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NOTE

A limited number of programs are available for the following non-current software operating systems:

DPO TEK BASIC
WDI TEK BASIC
TEK 31 Programmable Calculator

If you would like a catalog of available programs for these operating systems, write in "Non-Current Catalog" on the attached Program Library Order Form.

TEK SPS BASIC PROGRAM ABSTRACTS

5-5. Automatic Calibration with the CG551AP

Instruments Required: TEKTRONIX CG551AP Programmable Calibration Generator, 7612D Programmable Digitizer, 7A16P Programmable Amplifier.

Software Packages Required: IEEE 488 High-Level Instrument Driver.
Listing Length: 55 lines.

This program provides an automatic vertical calibration routine for a single 7612D Programmable Digitizer with a 7A16P Programmable Amplifier. the program can be adapted to other programmable digitizer systems. Reprinted from HANDSHAKE, Winter 1980-81.

5-10. Automatic Vertical Scaling

Instruments Required: Programmable Digitizer with Programmable Plug-Ins.
Software Packages Required: None.
Listing Length: 152 lines.

This program provides automatic vertical scaling to bring a signal within range of the digitizer. Reprinted from HANDSHAKE, Fall 1978.

5-20. Bar Graphs

Instruments Required: None.

Software Packages Required: Graphics.

Listing Length: 58 lines.

This program provides bar-graph displays of data. The user can choose one of three styles of bar graph display and two styles of cross-hatching of the bars. Reprinted from HANDSHAKE, Fall 1978.

5-25. Basic 7612D Acquisition Routines

Instruments Required: 7612D Programmable Digitizer,
7A16P Programmable Amplifier.

Software Packages Required: IEEE 488 High-Level Instrument Driver.

Listing Length: 70 lines with Low-Level GPIB Driver (GPI.SPS),
57 lines with High-Level Instrument Driver (INS.SPS).

This program provides a simple 7612D acquisition routine using the low-level GPIB Driver. The routine is then expanded to provide interrupt-driven acquisition. Then, both routines are repeated using the optional high-level Instrument Driver. Reprinted from HANDSHAKE, Winter 1980-81.

5-30. Computation of Magnitude and Phase Spectra

Instruments Required: None.

Software Packages Required: Signal Processing.

Listing Length: 152 lines.

This program computes the magnitude and phase spectra for both transient and periodic signals.

5-32. Contour Plotting

Instruments Required: None.

Software Packages Required: None.

Listing Length: 68 lines.

This program produces a contour plot which shows variations in data levels. Reprinted from HANDSHAKE, Winter 1981/82.

5-35. Data Logging with the 7612D

Instruments Required: 7612D Programmable Digitizer

Software Packages Required: High-Level Instrument Driver,
Signal Processing, Graphics

Listing Length: Depends on routines used.

This is a set of three articles on data logging with the 7612D and TEK SPS BASIC software. Background information and a variety of routines for data logging, event detection, and data retrieval are provided in the article with explanations of how each routine works. Reprinted from HANDSHAKE, Spring/Summer 1981.

5-40. Dynamic Performance Testing of Digitizers

Instruments Required: None, but stored instrument data is required.

Software Packages Required: Graphics and Signal Processing.

Listing Length: 1620 lines.

This analysis sequence uses two programs to determine digitizer dynamic performance. The first program in the sequence operates on stored output data from the digitizer to synthesize the digitizer's analog input. The synthesis is done by least-squares fitting an appropriate model to the digitizer output data. Then, key statistics describing the digitizer's dynamic performance are computed and stored. The second program provides several options for further analyses of the stored performance statistics.

5-45. Engineering Notation Conversion

Instrument Required: None.

Software Packages Required: None.

Listing Length: 27 lines.

This program converts numeric values from scientific notation to engineering notation.

5-50. Evaluation of Optical Fiber Transmission Characteristics

Instruments Required: DPO, 7S12 sampling plug-in, S4 or S6 sampling head, and S53 trigger recognizer head.

Software Packages Required: DPO Driver, Signal Processing, and Graphics.

Listing Length: 1700 lines.

