

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.)

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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 M Ω \pm 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 \pm 4%) (AC only for \pm 1 mV to 5 mV ranges)
Voltage ranges	\pm 1 mV, \pm 2 mV, \pm 5 mV \pm 10 mV, \pm 20 mV, \pm 50 mV \pm 100 mV, \pm 200 mV, \pm 500 mV \pm 1 V \pm 2 V, \pm 5 V \pm 10 V, \pm 20 V, \pm 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 k Ω \pm 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 $\pm 1/128$ of the full-scale voltage range (minimum: – 95.5%, maximum: + 95.3%) External trigger full scale: $\pm 5V$
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
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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)
40 kHz	20ms	50 Hz	10ms	100 Hz
20 kHz	40ms	25 Hz	20ms	50 Hz
10 kHz	80ms	12.5 Hz	40ms	25 Hz
5 kHz	160ms	6.25 Hz	80ms	12.5 Hz
2 kHz	0.4 s	2.5 Hz	0.2 s	5 Hz
1 kHz	0.8 s	1.25 Hz	0.4 s	2.5 Hz
500 Hz	1.6 s	0.625 Hz	0.8 s	1.25 Hz
200 Hz	4 s	0.25 Hz	2 s	0.5 Hz
100 Hz	8 s	0.125 Hz	4 s	0.25 Hz
50 Hz	16 s	62.5mHz	8 s	0.125 Hz
20 Hz	40 s	25mHz	20 s	50mHz
10 Hz	80 s	12.5mHz	40 s	25mHz
5 Hz	160 s	6.25mHz	80 s	12.5mHz
2 Hz	400 s	2.5mHz	200 s	5mHz
1 Hz	800 s	1.25mHz	400 s	2.5mHz

Sampling speed 2.56 times the analysis range or governed by an external sampling clock

Frequency accuracy $\pm 0.01\%$ 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 1-4

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	<p>Time domain: Time-axis waveform, auto-correlation function, cross correlation function, impulse response, orbit (lissajous pattern)</p> <p>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)</p> <p>Amplitude domain Amplitude probability density function, amplitude probability distribution function</p> <p>Other data Cepstrum, list data, time-axis envelope, mass memory stored data, floppy disk stored data</p>
Display modes	<p>Single-frame display mode Any 1 frame displayed, including data from memory</p> <p>Dual-frame display mode Any 2 frames displayed, including data from memory (but not including Nyquist plots and lissajous displays)</p> <p>Overlaid display mode Overlaid display of any two frames of data of the same domain (but not including Nyquist plots and lissajous displays)</p> <p>3-Dimensional display mode* 20-line mode</p> <ul style="list-style-type: none">• 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) <p>60- and 90-line modes</p> <ul style="list-style-type: none">• 60- or 90-line 3-dimensional display of the power spectrum <p>Nyquist plot mode Nyquist display of Fourier spectrum, cross spectrum and transfer function</p>

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 10 spectral 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 ² rms, 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 <i>f</i> , <i>t</i> 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 K words (1 ch) 1 data
 127 K words (2 ch) 1 data
 31 K words (1 ch) 8 data
 31 K words (2 ch) 4 data

CMOS memory* (when installed)

768 K words (1 ch) 1 data
 384 K words (2 ch) 1 data
 255 K words (1 ch) 3 data
 127 K words (2 ch) 3 data
 31 K words (1 ch) 24 data
 31 K words (2 ch) 12 data

Time Record Memory Time Lengths

	7 6 8 k (1ch)	3 8 4 k (2ch)	2 5 5 k (1ch)	1 2 7 k (2ch)	3 1 k (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 K words 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-p} (open circuit) Setting resolution: 1 mV _{0-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-p})

Accuracy:

- 40 kHz $\geq f > 2$ kHz:
 ± 12.5 mHz ± 50 ppm
- 2 kHz $\geq f > 200$ Hz:
 ± 5 mHz ± 50 ppm
- 200 Hz $\geq f > 20$ Hz:
 ± 8 mHz ± 50 ppm
- 20 Hz $\geq f > 2$ Hz:
 ± 3.5 mHz ± 50 ppm
- 2 Hz $\geq f$: ± 650 μ Hz ± 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) \times 199 (H) \times 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

