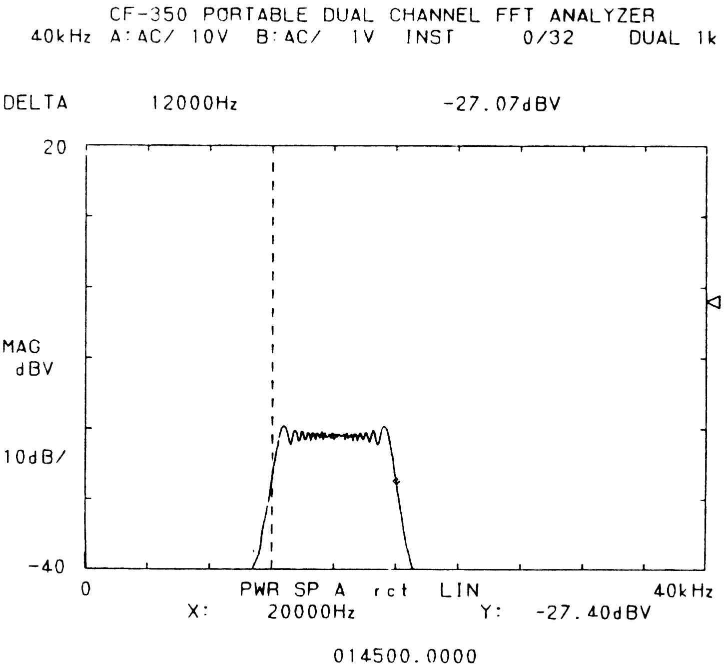
Use the CURSOR up/down and left/right switches to move the search point to the starting point of the desired output frequency band.

Press the ΔSET switch to display the delta cursor at the search point position.

② Next, move the search point to the ending point of the desired frequency band.

③ Press the BAND key and then the SET key in this sequence to complete the output frequency band setting.

If the swept sine was selected, output will be made at the point at which the frequency band is set.



```
        CF-350 PORTABLE DUAL CHANNEL FFT ANALYZER
40kHz  A:AC/ 10V  B:AC/  1V  INST     0/32    DUAL 1k

DELTA        12000Hz                -27.07dBV
```

```
X:    20000Hz          Y:  -27.40dBV

           014500.0000
```

Fig. 10-10 Swept Sine Setting

Sine Sweep Output

To obtain a sine sweep output, perform the following procedure.

Make the following soft key settings.

FREQUENCY SET

FRQ	Hz	kHz	BAND	SET	**AUTO**	PINK FL	RETURN

Execute sweep averaging by making the following settings.

<<< MENU A >>>

TRIG	**AVERAGE**	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

AVERAGE SET

PWR SP	TIME	HIST	FOURIER	MAXoval	DISPLAY	CONTROL	RETURN

SPECTRUM AVG

SUM	EXP	PEAK	**SWEEP**	DIFF	INC	DEC	RETURN

Set the AVG switch of the COMMAND group to on and then press START to set it on as well.

(c) Pink Filter

The pink filter can be applied to output signals. This guarantees a −3 dB/octave rolloff over the range 20 Hz to 20 kHz.

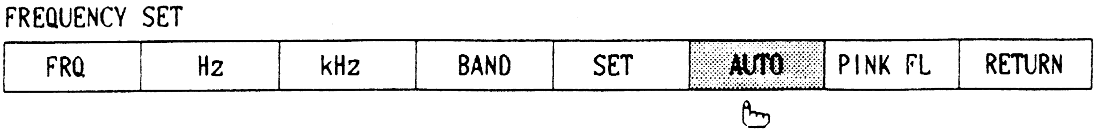
FREQUENCY SET

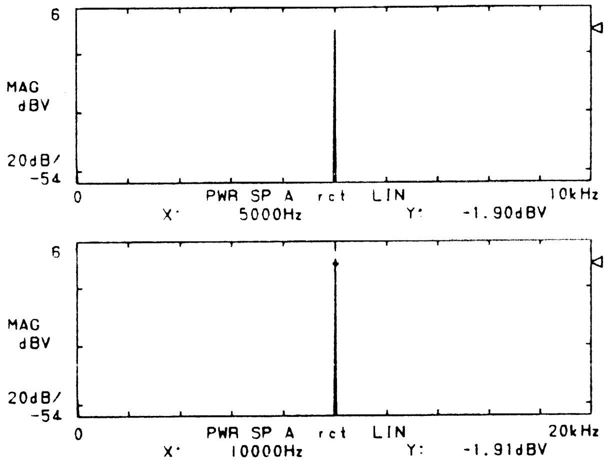
FRQ	Hz	kHz	BAND	SET	AUTO	**PINK FL**	RETURN

(d) Auto Mode

When the frequency range is changed, the output frequency is automatically adjusted to the delta cursor position frequency. It should be noted, however, that this is only true when the output frequency was set using the delta cursor.

<Procedure>

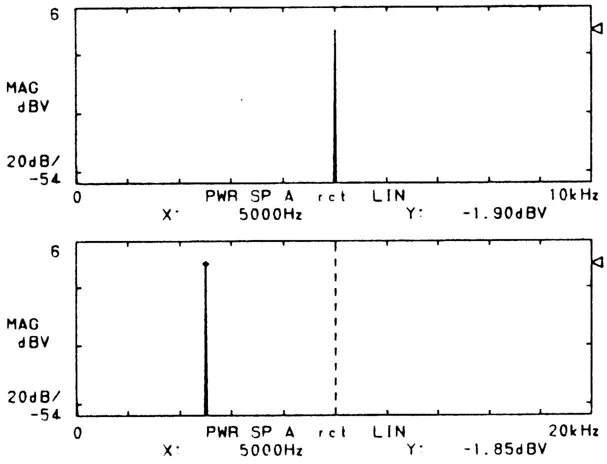




5-kHz Output frequency setting in 10-kHz range (top)

When range is switched to 20 kHz, a 10-kHz signal is output (bottom)

(a) Auto Mode On



When the range is switched to 20 kHz, a 5-kHz signal is output (bottom)

(b) Auto Mode Off

Fig. 10-11 Auto Mode

With the AUTO key set to off, when the frequency range is switched both the frequency and data length stay the same (i.e. they are not linked automatically to the frequency range setting).

Note that the AUTO key is operative also for the sine sweep and swept sine bandwidth setting.

(e) Output Voltage Setting

The output voltage may be set from 10 mV to 5 V in 1-mV steps.

<Procedure>

Make the following soft key settings.

SIGNAL OUT

FRQ SET	SELECT	AMPLITD	MEM OUT	OUTcont			RETURN

AMPLITUDE SET

ON	50ohm						RETURN

When the ON key is pressed to highlight it, "1.000 V" will appear above the soft key menu in the display as the voltage. The leftmost digit will be highlighted.

Use the up/down and left/right CURSOR switches of the SEARCH group to set the value of the highlighted digit.

The up switch increments the highlighted digit by 1.

The down switch decrements the highlighted digit by 1.

The left switch moves the highlighted digit to the left.

The right switch moves the highlighted digit to the right.

When the ON key is pressed again to turn it off, the value is set.

Direct Reading for 50-Ω Termination

AMPLITUDE SET

ON	50ohm						RETURN

If the 50ohm key is set to on, the voltage value will be displayed as half the set value. This will provide a direct reading of voltage for a 50-Ω termination.

(f) Continuous and One-Time Outputs Selection

<Procedure>

Make the following soft key settings.

SIGNAL OUT

FRQ SET	SELECT	AMPLITD	MEM OUT	**OUTcont**			RETURN

OUTPUT CONTROL

CONTINU	**SINGLE**	BURST	CYCLE	TIME	SET		RETURN
a	b						

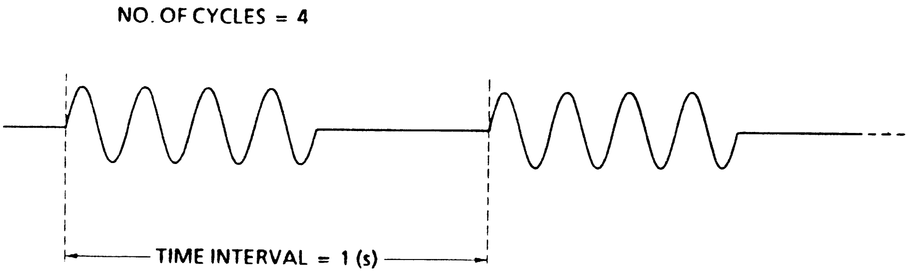
a CONTINU .... Selects continuous signal output.

b SINGLE .... Selects one frame of output each time the key is pressed.

Note that the SINGLE key is invalid for random noise.

(g) Burst Output

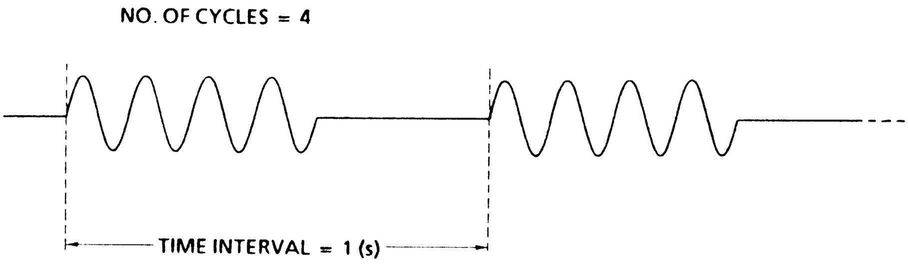
A burst output is possible for each of the signal types. For this type of output, the number of cycles and time interval are set as follows.



The set number of cycles is repeated at the given time interval (set in units of seconds). Note that this burst output is not possible for a random signal.

The number of cycles and time interval are set as follows for the various waveform types.

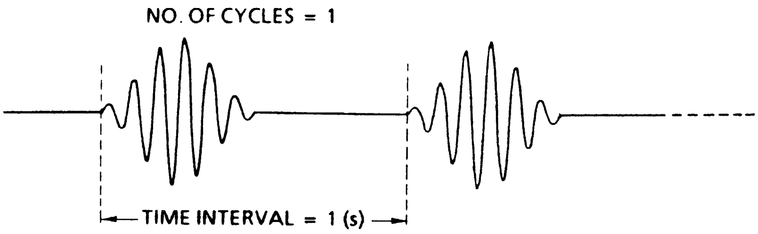
① Sinewave



4-Cycle Burst at 1-s Intervals

② Pip Signal

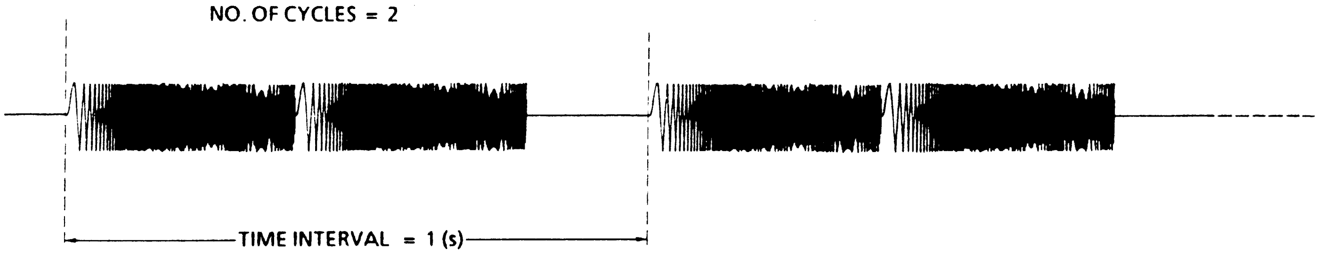
Since the pip signal is defined as a 6-cycle tone burst with Hamming-window weighting, the 6 cycles are defined as 1 cycle for this signal.



1-Cycle Pip Waveform at 1-s Intervals

③ Swept Sine

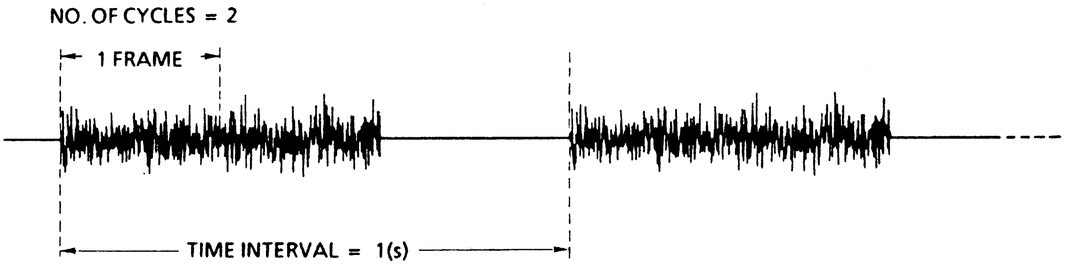
A swept sine signal of length equal to the CF-350 frame length is output and lengths shorter than the frame length cannot be set. Each frame is considered to be one cycle. If the interval time is set at longer than the frame length, there will be sections with no signal output.



2-Cycle Swept Sine at 1-s Intervals

④ Periodic Random Signal

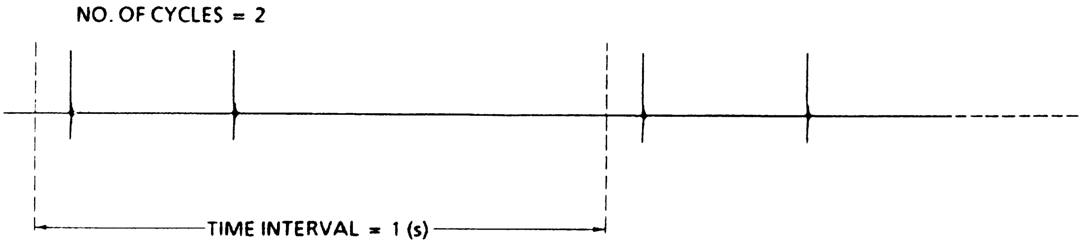
As is the case with the swept sine signal, one frame is considered to be one cycle.



2 Cycles of Periodic Random Signal at 1-s Intervals

⑤ Impulse Signal

As is the case with the swept sine signal, 1 frame is considered to be one cycle.

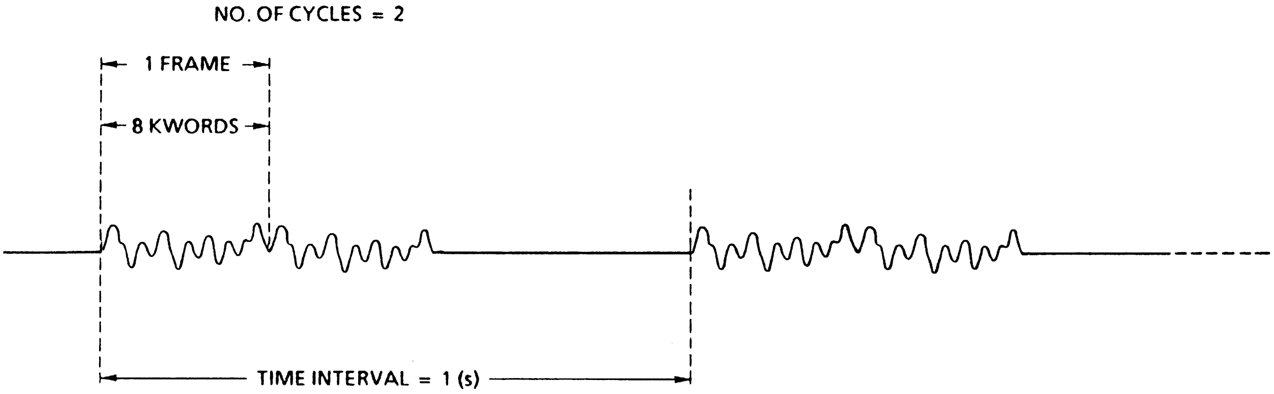


2 Cycles of Impulse at 1-s Intervals

⑥ Time Waveforms

It is possible to obtain a burst output of the time waveform set as described in Section 10.3.3.

As is the case with the swept sine signal, 1 frame is considered to be 1 cycle.



2 Cycles of Time Waveform at 1-s Intervals

< Procedure >

Make the following soft key settings.

SIGNAL OUT

FRQ SET	SELECT	AMPLITD	MEM OUT	OUTcont			RETURN

OUTPUT CONTROL

CONTINU	SINGLE	BURST	CYCLE	TIME	SET		RETURN

When the CYCLE key is pressed, "0001" appears above the soft keys, with the leftmost digit highlighted.

Use the numeric keys on the front panel to input the number of waveform repetitions.

Press the SET key to make the setting.

When the TIME key is pressed, "0001" is displayed above the soft key menu, with the leftmost digit highlighted.

Use the numeric keys of the front panel to input the time interval for the burst output (in units of seconds).

Press the SET key to make the setting.

Note

If the set time interval is shorter than the signal output time (1 cycle length/frame length × number of cycles), the burst will not be output.

10.3.3 Time Waveform Output

One frame of time waveform displayed on the CRT or 4 or 8 Kwords of data from time record memory can be output one time or repeatedly. The output speed is the same as the sampling speed.

In addition, one frame (1024 points) of time waveform displayed on the CRT can be output from the SG-450 Signal Source Unit.

<Procedure>

Make the following soft key settings.

<<< MENU C >>>

SERVO	Y axis	DATAset	OTHERS			OPTION	NEXT
						☞	

<<< MENU D >>>

CmosMEM	SIG OUT	X-Y REC	TRACK	COMP	Opt 6	Opt 7	NEXT
	☞						

SIGNAL OUT

FRQ SET	SELECT	AMPLITD	MEM OUT	OUTcont			RETURN
			☞				

TIME DATA OUT

CRT	RECORD	8K REC					RETURN

(a) Time Waveform Frame Analog Output

<Procedure>

Display the time waveform. For a dual-frame display, output will be made from the data at the bottom of the screen.

TIME DATA OUT

CRT	RECORD	8K REC					RETURN
☞							

① The data on the screen at the at the instant that the CRT key is set to on will be stored in the Signal Output Card.

② Make the following soft key settings.

SIGNAL OUT

FRQ SET	SELECT	AMPLITD	MEM OUT	OUTcont			RETURN
				☞			

OUTPUT CONTROL

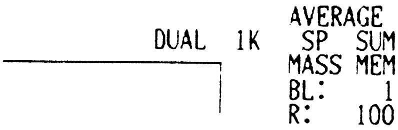
CONTINU	SINGLE						RETURN
a	b						

a CONTINU	....	Selects repeated output of the one frame of waveform stored at step ①.
b SINGLE	....	Makes one output of the waveform of the frame of data stored at step ① each time the key is pressed.

(b) Time Record Analog Output

<Procedure>

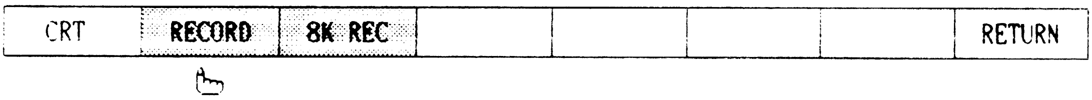
① Set the time record memory address to the starting address for output. The address is displayed in a format "R:" in the VIEW display at the right of the screen.



```
                    AVERAGE
       DUAL  1K      SP  SUM
                    MASS MEM
                    BL:    1
                    R:   100
```

Display the time waveform. for a dual-frame display, output will be made from the data at the bottom of the screen. (The time record memory data need not be displayed.)

TIME DATA OUT



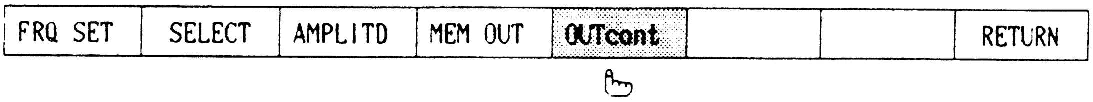
CRT	RECORD	8K REC					RETURN

② Set the RECORD key to on. When this is set to on, output of 4 K or 8 K of data will be made starting at the address displayed in the VIEW section of the CRT display.

③ When 8 K REC key is set to on, 8 Kwords are output and this is set to off, 4 Kwords of data are output.

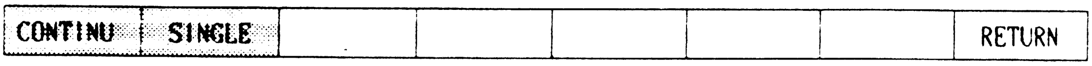
④ Make the following soft key settings.

SIGNAL OUT



FRQ SET	SELECT	AMPLITD	MEM OUT	OUTcont			RETURN

OUTPUT CONTROL



CONTINU	SINGLE						RETURN

a b

a CONTINU	....	Selects repeated output of 4 or 8 Kwords of memory data.
b SINGLE	....	Selects output of one 4 or 8 Kword memory data section each time the key is pressed.

It should be noted that for the 1-Hz frequency range, if the 8K REC key is set to on, the output will be made at double the frequence (speed).

(c) Time Waveform Screen Analog Output From the SG-450

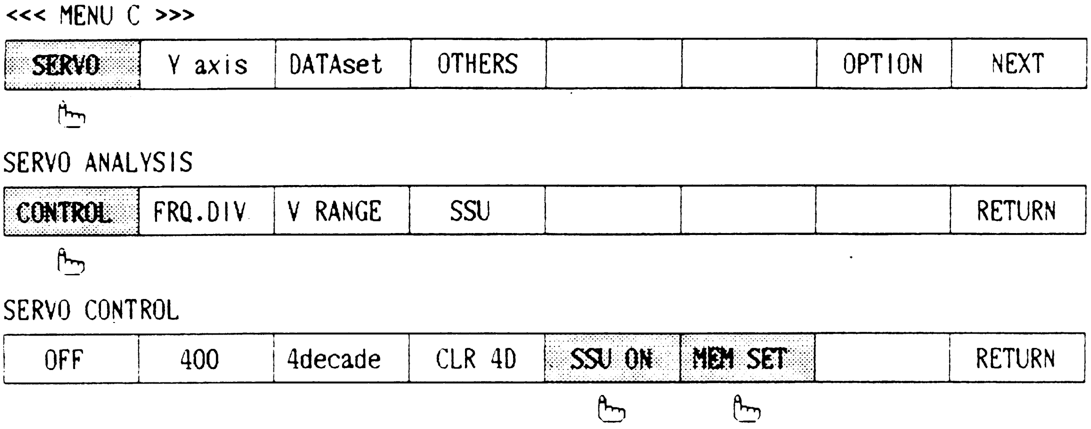
<Procedure>

Connect the SG-450 to the CF-350 using the AX-401 Cable.

Display a time waveform. For a dual-frame display, output will be made for the data on the bottom of the screen.

Set the PAUSE switch of the COMMAND group to on to enable the PAUSE condition.

Make the following soft key settings.



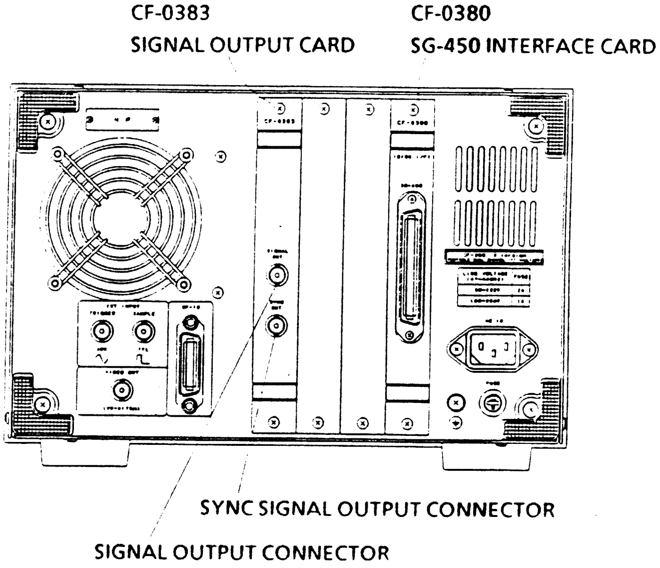
Set the SSU ON key to on.

When the MEM SET key is pressed, the time data displayed will be transferred to the SG-450 and repeated output of this data will be made from the SG-450.

To stop this output and make output of another signal, select the signal at the SG-450 FUNCTION group.

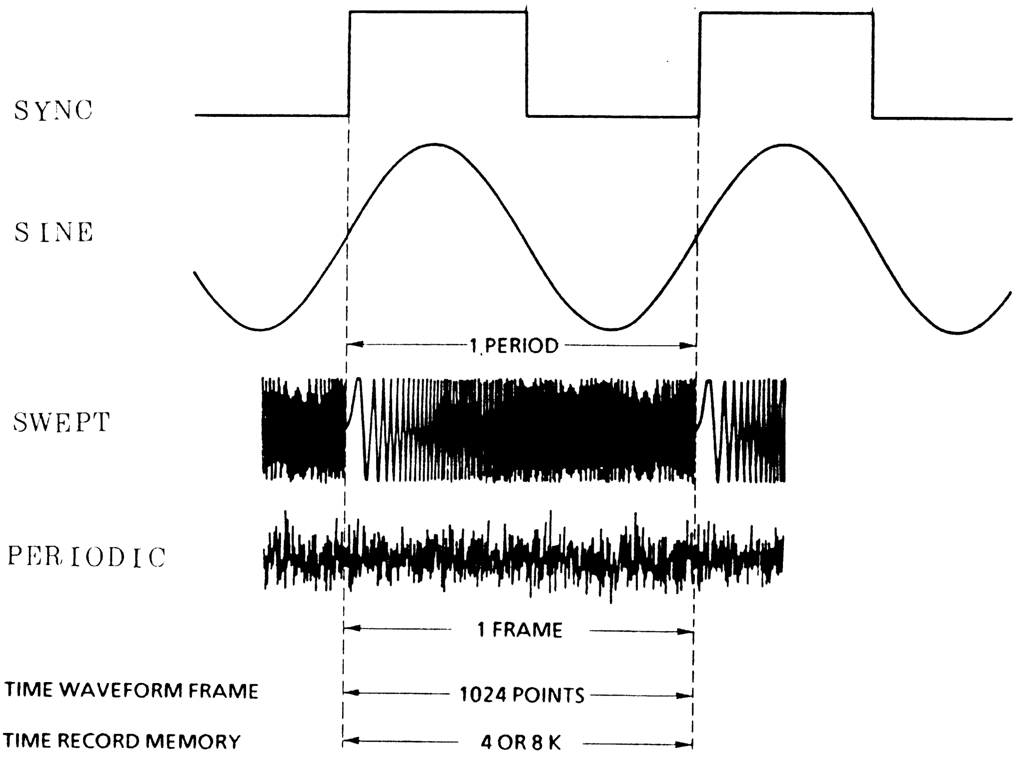
10.3.4 Sync Pulse Output

A pulse signal synchronized to the analog signal output is available at the SYNC OUT connector of the CF-0383 Signal Output Card.

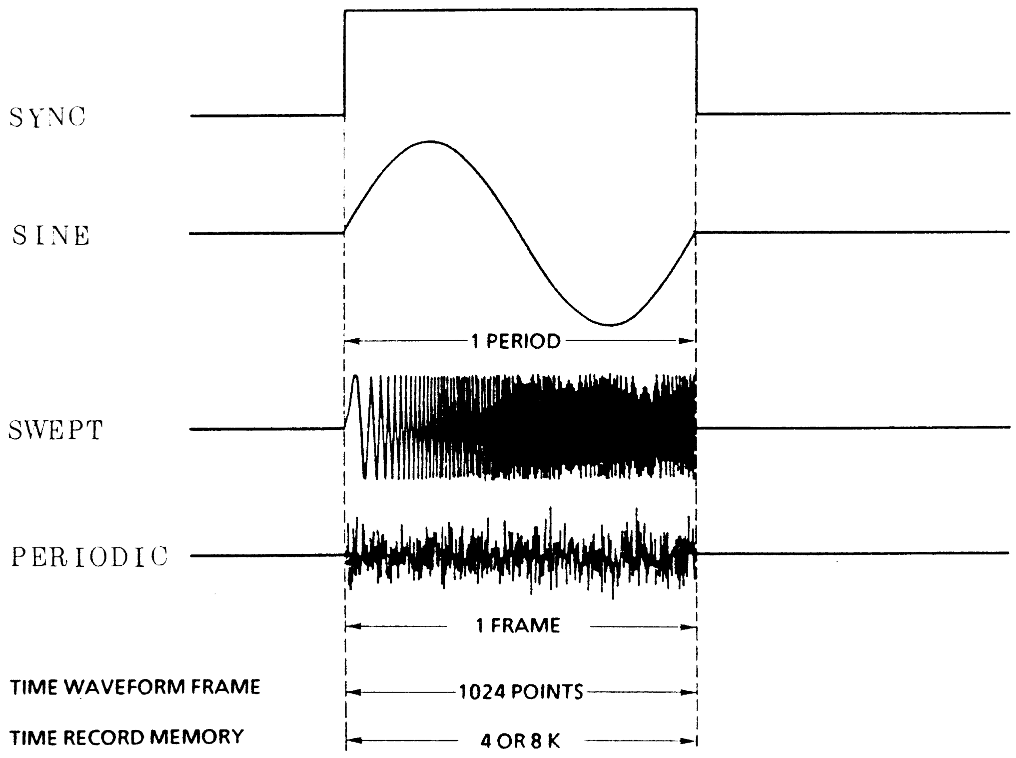


Note that this sync signal is not output for a random analog signal output.

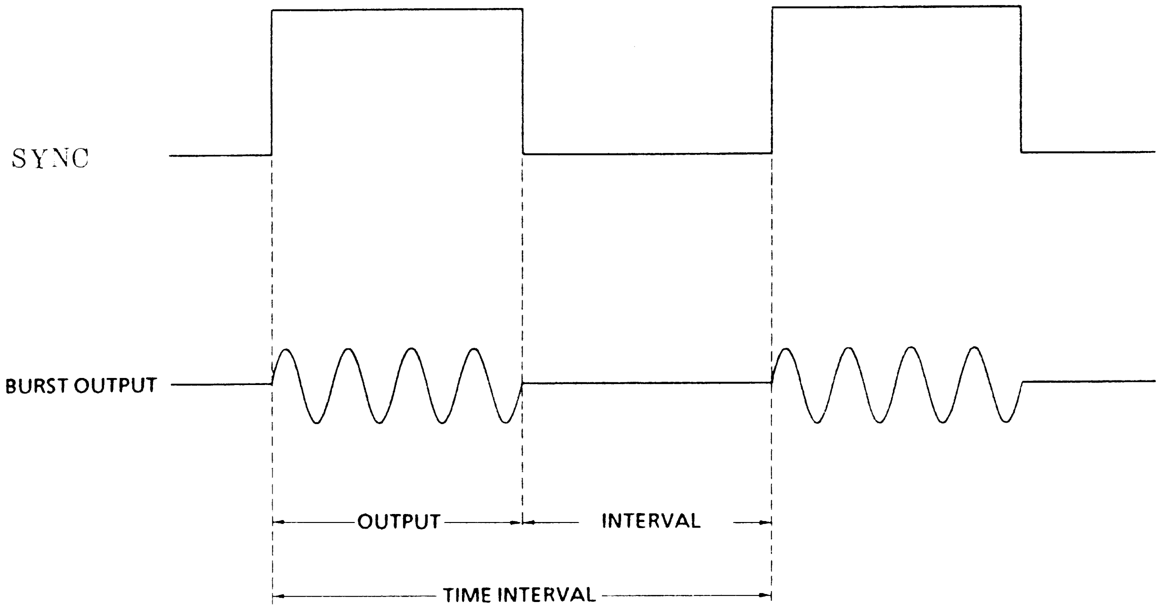
- Continue Mode



- **Single Mode**



- **Burst Output Mode**



When the CF-0354 Servo Analysis Software is installed in the CF-350, a servo analysis function which enables high-accuracy measurement of the transfer function (frequency response function) is possible.

The major features of the servo analysis function are as follows.

1. Autoranging analysis with a dynamic range of 130 dB or greater.

2. A 400-line analysis mode and 4-decade, 1117-line resolution analysis mode.

3. Two types of signal outputs can be selected.

   Internal signal source: CF-0383 Signal Output Card

   External signal source: SG-450 Signal Source Unit (connection to the SG-450 requires the installation of the CF-0380 Floppy Disk and Signal Generator Interface.)

4. Division of the measurement range up to 10 sections and application of specific signal types in each frequency range (signal sequencing function).

   In addition, even if the CF-0354 Servo Analysis Software is not installed, the following functions are possible with respect to the transfer function.

5. Transformations between open-loop and closed-loop functions.

6. Easy synthesis and separation of transfer functions.

7.
   - Time waveform monitoring
   - Power spectrum and instantaneous spectrum display
   - Coherence function display

11. SERVO ANALYSIS

11.1 Servo Analysis Method

The major purpose of servo analysis is to measure the loop gain of a servo system loop and determine the stability and response characteristics of the system.

The following is a simple description of how the loop gain can be measured without having to break the servo loop. (In the figure, SG is a signal source.)

- Calculation Method

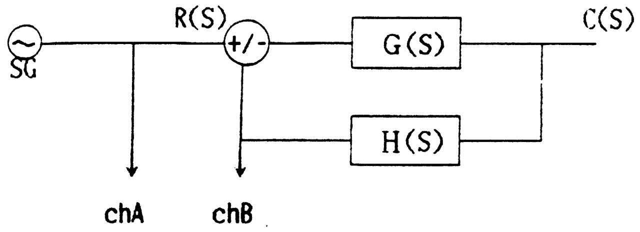


Fig. 11-1 Servo Loop

Measuring the system shown in Fig. 11-1, the transfer function H_1 is as follows.

$$H_1 = \frac{GH}{1+GH}$$

In this relationship, the transformation can be made from closed-loop to open-loop transfer function to obtain the loop gain GH, as follows.

$$GH = \frac{H_1}{1-H_1}$$

- Direct Determination Method

To determine the loop gain of the system directly without having to break the loop, a signal can be inserted into the loop (this signal is treated by the system as a perturbation), and the relevant transfer function at input and output of the system determined.

The actual methods employed consist of the following.

(1) Resistance method

(2) Operational amplifier method

(3) Transformer method (or current-probe method)

Of these methods, (3) uses electromagnetic coupling and, because of its poor characteristics at low frequencies, is not often used.

(1) Resistance Method

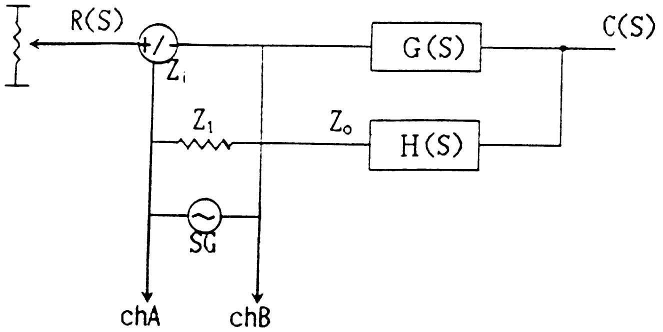


Fig. 11-2 Resistance Method

As shown in Fig. 11-2, the resistance Z_1 is inserted and the signal from the signal source is applied accross this resistances. The voltage accross this resistance is applied to the channel A and channel B inputs and the transfer function is measured. To enable this method to work, the following conditions must be satisfied.

A. If the input impedance and the output impedance accross Z_1 are Z_i and Z_o, the value of Z_1 must be selected to satisfy the following relationship.

$$Z_i >> Z_1 >> Z_o$$

B. Channel A must be isolated from channel B.

Note

In the CF-350, the resistance method cannot be used because of condition B.

(2) Operation Amplifier Method

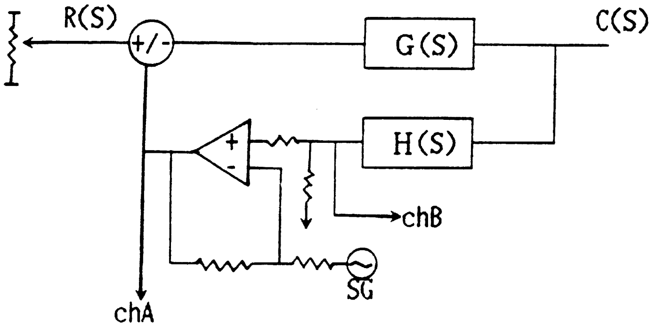


Fig. 11-3 Operational Amplifier

If an operational amplifier is inserted in the circuit and a signal from a signal source is applied, the input/output transfer function can be measured. Compared with the resistance method described above in (1), this method enables high-accuracy measurements, although it requires an added circuit.

Note

In the case of methods (1) and (2), the signal level to be injected should be selected as appropriate to the trade-off between servo stability during measurement and S/N ratio. The level of signal to be injected will also vary depending upon the type of signal.

11.2 Signal Source Connection

The CF-0354 Servo Analysis Software is programmed to use as a signal source either the CF-0383 Signal Ouput Card or the SG-450 Signal Source Unit.

The signals that can be output from these sources are as follows.

	CF-0383 Signal Output Card	SG-450 Signal Source Unit
Output signals	Sine sweep, swept sine, random, periodic random, impulse, arbitrary waveform and pip waveforms	
Pink filter	The pink filter can be applied to the above waveforms	Pink random and pink periodic random
Output voltage	±5 V (open circuit)	±10 V (open circuit)
Output impedance	50 Ω	
Maximum output frequency	40 kHz	100 kHz
DC offset setting	Not provided	Provided

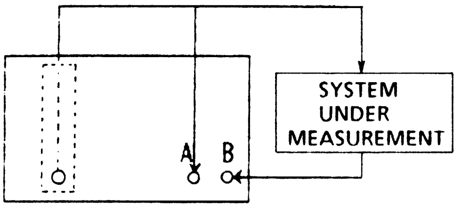
Table 11-1 Signal Outputs

* For the specifications of each of these signals, for the CF-0383, refer to the subsection in Section 1 on signal output and for the SG-450 refer to the SG-450 Instruction Manual Section 1.2.

<Procedure>

A. **Using the CF-0383 Signal Output Card**

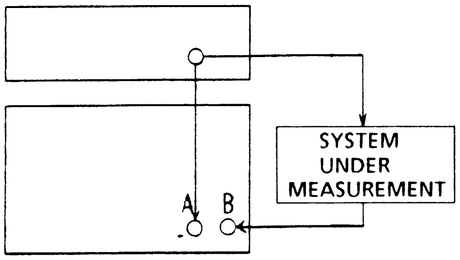
The signal is output from the CF-0383 SIGNAL OUT connector on the rear panel of the CF-350. The signal can then be divided, with one part connected to the front-panel channel A signal input connector and the other part connected to the system under measurement. The output of the system is connected to the channel B signal input connector.



The CF-0383 Signal Output Card can be installed in any of 4 slots.

B. Using the SG-450 Signal Source Unit

Use the AX-401 connecting cable to connect the PERIPHERAL INTERFACE on the SG-450 rear panel to the SG-450 interface on the rear panel of the CF-350. Then divide the signal from the signal output connector of the SG-450 front panel, with one part of this input to channel A of the CF-350 and the other part input to the system to be measured. The output of the system is connected to channel B.



11.3 Analysis Mode Selection and Analysis Execution

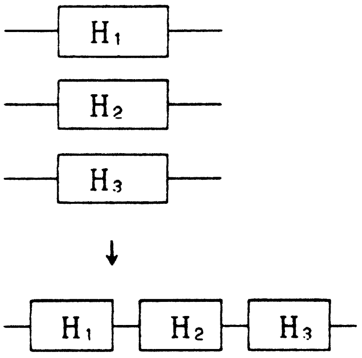
For servo analysis, a 400-line analysis mode and 4-decade analysis mode are available for selection. In the servo analysis mode, the input voltage range can be automatically set using autoranging analysis, which sets the range for each frame or line (for sine sweep). This autoranging analysis function can be switched off or switched off for either channel, if desired.

11.3.1 Analysis Mode Selection

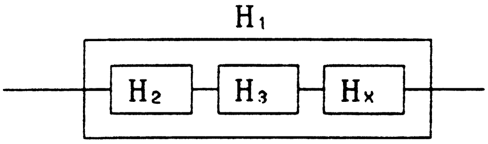
(a) 400-Line Analysis Mode (Differences With Respect to Normal Transfer Function Analysis)

The differences between the transfer function measurement in the servo analysis mode and the normal transfer function measurement (i.e. the measurement performed when SERVO CONTROL is OFF), are as follows. It is also possible to convert normal transfer function data to servo analysis mode transfer function data.

In contrast to the normal transfer function in which data and voltage values are stored separately, in the servo analysis mode, the voltage values are added to the data. For this reason, with the conventional transfer function, it is not possible to store the results of multiplications and divisions between transfer functions into memory, although in 400-line analysis mode transfer functions, these results can be stored. Calculations can be performed between memory data and subsequent data, enabling the calculation of several transfer functions.



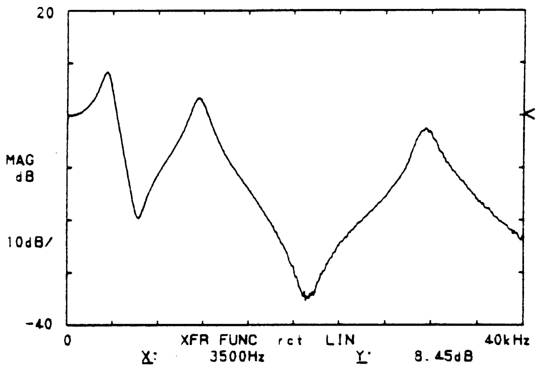
$H_1 \times H_2 \times H_3$



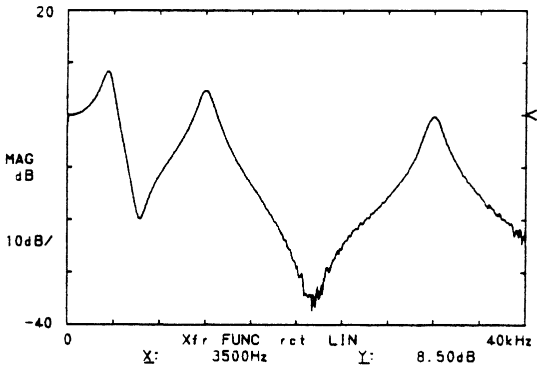
$$H_x = \frac{H_1}{H_2 \times H_3}$$

Conversion to Servo Analysis Mode Transfer Function

It is possible to convert a transfer function which was measured with the servo analysis mode off to a form equivalent to that of servo analysis mode data.



A normal transfer function is indicated by the characters "XFR" at the bottom of the display screen.



A transfer function measured in the servo analysis mode is indicated by the characters "Xfr" at the bottom of the display screen.

<Procedure>

This transformation is possible on a transfer function stored in CRT block memory.

First, display the transfer function by recalling it from memory. Then make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

FUNCTION SET 2

IFFT	ENVELOP	LOOP	XFER	FITTING	ZOOM		RETURN

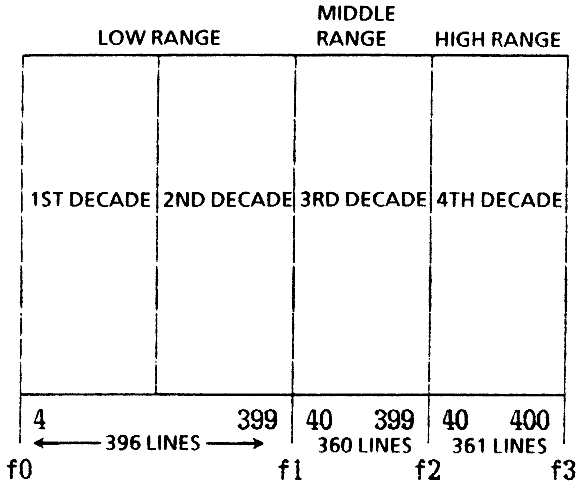
XFER

NICO	1/H	conv SV	CRT IMP				RETURN

(b) 4-Decade Analysis Mode

4-decade analysis divides the frequency range into a low, middle and high range and combines the results of three measurements (lines 4 to 399 in the lower range, 40 to 399 in the middle range and 40 to 400 in the higher range), for a total of 1117 lines in the synthesized transfer function. The X axis is displayed logarithmically.

The line settings are as follows.



The relationship of the frequency range and the analysis range for the 4-decade analysis mode is as follows.

Frequency range (Hz)	Analysis range (Hz)			
	f0	f1	f2	f3
20 k	**2**	**200**	**2k**	**20k**
10 k	1	100	1k	10k
5 k	0.5	50	500	5k
2 k	0.2	20	200	2k
1 k	0.1	10	100	1k
500	0.05	5	50	500
200	0.02	2	20	200
100	0.01	1	10	100

Note

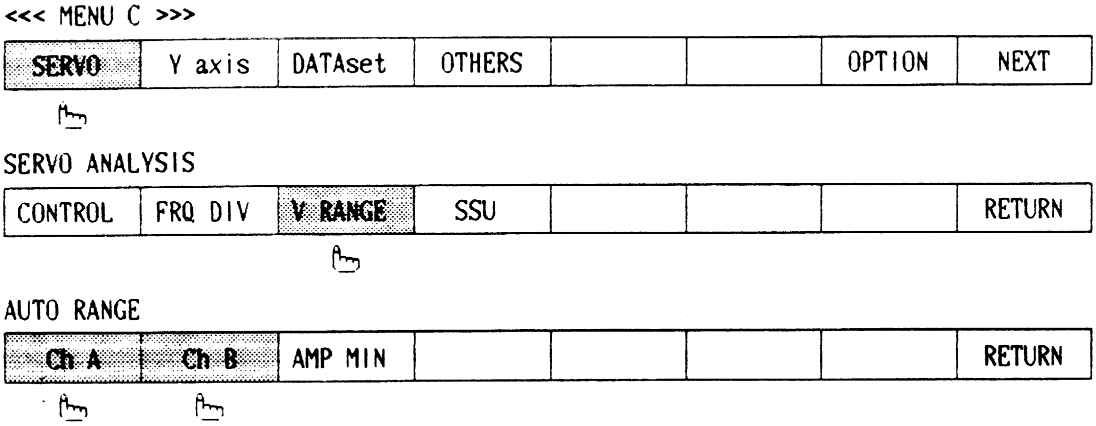
Execution is not possible in the 40-kHz range.

* In the CF-350, execution of 1/H is possible for 4-decade data.

11.3.2 Autoranging Analysis

In the servo analysis mode, autoranging analysis is possible. This function automatically sets the voltage range for each frame of the input signal or each line for a sine sweep. This achieves a dynamic range of 130 dB or greater.

<Procedure>



<<< MENU C >>>

SERVO	Y axis	DATAset	OTHERS			OPTION	NEXT

SERVO ANALYSIS

CONTROL	FRQ DIV	V RANGE	SSU				RETURN

AUTO RANGE

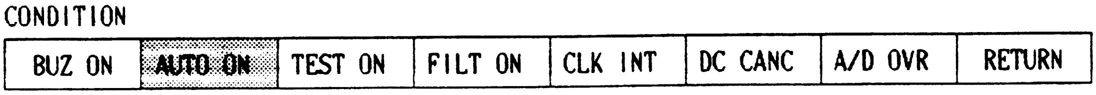
Ch A	Ch B	AMP MIN					RETURN

In the initialized condition, autoranging is set to on for both channels. The Ch A and Ch B keys can be used to turn this function off for either or both channels.

AMP MIN	......	When this key set to on, the output of the SG-450 is made 0 V when analysis is not being performed (i.e. in the PAUSE condition). This does not apply to the output from the CF-0383, however.

Notes

1. When this function is used to perform servo analysis using autoranging, the standard autoranging function (see Section 3.3) is automatically set to on.



CONDITION

BUZ ON	AUTO ON	TEST ON	FILT ON	CLK INT	DC CANC	A/D OVR	RETURN

2. With modes other than servo analysis, the autoranging function (Section 3.3) should be set.

11.3.3 Execution of Analysis

<Procedure>

① On/Off Control Setting of the SG-450

<<< MENU C >>>

SERVO	Y axis	DATAset	OTHERS			OPTION	NEXT
☞							

SERVO ANALYSIS

CONTROL	FRQ.DIV	V RANGE	SSU				RETURN
☞							

SERVO CONTROL

OFF	400	4decade	CLR 4D	SSU ON	MEM SET		RERUTN
				☞			

If the SG-450 Signal Source Unit is connected, the SSU ON key will be on when power is applied or when the system is reset.

When using the SG-450 as a signal source, set the SSU ON key to on. This should be set to off, however, the CF-0383 Signal Output Card is used.

② Selection of 400-Line or 4-Decade Analysis Mode

Set the PAUSE switch of the COMMAND group to on to enable the PAUSE condition.

Make the following soft key settings.

<<< MENU C >>>

SERVO	Y axis	DATAset	OTHERS			OPTION	NEXT
☞							

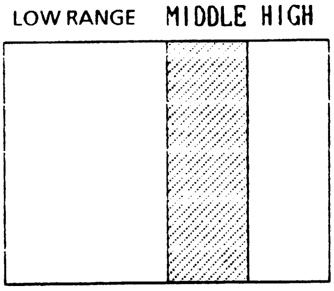
SERVO ANALYSIS

CONTROL	FRQ.DIV	V RANGE	SSU				RETURN
☞							

SERVO CONTROL

OFF	400	4decade	CLR 4D	SSU ON	MEM SET		RETURN
	a	b	c				

a	400	**Selects the 400-line analysis mode.**
b	4decade	Selects the 4-decade analysis mode.
c	CLR 4D	When this key is on, if analysis is performed the previous 4-decade analysis data will be cleared. When this key off, the previous analysis data will be held and the data will be rewritten at the next analysis.



For example, with CLR 4D off, when the middle range analysis is performed the previous data for low and high range are maintained and the middle range data is rewritten.

③ When the START switch of the COMMAND group is set to on, analysis will be began.