This program is set up to automatically acquire optical fiber test signals (laser pulse and broadband lamp) via a Digitizing Oscilloscope. The acquired signals are then used to compute pulse attenuation, pulse spreading, fiber frequency response, fiber impulse response, spectral attenuation, and numerical aperture.

5-60. Exponential Decay Curve Fitting, Simple

Instruments Required: None.

Software Packages Required: None.

Listing Length: 570 lines.

This program uses a Gauss-Newton, nonlinear, least-squares algorithm to fit simple exponential decay models to data.

5-70. Exponential Decay Curve Fitting, Multiple

Instruments Required: None.

Software Packages Required: None.

Listing Length: 700 lines.

This program fits decay models consisting of either a single exponential or the sum of several exponentials to the decay data. The algorithm used is a Marquardt, nonlinear, least-squares algorithm.

5-80. File Converter

Instruments Required: Cassette tape drive.

Software Packages Required: None.

Listing Length: 65 lines.

This program converts DPO/WDI TEK BASIC data files on cassette tape to TEK SPS BASIC format.

5-90. Formatting Specification Sheets

Instruments Required: None.

Software Packages Required: Graphics.

Listing Length: 111 lines.

This program combines test data and graphs of system response to produce a formatted specification sheet. Reprinted from HANDSHAKE, Summer 1978.

5-92. Getting ATTACHed to the INS Driver

Instruments Required: Not Specified.

Software Packages Required: High-Level Instrument Driver

Listing Length: 29 lines.

This program will auto-attach instruments under program control.

5-93. Graphics Driver for 4662

Instruments Required: 4662 DIGITAL PLOTTER.

Software Packages Required: None.

Listing Length: 33 lines.

This program drives the Tektronix 4662 via the GPIB.

5-95. Graphing Data in Log and Log-Log Formats

Instruments Required: None.

Software Packages Required: Graphics.

Listing Length: 70 lines for main program, 27 lines for subroutine.

This program provides a routine for converting data to log and log-log format and displaying it using the GRAPH command. Reprinted from HANDSHAKE, Winter 1980-81.

5-100. Gray-Scale Displays

Instruments Required: None.

Software Packages Required: Graphics.

Listing Length: Gray-scale routine - 23 lines.

Demo program #1 - 17 lines.

Demo program #2 - 16 lines.

Partial program - 66 lines.

This program provides a gray-scale plot of data. Two demonstration routines are included along with partial program to demonstrate a practical application of the gray-scale routine. Reprinted from HANDSHAKE, Spring 1978.

5-105. Interactive Communication with the 5223

Instruments Required: 5223 Digitizing Oscilloscope with Option 10

Software Packages Required: None.

Listing Length: 78 lines.

This program allows interactive communication with the 5223. It accepts input from the terminal keyboard and handles all the details of sending the message and, if necessary, reading the reply from the instrument. Reprinted from HANDSHAKE, Winter 1981/82.

5-110. Interactive 7612D Acquisition Routine

Instruments Required: 7612D Programmable Digitizer.

Software Packages Required: V02-01 or higher software.

High-Level Support Package optional.

Listing Length: 28 lines.

This program provides operator prompts to aid in acquiring data from a single 7612D. Reprinted from HANDSHAKE, Spring/Summer 1980.

5-115. Isometric Projection

Instruments Required: None.

Software Packages Required: None.

Listing Length: 104 lines.

This program produces an isometric display which can be tilted and rotated to specified angles. Reprinted from HANDSHAKE, Spring/Summer 1981.

5-117. Limit Testing, Linearity, Aberrations, and Other Measurements by Comparison.

Instruments Required: None.

Software Packages Required: None.

Listing length: Generating Ideal Pulse - 33 lines.

Normalized Point-To-Point linearity of a Ramp - 29 lines.

Correlation - 30 lines.

These programs are part of a concept article which provides the background and theory of comparison-type measurements. While the programs are used as examples, they provide useable measurement routines. Reprinted from HANDSHAKE, Fall/Winter 1979.

5-120. Linear Regression, Simple

Instruments Required: None.

