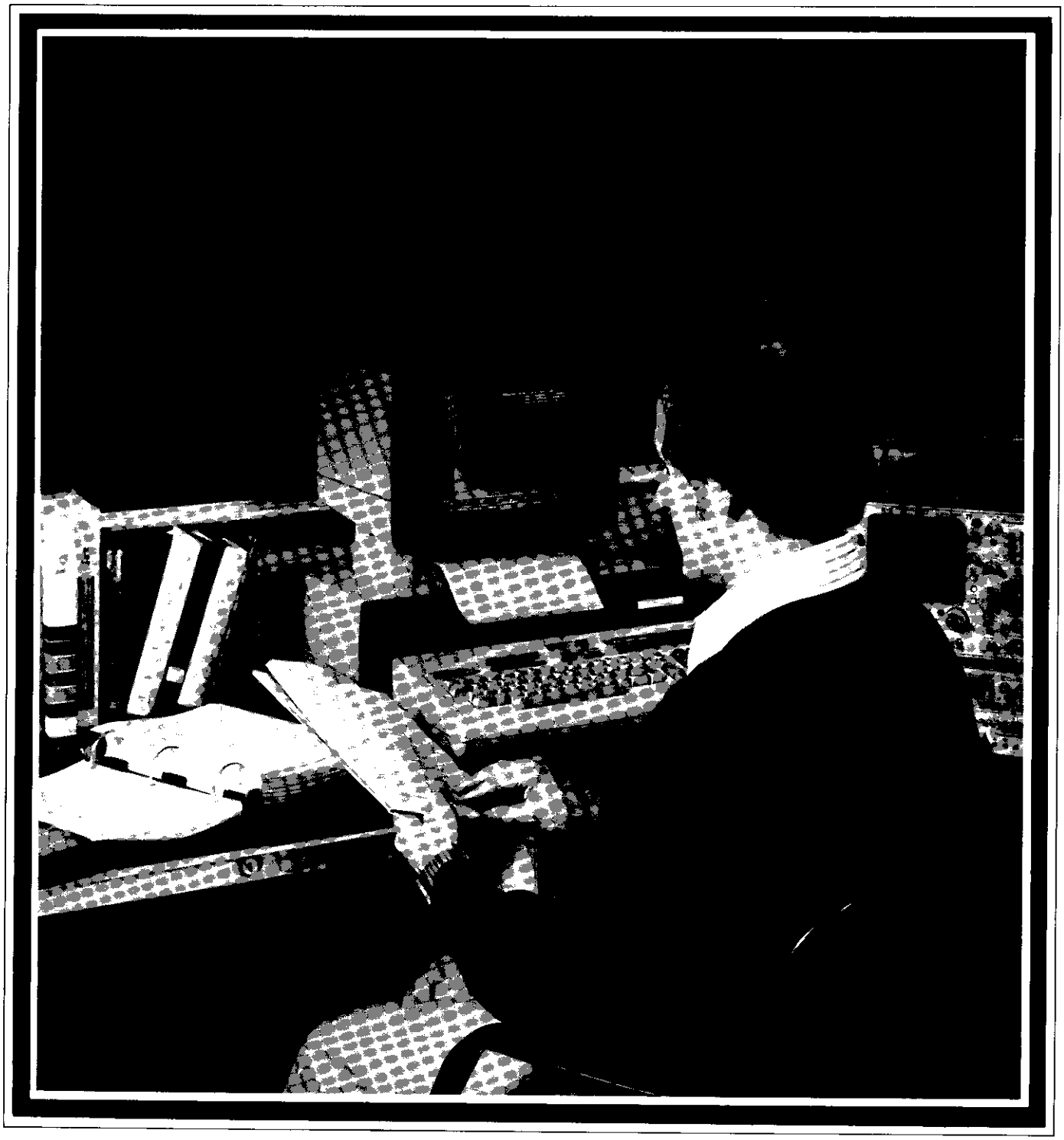
A Hewlett-Packard Software Summary
for the System 45B Desktop Computer

# System 45B Waveform Analysis





# A complete solution for solving complex problems.

## Waveform Analysis in the Lab

Design engineering and data acquisition applications have become increasingly complex, with waveform analysis (digital signal processing) being no exception. Waveform analysis has become increasingly important in acoustics, bioengineering, vibration analysis and image processing, to name a few applications.