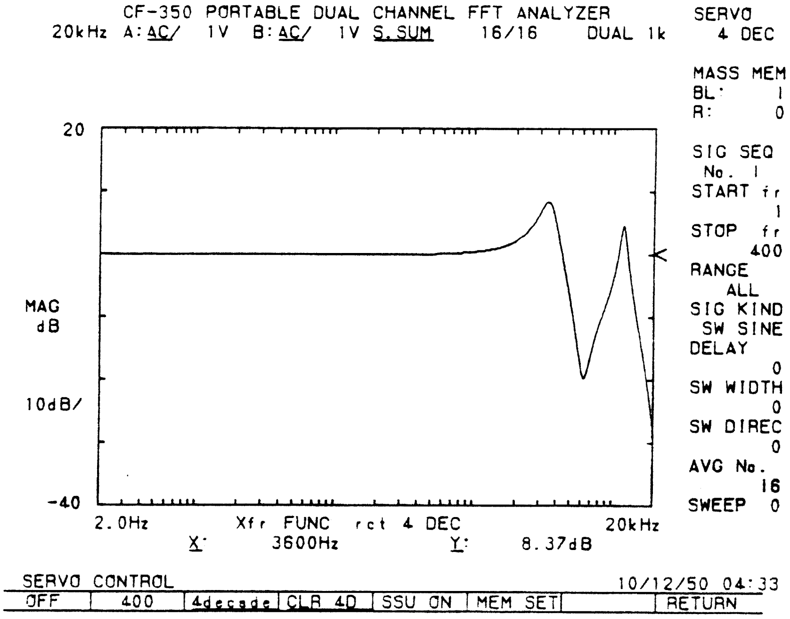
Note

When the OFF key is pressed to set the servo analysis mode to off and return to the normal analysis mode, the averaging type, number of averages, window type, output signal type, output voltage and standard autoranging (see Section 3.3) will not return to their original settings and must be reset.

Before changing to the servo analysis mode, therefore, it is best to store the normal **mode setting conditions in the panel condition memory. (Refer to Section 8.1)**

11.3.4 Servo Analysis Mode Display

When the servo analysis mode is executed, the following display appears.



CF-350 PORTABLE DUAL CHANNEL FFT ANALYZER SERVO
20kHz A:AC/ 1V B:AC/ 1V S.SUM 16/16 DUAL 1k 4 DEC

MASS MEM
BL: 1
R: 0

SIG SEQ
No. 1
START fr
1
STOP fr
400
RANGE
ALL
SIG KIND
SW SINE
DELAY
0
SW WIDTH
0
SW DIREC
0
AVG No.
16
SWEEP 0

Xfr FUNC rct 4 DEC
X: 3600Hz Y: 8.37dB

SERVO CONTROL 10/12/50 04:33

OFF	400	4decade	CLR 4D	SSU ON	MEM SET		RETURN

Fig. 11-4 4-Decade Analysis Display

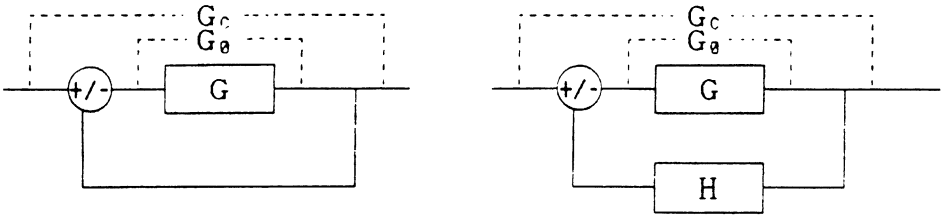
The VIEW section at the right side of the display appears as follows.

SERVO 4 DEC MASS MEM BL: 1 R: 0	.... Indicates the 400-line or 4-decade mode.
SIG SEQ No. 1	.... Indicates the sequence No. during execution. If the signal sequence is on, this will be highlighted. When off, the display will be fixed at No. 1.
START fr 1 STOP fr 400 RANGE ALL SIG KIND SW SINE DELAY 0 SW WIDTH 0 SW DIREC 0 AVG No. 16 SWEEP 0	.... Indicates the sequence analysis conditions.

* For analysis conditions, refer to Section 11.4 on signal sequence analysis conditions.

11.3.5 Transformations Between Open-Loop and Closed-Loop Transfer Functions

It is possible to transform a measured open-loop transfer function to a closed-loop transfer function and vice versa. When a feedback element is present, the transfer function of the feedback element is set.



Unity Feedback System (H = 1)

Closed-Loop Transfer Function

$$G_c = \frac{G_0}{1+G_0}$$

Open-Loop Transfer Function

$$G_0 = \frac{G_c}{1-G_c}$$

System With Feedback Element

Closed-Loop Transfer Function

$$G_c = \frac{G_0}{1+G_0 H}$$

Open-Loop Transfer Function

$$G_0 = \frac{G_c}{1-G_c H}$$

Fig. 11-5 Feedback Systems

<Procedure>

- Unity Feedback Systems (H = 1)

  First, display the transfer function. Then make the following soft key settings.

<<< MENU A >>>

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

FUNCTION SET 2

IFFT	ENVELOP	LOOP	XFER	FITTING	ZOOM		RETURN

LOOP ANALYSIS

OFF	ON	OPEN	CLOSE	H= 1	H SET		RETURN
		a	b				

a	OPEN	.... Selects conversion from closed-loop to open-loop transfer function.
b	CLOSE	.... Selects conversion from open-loop to closed-loop transfer function.

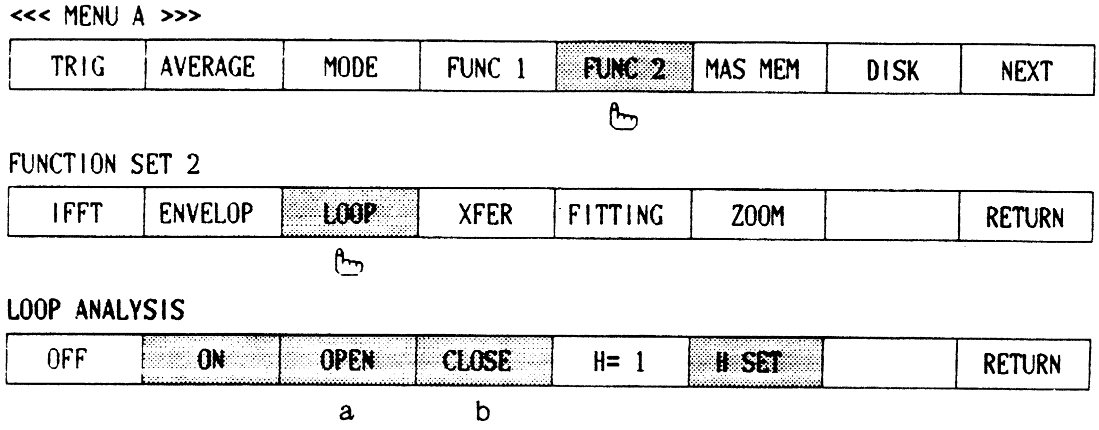
Select either *a* or *b*.

Press the H = 1 key and then the ON key. These operations cause execution of the transformation calculation.

- Systems Having Feedback Elements

First, display the transfer function.

① Make the following soft key settings.



a	OPEN	.... Selects conversion from closed-loop to open-loop transfer function.
b	CLOSE	.... Selects conversion from open-loop to closed-loop transfer function.

② Display the feedback element H (transfer function) on the CRT.

③ Press the H SET key.

④ Display the transfer functions to be calculated upon.

⑤ Press the ON key.

The above operations execute the transformation.

11.4 Signal Sequence Condition Settings

In the servo analysis mode, the measurement range for a continuous analysis sequence can be broken up into as many as 10 divisions with arbitrary signal types, voltage levels and number of averages set for each section, using the signal sequence function.

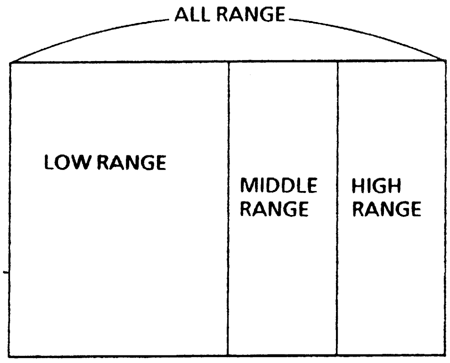
The signal sequence function is set either on or off and settings are made of the division of the measurement range, the individual sequence signal output conditions and analysis conditions. (When the signal sequence function is not being used, the analysis is performed with the conditions set for sequence No. 1.) The set conditions are stored in the signal sequence memory. This memory is battery backed up so that contents are not lost even when the power is switched off.

The signal sequence function enables the following settings.

- 400-Line Analysis Mode

  When using the sine sweep or swept sine, analysis is possible over a specified range only. For other signals, the entire analysis is performed with 400 lines.

- 4-Decade Analysis Mode



For ALL, LOW, MIDDLE or HIGH range, it is possible to set separate analysis conditions. When doing this, even for signals other than sine sweep and swept sine, the specified signal is used for only the specified range.

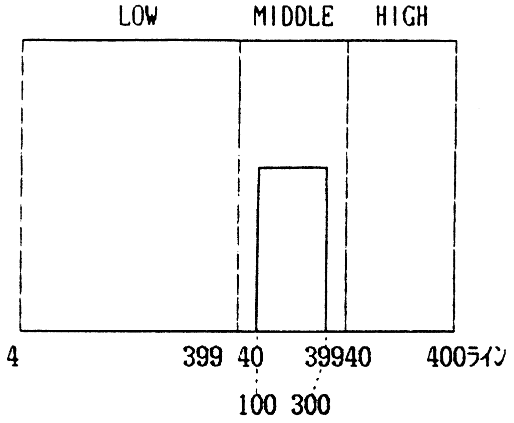
In addition, for sine sweep and swept sine, the range selection can be made as follows.

	Sine sweep		Swept sine	
	ALL ranges	L, M and H ranges	ALL ranges	L, M and H ranges
Starting frequency Stopping frequency	×	○	×	○
Log sweep	×	○	–	–
Sweep width	–	–	×	○

Settings marked ○ are valid and those marked × are invalid.

(Example)

Sine sweep
MIDDLE range
Starting frequency: 100
Stopping frequency: 300



11.4.1 Division of the Measurement Range

The starting and stopping frequencies for signal sequence No. 1 thru No. 10 are set while observing the waveform display. It is also possible to set the signal type for each sequence.

Notes

1. If division is not necessary (i.e. when the signal sequence function is not required), this operation is not necessary. In such cases, the analysis should be performed on all frames with the analysis conditions set for sequence No. 1.

2. The procedure described below describes the method of dividing the frequency range using the cursor. The method described in Section 11.4.3 can also be used to set the starting frequency, stopping frequency and signal type using numerical input.

<Procedure>

Display the power spectrum or transfer function on the bottom part of the CRT and list at the top part.

Set the PAUSE switch of COMMAND group to on to enable the PAUSE condition.

① Make the following soft key settings.

<<< MENU C >>>

SERVO	Y axis	DATAset	OTHERS			OPTION	NEXT

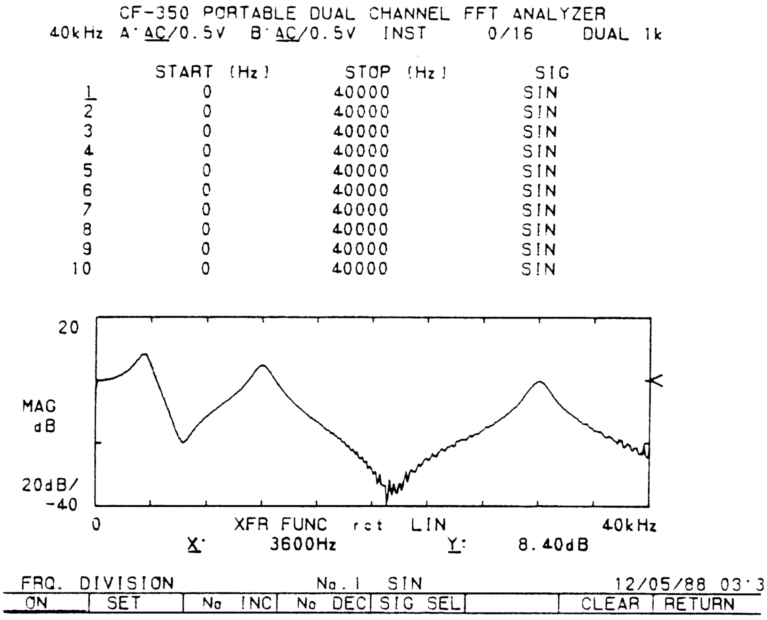
SERVO ANALYSIS

CONTROL	FRQ.DIV	V RANGE	SSU				RETURN

FRQ. DIVISION No.1 S. S

ON	SET	No INC	No DEC	SIG SEL		CLEAR	RETURN

When ON key is pressed, the display will appear as follows.



CF-350 PORTABLE DUAL CHANNEL FFT ANALYZER
40kHz A:AC/0.5V B:AC/0.5V INST 0/16 DUAL 1k

	START (Hz)	STOP (Hz)	SIG
1	0	40000	SIN
2	0	40000	SIN
3	0	40000	SIN
4	0	40000	SIN
5	0	40000	SIN
6	0	40000	SIN
7	0	40000	SIN
8	0	40000	SIN
9	0	40000	SIN
10	0	40000	SIN

XFR FUNC rct LIN
X: 3600Hz Y: 8.40dB

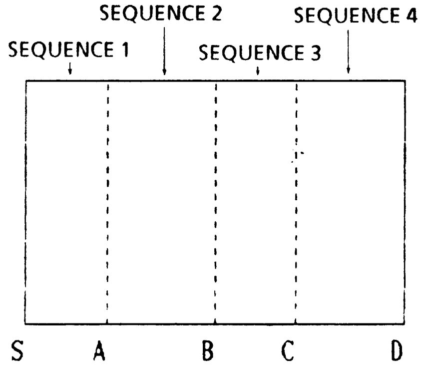
FRQ. DIVISION No. 1 SIN 12/05/88 03:34

Fig. 11-6 Division Setting Frame

In the list display, numbers 1 thru 10 indicate the sequence numbers, START (Hz) and STOP (Hz) indicate the starting and stopping frequencies and SIG indicates the type of signal for the given sequence.

② The sequence number to be set currently will be displayed highlighted. Use the No INC and No DEC keys to move the position of a highlighted number to the sequence number to be set.

③ For example, let us divide the frequency range into four parts as shown below.



First, set sequence No. 1. Press the ON switch of the SEARCH group to set it to on and use the left and right CURSOR switches to move the search point to the starting frequency (S).

Then press the ΔSET switch.

Next, move the search point to the stopping frequency (A).

④ Next, select the type of signal.

Each time the SIG SEL key is pressed, the type of signal displayed above the soft key will change as follows.

SIN (sine)→S.S (sweep sine)→P.R (periodic random)→RAN (random)→IMP (impulse)→MEM (time waveform)

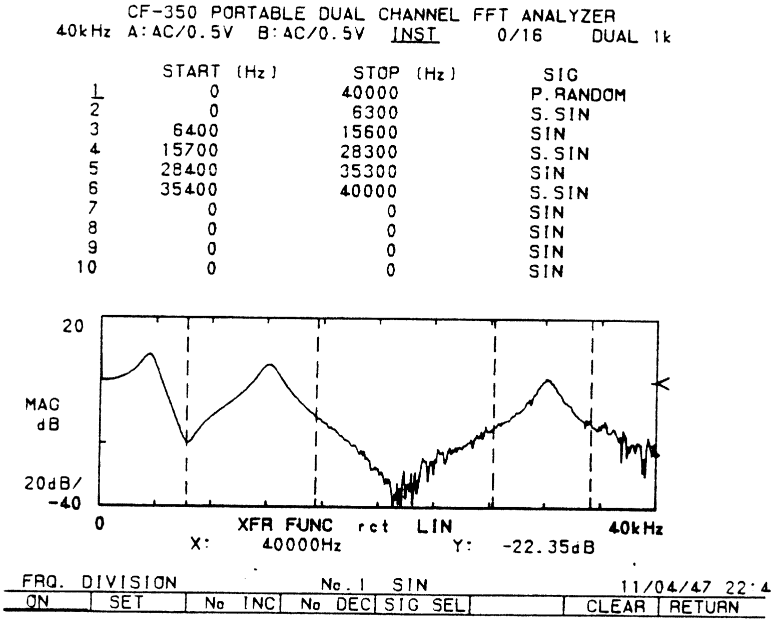
Select the desired signal.

⑤ Press the SET key to make the setting.

When this is done, the range and signal type for sequence No. 1 will be set and the highlighted number will change to No. 2.

⑥ Make the settings for sequence No. 2.

Move the search point to the stopping frequency (B) for sequence No. 2. Then press the ΔSET switch to make the setting. As was the case for step ④, specify the type of signal and then press SET. Repeat step ⑥ to set the sequence No. 3, 4, 5 and so on.



CF-350 PORTABLE DUAL CHANNEL FFT ANALYZER
40kHz A:AC/0.5V B:AC/0.5V INST 0/16 DUAL 1k

	START (Hz)	STOP (Hz)	SIG
1	0	40000	P.RANDOM
2	0	6300	S.SIN
3	6400	15600	SIN
4	15700	28300	S.SIN
5	28400	35300	SIN
6	35400	40000	S.SIN
7	0	0	SIN
8	0	0	SIN
9	0	0	SIN
10	0	0	SIN

FRQ. DIVISION No. 1 SIN 11/04/47 22:44
ON | SET | No INC | No DEC | SIG SEL | | CLEAR | RETURN

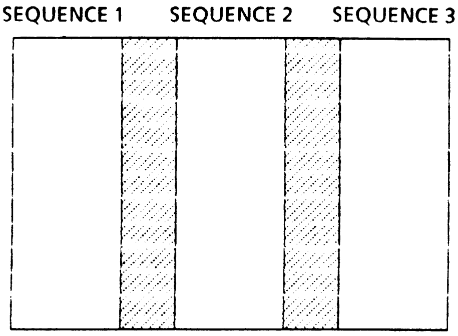
Fig. 11-7 Frequency Range Division

When the CLEAR key is pressed, the starting and stopping frequencies for the highlighted sequence will be cleared to the value zero. If a 4-decade analysis screen was displayed, this will be the starting point frequency (i.e. 2.00 for the 20-kHz range).

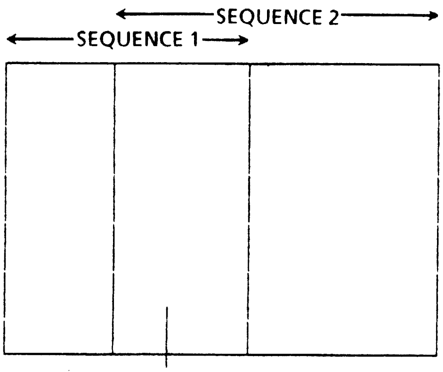
Once the frequency division has been made, when the ON key is pressed, the division setting shown above is displayed.

Notes

1. If there is a space between the stopping frequency of a given sequence and the staring of the next sequence, measurement will not be performed for the open interval. If adjacent sequences overlap, the data for the latter sequence will overwrite the data for the previous sequence.

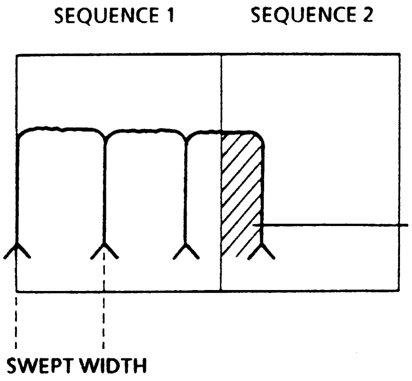


▨ **The shaded portions are not measured.**



Part of sequence 1 data is overwritten by sequence 2 data.

2. When using a swept sine signal, if the sweep width is narrower than the sequence setting width and the division (sequence setting width/sweep width) is not possible, measurement will be made up until the sequence division mark.



The swept sine signal output will be narrowed by this amount, so that the shaded section is not measured.

4-Decade Analysis Settings

For 4-decade analysis, measurement is made in three ranges: LOW, MIDDLE and HIGH.

Division for each sequence can be made within the LOW, MIDDLE and HIGH ranges, although ranges may not be straddled by the sequences. (If this occurs, when the SET key is pressed, the stopping frequency will automatically be set to a border of a range.) In such cases, use the next sequence and set the same conditions.

11.4.2 Signal Sequence Control Condition Settings

<Procedure>

Set the PAUSE switch of the COMMAND group to on to enable the PAUSE condition.

Make the following soft key settings.

<<< MENU C >>>

SERVO	Y axis	DATAset	OTHERS			OPTION	NEXT

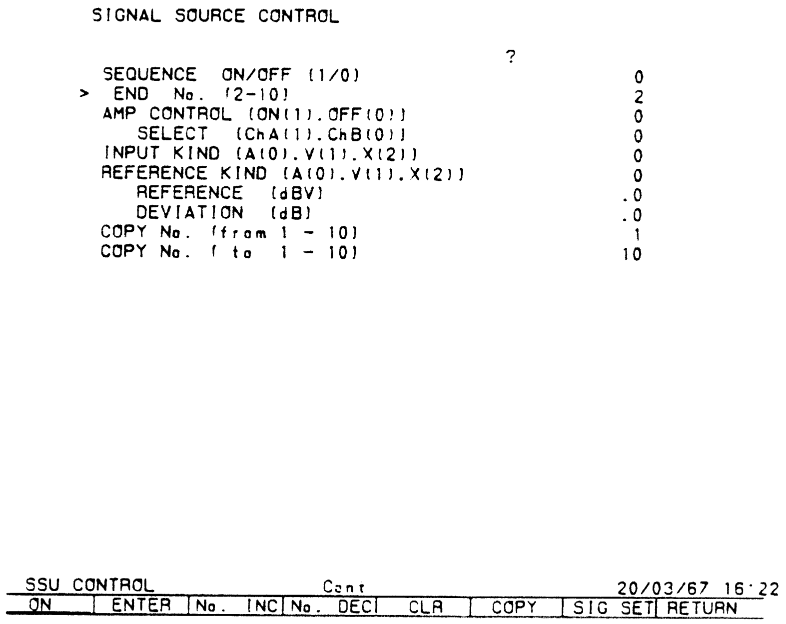
SERVO ANALYSIS

CONTROL	FRQ.DIV	V RANGE	SSU				RETURN

SSU CONTROL Cont

ON	ENTER	No. INC	No. DEC	CLR	COPY	SIG SET	RETURN

The No. INC key causes the display above the soft keys to sequence through "Cont", "No.1", "No.2", and so forth. The No. DEC key moves through the reverse sequence. At this point, set the "Cont". The condition settings will appear on the display as follows.



```
SIGNAL SOURCE CONTROL

                                          ?
 SEQUENCE  ON/OFF (1/0)                             0
> END  No. (2-10)                                   2
 AMP CONTROL (ON(1).OFF(0))                         0
    SELECT  (ChA(1).ChB(0))                         0
 INPUT KIND (A(0).V(1).X(2))                        0
 REFERENCE KIND (A(0).V(1).X(2))                    0
    REFERENCE  (dBV)                               .0
    DEVIATION  (dB)                                .0
 COPY No. (from 1 - 10)                             1
 COPY No. ( to  1 - 10)                            10




SSU CONTROL                 Cont                   20/03/67 16:22
 ON    | ENTER |No.  INC|No. DEC|  CLR  | COPY  |SIG SET|RETURN
```

Fig. 11-8 Signal Sequence Control Condition Settings

This display indicates the execution conditions for the signal sequence.

Move the cursor to the item to be set using up/down CURSOR switches of the SEARCH group.

Input the desired value using the numeric keys on the front panel. The value will be displayed at the upper right of the CRT.

```
SIGNAL SOURCE CONTROL

                                          ?     10
 SEQUENCE  ON/OFF [1/0]                               0
> END  No. [2-10]
```

If you make an error in making the entry, press the CLEAR key to delete it. The ENTER key is pressed to complete the entry.

The setting items are as follows.

① SEQUENCE ON/OFF [1/0]

This setting establishes whether or not the signal sequence (measurement range division) function is to be executed. To execute it (ON) input 1, and inhibit execution (OFF) input 0. If the function is off, all frames will be analyzed using the conditions set for sequence No. 1.

② END No. [2-10]

When executing the signal sequence function, this setting establishes up to what number execution is to be performed. (Execution is performed from sequence No. 1 to the sequence number specified here.)

Note

If at this point a value larger than the sequences for which conditions have been set is input, execution of a meaningless sequence will occur. If it happens that this coincides with a sequence previously measured, data measured from the previous sequence will be overwritten. Care is required that this condition does not destroy valuable data.

③ AMP CONTROL [ON(1),OFF(0)]

When performing a linear sine sweep, this is used to control the signal output (from the CF-0383 or SG-450) so that the power spectrum amplitude on the specified channel is constant. The settings ③ thru ⑧ described below are only valid when analysis is performed using a linear sine sweep and are invalid for all other signals, including analysis using a log sweep. To execute (ON), input 1 and inhibit execution (OFF), input 0.

④ SELECT [ChA(1),ChB(0)]

This setting establishes the channel to be selected for constant power spectrum amplitude control set by AMP CONTROL described above. For channel A, input 1 and for channel B, input 0.

For example, to measure the transfer function of a low pass filter such as shown in Fig. A below (input to the filter applied to CHA and output from the filter applied to CHB), if ChB is selected at ④, to obtain a flat channel B power spectrum, the control of a signal source is made to increase the signal output as the frequency is increased. The power spectra for channels A and B will, under these conditions, appear as in Fig. B. (However, since automatic gain control is performed, changing the voltage range will result in a step change, so that the power spectrum shown in the figure will not be actually displayed.)

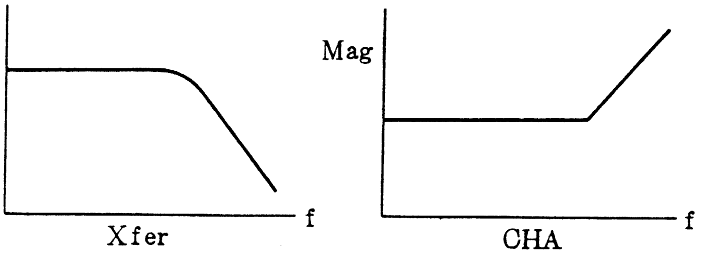


Fig. A

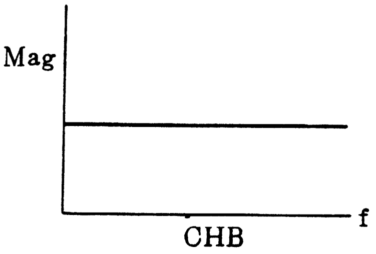


Fig. B

⑤ INPUT KIND [A(0),V(1),X(2)]

Using AMP CONTROL, control is possible to achieve a constant acceleration, velocity or displacement. For example, with an acceleration signal input, to obtain a constant displacement, control is performed by executing a double integration of the power spectrum with respect to frequency. This setting is made appropriate to the type of input signal. It is 0, 1 or 2 for acceleration, velocity or displacement, respectively.

⑥ REFERENCE KIND [A(0),V(1),X(2)]

This setting establishes what signal is to be held constant when the signal selected by item ⑤ is differentiated and integrated. The setting should be made 0, 1 or 2 for constant acceleration, velocity or displacement, respectively.

For example, if ChB is selected at item ④ and the setting of item ⑤ is used to indicate an acceleration signal, when ⑥ is used to control the acceleration stimulus for constant displacement, the signal source output is made to increase the acceleration as frequency is increased, the result·being a constant displacement. This is an effective means of measuring compliance.

⑦ REFERENCE [dBV]

A reference value is input in units of dBV using a reference which is set at REFERENCE KIND. The channel specified by item ④ is controlled to the specified value.

⑧ DEVIATION [dB]

This is the input of the reference value allowable deviation in dB units. If input xdB is made, control to within the reference value ±xdB is performed. The maximum output of the CF-0383 is ±5 V (open circuit) and that of the SG-450 is ±10 V (open circuit). For control within this range, if the value is within the allowable reference value deviation limits, the frequency is changed to the next value. If a calculation results in a required output beyond the maximum value allowable, a move is made to the next frequency without attempting output. In such cases, the spectrum may not be flat.

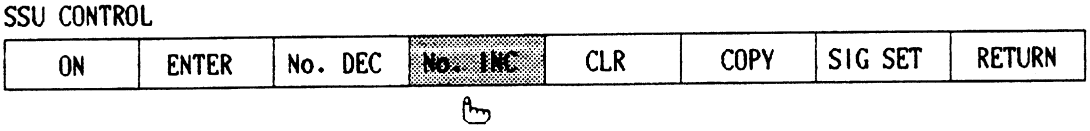
⑨ COPY No. [from 1 - 10]

This item is used to copy the settings of one sequence into another sequence. The number of the sequence to be copied is input as a value from 1 to 10.

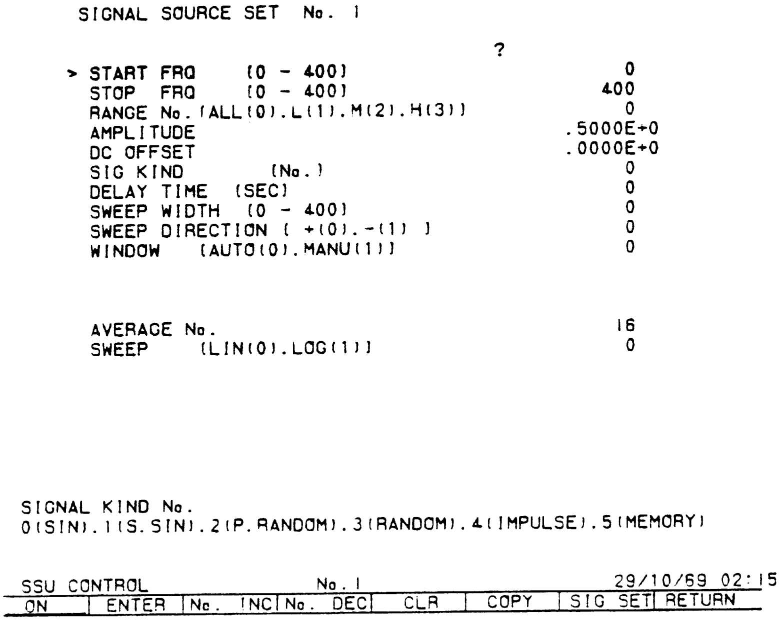
⑩ COPY No. [to 1 - 10]

This specifies to what sequence a copy is to be made. The actual copy is made by pressing the COPY soft key. This copy function copies the starting frequency and stopping frequency as well. For this reason, it is recommended that after conditions ① thru ⑩ and the sequence condition settings described in Section 11.4.3 are set, the measurement range division described in Section 11.4.1 be set.

11.4.3 Sequence Condition Settings



Press the No INC key to display "No.1" above the soft keys. The display of condition settings will appear as follows.



```
      SIGNAL SOURCE SET  No. 1

                                           ?
    > START FRQ     (0 - 400)                            0
      STOP  FRQ     (0 - 400)                          400
      RANGE No.(ALL(0).L(1).M(2).H(3))                   0
      AMPLITUDE                                   .5000E+0
      DC OFFSET                                   .0000E+0
      SIG KIND          (No.)                            0
      DELAY TIME  (SEC)                                  0
      SWEEP WIDTH  (0 - 400)                             0
      SWEEP DIRECTION ( +(0).-(1) )                      0
      WINDOW   (AUTO(0).MANU(1))                         0


      AVERAGE No.                                       16
      SWEEP    (LIN(0).LOG(1))                           0



SIGNAL KIND No.
0(SIN).1(S.SIN).2(P.RANDOM).3(RANDOM).4(IMPULSE).5(MEMORY)

SSU CONTROL                  No. 1                  29/10/69 02:15
 ON     | ENTER |No. INC|No. DEC|  CLR  |  COPY  |SIG SET|RETURN
```

Fig. 11-9 Sequence Condition Setting Display

The signal output conditions and analysis conditions for sequence No. 1 are set.

Move the > cursor using the up and down CURSOR switches of the SEARCH group and then input the desired value, using the front-panel numeric keys. If an error is made in entering the value, press the CLR key to clear the entry Press the ENTER key to actually make the setting. Make the settings of analysis conditions for sequence No. 2, 3 and so on in the same manner.

The setting items are as follows.

① START FRQ [0 - 400]

The starting frequency of sequence No. 1 is set in terms of line number. A value in the range 0 to 400 is input. When the measurement range is divided as described in the beginning of Section 11.4, this setting value is input.

② STOP FRQ [0 - 400]

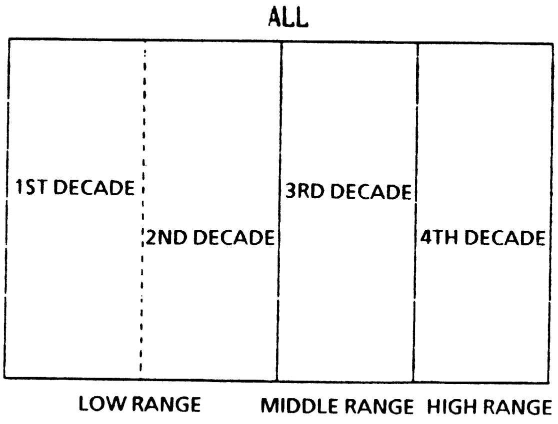
The ending frequency of sequence No. 1 is set in terms of line numbers. A value in the range 0 to 400 is input. When the measurement range is divided as described in the beginning of Section 11.4, this setting value is input.

If "−" slope is set at item ⑨ (SWEEP DIRECTION), the values will automatically be adjusted so that the condition START > STOP is satisfied.

③ RANGE No. [ALL(0), L(1), M(2), H(3)]

When performing 4-decade analysis, the sequence range is specified in separate ranges. For the entire range, input 0, for LOW input 1, for MIDDLE input 2 and for HIGH input 3.

For the 400-line analysis mode, this setting has no effect.



Analysis is performed under the following conditions, according to the setting of this item.

- When ALL is specified for sine sweep or swept sine:

  The ① START FRQ and ② STOP FRQ setting become invalid and the entire 4 decades (1117 lines) are swept.

  For the sine sweep, the log sweep setting for 12 SWEEP becomes invalid. For swept sine, the ⑧ SWEEP WIDTH setting becomes invalid, as this is not possible with the swept sine.

- When L, M and H are specified for sine sweep or swept sine:

  The ① START FRQ and ② STOP FRQ setting become valid. For example, for START FRQ: 200, STOP: 300, when the LOW range is analyzed, analysis is performed from the 200th line to the 300th line of the LOW range.

  The log sweep setting of 12 SWEEP becomes valid, as does the ⑧ SWEEP WIDTH setting.

- When ALL or L, M and H are selected for other signal types:

  The analysis will be performed using the selected signal over the selected range.

  The ① START FRQ and ② STOP FRQ settings become invalid.

In performing a general transfer function measurement, ALL can be specified and the measurement performed with a random signal, after which remeasurement is possible in the desired ranges.

④ AMPLITUDE

This item sets the signal output amplitude. The value is input in units of volts. The value is valid for the SG-450 with a 50-Ω termination (an open circuit results in double the voltage) and for the CF-0383 with an open circuit output. **The display will be in the format .5000E+1** ($=0.5\times10^1$ V). The setting range is the same as the setting range for the CF-0383 or the SG-450 output, this being summarized below.

CF-0383	Amplitude (open circuit)	Setting resolution
	10 mV to 5 V	1 mV
SG-450	Amplitude offset (50-Ω termination)	Setting resolution
	50 mV to 1 mV	0.1 mV$_{0\text{-p}}$
	500 mV to 51 mV	1 mV$_{0\text{-p}}$
	5 V to 510 mV	10 mV$_{0\text{-p}}$

This item is invalid when the ③ AMP CONTROL described in the previous subsection has been set to on.

⑤ DC OFFSET

This is the DC offset setting for the output signal. It is valid only when connection is made to the SG-450 and has no significance when using the CF-0383. However, the setting value assumes a 50-Ω termination. The display is in the format .1500E + 1 ($=0.15\times10^1=1.5$ V). The setting range is up to 5 V (same as ④ AMPLITUDE), with the setting resolution as follows.

SG-450 Offset	Amplitude + Offset	Setting Resolution
	50 mV to 1 mV	1 mV
	500 mV to 51 mV	10 mV
	5 V to 510 mV	**100 mV**

⑥ SIG KIND [No.]

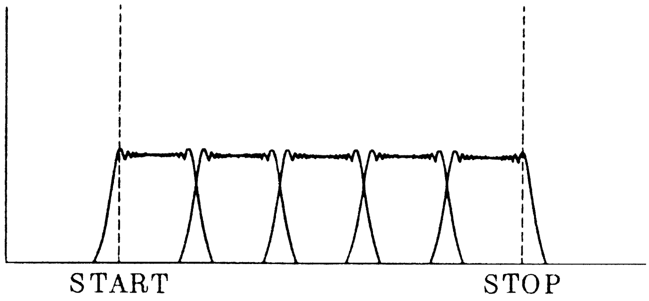
This is the setting of the type of output signal. The values input are 0 for sine sweep, 1 for swept sine, 2 for periodic random, 3 for random, 4 for impulse, and 5 for arbitrary waveform. (An arbitrary waveform is the analog output of a time waveform displayed on the CRT. Refer to Section 10.2.)

⑦ DELAY TIME [SEC]

This is the delay time at the start of sequence No. 1 and between each sequence, measured from the start of signal output to the start of the measurement. The value is input in the range 1 to 9999. This delay should be used for systems required time to stabilize after a signal is applied.

⑧ SWEEP WIDTH [0 - 400]

This is the sweep width for the swept sine, expressed in number of lines. The value is input in the range 2 to 400. Values of 0 and 1 will be taken as 400. This item is invalid if a signal other than swept sine is specified at ⑥ SIG KIND.



As shown in the figure, the sweep is performed from the starting frequency to the stopping frequency with the width of each sweep specified by this setting.

⑨ **SWEEP DIRECTION [+(0), −(1)]**

This is the setting of the direction of the sweep. Input 0 to sweep from the low-frequency end to the high-frequency end and 1 to sweep in the reverse direction. If the "−" direction is selected, the starting and stopping frequencies are adjusted to satisfy the condition START FRQ>STOP FRQ. This setting is only valid for the sine sweep and swept sine signals.

⑩ WINDOW [AUTO(0), MANU(1)]

This is the selection of automatic or manual window setting. The input value is 0 for automatic and 1 for manual setting. For automatic setting, the rectangular window will be selected for all signals except the random signal.

⑪ AVERAGE No.

This is the setting of the number of averages for each band. The value is input in the range 1 to 32,767.

⑫ SWEEP [LIN(0),LOG(1)]

For the sine sweep signal, linear or log sweep can be selected. The input is 0 for linear sweep and 1 for log sweep.

Using log sweep, the sine sweep is performed up to the 18th line, with the swept sine width gradually increasing. The result, when viewed on a linear scale is a narrowing at the low-frequency end, with lost resolution in the high-frequency end. The log scale will show even spacing, however.

Using 4-decade analysis, if the log sweep is performed, the signal sequence should be used to set the LOW, MIDDLE and HIGH ranges. (Log sweep is not possible if ALL was selected at item ③ RANGE No.)

When log sweep is selected, amplifier control items ③ thru ⑧ of the signal sequence control condition settings (Section 11.4.2) are not possible.

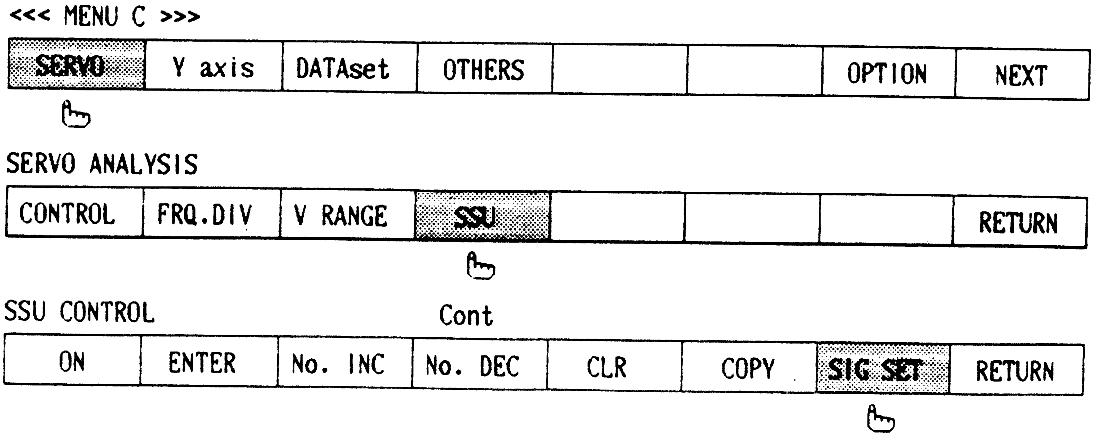
11.4.4 Checking the SG-450 Output

When using the SG-450 as a signal source, if the servo analysis is performed, the set signal will be output. The output can be verified before performing the actual analysis.

<Procedure>

Press the PAUSE switch of the COMMAND group to enable the PAUSE condition.

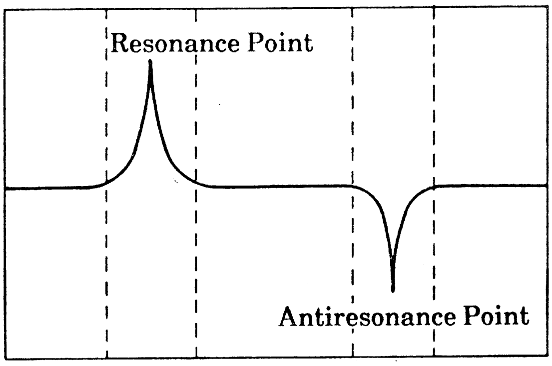
Make the following soft key settings.



When the SIG SET key is pressed, the setting conditions are sent to the SG-450 and the set signal is output from the SG-450.

Signal Sequence Function

When measuring the transfer function of a transmission system having transfer characteristics as shown below using a random signal to perform analysis over the entire range, the measurement time will be short. However, definition will not be sufficient at resonances and anti-resonances, causing loss of these points, thereby marring the accuracy of the measurement. If the system is measured using a swept sine, on the other hand, accuracy will be obtained at the cost of a long measurement time--again, an impractical approach.

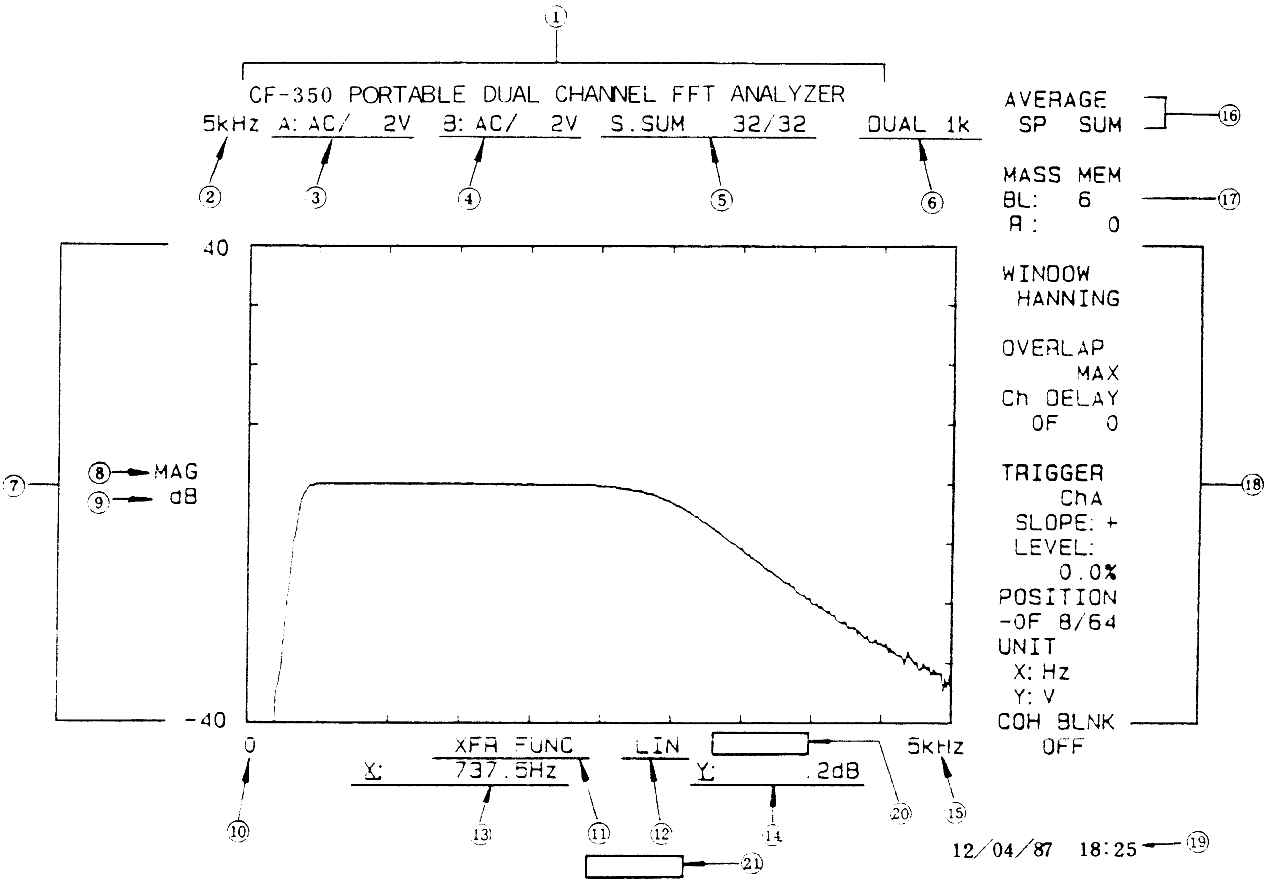


The signal sequence function solves this problem. At high-Q resonances and anti-resonances in the transfer function, a sine or swept sine having a small crest factor (peak/rms ratio) can be used to ensure sufficient resolution and along roughly flat sections, a broad swept sine can be used to enhance measurement speed.

In addition, when using a sine sweep or similar signal having a small crest factor, it is necessary to take care that large inputs do not cause non-linear operation near resonances. In such cases, observe the output spectrum to verify that such non-linear operation (as manifested by harmonics and similar components) is not occurring. For the operation procedure, refer to Section 5.1 on display the instantaneous spectrum. At anti-resonances, on the other hand, the output will be low, thereby running the risk of superimposed noise. It is therefore necessary to increase the input level over these portions of the spectrum. The signal source control settings ③ thru ⑧ of Section 11.4 provide the means of solving these problems created by resonances and anti-resonances. The signal source is normally controlled to obtain a constant output spectrum.

12. DISPLAY AND SOFT KEY DESCRIPTION

12.1 Display



Display part	Displayed pattern	Description and comments
① Label		Identification index for use with disk files
② Frequency range (Highlighted for external sampling)	* Hz	* is a value in the range 1 to 40 k
③,④ AC/DC coupling and voltage range display (for channels)	AC DC * V	AC coupling Highlighted display DC coupling for DC cancel * is a value in the range 1 m to 5 m (AC only), 10 m to 50
⑤ Averaging and number of averages display (If number of averages is highlighted, display-inhibit function is on.) (If averaging is highlighted, high-precision mode is on.)	S. SUN */** S. EXP */** S. PEK */** S. SWP */** T. SUM*/** T. EXP */** T. ABS */** H. SUM */**	Normalized average (* = 1 to 32767) Exponential average (* = 2 to 16) Peak hold (unlimited) Sweep average Time-axis normalized average (* = 1 to 32767) Time-axis exponential average (* = 2 to 16) Time-axis absolute-value average (* = 1 to 32767) Histogram normalized average (* = 1 to 32767)

Display part	Displayed pattern	Description and comments
⑥ Data length display (If highlighted, playback from record memory is in progress.)	DUAL 1 K	Ch A and Ch B used, 1,024 points
	Ch A 2 K	Ch A used, 2,048 points
	Ch B 2 K	Ch B used, 2,048 points
⑦ Y-axis span display		
⑧ Waveform type	MAG	Magnitude
	PHASE	Phase
	REAL	Real part, level (for TIME)
	IMAG	Imaginary part
	PDF	Probability density function
	CDF	Probability density distribution
	M *	CRT block memory display (* = 1 to 60)
⑨ Y-axis units display	dBV	
	dBEU	Operative when the Y UNIT switch is on.
	dBVr	
	V	
	EU	Operative when the Y UNIT switch is on.
	Vr	〃
⑩ X-axis starting point	0	0 Hz = DC (For DC coupling)
		For time-waveform display
	***** sec	For time-waveform expanded display and correlation function
	* V	For PDF and CDF (* = ± 1 m to 50 m, ±0.1 to 50)
	BN *	For octave display (* = −2 to 36)
⑪ Function name display	TIME *	Time waveform (* = A, B = channel)
	PWR SP *	Spectrum (* = A, B = channel)
	SPECT *	Fourier spectrum (* = A, B = channel)
	CRS SPEC	Cross spectrum
	XFR FUNC	Transfer function
	COH	Coherence function
	COP	Coherence output power
	IMP RESP	Impulse response
	CORR *	Auto-correlation function (* = A, B = channel)
	CRS CORR	Cross-correlation function
	HIST *	Histogram (* = A, B = channel)
	* OCT	Octave spectrum (* = 1/1, 1/3)
	CEPST *	Cepstrum (* = A, B = channel)
	4 DEC	4-decade transfer function

Display part	Displayed pattern	Description and comments
⑫ X-axis scaling	LIN	Linear display
	LOG	Log display
	Ex n	Time-axis expansion (n = 2 to 16)
	X N	Frequency zoom (N = 2 to 256)
⑬ X-axis reading value	SEC	
	Hz	
	CPM	Enabled when X-axis UNIT switch is on.
	ORD	(Order) "
	***	Number of PDF and CDF samples
	[***] Hz	For octave display ([***] = 2 to 50)
⑭ Y-axis reading value (Note: P – is when partial overall is executed)	V, PV	
	Vr, PVr	Enabled when Y-axis UNIT switch is on.
	dBV, PdBV	
	dBr, PdBr	Enabled when Y-axis UNIT switch is on.
	dBEU, PdBEU	"
		"
⑮ X-axis ending point	* sec	Time length of 1 frame (± = 1/f max data length)
		Arbitrary for expansion.
	* Hz	Frequency span upper limit (* = 1 to 40 k)
		Arbitrary for zooming.
	***	Number of PDF and CDF samples
	BN *	Band number for octave display (* = 12 to 50)
⑯ Averaging setting condition		Highlighted when the analysis source is the disk.
⑰ CRT block memory and time record memory	BL: **	Highlighted when storage is completed (* = 1 to 60)
	R: *****	Storage completed unless address is 0.
⑱ VIEW function		8 functions are available
⑲ TIME, TIMER (Highlighted when interval function is on.)	**/**/**	Current date (day/month/year)
	** : **	Time
⑳ FUNCTION	ADD	Addition
	DEF	Subtraction
	MULT	Multiplication
	DIV	Division
㉑ TIME INTERVAL	* SEC	* = 1 to 9999 interval time

OPERATION MESSAGE LIST

	Message	Meaning and comments (including limitations)
A	A Ch ONLY	Possible for Ch A only. A 2048-point data length is selected. The Ch A only recording mode is selected.
	AC ONLY	Only AC coupling is possible. The attenuation range is 50 mV or lower.
	ANALOG OUT BUSY	X-Y output or analog output in progress. Plotting is not possible.
	AUTO SEQUENCE	Auto sequence in progress. As long as auto sequence is not switched off, other key operations will cause an error.
	AUTO ZERO	Auto zero function processing in progress. Execution will be possible after processing is completed.
	AVERAGING	Averaging in progress. As long as the averaging switch is not set to off, the type of averaging cannot be changed.
B	B Ch ONLY	Possible for Ch B only. B 2048-point data length is selected. The Ch B only recording mode is selected.
	BUSY	Calculation in progress/data recall in progress Panel condition, sequence recall/exponential window calculation/X-axis expansion, etc.
C	CHANGE DISPLAY	Change display. An attempt was made to set a mode differing from the display screen using soft key operations (e.g., exponential window). An attempt was made to set panel conditions during a mass memory content display.
	CHANGE LENGTH	Change number of data points. An attempt was made to execute a function impossible with the current number of data points.
	CHANGE SOFTKEY	Change soft key display. When the soft key function-selection display is on the screen, it is not possible to load panel conditions.
	CHANGE SUM	Change the averaging mode. During the execution of histogram averaging, an attempt was made to display a different function.

	Message	Meaning and comments (including limitations)
	CHANGE TRIG	Change the type of trigger.
	Ch A(B) A/D OVER	Ch A(Ch B) A/D converter has overflowed. Lower the input sensitivity appropriately.
	Ch A (B) ONLY	Ch A (Ch B) only analysis mode.
	CLEAR REC MEMORY	Clear the record memory. When switching from the 255-Kword to the 31-Kword mode, the record memory data was not cleared, or the reverse occurred.
	COMPLETE	Setting, storage or recall is complete.
	CONDITION DISAGREE	Improper condition setting. For example, an attempt was made to perform a calculation between waveforms having a different frequency ranges.
	CRT MEM CLEAR OK?	Is it OK to clear CRT data from mass memory?
D	DATA NOT STORED	Data not stored. For example, there was no data to be equalized for the equalization transfer function.
	DELTA OFF	Delta cursor off. Delta cursor turned off for the search-enhance function execution.
	DEVICE MISMACH	Data is not compatible with CF-350 format. For example, 50-kHz or 100-kHz range data from the CF-900 series.
	DIFFERENT RANGE	In the servo mode, when setting the signal sequence, the specified range was exceeded.
	DISK COPY	Disk self-copy in progress. When the START key pressed, the self-copy will be executed.
F	FILE END	No more file remaining. The floppy disk is full. During a disk playback, the last file was reached and stop was made.
	FORMAT ERROR	Improper disk format. Reformat disk.
	FUNCTION DISAGREE	Disagreement with calculation execution conditions. For example, for the calculation function, an attempt is made to perform a division between time-axis waveforms.

	Message	Meaning and comments (including limitations)
G	GAIN OVER	Gain overflow. X-axis expansion, Y-axis gain.
M	MATCH Ch A (Ch B) AMP	Make the Ch A (Ch B) attenuation range agree. The equalization transfer function set data and current data attenuation ranges are not in agreement
	MATCH FRQ RANGE	For the equalized transfer function, the frequency ranges of Ch A must agree.
	MATCH DATA LENGTH	For the equalization transfer function, the data length of Ch B must agree.
	MEMORY PROTECT	Mass memory is protected by soft key operations.
N	NO STORE	No data stored. An attempt was made to recall an address at which no data in mass memory or disk was stored.
	NOT AVAILABLE	Execution not possible.
	NOT CONTINUE	Continuation not possible. Attempt was made to continue averaging even after reaching the set number of averages.
	NOT READY No.0	No disk in drive 0.
	NOW PLAYBACK	Playback in progress.
	NOW SERVO MODE	Servo mode execution in progress; that function disabled.
	NOW SETUP VIEW MODE	Setup view display in progress. Turn the setup view soft key off.
	NOW USING MARKER	Marker already being used. Cannot be used for other function.
O	OFF COH BLANK	Set coherence blanking to off.
	OFF OCTAVE	Set octave analysis mode to off.
	OPTION	That function is an option.
P	processing	Processing in progress.
R	RANGE OVER	Attenuator or frequency range upper limit or lower limit reached.
	READ ERROR	Readout error. Disk data is lost.

	Message	Meaning and comments (including limitations)
	RECALIB ERROR	Disk drive error.
	RECORD MEM CLEARED	Contents of mass memory erased. Before this message, CRT MEM CLEAR OK? will be displayed.
	RECORD COMPLETE	Storage completed.
	RD-WT TEST ERROR	Readout and writing test error. During disk formatting, a misoperation caused loss of disk data.
	REMOTE OR LLO	Remote or local lockout condition. The panel switches are in remote condition set via GPIB or the local lockout condition has been set.
S	SEEK ERROR	Disk drive error.
	SELECT LOW or UP	Specify LOW (lower frame) or UP (upper frame).
	SELECT WINDOW	Set the window value and range.
	SERVO MODE	In the servo mode, that function is disabled.
	SET COH BLANK OFF	Set the coherence blanking to off.
	SET COMPLETE	Setting complete.
	SET DELTA CURSOR	Set the delta cursor. Used for signal output, force window and partial overall settings.
	SET OCTAVE OFF	Set the octave analysis to off.
	SET SEARCH ON	Set the search function to on. For example, if the first order component is set for a harmonic list.
	SET SEQ MODE	Set the autosequence mode or execution mode. The panel switch sequence key was pressed without making the soft key setting.
	SET START	Set the START condition at the COMMAND group. Real time zoom is operative in the start condition. This is true of data length switching as well.
	SET PAUSE	Set the PAUSE condition at the COMMAND group. When soft key settings are made, and during plotting.
	SET TALK ONLY	Set GPIB to talk only mode.

	Message	Meaning and comments (including limitations)
	SET TRG FREE	Set the trigger mode to free.
	SET Y LOG	Set the Y-axis scaling to log display. For example, for cepstrum.
	SET ZOOM OFF	Set zoom function to off. During zoom execution, the X-axis log scaling is not possible.
	SET + OR –	Input + or – character. When performing EU calibration using dB/S.P, input is made with a sign (e.g. +124 dB or –4 dB).
	SEQUENCE END	Autosequence end.
	SEQUENCE MEMO FULL	Autosequence memory is full. During setting, step 63 was exceeded.
	SINGLE MODE	Single-channel execution mode. For example, data length of 2048 points.
	SINGLE ONLY	Single-frame display mode. Dual-frame display with Nyquist plot not possible. List display not possible on lower frame.
	SPE ONLY MODE	Spectrum-only mode display.
	SSU not present	SG-450 is not connected using the AX-401 or soft key <<<MENU C>>> SERVO, SSU not on.
	STOP PLOTTER	Stop plotter output. While this display is output, other functions cannot be used.
	STOP STORE	Stop storage.
	STORE NOT AVAILABLE	Storage not possible. Attempt was made to store faster than internal calculation timing.
T	TIME ONLY MODE	Time-only mode enabled.
	TRIG MISMATCH	Change trigger type.
W	WRITE ERROR	Writing error. Disk operational error or disk formatting error.
	WRITE PROTECT	Writing is not possible due to protection. The disk write protect tab has been bent.

12.2 Soft Key Function Summary

(Does not include NEXT and RETURN)

TRIG	AVERAGE	MODE	FUNC 1	FUNC 2	MAS MEM	DISK	NEXT

TRIG

1	2	3	4	5	6	7	8
SOURCE	SLOPE	POSIT	LEVEL	SELECT			RETURN

1. SOURCE ... Selection of the Signal Used as the Trigger Reference

Ch A	.... Apply trigger using Ch A signal as reference.
Ch B	.... Apply trigger using Ch B signal as reference.
EXT	.... Apply trigger with an external signal as reference.
VIEW A	.... Monitor the external trigger signal on Ch A.
VIEW B	.... Monitor the external trigger signal on Ch B.

2. SLOPE ... Selection of Trigger Polarity

+	.... Selects rising edge (positive polarity).
–	.... Selects falling edge (negative polarity).

3. POSIT ... Setting of Trigger Position (Position on X-Axis)

NUMERIC	.... Enables input of the numerical trigger position using numeric keys.
SET	.... Sets the trigger position.

4. LEVEL ... Setting of the Trigger Level (Position on the Y-Axis).

MRK SET	.... Sets the trigger level using the search marker.

5. SELECT ... Selection of the Trigger Type

REPEAT	.... Selects the repeated trigger.
SINGLE	.... Selects the single trigger.
ONE shot	.... Selects the one-shot trigger.
CANCEL	.... Executes the cancel function (when summation average is performed with repeated triggering).

AVERAGE

1	2	3	4	5	6	7	8
PWR SP	TIME	HIST	FOURIER	MAXoval	DISPLAY	CONTROL	RETURN

1. PWR SP ... Selection of Spectrum Averaging Type

SUM	....	Selects summation averaging.
EXP	....	Selects exponential averaging.
PEAK	....	Selects peak hold.
SWEEP	....	Selects sweep averaging.
DIFF	....	Selects differential averaging.
INC	....	Increments the number of averages.
DEC	....	Decrements the number of averages.

2. TIME ... Selection of the Type of Time-Axis Averaging

SUM	....	Selects summation averaging.
EXP	....	Selects exponential averaging.
ABS	....	Selects absolute-value averaging.
INC	....	Increments the number of averages.
DEC	....	Decrements the number of averages.

3. HIST ... Selection of Averaging on the Amplitude Axis

SUM	....	Selects summation averaging.
HIST A	....	Displays the amplitude probability density function for Ch A.
HIST B	....	Displays the amplitude probability density function for Ch B.
INC	....	Increments the number of averages.
DEC	....	Decrements the number of averages.

4. FOURIER ... Selection of FOURIER Spectrum Averaging

SUM	....	Selects summation averaging.
EXP	....	Selects exponential averaging.
INC	....	Increments the number of averages.
DEC	....	Decrements the number of averages.

5. MAXoval ... Execution of Maximum Overall Function (For Peak Hold Mode Execution)

OFF .... Sets execution to off.

ON .... Sets execution to on.

6. DISPLAY ... Instant Waveform Screen Display During Averaging Execution

LOW .... Enables the instant mode for single-frame display or the lower part of a dual-frame display.

UP .... Enables the instant mode for the upper part of a dual-frame display.

7. CONTROL ... Execution of Average Control Function

CONTINU .... Executes the continue function.

SUM NUM .... Sets an arbitrary number of averages.

MODE

1	2	3	4	5	6	7	8
OVERLAP	LENGTH	WINDOW	W SET	DELAY	SP ONLY	SOURCE	RETURN

1. OVERLAP ... Selection of the Amount of Overlap (Window Overlap)

MAX .... Sets the maximum possible overlap.

50% .... Sets the overlap to 50%.

0% .... Sets no overlap.

2. LENGTH ... Selection of the Number of Sampling Points and Display Resolution

ChA 2K .... Selects 2048-point Ch A sampling (1/800).

ChB 2K .... Selects 2048-point Ch B sampling (1/800).

DUAL 1K .... Selects 1024-point 2-Ch sampling (1/400).

3. WINDOW ... Selection of Window Type

RECT	....	Rectangular window.
HANN	....	Hanning window.
FLAT	....	Flat-top window.
USER	....	User-defined window.
F-F	....	Ch A force window and Ch B force window.
E-E	....	Ch A exponential window and Ch B exponential window.
F-E	....	Ch A force window and Ch B exponential window.

4. W SET ... Setting of Force Window, Exponential Window and User-Defined Window

FORCE	....	Force window setting mode.
EXP	....	Exponential window setting mode.
USER	....	Sets a displayed waveform as the window (user definded window).
DISPLAY	....	Display of window-processed time-axis waveform.
SET	....	Sets the window coefficient.

5. DELAY ... Channel-To-Channel Delay Function

ON	....	Sets the channel-to-channel delay function to on.
NUMERIC	....	Delay-time input.
SET	....	Delay-time setting.

6. SP ONLY ... Spectrum-Only Mode

OFF	....	Normal mode.
ON	....	Power spectrum only calculation mode.
Aweight	....	Power spectrum A-weighting compensation.
V^2	....	Power spectrum amplitude V^2 display (normally this is V).
OA DISP	....	Make constant display of overall value.

7. SOURCE ... Selection of Analysis Data Source

ANALOG	....	Analog signal input (normal analysis mode).
MASS	....	Digital signal stored in CRT block memory.
DISK	....	Digital signal stored on floppy disk.
CONTINU	....	Set to on for mass memory and disk data averaging.
FILE NO	....	Floppy disk file number setting mode.
BLK NO	....	CRT block memory block number setting mode.
DUAL	....	Used for a set of data when storing data for Ch A and Ch B alternately.

FUNC 1

1	2	3	4	5	6	7	8
EQULIZE	CALC	$\int$dt,/dt	jω	OCTAVE	DENSITY	CEPSTRM	RETURN

1. EQULIZE ... Selection of the Transfer Function and Power Spectrum Equalization Function

OFF	....	Sets the transfer function equalization function to off.
ON	....	Sets the equalization function to on.
SET	....	Sets the transfer function to be used as the reference into memory.
PWR SP	....	Selects the power spectrum equalization function.

2. CALC ... Selection of Calculation Function

ON	....	Sets the calculation function to on.
+	....	Adds the data at the bottom of the CRT to the data at the top of the CRT.
−	....	Subtracts the data at the top of the CRT from the data at the bottom of the CRT.
×	....	Multiplies the data at the top of the CRT with the data at the bottom of the CRT.
/	....	Divides the data at the bottom of the CRT by the data at the top of the CRT.

3. $\int$ dt,/dt ... Time-Axis Differentiation and Integration Calculations

ON	....	Sets the function on.
d/dt	....	Time-axis first order differentiation.
d/dt^2	....	Time-axis second order differentiation.
$\int dt$	....	Time-axis single integration.
$\int dt^2$	....	Time-axis double integration.
B only	....	Performs calculation on Ch B only.
DC CANC	....	Sets DC cancel function on and off.

4. j ω ... Frequency-Axis Differentiation and Integration Function

ON	....	Sets function to on.
$\times j\omega$	....	Frequency-axis first order differentiation.
$\times (j\omega)^2$	....	Frequency-axis second order differentiation.
$1/j\omega$	....	Frequency-axis single integration.
$1/(j\omega)^2$	....	Frequency-axis double integration.
REF UP	....	Increases the display reference.
REF DW	....	Decreases the display reference.

5. OCTAVE ... Octave Analysis

OFF	.... Sects the octave function off.
30	.... 30 bands.
15	.... 15 bands.
1/3 OCT	.... 1/3 octave bands.
1/1 OCT	.... 1/1 octave bands.
Aweight	.... Executes A-weighting compensation.
SHARP	.... Groups octaves without regard to the octave filter response shape.

6. DENSITY ... Power Spectrum Density/Energy Spectrum Density

OFF	.... Sets function to off.
PSD	.... Power spectrum density.
ESD	.... Energy spectrum density.

7. CEPSTRM ... Cepstrum Function

OFF	.... Sets cepstrum display function to off.
ON	.... Sets cepstrum display function to on.
REAL	.... Cepstrum display.
MAG	.... Cepstrum absolute-value display.
ENVELOP	.... Determines the spectrum envelope from the liftered waveform.
LIFTER	.... Lifters the cepstrum.

FUNC 2

1	2	3	4	5	6	7	8
IFFT	ENVELOP	LOOP	XFER	FITTING	ZOOM		RETURN

1. IFFT ... Inverse Fourier Transform

IFFT	.... Executes inverse Fourier transform.
BAND	.... Bandlimited inverse Fourier transform.
ADJUST	.... Performs inverse Fourier transform after Hanning window compensation.
MULT H	.... Multiplies the spectrum data to be inverse transformed by a transfer function (option).
ST.FS	.... Stores a Fourier spectrum (option).

2. ENVELOP ... Display of the Time Envelope Determined by the Hilbert Transform

OFF	Sets the function to off.
ON	Executes the Hilbert transform.
MAG	Displays the imaginary part of the time envelope of the Hilbert transform.
LOG	Vertical-axis logarithmic scaling of the envelope.
BAND	Bandlimited Hilbert transform.
SET	Sets the bandlimiting.

3. LOOP ... Open-Loop-To-Closed-Loop Transfer Function Calculations

OFF	Sets the function to off.
ON	Calculation execution.
OPEN	Converts closed-loop function to open-loop function.
CLOSE	Converts open-loop function to closed-loop function.
H= 1	Press before ON for unity feedback system.
H SET	Press before ON for feedback element.

4. XFER ... Transfer Function

NICO	Transfer function Nichols plot display.
1/H	Reciprocal of transfer function.
conv SV	Converts normal transfer function to a servoanalysis mode transfer function.
CRT IMP	Calculates the impulse response of the displayed transfer function.

5. FITTING ... Curve Fitting Calculation Function

ON	Executes the curve fit calculation.
LIST	Performs a list display of the curve fitting results.
SYNTH	Displays the fit data.
STORE	Stores the fit data into block memory.
NUM SET	Inputs the number of poles for the curve fitting.
SET	Establishes the number of poles for the curve fitting.

6. ZOOM ... Real-Time Zoom Function

ON	Executes the zoom function.
SET	Sets the center frequency.
INC	Increments the zoom magnification.
DEC	Decrements the zoom magnification.

MAS MEM

1	2	3	4	5	6	7	8
RECORD	PLYBACK	PB.LENG	PB.ZOOM	PB.DISP	CRT LD	CRT MEM	RETURN

1. RECORD ... Time Record Function

ON	....	Sets time record function on.
RING	....	Capture stopped using PAUSE switch.
Ch A&B	....	Records time record data simultaneously for Ch A and Ch B.
Ch A	....	Time record for Ch A only.
Ch B	....	Time record for Ch B only.
CLEAR	....	Clears time data from mass memory.

2. PLYBACK ... Playback Condition Settings

ON	....	Set the playback function to on.
DOWN	....	Plays back memory contents in reverse sequence.
GAP INC	....	Increments the shift (gap) in number of dots.
GAP DEC	....	Decrements the shift (gap) in number of dots.
ADDRESS	....	Specifies the starting address for playback.
Ch B DLY	....	Delays Ch B with respect to Ch A.
SET	....	Sets the number of address and delay points.

3. PB. LENG ... Selection of Display and Analysis Data Length for Playback

2048	....	Display and analysis of 2048 points.
1024	....	Display and analysis of 1024 points.
BLOCK	....	Selects 30-Kword mode.
INC	....	Increments the block number in the 30-Kword mode.
DEC	....	Decrements the block number in the 30-Kword mode.
AD CLR	....	Returns the memory address to 0 during playback.

4. PB. ZOOM ... Record Zoom Execution

ON	....	Sets record zoom on.
FACTOR	....	Sets the zoom magnification.
CF SET	....	Sets the center frequency.
SINGLE	....	Perform zoom on one frame only in the PAUSE condition.

5. PB. DISP ... Time Record Data Compressed Display

OFF	....	Normal display.
ALL	....	Display of all time record data.
BLOCK	....	Display a block of time record data.

6. CRT LD ... CRT Block Memory Setting

LOAD	Sets the display condition to the same as that of the played back block memory data.
L. COPY	Copies a label to the block memory label.
LABEL	Displays a block memory label.
BLK No.	Sets the CRT block No.
LIST UP	Makes a listing of the CRT block memory.
INSERT	Makes an insertion into the CRT block memory.
DELETE	Makes a deletion from CRT block memory.

7. CRT MEM ... Storage of Screen Information

MANU	Stores a frame each time the store switch is pressed.
AUTO	Stores 60 frames continuously when the store switch is pressed.
EXTERNL	Performs a storage by means of an external signal.
DATE ON	Applies the date to the label.
TIME ON	Applies the time to the label.
PROTECT	Protects stored screen information.
ALL CLR	Clears stored frame information.

DISK

1	2	3	4	5	6	7	8
ST MASS	ST TIME	ST COND	LD MASS	LD TIME	LD COND	UTILITY	RETURN

1. ST MASS ... Storage of Mass Memory CRT Data on to Disk

CRT	Stores data displayed on the CRT on to floppy disk.
AUTO	Stores 300 files of data displayed on the CRT continuously.
MASS	Stores individual blocks of CRT block memory data.
MAS ALL	Stores all contents of CRT block memory.
FILE NO	Specifies the file number for storage.
SET	Sets the file.
START	Starts storage to disk.

2. ST TIME ... Storage of Mass Memory Time Data on to Disk

TIME	Stores time data from mass memory.
FILE NO	Sets the file to be stored.
SET	Sets the file.
START	Starts the storage to disk.

3. ST COND ... Storage of Panel Condition Memory and Autosequence Memory Contents on to Disk

P.COND	....	Stores panel condition memory contents on to disk.
SEQUENC	....	Stores autosequence program to disk.
P.No DW	....	Decrements the panel condition memory No.
P.No UP	....	Increments the panel condition memory No.
FILE NO	....	Specifies the file to be stored.
SET	....	Sets the file to be stored.
START	....	Starts the storage to disk.

4. LD MASS ... Playback of CRT Data from Disk into Mass Memory

MASS	....	Plays back disk data into the block memory of mass memory.
MAS ALL	....	Plays back disk data to all of block memory.
LIST UP	....	Makes a list display on the CRT of the disk data functions and labels.
L Kind	....	Makes a list of disk data functions only.
FILE NO	....	Specifies the file for data or listing.
SET	....	Sets the file to be played back.
START	....	Starts the playback.

5. LD TIME ... Playback of Disk Time Data into Mass Memory

ALL	....	Plays back all 256 files of disk time data into time record memory.
PRE 128	....	Plays 128 files of data into the first half of time record memory (128 Kwords, corresponding to the memory for channel A).
POS 128	....	Plays 128 files of data into the second half of time record memory (128 Kwords, corresponding to the memory for channel B).
FILE NO	....	Specifies the file number for playback.
SET	....	Sets the file number.
START	....	Starts playback.

6. LD COND ... Playback of Disk Panel Conditions and Autosequence Programs

P.COND	Plays back panel conditions from disk.
SEQUENC	Plays back autosequence programs.
P.No DW	Decrements the panel condition memory number.
P.No UP	Increments the panel condition memory number..
FILE NO	Specifies the file number.
SET	Sets the file number.
START	Starts playback.

7. UTILITY ... Floppy Disk Drive Copy and Formatting Operations

DRIVE 0	Specifies the built-in floppy disk drive.
RAM DSK	Specifies the optional CMOS memory as a RAM disk.
PROTECT	Performs a write protect with respect to screen data.
PURGE	Deletes the contents of one file.
COPY	Copies a floppy disk.
FORMAT	Performs formatting of a floppy disk.
START	Starts a copy or formatting operation.

MENU B

DISPLAY	UNIT	VIEW	TIMER	SEQUENC	PLOTTER	COND	NEXT

DISPLAY

1	2	3	4	5	6	7	8
FORMAT	LIST	3-ARRAY	COH	NYQ.ORB	P.OV	INHIBIT	RETUERN

1. FORMAT ... Setting Specifications for the CRT Display Format

SPLIT	.... Specifies the dual-frame (top/bottom) display mode.
OVERLAY	.... Specifies the dual-frame overlaid mode.
GRID ON	.... Displays a grid on the CRT screen.
BODE ON	.... Displays a Bode plot of a transfer function.
MAG LOG	.... For Y-axis logarithmically scaled display, reads from a linear scale.
X EXPAN	.... Expands the X-axis of the display.

2. LIST ... List Display

OFF	.... Sets list function to off.
ON	.... Sets list function to on.
SET	.... Sets the list.
INC	.... Increments the list display setting number.
DEC	.... Decrements the list display setting number.
CLR	.... Deletes a list number indicated by the cursor mark.
PEAK	.... Makes a ranking display of the 10 largest power spectrum peaks.

3. 3-ARRAY ... 3-Dimensional Display

SCROLL	.... Sets the scroll function to on.
DOWN	.... Causes downward scrolling of the 3-dimensional display.
20 LINE	.... 20-line 3-dimensional display.
60 LINE	.... 60-line 3-dimensional display.
90 LINE	.... 90-line 3-dimensional display.
degree	.... Changes the viewing angle.
Height	.... Sets the Y-axis height.

4. COH ... Coherence Blanking

OFF	Sets the coherence blanking function to off.
BLNK ON	Sets the coherence blanking function to on.
SET	Sets the level at the cursor.
S/N	Displays the SN calculation.

5. NYQ ORB ... Nyquist and Orbit Displays

LIMIT	Executes bandlimiting.
SET	Sets the bandlimit band edges.
3D	Sets the perspective display to on and off.
+ ROTATE	Rotates the display 45° clockwise.
− ROTATE	Rotates the display 45° counterclockwise.
COLE	Makes a Cole-Cole plot display.
Xfr M-P	Amplitude value and phase display for a Nyquist plot display.

6. P. OV ... Partial Overall

ON	Executes the partial overall function.

7. INHIBIT ... Display-Inhibit Function

ON	Executes the display-inhibit function.
ALL F.	Inhibits all display update.
1/2	Displays every other data during averaging.

UNIT

1	2	3	4	5	6	7	8
UNIT X	UNIT Y	Ch A EU	Ch B EU	HARMNIC			RETURN

1. UNIT X ... X-Axis Display Units

Hz	Frequency display.
CPM	Cycles per minute display.
ORDER	Order display.
SEC	Time display.

2. UNIT Y ... Y-Axis Display Units

rms	Rms-value display.

3. Ch A EU ... Channel A Calibration Function

EU/V	....	Sets EU value per 1 V.
V/EU	....	Sets voltage value for 1 EU.
S.P/EU	....	Sets the search point as 1 EU.
dB/S.P	....	Sets the search point as an arbitrary dB value.
EU=	....	Sets the EU display to an arbitrary character string.
SET Ch A	....	Executes the above settings.
SET	....	Sets the above calibration value.

4. Ch B EU ... Channel B Calibration Function

EU/V	....	Sets EU value per 1 V.
V/EU	....	Sets voltage value for 1 EU.
S.P/EU	....	Sets the search point as 1 EU.
dB/S.P	....	Sets the search point as an arbitrary dB value.
EU=	....	Sets the EU display to an arbitrary character string.
SET Ch B	....	Executes the above settings.
SET	....	Sets the above calibration value.

5. HARMNIC ... Harmonic Listing

ON	....	Executes the list display.
SET	....	Sets the fundamental frequency.
LIST UP	....	Scrolls the list for a dual-frame display up.
LIST DW	....	Scrolls the list for a dual-frame display down.
FIT	....	Adjusts for skew from frequency-resolution points.

VIEW

1	2	3	4	5	6	7	8
VIEW	LABEL	SET UP					RETURN

1. VIEW ... Display of Setting Conditions (8 Types)

OFF	....	Sets the view function to off.
NextINC	....	Changes to the next VIEW display.
NextDEC	....	Changes to the previous VIEW display.
COND	....	Changes the lower (second line) label to the initial conditions.
XCHG	....	Copies the upper (first line) label to the lower (second line).

2. LABEL ... Label Function

ON .... Sets the label function to on.
TEXT ON .... Enables the label writing mode.
LARGE .... Selects upper-case characters.
SMALL .... Selects lower-case characters.
INSERT .... Character-insertion mode.
DELETE .... Deletes one character.
CLR .... Deletes characters after the setting marker.

3. SET UP ... Setup View Function

ON .... Sets the setup view function to on.
OPTION .... Makes a list display of installed options.
INC .... Changes to the next setup view.
DEC .... Changes to the previous setup view.

TIMER

1	2	3	4	5	6	7	8
TIM SET	INTRVAL						RETURN

1. TIM SET ... Time Display

ON .... Sets the time display to on.
SET .... Sets the time.
← .... Moves the cursor.
→ .... Moves the cursor.

2. INTRVAL ... Interval Function

INT ON .... Sets the interval function to on.
SET ON .... Enables the interval-time setting mode.
SET .... Sets the interval time.

SEQUENC

1	2	3	4	5	6	7	8
SEQ SET	SEQ RUN	NUMBER	SP.CONT	COND.LD	EDIT		RETURN

1. SEQ SET ... Autosequence Program Generation

ON	....	Enables autosequence program setting.
SEQ 1	....	Selects autosequence memory No. 1.
SEQ 2	....	Selects autosequence memory No. 2.
SUB MRK	....	Subroutine movement mark.
DLY MRK	....	Sets the interval.

2. SEQ RUN ... Autosequence Program Execution

OFF	....	Interrupts autosequence.
STEP	....	Single-step manual execution of an autosequence.
AUTO	....	Performs automatic execution of an autosequence.
SEQ 1	....	Executes autosequence No. 1.
SEQ 2	....	Executes autosequence No. 2.
RING	....	Performs execution of an autosequence endlessly or a specified number of times.
TI CONT	....	Inserts an interval between autosequence steps.

3. NUMBER ... Number of Repetitions Setting

ON	....	Enables the number of repetitions setting mode.
SET	....	Sets the number of repetitions.

4. SP. CONT ... Search Point Control

OFF	....	Sets the search point control function to off.
ON	....	Specifies the search point position for each step.
MEM	....	Specifies that the search point is to be maintained at the same position throughout the execution.
SET	....	Stores the search point position.

5. COND. LD ... Loading of Panel Condition Memory Contents

LOAD ON	....	Sets the panel condition loading function to on.

6. EDIT ... Editing of Autosequence Programs

OFF	Sets the autosequence program editing function to off.
SEQ 1	Displays the contents of autosequence memory No. 1.
SEQ 2	Displays the contents of autosequence memory No. 2.
EDIT ON	Sets the autosequence program editing function to on.
INSERT	Inserts a program step.
DELETE	Deletes a program step.
CLEAR	Deletes all program contents.

PLOTTER

1	2	3	4	5	6	7	8
DEVICE	DATA	FRAME	CHARACT	FEED	SOURCE	FORMAT	RETURN

1. DEVICE ... Plotter Type Specification

PLOT 1	HP-GL command plotter (e.g. CX-338).
PLOT 2	Graphtec GPIB interface plotter.
P1-P2	Sets an HP-GL type plotter to an abritrary scaling point.
NUMERIC	Sets the plotting size and position as values from the CF-350.

2. DATA ... Waveform Plotting Specifications

PEN 1	Plots waveform with pen 1.
PEN 2	Plots waveform with pen 2.
PEN 3	Plots waveform with pen 3.
PEN 4	Plots waveform with pen 4.
OFF	Does not plot waveform.
BODE	Plots the phase and gain parts of a Bode plot of a transfer function with an arbitrary size ratio.
DOTT L	Plots the lower-frame waveform of a dual-frame overlaid display using a dotted line.

3. FRAME ... Frame Plotting Specifications

PEN 1	Plots the frame with pen 1.
PEN 2	Plots the frame with pen 2.
PEN 3	Plots the frame with pen 3.
PEN 4	Plots the frame with pen 4.
OFF	Does not plot the frame.
G.LINE	Plots the grid in solid lines when a grid was displayed on the CRT.

4. CHARACT ... Display Character Plotting Specifications

PEN 1	Plots characters with pen 1.
PEN 2	Plots characters with pen 2.
PEN 3	Plots characters with pen 3.
PEN 4	Plots characters with pen 4.
OFF	Does not plot characters.
SOFT KY	Plots soft keys.
SEARCH	Plots only the search value, axis values and date and time as characters.

5. FEED ... Paper Feed Control

ON	Sets the paper feed function to on.
MANU	Performs a feed of the set amount of paper.
BEFORE	Performs a paper feed before plotting.
FRONT	Feeds the paper to the front after recording (on the CX-338).

6. SOURCE ... Plotting Data Source Specification

CRT	Plots the frame displayed on the CRT.
MASS	Performs continuous plotting of screen data stored in mass memory.
DISK	Performs continuous plotting of screen data stored on to floppy disk.
TRACE	Performs a trace of the search point on the plotter.
DISK 3D	Performs a 3-dimensional plot of floppy disk data.
ARRAY N	Selects the number of data to be plotted in 3 dimensions.
STEP +2	Reads every other file from disk.

7. FORMAT ... Plotting Format Specification

FORMAT1	Specifies format 1 (A4 size).
FORMAT2	Specifies format 2 (A6 size).
FORMAT3	Specifies format 3 (A5 size).
LOCAT1	Specifies location 1.
LOCAT2	Specifies location 2.
LOCAT3	Specifies location 3.
LOCAT4	Specifies location 4.

COND

1	2	3	4	5	6	7	8
CONDIT		POL.CHG	SEARCH	HI PREC	TI ONLY	PH. adj	RETURN

1. CONDIT ... Condition Settings

BUZ ON	Sets the operational beeper to on and off.
AUTO ON	Sets the autoranging function to on and off.
TEST ON	Sets the internal test signal to on and off.
FILT ON	Sets the anti-aliasing filter to on and off.
CLK INT	Selects either internal or external sampling clock.
DC CANC	DC component elimination.
A/D OVR	Inhibits the warning beeper and calculation when an A/D overflow occurs.

3. POL. CHG ... Polarity Inversion

OFF	Cancels the time-axis signal polarity inversion.
Ch A	Inverts the polarity of the channel A time-axis signal.
Ch B	Inverts the polarity of the channel B time-axis signal.

4. SEARCH ... Search Function

PEAK	Moves the search point to the peak point.
delta Y	Using the delta function, the X-axis is not the delta value but rather the normal X-axis value.
NEXT PK	When the up and down switches are pressed, move is made to the next peak.
P-P	P-P function.
UP-move	The left and right switches move the upper-frame search point for a dual-frame display.
ENHANCE	Search enhance function.
S CURSOR	Changes the search point to a cursor.

5. HI PREC ... High-Precision Mode

OFF	Normal mode (sets high-precision mode to off).
ON	Sets the high-precision mode to on.

6. TI ONLY ... Time-only mode

OFF	Normal mode (sets time-only mode to off).
ON	Sets time-only mode to on.

7. PH. adj ... Channel-To-Channel Phase Mismatch Compensation

SET	....	Sets the phase adjustment function to on.

MENU C

SERVO	Y axis	DATA set	OTHERS				NEXT

SERVO

1	2	3	4	5	6	7	8
CONTROL	FRQ.DIV	V RANGE	SSU				RETURN

1. CONTROL ... Control of the Signal Source

OFF	....	Control is switched off.
400	....	400-line transfer function measurement mode.
4decade	....	4-decade transfer function measurement mode.
CLR 4D	....	Clear the 4 decades of data when analysis is started.
SSU ON	....	Turn control of the SG-450 Signal Source Unit on.
MEM SET	....	Output time data measured by the CF-350 as memory data to the signal source.

2. FRQ. DIV ... Frequency Division Specification for Signal Sequencing

ON	....	Sets the frequency division function to on.
SET	....	Sets the division range specified by the cursor.
No.INC	....	Increments the sequence number.
No.DEC	....	Decrements the sequence number.
SIG SEL	....	Selects the signal type.
CLEAR	....	Clears the set sequence.

3. V RANGE ... Servo-Mode Autoranging Function

Ch A	....	Sets the channel A autoranging function to on.
Ch B	....	Sets the channel B autoranging function to on.
AMP MIN	....	Sets the minimum signal output level from the signal source after the transfer function measurement is completed.

4. SSU ... SG-450 Signal Source Unit System Mode

ON	....	Sets the system setting mode to on.
ENTER	....	Inputs the specified item.
No.INC	....	Increments the signal sequence number.
No.DEC	....	Decrements the signal sequence number.
CLR	....	Deletes a specified item.
COPY	....	Copies the contents of a given sequence into a different sequence.
SSU SET	....	Sets specified signal sequence conditions into the SG-450.

Y axis

1	2	3	4	5	6	7	8
REF SET	GAIN	PHASE					RETURN

1. REF SET ... Reference Function

ON	....	Sets the reference function to on and off.
LOW	....	Enables the reference function for a single-frame display and the lower part of a dual-frame display.
UP	....	Enables the reference function for the upper part of a dual-frame display.
STEP 10	....	Sets the reference movement width.
0 SET	....	Sets the initial reference value.

2. GAIN ... Gain function

LOW	....	Enables the gain function for a single-frame display or the lower part of a dual-frame display.
UP	....	Enables the gain function for the upper part of a dual-frame display.
×1 SET	....	Sets the gain to 1 (initial value).

3. PHASE ... Phase Display Setting

FORMAT1	....	Changes the full-scale value to ±10, ±20, ±50, ±100, ±180, ±200, ±360, ±500, ±720, ±1000, ±2000, ±5000, ±10000 or ±20000 deg.
FORMAT2	....	Changes the full-scale value to ±10, ±20, ±50, ±100, ±180, ±200, 0 to 360, 0 to 500, 0 to 720, 0 to 1000, 0 to 2000, 0 to 5000, 0 to 10000 or 0 to 20000 deg.
FORMAT3	....	Changes the full-scale value to ±10, ±20, ±50, ±100, ±180, ±200, 0 to −360, 0 to −500, 0 to −720, 0 to −1000, 0 to −2000, 0 to −5000, 0 to −10000 or 0 to −20000 deg.
G-DLY	....	Group-delay display.
DLY.adj	....	Executes phase adjustment.
SET ON	....	Enables the phase adjustment time setting mode.
SET	....	Sets the phase adjustment time.

DATA set

1	2	3	4	5	6	7	8
PLOT							RETURN

1. PLOT ... Specification of Hardcopy Plotting Position as a Numerical Value from the CF-350

ON	....	Displays the numerical setting menu.
ENTER	....	Sets parameter input values.
CLR	....	Clears an input value.

OTHERS

1	2	3	4	5	6	7	8
P.COND	GP-IB	DISK	ANALOG				RETURN

1. P. COND ... Panel Condition Memory

ATrecal	....	Sets the autorecall function to on.
MEM 1	....	Selects panel condition memory No. 1.
MEM 2	....	Selects panel condition memory No. 2.
MEM 3	....	Selects panel condition memory No. 3.
MEM 4	....	Selects panel condition memory No. 4.
STORE	....	Performs storage into panel condition memory.

2. GP-IB ... GPIB Interface Function

TK.ONLY	....	Talk only mode.
ADDRESS	....	Addressable mode.
SET	....	Address setting.
SRQ	....	Sends service request.

3. DISK ... Playback from CF-910/920 Floppy Disks

SINGLE	....	Reading and writing of a single side of a floppy disk only.

4. ANALOG

AT ZERO	....	Sets the autozero function to on and off.

MENU D

CmosMEM	SIG OUT	X-Y REC	TRACK	COMP	Opt 6	Opt 7	NEXT

CmosMEM

1	2	3	4	5	6	7	8
UTILITY	RAMDISK	RECORD					RETURN

1. UTILITY ... Selection of CMOS Memory Card Application

BLK.MEM	....	Sets the CMOS memory card application to CRT block memory.
DISK	....	Sets the CMOS memory card application to disk.
RECORD	....	Sets the CMOS memory card application to record memory.

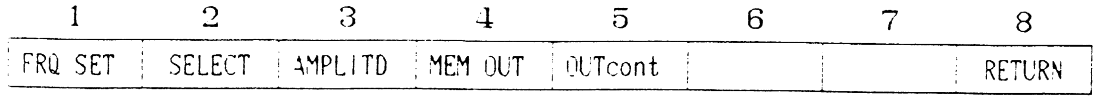
2. RAMDISK ... RAM Disk File Delection, Insertion and Purging

DELETE	....	Deletes one file.
INSERT	....	Inserts one file.
PURGE	....	Purgest the contents of one file.
FILE NO	....	Specifies the file number.
SET	....	Sets the file number.
START	....	Executes file deletion, insertion or purging.

3. RECORD ... Time Record Memory Mode Selection and 255 Kword Data Transfer

768K	....	Selects the 768-Kword mode.
XCHG1	....	Exchanges the time record memory 255 Kwords and the first 255 Kwords of CMOS memory.
XCHG2	....	Exchanges the time record memory 255 Kwords and the second 255 Kwords of CMOS memory.
F-256	....	Stores the first 256 Kwords of 768 Kwords on to floppy disk or plays them back from floppy disk.
M-256	....	Stores the middle 256 Kwords of 768 Kwords on to floppy disk or plays them back from floppy disk.
L-256	....	Stores the last 256 Kwords of 768 Kwords on to floppy disk or plays them back from floppy disk.

SIG OUT



1	2	3	4	5	6	7	8
FRQ SET	SELECT	AMPLITD	MEM OUT	OUTcont			RETURN

1. FRQ SET ... Output Frequency Setting

FRQ	....	Inputs the output frequency value.
Hz	....	Inputs the output frequency value, setting made in Hz.
kHz	....	Inputs the output frequency value, setting made in kHz.
BAND	....	Sets the sine sweep and swept sine output frequency bandwidth.
SET	....	Sets the output frequency delta cursor.
AUTO	....	Links the output frequency automatically to the selected frequency range.
PINK FL	....	Applied pink filtering to the output signal.

2. SELECT ... Output Signal Selection

SIN	....	Selects sinewave.
SWEPT.S	....	Selects swept sine waveform.
PERIOD	....	Selects periodic random signal.
RANDOM	....	Selects random signal.
IMPULSE	....	Selects impulse signal.
PIP	....	Selects pip (burst) waveform.

3. AMPLITD ... Output Voltage Selection

ON	....	Sets output voltage.
50ohm	....	Reads output voltage directly when terminated with 50 Ω (displayed as one half of the setting value).

4. MEM OUT ... Time Waveform Analog Output Setting

CRT	....	Selects time waveform screen analog output.
RECORD	....	Selects time record memory analog output.
8K REC	....	Executes 8 Kwords of time record memory analog output (4 Kwords if set to off).

5. OUTcont ... Single Output, Continuous Output and Burst Output Settings

CONTINU	Selects continuous output.
SINGLE	Selects single output (one frame).
BURST	Selects burst output.
CYCLE	Sets the number of cycles for each burst output.
TIME	Sets the time interval for the burst output.
SET	Sets the number of cycles and time interval.

X-Y REC

1	2	3	4	5	6	7	8
X-Y REC	SPEED	S.P OUT					RETURN

1. X-Y REC ... X-Y Recorder Output Setting

START	Starts X-Y recorder output.
DATA	Outputs waveform (data).
FRAME	Outputs a frame.
ZERO	Outputs a 0.5-V calibration voltage (corresponds to the lower left of the frame).
SPAN	Outputs a 4.5-V calibration voltage (corresponds to the upper right of the frame).
X EXPND	Records all waveforms at the same X-axis length.
BODE	For a transfer function Bode plot display, sets the upper frame (phase) and lower frame (gain) Y-axis lengths to any given ratio.

2. SPEED ... Pen Speed Modification

SPEED 1	Pen speed is increased in the sequence SPEED 1→SPEED 7.
SPEED 2	
SPEED 3	
SPEED 4	
SPEED 5	
SPEED 6	
SPEED 7	

3. S. P OUT ... Search Point Analog Output Setting

ON	Starts search at point analog output.
ZERO	Outputs a 0-V calibration signal.
SPAN	Outputs a 3.1-V calibration signal.