Until the introduction of System 45B, you faced making a very large investment when considering a computerized waveform analysis solution; an investment dedicated to a single application. Now you get a reasonably priced solution that is versatile; the system you can put to use supporting such applications as data acquisition and control, management functions and design analysis. System 45B, the computer that meets your needs for easy-to-use, easy-to-justify equipment.

## The Software Package

The Waveform Analysis software consists of the following routines:

- Single Data Input,
- Double Data Input,
- Fourier Series Coefficients for Equally Spaced Data,
- Fourier Coefficients for Unequally Spaced Data.

With these four routines, you can process digital-signal data to achieve such results as frequency domain and time domain measurements.

Some of the measurements performed include auto and cross correlation, convolution, cross power, power spectrum, modulation, Hanning function and change of domain. You can at any time choose to print, plot, display or store the data on a mass storage device. To do so, you simply press the Special Function key that initiates the desired operation (see Figure 1).

## Designed For Ease of Use

Both the hardware and software of System 45B make it easy to use. From prompts that appear on the CRT to guide you to a solution (see Figure 2) to the Special Function keys that initiate individual operations, it simplifies waveform analysis. Results of the computations appear on the CRT (graphically and fully annotated); you may also direct these results to a printer or plotter. For samples of outputted data, see Figures 3, 4 and 5.

A typical operation would be to enter the data, perform an FFT on it, calculate the power and then display the results in graphic form on the CRT. If the results require no further analysis, you would then have hard copies made on the printer or the plotter for reports or filing.