Soft Key Summary

<<<MENU A>>>

Major items		Subitems		Function-selection keys							
				1	2	3	4	5	6	7	8
1	TRIG	1	SOURCE	Ch A	Ch B	EXT	VIEW A	VIEW B			RETURN
		2	SLOPE	+	−						RETURN
		3	POSIT	NUMERIC	SET						RETURN
		4	LEVEL	MRK SET							RETURN
		5	SELECT	REPEAT	SINGLE	ONE shot		CANCEL			RETURN
2	AVERAGE	1	PWR SP	SUM	EXP	PEAK	SWEEP	DIFF	INC	DEC	RETURN
		2	TIME	SUM	EXP	ABS			INC	DEC	RETURN
		3	HIST	SUM		HIST A	HIST B		INC	DEC	RETURN
		4	FOURIER	SUM	EXP				INC	DEC	RETURN
		5	MAXoval	OFF	ON						RETURN
		6	DISPLAY	LOW	UP						RETURN
		7	CONTROL	CONTINU	SUM NUM						RETURN
3	MODE	1	OVERLAP	MAX	50%	0%					RETURN
		2	LENGTH	ChA 2k	ChB 2K	DUAL 1k					RETURN
		3	WINDOW	RECT	HANN	FLAT	USER	F-F	E-E	F-E	RETURN
		4	W SET	FORCE	EXP	USER			DISPLAY	SET	RETURN
		5	DELAY	ON	NUMERIC	SET					RETURN
		6	SP ONLY	OFF	ON	Aweight	V^2	OA DISP			RETURN
		7	SOURCE	ANALOG	MASS	DISK	CONTINU	FILE NO	BLK NO	DUAL	RETURN
4	FUNC 1	1	EQULIZE	OFF	ON	SET	PWR SP				RETURN
		2	CALC	ON	+	−	×	/			RETURN
		3	$\int dt./dt$	ON	d/dt	d/dt^2	$\int dt$	$\int dt^2$	B only	DC CANC	RETURN
		4	$j\omega$	ON	$\times j\omega$	$\times(j\omega)^2$	$1/j\omega$	$1/(j\omega)^2$	REF UP	REF DW	RETURN
		5	OCTAVE	OFF	30	15	1/3 OCT	1/1 OCT	Aweight	SHARP	RETURN
		6	DENSITY	OFF	PSD	ESD					RETURN
		7	CEPSTRM	OFF	ON	REAL	MAG	ENVELOP	LIFTER		RETURN
5	FUNC 2	1	IFFT	IFFT	BAND	ADJUST	MULT H	ST.FS			RETURN
		2	ENVELOP	OFF	ON	MAG	LOG	BAND	SET		RETURN
		3	LOOP	OFF	ON	OPEN	CLOSE	H= 1	H SET		RETURN
		4	XFER	NICO	1/H	conv SV	CRT IMP				RETURN
		5	FITTING	ON	LIST	SYNTH	STORE		NUM SET	SET	RETURN
		6	ZOOM	ON	SET	INC	DEC				RETURN
6	MAS MEM	1	RECORD	ON	RING		Ch A&B	Ch A	Ch B	CLEAR	RETURN
		2	PLYBACK	ON	DOWN	GAP INC	GAP DEC	ADDRESS	ChB DLY	SET	RETURN
		3	PB.LENG	2048	1024		BLOCK	INC	DEC	ADS CLR	RETURN
		4	PB.ZOOM	ON	FACTOR	CF SET	SINGLE				RETURN
		5	PB.DISP	OFF	ALL	BLOCK					RETURN
		6	CRT LD	LOAD	L. COPY	LABEL	BLK No.	LIST UP	INSERT	DELETE	RETURN
		7	CRT MEM	MANU	AUTO		DATE ON	TIME ON	PROTECT	ALL CLR	RETURN
7	DISK	1	ST MASS	CRT	AUTO	MASS	MAS ALL	FILE NO	SET	START	RETURN
		2	ST TIME	TIME				FILE NO	SET	START	RETURN
		3	ST COND	P.COND	SEQUENC	P.No DW	P.No UP	FILE NO	SET	START	RETURN
		4	LD MASS	MASS	MAS ALL	LIST UP	L Kind	FILE NO	SET	START	RETURN
		5	LD TIME	ALL	PRE 128	POS 128	BLOCK	FILE NO	SET	START	RETURN
		6	LD COND	P.COND	SEQUENC	P.No DW	P.No UP	FILE NO	SET	START	RETURN
		7	UTILITY	DRIVE 0	RAM DSK	PROTECT	PURGE	COPY	FORMAT	START	RETURN

<<<MENU B>>>

Major items		Subitems		Function-selection keys							
				1	2	3	4	5	6	7	8
1	DISPLAY	1	FORMAT	SPLIT	OVERLAY	GRID ON	BODE ON	MAG LOG		X EXPAN	RETURN
		2	LIST	OFF	ON	SET	INC	DEC	CLR	PEAK	RETURN
		3	3-ARRAY	SCROLL	DOWN	20 LINE	60 LINE	90 LINE	degree	Height	RETURN
		4	COH	OFF	BLNK ON	SET	S/N				RETURN
		5	NYQ ORB	LIMIT	SET	3D	+ROTATE	-ROTATE	COLE	Xfr M-P	RETURN
		6	P.OV	ON							RETURN
		7	INHIBIT	ON	ALL F.	1/2					RETURN
2	UNIT	1	UNIT X	Hz	CPM	ORDER	SEC				RETURN
		2	UNIT Y	rms							RETURN
		3	Ch A EU	EU/V	V/EU	S.P/EU	dB/S.P	EU=	SET ChA	SET	RETURN
		4	Ch B EU	EU/V	V/EU	S.P/EU	dB/S.P	EU=	SET ChB	SET	RETURN
		5	HARMNIC	ON	SET	LIST UP	LIST DW	FIT			RETURN
3	VIEW	1	VIEW	OFF	NextINC	NextDEC	COND	XCHG			RETURN
		2	LABEL	ON	TEXT ON	LARGE	SMALL	INSERT	DELETE	CLR	RETURN
		3	SET UP	ON	OPTION				INC	DEC	RETURN
4	TIMER	1	TIM SET	ON	SET		←	→			RETURN
		2	INTRVAL	INT ON	SET ON	SET					RETURN
5	SEQUENC	1	SEQ SET	ON	SEQ 1	SEQ 2	SUB MRK	DLY MRK			RETURN
		2	SEQ RUN	OFF	STEP	AUTO	SEQ 1	SEQ 2	RING	TI CONT	RETURN
		3	NUMBER	ON	SET						RETURN
		4	SP.CONT	OFF	ON	MEM	SET				RETURN
		5	COND.LD	LOAD ON							RETURN
		6	EDIT	OFF	SEQ 1	SEQ 2	EDIT ON	INSERT	DELETE	CLEAR	RETURN
6	PLOTTER	1	DEVICE	PLOT 1	PLOT 2				P1-P2	NUMERIC	RETURN
		2	DATA	PEN 1	PEN 2	PEN 3	PEN 4	OFF	BODE	DOTT L	RETURN
		3	FRAME	PEN 1	PEN 2	PEN 3	PEN 4	OFF	G.LINE		RETURN
		4	CHARACT	PEN 1	PEN 2	PEN 3	PEN 4	OFF	SOFT KY	SEARCH	RETURN
		5	FEED	ON	MANU	BEFORE	FRONT				RETURN
		6	SOURCE	CRT	MASS	DISK	TRACE	DISK 3D	ARRAY N	STEP +2	RETURN
		7	FORMAT	FORMAT1	FORMAT2	FORMAT3	LOCAT1	LOCAT2	LOCAT3	LOCAT4	RETURN
7	COND	1	CONDIT	BUZ ON	AUTO ON	TEST ON	FILT ON	CLK INT	DC CANC	A/D OVR	RETURN
		2									
		3	POL.CHG	OFF	Ch A	Ch B					RETURN
		4	SEARCH	PEAK	delta Y	NEXT PK	P-P	UP-move	ENHANCE	S CUSOR	RETURN
		5	HI PREC	OFF	ON						RETURN
		6	TI ONLY	OFF	ON						RETURN
		7	PH.adj	SET							RETURN

<<<MENU C>>>

Major items		Subitems		Function-selection keys							
				1	2	3	4	5	6	7	8
1	SERVO	1	CONTROL	OFF	400	4decade	CLR 4D	SSU ON	MEM SET		RETURN
		2	FRQ.DIV	ON	SET	No INC	No DEC	SIG SEL		CLEAR	RETURN
		3	V RANGE	Ch A	Ch B	AMP MIN					RETURN
		4	SSU	ON	ENTER	No.INC	No.DEC	CLR	COPY	SSU SET	RETURN
2	Y axis	1	REF SET	ON	LOW	UP	STEP 10	0 SET			RETURN
		2	GAIN	LOW	UP	×1 SET					RETURN
		3	PHASE	FORMAT1	FORMAT2	FORMAT3	G-DLY	DLY.adj	SET ON	SET	RETURN
3	DATA set	1	PLOT	ON	ENTER			CLR			RETURN
4	OTHERS	1	P.COND	ATrecal	MEM 1	MEM 2	MEM 3	MEM 4	STORE		RETURN
		2	GP-IB	TK.ONLY	ADDRESS	SET	SRQ				RETURN
		3	DISK	SINGLE							RETURN
		4	ANALOG	AT ZERO							RETURN

<<<MENU D>>>

Major items		Subitems		Function-selection keys							
				1	2	3	4	5	6	7	8
1	CmosMEM	1	UTILITY	BLK.MEM	DISK	RECORD					RETURN
		2	RAMDISK	DELETE	INSERT	PURGE		FILE NO	SET	START	RETURN
		3	RECORD	768K		XCHG1	XCHG2	F- 256	M- 256	L- 256	RETURN
2	SIG OUT	1	FRQ SET	FRQ	Hz	kHz	BAND	SET	AUTO	PINK FL	RETURN
		2	SELECT	SIN	SWEPT.S	PERIOD	RANDOM	IMPULSE	PIP		RETURN
		3	AMPLITD	ON	50ohm						RETURN
		4	MEM OUT	CRT	RECORD	8K REC					RETURN
		5	OUTcont	CONTINU	SINGLE	BURST	CYCLE	TIME	SET		RETURN
3	X-Y REC	1	X-Y REC	START	DATA	FRAME	ZERO	SPAN	X EXPND	BODE	RETURN
		2	SPEED	SPEED 1	SPEED 2	SPEED 3	SPEED 4	SPEED 5	SPEED 6	SPEED 7	RETURN
		3	S.P OUT	ON	ZERO	SPAN					RETURN
4	TRACK	1	CONTROL	TR MODE	TRCK ON	AT. MEM	AT. DSK	RPM DSP	SCHEDUL	CLK EXT	RETURN
		2	SETUP	ON	ENTER			NEXT	CLR		RETURN
		3	ANALY	ON	DUAL	SINGLE					RETURN
		4	LW DSP	TRACK 1	TRACK 2	TRACK 3	TRACK 4	OVERALL			RETURN
		5	UP DSP	TRACK 1	TRACK 2	TRACK 3	TRACK 4	OVERALL			RETURN
		6	TIME TR	ON							RETURN
		7	SMOOTH	SMOOTH1	SMOOTH2	SMTH No					RETURN
5	COMP	1	CONTROL	START	BLOCK	SHAPE	P OVALL	AVG DAT	LEV.DSP		RETURN
		2	SETUP	ON	ENTER			NEXT	CLR		RETURN
		3	BLOCK	ON	SET	BLK INC	UPPER	LOWER	WIDTH	DATA TR	RETURN
		4	SHAPE	ON	UPPER	LOWER	TRACE	% SET	BAND	CLEAR	RETURN
		5	KEY SET	IN 1	IN 2	IN 3	IN 4	VIEW			RETURN
		6	BK LIST	ON	CH A	CH B	SET ON	ENTER	CANCEL	CLEAR	RETURN
		7	DISK	COND ST	COND LD			FILE NO	SET	START	RETURN

13. GPIB

13.1 Introduction

The GPIB (General-Purpose Interface Bus), known also as the IEEE Bus, is recognized by the IEEE (Institute of Electrical and Electronics Engineers) as an instrumentation interface bus system. It uses a special connector (specified by the IEEE 488 Standard) and cable, and is used in making connections between digital equipment

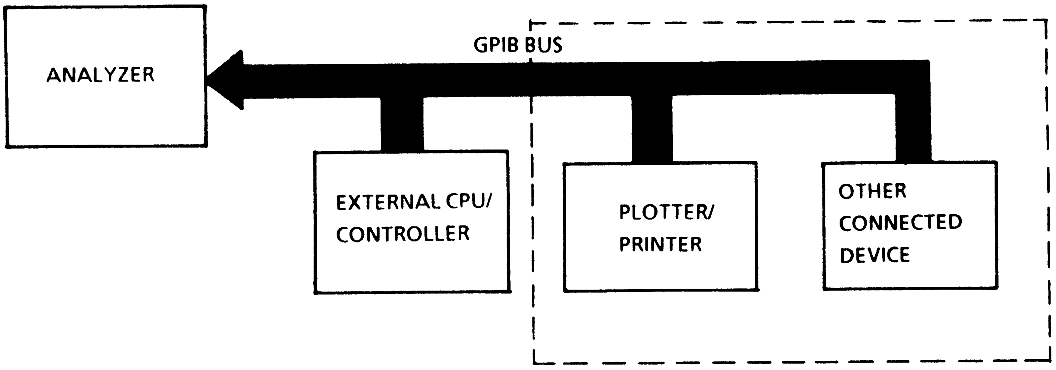
This GPIB Interface Bus may be used to interface equipment conforming to the same interface standards. Up to 15 units may be connected in parallel, in daisy chain fashion. Data transfer is performed by using three handshake lines, enabling reliable data transfer between equipment having differing transmission speeds.

This GPIB Interface provides the interface functions described elsewhere in this document, and enables panel setup and remote control of the CF-350, and data transfer to a minicomputer or other personal computer or controller using appropriate software.

Special Precautions Before Use

When connecting an external CPU (controller) to the CF-350, if the various devices (e.g., plotter, printer and other measuring instruments) connected to the controller have their power switched OFF, the noise margin with respect to the CF-350 will be adversely effected.

Therefore, when using equipment in this manner, each of the devices connected to the controller should have its power switched ON or, if not required, should be disconnected from the controller.



Connected devices:

- Always switched ON, even if not used.
- If not switched ON, and not required, disconnect from the controller.

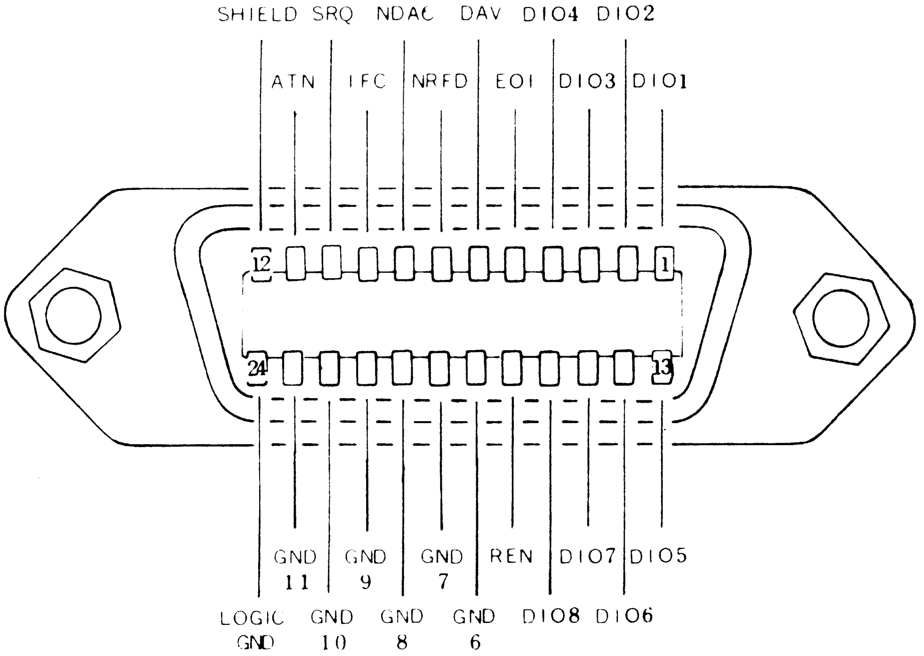
13.2 GPIB Specifications

13.2.1	**Cable length**	20m (maximum, including all cable lengths)
13.2.2	**Single cable**	5m (interconnection between devices only)
13.2.3	**No. of devices connectable**	15 (maximum, including one controller)

13.2.4 Signal Lines

The GPIB uses a special 24-pin connector. Of these 24 signal lines, eight are data lines (DIO1 to DIO8), eight are control lines, and the remaining eight are ground lines. Of the control lines, three are handshake lines (DAV, NRFD, NDAC) with the remaining five lines being used for control (ATN, REN, IFC, SRQ and EOI). In this manner, the three handshake lines can be used to control data transmission, enabling data transfer with high reliability even between transmitting equipment (talkers) and receiving equipment (listeners) having different transmission speeds.

- GPIB Interface Connector



13.2.5 Operations of Signal Lines

DIO1 to 8 (Data lines)

Used for general 8-bit parallel data and for address bus commands.

DAV (Data Valid)

Indicates that data on the DIO lines is valid.

NRFD (Not Ready For Data)

Indicates that reception of data on the DIO lines by the listener is enabled.

NDAC (Not Data Accepted)

Indicates that the listener has finished receiving data on the DIO lines.

ATN (Attention)

Signal line indicating that the data on the DIO lines is either general data or a bus command.

REN (Remote Enable)

This line is used to distinguish between remote and local control for each device.

IFC (Interface Clear)

This signal line is used to clear the interface for each device.

SRQ (Service Request)

This line is used to issue requests for serial and parallel polling to the controller.

EOI (End or Identify)

This signal line indicates the end of continuous data.

13.3 GPIB Interface Functions

The GPIB Interface for the CF-350 has the following functions.

CODE	FUNCTION
SH1	Has send handshake function
AH1	Has received handshake function
T5	Has basic talker function Has serial poll function Has talk only mode (for plotting mode only) Talker cancel using MLA (My Listen Address)
L4	Has basic listener function Has no listen only Listener cancel using MTA (My Talk Address)
SR1	Has service request function
RL1	Has remote/local function
PP0	Has no parallel poll function
DC1	Has device clear function
DT0	Has no device trigger function
C0	Has no controller function

13.3.1 Talker Functions

- Two or more talkers must not exist on the GPIB (IEEE 488) bus simultaneously.
- When the ATN signal from the controller is at high level, data is sent to listeners.
- Source handshaking is performed automatically.
- When the MTA (My Talk Address) is received from the controller, a talker is specified.
- When the MLA (My Listen Address) is received from the controller, a talker is canceled.
- When the UNT (Untalk) is received from the controller, a talker is canceled.

In actual use, when sending commands from a controller to the analyzer, some commands will result in impossible conditions, depending upon the commands which proceed or follow them. This will cause a hangup of the GPIB bus, locking the bus. Thus, all commands are not always valid.

(Examples)

1. A command to read data is sent from the analyzer (talker wait condition). Attempt is made to write data without specifying the analyzer as a talker.
2. A command is sent for the analyzer to write data (listener wait condition). An attempt is made to read data after specifying the analyzer as a talker.

In either of cases of 1 or 2 above, the sequence of commands and listener/talker specifications are incorrect and will result in a bus hangup condition.

13.3.2 Listener Functions

- Two or more listeners may exist on the GPIB (IEEE 488) bus at the same time.
- When the ATN signal from the controller is at the high level, data is read from the bus.
- Acceptor handshaking is performed automatically.
- When the MLA (My Listen Address) is received from the controller, a listener is specified.
- When the MTA (My Talk Address) is received from the controller, a listener is canceled.
- When the UNL (Unlisten) is received from the controller, a listener is canceled.

As is the case with a talker, for listeners, certain command sequences are not acceptable, and will result in a bus hangup.

To cancel such a condition, send IFC (single-line message) or DCL (multi-line message) to the analyzer. In the usual case, it is not necessary to press the system RESET.

Since for the PRINT (or OUTPUT) statement from a personal computer, the listener specification is executed first and, since for the INPUT (ENTER) statement the talker specification is executed first, this is usually not a problem, however.

13.3.3 Bus Commands

The following table lists the valid bus commands for use with this interface (multi-line message). Other commands will be ignored and no effect will be had on the operation of the analyzer.

COMMAND	SYMBOL	DATA LINE	FUNCTION
DEVICE CLEAR	DCL	x 0010100	Clears a device
GO TO LOCAL	GTL	x 0000001	Cancels remote condition
LOCAL LOCKOUT	LLO	x 0010001	Inhibits the local switch
MY LISTEN ADDRESS	MLA	x 01LLLLL	Specifies a listener
MY TALK ADDRESS	MTA	x 10TTTTT	Specifies a talker
OTHER TALK ADDRESS	OTA	x 10TTTTT	Other talker specification
SELECTED DEVICE CLEAR	SDC	x 0000100	Clears a specified listener
SERIAL POLL DISABLE	SPD	x 0011001	Disables serial poll
SERIAL POLL ENABLE	SPE	x 0011000	Enables serial poll
UNLISTEN	UNL	x 0111111	Cancels a listener
UNTALK	UNT	x 1011111	Cancels a talker

In the above, LLLLL and TTTTT represent the listener and talker addresses respectively.

Note

The DC (Device Clear) function is equivalent to the IFC function and will only initialize the interface.

13.3.4 Panel Description

- LOCAL Switch and Associated LED

  Whenever the LOCAL switch is pressed, the LOCAL LED lights and the remote condition is canceled. In this mode, the panel switches may be used to make manual settings.

  When a SYSTEM RESET is performed, (or whenever power is first applied), if the LOCAL LED lights, the analyzer's interface is in the addressable (i.e., controllable from an external controller) mode. If the LED is extinguished, it is in the talk only (plotter-control) mode.

- TALK LED

  When the analyzer is specified as a talker this LED lights.

  It is extinguished whenever the analyzer is specified as a listener or the talker function is otherwise canceled. It always lights in the talk only mode.

- LISTEN LED

  When the analyzer is specified as a listener, this LED lights. When it is specified as a talker or the listener function is otherwise canceled, it is extinguished.

- SRQ LED

  This LED lights when the GPIB service request (SRQ) is being used.

13.3.5 Addressable/Talker-Only Switching

In the CF-350. this switching is performed using soft keys

<<<MENU C>>>

SERVO	Y axis	DATAset	others			option	NEXT

OTHERS CONTROL

P.COND	GPIB	DISK	ANALOG				RETURN

GP-IB ADDRESS

TK.ONLY	ADDRESS	SET	SRQ				RETURN
①	②	③	④				

①	TK.ONLY	When this key is pressed, the talker-only mode (plotter-control mode) is enabled.
②	ADDRESS	When this key is pressed, the addressable mode (in which control is possible from an external controller) is enabled.
③	SET	This key enables the setting of the address as a numerical value. Press SET to turn it on. The address will be displayed as 09. Use the numeric keys on the front panel to input the desired address and press SET once again to make the actual setting.
④	SRQ	This key issues a service request. Service request is sent each time the key is pressed.

13.4 Commands by Type

The GPIB interface command set for the CF-350 consists of commands made up of three ASCII characters codes. The commands can be classified into five types. The numbers listed for each command in the command list indicate the type of command, these types being described below.

- Type 1

  This type of command is sent as three characters alone without any required parameters.

Ex.	"BON"	(Sets beeper ON)
	"CPS"	(Sets FUNCTION ON)

- Type 2

  This type of command consists of a 3-character command and numerical parameter which must be sent.

Ex.	"ANS4"	(Sets 16 averages)
	"AAS6"	(Sets the 1V range)

- Type 3

  After sending this type of command (3 characters), the parameters (ASCII data) must be read by the analyzer.

Ex.	"ANC"	(Reads the number of averages)
	"LXS"	(Reads the X search parameter of the lower screen)

- Type 4

  After this type of 3-character command is sent, binary data must be read from the analyzer.

Ex.	"BDR1"	(Reads the time axis waveform for Ch A)

- Type 5

  After sending this 3-character command, binary data must be sent to the analyzer.

Ex.	"FMW"	(Rewrites the FFT memory data)

Programs may be generated by using the above five types of commands. The user should bear in mind, however, what type of command is being used and arrange the program sequence appropriately.

13.4.1 Type 1 Commands

AAC	Selects AC coupling for the Ch A amplifier.
ACF	Cancels A/D converter overflow cancel function.
ACO	Activates A/D converter overflow cancel.
ACR	Displays Ch A autocorrelation function.
ADC	Selects DC coupling for the Ch A amplifier.
AH1	Specifies three-dimensional array height 1.
AH2	Specifies three-dimensional array height 2.
AH3	Specifies three-dimensional array height 3.
AHI	Displays Ch A histogram.
ASD	Selects downward scrolling of the 3-dimensional array.
ASF	Sets scrolling of the 3-dimensional array to OFF.
ASO	Sets scrolling of the 3-dimensional array to ON.
ASP	Displays Ch A spectrum.
ATI	Displays Ch A time waveform.
ASU	Selects upward scrolling of the 3-dimensional array.
AUF	Activates automatic switching of input amplifier sensitivity .
AUO	Cancels automatic switching of input amplifier sensitivity.
AVC	Sets averaging to the continue mode.
AVF	Cancels average mode.
AVO	Selects average mode.
BAC	Selects AC coupling for the CH B amplifier.
BCR	Displays the Ch B autocorrelation function.
BDC	Selects DC coupling for the Ch B amplifier.
BDF	Cancels the transfer function Bode plot display mode.
BDO	Selects the transfer function Bode plot display mode.
BHI	Displays the Ch B histogram.
BOF	Cancels the beeper function.
BON	Activates the beeper function.
BSP	Displays Ch B spectrum.

BSF	Cancels the short beeper. BON is used to reactivate the beeper.
BTI	Displays the Ch B time waveform.
CAN	Specifies cancel function ON/OFF or execution.
CBF	Cancels coherence blanking.
CBO	Selects coherence blanking.
CCN	Continues data capture (valid only in the PAUSE condition).
CCR	Displays cross correlation function.
CDF	Cancels the digital input mode (valid only in the PAUSE condition).
CDO	Selects the digital input mode (valid only in the PAUSE condition).
CMC	Clears the 60 blocks of CRT mask memory.
COF	Cancels the cepstrum mode.
COH	Displays the coherence function.
CON	Selects the cepstrum mode and displays the cepstrum.
COP	Displays the coherence output power spectrum.
CPE	Performs Fourier transform on the liftered cepstrum and displays the resulting envelope.
CPF	Removes CRT memory write protect.
CPL	Specifies cepstrum liftering.
CPM	Sets cepstrum display to MAG.
CPO	Activates the CRT memory write protect.
CPR	Sets cepstrum display to REAL.
CPS	Enables the PAUSE condition (valid only in the START condition).
CSP	Displays the cross spectrum.
CST	Begins data capture.
CSV	Converts normal-mode transfer functions stored in CRT block memory to servo analysis mode transfer functions.
DCF	Deactivates the sampled data DC cancel function.
DCO	Activates the sampled data DC cancel function.
DCS	Sets the delta cursor (or resets it).
DIF	Turns the CRT screen graph display inhibit off (valid only in the START condition).

DIO	Turns the CRT screen graph display inhibit on (valid only in the START condition).
DLS	Loads the data specified by the DLN command from the disk.
DOF	Cancels the delta search function.
DON	Selects the delta search function.
DOV	Sets the display format to overlay.
DSP	Sets the display format to split display.
DSS	Stores the data specified by the DSN command on the disk.
DUC	Specifies copy as the disk utility.
DUF	Specifies format as the disk utility.
DUP	Selects purge as the disk utility.
DUS	Executes the specified disk utility.
EAS	Selects 1EU as the Ch A search point.
	Note
	The lower screen (or single screen) must be the Ch A power spectrum.
EBS	Selects 1EU as the Ch B search point.
	Note
	The lower screen (or single screen) must be the Ch B power spectrum.
EVS	Selects envelope bandlimiting.
FIS	Stores curve fitting data in memory.
FIT	Executes curve fit.
FOF	Cancels the anti-aliasing filter.
FON	Selects the anti-aliasing filter.
GOF	Sets the grid to OFF
GON	Sets the grid to ON.
HMF	Disables harmonic display.
HMO	Enables harmonic display
HMS	Sets the fundamental point for a harmonic display.
IFT	Executes an inverse Fourier transform.
IMG	Sets the display attribute to the imaginary part.
IMP	Displays the impulse response.

IST	Stores the Fourier spectrum when performing an inverse Fourier transform.
ITF	Turns the time-axis integral off.
ITO	Turns the time-axis integral on.
LAS	Stores the next character string (up to 55 characters) sent after the command as a label. Characters sent: "LAS" (CR) (LF) Characters sent: ".... (desired character string)" (CR) (LF)
LCR	Clears the search list.
LHS	Sets the feedback element H for loop analysis.
LPC	Cancels closed loop.
LPO	Cancels open loop.
LST	Puts the display in list mode.
MAG	Makes the display attribute magnitude.
MBD	Decreases the CRT block memory block number.
MBU	Increases the CRT block memory block number.
MDL	Deletes 1 block from CRT block memory.
MIS	Inserts blank data into CRT block memory.
MLU	Lists CRT block memory contents.
MRC	Recalls data from the CRT block memory.
MST	Stores the screen in the CRT memory of the currently specified block number.
NLS	Sets the Nyquist plot and orbit display domains.
NYQ	Selects the Nyquist (orbit) display mode.
O1S	Selects the 1/1 octave mode.
O3S	Selects the 1/3 octave mode.
OAF	Cancels the A characteristic in the octave mode.
OAO	Activates the A characteristic in the octave mode.
PAF	Cancels the overall display of the Y-axis search section.
PAJ	Cancels the phase difference between channels A and B.
PAO	Activates the overall display of the Y-axis search section.
PCC	Clears the record memory playback address counter to zero.

PCF	Specifies the record zoom central frequency.
PDS	Selects the record memory playback address decrement mode.
PHS	Selects phase as the display attribute.
POF	Cancels the record memory playback mode and selects the current mode.
PON	Activates the record memory playback mode.
PPS	Puts data transfer to X-Y plotter on pause.
PSF	Cancels the software key unit drawing function during plotter output.
PSO	Activates the software key unit drawing function during plotter output.
PST	Starts data transfer to the X-Y plotter.
PUS	Selects the record memory playback address increase mode.
PZF	Turns the record zoom mode off.
PZO	Turns the record zoom mode on.
PZS	Executes record zoom once only.
RDL	Specifies file deletion from RAM disk.
REL	Sets the display attribute to the real part.
RIS	Specifies file insertion onto RAM disk.
RMC	Clears the time record memory.
ROF	Turns the time record mode off.
RON	Turns the time record mode on.
RPG	RAM disk purge (clears contents).
RRS	Specifies ring as the time record mode.
RSS	Specifies single as the time record mode.
SCE	Specifies the external sampling clock.
SCF	Cancels the search cursor.
SCI	Specifies the internal sampling clock.
SCO	Activates the search cursor.
SCT	Selects repeated signal output.
SDM	Sets the autosequence display mark.
SEC	Enables a dual-frame display. (Displays two screens.)
SEF	Cancels the search enhance function.

SEO	Activates the search enhance function.
SFS	Specifies the single sinewave frequency or swept sinewave frequency.
SLF	Disables search list setting mode.
SLO	Enables search list setting mode.
SLS	Sets the current search point to the search list.
SMD	Moves the current search marker 13 points to the left or horizontal cursor downward..
SML	Moves the current search marker 1 point to the left.
SMR	Moves the current search marker 1 point to the right.
SMU	Moves the current search marker 13 points to the right or horizontal cursor upward..
SOF	Disables the search function.
SON	Enables the search function.
SPF	Turns the signal out pink filter off.
SPO	Turns the signal out pink filter on.
SQS	Autosequence function ON/OFF toggle. (Same as panel switch)
SRE	Resets the analyzer.
SSF	Turns the sequence memory storage function off.
SSI	Outputs one frame of signal output.
SSM	Signal source unit memory setting.
SSO	Turns the sequence memory storage function on.
SVC	Clears 4-decade memory.
TDA	Selects the three-dimensional display mode.
TEF	Turns the transfer function equalize function off.
TEO	Turns the transfer function equalize function on.
TES	Stores data in the standard transfer function equalize buffer.
TEX	Selects the external trigger source.
TFR	Cancels the trigger function.
TIA	Selects the internal (Ch A) trigger source.
TIB	Selects the internal (Ch B) trigger source.
TIF	Turns the time interval function off.

TIO	Turns the time interval function on.
TOF	Cancels the input test signal and enables data capture.
TON	Activates the input test signal and deactivates data capture.
TPM	Sets the trigger slope to negative.
TPP	Sets the trigger slope to positive.
TRE	Selects the trigger repeat mode.
TSI	Selects trigger signal mode.
WST	Sets the window.
XFR	Displays the transfer function.
XLI	Selects X-axis linear scaling.
XLO	Selects X-axis logarithmic scaling.
XUF	Disables X-axis units and sets them to Hz.
XUO	Enables X-axis units and sets them to CPM.
XXF	Disables X-axis expansion.
XXO	Enables X-axis expansion
YGD	Decreases Y-axis gain
YGU	Increases Y-axis gain
YLI	Selects Y-axis linear scaling.
YLO	Selects Y-axis logarithmic scaling.
YUF	Turns theY-axis unit off.
YUO	Turns the Y-axis unit on.
ZCS	Specifies the center frequency of the real-time zoom.
ZED	Decreases the expansion ratio of the real-time zoom.
ZEU	Increases the expansion ratio of the real-time zoom.
ZOF	Turns realt-ime zoom off.
ZON	Turns real-time zoom on.

13.4.2 Type 2 Commands

This type of command consists of a 3-charadcter command which must always be followed by a numerical parameter value. Only the required digits must be sent. If extra digits are sent, an error condition will occur. This will be indicated by a long beeper. Leading zeros, however, may be suppressed before transmission without causing an error.

Example

"ANS08" → "ANS8" (Set 256 averages)

The Type 1 and Type 2 commands are chiefly related to the front panel and software key settings and as such, may be sent continuously. A string of up to 78 characters may be sent. Commands related to panel switches have the same effect as if the corresponding front panel switch was pressed (short beeper or, if ignored, a long beeper).

Example

"AAC AAS4 FRS10 AMC1 ANC3 ... CST" (CR) (LF)

(This command selects AC coupling, the 5 V input range and the frequency range of 1 kHz for Ch A, selects spectrum linear averaging, 8 averages, ... and starts analysis.)

AAS	Specifies the Ch A input voltage range. 1 (50 V), 2 (20 V), 3 (10 V), 4 (5 V), 5 (2 V), 6 (1 V), 7 (.5 V), 8 (.2 V), 9 (.1 V), 10 (50 mV), 11 (20 mV), 12 (10 mV), 13 (5 mV), 14 (2 mV), 15 (1 mV)
ACS	Specifies arithmetic operation for upper and lower screens. 1 (ON/OFF), 2 (+), 3 (−), 4 (×), 5 (÷)
ADS	Specifies the inclination of the 3-dimensional array. 1 (90°), 2 (Approx. 75°), 3 (Approx. 65°) C
AKI	Specifies the number of 3-dimensional display lines. 1 (20), 2 (60), 3 (90).
AMI	Specifies the minimum SG-450 output amplitude after servo analysis is completed. 1 (ON), 2 (OFF)
AMS	Specifies the average mode. 1 (SP, SUM), 2 (SP, EXP), 3 (SP, PEAK), 4 (SP, SWEEP) 5 (SP, DIFF), 6 (TI, SUM), 7 (TI, EXP), 8 (TI, ABS), 9 (HI, SUM), 10 (F.SP, SUM), 11 (F.SP, EXP)
AMX	Sets the average to maximum overall mode. 1 (ON), 2 (OFF).

AND	Specifies the number of averages as a value. 1 to 32,767
ANS	Specifies the number of averages. 1 (2), 2 (4), 3 (8), 4 (16), 5 (32), 6 (64), 7 (128), 8 (256), 9 (512), 10 (1024), 11 (2048), 12 (4096), 13 (8192), 14 (1)
AOS	Specifies the search point analog output function. 1 (ON), 2 (OFF)
ARA	Ch A autorangng (servo mode). 1 (ON), 2 (OFF).
ARB	Ch B autoranging (servo mode). 1 (ON), 2 (OFF).
ASC	Specifies either continuous analysis or one analysis pass when the analysis source is memory or disk. 1 (continuous), 2 (one pass).
ASM	Selects the analysis source. 1 (ANALOG), 2 (CRT memory), 3 (disk)
ASS	When the analysis source is memory or disk, 1 specifies 2-channel mode, and 2 specifies 1-channel mode.
BAS	Specifies Ch B input voltage range. Same as AAS command.
CBC	Clears CRT block memory. 1 to 540
CBS	Specifies the coherent blanking level. 1 to 255
CDS	Specifies the delay between A and B. 0 to +65,535
CIM	Calculates the impulse response from the transfer function displayed on the CRT. 1 (ON), 2 (OFF)
CLD	Turns the function that adds the purpose to the labels stored in the CRT memory on and off. 1 (ON), 2 (OFF).

CLL	Turns the function that loads the display condition when the CRT memory is recalled on and off. 1 (ON), 2 (OFF).
CLP	Turns the function that copies the CRT memory label on the current label on and off. 1 (ON), 2 (OFF).
CLT	Turns the function that appends the time to the label stored in the CRT memory on and off. 1 (ON), 2 (OFF).
CMM	Specifies the CRT screen memory store mode. 1 (manual), 2 (auto), 3 (external)
CMS	Specifies the use of the CMOS memory card. 1 (CRT block memory), 2 (RAM disk), 3 (time record memory), 4 (OFF)
CSN	Turns the function that sets the coherence function to S/N ratio display on and off. 1 (ON), 2 (OFF)
CUD	Turns the function that sets the CRT block memory number to increment or decrement in 10 steps on or off. 1 (ON), 2 (OFF)
DIA	Establishes whether the graph display function is valid over the entire display or not. 1: Inhibits display entirely. 2: Specifies spectrum linear averaging only.
DI2	Establishes whether every other average will be displayed or not during spectrum linear averaging. 1: Displays every other average. 2: Inhibits display until the end.
DFS	Specifies the disk file number. A 3-digit value between 1 and 300 is required.
DLN	Specifies the data to be loaded from the disk. 1 (CRT MASS), 2 (CRT MASS ALL), 3 (CATALOG LISTUP), 4 (RECORD TIME), 5 (PANEL CONDITION), 6 (AUTO SEQUENCE)
DPC	Specifies the panel condition number for storing to or loading from the disk. 1....4.

DSA Enables the mode which reads only a single side of a disk.

1 (ON), 2 (OFF)

DSN Specifies the type of data to be stored to the disk.

1 (CURRENT CRT), 2 (CURRENT CRT AUTO), 3 (CRT MASS), 4 (CRT MASS ALL), 5 (RECORD TIME), 6 (PANEL CONDITION), 7 (AUTO SEQUENCE)

DSY Causes the delta function to operate on Y-axis values only.

1 (ON), 2 (OFF)

DTS Sets Ⓐ , Ⓑ , or Ⓒ data.

Ⓐ = for whichever type of data,

0 = SSU control

1 = SSU No. 1
⋮
10 = SSU No. 10

11 = Plotter

Ⓑ = Which number data from the top?

Ⓒ = Data.

DUD Specifies the disk drive.

1 (Drive 0), 2 (RAM disk)

EAD Specifies the Ch A search point being displayed to any desired dB value.

Always specify with the software key in the same format as for "+0.125".

(Example) "EAD + 124.0"

Sets the current search point to 124 dB.

Note

The lower screen (or single screen) must be on Ch A power spectrum.

EAN Specifies the Ch A EU value. Specifies the physical quantity per 1 V.

(Exampe) "ENA 1234/−4"

Specifies that 1234 × 10^{-4} (EU/V) = 0.1234 (EU/V).

EA= Specifies the Ch A EU unit.

Example "EA= kg"

Sets the Ch A units to kg.

EBD	Specifies the Ch B search point being displayed to any desired dB value. The same as EAD.
ENB	Specifies the Ch B EU value. The same as EAN.
EB=	Specifies the Ch B EU unit.
EVB	Envelope analysis bandlimiting function. 1 (ON), 2 (OFF)
EVL	Sets Y-axis to logarithmic scaling during envelope display. 1 (ON), 2 (OFF)
EVM	Selects envelope display. 1 (ON), 2 (OFF)
EVP	Selects the envelope function. 1 (ON), 2 (OFF)
EWS	Specifies the index window numerical value.
FJS	Specifies spectrum differentiation and integration. 1 (OFF), 2 ($\times j\omega$), 3 ($\times(j\omega)^2$), 4 ($1/j\omega$), 5 ($1/(j\omega)^2$)
FLS	Specifies analysis frame length. 1 (Ch A 2K), 2 (Ch B 2K), 3 (dual 1K)
FLT	Selects the fitting data list.
FRS	Specifies the frequency range. 1 (1 Hz), 2 (2 Hz), 3 (5 Hz), 4 (10 Hz), 5 (20 Hz), 6 (50 Hz), 7 (100 Hz), 8 (200 Hz), 9 (500 Hz), 10 (1 kHz), 11 (2 kHz), 12 (5 kHz), 13 (10 kHz), 14 (20 kHz), 15 (40 kHz)
FSY	Displays fitted data. 1 (ON), 2 (OFF)
FTN	Sets the degree of the fitting. 1 to 20.
GLS	Specifies the grid function. 1 (ON), 2 (OFF)
IFA	Selects inverse Fourier transform window compensation. 1 (ON), 2 (OFF)

IFB	Selects inverse Fourier transform bandlimiting. 1 (ON), 2 (OFF)
IFM	Multiplies the transfer function when performing an inverse Fourier transform. 1 (ON), 2 (OFF)
IMS	Specifies the vibration mode. 1 (ON), 2 (OFF)
ISM	Specifies the channel on which time-domain differentiation/integration is to be performed. 1 (Ch B only), 2 (Ch A and Ch B)
ITS	Specifies the time-domain integration/differentiation calculation. 1 (single integration), 2 (double integration), 3 (first derivative), 4 (second derivative)
LBX	Sets the second line of the label. 1 (condition switch ON) Initializes the label. 2 (condition switch OFF) 3 (copy first line into second line)
LLU	When the peak list is being displayed, sets the display order either to the frequency order or to the size order. 1 (frequency), 2 (size)
LPA	Performs loop analysis. 1 (ON), 2 (OFF)
LPH	Specifies the feedback element as 1 for loop analysis. 1 ($H=1$), 2 ($H\neq 1$)
MBS	Specifies the CRT block memory number. A 2-digit value (1 to 540) is required.
MGL	The function that sets the display Y-axis to log and the search to linear. 1 (ON), 2 (OFF)
NCP	Cole-Cole plot mode. 1 (ON), 2 (OFF)
NLT	In Nyquist display and orbit plot, the display domain limiting function. 1 (ON), 2 (OFF)

NMP	The function that sets the search to gain single-phase in transmission function Nyquist display. 1 (ON), 2 (OFF)
NRT	In Nyquist display and orbit 3-dimensional display, rotates the display direction. 1 (+45°), 2 (+90°), 3 (135°), 4 (+180°), 5 (225°), 6 (+270°), 7 (+315°),
NTD	Nyquist and orbit 3-dimensional display. 1 (ON), 2 (OFF)
OMS	Selects the spectrum octave analysis mode. 1 (OFF), 2 (30 bands), 3 (15 bands)
ODS	Displays the overall value. 1 (ON), 2 (OFF)
OSP	Sets the octave sharp on and off. 1 (ON), 2 (OFF)
OVS	Specifies the data capture overlap. 1 (max.), 2 (50%), 3 (0%)
PAN	Specifies the number of lines for plotting in 3 dimensions from disk data. 1 (130), 2 (90), 3 (60), 4 (30)
PAS	Specifies the record memory playback address counter. A 6-digit numerical value (0 to max.) is required. 260096 (255 K mode) 129024 (127 K mode) MAX = 030720 (30 K mode) 784384 (768 K mode) 391168 (384 K mode) The above are the settings with the record zoom off, Ch B delay of 0, a data length of 1024 points, averaging and instant mode. If zoom and/or delay are used, the MAX should be set appropriately.
PAT	Plots every other file when making 3-dimensional plots from disk. 1 (ON), 2 (OFF)
PAW	A-weighting compensation of the power spectrum. 1 (ON), 2 (OFF)

PBA	In the playback mode, the all display function. 1 (ALL), 2 (BLOCK), 3 (OFF)
PBS	Specifies the Ch B delay during record memory playback. A 4-digit numerical value between 1 and 8191 is required.
PCA	Activates the panel condition autorecall. 1 (ON), 2 (OFF)
PCL	Loads the panel conditions for the specified Nth memory. A one-digit integer between 1 and 4 is required.
PCS	Stores the panel conditions in the specified Nth memory. A one-digit integer between 1 and 4 is required.
PDA	Selects delay adjustment. 1 (ON), 2 (OFF)
PDJ	Sets the display adjustment data. $1234/-3 = .1234 \times 10^1$
PDG	Plots the upper screen data in broken line when in 2-screen overlaid display. 1 (ON), 2 (OFF)
PDV	Specifies the plotter type. 1 (CX-338/335 having HP-GL command set) 2 (Graphtec command GPIB interface)
PEQ	Enables power spectrum equalization. 1 (ON), 2 (OFF)
PFD	Selects plotter paper feed. 1 (feed paper before plotting), 2 (feed paper after plotting) 3 (do not feed), 4 (deliver paper to the back), 5 (deliver paper to the front)
PFM	Specifies the plotting size. 1 (A4), 2 (A6), 3 (A5)
PFS	Specifies the record zoom magnification. 1 (×2), 2 (×4), 3 (×8), 4 (×16), 5 (×32), 6 (×64)
PGD	Selects group delay display. 1 (ON), 2 (OFF)

PGS	Specifies the record memory playback interval. 0 (1), 1 (2), 2 (4), 3 (8), 4 (16), 5 (32), 6 (64), 7 (128), 8 (256), 9 (512), 10 (1024), 11 (2048), 12 (4096), 13 (0)
PHF	Specifies the phase display format. 1 (+/−), 2 (0/+), 3 (0/−)
PLN	Specifies the plotting position. 1 (LOCAT 1), 2 (LOCAT 2), 3 (LOCAT 3), 4 (LOCAT 4)
PLS	Specifies the record memory playback frame length. 1 (2048), 2 (1024)
POM	Specifies the power spectrum only mode. 1 (ON), 2 (OFF)
PPC	Specifies the pen for plotting of characters. 1 (pen 1), 2 (pen 2), 3 (pen 3), 4 (pen 4), 5 (OFF)
PPD	Specifies the plotter pen for graphic data plotting. Same as PPC.
PPF	Specifies the plotter pen for frame plotting. Same as PPC.
PSC	Specifies the plotter scale function. 1 (P1 − P2), 2 (numeric), 3 (OFF)
PSH	Records only the search point value when making a plot. 1 (ON), 2 (OFF)
PSS	Specifies the plotting source. 1 (CRT hard copy) 2 (Mass memory CRT screen) 3 (Disk automatic plot)
PVS	Sets the power spectrum (linear) display units to V^2. 1 (ON), 2 (OFF)
RAL	Puts the time record memory into 768 Kword mode. 1 (ON), 2 (OFF)
RBM	Selects the 30 K record mode. 1 (ON), 2 (OFF)

RBS	Specifies the block number for the 30-K time record memory mode. 1 to 8
RCO	Specifies the time record memory conditions. Input ranges and frequency ranges for channels A and B.
RCS	Specifies the time record memory capture channel. 1 (Ch A & B), 2 (Ch A), 3 (Ch B)
REF	Activates the Y-axis reference function. 1 (ON, 2 (OFF)
RLW	Sets the lower screen reference value. ○○○
RMX	Switches 255-Kword memory data with the first half or second half of CMOS memory. 1 (first half), 2 (second half)
RSL	Establishes whether the begining, middle or end of 768 Kwords of data are to be stored on to disk. 1 (beginning), 2 (middle), 3 (end)
RUP	Sets the upper screen reference value.
S8K	Specifies the time record analog output 8-Kword mode. 1 (ON, 2 (OFF)
SAM	Sets the signal output amplitude units to mV. A 4-digit value in the range 10 to 5000 is required.
SBD	Specifies the signal output frequency band. 1 (ON, 2 (OFF)
SCL	Reads the panel conditions for auto sequence execution. 1 (ON, 2 (OFF)
SCY	Sets the number of outputs for each of the burst signals. A 3-digit value in the range 1 to 999 is required. After this setting, the SBT command is required again.
SDS	Specifies the power spectrum density. 1 (OFF), 2 (PSD), 3 (ESD)

SFR Sets the sinewave output frequency.

A 10-digit value is required (up to 4 decimal digits).

SHL Specifies the lower screen search point at any desired point.

The setting range is as follows.

Number of lines	400 lines	800 lines
Time-domain data	0 to 1023	0 to 2047
Frequency-domain data	0 to 401	0 to 801
Amplitude-domain data	0 to 255	0 to 255

SHU Specifies the upper screen search point at any desired point.

The setting range is the same as for SHL.

SLN Specifies the search list number.

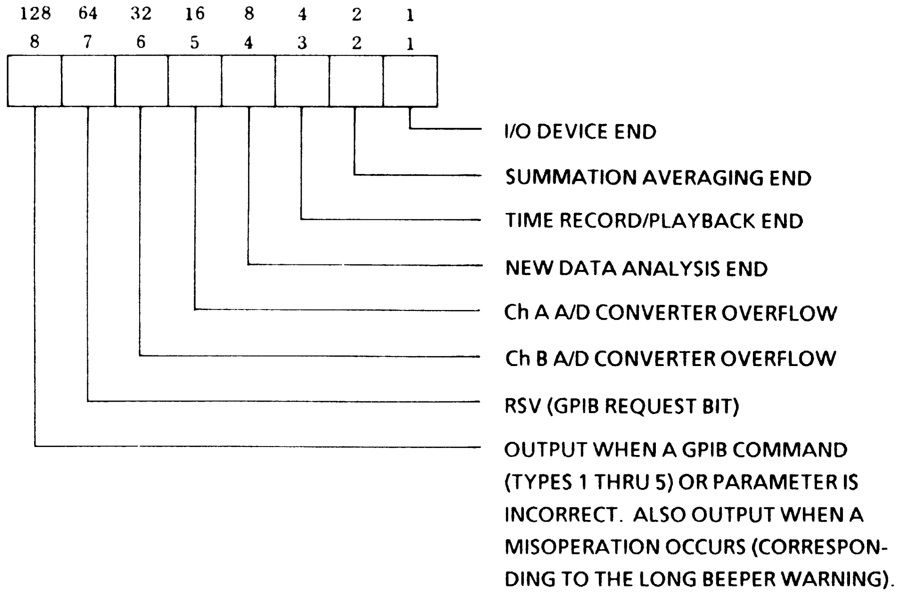
A 2-digit integer between 1 and 20 is required.

SLP Enables the 10-peak search list mode.

1 (ON), 2 (OFF)

SMS Specifies the service request mask.

By setting the corresponding interrupt factor bit to the 1 (mask removed) or 0 (masked), it is possible to issue an interrupt to the controller only for the desired factors. When power is first applied, and whenever the system is reset, all interrupt factors are disabled (i.e., all bits set to 0).



Note

The IO device end indicates the end of plotting, recording, or the end of a disk utility execution. For example, if an interrupt is to be enabled at the end of averaging and at the end of a record, the following is sent.

"SMS6" (6 = 2 + 4)

SNP Sets the search shift to next peak.

1 (ON), 2 (OFF)

SPP Specifies the function that displays the peak value when the search point is on.

1 (ON), 2 (OFF)

SPS Specifies a dot search marker at any desired point (top and bottom of screen simultaneously).

Any point from 0 to max. The value of max varies according to the content of the display or with the data length. If a point greater than the current max is specified, max is specified automatically.

However, the maximum number of digits for the numerical parameter is 5.

SRM Specifies the autosequencing run mode.

1 (run off), 2 (step), 3 (auto), 4 (ring on), 5 (ring off), 6 (start control on), 7 (start control off)

SRS	Specifies the autosequencing run mode ring number (number of repetitions). (0 to 999)
SRV	Specifies servo analysis. 1 (400 line), 2 (4 decade), 3 (OFF)
SQM	Specifies the sequence memory to be used. 1 (SEQ1), 2 (SEQ2) Same for set mode and run mode.
SSA	Outputs the frequency at the same delta cursor position even when the frequency range is switched. 1 (ON), 2 (OFF)
SSH	Specifies autosequencing search control. 1 (ON), 2 (OFF), 3 (MEM), 4 (SET)
SSU	Activates the SG-450 Signal Source Unit. 1 (ON), 2 (OFF)
SSS	Specifies the type of output analog signal. 1 (sine), 2 (swept sine), 3 (periodic random), 4 (random), 5 (impulse), 6 (pip), 7 (CRT), 8 (time record memory)
STM	Sets the burst signal output interval. A 3-digit value in the range 1 to 999 is required. After setting in units seconds, the SBT command is required again.
STP	Specifies time-axis single screen search (search off). 1 (peak-to-peak) , 2 (max, min)
SVC	Activates the memory clear function during servo analysis. 1 (ON), 2 (OFF)
TIS	Specifies the time interval in seconds. A 4-digit numerical value between 1 and 9999 is required.
TLS	Specifies the trigger level. The numerical range is −122 to +122. Full scale is considered to be the present voltage range (−128 to +127).
TMP	Specifies the polarity inversion function. 1 (Ch A), 2 (Ch B), 3 (Ch A & B), 4 (OFF)

TOS	Enables the trigger one-shot function. 1 (ON), 2 (OFF)
TPS	Specifies the trigger position. The setting is made in the range 0 to ±65536. The meaning of the numerical parameter setting is the same as for a manual setting.
TRS	Specifies the current realtime (24-hour) clock. Example. "TRS01/12/87 09:15"
VWS	Specifies the display setting view type. A one-digit integer between 1 and 9 is required.
WIS	Specifies the window type. 1 (RECTANGULAR), 2 (HANNING), 3 (FLAT-TOP), 4 (USER), 5 (FORCE-FORCE), 6 (EXPONENTIAL-EXPONENTIAL), 7 (FORCE-EXPONENTIAL)
WSL	Specifies which window, FORCE, EXP, or USER, is to be set. 1 (FORCE), 2 (EXP), 3 (USER).
XIS	Calculates the transfer function reciprocal (1/H). 1 (ON), 2 (OFF)
XNC	Enables the Nichols PLOT function. 1 (ON), 2 (OFF)
XUM	Specifies the X-axis units. 1 (CPM), 2 (ORD), 3 (ORD setting and execution), 4 (list scroll up), 5 (list scroll down), 6 (order fitting on), 7 (order fitting off), 8 (seconds)
XYD	Plots data on a X-Y recorder. 1 (ON), 2 (OFF)
XYF	Writes a frame at the X-Y recorder. 1 (ON), 2 (OFF)
XYP	Specifies the X-Y recorder pen speed. 1 to 7
XYS	Starts the X-Y recorder. 1 (start), 2 (stop).

XYX	Expands the horizontal axis of the X-Y recorder. (Time axis and histogram) 1 (ON), 2 (OFF)
YGH	Specifies the change in Y-axis gain (upper screen). 1 (ON), 2 (OFF)
YGL	Specifies the change in Y-axis gain for a single frame display or the lower screen of a dual-frame display. 1 (ON), 2 (OFF)

13.4.3 Type 3 Commands

Type 3 commands consists of a three-character (ASCII code) command, after which a numerical parameter or character string (all ASCII codes) must be read from the CF-350. The terminator is CR (13), LF (10). Simultaneous with the LF, EOI is also output.