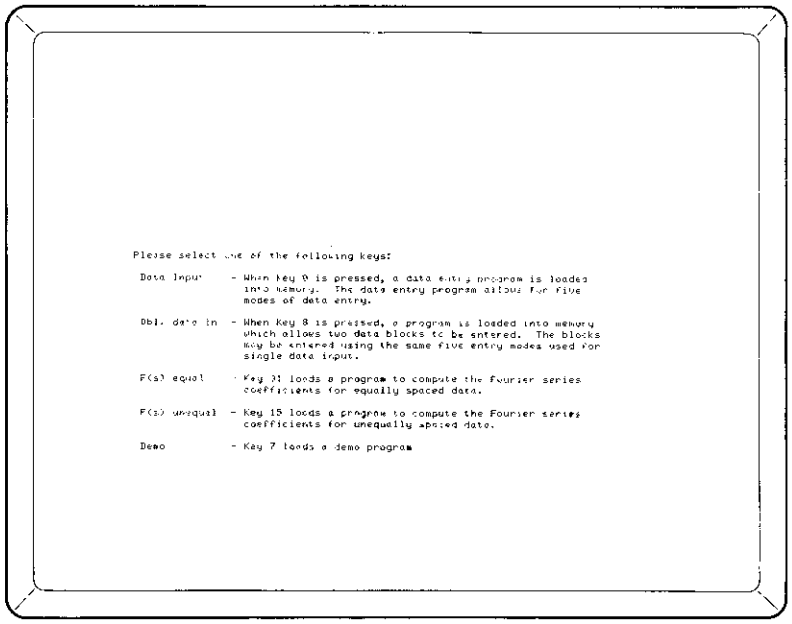



**Figure 2. Prompts guide you through the waveform analysis routines.**

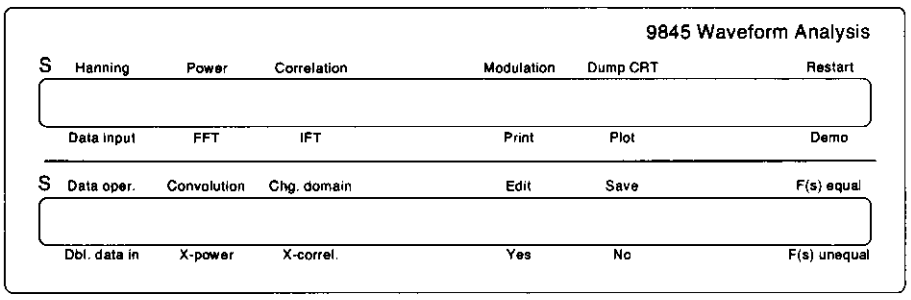



**Figure 1. This overlay indicates what Special Function each key initiates.**

TIME DOM

NUMBER OF DATA POINTS = 256
TIME=0 TO 1.00000E+00[SEC]
TIME INTERVAL= 3.90625E-03[SEC]

| DATA POINT | TIME[SEC] |
|---|---|
| 1 | 0.00000E+00 |
| 2 | 3.90625E-03 |
| 3 | 7.81250E-03 |
| 4 | 1.17188E-02 |
| 5 | 1.56250E-02 |
| 6 | 1.95313E-02 |
| 7 | 2.34375E-02 |
| 8 | 2.73438E-02 |
| 9 | 3.12500E-02 |
| 10 | 3.51563E-02 |
| 11 | 3.90625E-02 |
| 12 | 4.29688E-02 |
| 13 | 4.68750E-02 |
| 14 | 5.07813E-02 |
| 15 | 5.46875E-02 |
| 16 | 5.85938E-02 |
| 17 | 6.25000E-02 |
| 18 | 6.64063E-02 |
| 19 | 7.03125E-02 |
| 20 | 7.42188E-02 |
| 21 | 7.81250E-02 |
| 22 | 8.20313E-02 |
| 23 | 8.59375E- |
| 24 | 8.98438E-0 |

**Figure 4. For detailed study, you car**

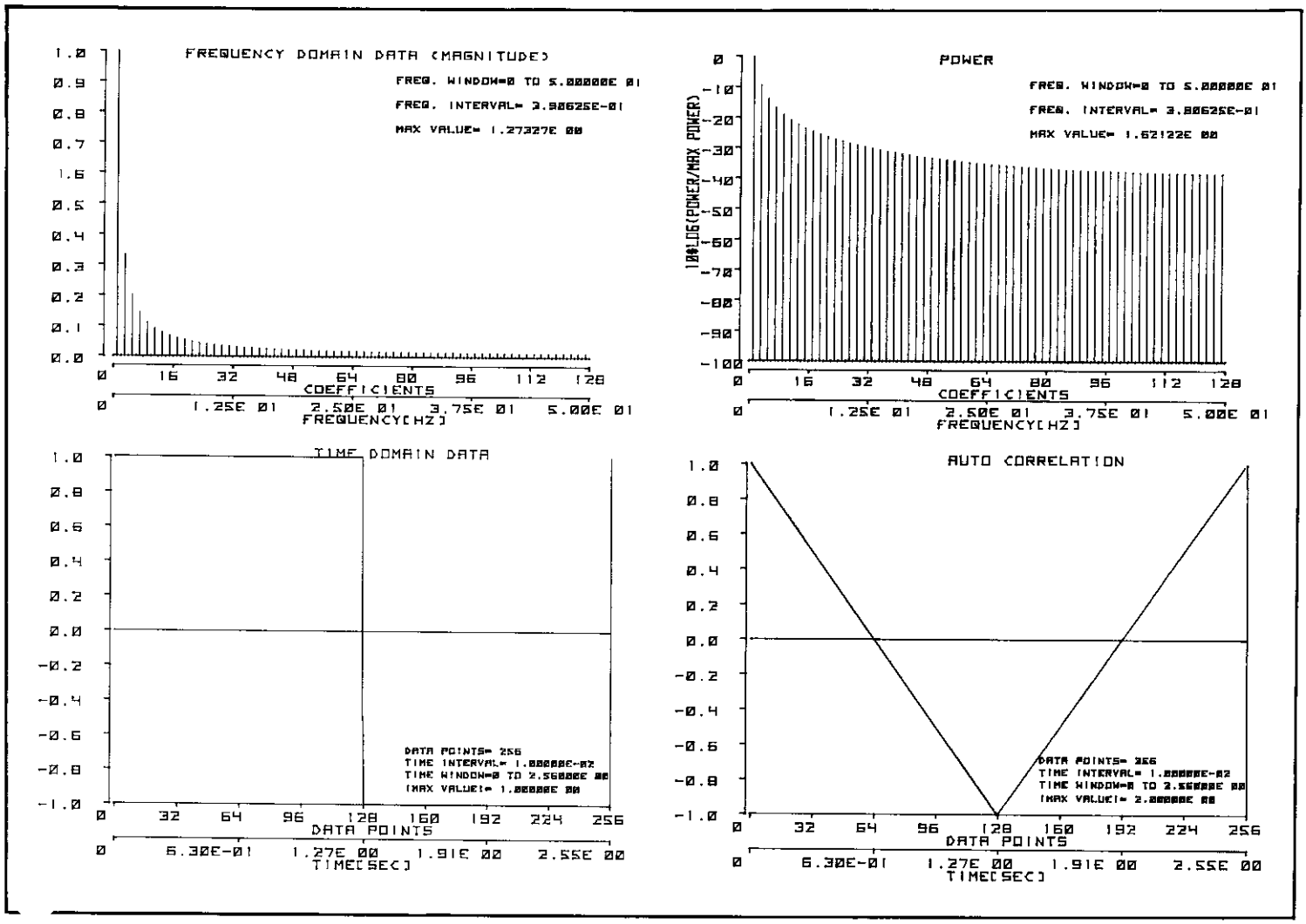



**Figure 3. This plot shows frequency and time-domain data as outputted on a 9872A Plotter.**

AIN DATA

| DATA |
|---|
| 3.17883E-01 |
| 2.93933E-01 |
| 2.70104E-01 |
| 2.46436E-01 |
| 2.22964E-01 |
| 1.99726E-01 |
| 1.76758E-01 |
| 1.54094E-01 |
| 1.31768E-01 |
| 1.09815E-01 |
| 8.82649E-02 |
| 6.71498E-02 |
| 4.64995E-02 |
| 2.63423E-02 |
| 6.70574E-03 |
| -1.23842E-02 |
| -3.09028E-02 |
| -4.88268E-02 |
| -3.38657E-02 |
| -1.71950E-02 |
| -1.17999E-03 |
| 1. 0E-02 |
| 2 E-02 |
| 4. 3E-02 |