AAR Reads the Ch A setting voltage range.

Sent AAR CR LF

Recd ○○ CR LF

(1- to 2-digit value)

AMC Reads the averaging mode.

Sent AMC CR LF

Recd ○ CR LF

(1- digit value)

ANC Reads the number of set averages.

Sent ANC CR LF

Recd ○○ CR LF

(1-2 digit value)

BAR Reads Ch B setting voltage range.

Sent BAR CR LF

Recd ○○ CR LF

(1-2 digit value)

CFL Reads the length of the currently set frame.

CLC Reads the type of CRT list mode.

Same as LDC.

COC Reads the analysis conditions.

DFC Reads the disk file number.

Sent DFC CR LF

Recd ○○○ CR LF

(1-3 digit value)

DLC Reads a list from disk @.

@: 1 to 20

DTC Reads Ⓐ and Ⓑ data.

A and B are the same as DTS.

EAC Reads the Ch A EU value (per 1 V)

Sent EAC CR LF

Recd ○○○○E ±○ CR LF

(Exponential-format numerical value)

EBC Reads the Ch B EU value (per 1 V)

Same as EAC.

ERN Reads the error number.

(The interrupt factor of bit 8 of SRQ.)

EWF Reads index window set value.

FMC FFT memory ready verification for digital input.

1 (ready), 0 (busy)

FRC Reads the analysis frequency range.

Sent FRC CR LF

Recd ○○ CR LF

(1-2 digit value)

ICC Reads the input coupling status.

LAC Reads the CRT display lower screen graph voltage range.

Sent LAC CR LF

Recd ○○ CR LF

(1-2 digit value)

LBC Reads the label being displayed as a character string.

Sent LBC CR LF

Recd AS CR LF

LDA When the lower screen is a cross spectrum or a transfer function, this command reads the CH A and CH B input voltage ranges for the displayed data.

Sent LDA@ 1 (Ch A), 2 (Ch B) CR LF

Recd ○○ CR LF (1- or 2-digit value)

LDC Reads the CRT display lower screen graph type.

Sent LDC CR LF

Recd abc CR LF

ab is a 2-digit type indicator, thus, e.g. 01 has to be sent to represent 1.

c is a 1-character attribute.

LDD Ⓐ, Ⓑ, Ⓒ (search markers)

Reads the lower screen or single-screen data in ASCII format.

A = 1 X-axis value B = start point

= 2 Y-axis value C = stop point

= 3 both X and Y

Example. "LDD2, 0 , 400"

Reads the Y coordinate from point 0 to point 400.

LFC Reads the CRT display lower screen graph frequency range.

Sent LFC CR LF

Recd ○○ CR LF

(1-2 digit value)

LFL Reads the frame length of the lower screen.

LTR Reads the list data being displayed.

ab, c ab := 1 to 20 (list no.)

c is the parameter number from 1 to 2 or 1 to 3.

Example. "LTR 5, 2" reads list number 5 Y-axis value.

"LTR15, 3" reads the 15th order distortion for the order list.

LXA@ Reads out the lower screen (or single) X-axis data.

1 (lower bound), 2 (upper bound)

LXS Reads the X-axis search value from the lower CRT screen.

Sent LXS CR LF

Recd ○○ ..... ○○ CR LF

The sent character string is precisely the same as the string displayed, including such units as Hz and seconds.

The receiving character buffer must be 14 characters or greater.

LXY Reads X- and Y-axis search value from the lower CRT display.

This command is combination of the LXS and LYS commands. Since the two values are separated by a comma (,), two character buffers should be used to receive these, each one have the capacity of at least 14 characters.

Sent LXY CR LF

Recd $\underbrace{\text{OOO.....O}}_{\text{X value}}$, $\underbrace{\text{OOO....O}}_{\text{Y value}}$ CR LF

LYA@ Reads out the lower screen (or single) Y-axis data.

1 (lower bound), 2 (upper bound)

LYS Reads the Y-axis search value from the lower CRT screen.

This operates the same as the LXS command.

MBC Reads the set CRT memory block number.

Sent MBC CR LF

Recd OO CR LF

(1-2 digit value)

MSC Reads the status of the currently set CRT memory block.

Sent MSC CR LF

Recd a bcd CR LF (must receive 4 digits)

a = 0 (no data)
= 1 (block 1 data)
= 2 (front half of block 2 data)
= 3 (later half of block 2 data)

bcd is the same as the "LDC" abc.

This command is used to check the status of the current plotter when the CRT memory block data is being read.

NLC Reads the type of the Nyquist (orbit) display X-axis data (lower screen).

Same as LDC.

NUC Reads the type of the Nyquist (orbit) display Y-axis data (upper screen).

Same as LDC.

PAC	Reads the record memory playback address counter. Sent PAS CR LF Recd ○○○○○ CR LF (1-5 digit value)
PDC	Reads out the record memory playback Ch B delay.
RAC	Reads the number of completed averages. Sent RAC CR LF Recd ○○○○○ CR LF (1-5 digit value)
RBC	Reads the currently set block number in the time record memory 30-Kword mode.
SPC	Reads the search value of single-screen or the lower screen.
SPL	Reads the search value of the lower display or the lower part of a dual-frame display.
SPU	Reads the search value of the upper screen.
THR	Reads the total harmonic distortion or the distortion with respect to the fundamental in the order list display mode. 1: Total harmonic distortion 2: Distortion factor
TIC	Reads the set time interval. Sent TIC CR LF Recd ○○○○ CR LF (1-4 digit value)
TPC	Reads the set trigger position. TPC CR LF 0 to ±65,536 (Same format as TPS)
TRC	Reads the timer value. Sent TRC CR LF Recd 00/00/00 00 : 00 CR LF

UAC Reads the CRT display upper screen data voltage range.

Sent UAC CR LF

Recd ○ ○ CR LF

(1-2 digit value)

UDA When the upper screen is a cross spectrum or transfer function, the command reads the Ch A and Ch B input voltage ranges for the displayed data.

Sent UDA@ 1 (Ch A), 2 (Ch B) CR LF

Recd ○ ○ CR LF (1- or 2-digit value)

UDC Reads the type of the CRT display upper screen data.

Same as LDC.

UDD Ⓐ, Ⓑ, Ⓒ

Reads the upper screen data in ASCII format.

Same as LDD.

UFC Reads the CRT display upper screen graph frequency range.

Sent UFC CR LF

Recd ○○ CR LF

(1-2 digit value)

UFL Reads the frame length of the upper screen.

UPS Reads the upper search data when a single screen is displayed.

UPS 1 X

UPS 2 Y

UPS 3 X and Y

UXA@ Reads the upper screen X-axis data.

1 (lower bound), 2 (upper bound)

UXS Reads the CRT display upper screen X search value.

Same as LXS.

UXY Reads the CRT display upper screen X and Y search value.

Same as LXY.

UYA@ Reads the upper screen Y-axis data.

1 (lower bound), 2 (upper bound)

UYS Reads the CRT display upper screen Y search value.

Same as LYS.

WIC Reads the window type.

YCL Reads the Y-axis gain value.

YCH

YCL	Lower screen or single screen
YCH	Upper screen

Sent YCL CR LF

Recd ab CR LF

answer = ab

a) = 1 (20 dB), 2 (30 dB), 3 (40 dB), 4 (50 dB), 5 (60 dB), 6 (70 dB), 7 (80 dB), 8 (90 dB), 9 (100 dB), 10 (120 dB), 11 (140 dB), 12 (160 dB), 13 (180 dB), 14 (200 dB)

b) = 1 (1/10), 2 (1/5), 3 (1/2), 4 (×1), 5 (×2), 6 (×5), 7 (×10), 8 (×20), 9 (×50), 10 (×100), 11 (×200), 12 (×500), 13 (×1000), 14 (×2000)

ZCC Reads the real-time zoom center frequency.

Sent ZCC CR LF

Recd ○ ○......○ Hz CR LF

ZEC Reads the realtime expansion factor.

Sent ZEC CR LF

Recd ○ CR LF

(1-digit value)

13.4.4 Type 4 Commands

This type of command consists of a three-character (ASCII) code, after which a binary data block must be read from the CF-350. The number of bytes to be read for each command is fixed. For this reason, the talker must read just the required number of bytes for each command. The data terminator is the last data EOI, so that it is necessary to terminate with EOI or read just the right number of bytes. The data block terminator is the two bytes CR (13) and LF (10), and EOI is sent with the last LF.

The format is as follows.

Fixed number of bytes + CR + LF (with EOI appended)

If, for some reason, it is not possible to receive data or the reception of data is stopped midway, when a device clear (or a selected device clear after listen is specified) or an interface clear (IFC) is sent, the CF-350 will stop sending data.

BDR (binary data read)

This command reads the CF-350 captured data or calculation results. The command send format is the same as that of Type 2 commands and it requires a 1- to 2-digit numerical value (type indicator).

Example BDR5

(Reads the Ch A power spectrum.)

Numerical Parameter	Description	1024-pt sampling	2048-pt sampling
1	Ch A time-axis waveform	2050	4098
2	Ch B time-axis waveform	2050	4098
3	Ch A Fourier spectrum	1612	3212
4	Ch B Fourier spectrum	1612	3212
5	Ch A power spectrum	1612	3212
6	Ch B power spectrum	1612	3212
7	Cross spectrum (real part)	1612	
8	Cross spectrum (imaginary part)	1612	
9	Ch A auto-correlation function	1026	2050
10	Ch B auto-correlation function	1026	2050*1
11	Cross-correlation function	2050	
12	Impulse response	2050	
13	Ch A probability density function	1026	1026
14	Ch B probability density function	1026	1026*2
15	Transfer function (real part)	1612	
16	Transfer function (imaginary part)	1612	
17	Coherence function	812	
18	Coherent output power	612	

Note

The numbers on the right indicate the number of bytes sent the sum of the fixed number of bytes and the terminator (CR, LF).

Example. Data transfer is enabled for numerical parameter types 1 to 8 independent of the CRT display, but all other types must be displayed on the CRT screen.

However, this restriction does not apply in the PAUSE condition.

*1 The BDR9 command is used.

*2 The BDR13 command is used

- The data sent using BDR is not subject to Y-axis scaling (rms, EU, jω, equalization, PSD, ESD, OCT).

(1) Time-Axis Waveform (1, 2)

- 1 word (2 bytes) × N + CR, LF = 2050 (N = 1024)

  = 4098 (N = 2048)

  N is the data length.

- Transfer Format (16 bits, 2's compliment)

↓MSB

Upper byte	S 2^{14} 2^{13} 2^{12} 2^{11} 2^{10} 2^{9} 2^{8}	X(1)
Lower byte	2^{7} 2^{6} 2^{5} 2^{4} 2^{3} 2^{2} 2^{1} 2^{0}	X(2)

↑ LSB

↓ Transmission sequence

- Conversion to Numerical Variable

① Reading by bytes (8 bits)

$X = x(1) \cdot 2^{8} + x(2) - 2^{16} \cdot \text{Sign}$

where Sign = 0 (S = (positive))

= 1 (S = 1 (negative))

② Reading by words (16 bits)

Substitution may be made as is, without conversion.

- Conversion to Search Values

$Y = A \cdot X/32768$

X : Time value data

A: Input voltage range

Y: Search value (V)

(2) Fourier Spectrum (3, 4)

This transfers the real part and imaginary part data of the last Fourier coefficient subjected to Fourier transformation.

The real part (1 word) and the imaginary part (1 word) are transferred alternately. Thus, one transfer involves 2 words (4 bytes) and the data is transferred to the M point (401, 801).

- Two words (4 bytes) × M + 6 + CR, LF = 1612 (M = 401)

  = 3212 (M = 801)

  M is the number of sampled data points.

  6 is dummy data to ensure that it has the same number as the power spectrum. (For the power spectrum, it is the overall value.) Otherwise it has the same data format as that of the spectrum system.

- Transmission format (16 bits, 2's complement)

Real part

Upper byte	S 2^{14} 2^{13} 2^{12} 2^{11} 2^{10} 2^{9} 2^{8}
Lower byte	2^{7} 2^{6} 2^{5} 2^{4} 2^{3} 2^{2} 2^{1} 2^{0}

↓ Transmission sequence

Imaginary part

Upper byte	S 2^{14} 2^{13} 2^{12} 2^{11} 2^{10} 2^{9} 2^{8}
Lower byte	2^{7} 2^{6} 2^{5} 2^{4} 2^{3} 2^{2} 2^{1} 2^{0}

↓ Transmission sequence

- Conversion to Numerical Values

This is the same as for the time-axis waveform.

- Conversion to Search Values

This is the same as for the time-axis waveform.

(3) Power Spectrum (5, 6)

One point is 32 bits (2 words = 4 bytes) of data.

- Two words (4 bytes) × M + $\underline{6}$ + CR, LF = 1612 (M = 401)

= 3212 (M = 801)

$\underline{6}$ is the overall value.

- Transmission Format (32 bits, 2's complement)

MSB

1	S	2^{30}	2^{29}	2^{28}	2^{27}	2^{26}	2^{25}	2^{24}	x(1)	X (1)
2	S^{23}	2^{22}	2^{21}	2^{20}	2^{19}	2^{18}	2^{17}	2^{16}	x(2)	
3	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}	x(3)	X (2)
4	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}	x(4)	

↓ Transmission sequence

LSB

Note

Because it is the power spectrum, *s* must be 0 (positive).

- Conversion to Numerical Variables

① Reading by bytes (8 bits)

$X = x(1) \cdot 2^{24} + x(2) \cdot 2^{16} + x(3) \cdot 2^{8} + x(4)$

② Reading by words (16 bits)

If X (2) is negative, after setting $(X2) = X(2) + 2^{16}$, the following is performed.

$$X = X(1) \cdot 2^{16} + X(2)$$

Note

The overall value has an additional word of exponent. If this value is P, the overall value with the respect to the above X is as follows.

$$X_{OA} = X \cdot 2^{P}$$

- Conversion to Search Values

① For LOG (Units: dBV)

$$Y_{(n)} = 10 \log (A^{2} \cdot P_{(n)}/F)$$

② For LIN (Units: V)

$$Y_{(n)} = A \cdot \sqrt{(P(n)/F)}$$

$Y_{(n)}$: nth point search value

$P_{(n)}$: nth point spectrum numerical data

A: Input voltage range

F: 2^{30}

(4) Cross Spectrum (7, 8)

The real and imaginary parts of the cross spectrum are sent separately using the same number of bytes and the same data format. One point is 32 bits (2 words = 4 bytes).

- Two words (4 bytes) $\cdot$ M + $\underline{6}$ + CR, LF = 1612 (M = 401)
- Transmission Format (32 bits, 2's complement)

The same as for the power spectrum.

- Conversion to Numerical Variables

① Reading by bytes (8 bits)

$X = x(1) \cdot 2^{24} + x(2) \cdot 2^{16} + x(3) \cdot 2^{8} + x(4) - \text{Sign} \cdot 2^{32}$

Where Sign = 0 (δ = 0 (positive))

= 1 (S = 1 (negative))

② Reading by words (16 bits)

If X (2) is negative, after setting (X2) = X (2) + 2^{16}, the following is performed.

$$X = X(1) \cdot 2^{16} + X(2)$$

- Conversion to search values

① Real part (or imaginary part)

$Y = A \cdot B \cdot X/F$ (volt^2)

Y: Search value

A: Ch A voltage range (V)

B: Ch B voltage range (V)

X: Real part (imaginary part) numerical data

F: $= 2^{30}$

② LOG (MAG display) (Units: dBV)

$Y = 10 \log 10 \ (A \cdot B \cdot \sqrt{(X_R^2 + X_I^2)/F})$

③ LIN (MAG display) (Units: V^2)

$Y = A \cdot B \cdot \sqrt{(X_R^2 + X_I^2)/F}$

Y: Search value

A: Ch A voltage range (V)

B: Ch B voltage range (V)

X_R: Real part numerical data

X_I: Imaginary part numerical data

F: 2^{30}

(5) Correlation Functions (9, 10, 11)

Just as for the time-axis waveform, one point also occupies one word (two bytes) for the correlation functions. The autocorrelation function is an even function, so only the positive side is sent. Thus, data is sent for delays from zero to max.

- Autocorrelation Function

One word (2 bytes) × N/2 + CR, LF = 1026 (N = 1024)

= 2050 (N = 2048)

- Cross-Correlation Function

  One word (2 bytes) × N + CR, LF = 2050 (N = 1024)

- Data Transmission Format

  The same as for the time-axis waveform.

- Conversion to Numerical Variables

  The same as for the time-axis waveform.

- Conversion to Search Values

  ±1 has no dimensions.

  $Y = X/32768$

  Y: Search value

  X: Numerical data

  Note

  Only one channel has to be displayed for the autocorrelation function (ACF). The other channel data will be read in the same way. For example, displaying only the Ch A ACF on the CRT screen also enables transfer of the Ch B ACF data.

(6) Impulse Response (12)

The impulse response after transfer has the same format as the transfer format and all the points are the same as the cross-correlation function.

(7) Probability Density Function

One point is two words (32 bits) of data and 256 points are output.

- 2 words (4 bytes) ·256 + CR, LF = 1026

- Transmission Format

  The same as the power spectrum.

- Conversion to Numerical Variables

  The same as the power spectrum.

- Conversion to Search Values

  $Y = X/(N \cdot AVNO)$

  Y: Search value

  X: Transmission numerical value data

  N: Length of analyzed data (= 1024, 2048)

  AVNO: Number of executed averages;1 in the INSTANT mode

(8) Coherence Function (17)

The coherence function consists of one point and 401 points are transmitted.

- 1 word (2 bytes) $\times$ M + $\underline{8}$ + CR, LF = 812 (M = 401)

  Note

  $\underline{8}$ is an exception to the usual value $\underline{6}$. $\underline{8}$ is only used for the coherence function. (Equivalent to power spectrum O and A)

- Transmission Format (16 bits, 2's complement)

↓ MSB

Upper byte	$S\ 2^{14}\ 2^{13}\ 2^{12}\ 2^{11}\ 2^{10}\ 2^{9}\ 2^{8}$	X(1)
Lower byte	$2^{7}\ 2^{6}\ 2^{5}\ 2^{4}\ 2^{3}\ 2^{2}\ 2^{1}\ 2^{0}$	X(2)

↓ Transmission sequence

LSB

S is always zero (positive).

- Conversion to Numerical Variables

① Reading by bytes (8 bits)

$$X = x(1) \cdot 2^{8} + x(2)$$

② Reading by words (16 bits)

Substitution may be made as is , without conversion.

- Conversion to Search Values

$$Y = X/16384$$

X : Numerical value data

Y: Search value

(9) Coherent Output Power (18)

This is the same as for the power spectrum, except that there is no 801-point mode.

(10) Transfer Function (15, 16)

The real and imaginary parts of the propagation function are transferred separately with the same data format and occupying the same number of bytes. One point is 32 bits of data (one word for the exponent and one word for the mantissa).

- 2 words (4 bytes) ·M + $\underline{6}$ + CR, LF = 1612 (M = 401)

- Transmission format (both exponent and mantissa are 16 bits, 2's compliment)

Exponent	Upper byte	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8
	Lower byte	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Mantissa	Upper byte	S	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8
	Lower byte	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

Transmission sequence

- Conversion to numerical variables

Same as time-axis waveforms for both exponent and mantissa.

- Conversion to search values

① For the real part (or imaginary part), we have the following.

$$Y = (B/A) \cdot X_M \cdot 2^{(X_E-16)}$$

Y: Search value (V)

A: Ch A voltage range (V)

B: Ch B voltage range (V)

X_M: Mantissa

X_E: Exponent

② For LOG (MAG display) (Units:dB), we have the following.

$$Y = 10 \log 10\ (X_R^2 + X_I^2)$$

③ For LIN (MAG display), we have the following.

$$Y = \sqrt{(X_R^2 + X_I^2)}$$

④ For the phase (Units: deg), we have the following.

$$Y = \tan^{-1}(X_I/X_R)$$

Y: Search value

X_R: Real part determined by equation in ①

X_I: Imaginary part determined by equation in ①.

2. CMR (CRT mass memory read)

Reads the data from the currently set CRT memory block. One block consists of a data area (2Kbytes) and index data (80 bytes)

There are 128 bytes of index data, but only the first 80 bytes are output because of the interchangeability with CF-350.

- 2 Kbytes + 80 bytes + CR, LF = 2130 bytes

Note

The MSC command can be used to read the status of the current CRT memory block.

3. LCI (Reads CRT lower screen bit image data)

This command reads the image data for the current lower CRT display. In contrast to the BDR command, one point consists of 1 word (2 bytes) and the data length is not effected by the type of data.

- 1 word (2 bytes) × POINTS + CR, LF = Number of bytes transferred

For a time X-axis, POINTS = 1024, 2048

For a spectrum X-axis, POINTS = 402, 802

Note

For example, 402 = DC + 400 + O.A. (which has significance only for the power spectrum, however).

For the probability density function, POINTS = 256

- Full scale is 0 to 320.

Note

This command can also be used in the single-screen mode. To determine the content of the current display, use the LDC command.

4. UCI (Reads CRT upper screen bit image data)

This command reads the image data for the current upper CRT display. The specifications are exactly the same as those for the LCI command.

5. RAR (Reads time record memory Ch A data)

This command transfers the Ch A time-axis waveform data stored in the record memory. The command format is the same as for Type 2 commands, and the two numerical parameters transfer start address and number of transfer points are required.

FORMAT RAR a, b

a: Up to 6 digits for the transfer start address (0 to)

b: Up to 5 digits for the number of transfer points

Example. RAR2000, 1024 (CR), (LF)

(Transfers 1024 (or 2048) points of data starting from address 2000.)

The transmission format is exactly the same as that for the time-axis waveform. Each point consists of two bytes of data.

Note

If no data has been stored, a long beeper tone will be issued indicating that data will not be transferred. Care should be taken on this point.

Another point to watch is that if the specified address is beyond the area where the data is stored, then meaningless data will be transferred.

6. RBR (Reads time record memory Ch B data)

This command transfers the Ch B time-axis waveform data stored in the record memory. Its specifications are exactly the same as those for RAR.

For the time record block mode (in which 1 block = 31-Kword mode), the transfers from address 0, address 32,768 and so forth , for block 1, 2 and 3, respectively.

For example, for block 2 address 0 to 1024, the command is RAR32768,1024.

7. BFD (Reads binary floating format data)

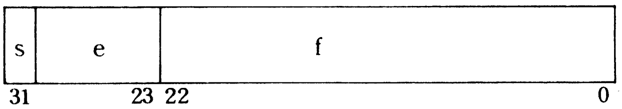
The CF-350 internal binary data read by the BDR command can be classified into two main groups.

① Two bytes (one word) for each point ....Time axis data

② Four bytes (or more) for each point ......Spectra and histograms

The data in group ② can also be read in the following three binary formats other than the analyzer internal binary format.

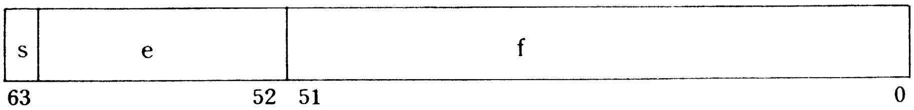
① IEEE standard single-precision floating-point format (4 bytes)



s: sign, e: exponent, f: mantissa

The value represented by this format: $(-1)^{s} \cdot 2^{e-127}(1.f)$

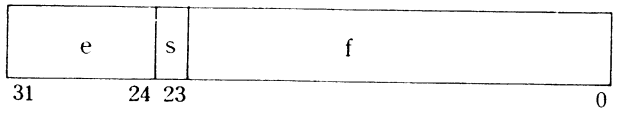
② IEEE standard double-precision floating-point format (8 bytes)



s: sign, e: exponent, f: mantissa

The value represented by this format: $(-1)^{s} \cdot 2^{e-1023}(1.f)$

③ MS BASIC single-precision floating-point format (4 bytes)



s: sign, e: exponent, f: mantissa

The value represented by this format: $(-1)^{s}\cdot 2^{e-191}(1.f)$

In contrast to the other modes, data transfer in this mode is performed sequentially from the LS.

Note

The IEEE standard data formats are adopted in the Intel NDP 8087 and the Hewlett-Packard HP9000 series computers.

MS BASIC refers to the BASIC language of Microsoft, Inc.

The BFD command can be used to read data in any of the above three formats.

BFD a, b

a: 1 (IEEE single precision)

2 (IEEE double precision)

3 (MS BASIC single precision)

b: Values listed in the table below

Numerical parameter (b)	Description	1024	2048	4 Decade
1	Ch A power spectrum	1606 (3210)	3206 (6410)	4470 (8938)
2	Ch B power spectrum	1606 (3210)	3206 (6410)	4470 (8938)
3	Cross spectrum (real part)	1606 (3210)		4470 (8938)
4	Cross spectrum (imaginary part)	1606 (3210)		4470 (8938)
5	Ch A probability density function	1026 (2050)	1026 (2050)	
6	Ch B probability density function	1026 (2050)	1026 (2050)	
7	Transfer function (real part)	1606 (3210)		4470 (8938)
8	Transfer function (imaginary part)	1606 (3210)		4470 (8938)
9	Coherent output power	1606 (3210)		

Note

- The numerical values on the right indicate the number of bytes sent, the fixed number of bytes + terminator (CR, LF). The values in parentheses are for the double-precision mode.
- Data transfer is enabled for type parameters 1 to 4 independent of the CRT display, but the other data types must be displayed on the CRT.

  This restriction does not apply in the PAUSE condition.
- Data types 1 to 9 are all current analysis data.
- For all the data types, one point is four bytes for single precision and eight bytes for double precision.

(1) Power Spectrum (numerical parameters = 1, 2, 9)

- Number of bytes transferred

① Single precision

4 bytes × M + CR, LF = 1606 (M = 401)

= 3206 (M = 801)

= 4470 (M = 1117)

② Double precision

8 bytes × M + CR, LF = 3210 (M = 401)

= 6410 (M = 801)

= 8938 (M = 1117)

In contrast to the BDR command, the overall value is not transferred.

- Conversion to Search Values (n = 0,....., N, N = 400, 800, 1116)

① For LOG (Units: dbV)

$Y(n) = 10 \cdot \log 10 \, (A^2 \cdot P(n))$

Y(n): nth point search value

P(n): nth point numerical data (value read by the BFD command)

A: Input voltage range

② For LIN (Units: V)

$Y(n) = A \cdot \sqrt{P(n)}$

For servo analysis data, A (voltage range) is not required.

(2) Cross Spectrum (numerical parameters 3, 4)

The real and imaginary parts of the cross spectrum are transferred separately with the same data format and number of transfer points.

Number of transfer bytes

① Single precision

$$4 \text{ bytes} \times M + CR, LF = 1606 \quad (M = 401)$$

$$= 4470 \quad (M = 1117)$$

② Double precision

$$8 \text{ bytes} \times M + CR, LF = 3210 \quad (M = 401)$$

$$= 8938 \quad (M = 1117)$$

- Conversion to Search Values ($n = 0,\ldots, N = 400, 1116$)

① For LOG (Units: dbV)

$$Y(n) = 10\cdot\log 10\,(A\cdot B\cdot\sqrt{R(n)^2 + I(n)^2)}$$

Y(n): nth point search value

R(n): nth point numerical data real part (value read by the BFD command)

I(n): nth point numerical data imaginary part (value read by the BFD command)

A: Ch A input voltage range

B: Ch B input voltage range

② For LIN (Units: V^2)

$$Y(n) = A\cdot B\cdot\sqrt{R(n)^2 + I(n)^2}$$

A and B (voltage ranges) are not required for servo analysis data.

(3) Probability Density Function (numerical parameters 5, 6)

256 points are output.

- Number of Points Transferred

① Single precision

$$4 \text{ bytes} \times M + CR, LF = 1026 \quad (M = 256)$$

② Double precision

$$4 \text{ bytes} \times M + CR, LF = 2050 \quad (M = 256)$$

- Conversion to Search Values

  $Y(n) = X(n)/N \cdot AVNO$

  Y(n): nth point search value

  X(n): Numerical value transferred (value read by the BFD command)

  N: Analyzed data table (= 1024, 2048)

  AVNO: Number of executed averages;1 in the INSTANT mode

(4) Transfer Function (numerical parameters 7, 8)

The real and imaginary parts of the transfer function are transferred separately with the same data format and number of transfer points.

- Number of bytes transferred

  Same as for the cross spectrum.

- Conversion to Search Values ($n = 0, \ldots\ldots, N$, $N = 400, 1116$)

① For real (imaginary) part

$Y(n) = B/A \cdot X(n)$

Y(n): nth point search value

X(n): Numerical value transferred (value read by the BFD command)

A: Ch A voltage range

B: Ch B voltage range

② For LOG (MAG display) (Units: dB)

$Y(n) = 10\log 10\,(X_R^2(n) + X_i^2(n))$

Y(n): Search value

$X_R(n)$: Real part obtained from formula in ①.

$X_i(n)$: Imaginary part obtained from formula in ①.

③ For LIN (MAG display)

$Y(n) = \sqrt{X_R^2(n) + X_i^2(n)}$

④ For phase (Units: deg)

$Y(n) = \tan^{-1}(X_i(n)/X_R(n))$

A and B (voltage ranges) are not required for servo analysis.

8. CRD (with CRT mass memory read display condition)

Reads currently set CRT memory block contents. Each block consists of a data area (2 Kbytes) and index data (128 bytes).

One memory block consists of screen memory data including screen playback data (index data), so the previous screen can be played back if the contents read out are again written to the analyzer (CMW).

- 2 Kbytes + 128 bytes + CR, LF = 2178 bytes

  Note

  The status of the current CRT memory block can be read by using the MSC command.

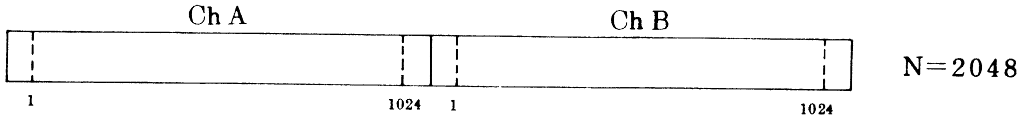
13.4.5 Type 5 Commands

This type of command consists of three characters (ASCII) codes, after which it is necessary to write a binary data block into the analyzer. The number of bytes to be written is fixed for each command. Because of this, the controller must send just the correct number of bytes, or the end of data must be marked with an EOI. However, trailing data can be padded with zeros.

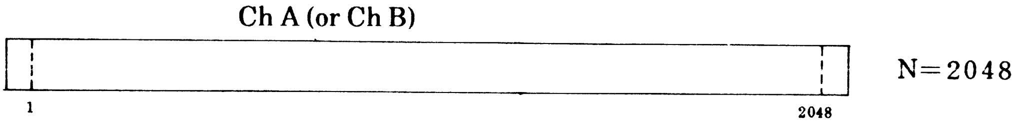
1. FMW Writes the time data to the FFT memory.

Set the data transmission points in the above way according to the length of the currently set frame (or that set by the FLS command).

- Dual 1-K mode



- Single 2-K mode



Number of bytes transferred = N × 2 = 2048 (N = 1024)

= 4096 (N = 2048)

Note

If only Ch A is to be written in the Dual 1-K mode, if 1-Kwords of data is terminated with EOI, then the Ch B data is taken as zero.

The CF-350 can be operated as an FFT processor by using this command together with the CDO command.

For example, four averages are taken by the following procedure.

① Send CDO to enter the digital-input mode.

② Set the number of averages to four and start.

③ Send FMC and check whether the memory is ready.

④ If ready, transfer the data after sending FMW.

⑤ Repeat steps ③ and ④ four times. The system then goes into the PAUSE condition.

⑥ Send CDF to return to the normal mode.

2. CMW Write to the CRT memory.

This command is used to retransfer CRT memory block data to the CRT which had been read by the CRD command. The currently displayed block number is stored in memory. The number of bytes transferred is 2176, the same as for the CRD command.

Notes

1. Data other than data which was read by the CRD command should under no circumstances be read into the analyzer.
2. Once the current block number is stored, and when the CRT memory is write protected, a long beep tone will sound indicating that the analyzer cannot read data.

13.4.6 Other Commands (Write to Time Record Mode)

Any desired time waveform can be written from an external CPU via the GPIB to the CF-350 TIME RECORD MEMORY.

Now, data cannot be written to any address, and it is written in 1-Kword blocks.

The data must also be stored in the record memory before the write operation. If this is not done playback will be impossible.

The write procedure is as follows.

① Put the record memory in an appropriate mode.

(E.g., 127 KW, Ch A & Ch B)

② Record at as fast a sampling frequency as possible.

(E.g., 40 kHz)

③ Write data. Commands RAW@ and RBW@ are used to write 1-KW blocks repeatedly.

Actually, it is not necessary to fill the entire memory.

④ Next write the actual voltage range (Ch A and Ch B) and the frequency span. (Write number) using the following command.

RCO@@, @@, @@

(1) RAW@ and RBW@

These commands write time-axis data to the channel-A (RAW) or channel-B (RBW) record memory. One point is one word (16 bits) and the unit is 1 Kwords (1024 points), i.e., 2048 bytes. The numerical parameter is the address for the 1-Kword block.

Examples

RAW1 Write the first 1 KW of the channel-A memory.

RBW20 Write to the 20 Kth word of the channel-B memory.

(2) RCO@@, @@, @@

Writes the written time-axis data input conditions in the following sequence.

RCO [Ch A voltage no.] , [Ch B voltage no.], [frequency span no.]

See AAS and FRS in the command list for details on the numbers.

Example

RCO5, 4, 10	Ch A voltage: 2 V Ch B voltage: 5 V Frequency span: 1 kHz

(3) Soft Key GPIB Control

TK ONLY	ADDRESS	SET	SRQ	

When the SRQ soft key is pressed, a service request is generated.

SKY Ⓐ, Ⓑ, Ⓒ	Set the C of the A-th B to on.

(Example)

TRIG	A=1	DISPLAY	A=8
SLOP	B=2	FORMAT	B=1
Minus	C=2	GRID	C=3

SKR Ⓐ, Ⓑ	Read the status of the A-th B

(Example)

TRIG 1

AVERAGE 2

MODE 3

:

DISK 7

DISPLAY 8

UNIT 9

VIEW 10

:

COND 14

SERVO 15

Y axis 16

OTHRS 18

13.5 Cautions when Writing Programs and Using the Analyzer

(1) The GPIB cable must be securely installed.

Power to all connected equipment must be turned on.

(2) Check the analyzer device number. The right VIEW is displayed on the CRT by pressing the software VIEW key. Check this first and then program it. The bit switches on the rear panel can only be changed when the power is applied or when the system is reset. It is also necessary that the switch status is ADDRESSABLE (bit-switch position 8 must be 0).

(3) What is the situation with the computer terminator?

(CR)(LF) or (LF) must be used as terminators to transmit ASCII code.

In the case of binary transmission either EOI must be used as the terminator or the exact number of bytes must be sent.

(4) Does the the analyzer long-tone beeper sound?

When an undefined command or a mistaken parameter is sent, the long-tone beeper sounds to indicate the error. (An SRQ interrupt can also be output at this time.) The tone also sounds if a command incompatible with the current analyzer status is sent (e.g., commands only valid in the PAUSE condition, or commands sent when thee is no data in the analyzer).

Consult the Programming and Analyzer Manuals if the beeper sounds when a program is run.

(5) Does the command type agree with the program sequence?

For example, once the command for the next data to be read is sent, even when the next command is sent the analyzer waits for a talker to be specified, locking the program. It should also be checked whether the status LED agrees with the program sequence.

(6) SRQ (Service Request)

The analyzer can issue a service request (SRQ) to indicate the completion of a given processing sequence.

The SMS command can be used to issue the request at will, or to stop issuance at will. If the service request is on, an appropriate program (serial poll) must be available.

(7) After sending the Type 1 commands listed below (CR) (LF) must be sent to terminate the transmission.

This is to ensure that commands are not sent continuously.

- Commands to change the CRT display (same as switches)

  ASP, ACR, AHI, ATI, BSP, BCR, BHI, BTI, CSP, CCR, XFR, COH, COP, IMP, PHS, MAG, IMG, REL, NYQ, LST, SEC, MRC, etc.

- Commands affecting commands (same as switches)

  CST, CPS, CCN, PST, PPS, etc.

(8) Binary Data Block Transmission

There appear to be no problems about transmission of data between a computer with a GPIB installed (referred to below as a controller) and the analyzer if it is in ASCII code. However, at present various problems do seem to arise for the different types of controller in the case of binary data block transmission.

The following two problems are common.

① Too many bytes of data are sent.

② Data transmission completion identification.

As far as ① is concerned, there is no problem if the controller is of the type that allows dimension definition (numerical frequency or character string variable), or if it of the type to which the entire data can be read all at once. For all other types of controller, care has to be taken on many points including the fact that the data is read one byte at a time.

As for ②, the same considerations apply as for ① except that a character string has to be terminated not by (CR (LF), but by EOI. However, the number of bytes to be transmitted is fixed for each command, so that programs have to be written ensuring that only the specified number of bytes is read for the comands.

(9) BIT 8 (Error) Service Request

When the long-tone beeper sounds the bit 8 service request is output enabling the analyzer to send an interrupt to the external controller.

The main reasons why the beeper sounds are:

① Analyzer misoperation (including operations from the GPIB)

② Mistaken specification of GPIB command or parameter

The interrupt cause can be read using the ERN command (Type 3).

This function can be used when developing user application programs or to check them, and to check the analyzer status.

See the Long Beeper Message List which follows.

Long Beeper Message List

```
*** LONG BUZZER MESSAGE LIST  ****

No             Message

 0             NO  MESSAGE
 1             SET SEARCH ON
 2             GAIN OVER
 3             SET SEARCH ON
 4             SET ZOOM OFF
 5             chB ONLY
 6             CHANGE SUM
 7             SINGLE MODE
 8             STOP PLOTTER
 9             SINGLE ONLY
 10            chA ONLY
 11            SET DELTA CURSOR
 12            SINGLE ONLY
 13            STORE NOT AVAILABLE
 14            CHANGE DISPLAY
 15            NO STORE
 16            NOT AVAILABLE
 17            NOW SETUP VIEW MODE
 18            DATA LENGTH 0.5k
 19            RECORD MEM cleared
 20            RANGE OVER
 21            RANGE OVER
 22            AC ONLY
 23            SET PAUSE
 24            NO STORE
 25            AVERAGING
 26            SET START
 27            NOT AVAILABLE
 28            DATA NOT STORED
 29            set complete
 30            MATCH chA AMP
 31            MATCH chB AMP
 32            MATCH FRQ RANG
 33            MATCH DATA LENGTH
 34            SET Y_LOG
 35            chA A/D OVER
 36            chB A/D OVER
 37            RECORD complete
 38             DISK COPY
 39            CRT MEM CLEAR OK ?
 40            NOT READY No.0
 41            NOT READY No.1
 42            NOT READY No.2
 43            SEEK ERROR
 44            RECALIB ERROR
 45            FORMAT ERROR
 46            READ ERROR
 47            WRITE ERROR
 48            MEM CLEAR OK ?
```

49	RD_WT TEST ERROR
50	complete
51	ERROR
52	BUSY
53	SET TRG FREE
54	SET ZOOM OFF
55	SET + OR -
56	REMOTE or LLO
57	SET DELTA CURSOR
58	STOP STORE
59	WRITE PROTECT
60	FILE END
61	SEQUENCE MEMO FULL
62	SET SEQ MODE
63	SEQUENCE end
64	CONDITION DISAGREE
65	FUNCTION DISAGREE
66	CHANGE SOFT KEY
67	SET TALK ONLY
68	SET OCTAVE OFF
69	SET COH_BLANK OFF
70	CHANGE LENGTH
71	SELECT WINDOW
72	AUTO SEQUENCE
73	DELTA OFF
74	TRIG MISMATCH
75	option
76	DEVICE MISMATCH
77	DEVICE MISMATCH
78	SPE ONLY MODE
79	ANALOG OUT BUSY
80	NOT CONTINUE
81	MEMORY PROTECT
82	CHANGE TRG
83	DEVICE MISMACTH
84	DEVICE MISMATCH
85	SLAVE MODE
86	SLAVE not present
87	Cannot Master
88	SERVO MODE
89	SELECT LOW or UP
90	NOW USING MARKER
91	SSU not present
92	NOW SERVO MODE
93	NOW PLAYBACK
94	DIFFERENT RANGE
95	CHANGE FRQ RANGE
100--> 202	TEST SW (at SELF TEST)
255	GPIB error

13.6 CF-350 FFT Analyzer GPIB Sample Programs

13.6.1 General

These GPIB sample programs are for the CF-350 FFT analyzers.

The following two types of CPU can be used.

① HP9000 series model 200 (BASIC 3.0)

② NEC PC9801 series (N_{88} – $BASIC_{(86)}$)

Note

These programs are given as examples of how to use the GPIB commands. The user should consult these when developing application programs.

13.6.2 The Programs

(1) POWERMAX

① Sets up the appropriate analysis conditions.

② It contains a service request for the end of the average that has started.

③ Reads internal binary data with the BDR5 command (Ch A power spectrum).

④ Converts to numerical values and obtains the maximum value.

⑤ Displays the maximum value.

(2) SCH – GR

① Turns the search function on and sets the search marker to the zeroth point.

② Reads only the number (Number) specified as the Y-axis search value by the LYS command.

③ Produces a graphic display.

(3) C – POWER

① Reads the internal cross spectrum (real/imaginary) internal binary data with the BDR7 BDR8 commands .

② Converts the floating point data in the CPU to numerical values.

③ Produces a graph display.

Note

Ch A and Ch B voltage ranges must be 1 V.

(4) TIME－AB

① Reads the Ch A and Ch B time-axis waveform internal binary data with the BDR1 BDR2 commands.

② Produces graph displays on the CPU CRT, Ch A in the upper screen and Ch B in the lower screen.

(5) READ－XFR

① Stores the voltage range (Amp( )) and frequency range (Frq( )) values in an array.

② Reads the transfer function (REAL/IMAG) internal binary data with the BDR15 BDR16 commands.

③ Or stores it in the CRT block memory using the CMR command. Reads the transfer function (REAL/IMAG) internal binary data.

④ Converts the CPU internal floating point data to numerical values.

⑤ Produces a graph display of the transfer function with MAG LOG (dB).

(6) IMAGE

① Reads the currently displayed CRT image binary data with the LCI command.

② Produces a graph display. (Full scale = 320)

(7) RECORD

① Starts the time record memory read operation.

② The program contains a read end service request.

③ After specifying the start address and the number of points, reads the time record data stored with the RAR (Ch A) or RBR (Ch B) command.

④ Produces a graph display.

(8) OCT－SCH

① Turns the search function on and specifies the search marker as the first band of the 1/3 octave display.

② Displays the 1/3 octave display X and Y search data in 31 points (30 bands + overall point) with the LXY command.

Note

When the 1/3 octave data is list displayed it can also be read with the LTR command.

(9) DIGITALIN

① Substitutes appropriate time-axis waveform data in the array variable.

② Specifies the number of averages. 1 in the INSTANT condition.

③ Puts the CF-350 into the PAUSE condition and sets the digital-input mode using the CDO command.

(Analog mode → digital mode)

④ Starts the CF-350.

⑤ Performs FFT memory busy check using the FMC command.

⑥ Writes the Ch A (Ch B) time data using the FMW command. (FFT is performed automatically.)

⑦ Returns to the normal state with the CDF command.

(Digital mode → analog mode)

(10) LDD

① Reads the spectrum (402 points) or 1/3 octave data (31 lines) using the LDD command.

- For 1/3 octave:

  31 bands including overall value are read and displayed.

Note

The difference with respect to the LYS command is that although the read data format is exactly the same, even if the CF-350 is being started, all the data is that of analyses performed at the same point in time so that it can be read at much higher speed.

- For narrow-band spectrum:

  402 lines including overall value are read and displayed.

Note

The difference with respect to the BDR command is that although the reading speed is no faster, but the data is in ASCII code which makes reading very easy and postprocessing, such as conversion to numerical values, is not necessary.

(11) FFT pro

① Substitutes 1024 points of appropriate time-axis data in the array variable.

② Write time-axis data to the FFT processor memory (Fmem) with the FTW5 command.

③ Executes FFT with command FFT1.

④ Reads the complex Fourier spectrum (Real/Imag) with the FTR9 FTR11 command and displays the plot.

⑤ Write the complex Fourier spectrum to the Fmem using the FTW1 and FTW3 commands.

⑥ Executes an inverse FFT with the FFT2 command.

⑦ Reads the time waveform obtained from the inverse FFT and displays the plot.

(12) POWERf1

① Voltage range (Amp( )) values are stored in the array.

② Reads the power spectrum values in the CPU internal real number format with the BFD command. (Same below)

HP9000 series model 200:

BFD2, @

PC9801 series:

BFD3, @ (@ = 1,2 9)

③ Produces the plot display (MAG LOG) and obtains the maximum value.

Note

There is no need to consider the voltage range for servo (400-line) data. (This applies below also.)

(13) POWERf14D

This is the same as (12) POWERf1 program for reading the 4-decade (servo analysis) power spectrum.

(14) CROSSf1

① Voltage range (Amp( )) values are stored in an array.

② Reads the cross spectrum (Real/Imag) values in the CPU internal real number format with the BFD command.

③ Produces the plot display (MAG LOG) and obtains the maximum value.

(15) CROSSf14D

This is the same as (12) CROSSf1 program for reading the 4-decade (servo analysis) cross spectrum.

(16) XFERf1

① Voltage range (Amp( )) values are stored in the array.

② Reads the transfer function (Real/Imag) values in the CPU internal real number format with the BFD command.

③ Produces the plot display (MAG LOG) and obtains the maximum value.

(17) XFERf14D

This is the same as (16) XFERf1program for reading the 4-decade (servo analysis) transfer function.

(18) HISTf1

① Reads the histogram values in the CPU internal real number format with the BFD command.

② Produces the plot display (MAG LOG) and obtains the maximum value.

Note

The number of averages = 1.

13.6.3 Reading CF-350 Internal Data

The following four methods are used to read the CF-350 internal memory data.

① Reading by search markers

Commands:	LYS, LXS, LXY, UYS, UXS, UXY
Format:	ASCII

This is the most general method, in which the search marker is specified each time and the search values for that point are read.

This is the slowest reading method, but it should be compatible with any computer system.

However, the desired data must be graphed on the CRT screen before execution.

② Reading ASCII data

Commands:	LDD, UDD
Format:	ASCII

This method takes a different form from ①. The readout format is exactly the same as that for ①, but it is not necessary to specify the search marker each time and this alone makes for higher reading speed. As in method ① the desired data must be graphed on the CRT screen before execution.

Compared with methods ③ and ④ below, ①and ② do not require conversion to numerical values (or to search values) which simplifies the CPU programs.

③ Reading with floating-point data

Commands: BFDa, b

Format: Floating-point binary data

a = 1 (IEEE = P754 standard, single precision)

= 2 (IEEE = P754 standard, double precision)

= 3 (MS BASIC single precision)

This method outputs the data after converting it to the specified real-number (floating-point) format, so it does not require conversion to numerical values and overall it is the fastest processing method. There are not limitations on the data types that can be read by this method.

④ Read internal CF-350 binary data.

Commands: BDR, CMR, CRD

Format: Internal binary data

This method of reading internal binary data provides the highest data-reading speed. However, since it is necessary to convert internal CPU data, the overall speed may actually be lower than the method ③.

13.6.4 Data Reading Speed

The speed at which the data is read depends to a great extent on the CPU (microcomputer) used, its programs, and the reading method, so reading speed cannot be specified in general. Times for processing given below are based on actual measurements.

● Maximum data transmission speed	Approx. 40 Kbyte/s
● Times using BDR	
Power spectrum (401 lines)	Approx. 40 ms
(1024 points)	Approx. 50 to 55 ms
● Times using BFD	
Power spectrum (401 lines)	Approx. 150 ms
Transfer function (Real/Imag, 401 lines)	Approx. 250 ms
● Times using LDD	
1/3 octave data (31 bands)	Approx. 0.34 s
Power spectrum (401 lines)	Approx. 5 to 5.5 s
Transfer function (MAG, 401 lines)	Approx. 13 to 13.5 s
Time waveform (1024 points)	Approx. 10.5 s

```
10    !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
20    !   SPECTRUM DATA READ & MAX DATA     !
21    !      "POWERMAX"                     !
30    !        CPU= HP9816S                 !
40    !        device #=9                   !
50    !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
51    Slot=7
60    ABORT Slot               ! IFC
80    Cf=Slot*100+9            ! device set
90    OPTION BASE 1
100   INTEGER P(806)            ! =1612 bytes(1K power spectrum)
110   ON INTR Slot GOSUB Service ! SRQ service routine set
120   ENABLE INTR Slot;2         ! interrupt on
130   ASSIGN @Cff TO Cf;FORMAT OFF ! IO channel set & internal format
140   Srq=0
150   OUTPUT Cf;"AACAAS7FRS13TREANS3AMS1AVOASP"
160   !  chA AC,chA input range =.5V,frequency span =10kHz
170   !  trigger repeat,average #= 8,average mode = SP SUM
180   !  average On,chA spec display
190   OUTPUT Cf;"SMS2"            ! SUM end SRQ on !!
200   OUTPUT Cf;"CST"             ! start
210      IF Srq=0 THEN 210
220   !!!!  data read !!!!!!
230    OUTPUT Cf;"BDR5"           ! chA aps read command
240    ENTER @Cff;P(*)            !  fast data read until buffer full
241      PRINT "data transfer end !!"
250  !!!!  max data search !!!!
260    Maxdata=0
270      FOR I=1 TO 801 STEP 2
280        A=P(I+1)
281        IF A<0 THEN A=A+65536.0
282        A=P(I)*65536.0+A
290        IF A>Maxdata THEN Maxdata=A
300      NEXT I
310   M=10*LGT(Maxdata*.5*.5/2^30)  ! change SEARCH log value
320   PRINT "max data=";M
330  GOTO Progend
340 !!!!  SRQ service !!!!!
350 Service:!!
360         Srq=SPOLL(Cf)
370         ENABLE INTR Slot;2
380         RETURN
390 Progend: END
```

```
10    !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
20    !  SEARCH READ OUT & GRAPH DISPLAY     !
21    !     "SCH_GR"                         !
30    !        CPU= HP9816S                  !
40    !        device #=9                    !
50    !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
60    ABORT 7                        ! IFC
70    Cf=709                         ! device # set
80    DIM P(1024)
90    INPUT "max,min & number ?",Maxd,Mind,Number
100   OUTPUT Cf;"CPS"
110   OUTPUT Cf;"SONSPS0"             ! search on & point=0
120     FOR I=0 TO Number-1
130        OUTPUT Cf;"LYS"            ! search read command
140        ENTER Cf;A$                ! read
150        OUTPUT Cf;"SMR"            ! search marker right shift
170        IF A$[1,2]=".." THEN
171                        P(I)=Mind
172                        ELSE
173                        P(I)=VAL(A$)
174                        END IF
180     NEXT I
190  !!!!  GRAPH !!!!!!!
200  GCLEAR
210  GRAPHICS ON
220  VIEWPORT 20,120,10,90
230  FRAME
240  WINDOW 0,Number,Mind,Maxd
250   FOR I=0 TO Number-1
260      PLOT I,P(I)
270   NEXT I
280  END
```

```
10    !!!!!!!!!!!!!!!!!!!!!!!!!!!!
20    !  CROSS POWER             !
30    !  (FLOATING CONVERT)      !
31    !     "C_POWER"            !
33    !   CPU=HP9816S            !
40    !    by ONO SOKKI          !
50    !!!!!!!!!!!!!!!!!!!!!!!!!!!!
100  !
110   INTEGER Cr(806),Ci(806)    ! real/imag integer buffer
120   DIM Crf(400),Cif(400)      ! real/imag float data buffer
130   Cf=709                     ! device address
131   A0=2^16
132   A1=2^32
140     ! data read from CF900
150    OUTPUT Cf;"BDR7BDR8"
160      ENTER Cf USING "%,W";Cr(*)  ! real read
170      ENTER Cf USING "%,W";Ci(*)  ! imag read
180     ! convert to floating
190     FOR I=0 TO 400
200        J=I*2
210         X1=Cr(J)
230         X2=Cr(J+1)
240         GOSUB Conv
241         Crf(I)=X     ! real convert
244         X1=Ci(J)
245         X2=Ci(J+1)
246         GOSUB Conv
247         Cif(I)=X     ! imag convert
248     NEXT I
250     !  GRAPH
251    GCLEAR
252    GRAPHICS ON
253    VIEWPORT 20,120,20,90
254    FRAME
255    WINDOW 0,400,-60,0
256      FOR I=0 TO 400
257         X=Crf(I)*Crf(I)+Cif(I)*Cif(I)
258         IF X=0 THEN
259                 X=-60
260                 GOTO Xx
261                 END IF
262         X=5*LGT(X/2^60)   ! neglect voltage range !!!
263 Xx:   DRAW I,X
264     NEXT I
265      GOTO Progend
267 Conv:!
280      IF X2<0 THEN X2=X2+A0
290      X=X1*A0+X2
310      RETURN
320      !
330 Progend:  END
```

```
10     !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
20     !   TIME DATA(chA &chB)                 !
21     !      "TIME_AB"                        !
30     !        CPU= HP9816S                   !
40     !        device #=9                     !
50     !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
51     Slot=7
60     ABORT Slot                ! IFC
80     Cf=Slot*100+9             ! device set
81     GINIT
90     OPTION BASE 1
100    INTEGER Tima(1024),Timb(1024)  ! dual 1k time buffer
110    ASSIGN @Cff TO Cf;FORMAT OFF
120    !!!  time data read !!!
130      OUTPUT Cf;"BDR1 BDR2"
140       ENTER @Cff;Tima(*)           ! chA time read
150       ENTER Cf USING "%,W";Dummy ! dummy read (=cr,lf)
160       ENTER @Cff;Timb(*)          ! chB time read
170       ENTER Cf USING "%,W";Dummy ! dummy read (=cr,lf)
180     PRINT "data read end !!"
190    !!  graph !!
200     GRAPHICS ON
201      Mind=-32768
202      Maxd=32767
203      Tnum=1024
210      !!  ch A TIME diplay !!
220       VIEWPORT 20,120,10,45
230       FRAME
240       WINDOW 1,Tnum,Mind,Maxd
250         FOR I=1 TO Tnum
260           PLOT I,Tima(I)
270         NEXT I
280      !!  ch B TIME diplay !!
290       VIEWPORT 20,120,55,90
300       FRAME
310       WINDOW 1,Tnum,Mind,Maxd
320         FOR I=1 TO Tnum
330           PLOT I,Timb(I)
340         NEXT I
350     !
360     END
```

```
10     !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
20     !   READ OUT of TRANSFER FUNCTION        !
30     !      "READ_XFR"                        !
40     !     CPU= HP9816S                       !
50     !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
60     ABORT 7                         ! IFC
70     Cf=709                          !  device #
80     GINIT
90     OPTION BASE 1
100    INTEGER Xr(1089),Xi(1089)
110    DIM Xreal(401),Ximag(401),Amp(15),Frq(16)
120    READ Amp(*)
130    READ Frq(*)
140    !!!!
150     INPUT "current/mass(1/2) ?",A$
160      IF A$="2" THEN Mass
170    ! current xfer read
180    OUTPUT Cf;"BDR15 BDR16"
190    ENTER Cf USING "%,W";Xr(*)      ! real part read
200    ENTER Cf USING "%,W";Xi(*)      ! imag part read
210      OUTPUT Cf;"AAR"
220      ENTER Cf;Volt_a
230      OUTPUT Cf;"BAR"
240      ENTER Cf;Volt_b
250      V_f=Amp(Volt_b)/Amp(Volt_a)       ! input amp. factor  !!!
260      OUTPUT Cf;"FRC"
270      ENTER Cf;F_r
280      Fr=Frq(F_r)
290        GOTO Cfloat
300    !
310 Mass:  ! mass xfer read
320      INPUT "BLOCK # ?",Block
330       OUTPUT Cf;"MBS";Block;"CMR MBS";Block+1;"CMR"
340    ENTER Cf USING "%,W";Xr(*)      ! real part read
350    ENTER Cf USING "%,W";Xi(*)      ! imag part read
360    ! condition data real part only !!!
370      Volt_a=(Xr(1024+2) DIV 256)+1
380      Volt_b=BINAND(Xr(1024+2),255)+1
390      V_f=Amp(Volt_b)/Amp(Volt_a)
400      Fr=Frq((Xr(1024+3) DIV 256)+1)
410    !
420 Cfloat: ! convert folating data
430     FOR I=1 TO 401
440       I1=I*2
450       Xreal(I)=V_f*Xr(I1)*2^(Xr(I1-1)-16)
460       Ximag(I)=V_f*Xi(I1)*2^(Xi(I1-1)-16)
470     NEXT I
480 Gra:!! GRAPH !!!!
490    GRAPHICS ON
500    Yc=20*LGT(V_f)
510    Xnum=401
520    VIEWPORT 20,110,30,90
530    FRAME
540    WINDOW 1,Xnum,Yc-40,Yc+40
550     FOR I=1 TO Xnum
560       A=Xreal(I)*Xreal(I)+Ximag(I)*Ximag(I)
570       IF A=0 THEN
580             DRAW I,Yc-40
590              GOTO 620
600              END IF
610        DRAW I,10*LGT(A)
620     NEXT I
630      PRINT Fr;"Hz"
640     DATA 50,20,10,5,2,1,.5,.2,.1,.05,.02,.01,.005,.002,.001  ! amplitude
650     DATA 1,2,5,10,20,50,100,200,500,1000,2000,5000,10000,20000
660     DATA 50000,100000       ! frequency range
670     END
```

```
10    !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
20    !  CRT IMAGE DATA READ & GRAPH DISPLAY !
21    !      "IMAGE"                         !
30    !        CPU= HP9816S                  !
40    !        device #=9                    !
50    !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
60    ABORT 7                  ! IFC
70    Cf=709                   ! device # set
80    DIM P(1024)
90    INPUT " number ?",Number
110    OUTPUT Cf;"LCI"          ! lower crt image data read command
120    ENTER Cf USING "%,W";P(*)   ! read until EOI sent
190  !!!!  GRAPH !!!!!!!
200  GCLEAR
210  GRAPHICS ON
220  VIEWPORT 20,120,10,90
230  FRAME
240  WINDOW 0,Number,0,320
250   FOR I=0 TO Number-1
260      PLOT I,P(I)
270   NEXT I
280  END
```

```
10     !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
20     !  TIME RECORD READ           !
30     !     "RECORD"                !
40     !   CPU= HP9816S              !
50     !   device #=9                !
60     !   command:RAR(chA),RBR(chB) !
70     !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
80     ABORT 7
90     Cf=709                          ! device # set
100    INTEGER T(20000)
110    ON INTR 7 GOSUB Service
120    ENABLE INTR 7;2
130    OUTPUT Cf;"RON"                 ! set RECORD mode & pause
140    OUTPUT Cf;"RCS1"                ! chA&B
150    WAIT 1
160    Srq=0
170    OUTPUT Cf;"SMS4"
180    OUTPUT Cf;"CST"
190      IF Srq=0 THEN 190
200    INPUT "COM,addr,point ?",C$,Adr,Point
210    OUTPUT Cf;C$;Adr;",";Point        ! command set
220                               ! com start address ,point #
230    ENTER Cf USING "%,W";T(*)  ! data read until EOI send
240    !!!!!  graph !!!!!!
250    GINIT
260    GRAPHICS ON
270    GCLEAR
280    VIEWPORT 20,130,20,95
290    FRAME
300    WINDOW 0,Point-1,-32768,32768
310    PENUP
320    MOVE 0,0
330    FOR I=0 TO Point-1
340    DRAW I,T(I)
350    NEXT I
360     GOTO Progend
370   !!! SRQ service !!!!
380 Service:  !
390            Srq=SPOLL(Cf)
400            ENABLE INTR 7;2
410            RETURN
420 Progend: END
```

```
10    !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
20    !   1/3 OCTAVE DATA READ               !
21    !       "OCT_SCH"                      !
30    !        CPU= HP9816S                  !
40    !        device #=9                    !
50    !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
60    ABORT 7                  ! IFC
70    Cf=709                   ! device # set
71     DIM A$[40]
80    OUTPUT Cf;"SONSPS11"     ! analyzed first band set
90      FOR I=1 TO 31          !  30 band + overall
100        OUTPUT Cf;"LXY"     !  X,Y read command set
110        ENTER Cf;A$         ! read
120        OUTPUT Cf;"SMU"     ! next band
130        PRINT A$
140     NEXT I
150   END
```

```
10     !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
20     !  GP-IB DIGITAL IN MODE             !
21     !       "DIGITALIN"                  !
23     !      CPU = HP9816S                 !
24     !      device #= 9                   !
30     !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
31     ABORT 7                              ! IFC
40     Cf=709                               ! device address
41     OPTION BASE 1
50     INTEGER T(1024)
51       A=30000
52       X0=2*PI/1024*10
60     FOR I=1 TO 1024                     ! dummy data generate
70                 T(I)=A*SIN(X0*I)
80     NEXT I
90     !!!
92     ASSIGN @Cff TO Cf;FORMAT OFF
93        INPUT "SUM # ",Sum_n              ! if INSTANT then =1
100    OUTPUT Cf;"CPS"
101    WAIT .1
110    OUTPUT Cf;"CDO"                       ! make digital in mode
120    OUTPUT Cf;"CST"                       ! make start
121    FOR I=1 TO Sum_n
122     OUTPUT Cf;"FMC"                      ! FFT mem busy check
123     ENTER Cf;A
124     IF A=0 THEN 122
130     OUTPUT Cf;"FMW"                      ! FFT mem write
131     OUTPUT @Cff;T(*)                     ! chA write
150     OUTPUT @Cff;T(*),END                 ! chB write (same data)
151    NEXT I
160    BEEP
170    OUTPUT Cf;"CPS"                       ! If sum NORMAL end then no need
180    OUTPUT Cf;"CDF"                       ! make normal mode
190    LOCAL 7
200     END
```

```
10     !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
20     !  ASCII data transfer                  !
30     !   Transferred data depends on         !
31     !    CRT display trace                  !
32     !       "LDD"                           !
40     !   command : LDD(single or lower)      !
41     !           : UDD( upper)               !
50     !   CPU=HP9816S                         !
60     !    device #=9                         !
70     !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
110  ABORT 7                           ! IFC
111  GINIT
120  Cf=709                            ! address
130   DIM Dbuf(401),Oct$(30)[40]       ! ASCII data buffer
131    ON ERROR GOTO Ertrap            ! In case Y axis dB !!
132   INPUT "1/3 OCTAVE (1/0) ?",Oct
140  !!! read  Ydata from No.0 until No.401(O.A.)
150    OUTPUT Cf;"LDD2,0,401"
151     IF Oct=0 THEN Notoct
152 Octave:  !! octave read
153      PRINT
155      FOR I=0 TO 30                 ! 30 band +overall
156         ENTER Cf;Oct$(I)
157         PRINT Oct$(I),
158      NEXT I
159      GOTO Progend
160 Notoct:  !! 400line spectrum read
161      FOR I=0 TO 401
170        ENTER Cf;Dbuf(I)
180      NEXT I
181   !!  graph !!!
182    GRAPHICS ON
183    VIEWPORT 25,120,30,80
184      FRAME
185      INPUT "Ymin,Ymax ?",Ymin,Ymax
186      WINDOW 0,400,Ymin,Ymax
187        FOR I=0 TO 400
188          PLOT I,Dbuf(I)
189        NEXT I
191      GOTO Progend
192 Ertrap:! dB MAG value  -infinit  ---> not numeric !!
193          Dbuf(I)=-300
200          GOTO 180
210 Progend: !
220          LOCAL 7
230          END
```

```
1      !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
2      ! IEEE floating data transfer            !
3      !  for POWER SPECTRUM(400lines)          !
4      !   PA(1),PB(2),COP(9)                   !
5      !      "POWERf1"                         !
6      !      CPU=HP9816S(BASIC3.0)             !
7      !        device #= 9                     !
9      !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
10     ABORT 7                              ! IFC
11     D=709                                ! address
12     M=401                                ! dual 1K mode
20     OPTION BASE 1
21     DIM Pw(401),Amp(15)
22     READ Amp(*)
24     ON ERROR GOTO Errtrap
25     INPUT "SERVO(1/0) ?",Servo
27   !
40        ASSIGN @Cff TO D;FORMAT OFF ! set CPU internal data format
42    INPUT "KIND ?",Kind
45     OUTPUT D;"BFD2,";Kind           ! IEEE double precision
50        ENTER @Cff;Pw(*)
51        ENTER D USING "%,W";A        ! dummy (cr,lf) read
54          OUTPUT D;"AAR"
55          ENTER D;V_a
56          IF Kind=1 THEN 60
58          OUTPUT D;"BAR"
59          ENTER D;V_a
60    !  GRAPHICS
70     GINIT
71     GRAPHICS ON
72     VIEWPORT 40,300,30,120
73     FRAME
120    !!  SPECTRUM
121     INPUT "Ymin,Ymax ?",Ymin,Ymax
130    WINDOW 1,M,Ymin,Ymax
131    Pmax=-300
140    FOR I=1 TO M
150    A=Pw(I)
160    IF Servo=1 THEN 170
161       A=A*Amp(V_a)*Amp(V_a)
170    P1=10*LGT(A)
171    Pmax=MAX(P1,Pmax)
200   PLOT I,P1
210   NEXT I
211   PRINT "MAX data =";Pmax;"dB"
213   GOTO Progend
214 Errtrap:!!
215      P1=-300
216      GOTO 200
217      !
218      DATA 50,20,10,5,2,1
219      DATA .5,.2,.1,.05,.02,.01
220      DATA  .005,.002,.001
221 Progend:BEEP
230         LOCAL D
240         END
```

```
10     !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
20     ! IEEE folating data transfer            !
30     !   for POWER SPECTRUM (4 decades)       !
40     !      PA(1),PB(2)                       !
50     !         "POWERf14D"                    !
60     !      CPU=HP9816S(BASIC3.0)             !
70     !        device #=9                      !
80     !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
90     ABORT 7                              ! IFC
91     GINIT
100    D=709                                ! address
110    OPTION BASE 1
120    DIM Pw(1117),Amp(15)
130    READ Amp(*)
140    ON ERROR GOTO Errtrap
150    Servo=1
160 Sample:  !!
170        ASSIGN @Cff TO D;FORMAT OFF     ! set CPU internal data format
180   INPUT "KIND ?",Kind
200    OUTPUT D;"BFD2,";Kind              ! IEEE double precision
210        ENTER @Cff;Pw(*)
220        ENTER D USING "%,W";A          ! dummy (cr,lf) read
300   !  GRAPHICS
320    GRAPHICS ON
330    VIEWPORT 40,120,30,90
340    FRAME
350    !!  SPECTRUM
360     INPUT "Ymin,Ymax ?",Ymin,Ymax
380    WINDOW 0,4,Ymin,Ymax               ! 4 decades
390    Pmax=-300
400      FOR I=1 TO 1117
410          A=Pw(I)
440          P1=10*LGT(A)
450          Pmax=MAX(P1,Pmax)
470          CALL Xpoint(I,J)          ! get 4dec X point
480          PLOT J,P1
490      NEXT I
500   PRINT "MAX data =";Pmax;"dB"
510   GOTO Progend
520 Errtrap:!!
530       P1=Ymin
540       GOTO 480
550       !
560       DATA 50,20,10,5,2,1
570       DATA .5,.2,.1,.05,.02,.01
580       DATA  .005,.002,.001
590 Progend:BEEP
600         LOCAL D
610         END
620   SUB Xpoint(I,J)
630               J=I-1
640               IF J>396 THEN Xp10
650                J=J+4
660                J=LGT(J/400)+2
670                GOTO Xpend
680 Xp10:         IF J>396+360 THEN Xp20
690                 J=J-396+40
700                 J=LGT(J/400)+3
710                 GOTO Xpend
720 Xp20:         J=J-396-360+40
730                 J=LGT(J/400)+4
740 Xpend: SUBEND
```

```
1       !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
2       !  IEEE floating data transfer            !
4       !    for CROSS SPECTRUM(400lines)         !
5       !    Creal(3),Cimag(4)                    !
6       !       "CROSSf1"                         !
8       !     CPU= HP9816S(BASIC 3.0)             !
9       !     device #=9                          !
10      !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
11      ABORT 7                         ! IFC
12      GINIT
14      Cf=709                          !  device #
15      M=401                           ! dual 1k mode
20      OPTION BASE 1
40      DIM Creal(401),Cimag(401),Amp(15)
41      READ Amp(*)
43      INPUT "SERVO (1/0)",Servo
45      ASSIGN @Cff TO Cf;FORMAT OFF
50      OUTPUT Cf;"BFD2,3 BFD2,4"       ! IEEE double precision
60      ENTER @Cff;Creal(*)             ! real part read
61        ENTER Cf USING "%,W";A        ! dummy (cr,lf) read
80      ENTER @Cff;Cimag(*)             ! imag part read
81        ENTER Cf USING "%,W";A        ! dummy(cr,lf) read
91            OUTPUT Cf;"AAR"
101           ENTER Cf;V_a
111           OUTPUT Cf;"BAR"
121           ENTER Cf;V_b
131           V_r=Amp(V_b)*Amp(V_a)
190     !!!! GRAPH !!!!
200     GRAPHICS ON
210      INPUT "Ymin,Ymax ?",Ymin,Ymax
213       VIEWPORT 20,120,20,90
214       FRAME
220       WINDOW 1,M,Ymin,Ymax
230      FOR I=1 TO M
240        A=SQR(Creal(I)*Creal(I)+Cimag(I)*Cimag(I))
241        IF Servo=1 THEN 250
242        A=A*V_r
250        IF A=0 THEN
260              P1=Ymin
270               GOTO 290
280               END IF
281        P1=10*LGT(A)
290         DRAW I,P1
300      NEXT I
303      DATA 50,20,10,5,2,1,.5,.2,.1,.05,.02,.01,.005,.002,.001   ! amplitude
310      END
```

```
10     !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
20     !  IEEE floating data transfer           !
30     !   for CROSS SPECTRUM (4 decades)       !
40     !      Creal(3),Cimag(4)                 !
50     !           "CROSSf14D"                  !
60     !     CPU= HP9816S(BASIC3.0)             !
70     !     device #=9                         !
80     !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
90     Cf=709                           !  device #
100    GINIT
110    OPTION BASE 1
120    DIM Creal(1117),Cimag(1117)
140    ASSIGN @Cff TO Cf;FORMAT OFF     ! set CPU internal data format
150     OUTPUT Cf;"BFD2,3 BFD2,4"       ! IEEE double precision
160       ENTER @Cff;Creal(*)           ! real part read
170       ENTER Cf USING "%,W";A        ! dummy(cr,lf) read
180       ENTER @Cff;Cimag(*)           ! imag part read
190       ENTER Cf USING "%,W";A        ! dummy(cr,lf) read
200    !!!! GRAPH !!!!
210    GRAPHICS ON
220     INPUT "Ymin,Ymax ?",Ymin,Ymax
230      VIEWPORT 20,120,20,90
240      FRAME
250       WINDOW 0,4,Ymin,Ymax          ! X axis :4 dec
260     FOR I=1 TO 1117
270       A=SQR(Creal(I)*Creal(I)+Cimag(I)*Cimag(I))
280       P1=Ymin
290       IF A=0 THEN 286
300       P1=10*LGT(A)
310       CALL Xpoint(I,J)
320        PLOT J,P1
330     NEXT I
350     LOCAL Cf
360     END
370     SUB Xpoint(I,J)
380              J=I-1
390              IF J>396 THEN Xp10
400               J=LGT((J+4)/400)+2
410               GOTO Xpend
420 Xp10:        IF J>396+360 THEN Xp20
430                J=LGT((J-396+40)/400)+3
440                GOTO Xpend
450 Xp20:        J=LGT((J-396-360+40)/400)+4
460 Xpend: SUBEND
```

```
1     !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
2     !  IEEE floating data transfer               !
3     !   for TRANSFER FUNCTION(400lines)          !
4     !    Xreal(7),Ximag(8)                       !
5     !          "XFERf1"                          !
7     !     CPU= HP9816S(BASIC3.0)                 !
8     !     device #=9                             !
9     !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
10    ABORT 7                             ! IFC
11    GINIT
13    Cf=709                              !  device #
14    M=401                               ! dual 1k mode
20    OPTION BASE 1
40    DIM Xreal(401),Ximag(401),Amp(15)
41    READ Amp(*)
43    INPUT "SERVO (1/0)",Servo
45    ASSIGN @Cff TO Cf;FORMAT OFF        ! set CPU internal data format
50    OUTPUT Cf;"BFD2,7 BFD2,8"           ! IEEE double precision
60    ENTER @Cff;Xreal(*)                 ! real part read
61      ENTER Cf USING "%,W";A            ! dummy (cr,lf) read
80    ENTER @Cff;Ximag(*)                 ! imag part read
81      ENTER Cf USING "%,W";A            ! dummy (cr,lf) read
91          OUTPUT Cf;"AAR"
101         ENTER Cf;V_a
111         OUTPUT Cf;"BAR"
121         ENTER Cf;V_b
131         V_r=Amp(V_b)/Amp(V_a)
190   !!!! GRAPH !!!!
200   GRAPHICS ON
210    INPUT "Ymin,Ymax ?",Ymin,Ymax
213     VIEWPORT 20,120,20,90
214     FRAME
220   WINDOW 1,M,Ymin,Ymax
221   Xmax=-300
230    FOR I=1 TO M
240      A=Xreal(I)*Xreal(I)+Ximag(I)*Ximag(I)
241      IF Servo=1 THEN 250
242      A=A*V_r*V_r
250      IF A=0 THEN
260            P1=Ymin
270             GOTO 286
280             END IF
281      P1=10*LGT(A)
286      Xmax=MAX(P1,Xmax)
290       DRAW I,P1
300    NEXT I
301    PRINT Xmax
303    DATA 50,20,10,5,2,1,.5,.2,.1,.05,.02,.01,.005,.002,.001   ! amplitude
310    END
```

```
10     !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
20     !  IEEE floating data transfer              !
30     !   for XFER FUNCTION (4 decades)           !
40     !      Xreal(7),Ximag(8)                    !
50     !         "XFERf14D"                        !
60     !     CPU= HP9816S(BASIC3.0)                !
70     !     device #=9                            !
80     !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
90     Cf=709                            !  device #
100    GINIT
110    OPTION BASE 1
120    DIM Xreal(1117),Ximag(1117)
130    ASSIGN @Cff TO Cf;FORMAT OFF      ! set CPU internal data format
140     OUTPUT Cf;"BFD2,7 BFD2,8"        ! IEEE double precision
150      ENTER @Cff;Xreal(*)             ! real part read
160      ENTER Cf USING "%,W";A          ! dummy(cr,lf) read
170      ENTER @Cff;Ximag(*)             ! imag part read
180      ENTER Cf USING "%,W";A          ! dummy(cr,lf) read
190    !!!! GRAPH !!!!
200    GRAPHICS ON
210     INPUT "Ymin,Ymax ?",Ymin,Ymax
220      VIEWPORT 20,120,20,90
230      FRAME
240     WINDOW 0,4,Ymin,Ymax             ! Xaxis :4 dec
250    Xmax=-300
260     FOR I=1 TO 1117
270       A=Xreal(I)*Xreal(I)+Ximag(I)*Ximag(I)
280       P1=Ymin
290       IF A=0 THEN 310
300       P1=10*LGT(A)
310       Xmax=MAX(P1,Xmax)
320       GOSUB Xpoint
330        DRAW J,P1
340     NEXT I
350     PRINT Xmax
360     GOTO Progend
370 Xpoint:        !
380                J=I-1
390                IF J>396 THEN Xp10
400                 J=LGT((J+4)/400)+2
410                 GOTO Xpend
420 Xp10:          IF J>396+360 THEN Xp20
430                  J=LGT((J-396+40)/400)+3
440                  GOTO Xpend
450 Xp20:          J=LGT((J-396-360+40)/400)+4
460 Xpend: RETURN
470 Progend: LOCAL Cf
480          END
```

```
1       !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
2       !  IEEE floating data transfer                !
3       !    for HISTOGRAM                            !
4       !       chA(5),chB(6)                         !
5       !         "HISTf1"                            !
6       !       CPU=HP9816S(BASIC3.0)                 !
7       !       device #=9                            !
8       !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
9       ABORT 7                           ! IFC
10      GINIT
12      Cf=709                            ! address
13      OPTION BASE 1
14      DIM Hist(256)
15      ASSIGN @Cff TO Cf;FORMAT OFF      ! set CPU internal data format
16       INPUT "chA(5)/chB(6) ?",Kind
20      OUTPUT Cf;"BFD2,";Kind            ! IEEE double precision
30        ENTER @Cff;Hist(*)
31        ENTER Cf USING "%,W";A          ! dummy(cr,lf) read
40      Ymax=0
50     !!! GRAPH !!
51       INPUT "GAIN ?",G
60      GRAPHICS ON
70        VIEWPORT 30,120,40,90
80          FRAME
90        WINDOW 1,256,0,1/G
100        FOR I=1 TO 256
110          A=Hist(I)/1024              ! SUM #=1
120          Ymax=MAX(Ymax,A)
130         PLOT I,A
140       NEXT I
150       PRINT Ymax
160     END
```

```
10     !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
20     !   GPIB digital in & USER WINDOW SET!
30     !   HAMMING WINDOW                   !
40     !   CPU  HP9816                      !
50     !   device #9(cf).0(HP)
60     !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
70     ABORT 7
80     Cf=709
90     OPTION BASE 1
100    INTEGER Tbuff(2048)
110    !!!!!  WINDOW DATA GENERATE
120    FOR I=1 TO 2048
130     Tbuff(I)=(.54-.46*COS(2*PI*I/2048))*32767
140    NEXT I
150  !
160    OUTPUT Cf;"CST"   ! CF START
170    OUTPUT Cf;"ATI"   ! A ch TIME DISPLAY
180    OUTPUT Cf;"FLS1"  ! DATA LENGTH 2K MODE SET
190    OUTPUT Cf;"CPS"   ! CF PAUSE
200    OUTPUT Cf;"CDO"   ! DIGITAL IN MODE ON
210    OUTPUT Cf;"CST"   ! CF START
220    !
230    OUTPUT Cf;"FMC"   !  BUSY CHECK
240    ENTER Cf;A
250    IF A=0 THEN 230
260    !
270    OUTPUT Cf;"FMW"   !  DATA WRITE COMM.
280    OUTPUT Cf USING "%,W";Tbuff(*)    | DATA SEND
290    OUTPUT Cf;"CPS"   ! CF PAUSE
300    OUTPUT Cf;"CDF"   ! DIGITAL IN MODE OFF
310    OUTPUT Cf;"WSL3"  ! USER WINDOW SET SELECT
320    OUTPUT Cf;"WST"   !    SET
330    END
```

```
100 '''''''''''''''''''''''''''''''''''
110 '  SPECTRUM DATA READ & MAX DATA  '
115 '     "powermax"                   '
120 '     CPU = PC-9801 (device= 0)    '
130 '     device # = 9                 '
140 '''''''''''''''''''''''''''''''''''
150 ISET IFC:ISET REN            ' GPIB initialize
160 ON SRQ GOSUB *PROCESS
170 SRQ ON
180 CF=9:PC=0                    ' device set
184 OPTION BASE 1
185 DIM P(1612)
190 P=0
200 PRINT@CF;"AACAAS7FRS13TREANS3AMS1AVOASP"
210 '  chA AC,chA input range .5V,frequency range 10kHz
220 '  trigger repeat,average # 8,average mode SP SUM
230 '  average On ,chA spec display
240 PRINT@CF;"SMS2"              ' SUM end SRQ on !!
250 PRINT@CF;"CST"               ' start
260    IF P=0 THEN  260           ; SUM END WAIT
280 ' data read
290 PRINT@CF;"BDR5"              ' chA APS data read command
300 WBYTE &H20+PC,&H40+CF;       ' PC=LISTER,CF=TALKER
310   FOR I= 1 TO 1612:RBYTE;P(I):NEXT  ' 1612 BYTES READ
355 MAXDATA=0
357 ' '''  max data search ''''''''
360   FOR I= 1 TO 401:I1=I*4
370     P=P(I1-3)*1.67772E+07+P(I1-2)*65536!+P(I1-1)*256+P(I1)
380     IF P>MAXDATA THEN MAXDATA=P
390   NEXT
400  M= 10*LOG(MAXDATA*.5*.5/2^30)/LOG(10)  ' CHANGE SEARCH LOG VALUE
410  PRINT "max data =";M                  ' INPUT VOLTAGE =.5
900 END
1000 '' SRQ PROCESS ''''''
1010 *PROCESS
1020   POLL CF,P                           ' SERIAL POLL
1030   SRQ ON
1040  RETURN
```

```
10 '''''''''''''''''''''''''''''''''''''''''
20 '    search read out & graph display      '
30 '      "sch.gr"                            '
40 '      cpu = pc9801                        '
50 '      device #= 9(cf),0(pc)               '
60 '''''''''''''''''''''''''''''''''''''''''
70  ISET IFC:ISET REN          ' GPIB init
80  CF=9:PC=0                  ' device address
90  DIM DBUFF(1024)
100 INPUT "ymax,ymin & xnumber ";MAXD,MIND,NUM
110 PRINT@CF;"CPS"
120 PRINT@CF;"SONSPSO"         ' search on & point=0
130   FOR I= 0 TO NUM-1
140       PRINT@CF;"LYS"       ' lower trace search read
150        INPUT@CF;A$
160       PRINT@CF;"SMR"       ' next right search point
170       DBUFF(I)=MIND
180        IF LEFT$(A$,2)<>".." THEN DBUFF(I)=VAL(A$)
190   NEXT
200  ''  graph '''''
210  SCREEN 0,0:CLS 2
220  VIEW(100,20)-(600,180),,7
230  WINDOW(0,-MAXD)-(NUM,-MIND)
240  POINT(0,-DBUFF(0))
250   FOR I=0 TO NUM-1
260       LINE-(I,-DBUFF(I)),4
270   NEXT
280  LOCATE 8,2:PRINT MAXD
290  LOCATE 8,22:PRINT MIND
300  GOTO 300
310 END
```

```
10  '''''''''''''''''''''''''''''''''''''''''''
20  '  crosspower                             '
30  '   (floating convert)                    '
40  '    "c power"                            '
50  '   cpu= pc9801                           '
60  '''''''''''''''''''''''''''''''''''''''''''
70   ISET IFC:ISET REN              ' GPIB initialize
80   DIM CRF(400),CIF(400)          ' real/imag floating data buffer
90   A0=2^60:A1=2^32
100   CF=9:PC=0                      ' device address
110   ' data read from cf350
120    PRINT@CF;"BDR7"
130    WBYTE &H20+PC,&H40+CF;
140     FOR I=0 TO 400              ' real read
150        RBYTE;X1,X2,X3,X4
160        GOSUB *CONV
170        CRF(I)=X
180     NEXT
185     FOR I=1 TO 8:RBYTE;X:NEXT   ' dummy read
186    PRINT@CF;"BDR8"
187    WBYTE &H20+PC,&H40+CF;
190     FOR I=0 TO 400              ' imag read
200        RBYTE;X1,X2,X3,X4
210        GOSUB *CONV
220        CIF(I)=X
230     NEXT
235     FOR I=1 TO 8:RBYTE;X:NEXT   ' dummy read
240    '  graph
250     CLS 2
260     VIEW(100,20)-(600,180),,7
270     WINDOW(0,0)-(400,60)
280        FOR I=0 TO 400
290           Y=CRF(I)*CRF(I)+CIF(I)*CIF(I)
300           IF Y=0 THEN X=-60 ELSE X=5*LOG(Y/A0)/LOG(10)
310           LINE-(I,-X),4
320        NEXT
330     END
340 *CONV
350     X=X1*1.67772E+07+X2*65536!+X3*256+X4
360     IF X1>127  THEN X=X-A1
370     RETURN
```

```
10 ''''''''''''''''''''''''''''''''''''''''''
20 '  time data read (chA & chB)             '
30 '      "time.ab"                          '
40 '      cpu = pc9801                       '
50 '      device = 9(cf),0(pc)               '
60 ''''''''''''''''''''''''''''''''''''''''''
62   SCREEN 0,0:CLS 2
65   CLEAR ,&H4000   :GOSUB *BINPROG
70  ISET IFC:ISET REN           ' GPIB init
80  CF=9:PC=0                   ' device address
84  DEFINT T,I
85  TNUM= 1024
90  OPTION BASE 1
100 DIM TIMA(TNUM+1),TIMB(TNUM+1) ' dual 1k time buffer
110 PRINT@CF;"BDR1 BDR2"
120   WBYTE &H3F,&H20+PC,&H40+CF;
130  ' chA time read   !!!
140   TIMED%=1
150    SADR%=VARPTR(TIMA(1),1):OADR%=VARPTR(TIMA(1),0)
160    BYTENUM%=3000 :DELIM%=&H80
170    CALL PROG%(TIMED%,SADR%,OADR%,BYTENUM%,DELIM%)
190  ' chB time read   !!!
195   WBYTE &H3F,&H20+PC,&H40+CF;
200   TIMED%=1
210    SADR%=VARPTR(TIMB(1),1):OADR%=VARPTR(TIMB(1),0)
220    BYTENUM%=3000 :DELIM%=&H80
230    CALL PROG%(TIMED%,SADR%,OADR%,BYTENUM%,DELIM%)
250  PRINT "data read end !!"
260  ' graph     '''''''
270  MIND= -32768!:MAXD=32767
275 '  chA time display !!!!!!!!
280  VIEW(100,20)-(600,90),,7
290  WINDOW(1,-MAXD)-(TNUM,-MIND)
295   POINT(1,-TIMA(1))
300   FOR I=1 TO TNUM
310     LINE-(I,-TIMA(I))
320   NEXT
325 '  chB time display !!!!!!!!
330  VIEW(100,110)-(600,180),,7
340  WINDOW(1,-MAXD)-(TNUM,-MIND)
345   POINT(1,-TIMB(1))
350   FOR I=1 TO TNUM
360     LINE-(I,-TIMB(I))
370   NEXT
375  'GOTO 110
380 END
10000  *BINPROG
10010 DATA 50,53,51,52,56,57,06,C4,77,10,26,8B,04,50
10020 DATA C4,77,0C,26,8B,04,50,C4,77,08,26,8B,3C
10030 DATA C4,77,04,26,8B,0C,C4,37,26,8B,04,07,06,57,BB,00,00
10040 DATA BE,00,00,B4,05,CD,D1
10050 DATA 5B,07,59,23,C9,74,10,8B,CA,D1,E9
10060 DATA 26,8B,07,86,E0,26,89,07,43,43,E2,F4
10070 DATA 07,5F,5E,5A,59,5B,58,CF
10090 DEF SEG=&H4000 : PROG%=0
10100  FOR I=PROG% TO &H51
10110   READ A$:POKE I,VAL("&H"+A$)
10120  NEXT
10130  RETURN
```

Note

The &H4000 of lines 65 and 10090 should be changed to agree with the memory capacity of the personal computer being used.

```
10 ''''''''''''''''''''''''''''''''''''''''''
20 '  READ OUT of TRANSFER FUNCTION          '
30 '       "read.xfr"                        '
40 '       cpu = pc98101(device#=0)          '
50 ''''''''''''''''''''''''''''''''''''''''''
60  ISET IFC:ISET REN
70  CF=9:PC=0
80  OPTION BASE 1
90  DIM XR(2178),XI(2178)
100 DIM XREAL(401),XIMAG(401),AMP(15),FRQ(16)
110   FOR I=1 TO 15:READ AMP(I):NEXT
120   FOR I=1 TO 16:READ FRQ(I):NEXT
130   '
140   INPUT "current/mass(1/2)";A$
145  PRINT "data transferring !!"
150  IF A$="2" THEN *MASS
160    ' current xfer read
170    PRINT@CF;"BDR15 BDR16"
180    WBYTE &H20+PC,&H40+CF;
190    FOR I=1 TO 1612:RBYTE;XR(I):NEXT
200    FOR I=1 TO 1612:RBYTE;XI(I):NEXT
210    PRINT@CF;"AAR":INPUT@CF;VOLT.A
220    PRINT@CF;"BAR":INPUT@CF;VOLT.B
230    V.F= AMP(VOLT.B)/AMP(VOLT.A)   ' input amp. factor
240    PRINT@CF;"FRC":INPUT@CF;F.R
250    FR=FRQ(F.R)
260    GOTO *CFLOAT
270  *MASS
280    INPUT "BLOCK #(first) ";BLOCK
290    PRINT@CF;"MBS"+STR$(BLOCK)+"CRD MBS"+STR$(BLOCK+1)+"CRD"
300    WBYTE &H20+PC,&H40+CF;
310    FOR I=1 TO 2178:RBYTE;XR(I):NEXT
320    FOR I=1 TO 2178:RBYTE;XI(I):NEXT
330    '  condition data real part only !!!
340     VOLT.A=XR(2048+4)+1
350     VOLT.B=XR(2048+5)+1
360     V.F= AMP(VOLT.B)/AMP(VOLT.A)
370     FR=FRQ(XR(2048+5)+1)
380     '
390  *CFLOAT        ' convert floating point
395   PRINT "convert float "
400     FOR I=1 TO 401 :J=I*4
410         XR1=XR(J-3)*256!+XR(J-2):IF XR(J-3)>127 THEN XR1=XR1-65536!
420         XR2=XR(J-1)*256!+XR(J)  :IF XR(J-1)>127 THEN XR2=XR2-65536!
430         XREAL(I)=V.F*XR2*2^(XR1-16)
440         XI1=XI(J-3)*256!+XI(J-2):IF XI(J-3)>127 THEN XI1=XI1-65536!
450         XI2=XI(J-1)*256!+XI(J)  :IF XI(J-1)>127 THEN XI2=XI2-65536!
460         XIMAG(I)=V.F*XI2*2^(XI1-16)
470     NEXT
480 *GRA     '  graph '''''''''''''''''
490    CLS 2
500    VIEW(100,20)-(600,180),,7
510    XNUM=401
520    YC=20*LOG(V.F)/LOG(10):YC1=YC+40:YC2=YC-40
530    WINDOW(1,-YC1)-(XNUM,-YC2)
540      FOR I=1 TO XNUM
550         A=XREAL(I)*XREAL(I)+XIMAG(I)*XIMAG(I)
560         IF A=0 THEN A=YC2:GOTO 580
570         A=10*LOG(A)/LOG(10)
580         LINE-(I,-A),4
590      NEXT
600    PRINT FR;"Hz"
610 DATA 50,20,10,5,2,1,.5,.2,.1,.05,.02,.01,.005,.002,.001
620 DATA 1,2,5,10,20,50,100,200,500
630 DATA 1000,2000,5000,10000,20000
640 DATA 50000,100000
650 END
```

```
10 ''''''''''''''''''''''''''''''''''''''''
20 ' CRT image data read & graph display  '
30 '   "image"                            '
40 '   cpu= pc9801                        '
50 '   device #= 9)cf),0(pc)              '
60 ''''''''''''''''''''''''''''''''''''''''
70  ISET IFC:ISET REN              ' GPIB INIT
80  CF=9:PC=0                      ' device address
90  DIM DBUFF(1024)
100 INPUT "data number ";NUM
110 PRINT@CF;"LCI"                 ' lower CRT image data read
120  WBYTE &H20+PC,&H40+CF;
130  FOR I=0 TO NUM-1
140    RBYTE;X1,X2:X=X1*256+X2:IF X1>127 THEN X=X-65536!
150    DBUFF(I)=X
160  NEXT
165  RBYTE;X1,X2                   ' dummy (cr,lf) read
170  '  grapg !!  ''''
175  MAXD=320                      ' full sacle data
180  SCREEN 0,0:CLS 2
190  VIEW(100,20)-(600,180),,7
200  WINDOW(0,-320)-(NUM,0)
210  POINT(0,DBUFF(0))
220  FOR I= 0 TO NUM-1
230     LINE-(I,-DBUFF(I)),4
240  NEXT
250 END
```

```
10 ''''''''''''''''''''''''''''''''''''''
20 '  time record data read             '
30 '    "record"                        '
40 '   cpu=pc9801                       '
50 '   device #= 9(cf),0(pc)            '
60 '  comm.:RAR(chA),RBR(chB)           '
65 '  max seg &H6000(384K),&HA000(640K) '
67 '          &H2000(128K),&H4000(256K) '
70 ''''''''''''''''''''''''''''''''''''''
75  CLEAR ,&H5F00  : GOSUB *BINPROG  ' depends on sytem memory size
80  ISET IFC:ISET REN             ' GPIB init
90  CF=9:PC=0                     ' device address
95  DEFINT T
100 DIM TBUFF(32000)
110 ON SRQ GOSUB *PROCESS
120 SRQ ON
130 PRINT@CF;"RON"                ' set RECORD mode & pause
140 PRINT@CF;"RCS1"               ' chA&B
150 SRQD=0
160 PRINT@CF;"SMS4"               ' set record end interrupt
170 PRINT@CF;"CST"
180   IF  SRQD=0 THEN 180         ' waiting loop
190  INPUT "COM,addr,point ";C$,ADR,NUM
200  PRINT@CF;C$+STR$(ADR)+","+STR$(NUM)
210                               ' send com , start address & number
220    WBYTE &H3F,&H5F,&H20+PC,&H40+CF;
230       TIMED%=1:SADR%=VARPTR(TBUFF(0),1):OADR%=VARPTR(TBUFF(0),0)
235       A=NUM*2+2 :IF A>32767 THEN A=A-65536!
237       BYTENUM%=A
240       DELIM%=&H80
250       CALL PROG%(TIMED%,SADR%,OADR%,BYTENUM%,DELIM%)
280  ' graph ''''''
290  MAXD=32767:MIND=-32768!
300  SCREEN 0,0:CLS 2
310  VIEW(100,20)-(600,180),,7
320  WINDOW(0,-MAXD)-(NUM-1,-MIND)
330  POINT(0,-TBUFF(0))
340  FOR I= 0 TO NUM-1
350     LINE-(I,-TBUFF(I)),4
360  NEXT
370  END
380  *PROCESS
390    POLL CF,SRQD
400    SRQ ON
410    RETURN
```

```
10000 ''''''''''''''''''''''''''''''''''''
10010 '  binary data fast receive prog   '
10020 '  call prog%(a%,b%,c%,d%,e%)      '
10030 '   a% = 1(TIME data),0(others)    '
10040 '   b% = segment of array          '
10050 '   c% = offset  of array          '
10060 '   d% = receive byte number       '
10070 '   e% = delimiter eoi (=&h80)     '
10080 ''''''''''''''''''''''''''''''''''''
10090  *BINPROG
10100 DATA 50,53,51,52,56,57,06,C4,77,10,26,8B,04,50
10110 DATA C4,77,0C,26,8B,04,50,C4,77,08,26,8B,3C
10120 DATA C4,77,04,26,8B,0C,C4,37,26,8B,04,07,06,57,BB,00,00
10130 DATA BE,00,00,B4,05,CD,D1
10140 DATA 5B,07,59,23,C9,74,10,8B,CA,D1,E9
10150 DATA 26,8B,07,86,E0,26,89,07,43,43,E2,F4
10160 DATA 07,5F,5E,5A,59,5B,58,CF
10170 DEF SEG=&H5F00 : PROG%=0
10180  FOR I=PROG% TO &H51
10190   READ A$:POKE I,VAL("&H"+A$)
10200  NEXT
10210  RETURN
```

Note

The &H5F00 of lines 75 and 10170 should be changed to agree with the memory capacity of the personal computer being used.

```
10 '''''''''''''''''''''''''''''''''''''''''
20 '  1/3 OCTAVE data read                  '
30 '    "oct.sch"                           '
40 '    cpu=pc9801                          '
50 '    device #= 9(cf)                     '
60 '''''''''''''''''''''''''''''''''''''''''
70   ISET IFC:ISET REN           ' GPIB init
80   CF=9                        ' device address
90   PRINT@CF;"SONSPS11"         ' analyzed first band set
100   FOR I=1 TO 31              ' 30band + overall
110       PRINT@CF;"LXY"         ' x,y data read
120       INPUT@CF; X$,Y$
130       PRINT@CF;"SMU"         ' next band
140       PRINT X$,Y$
150   NEXT
160  END
```

```
10 ''''''''''''''''''''''''''''''''
20 '  GPIB digital in mode        '
30 '   "digitalin"                '
40 '   cpu= pc9801                '
50 '   device #=9(cf),0(pc)       '
60 ''''''''''''''''''''''''''''''''
70  ISET IFC:ISET REN         ' GPIB init
80  CF=9 :PC=0                ' device address
90  OPTION BASE 1
100 DEFINT T,I
110 DIM TBUFF(1024)           ' time buffer 1k
120   A=30000
130   X0=2*3.14159/1024*10    ' order=10
140   FOR I=1 TO 1024         ' dummy data generate
150       TBUFF(I)=A*SIN(X0*I)
160   NEXT
170  INPUT " sum # ";SUM      ' if INSTANT then sum=1
180  PRINT@CF;"CPS"
190  PRINT@CF;"CDO"           ' digital in mode
200  PRINT@CF;"CST"
210  FOR I= 1 TO SUM
220  *LOOP:PRINT@CF;"FMC"     ' FFT mem busy check
230        INPUT@CF;A
240        IF A=0 THEN *LOOP
250     PRINT@CF;"FMW"        ' write to FFT mem
255      ' chA write
260      FOR I=1 TO 1024
270         A$=MKI$(TBUFF(I)):WBYTE;ASC(MID$(A$,2)),ASC(LEFT$(A$,1))
280      NEXT
290      ' chB write (same data)
300      FOR I=1 TO 1024
310         A$=MKI$(TBUFF(I)):WBYTE;ASC(MID$(A$,2)),ASC(LEFT$(A$,1))
320      NEXT
330  NEXT
340  PRINT@CF;"CPS"           ' if SUM normal end then no need
350  PRINT@CF;"CDF"           ' make normal(analog) mode
360 END
```

```
10  '''''''''''''''''''''''''''''''''''''
20  '  ASCII data transfer                 '
30  '   Transferrd data depend  on         '
40  '    CRT display trace                 '
50  '   "LDD"                              '
60  '   command:LDD(single or lower)       '
70  '          :UDD(upper)                 '
80  '   cpu=pc9801                         '
90  '   device #=9(cf)                     '
100 '''''''''''''''''''''''''''''''''''''
110 ISET IFC:ISET REN              ' GPIB init
120 CF=9                           ' device address
130  DIM DBUFF(401),OCTA$(30)       ' data buffer
150  INPUT "1/3 octave (1/0) ";OC
160  ' read y spec data from no.0 to 401 (o.a.)
170    PRINT@CF;"LDD2,0,401"
180    IF OC  =0 THEN *NOTOCT
190 *OCT     ' octave read
200    PRINT
210    FOR I=0 TO 30
220        INPUT@CF;OCTA$(I)
230        PRINT OCTA$(I),
240    NEXT
250  END
260 *NOTOCT  ' 400 LINES spactrum read
270    FOR I= 0 TO 401
280        INPUT@CF;A$
285        DBUFF(I)=VAL(A$):IF LEFT$(A$,2)=".." THEN DBUFF(I)=-300
290    NEXT
300    ' graph !! ''''
310   SCREEN 0,0:CLS 2
320   VIEW(100,20)-(600,180),,7
330    INPUT "Ymin,Ymax ";YMIN,YMAX
340   WINDOW(0,-YMAX)-(400,-YMIN)
350     POINT(0,-DBUFF(0))
360     FOR I= 0 TO 400
370        LINE-(I,-DBUFF(I)),4
380     NEXT
450   END
```

```
10 '''''''''''''''''''''''''''''''''''
20 '  MS basic floating data transfer  '
30 '  for POWER SPECTRUM(400lines)     '
40 '    PA(1),PB(2),COP(9)             '
50 '     "POWERfl"                     '
60 '                                   '
70 '    cpu=pc9801                     '
80 '    device #=9(cf),0(pc)           '
90 '''''''''''''''''''''''''''''''''''
95   CLEAR  ,&H1D00
100 ISET IFC :ISET REN           ' GPIB init
110 CF=9:PC=0                    ' device address
120 M=401                        ' 400 lines
130 DEFINT I
140 DIM PW(401),AMP(15)
150  FOR I=1 TO 15:READ AMP(I):NEXT
155  GOSUB *BINPROG
160  INPUT "servo(1/0) ";SERVO
170  INPUT "KIND (pa(1),pb(2),cop(9)) ";KIND
175   DKIND$="ASP" :IF KIND=1 THEN 179
177   DKIND$="BSP" :IF KIND=9 THEN DKIND$="COP"
179   PRINT@CF;DKIND$
180  PRINT@CF;"BFD3,"+STR$(KIND) ' MS basic floating format
190    WBYTE &H20+PC,&H40+CF;
195       TIMED%=0                   '
210       SADR%=VARPTR(PW(1),1):OADR%=VARPTR(PW(1),0)
212       BYTE%=2000:DLIM%=&H80
230       CALL PROG%(TIMD%,SADR%,OADR%,BYTE%,DLIM%)
250  AMPF=1                        ' amp factor
260  IF SERVO=1 THEN *GR
270    PRINT@CF;"AAR":INPUT@CF;VA
280     IF KIND =1 THEN 300
290    PRINT@CF;"BAR":INPUT@CF;VA
300    AMPF=AMP(VA)*AMP(VA)
310 *GR      ' graph !!
320   SCREEN 0,0:CLS 2
330   VIEW(150,30)-(600,180),,7
340   ''  spectrum
345   INPUT "log/lin(1/0) ";LOGLIN
350   'INPUT "Ymin,Ymax ";YMIN,YMAX
352    PRINT@CF;"LYA1":INPUT@CF;YMAX
354    PRINT@CF;"LYA2":INPUT@CF;YMIN
360   WINDOW(1,-YMAX)-(M,-YMIN)
370   PMAX=-1E+38
375    POINT (1,-YMIN)
380     FOR I= 1 TO M
390        A= AMPF*PW(I)
395        IF LOGLIN =0 THEN P1=SQR(A) :GOTO 410
400        IF A=0 THEN P1=-300 ELSE P1=10*LOG(A)/LOG(10)
410        IF PMAX<P1 THEN PMAX=P1
420        LINE-(I,-P1),4
430     NEXT
440   PRINT "MAX DATA =";PMAX;
445   IF LOGLIN=1 THEN A$="dBV" ELSE A$=" V"
447   PRINT A$
450  DATA 50,20,10,5,2,1,.5,.2,.1
460  DATA .05,.02,.01,.005,.002,.001
470 END
```

```
10000 ''''''''''''''''''''''''''''''''''''
10010 '  binary data fast receive prog    '
10020 '  call prog%(a%,b%,c%,d%,e%)       '
10030 '   a% = 1(TIME data),0(others)     '
10040 '   b% = segment of array           '
10050 '   c% = offset  of array           '
10060 '   d% = receive byte number        '
10070 '   e% = delimiter eoi (=&h80)      '
10080 ''''''''''''''''''''''''''''''''''''
10090  *BINPROG
10100 DATA 50,53,51,52,56,57,06,C4,77,10,26,8B,04,50
10110 DATA C4,77,0C,26,8B,04,50,C4,77,08,26,8B,3C
10120 DATA C4,77,04,26,8B,0C,C4,37,26,8B,04,07,06,57,BB,00,00
10130 DATA BE,00,00,B4,05,CD,D1
10140 DATA 5B,07,59,23,C9,74,10,8B,CA,D1,E9
10150 DATA 26,8B,07,86,E0,26,89,07,43,43,E2,F4
10160 DATA 07,5F,5E,5A,59,5B,58,CF
10170 DEF SEG=&H1D00 : PROG%=0
10180  FOR I=PROG% TO &H51
10190   READ A$:POKE I,VAL("&H"+A$)
10200  NEXT
10210  RETURN
```