**get results in list form.**

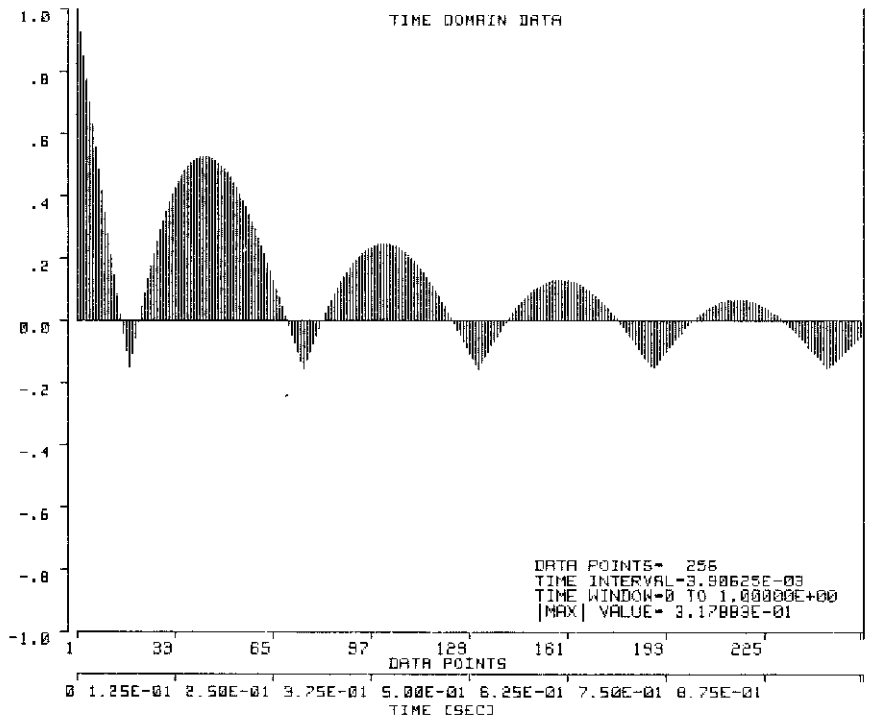



**Figure 5. Using graphics, you can quickly analyze results.**

## The Measurements Performed.

There are many measurements you might wish to perform on a signal. Your interaction with the System 45B allows you to achieve the desired results quickly and easily. Descriptions of some of these functions follow.

**Hanning function.** This routine provides the Hanning Window to the frequency domain data.

**Power spectrum.** The power spectrum function permits you to calculate signal power from the time domain or frequency domain. It provides outputs traditionally performed by a spectrum analyzer.

**Auto correlation.** Calculated from time domain or frequency domain data, the auto correlation function acts to segregate the signal from surrounding noise. The main application is with sinusoids; autocorrelation of complex signals proves too difficult to interpret.

**Cross correlation.** This operation is very similar to the auto correlation function just discussed. The difference is that it deals with the relationship between two separate signals. The major application is in determining relative delay between two signals.

**Cross power.** You can get a frequency domain representation of the cross correlation function using the cross power function. It provides a power versus frequency representation of the mutual power and phase between two signals.

**Data input.** With this operation, you can input a single function. The structure of the software allows you to analyze up to 4 096 data points.

**Double data input.** You can enter information on two separate functions into the system using double data input, with each function characterized by up to 4 096 data points.

**Convolution.** The convolution function allows the transformation of a function, which can be recognized as the product of two other functions, to the other domain.

**Change domain.** By using the double data input function and change domain together, you can transform time domain data to frequency domain data or vice versa.

**Modulation.** This applies a modulation function (H Cos $\omega t$) to the time-domain data causing a frequency shift of the data in the frequency domain.

**Dump CRT.** This results in CRT-displayed graphics being copied directly onto the thermal printer.

**Print.** The print function directs the system to output data to the specified printer.

**Plot.** Using the plot function you can direct the system to output data to an external plotter in graphic form; the plots are fully annotated.

**Edit.** The edit function allows you to alter time and frequency domain data.

**Save.** This function allows you to store data on a mass storage device.

**Yes/no.** You use the yes/no function to answer prompts that the system displays on the CRT.

**F(s) equal.** Using this function, you can input data and calculate the fourier coefficients on it.

**F(s) unequal.** Similar to F(s) equal, except that the data can be spaced unequally.

**Demo.** A preprogrammed demonstration built into the software library allows you to examine features of the programs.

## Ordering Information

Included in the Waveform Analysis Package (P.N. 09845-12600) are:

- A manual containing a description of each routine, samples of each subprogram, general operating procedures for each routine and general information about system configuration, operating speed and program part numbers,
- A prerecorded tape cartridge containing the software,
- A Special Function keys overlay.

## Hardware Configuration

To run the waveform analysis routines, you need the following:

| | |
|---|---|
| 9845B | Desktop Computer |
| Opt. 204 | 187 306 byte memory |
| Opt. 700 | Graphics display subsystem |
| Opt. 311 | Graphics ROM |
| Opt. 560/ 561 | Thermal printer, Standard ASCII |

The following optional peripherals can be ordered to enhance your system:

| | |
|---|---|
| Opt. 600 | Built-in second tape cartridge |
| 9872A, Opt. 045 | Four-color Plotter |
| 9885M, Opt. 045 | Flexible Disk Drive (Master) |

HEWLETT hp PACKARD

3404 E. Harmony Road, Fort Collins, Colorado 80525



Printed in U.S.A.
(1/79)

5953-1029(40)