Note

The &H1D00 of lines 90 and 10170 should be changed to agree with the memory capacity of the personal computer being used.

```
10 ''''''''''''''''''''''''''''''''''''''
20 '  MS basic floating data transfer  '
30 '  for POWER SPECTRUM(4 decades)     '
40 '    PA(1),PB(2)                     '
50 '      "POWERfl4D"                   '
60 '       cpu=pc9801                   '
80 '    device #=9(cf),0(pc)            '
90 ''''''''''''''''''''''''''''''''''''''
95   CLEAR  ,&H1D00
100 ISET IFC :ISET REN          ' GPIB init
110 CF=9:PC=0                   ' device address
130 DEFINT I
140 DIM PW(1118),AMP(15)
150  FOR I=1 TO 15:READ AMP(I):NEXT
155  GOSUB *BINPROG
170  INPUT "KIND (PA(1),PB(2)) ";KIND
175   DKIND$="ASP" :IF KIND=2 THEN DKIND$="BSP"
179   PRINT@CF;DKIND$
180  PRINT@CF;"BFD3,"+STR$(KIND) ' MS basic floating format
190    WBYTE &H20+PC,&H40+CF;     ' pc=listen,cf=talk
195       TIMED%=0                '
210       SADR%=VARPTR(PW(1),1):OADR%=VARPTR(PW(1),0)
212       BYTE%=1118*4:DLIM%=&H80
230       CALL PROG%(TIMD%,SADR%,OADR%,BYTE%,DLIM%)
310 *GR       ' graph !!
320   SCREEN 0,0:CLS 2
330   VIEW(150,30)-(600,180),,7
340   ''   spectrum
345   INPUT "log/lin(1/0) ";LOGLIN
350   'INPUT "Ymin,Ymax ";YMIN,YMAX
352    PRINT@CF;"LYA1":INPUT@CF;YMAX
354    PRINT@CF;"LYA2":INPUT@CF;YMIN
360   WINDOW(0,-YMAX)-(4,-YMIN)
370   PMAX=-1E+38
375    POINT (0,-YMIN)
380     FOR I= 1 TO 1117
390        A= PW(I)
395        IF LOGLIN =0 THEN P1=SQR(A) :GOTO 410
400        IF A=0 THEN P1=-300 ELSE P1=10*LOG(A)/LOG(10)
410        IF PMAX<P1 THEN PMAX=P1
415        GOSUB *XPOINT
420        LINE-(J,-P1),4
430     NEXT
440   PRINT "MAX DATA =";PMAX;
445   IF LOGLIN=1 THEN A$="dBV" ELSE A$=" V"
447   PRINT A$
450  DATA 50,20,10,5,2,1,.5,.2,.1
460  DATA .05,.02,.01,.005,.002,.001
470 END
```

```
10000 '''''''''''''''''''''''''''''''''''''
10010 '  binary data fast receive prog     '
10020 '  call prog%(a%,b%,c%,d%,e%)        '
10030 '   a% = 1(TIME data),0(others)      '
10040 '   b% = segment of array            '
10050 '   c% = offset  of array            '
10060 '   d% = receive byte number         '
10070 '   e% = delimiter eoi (=&h80)       '
10080 '''''''''''''''''''''''''''''''''''''
10090  *BINPROG
10100 DATA 50,53,51,52,56,57,06,C4,77,10,26,8B,04,50
10110 DATA C4,77,0C,26,8B,04,50,C4,77,08,26,8B,3C
10120 DATA C4,77,04,26,8B,0C,C4,37,26,8B,04,07,06,57,BB,00,00
10130 DATA BE,00,00,B4,05,CD,D1
10140 DATA 5B,07,59,23,C9,74,10,8B,CA,D1,E9
10150 DATA 26,8B,07,86,E0,26,89,07,43,43,E2,F4
10160 DATA 07,5F,5E,5A,59,5B,58,CF
10170 DEF SEG=&H1D00 : PROG%=0
10180  FOR I=PROG% TO &H51
10190   READ A$:POKE I,VAL("&H"+A$)
10200  NEXT
10210  RETURN
20000 '
20010  *XPOINT
20020    J=I-1
20030    IF J>396 THEN *XP2
20040       J=J+4
20050       J=LOG(J/400)/LOG(10)+2
20060       GOTO *XPEND
20070  *XP2
20080    IF J>396+360 THEN *XP4
20090       J=J-396+40
20100       J=LOG(J/400)/LOG(10)+3
20110       GOTO *XPEND
20120  *XP4
20130       J=J-396-360+40
20140       J=LOG(J/400)/LOG(10)+4
20150  *XPEND: RETURN
```

Note

The &H1D00 of lines 95 and 10170 should be changed to agree with the memory capacity of the personal computer being used.

```
100 '''''''''''''''''''''''''''''''''''''
110 '  MS basic floating data transfer  '
120 '   for CROSS SPECTRUM(400lines)     '
130 '     Creal(3),Cimag(4)              '
140 '      "CROSSfl"                     '
160 '     cpu=pc9801                     '
170 '     device #=9(cf),0(pc)           '
180 '''''''''''''''''''''''''''''''''''''
190   CLEAR  ,&H1D00
200 ISET IFC :ISET REN          ' GPIB init
210 CF=9:PC=0                   ' device address
220 M=401                       ' 400 lines
230 DEFINT I
240 DIM CREAL(402),CIMAG(402),AMP(15)
250  FOR I=1 TO 15:READ AMP(I):NEXT
260  GOSUB *BINPROG
270  INPUT "servo(1/0) ";SERVO
280   PRINT@CF;"CSP"               ' CROSS SPEC display
290  PRINT@CF;"BFD3,3 BFD3,4"      ' MS basic floating format
300    WBYTE &H20+PC,&H40+CF;
310        TIMED%=0                 '
320        SADR%=VARPTR(CREAL(1),1):OADR%=VARPTR(CREAL(1),0)
330        BYTE%=2000:DLIM%=&H80
340    '  real data read
350        CALL PROG%(TIMD%,SADR%,OADR%,BYTE%,DLIM%)
360        SADR%=VARPTR(CIMAG(1),1):OADR%=VARPTR(CIMAG(1),0)
370    '  imag data read
380        CALL PROG%(TIMD%,SADR%,OADR%,BYTE%,DLIM%)
390  AMPF=1                         ' amp factor
400  IF SERVO=1 THEN *GR
410    PRINT@CF;"AAR":INPUT@CF;VA
420    PRINT@CF;"BAR":INPUT@CF;VB
430    AMPF=AMP(VA)*AMP(VB)
440 *GR      ' graph !!
450   SCREEN 0,0:CLS 2
460   VIEW(150,30)-(600,180),,7
470   ''  spectrum
480   'INPUT "Ymin,Ymax ";YMIN,YMAX
490    PRINT@CF;"LYA1":INPUT@CF;YMAX
500    PRINT@CF;"LYA2":INPUT@CF;YMIN
510   WINDOW(1,-YMAX)-(M,-YMIN)
520   PMAX=-1E+38
530    POINT (1,-YMIN)
540     FOR I= 1 TO M
550        A= SQR(CREAL(I)*CREAL(I)+CIMAG(I)*CIMAG(I))
560        A= AMPF*A
570        IF A=0 THEN P1=-300 ELSE P1=10*LOG(A)/LOG(10)
580        IF PMAX<P1 THEN PMAX=P1
590        LINE-(I,-P1),4
600     NEXT
610   PRINT "MAX DATA =";PMAX;"dBV"
620   PRINT A$
630  DATA 50,20,10,5,2,1,.5,.2,.1
640  DATA .05,.02,.01,.005,.002,.001
650 END
```

```
10000 '''''''''''''''''''''''''''''''''''
10010 '  binary data fast receive prog   '
10020 '  call prog%(a%,b%,c%,d%,e%)       '
10030 '   a% = 1(TIME data),0(others)     '
10040 '   b% = segment of array           '
10050 '   c% = offset  of array           '
10060 '   d% = receive byte number        '
10070 '   e% = delimiter eoi (=&h80)      '
10080 '''''''''''''''''''''''''''''''''''
10090  *BINPROG
10100 DATA 50,53,51,52,56,57,06,C4,77,10,26,8B,04,50
10110 DATA C4,77,0C,26,8B,04,50,C4,77,08,26,8B,3C
10120 DATA C4,77,04,26,8B,0C,C4,37,26,8B,04,07,06,57,BB,00,00
10130 DATA BE,00,00,B4,05,CD,D1
10140 DATA 5B,07,59,23,C9,74,10,8B,CA,D1,E9
10150 DATA 26,8B,07,86,E0,26,89,07,43,43,E2,F4
10160 DATA 07,5F,5E,5A,59,5B,58,CF
10170 DEF SEG=&H1D00 : PROG%=0
10180  FOR I=PROG% TO &H51
10190   READ A$:POKE I,VAL("&H"+A$)
10200  NEXT
10210  RETURN
```

```
100 '''''''''''''''''''''''''''''''''''
110 '  MS basic floating data transfer  '
120 '  for CROSS SPECTRUM(4decades)     '
130 '     Creal(3),Cimag(4)             '
140 '      "CROSSfl4D"                  '
160 '     cpu=pc9801                    '
170 '     device #=9(cf),0(pc)          '
180 '''''''''''''''''''''''''''''''''''
190   CLEAR  ,&H1D00 :GOSUB *BINPROG
200 ISET IFC :ISET REN            ' GPIB init
210 CF=9:PC=0                     ' device address
230 DEFINT I
240 DIM CREAL(1117),CIMAG(1117)
280   PRINT@CF;"CSP"               ' CROSS SPEC display
290  PRINT@CF;"BFD3,3 BFD3,4"      ' MS basic floating format
300    WBYTE &H20+PC,&H40+CF;
310       TIMED%=0                   '
320       SADR%=VARPTR(CREAL(0),1):OADR%=VARPTR(CREAL(0),0)
330       BYTE%=1117*4+2:DLIM%=&H80
340   '  real data read
350       CALL PROG%(TIMD%,SADR%,OADR%,BYTE%,DLIM%)
360       SADR%=VARPTR(CIMAG(0),1):OADR%=VARPTR(CIMAG(0),0)
370   '  imag data read
380       CALL PROG%(TIMD%,SADR%,OADR%,BYTE%,DLIM%)
390  AMPF=1                        ' amp factor
440 *GR     ' graph !!
450   SCREEN 0,0:CLS 2
460   VIEW(150,30)-(600,180),,7
470   ''  spectrum
480   'INPUT "Ymin,Ymax ";YMIN,YMAX
490    PRINT@CF;"LYA1":INPUT@CF;YMAX
500    PRINT@CF;"LYA2":INPUT@CF;YMIN
510   WINDOW(0,-YMAX)-(4,-YMIN)
520   PMAX=-1E+38
530    POINT (0,-YMIN)
540     FOR I= 0 TO 1116
550         A= SQR(CREAL(I)*CREAL(I)+CIMAG(I)*CIMAG(I))
560         A= AMPF*A
570         IF A=0 THEN P1=-300 ELSE P1=10*LOG(A)/LOG(10)
580         IF PMAX<P1 THEN PMAX=P1
585         GOSUB *XPOINT
590         LINE-(J,-P1),4
600     NEXT
610   PRINT "MAX DATA =";PMAX;"dBV"
620   PRINT A$
650 END
```

```
10000 '''''''''''''''''''''''''''''''''''''
10010 '  binary data fast receive prog     '
10020 '  call prog%(a%,b%,c%,d%,e%)        '
10030 '   a% = 1(TIME data),0(others)      '
10040 '   b% = segment of array            '
10050 '   c% = offset  of array            '
10060 '   d% = receive byte number         '
10070 '   e% = delimiter eoi (=&h80)       '
10080 '''''''''''''''''''''''''''''''''''''
10090  *BINPROG
10100 DATA 50,53,51,52,56,57,06,C4,77,10,26,8B,04,50
10110 DATA C4,77,0C,26,8B,04,50,C4,77,08,26,8B,3C
10120 DATA C4,77,04,26,8B,0C,C4,37,26,8B,04,07,06,57,BB,00,00
10130 DATA BE,00,00,B4,05,CD,D1
10140 DATA 5B,07,59,23,C9,74,10,8B,CA,D1,E9
10150 DATA 26,8B,07,86,E0,26,89,07,43,43,E2,F4
10160 DATA 07,5F,5E,5A,59,5B,58,CF
10170 DEF SEG=&H1D00 : PROG%=0
10180  FOR I=PROG% TO &H51
10190   READ A$:POKE I,VAL("&H"+A$)
10200  NEXT
10210  RETURN
20000 '
20010  *XPOINT
20020    J=I-1
20030    IF J>396 THEN *XP2
20040       J=J+4
20050       J=LOG(J/400)/LOG(10)+2
20060       GOTO *XPEND
20070  *XP2
20080    IF J>396+360 THEN *XP4
20090       J=J-396+40
20100       J=LOG(J/400)/LOG(10)+3
20110       GOTO *XPEND
20120  *XP4
20130       J=J-396-360+40
20140       J=LOG(J/400)/LOG(10)+4
20150  *XPEND: RETURN
```

Note

The &H1D00 of lines 190 and 10170 should be changed to agree with the memory capacity of the personal computer being used.

```
10 ''''''''''''''''''''''''''''''''''''''
20 '  MS BASIC floating data transfer   '
30 '   for transfer function(400lines)  '
40 '     Xreal(7),Ximag(8)              '
50 '     "XFERfl"                       '
60 '     cpu=pc9801                     '
70 '     device #=9(cf),0(pc)           '
80 ''''''''''''''''''''''''''''''''''''''
90 '
100 ISET IFC:ISET REN          ' GPIB init
110 CF=9:PC=0                  ' device address
120 OPTION BASE 1
130 M=401
140 DEFINT I
150 DIM XREAL(M),XIMAG(M),AMP(15)
160  FOR I=1 TO 15:READ AMP(I):NEXT
170  INPUT "servo(1/0) ";SERVO
180  PRINT@CF;"BFD3,7 BFD3,8"  ' MS BASIC floating format
190                            ' xfer real(7),xfer imag(8)
200  WBYTE &H20+PC,&H40+CF;    ' pc=listen,cf=talk
210  ' read XFER real
220    FOR I= 1 TO M
230       RBYTE;I1,I2,I3,I4
240       XREAL(I)=CVS(CHR$(I1)+CHR$(I2)+CHR$(I3)+CHR$(I4))
250    NEXT
260    RBYTE;I1,I2             ' dummty(cr,lf) read
270  ' read XFER imag
280    FOR I= 1 TO M
290       RBYTE;I1,I2,I3,I4
300       XIMAG(I)=CVS(CHR$(I1)+CHR$(I2)+CHR$(I3)+CHR$(I4))
310    NEXT
320    RBYTE;I1,I2             ' dummty(cr,lf) read
330  AMPF=1                    ' amp factor
340  IF SERVO=1 THEN *GR
350     PRINT@CF;"AAR":INPUT@CF;VA
360     PRINT@CF;"BAR":INPUT@CF;VB
370     AMPF=AMP(VB)/AMP(VA)
375     AMPF=AMPF*AMPF
380  ''' graph ''''
390 *GR
400  SCREEN 0,0:CLS 2
410  VIEW(150,30)-(600,180),,7
420  INPUT "Ymin,Ymax ";YMIN,YMAX
430  WINDOW(1,-YMAX)-(M,-YMIN)
440   A=AMPF*(XREAL(1)*XREAL(1)+XIMAG(1)*XIMAG(1))
450   IF A=0 THEN PMAX=-1E+38 ELSE PMAX=10*LOG(A)/LOG(10)
460   POINT(1,-PMAX)
470   FOR I= 1 TO M
480       A=AMPF*(XREAL(I)*XREAL(I)+XIMAG(I)*XIMAG(I))
490       IF A=0 THEN P=YMIN ELSE P=10*LOG(A)/LOG(10)
500       IF PMAX<P THEN PMAX =P
510       LINE-(I,-P)
520   NEXT
530   PRINT "max value =";PMAX;"dB"
540  DATA 50,20,10,5,2,1,.5,.2,.1
550  DATA .05,.02,.01,.005,.002,.001
560 END
```

```
10 ''''''''''''''''''''''''''''''''''''''
20 '  MS BASIC floating data transfer   '
30 '   for transfer function(4decades)  '
40 '     Xreal(7),Ximag(8)              '
50 '     "XFERfl4D"                     '
60 '     cpu=pc9801                     '
70 '     device #=9(cf),0(pc)           '
80 ''''''''''''''''''''''''''''''''''''''
90 '
100 ISET IFC:ISET REN             ' GPIB init
110 CF=9:PC=0                     ' device address
120 OPTION BASE 1
140 DEFINT I
150 DIM XREAL(1117),XIMAG(1117),AMP(15)
160  FOR I=1 TO 15:READ AMP(I):NEXT
180  PRINT@CF;"BFD3,7 BFD3,8"    ' MS BASIC floating format
190                               ' xfer real(7),xfer imag(8)
200  WBYTE &H20+PC,&H40+CF;       ' pc=listen,cf=talk
210  ' read XFER real
220    FOR I= 1 TO 1117
230       RBYTE;I1,I2,I3,I4
240       XREAL(I)=CVS(CHR$(I1)+CHR$(I2)+CHR$(I3)+CHR$(I4))
250    NEXT
260    RBYTE;I1,I2                ' dummty(cr,lf) read
270  ' read XFER imag
280    FOR I= 1 TO 1117
290       RBYTE;I1,I2,I3,I4
300       XIMAG(I)=CVS(CHR$(I1)+CHR$(I2)+CHR$(I3)+CHR$(I4))
310    NEXT
320    RBYTE;I1,I2                ' dummty(cr,lf) read
380  ''' graph ''''
390 *GR
400  SCREEN 0,0:CLS 2
410  VIEW(150,30)-(600,180),,7
420  INPUT "Ymin,Ymax ";YMIN,YMAX
430  WINDOW(0,-YMAX)-(4,-YMIN)
440   A=XREAL(1)*XREAL(1)+XIMAG(1)*XIMAG(1)
450   IF A=0 THEN PMAX=-1E+38 ELSE PMAX=10*LOG(A)/LOG(10)
460   POINT(0,-PMAX)
470   FOR I= 1 TO 1117
480       A=XREAL(I)*XREAL(I)+XIMAG(I)*XIMAG(I)
490       IF A=0 THEN P=YMIN ELSE P=10*LOG(A)/LOG(10)
500       IF PMAX<P THEN PMAX =P
505       GOSUB *XPOINT
510       LINE-(J,-P)
520   NEXT
530   PRINT "max value =";PMAX;"dB"
540  DATA 50,20,10,5,2,1,.5,.2,.1
550  DATA .05,.02,.01,.005,.002,.001
560 END
20000 '
20010  *XPOINT
20020    J=I-1
20030    IF J>396 THEN *XP2
20040       J=J+4
20050       J=LOG(J/400)/LOG(10)+2
20060       GOTO *XPEND
20070  *XP2
20080    IF J>396+360 THEN *XP4
20090       J=J-396+40
20100       J=LOG(J/400)/LOG(10)+3
20110       GOTO *XPEND
20120  *XP4
20130       J=J-396-360+40
20140       J=LOG(J/400)/LOG(10)+4
20150  *XPEND: RETURN
```

```
10 ''''''''''''''''''''''''''''''''''''''
20 ' MS BASIC floating data transfer     '
30 '  for HISTOGRAM [chA(5),chB(6)]      '
40 '   "HISTfl"                          '
50 '   cpu=pc9801                        '
60 '   deviice #=9(cf),0(pc)             '
70 ''''''''''''''''''''''''''''''''''''''
80  ISET IFC:ISET REN         ' GPIB init
90  CF=9:PC=0                 ' device address
100 OPTION BASE 1
110 DIM HIST(256)
120 INPUT "chA/chB(5/6) ,sum# ";KIND,SUM
130  PRINT@CF;"BFD3,"+STR$(KIND)   ' MS BASIC floating format
140    WBYTE &H20+PC,&H40+CF;      ' pc=listen,cf=talk
150    FOR I=1 TO 256
160        RBYTE;X1,X2,X3,X4
170        HIST(I)=CVS(CHR$(X1)+CHR$(X2)+CHR$(X3)+CHR$(X4))
180    NEXT
190    RBYTE;X1,X2            ' dummy (cr,lf) read
200  ''''  garph '''''''''
210  YMAX=0
220  VIEW(200,20)-(600,180),,7
230  INPUT "gain ";GAIN
240  WINDOW(1,-1/GAIN)-(256,0)
245  POINT (1,-HIST(1)/1024/SUM)
250  FOR I=1 TO 256
260     A=HIST(I)/1024/SUM
270     IF YMAX <A THEN YMAX=A
280     LINE-(I,-A),4
290  NEXT
300  PRINT YMAX
310 END
```

```
10 ''''''''''''''''''''''''''''''''''''''
20 '  GPIB digital in & USER WINDOW SET '
30 '   HAMMING WINDOW                   '
40 '   cpu= pc9801                      '
50 '   device #=9(cf),0(pc)             '
60 ''''''''''''''''''''''''''''''''''''''
70  ISET IFC:ISET REN          ' GPIB init
80  CF=9 :PC=0                 ' device address
90  OPTION BASE 1
100 DEFINT T,I
110 DIM TBUFF(2048)            ' time buffer 2k
120 ' WINDOW DATA GENERATE '
130   FOR I= 1 TO 2048
140   TBUFF(I)=32767*(.54-.46*COS(2*3.1415*I/2048))
150   NEXT I
160 '
170  PRINT@CF;"CST"            ' CF START
180  PRINT@CF;"ATI"            ' A ch TIME DISPLAY
190  PRINT@CF;"FLS1"           ' DATA LENGTH 2K MODE
200  PRINT@CF;"CPS"            ' CF PAUSE
210  PRINT@CF;"CDO"            ' DIGITAL IN MODE ON
220  PRINT@CF;"CST"            ' CF START
230  *LOOP:PRINT@CF;"FMC"      ' FFT mem busy check
240        INPUT@CF;A
250        IF A=0 THEN *LOOP
260   PRINT@CF;"FMW"         ' write to FFT mem
270    FOR I=1 TO 2048
280    A$=MKI$(TBUFF(I)):WBYTE;ASC(MID$(A$,2)),ASC(LEFT$(A$,1))
290    NEXT
300  PRINT@CF;"CPS"            ' CF PAUSE
310  PRINT@CF;"CDF"            ' DIGITAL IN MODE OFF
320  PRINT@CF;"WSL3"           ' USER WINDOW SET SELECT
330  PRINT@CF;"WST"            ' SET
340 END
```

13.7 Commands Classified by Function

Input Amplifier

Command	Description	Type	Remarks
AAC	AC couples Ch A	1	Same as switch
BAC	AC couples Ch B	1	Same as switch
ADC	DC couples Ch A	1	Same as switch
BDC	DC couples Ch B	1	Same as switch
TON	Turns TEST signal on	1	
TOF	Turns TEST signal off	1	
TMP@	Inverts input polarity 1 (inverts Ch A), 2 (Ch A normal) 3 (inverts Ch B), 4 (Ch B normal)	2	
AAS@	Specifies Ch A input sensitivity 1 (50 V), 2 (20 V), 3 (10 V), 4 (5 V), 5 (2 V), 6 (1 V), 7 (.5 V), 8 (.2 V), 9 (.1 V), 10 (50 mV), 11 (20 mV), 12 (10 mV), 13 (5 mV), 14 (2 mV), 15 (1 mV)	2	
BAS@	Specifies Ch B input sensitivity Same as AAS@	2	
AAR	Reads the Ch A sensitivity Same as AAS@	3	
BAR	Reads the Ch B sensitivity Same as AAS@	3	
AUO	Sets the input sensitivity to autorange	1	Only available during start
AUF	Disables autorange	1	
ARA	Selects Ch A autoranging. 1 (on), 2 (off)	2	
ARB	Selects Ch B autoranging. 1 (on), 2 (off)	2	
FON	Turns antialiasing on.	1	
FOF	Turns antialiasing off.	1	
ICC	Reads input coupling state setting. 0 (Ch A: DC, Ch B: DC) 1 (Ch A: AC, Ch B: DC) 2 (Ch A: DC, Ch B: AC) 3 (Ch A: AC, Ch B: AC)	3	

Trigger Function

Command	Description	Type	Remarks
TFR	Disables trigger function. (Free)	1	Same as switch
TRE	Sets trigger to repeat.	1	Same as switch
TSI	Sets trigger to single.	1	Same as switch
TIA	Sets Ch A as trigger source.	1	
TIB	Sets Ch B as trigger source.	1	
TEX	Sets external trigger source.	1	
TPP	Sets trigger slope to +.	1	
TPM	Sets trigger slope to –.	1	
TLS@	Specifies the trigger level. (Parameters in range ±122)	2	
TPS@	Specifies trigger position. @ = 0 to ± 6.5536	2	
TLC	Reads out trigger level. Same as TLS@	3	
TPC	Reads out trigger position. Same as TPS	3	
TOS	Enables the trigger one-shot function.	2	

A/D Converter

Command	Description	Type	Remarks
SCI	Activates the internal sampling clock.	1	
SCE	Activates the external sampling clock.	1	
FRS@	Sets the frequency range. 1(1 Hz), 2 (2 Hz), 3 (5 Hz), 4 (10 Hz), 5 (20 Hz), 6 (50Hz), 7 (100Hz), 8 (200Hz), 9 (500 Hz), 10 (1 kHz), 11 (2 kHz), 12 (5 kHz), 13 (10 kHz), 14 (20 kHz), 15 (40 kHz)	2	
FRC	Reads out the freqency range. Same as FRS	3	
ACD	Activates A/D overflow cancel function.	1	
ACF	Deactivates A/D overflow cancel function.	1	

Analysis Conditions

Command	Description	Type	Remarks
WIS@	Specifies window type. 1 (Rectangular), 2 (Hanning) 3 (Flat), 4 (User), 5 (F-F), 6 (E-E), 7 (F-E)	2	
WIC	Reads out type of the specified window.	3	
ASM@	Specifies analog, block memory, or disk. 1 (analog), Z (block memory), 3 (disk)	2	
ASS@	Specifies single analysis or dual analysis. 1 (dual), 2 (single)	2	
ASC@	Specifies continuous analysis or single analysis. 1 (continuous), Z (single)	2	
FLS@	Specifies analysis frame length. 1 (Ch A 2 K), 2 (Ch B 2 K) 3 (Dual 1 K)	2	Only available in start condition
FLC	Reads out analysis frame length. Same as FLS@	3	
OVS@	Specifies amount of data capture overlap. 1 (max.), 2 (50%), 3 (0%)	2	
CFL	Reads out currently set frame length.		
LFL	Reads out lower screen frame length.		
POM@	Specifies power spectrum only mode. 1 (on), 2 (off)	2	

Analysis Conditions (Continued)

Command	Description	Type	Remarks
IMS@	Specifies the vibration mode 1 (on), 2 (off)	2	
CDS@	Specifies extent of delay between channels A and B. 1 to 65,535	2	
CDL@	Delay between channels on/off switch. 1 (delay on), 2 (off)	2	
DCO	Activates DC cancel function.	1	
DCF	Disables DC cancel function.	1	
EWF	Reads index window coefficient (%). 0 means 0.1%.	3	
EWS@	Reads index window coefficient (%). (E.g., "EWS1234/−3" = .1234 × 10^1)	2	
FWF@	Reads out the force window setting point. 1 (START point), 2 (STOP point)	3	
WSL@	Specifies which window, FORCE, EXP, or USER, is to be set. 1 (FORCE), 2 (EXP), 3 (USER).	2	
WST	Window setting.	1	Same as switch
CDO	Sets the digital-in mode. Set before FMC and FMW.	1	Only available in PAUSE condition
CDF	Exits the digital-in mode.	1	Only available in PAUSE condition
UFL	Reads out the upper screen frame length.	3	
SRV@	Specifies servo analysis mode. 1 (400 lines), 2 (4 decades), 3 (off)	2	

Averaging

Command	Description	Type	Remarks
AMS@	Specifies the averaging mode. 1 (spectrum linear average), 2 (spectrum exponential average), 3 (spectrum peak), 4 (spectrum sweep), 5 (spectrum subtraction), 6 (time linear average), 7 (itme exponential average), 8 (time absolute value average), 9 (histogram linear average) 10 (Fourier spectrum linear average) 11 (Fourier spectrum exponential average)	2	
AMC	Reads out the averaging mode. Same as AMS@	3	
ANS@	Specifies number of averages. 1 (2), 2 (4), 3 (8), 4 (16), 5 (32), 6 (64), 7 (128), 8 (256), 9 (512), 10 (1024), 11 (2048), 12 (4096), 13 (8192), 14 (0)	2	
ANC	Reads out the number of averages. 0 (1), 1 (2), 2 (4), 3 (8), 4 (16), 5 (32), 6 (64), 7 (128), 8 (256), 9 (512), 10 (1024), 11 (2048), 12 (4096), 13 (8192)	3	
AVC	Sets averaging to the continue mode.	1	
AVO	Sets the averaging mode.	1	Same as switch
AVF	Sets the instant mode.	1	Same as switch
RAC	Reads out the number of averages completed up to now.	3	
AMX@	Overall average maximum. 1 (on), 2 (off)	2	
AND@	Sets the number of averages as a value. 1 to 32,767	2	

Zoom Function

Command	Description	Type	Remarks
ZCS	Specifies center frequency.	1	Same as switch
ZCC	Reads out center frequency.	3	
ZEU	Increases the magnification.	1	Same as switch
ZED	Decreases the magnification.	1	Same as switch
ZON	Turns real-time zoom on.	1	Same as switch
ZOF	Turns real-time zoom off.	1	Same as switch
ZEC	Reads out magnification. 1 (×2), 2 (×4), 3 (×8), 4 (×16), 5 (×32), 6 (×64)	3	

Mass Memory

Command	Description	Type	Remarks
CMM@	Specifies CRT block memory storage mode. 1 (manual), 2 (auto)	2	
CBC	Clears CRT block memory. 1 to 540	2	
CMC	Clears the entire CRT block memory.	1	
CPO	Sets the CRT block memory write-protect mode.	1	
CPF	Releases the CRT block memory write-protect mode.	1	
CLP@	During CRT block memory recall, copies the label to the current label memory. 1 (on), 2 (off)	2	

Mass Memory (Continued)

Command	Description	Type	Remarks
CLT@	Adds the current time to the CRT block memory label. 1 (on), 2 (off)	2	
CLD@	Adds the current date to the CRT block memory label. 1 (on), 2 (off)	2	
CLL@	Determines whether the display condition (YLOG, XLOG, etc.) will also be recalled when the CRT block memory is played back. 1 (on), 2 (off)	2	
MBS@	Specifies the CRT block memory block no. @ = 1 to 540	2	
MBC	Reads out the CRT block memory block no.	3	
MBU	Increases the CRT block memory block no.	1	Same as switch
MBD	Decreases the CRT block memory block no.	1	Same as switch
MLU	Lists block memory contents.	1	
MIS	Inserts into block memory	1	
MDL	Deletes contents of block memory.	1	
CUD@	Increases or decreases the CRT block memory block no. by 10. 1 (on), 2 (off)	2	
MST	Stores to the CRT block memory.	1	Same as switch

Mass Memory (Continued)

Command	Description	Type	Remarks
MSC	Reads out the currently set CRT block memory status. Four parameters are received in the format a bcd. a: 0 (no data), 1 (block 1 data), 2 (first half of block 2), 3 (last half of block 2) bcd: Same as LDC	3	
RON	Specifies the time record mode.	1	
ROF	Releases the time record mode	1	
RBC	Reads the time record 30-K mode block no.	3	
RBM@	Selects the 30-K record mode. 1 (on), 2(off)	2	
RBS@	Specifies the block number for the 30-K time record memory mode.	2	
RAL@	Puts the time record memory into the 768-K mode. 1 (on), 2 (off)	2	
RCS@	Specifies the timer record channel. 1 (Ch A & B), 2 (Ch A), 3 (Ch B)	2	
RMC	Clears the time record memory entirely.	1	
RRS	Sets the time record to ring mode.	1	
RSS	Sets the time record to single mode.	1	
PON	Sets the time record to playback mode.	1	
POF	Releases the time record playback mode.	1	
PAS@	Sets the playback address counter.	2	
PAC	Reads out the playback address counter.	3	

Mass Memory (Continued)

Command	Description	Type	Remarks
PBS@	Sets the Ch B delay. 1 to 8191	2	
PDC	Reads out the record memory playback Ch B delay.	3	
PCC	Clears the playback address counter	1	
PUS	Sets the playback address increase mode.	1	
PDS	Sets the playback address decrease mode.	1	
PLS@	Specifies the playback frame length. 1 (2048), 2 (1024)	2	
PGS@	Specifies the playback gap. 0 (1), 1 (2), 2 (4), 3 (8), 4 (16), 5 (32), 6 (64), 7 (128), 8 (256), 9 (512), 10 (1024), 11 (2048), 12 (4096), 13 (0)	2	
PZO	Sets the record zoom mode.	1	
PZF	Releases the record zoom mode.	1	
PZS	Executes record zoom once.	1	
PFS@	Specifies the record zoom magnification. 1 (×2), 2 (×4), 3 (×8), 4 (×16), 5 (×32), 6 (×64)	2	
FCF	Specifies record zoom center frequency.	1	
PBA@	Specifies playback entire display. 1 (on), 2 (off)	2	
CMS@	Specifies the use of the CMOS memory card. 1 (CRT block memory), 2 (RAM disk), 3 (time record memory), 4 (off)	2	
RDL	Specifies deletion from RAM disk (file deletion).	1	
RIS	Specifies insertion onto RAM disk.	1	

Mass Memory (Continued)

Command	Description	Type	Remarks
RPG	RAM disk purge (clears contents).	1	
RMX@	Switches 255-Kword memory data with the first half or second half of CMOS memory. 1 (first half), 2 (last half)	2	
RSL@	Establishes whether the beginning, middle or end of 768 Kwords of data are to be stored on to disk. 1 (beginning), 2 (middle), 3 (end)	2	

Command	Description	Type	Remarks
DFS@	Specifies the disk file no.	2	
DFC	Reads the disk file no.	3	
DLN@	Specifies type of data to be loaded from the disk. 1 (CRT MAS), 2 (CRT MASS ALL) 3 (LIST UP), 4 (RECORD TIME) 5 (PANEL CONDITION), 6 (AUTO SEQUENCE), 7 (PRE 128), 8 (POST 128), 9 (BLOCK)	2	
DLS	Executes a disk load operation.	1	
DSN@	Specifies the type of the data to be stored to disk. 1 (CURRENT CRT), 2 (CURRENT CRT AUTO), 3 (CRT MASS), 4 (CRT MASS ALL), 5 (RECORD TIME), 6 (PANEL CONDITION), 7 (AUTOSEQUENCE)	2	
DPC@	Specifies the store to disk or load from disk panel condition number. @ = 1 to 4	2	
DSS	Executes a store to disk operation.	1	
DUD	Specifies the disk drive. 1 (DRIVE 0), 2 (RAM DISK)	2	
DUC	Specifies copy (disk utility)	1	
DUF	Specifies format (disk utility)	1	
DUP	Specifies purge (disk utility).	1	
DUS	Executes disk utility program.	1	
DLC@	Reads out the contents of the disk listing. (@ = 1 to 20)	3	
DSA@	Enables the mode which reads from a single side of a disk. 1 (ON), 2 (OFF)	2	

Command	Description	Type	Remarks
ACS@	Specifies the arithmetic operation. 1 (on/off), 2 (addition), 3 (subtraction), 4 (multiplication), 5 (division) Type can only be changed when this function is of.	2	
FJS@	Specifies frequency differentiation or integration. 1 (on/off), 2 ($\times j\omega$), 3 ($\times (j\omega)^2$), 4 ($1/j\omega$), 5 ($1/(j\omega)^2$)	2	
ITO	Activates time-axis diffeentiationor integration.	1	
ITF	Deactivates time-axis diffeentiationor integration.	1	
ITS@	Specifies time-axis differentiation or integration. 1 (single integration), 2 (second integration), 3 (first-order differential), 4 (second-order differential)	2	
TEO	Turns the transfer function equalise function on.	1	
TEF	Turns the transfer function equalise function off.	1	
TES	Stores the transfer functionin the equalize memory.	1	
OMS@	Specifies the octave analysis mode. 1 (off), 2 (30 bands), 5 (15 bands)	2	
O3S	Sets the 1/3 octave mode.	1	

Function (Continued)

Command	Description	Type	Remarks
O1S	Sets the 1/1 octave mode.	1	
OSP@	Sets the octave jump on and off. 1 (on), 2 (off)	2	
OAO	Turns the A characteristic filter function on.	1	
OAF	Turns the A characteristic filter function off.	1	
SDS@	Speicfies the spectrum density. 1 (off), 2 (PSD), 3 (ESD)	2	
CON	Turns the cepstrum function on.	1	
COF	Turns the cepstrum function off.	1	
CPM	Sets the cepstrum display to MAG.	1	
CPR	Sets the cepstrum display to REAL.	1	
CPL	Estimates the cepstrum lifter.	1	
CPE	Calculates the liftered spectrum (envelope).	1	
ISM@	Specifies whether time integration should be performed for Ch B only or not.. 1 (Ch B only), 2 (Ch A & Ch B)	2	
PAW@	Applies an A-characteristic filter to the narrow-band power spectrum. 1 (on), 2 (off)	2	
PEQ@	Performs equalization using the power spectrum. 1 (on), 2 (off)	2	
IFT	Executes an inverse Fourier transform.	1	
IFB@	Selects inverse Fourier transform bandlimiting. 1 (on), 2 (off)	2	
IFA@	Selects inverse Fourier transform window compensation. 1 (on), 2 (off)	2	
IFM@	Multiplies the transfer function when performing an inverse Fourier transform. 1 (on), 2 (off)	2	

Function (Continued)

Command	Description	Type	Remarks
EVP@	Selects the envelope function. 1 (on), 2 (off)	2	
EVM@	Selects envelope Mag display. 1 (on), 2 (off)	2	
EVL@	Sets Y-axis to logarithmic scaling during envelope display. 1 (on), 2 (off)	2	
EVB@	Envelope analysis bandlimiting function. 1 (on), 2 (off)	2	
EVS	Selects envelope bandlimiting.	1	Same as switch
LPA@	Performs loop analysis. 1 (on), 2 (off)	2	
LPO	Executes open-loop calculation.	1	
LPC	Executes closed-loop calculation.	1	
LPH@	Specifies the feedback element as 1 for loop analysis. 1 (on), 2 (off)	2	
LHS	Selects calculation of the loop tansfer function	1	
XNC@	Enables the Nichols plot function. 1 (on), 2(off)	2	
FIT	Executes curve fit.	1	
FSY@	Displays fitted data. 1 (on), 2 (off)	2	
FTN@	Sets the degree of the fitting.	2	
FLT@	Selects the fitting data list. 1 (on), 2 (off)	2	
FIS	Stores curve fitting data in memory.	1	Same as switch
CIM@	Calculates the impulse response from the transfer function displayed on the CRT. 1 (on), 2 (off)	2	

Signal Output

Command	Description	Type	Remarks
SSS@	Specifies signal source. 1 (sinewave), 2 (swept sine), 3 (periodic random), 4(random), 5 (impulse), 6 (pip), 7 (CRT)	2	
SFS	Specifies the sinewave frequency.	1	
SAM@@ @@	Sets the signal output amplitude units to mV. @ = 10 to 5000	2	
SPO	Turns the pink filter on.	1	
SPF	Turns the pink filter off.	1	
SBD@	Specifies the signal output frequency band. 1 (on), 2 (off)	2	
S8K@	Specifies the time record analog output 8-Kword mode. 1 (on), 2 (off)	2	
SCT	Selects repeated signal output.	1	
SSI	Outputs one frame of signal output.	1	
SFR@@	Sets the sinewave output frequency. (0.001 to 40 000 Hz), 10 digits with up to 4 decimal digits.	2	
SSA	Outputs the frequency at the same delta cursor position even when the frequency range is switched. 1 (on), 2 (off)	2	
SBT	Specifies the burst signal mode.	1	
SCY@	Sets the number of outputs for each of the burst signals. @ = 1 to 999 After this setting, the SBT command is required again.	2	
STM@	Sets the burst signal output interval. @ = 1 to 999 After this setting, the SBT command is required again.	2	

Units Function

Command	Description	Type	Remarks
XUO	Turns the X UNIT function on (sets CPM).	1	Same as switch
XUF	Turns the X UNIT function off (sets Hz).	1	Same as switch
YUO	Turns the Y UNIT function on.	1	Same as switch
YUF	Turns the Y UNIT function off.	1	Same as switch
EAN@	Sets the EU value per 1 V for Ch A. (E.g., "EAN1234/−3" (= .1234 × 10^1 EU/V))	2	
EBN@	Sets the EU value per 1 V for Ch B. (Same as EAN)	2	
EAC	Reads out the EU value (for 1 V) setting for Ch A.	3	
EBC	Reads out the EU value (for 1 V) setting for Ch B.	3	
EAS	Sets the Ch A search point value to 1 EU.	1	
EBS	Sets the Ch B search point value to 1 EU.	1	
EAD@	Sets the Ch A search point value to anydesired dB value.	2	
EBD@	Sets the Ch B search point value to anydesired dB value. Note. This must be performed using the same format as for the analyzer soft key. Note. EAS, EBS, EAD, and EBD all require that the power spectra of each channel be displayed.	2	

Unit Function (Continued)

Command	Description	Type	Remarks
EA=	Specifies the Ch A EU unit name.	2	
EB=	Specifies the Ch B EU unit name.	2	
XUM@	Specifies the X-axis unit mode (execution). 1 (CPM), 2 (ORDER), 3 (ORDER SET), 4 (LIST UP), 5 (LIST DOWN), 6 (ORDER FIT ON), 7 (ORDER FIT OFF), 8 (SEC)	2	
HMF	Cancels the harmonic display (Order) bright point.	1	
HMO	Enables the harmonic display bright point.	1	
HMS	Sets the fundamental frequency for the harmonic display	1	
YUM@	Sets the Y-axis unit to rms. 1 (on), 2 (off)	2	

Display

Command	Description	Type	Remarks
ASP	Displays the Ch A power spectrum.	1	Same as switch
BSP	Displays the Ch B power spectrum.	1	Same as switch
CSP	Displays the cross spectrum.	1	Same as switch
ATI	Displays the Ch A time waveform.	1	Same as switch
BTI	Displays the Ch B time waveform.	1	Same as switch
ACR	Displays the Ch A correlation function.	1	Same as switch
BCR	Displays the Ch B correlation function.	1	Same as switch
CCR	Displays the autocorrelation function.	1	Same as switch
AHI	Displays the Ch A histogram.	1	Same as switch
BHI	Displays the Ch B histogram.	1	Same as switch
MRC	Displays the CRT block memory.	1	Same as switch
XFR	Displays the transfer function.	1	Same as switch
COH	Displays the coherence function	1	Same as switch
COP	Displays the coherent output power.	1	Same as switch
IMP	Displays the impulse response.	1	Same as switch
MAG	Selects a magnified display.	1	Same as switch
PHS	Selects phase display.	1	Same as switch
REL	Selects real part display.	1	Same as switch
IMG	Selects imaginary display.	1	Same as switch
NYQ	Selects Nyquist (Orbit) display.	1	Same as switch

Display (Continuation)

Command	Description	Type	Remarks
LST	Selects the list display.	1	Same as switch
SEC	Selects second display (screen 2).	1	Same as switch
TDA	Selects 3-dimensional display.	1	Same as switch
YGU	Increases the Y-axis gain.	1	Same as switch
YGD	Decreases the Y-axis gain.	1	Same as switch
YLO	Selects Y-axis log.	1	Same as switch
YLI	Selects Y-axis linear.	1	Same as switch
XLO	Selects X-axis log.	1	Same as switch
XLI	Selects X-axis linear.	1	Same as switch
MGL	Enables linear search point value for log scaled Y-axis. 1 (on), 2 (off)	2	
XIS@	Calculates 1/H (transfer function inverse). 1 (on), 2 (off)	2	
BDO	Turns the transfer function board line drawing display on.	1	
BDF	Turns the transfer function board line drawing display off.	1	
DSP	Selects split mode for the 2-screen display.	1	
DOV	Selects overlay mode for the 2-screen display.	1	
GON	Turns the grid display on.	1	
GOF	Turns the grid display off.	1	

Display (Continued)

Command	Description	Type	Remarks
PVS@	Sets power spectrum (linear) display units to V^2. 1 (on), 2 (off)	2	
DIO	Activates the display inhibit function.	1	
DIF	Deactivates the display inhibit function.	1	
DIA@	Puts the entire displayint he inhibit mode. 1 (on), 2 (off)	2	
DI2@	Displays once for every two averages whle linear averaging is being performed. 1 (on), 2 (off)	2	
VWS@	Specifies the display view type. 1 (OFF), 2 (VIEW1), 3 (VIEW2), 4 (VIEW3), 5 (VIEW4), 6 (VIEW5), 7 (VIEW6), 8 (VIEW7), 9 (VIEW8).	2	
LDC	Reads out the type of the lower screen (or screen 1). Three parameters are accepted in the format ab c. ab: 1 (TA), 2 (TB), 3 (PA), 4 (PB), 5 (CRS), 6 (XFER), 7 (HA), 8 (HB), 9 (AACF), 10 (BACF), 11 (CCF), 12 (COH), 13 (COP), 14 (IMP), 15 (LIST or NYQ). c: 1 (MAG), 2 (REAL), 3 (IMAG), 4 (PHASE), 5 (NYQ), 6 (LIST).	3	
UDC	Reads out the upper screen display type. Same as LDC.	3	
LAC	Reads out the voltage range of the lower screen (or screen 1) display data. Same as AAS.	3	

Display

Command	Description	Type	Remarks
UAC	Reads out the voltage range of the upper screen display data. Same AAS.	3	
LFC	Reads out the lower screen (or single screen) display data frequency range. Same as FRS	3	
UFC	Reads out the frequency range of the upper screen display data. Same FRS.	3	
NLC	Reads out the type of the lower screen in the Nyquist (orbit) display. Same as LDC.	3	
NUC	Reads out the type of the upper screen in the Nyquist (orbit) display. Same as LDC.	3	
CBO	Turns the coherent blank function on.	1	
CBF	Turns the coherent blank function off.	1	
CBS@	Specifies the coherence blanking level. (@ = 0 to 255)	2	

Display (Continued)

Command	Description	Type	Remarks
YCL	Reads out the Y-axis gain setting. (1, lower screen)	3	
YCH	Reads out the Y-axis gain setting. (upper screen) a b 0 0 0 0: 4 parameters are accepted in this format. a: 1 (20 dB), 2 (30 dB), 3 (40 dB), 4 (50 dB), 5 (60 db), 6 (70 dB), 7(80 dB), 8 (90 dB), 9 (100 dB), 10 (120 dB), 11 (140 dB), 12 (160 dB), 13 (180 dB), 14 (200 dB). b: 1 (1/10), 2 (1/5), 2 (1/2), 4 (×1), 5 (×2), 6 (×5), 7 (×10), 8 (×20), 9 (×50), 10 (×100), 11 (×200), 12 (×500), 13 (×1000), 14 (×2000)	3	
LDA@	Reads the Ch A & B input ranges when lower screen display is cross spectrum or transfer function. 1 (Ch A), 2 (Ch B)	3	
UDA@	Reads the Ch A & B input ranges when upper screen display is cross spectrum or transfer function. 1 (Ch A), 2 (Ch B)	3	
REF@	Selects the Y-axis reference function. 1 (on), 2 (off)	2	
RLW@	Sets the single-screen or lower screen offset value.	2	
RUP@	Sets the upper screen offset value. ±640.	2	
YGL@	Selects single-screen or lower screen gain change. 1 (on), 2 (off)	2	
YGH@	Selects upper screen gain change. 1 (on), 2 (off)	2	
PHF@	Selects the phase display format type. 1 (+/−), 2 (0/+), 3 (0/−)	2	

Display (Continued)

Command	Description	Type	Remarks
PGD@	Selects group delay analysis. 1 (on), 2 (off)	2	
PDA@	Selects delay adjustment function. 1 (on), 2 (off)	2	
PDJ@	Specifies the adjustment data. (E.g., PDJ1234/-3 = .1234 × 10^1)	2	
CSN@	Displays the S/N ratio. (Coherence) 1 (on), 2 (off)	2	
NCP@	Specifies Cole-Cole plot mode. 1 (on), 2 (off)	2	
NLT@	Activates specification of Nyquist (Orbit) display range. 1 (on), 2 (off)	2	
NLS	Range setting.	1	
NTD@	Selects 3-dimensional display of Nyquist (Orbit) plot. 1 (on), 2 (off)	2	
NRT@	Specifies rotation. @ = 1 to 7	2	
NMP@	Selects the magnitude and phase vlaues of the search value in the Nyquist plot display of the transfer function. 1 (on), 2 (off)	2	
ODS@	Displays overal value. 1 (on), 2 (off)	2	
XXF	Disables X-axis expansion	1	
XXO	Enables X-axis expansion.	1	

Three-Dimensional Display

Command	Description	Type	Remarks
ADS@	Specifies the angle of 3-dimensional display. 1 (90°), 2 (approx. 75°), 3 (approx. 65°)	2	
AH1	Sets 3-dimensional display Y-axis scale to 1.	1	
AH2	Sets 3-dimensional display Y-axis scale to 2.	1	
AH3	Sets 3-dimensional display Y-axis scale to 3.	1	
ASO	Turns scrolling on.	1	
ASF	Turns scrolling off.	1	
ASU	Sets upward scrolling.	1	
ASD	Sets downward scrolling.		
AKI@	Selects the number of lines for the 3-dimensional display. 1 (20), 2 (60), 3 (90)	2	

Search Function

Command	Description	Type	Remarks
SON	Turns the search function on.	1	Same as switch
SOF	Turns the search function off.	1	Same as switch
SMD	Moves the current search marker 13 points only to the left. Or moves the horizontal cursor down.	1	Same as switch
SMU	Moves the current search marker 13 points only to the right. Or moves the horizontal cursor up.	1	Same as switch
SMR	Moves the current search marker 1 point only to the right.	1	Same as switch
SML	Moves the current search marker 1 points only to the left.	1	Same as switch
DON	Turns the delta search function on.	1	Same as switch
DOF	Turns the delta search function off.	1	Same as switch
DSY@	Performs delta search function on the Y-axis only. 1 (on), 2 (off)	2	
DCS	Sets (resets) the delta cursor.	1	Same as switch
SPS@	Places the search marker at any desired point (simultaneously for top and bottom frames).	2	Upper screen: SHU@ Lower screen: SHL@
SHL@	Specifies the lower screen search point at any desired point. Number of lines 400 lines 800 lines Time-domain data 0 to 1023 0 to 2047 Frequency-domain data 0 to 401 0 to 801 Amplitude-domain data 0 to 255 (Example) 0 ....DC @= 1 to 400 ....spectrum lines 401 ....Overall	2	
SHU@	Specifies the upper screen search point at any desired point. (same as SHL)	2	
SPC	Reads out the current search marker point. (Single frame or lower part of dual-frame display.)	3	Upper: SPU Lower: SPL

Search Function (Continuation)

Command	Description	Type	Remarks
SPL	Reads the lower screen search point.	3	
SPU	Reads the upper screen search point.	3	
SPP@	Sets the search point automatically to the peak value when search is turned on. 1 (on), 2 (off)	2	
SCO	Displays the search cursor.	1	
SCF	Turns search cursor display off.	1	
SEO	Turns the search enhance function on.	1	Same as switch
SEF	Turns the search enhance function off.	1	Same as switch
LXS	Reads out the lower screen (or single screen) X-axis search value.	3	
LYS	Reads out the lower screen (single screen) Y-axis search value.	3	
LXY	Reads out the lower screen (or single-screen) X and Y search values.	3	
UXS	Reads out the upper screen X-axis search value.	3	
UYS	Reads out the upper screen Y-axis search value.	3	
UXY	Reads out the upper screen X and Y search values.	3	
PAO	Turns the partial overall function on.	1	
PAF	Turns the partial overall function off.	1	

Search Function (Continued)

Command	Description	Type	Remarks
UPS@	Reads out the upper screen data. 1 (X), 2 (Y), 3 (X, Y)	3	
SNP@	Next peak function. 1 (on), 2 (off)	2	
STP@	Specifies time-axis search function for a single-frame display. 1 (P-P), 2 (MAX, MIN)	2	

List Function

Command	Description	Type	Remarks
SLS	Sets the search list.	1	
SLP@	Lists spectrum peaks at a maximum of 10 points. 1 (on), 2 (off)	2	
CLC	Reads out the list display type. Same as LDC.	3	
LTR	Reads out the list data. LTR ab, c (ab = 1 to 20), (c = 1 to 3)	3	
THR	Reads out all harmonic data. 1 (numerical values), 2 (%)	3	
SLN@	Specifies the address to be set with the SLS command. (@ = 1 to 20)	2	
SLO	Turns the search list setting mode on.	1	
SLF	Turns the search list setting mode off.	1	
LLU@	Arranges the peak list in the order of frequencies. 1 (on), 2 (off)	2	

PlotterFunction

Command	Description	Type	Remarks
PST	Starts the plotter.	1	Same as switch
PPS	Stops the plotter.	1	Same as switch
PPD@	Specifies the data pen. 1 (Pen 1), 2 (Pen 2), 3 (Pen 3), 4 (Pen 4), 5 (off)	2	
PPF@	Specifies the frame pen. Same as "PPD"	2	
PPC@	Specifies the character pen. Same as "PPD"	2	
PDV@	Specifies the plotter type. 1 (Plot 1), 2 (Plot 2),	2	
PFD@	Specifies plotter paper feed. 1 (feed on, feed paper before plotting). 2 (feed on, feed paper after plotting) 3 (feed off)	2	
PSS@	Specifies the plotter data source. 1 (CRT), 2 (mass memory), 3 (disk), 4 (trace), 5 (disk 3D)	2	
PSO	Plots the soft keys.	1	
PSF	Disables soft key plotting.	1	
PFM@	Specifies the plotter format 1 (A4 size), 2 (A6 size), 3 (A5 size)	2	
PSH@	Plots characters only for search function. 1 (ON), 2 (OFF)	2	

Plotter Function (continued)

Command	Description	Type	Remarks
PAN@	Specifies the number of disk data for 3-dimensional plotting. 1 (130), 2 (90), 3 (60), 4 (30)	2	
PSC@	Plotter scaling function 1 (P1-P2), 2 (Numeric), 3 (OFF)	2	
PLN@	Specifies the plotting position. 1 (position 1), 2 (position 2), 3 (position 3), 4 (position 4)	2	
GLS@	Plots solid grid lines. 1 (solid lines), 2 (broken lines)	2	
PDG@	For an overlaid display, specifies broken lines for the upper frame data. 1 (broken lines), 2 (solid lines)	2	
PAT@	Plots every other data from disk in 3 dimensions. 1 (on), 2 (off)	2	

Recorder Function

Command	Description	Type	Remarks
XYD	Plots data on X-Y recorder. 1 (on), 2 (off)	2	
XYF	Plots frame on X-Y recorder. 1 (on), 2 (off)	2	
XYP	Specifies X-Y recorder pen speed. 1 to 7	2	
XYS	Starts X-Y recorder. 1 (start), 2 (stop)	2	
XYX	Expands X-Y recorder horizontal axis. 1 (on), 2 (off)	2	

Data Transfer

Command	Description	Type	Remarks
BDR@	Reads out binary data 1 (TA), 2 (TB), 3 (FA), 4 (FB), 5 (PA), 6 (PB), 7 (CR), 8 (CI), 9 (CA), 10 (CB), 11 (CCF), 12 (IMP), 13 (HA), 14 (HB), 15 (XR), 16 (XI), 17 (COH), 18 (COP)	4	
LCI	Reads out the display impage of the lower (or single) screen as binary data. Full scale is 320.	4	
UCI	Reads out the display impage of the upper screen as binary data. Full scale is 320.	4	
CRD	Reads out binary data from CRT block memory, along with conditoins (2178 bytes).	4	
CMR	Reads out binary data from CRT block memory, along with conditoins (2130 bytes).	4	
CMW	Re-writes the data read out by the CRD command.	5	
RAR@	Reads out data from the time record memory for Ch A. RAR x, y x: Starting address y: No. of points (words)	4	
RBR@	Reads out data from the time record memory for Ch B. Format is the same as for RAR@.	4	
FMC	Checks whether it is possible to write into the FFT memory. Used before the FMW command. 1 (ready), 0 (busy)	3	
FMW	Writes time-axis data into the FFT memory in the digital input analysis mode.	5	

Data Transfer (continued)

Command	Description	Type	Remarks
RAW@	Writes data into the Ch A time record memory. @: Number of 1-Kword blocks to be written.	5	
RBW@	Writes data into the Ch B time record memory. @: Number of 1-Kword blocks to be written.	5	
RCO	Writes the data conditions for RAW and RBW commands. RCO aa, bb, ff aa: Ch A voltage range number bb: Ch B voltage range number ff: Frequency range number	2	

Command Group

Command	Description	Type	Remarks
CST	Starts data analysis.	1	Same as switch
CPS	Causes a pause in data analysis.	1	Same as switch
CCN	Executes data analysis.	1	Same as switch
CAN	Cancel mode ON/OFF and execution.	1	Same as switch
SRE	Initializes internal program variables and parameters and sets the analysis up as if the power were just switched on.	1	

Timer Function

Command	Description	Type	Remarks
TIO	Activates the time interval function.	1	
TIF	Deactivates the time interval function.	1	
TIS@	Sets the time interval. @: 1 to 9999 seconds	2	
TIC	Reads out the time interval setting value.	3	
TRS	Sets the time. TRS 00/00/00 00:00	2	
TRC	Reads out the time.	3	

Sequence Function

Command	Description	Type	Remarks
SQM@	Specifies the sequence memory. 1 (SEQ1), 2 (SEQ2)	2	
SQS	Sets and resets the sequence setting (execution) mode.	1	Same as switch
SRM@	Sets the sequence execution mode. 1 (OFF), 2 (STEP), 3 (AUTO), 4 (RING ON), 5 (RING OFF), 6 (TI CONT ON), 7 (TI CONT OFF)	2	
SRS@	Specifes the number of ring repetitions of sequence execution. (@=1 to 999)	2	
SDM	Specifies the sequence delay mark.	1	
SSB	Specifies the sequence sub mark.	1	
SSH@	Specifies the search point control function. 1 (ON), 2 (OFF), 3 (MEH), (4 SET)	2	
SSF	Deactivates the sequence setting mode.	1	
SSO	Activates the sequence setting mode.	1	
SCL@	Activates panel condition loading. 1 (ON), 2 (OFF)	2	

Other Commands

Command	Description	Type	Remarks
BON	Turns the beeper ON.	1	
BOF	Turns the beeper OFF.	1	
BSF	Turns OFF only the short beeper.	1	
PCA@	Enables autorecall of panel conditions. 1 (on), 2 (off)	2	
PCS@	Performs storage into panel condition memory. (@ = 1 to 4)	2	
PCL@	Loads conditions from panel condition memory.	2	
LAS	Sets the label mode.	1	
LBC	Reads out the displayed label.	3	
LBX@	Copies label to 2nd line. 1 (condition switch on) 2 (condition switch off) 3 (copies line 2 to line 1)	2	
SMS@	Specifies the service request mask.	2	
PAJ	Performs compensation for the phase difference between channels.	1	
DTS@	Sets the SSU data and plotter data. (Example) DTS X, Y, DDD X = 0 SSU-C 1 SSU No.1 2 SSU No. 2 3 SSU No. 3 : SS 11 PLOT Y = Which number from the top DDD = DATA	2	
DTC	Reads the SSU and PLOT data. DTC X, Y (where X and Y are the same as for DTS)	3	

Other Commands (continued)

Command	Description	Type	Remarks
SSU@	Enables use of signal source unit. 1 (on), 2 (off)	2	
SVC	Clears 4-decade memory.	1	
AMI@	Sets SG-450 output to minimum after completion of servo analysis. 1 (ON), 2 (OFF)	2	
AOS@	Specifies search point analog output function. 1 (ON), 2 (OFF)	2	

ASCII Code Data Transfer

Command	Description	Type	Remarks
LDD@	Reads the lower (or single) screen data as ASCII code.	3	
UDD@	Reads the upper screen data as ASCII code. For the LDD and UDD commands: LDDA, B, C A 1 (X-axis value), 2 (Y-axis value), 3 (X, Y) B Starting point for transfer C Ending point for transfer (Example) LDD2, 0, 400 would cause transfer of 401 points of Y-axis values (from point 0 to point 400). For octave analysis, the next band is selected automatically. Up to 31 pooints can be transferred.	3	LDD2, 11, 401 would transfer 30 points plus the overall value (31st point).

13.8 Alphabetical Command Listing

AAC	chA AC	〔1〕
AAR	chA Amplitude Range call 1(50V),2(20V),3(10V),4(5V),5(2V),6(1V) 7(.5V),8(.2V),9(.1V),10(50mV),11(20mV) 12(10mV),13(5mV),14(2mV),15(1mV)	〔3〕
AAS@@	chA Amplitude range Set same as AAR	〔2〕
ACF	A/D converter overflow Cancel oFf	〔1〕
ACO	A/D converter overflow Cancel On	〔1〕
ACR	chA CoRrelation Display	〔1〕
ACS@	Arithmetic Calculation Set 1(ON/OFF),2(+),3(−),4(×),5(/)	〔2〕
ADC	chA DC	〔1〕
ADS@	Array Degree Set (@=1,2,3)	〔2〕
AH1	Array Height 1	〔1〕
AH2	Array Height 2	〔1〕
AH3	Array Height 3	〔1〕
AHI	chA HIstogram display	〔1〕
AKI@	Array KInd 1(20),2(60),3(90)	〔2〕
AMC	Average Mode Call 1(SP,SUM)2(SP,EXP),3(SP,PEAK),4(SP,SWEEP) 5(SP,DIFF),6(TI,SUM),7(TI,EXP)8(TI,ABS) 9(HI,SUM),10(F,SP SUM),11(F, SP EXP)	〔3〕
AMI@	Amp MInimum	〔2〕
AMS@	Average Mode Set same as AMC	〔2〕
AMX@	Average MaX-ovall 1(ON),2(OFF)	〔2〕
ANC	Average Number Call 0(1),1(2),2(4),3(8),4(16),5(32),6(64),7(128) 8(256),9(512),10(1024),11(2048),12(4096),13(8192)	〔3〕
AND	Average Number Direct set 1～32767	〔2〕
ANS@@	Average Number Set 1(2),2(4),3(8),4(16),5(32),6(64),7(128),8(256) 9(512),10(1024),11(2048),12(4096),13(8192),14(1)	〔2〕
AOS@	Analog Out Search point 1(ON),2(OFF)	〔2〕

ARA@	Auto Range chA 1(ON),2(OFF) only servo mode	〔2〕
ARB@	Auto Range chB 1(ON),2(OFF) only servo mode	〔2〕
ASC@	Analysis Source Continue 1(ON),2(OFF)	〔2〕
ASD	Array Scroll Down	〔1〕
ASF	Array Scroll oFf	〔1〕
ASM@	Analysis Source Mode set 1(analog),2(crt block mem),3(disk)	〔2〕
ASO	Array Scroll On	〔1〕
ASP	chA SPect display	〔1〕
ASS@	Analysis Source Single 1(DUAL),2(SINGLE)	〔2〕
ASU	Array Scroll Up	〔1〕
ATI	chA TIme display	〔1〕
AUF	AUto range oFf	〔1〕
AUO	AUto range On	〔1〕
AVC	AVerage Continue mode	〔1〕
AVF	AVerage oFf	〔1〕
AVO	AVerage On	〔1〕
BAC	chB AC	〔1〕
BAR	chB Amplitude Range call same as AAR	〔3〕
BAS@@	chB Amplitude range Set same as AAR	〔2〕
BCR	chB CoRrelation display	〔1〕
BDC	chB DC	〔1〕
BDF	xfer function BoDe display oFf	〔1〕
BDO	xfer function BoDe display On	〔1〕
BDR@	Binary Data read 1(TA),2(TB),3(FA),4(FB),5(PA),6(PB),7(CR),8(CI) 9(CA),10(CB),11(CCF),12(IMP),13(HA),14(HB) 15(XR),16(XI),17(COH),18(COP)	〔4〕
BFD	Binary data Floating Data read	〔4〕

BHI	chB HIstogram display	〔1〕
BOF	Buzzer OFf	〔1〕
BON	Buzzer ON	〔1〕
BSF	Buzzer Short oFf	〔1〕
BSP	chB SPect display	〔1〕
BTI	chB TIme display	〔1〕
CAN	CANcel mode on/off or execute	〔1〕
CBC@	Clear crt memory BloCk	〔2〕
CBF	Cohernce Blank oFf	〔1〕
CBO	Cohernce Blank On	〔1〕
CBS@@@	Cohernce Blank Set @@@=1--->255	〔2〕
CCN	Command of ContiNue(not PAUSE)	〔1〕
CCR	Cross CoRrelation display	〔1〕
CDF	Command of Digital in oFf	〔1〕
CDL@	Channel DeLay on/off 1(ON),2(OFF)	〔2〕
CDO	Command of Digital in On	〔1〕
CDS@@@@@	inter Channel (a-b) Delay Set @@@@@= 1～65535	〔2〕
CFL	Current Flame Length call 1(2k),2(1k)	〔3〕
CIM@	Crt IMpulse response 1(ON),2(OFF)	〔2〕
CLC	Crt List kind # Call	〔3〕
CLD@	Crt block memory Label Date addition 1(ON),2(OFF)	〔2〕
CLL@	Crt bLock memory Load condition 1(ON),2(OFF)	〔2〕
CLP@	Crt block memory Label coPy to current label 1(ON),2(OFF)	〔2〕
CLT@	Crt block memory Label Timer addition 1(ON),2(OFF)	〔2〕
CMC	Crt Memory all Clear (execute)	〔1〕

CMM@	Crt Memory store Mode set 1(manual),2(auto),3(external)	〔2〕
CMR	Crt Memory data Read	〔4〕
CMS@	CMos Select 1(CRT BLOCK MEM),2(DISK),3(RECORD MEM),4(OFF)	〔2〕
CMW	Crt Memory data Write	〔5〕
COC	analysis COndition Call same soft key data	〔3〕
COF	Cepstrum OFf	〔1〕
COH	COHernce function display	〔1〕
COP	Cohernce Output Power spectrum display	〔1〕
CON	Cepstrum ON	〔1〕
CPE	CePstrum Envelope execute	〔1〕
CPF	Crt memory Protect oFf	〔1〕
CPL	CePstrum Lifter set	〔1〕
CMP	CePstrum Mag display	〔1〕
CPO	Crt memory Protect On	〔1〕
CPR	CePstrum Real display	〔1〕
CPS	Command of PauSe	〔1〕
CRD	CRt memory read with Display condition	〔4〕
CSN@	Cohernce to S/N disp 1(ON),2(OFF)	〔2〕
CSP	Cross SPect display	〔1〕
CST	Command of STart	〔1〕
CSV	Convert SerVo	〔1〕
CUD@	Crt block mem Up or Down step 10 block 1(ON),2(OFF)	〔2〕
DCF	Dc Cancel oFf	〔1〕
DCO	Dc Cancel On	〔1〕
DCS	Delta Cursor Set	〔1〕
DCS	Delta Cursor Set	〔1〕
DFC	Disk File # Call	〔3〕
DFS@@@	Disk File # Set (@@@=1--->300)	〔2〕

DI2@	Display Inhibit 1/2 at linear summation @=1(ON),2(OFF)	〔2〕
DIA@	Display Inhibit All function	〔2〕
DIF	Display Inhibit oFf	〔1〕
DIO	Display Inhibit On	〔1〕
DLC@	Disk List up Call @ = 1～20	〔3〕
DLN@	Disk Load kind Number set 1(CRT MASS),2(CRT MASS ALL),3(CATALOG LISTUP) 4(RECORD TIME),5(PANEL CONDITION),6(AUTO SEQUENCE)	〔2〕
DLS	Disk Load Start (execute)	〔1〕
DOF	Delta serch OFf	〔1〕
DON	Delta serch ON	〔1〕
DOV	Display format OVerlay	〔1〕
DPC@	Disk <-> Panel Condition no.set 1--> 4	〔2〕
DSA@	Disk Single side Access 1(ON),2(OFF)	〔2〕
DSN@	Disk Store kind Number set 1(CURRENT CRT),2(CURRENT CRT AUTO) 3(CRT MASS),4(CRT MASS ALL),5(RECORD TIME) 6(PANEL CONDITION),7(AUTO SEQUENCE)	〔2〕
DSP	Display format SPrit	〔1〕
DSS	Disk Store Start	〔1〕
DSY@	Delta Serch Y ax value only 1(ON),2(OFF)	〔2〕
DTC@,@	DaTa setup Call @ = what kind setup @ = what No. from TOP	(3〕
DTS@,@,@	DaTa Set to setup @ = what kind setup @ = what No. from TOP @ = DATA	〔2〕
DUC	Disk Utility Copy set	〔1〕
DUD@	Disk Utility Drive set 1(DRIVE 0),2(RAM DISK)	〔2〕
DUF	Disk Utility Format set	〔1〕
DUP	Disk Utility Purge	〔1〕
DUS	Disk Utility (PURGE OR COPY OR FORMAT) Start	〔1〕

EAC	Eu chA data value Call	〔3〕
EAD + @@@,@	Eu chA Db/s.p set + represents + or −	〔2〕
EAN@@@@/±@	Eu chA Numeric value set(lv=)	〔2〕
EAS	Eu chA Search reference set(execute)	〔1〕
EA=	Eu(chA) unit name set	〔2〕
EBC	Eu chB data value Call	〔3〕
EBD + @@@,@	Eu chB Db/s.p set + represents + or −	〔2〕
EBN@@@@/±@	Eu chB Numeric value set(lv=)	〔2〕
EBS	Eu chB Serch reference set(execute)	〔1〕
EB=	Eu(chB) unit name set	〔2〕
ERN	ERror Number	〔3〕
EVB@	EnVelope Band on/off 1(ON),2(OFF)	〔2〕
EVL@	EnVelope display Y Log 1(ON),2(OFF)	〔2〕
EVM@	EnVelope Mag 1(ON),2(OFF)	〔2〕
EVP@	EnVeloPe on/off 1(ON),2(OFF)	〔2〕
EVS	EnVelope band Set	〔1〕
EWF	Exponetial Window Factor read	〔3〕
EWS@@@@/±@	Exponential Window data Set (%)	〔2〕
FIS	FItting data Store to memory	〔1〕
FIT	curve FIT on	〔1〕
FJS@	Freqency Jw Set 1(OFF),2(×jw),3(×$(jw)^2$),4(1/jw),5(1/$(jw)^2$)	〔2〕
FLS@	Frame Length Set 1(chA 2K),2(chB 2K),3(dual 1K)	〔2〕
FLT@	curve Fit LisT on 1(ON),2(OFF)	〔2〕
FMC	Fft Memory busy Check 1=ready, 0=busy	〔3〕
FMW	Fft Memory data Write	〔5〕

FOF	anti-aliasing Filter OFf	〔1〕
FON	anti-aliasing Filter ON	〔1〕
FRC	Frequency Range Call 1(1Hz),2(2Hz),3(5Hz),4(10Hz),5(20Hz),6(50Hz) 7(100Hz),8(200Hz),9(500Hz),10(1kHz),11(2kHz) 12(5kHz),13(10kHz),14(20kHz),15(40kHz)	〔3〕
FRS@@@	Frequency Range Set same as FRC	〔2〕
FSY@	Fitting SYnthesis display 1(ON),2(OFF)	〔2〕
FTN@	FiTting Number set 0=1-->20	〔2〕
GLS@	Grid Line Set 1(ON),2(OFF)	〔2〕
GOF	display format Grid OFf	〔1〕
GON	display format Grid ON	〔1〕
HMF	HarMonics oFf	〔1〕
HMO	HarMonics On	〔1〕
HMS	HarMonics Set	〔1〕
ICC	Input Coupling Call #0 ch A, #1 ch B = if "1"AC coupl	〔3〕
IFA@	Inverse Fft window Adjust 1(ON),2(OFF)	〔2〕
IFB@	Inverse Fft Band set 1(ON),2(OFF)	〔2〕
IFM@	Inverse fft xFer Mult 1(ON),2(OFF)	〔2〕
IFT	Inverse FfT	〔1〕
IMG	display IMaG set	〔1〕
IMP	IMPulse response display	〔1〕
IMS@	hI precision Mode set 1(ON),2(OFF)	〔2〕
ISM@	time Integral Single display Mode 1(single),2(dual)	〔2〕
IST	Ifft STore f.spect	〔1〕

ITF	Integral & difference of Time oFf	〔1〕
ITO	Integral & difference of Time ON	〔1〕
ITS@	Integral & difference of Time Set 1(Integ single),2(Inted double) 3(diff single),4(diff double)	〔2〕
LAC	Lower crt display Amplitude range Call same as AAR	〔3〕
LAS	LAbel write mode Set	〔1〕
LBC	setted LaBel Call	〔3〕
LBX@	LaBel eXchange 1 CONDITION ON 2 CONDITION OFF 3 LABEL XCHG	〔2〕
LCI	Lower Crt display data of bit Image read	〔4〕
LCR	List CleaR	〔1〕
LDA	Lower crt Display Amplitude range call same as AAR	〔3〕

LDC	Lower crt Display kind # Call
	answer=abc ab=:1(TA),2(TB),3(PA),4(PB),5(CRS)
	6(XFER),7(HA),8(HB),9(AACF)
	10(BACF),11(CCF),12(COH),13(COP)
	14(IMP),15(LIST or NYQ)
	c:=1(MAG)2(REAL),3(IMAG),4(PHASE)
	5(NYQ),6(LIST)
		〔3〕

LDD@,@@@,@@@	Lower Display Data read @ = 1(X value),2(Y value),3(X,Y value) @ = START POINT @ = STOP POINT	〔3〕
LFC	Lower crt display Frequency range Call same as FRC	〔3〕
LFL	Lower display Flame Length call 1(2k),2(1k)	〔3〕
LHS	Loop analysis 〔H〕 Set	〔1〕
LLU@	List LineUp in order frequency or mag 1(frq),2(Mag)	〔2〕
LPA@	LooP Analysis on/off 1(ON),2(OFF)	〔2〕
LPC	LooP analysis -> Closed loop	〔1〕
LPH@	LooP analysis 〔H〕 = 1set 1(H=1),2(H)	〔2〕
LPO	LooP analysis -> Open loop	〔1〕

LST	display LiST set	〔1〕
LTRab,c	LisT data Read ab:=1--->20, c:1--3	〔3〕
LXA	Lower display X Axis	〔3〕
LXS	Lower crt display X Search data call	〔3〕
LXY	Lower crt display X & Y search data call	〔3〕
LYA	Lower display Y Axis	〔3〕
LYS	Lower crt display Y Search data call	〔3〕
MAG	display MAG set	〔1〕
MBC	crt Memory Block # Call	〔3〕
MBD	crt Memory Block # Down	〔1〕
MBS@@	crt Memory Block # Set (@@=1-->540)	〔2〕
MBU	crt Memory Block # Up	〔1〕
MDL	crt Memory block DeLete	〔1〕
MGL@	display y ax MaG-Log 1(ON),2(OFF)	〔2〕
MIS	crt Memory block InSert	〔1〕
MLU	crt Memory block ListUp	〔1〕
MRC	crt Memory ReCall	〔1〕
MSC	crt Memory block data Status Call	〔3〕
MST	crt Memory STore (execute)	〔1〕
NCP@	Nyquist Cole Plot	〔2〕
NMP@	Nyquist Mag-Phase search 1(ON),2(OFF)	〔2〕
NLC	Nyquist Lower display kind # Call same as LDC	〔3〕
NLS	Nyquist Limit Set	〔1〕
NLT@	Nyquist LimiT 1(ON),2(OFF)	〔2〕
NRT@	Nuquist 3D RotaTe num. 1(+45°),2(+90°),3(+ 135°),4(+180 °) 5(+225 °),6(+270 °),7(+315 °)	〔2〕
NTD@	Nyquist Three dimensional Display 1(ON),2(OFF)	〔2〕

NUC	Nyquist Upper display kind # Call same as LDC	〔3〕
NYQ	display NYQuist set	〔1〕
01S	Octave 1/1 Set	〔1〕
03S	Octave 1/3 Set	〔1〕
OAF	Octave A weighting oFf	〔1〕
OAO	Octave A weighting On	〔1〕
ODS@	Overall Display Set 1(ON)2(OFF)	〔2〕
OMS@	Octave Mode Set 1(OFF),2(30 band),3(15 band)	〔2〕
OSP	Octave SharP	〔2〕
OVS@	OVerlap Set 1(max),2(50%),3(0%)	〔2〕
PAC	Playback Address counter (displayed) Call	〔3〕
PAF	Partial overAll oFf	〔1〕
PAJ	Phase AdJust set (correct A-Bch phase difference)	〔1〕
PAN@	Plotter disk 3d Array Number set 1(130),2(90),3(60),4(30)	〔2〕
PAO	Partial overAll On	〔1〕
PAS@@@@@	Playback Address counter Set	〔2〕
PAT@	Plot Array mode step Two	〔2〕
PAW@	Power spectrum(narrow band)A Weighting 1(ON),2(OFF)	〔2〕
PBA@	PlayBack All display 1(ALL),2(BLK),3(OFF)	〔2〕
PBS@@@@	Playback chB delay number Set 1 ～ 8191	〔2〕
PCA@	Panel Condition Auto recall 1(ON),2(OFF)	〔2〕
PCC	Playback address Counter Clear	〔1〕
PCF	Playback zoom Center Frequency set	〔1〕
PCL@	Panel Condition Load (@=1,2,3,4)	〔2〕

PCS@	Panel Condition Store (@=1,2,3,4)	〔2〕
PDA@	Phase group Delay Adjust 1(ON),2(OFF)	〔2〕
PDC	Playback Bch Delay CALL	〔3〕
PDG@	Plotter Data dott Graphic 1(dott ON),2(OFF)	〔2〕
PDJ@@@@/@	Phase Delay adJust data set	〔2〕
PDS	Playback Down Set	〔1〕
PDV@	Plotter DeVice set 1(plotter 1),2(plotter 2)	〔2〕
PEQ@	Power spectrum EQualize 1(ON),2(OFF)	〔2〕
PFD@	Plotter FeeD 1(feed before plot),2(feed after plot),3(OFF) 4(REAR FEED),5(FRONT FEED)	〔2〕
PFM@	Plotter ForMat set 1(A4 size),2(A6 size),3(A5 size)	〔2〕
PFS@	Playback zoom Factor Set 1(×2),2(×4),3(×8),4(×16),5(×32),6(×64)	〔2〕
PGD@	Phase Group Delay 1(ON),2(OFF)	〔2〕
PGS@@	Playback Gap Set 0(1),1(2),2(4),3(8),4(16),5(32),6(64),7(128) 8(256),9(512),10(1024),11(2048),12(4096),13(0)	〔2〕
PHF@	PHase display Format @= 1-->3	〔2〕
PHS	display PHaSe set	〔1〕
PLN@	Plotter Location Number set 1(LOCAT 1),2(LOCAT 2),3(LOCAT 4),4(LOCAT 4)	〔2〕
PLS@	Playback Length Set 1(2048),2(2024)	〔2〕
POF	time recored Playback OFf	〔1〕
POM@	Power spectrum Only Mode 1(ON),2(OFF)	〔2〕
PON	time recored Playback ON	〔1〕
PPC@	Plotter Pen select of Character 1(PEN 1),2(PEN 2),3(PEN 3),4(PEN 4),5(OFF)	〔2〕

PPD@	Plotter Pen select of Data 1(PEN 1),2(PEN 2),3(PEN 3),4(PEN 4),5(OFF)	〔2〕
PPF@	Plotter Pen select of Frame 1(PEN 1),2(PEN 2),3(PEN 3),4(PEN 4),5(OFF)	〔2〕
PPS	Plotter PauSe	〔1〕
PSC@	Plotter SCale set	〔2〕
PSF	Plotter Soft key oFf	〔1〕
PSH@	Plotter charactor SearcH only 1(ON),2(OFF)	〔2〕
PSO	Plotter Soft key On	〔1〕
PSS@	Plotter Source Set 1(CRT),2(MASS),3(DISK)	〔2〕
PST	Plotter STart	〔1〕
PUS	Playback Up Set	〔1〕
PVS	Powerspectrum V Square	〔2〕
PZF	Playback Zoom oFf	〔1〕
PZO	Playback Zoom On	〔1〕
PZS	Playback Zoom Single (execute)	〔1〕
RAC	Running Average # Call	〔3〕
RAL@	Record Address Long 1(ON),2(OFF)	〔2〕
RAR@@@@@,@@@@@	time Record data chA Read (binary) (start address points)	〔4〕
RAW@	time Record memory chA Write @=1--< n(memory block number) n=31,127,255,384,768 1 block = 1kword	〔5〕
RBC	Record Block no.Call	〔3〕
RBM@	Record Block Mode	〔2〕
RBR@@@@@,@@@@@	time Record data chB Read (binary) (start address,points)	〔4〕
RBS@	Record Block Set @ = 1～8	〔2〕

RBW@	time Record memory chB Write same as RAW	〔5〕
RCOaa,bb,ff,	time Record memory COndition set aa = chA amplitude range number bb = chB amplitude range number ff = frequence range number	〔2〕
RCS@	Record Channel Set 1(chA&B),2(chA),3(chB)	〔2〕
RDL	Ramdisk DeLete	〔1〕
REF@	REFerence of yaxis 1(ON),(OFF)	〔2〕
REL	display REaL set	〔1〕
RIS	Ramdisk InSert	〔1〕
RLW@@@	Reference of LoWer display	〔2〕
RMC	time Record Memory all Clear (execute)	〔1〕
RMX@	Record Memory exchange 1(the first half),2(the latter half)	〔2〕
ROF	time Record mode OFf	〔1〕
RON	time Record mode ON	〔1〕
RPG	Ramdisk PurGe	〔1〕
RRS	time Record mode Ring Set	〔1〕
RSL@	Record SeLect cmos 1(FIRST),2(MIDDLE),3(LAST)	〔2〕
RSS	Time Record mode Single Set	〔1〕
RUP@@@	Reference of UPper display	〔2〕
S8K@	Signal 8K record 1(ON),2(OFF)	〔2〕
SAM@@@@	Signal AMplitude set	〔1〕
SBD@	Signal BanD 1(ON),2(OFF)	〔2〕
SBT	Signal Burst	〔1〕
SCE	Sampling Clock External set	〔1〕
SCF	Search Cursor oFf	〔1〕

SCI	Sampling Clock External set	〔1〕
SCL@	Sequence Condition Load 1(ON),2(OFF)	〔2〕
SCO	Search Cusor On	〔1〕
SCT	Signal ConTinue	〔1〕
SCY@@@	Signal CYcle num set @ = 1～999	〔2〕
SDM	Sequence Dlay Mark set	〔1〕
SDS@	Spectrum Density Set 1(OFF),2(PSD),3(ESD)	〔2〕
SEC	SECond display set	〔1〕
SEF	Search Enhancement oFf	〔1〕
SEO	Search Enhancement On	〔1〕
SFR@@@@@@@@@@	Signal FRequency direct set	〔2〕
SFS	Signal Frequency cursor Set	〔1〕
SHL@@@@	SearcH marker position Lower display	〔2〕
SHU@@@@	SearcH marker position Upper display	〔2〕
SLF	Search List set mode oFf	〔1〕
SLN@@	Search List Number set (@@=1-->20)	〔2〕
SLO	Search List set mode On	〔1〕
SLP	Search List Point set	〔2〕
SLS	Search List Set (execute)	〔1〕
SMD	Search Marker Down	〔1〕
SML	Search Marker Left	〔1〕
SMR	Search Marker Right	〔1〕
SMS@@@	Service request Mask Set	〔2〕
SMU	Search Marker Up	〔1〕
SNP@	Search move Next Peak 1(ON),2(OFF)	〔2〕
SOF	Search OFf	〔1〕

SON	Search ON	〔1〕
SPC	Search Marker Position Call (Lower)	〔3〕
SPF	Signal noise Pink oFf	〔1〕
SPL	Search Marker Position Lower	〔3〕
SPO	Signal noise Pink On	〔1〕
SPP@	Search Point Peak Set 1(ON),2(OFF)	〔2〕
SPS@@@@	Search marker Position Set	〔2〕
SPU	Search marker Position Upper	〔3〕
SQM@	SeQuence Memory set 1(SEQ 1),2(SEQ 2)	〔2〕
SQS	SeQuence Set/reset	〔1〕
SRE	System REset	〔1〕
SRM@	Sequence Run Mode set 1(RUN OFF),2(STEP),3(AUTO),4(RING ON),5(RING OFF) 6(START CONTROL ON),7(START CONTROL OFF)	〔2〕
SRS@@@	Sequence run Ring number set	〔2〕
SRV@	SeRVo analysis mode set 1(400 line),2(4 decade),3(OFF)	〔2〕
SSA	Signal Source Auto 1(ON),2(OFF)	〔1〕
SSF	Sequence memory Set mode oFf	〔1〕
SSH@	Sequence SearcH control 1(ON),2(OFF),3(MEM),4(SET)	〔2〕
SSI	Signal SIngle	〔1〕
SSM	Signal Source Memory set	〔1〕
SSO	Sequence memory Set mode On	〔1〕
SSU@	Signal Source Unit on 1(ON),2(OFF)	〔2〕
SSS@	Signal Source Select 1(SINE),2(SWEPT SINE),3(PERIODIC RANDOM) 4(RANDOM),5(IMPULSE),6(PIP),7(CRT), 8(MEMORY)	〔2〕

STM@@@	Signal TiMe interval set @ = 1 ~999	〔2〕
STP@	Search of Time disPlay at one display	〔2〕
SVC@	SerVo 4 decade memory Clear 1(ON),2(OFF)	〔2〕
TDA	Three Dimensional Array display	〔1〕
TEF	Transfer function Equalized oFf	〔1〕
TEO	Transfer function Equalized On	〔1〕
TES	Transfer function Equalized Set	〔1〕
TEX	Trigger source EXternal set	〔1〕
TFR	Trigger FRee	〔1〕
THR@	Total Harmonic data Read @ = 1(value),2(% data)	〔3〕
TIA	Trigger source Internal chA	〔1〕
TIB	Trigger source Internal chB	〔1〕
TIC	Time Interval Call	〔3〕
TIF	Time Interval oFf	〔1〕
TIO	Time Interval On	〔1〕
TIS@@@	Time Interval Set (@@@=1-->999)	〔2〕
TLC	Trigger Level Call	〔3〕
TLS + @@@	Trigger Level Set (@@@=122-->+122) + represents + or −	〔2〕
TMP@	TiMe Polarity set 1(ch A ON),2(chB ON),3(chA&B ON),4(OFF)	〔2〕
TOF	Test OFf	〔1〕
TON	Test ON	〔1〕
TOS@	Trigger One Shot 1(ON),2(OFF)	〔2〕
TPC	Trigger Position Call same as TPS	〔3〕

TPM	Trigger Ploarity Minus	〔1〕
TPP	Trigger Ploarity Plus	〔1〕
TPS@	Trigger Position Set @ = 0～±65536	〔2〕
TRC	TimeR Call same as TRS	〔3〕
TRE	Trigger Repeat set	〔1〕
TRS@@/@@/@@ @@:@@	TimeR Set	〔1〕
TSI	Trigger SIngle set	〔1〕
UAC	Upper crt display Amplitude range Call same as AAR	〔3〕
UCI	Upper Crt display data of bit Image read	〔4〕
UDA	Upper crt Display Amplitude range call same as AAR	〔3〕
UDC	Upper crt Display kind # Call same as LDC	〔3〕
UDD@,@@@,@@@	Upper Display Data read @ = 1(X value),2(Y value),3(X,Y value) @ = START POINT @ = STOP POINT	〔3〕
UFC	Upper crt display Frequency range Call same as FRC	〔3〕
UFL	Upper display Flame Length call 1(2k),2(1k)	〔3〕
UPS@	Upper Position Search read	〔3〕
UXA	Upper display X Axis	〔3〕
UXS	Upper crt display X Search data call	〔3〕
UXY	Upper crt display X&Y Search data call	〔3〕
UYA	Upper display Y Axis	〔3〕
UYS	Upper crt display Y Search data call	〔3〕
VWS@	VieW Set 1(OFF)--9	〔2〕
WIC	WIndow # Call same as WIS This figure is not setted but analyzed	〔3〕

WIS@	WIndow Select 1(RECTANGULAR),2(HANNING),3(FLAT),4(USER) 5(F-F),6(E-E),7(F-E)	〔2〕
WSL@	Window Set seLect 1(FORCE),2(EXP),3(USER)	〔2〕
WST	Window SeT	〔1〕
XFR	display XFeR	〔1〕
XIS@	Xfer function Inverse Set 1(ON),2(OFF)	〔2〕
XLI	X LInear	〔1〕
XLO	X LOg	〔1〕
XNC@	Xfer NiCo display 1(ON),2(OFF)	〔2〕
XUF	X Unit oFf	〔1〕
XUM@	X Unit Mode set 1(CPM),2(ORDER),3(ORDER SET),4(LIST UP) 5(LIST DOWN),6(ORDER FIT ON), 7(ORDER FIT OFF),8(sec)	〔2〕
XUO	X Unit On	〔1〕
XXF	X axis eXpand oFf	〔1〕
XXO	X axis eXpand On	〔1〕
XYD@	X-Y recorder Data write 1(ON),2(OFF)	〔2〕
XYF@	X-Y recorder Frame write 1(ON),2(OFF)	〔2〕
XYP@	X-Y recorder Pen speed @=1---7	〔2〕
XYS@	X-Y recorder Start/stop 1(start),2(stop)	〔2〕
XYX@	X-Y recorder eXpand 1(ON),2(OFF)	〔2〕
YCL	Y gain number Call Low display answer=ab a:=1(20dB),2(30dB),3(40dB),4(50dB) 5(60dB),6(70dB),7(80dB),8(90dB) 9(100dB),10(120dB),11(140dB) 12(160dB),13(180dB),14(200dB) b:=1(1/10),2(1/5),3(1/2),4(x1),5(x2) 6(x5),7(x10),8(x20),9(x50),10(x100) 11(200),12(500),13(x1000),14(x2000)	〔3〕

YCH	Y gain number Call Hight display same as YCL	〔3〕
YGD	Y Gain Down	〔1〕
YGH@	Y Gain High on 1(ON),2(OFF)	〔2〕
YGL@	Y Gain LOW on 1(ON),2(OFF)	〔2〕
YGU	Y Gain Up	〔1〕
YLI	Y LInear	〔1〕
YLO	Y LOg	〔1〕
YUF	Y Unit oFf	〔1〕
YUM@	Y Unit Mode set 1(VRMS ON),2(OFF)	〔2〕
YUO	Y Unit On	〔1〕
ZCC	Zoom Center frequency Call	〔3〕
ZCS	Zoom Center frequency Set	〔1〕
ZEC	Zoom Expansion factor Call 1(x2),2(x4),3(x8),4(x16),5(x32),6(x64)	〔3〕
ZED	Zoom Expansion factor Down	〔1〕
ZEU	Zoom Expansion factor Up	〔1〕
ZOF	real time Zoom OFf	〔1〕
ZON	real time Zoom ON	〔1〕

```
          ***  INDEX LIST of CRT MEMORY ***
0              Display kind                   byte (next page)
1              Display Data Length            byte 1K=0 first of 2K=1 other OFFH
2              Ch A AMP RANGE                 byte 0(50V)---- > 14(1mV)
3              Ch B AMP RANGE                 byte 0(50V)---- > 14(1mV)
4              FRQ RANGE                      byte 0(1Hz)---- > 14(40KHz)
5              ?????
6,7            CURRENT AVG #
8              ANALYSIS
9              ?????
10             SMP CLK FLAG & Xfer 1/H FLAG & env func FLAG
               bit0(1:EXT,0:INT),bit1(1:1/H,0:H),bit2(1:env on,0:off)
               bit3(1:env mag,0:mag off),bit7(1、Hight Precision on, 0:off)
11             OCT FLAG   2(30band),4(15band)
12             Code(0CFH)
13             Code(091H)
14             Data Length  0=2K data 1=1K data
15             WINDOW Kind (1、RECT,2:HANN,4:FLAT,16:F-F,32:E-E,64:F-E)
16             ?????
17             ?????
18,19          ZOOM FACTOR (word)  XXXYYYYYYYYYZZZZ
                 XXX=0(x2),1(x4),2(x8),3(x16),4(x32),5(x64)
                 center freq. = (YYYYYYYYY)* deltaF+(ZZZZ)/16*deltaF
20             ?????
21             ?????
22             ?????
23             ?????
24-->79            LABEL(55bytes)
79  0
**
80,81          CODE #CF350
82,83          LOWER or 1 DISPLAY SEARCH POINT   word
84,85          UPPER SEARCH POINT                word
86,87,88,89    ch A EU DATA                      floting data
90,91,92,93    ch B EU DATA                      floting data
94,95,         LOWER REFERENCE DATA              word
96,97          UPPER REFERENCE DATA              word
98             SOFT KEY REFERENCE
99             REFERENCE ON FLAG
100            Y LOG FLAG     1=LOG ON 0=OFF
101            X LOG FLAG     1=LOG ON 0=OFF
102            LOWER Y LOG GAIN   0=>13
103            LOWER Y LIN GAIN   0=>13
104            UPPER Y LOG GAIN   0=>13
105            UPPER Y LIN GAIN   0=>13
106            Y UNIT FLAG    1=ON  0=OFF
107            X UNIT FLAG    1=ON  0=OFF
108            SOFT KEY   jw
109            SOFT KEY   OCT
110            SOFT KEY   DENSITY
111            SOFT KEY   XFR
112            SOFT KEY   X UNIT
113            SOFT KEY   Y UNIT
114            SOFT KEY   PHASE
115            SOFT KEY   FORMAT                :DISPLAY FORMAT
116,117        FRQ EXP  START POINT     word
118,119        FRQ EXP STOP POINT       word
120,121,122    chA EU name
123,124,125    chB EU name
126,127        reserved
```

```
!!!!!!!!       contents of Display Kind       !!!!!!!!!!!!

1:             TIME chA
7:             TIME chB
12:            SP MAG   chA
13:            SP REAL  chA
14:            SP IMAG  chA
15:            SP PHASE chA
18:            SP MAG   chB
19:            SP REAL  chB
20:            SP IMAG  chB
21:            SP PHASE chB
24:            CROSS SP MAG
25:            CROSS SP REAL
26:            CROSS SP IMAG
27:            CROSS SP PHASE
30:            XFER     MAG
31:            XFER     REAL
32:            XFER     IMAG
33:            XFER     PHASE
37:            HIST chA (PDF)
38:            HIST chA (CDF)
43:            HIST chB (PDF)
44:            HIST chB (CDF)
49:            ACF chA
55:            ACF chB
61:            CCF
66:            COH
72:            COP
79:            IMP RESP
```

INSPECTION CERTIFICATION

Your instrument was carefully inspected, calibrated and met ONO SOKKI CO., LTD. performance specifications and workmanship standards.

MODEL : CF-350
SERIAL NO. 80714615

Inspected by :
ONO SOKKI CO., LTD.

ONO SOKKI CO., LTD.
HEAD OFFICE: SHINJUKU NS BLDG. P.O. BOX 6068
4-1 NISHISHINJUKU 2-CHOME,
SHINJUKU-KU, TOKYO 163, JAPAN.
PHONE: 03-342-9181
TELEX: 232-3169 ONOSOK J
FACSIMILE: 03-342-9189