Software Packages Required: None.

Listing Length: 187 lines.

This program is a simple linear regression that fits a straight line to the data.

5-130. Linear Regression, Multiple

Instruments Required: None.

Software Packages Required: None.

Listing Length: 336 lines.

The data is fit by a model which is linear in its parameters. Straight line fitting is included as a special case.

5-135. Listing Programs on the GPIB

Instruments Required: GPIB output device.

Software Packages Required: None.

Listing Length: 35 lines.

This program allows transmission of any program to a device attached to the GPIB (IEEE 488) such as a printer, tape, modem, etc. Variable names beginning with Z and large line numbers are used so that the listing program can be stored in memory along with the program to be listed.

5-140. Long-Term Variations

Instruments Required: DPO.

Software Packages Required: DPO Driver and Graphics.

Listing Length: 100 lines.

With stable triggering on repetitive waveforms, this program acquires and plots multiple sweeps of long-term variations such as electrocardiogram data. A hidden line routine is included. Reprinted from HANDSHAKE, Spring 1977.

5-145. Lower Case to Upper Case Conversion

Instruments Required: None.

Software Packages Required: None.

Listing Length: 9 lines.

This program converts any lower-case alphabetic characters used in programs to upper case. Non-alphabetic characters are unchanged. Reprinted from HANDSHAKE, Winter 1980-81.

5-147. Making the Most of Your Interrupts

Instruments Required: None.

Software Packages Required: None.

Listing Length: Not applicable.

This program provides the building blocks to help you use interrupts in your programs. While some program examples are given, the actual interrupt routines will need to be written by the user. Reprinted from HANDSHAKE, Winter 1981/82.

5-150. Orthogonal Projection of Sin X/X

Instruments Required: None.

Software Packages Required: Graphics.

Listing Length: 30 lines.

This program computes and plots an orthogonal projection of $\sin x/x$. It contains a hidden line algorithm. Reprinted from HANDSHAKE, Winter 1976-77.

5-160. Power Spectrum of a Random Signal

Instruments Required: None.

Software Packages Required: None.

Listing Length: 296 lines.

This program estimates the power spectrum (one-sided) of a random signal. The data record must consist of a series of waveforms stored on a data file. The waveforms must be equal in size and less than or equal to 512.

5-165. Pulse Pair Delays

Instruments Required: None.
Software Packages Required: None.
Listing Length: 108 lines.

These routines operate on a 512-point waveform which is expected to contain two positive going pulses. The routines calculate two parameters: 1) Time between ascending pulse edges at the 10% level above the base line and 2) Time between the first pulse descending edge and the second pulse ascending edge at the 10% level above the base line.

5-170. Response Estimation, Impulse

Instruments Required: None.
Software Packages Required: Signal Processing.
Listing Length: 405 lines.

This program, given the input and output signals, estimates the impulse response of a system. It can also estimate the input to a system, given the impulse response and output signal.

5-180. Response Estimation, Frequency

Instruments Required: None.
Software Packages Required: Signal Processing.
Listing Length: 214 lines.

Using digitized and stored versions of the wideband input signal to a system and the corresponding output signal, this program computes an estimate of the system's frequency-response function.

5-185. Single-Key Program Selection

Instruments Required: None.
Software Packages Required: None; V02 software required.
Listing Length: 35 lines.

This menu program allows you to call up as many as nine different routines or programs simply by pressing the terminal keys for numbers 1 through 9. Reprinted from HANDSHAKE, Spring/Summer 1981.

5-190. Snowflake Generator

Instruments Required: None.

Software Packages Required: Signal Processing and Graphics.

Listing Length: 13 lines.

This program generates pleasing and often artistic geometric patterns on the terminal screen. Reprinted from HANDSHAKE, Fall 1976.

5-195. Some Useful Approaches to Pulse Analysis

Instruments Required: None.

Software Packages Required: None.

Listing Length: Histogram - 15 lines.

Analyzing Trapezoidal Pulses - 62 lines.

Rate of Rise Calculations - 20 lines.

Burst Frequency - 7 lines.

Isolation of Positive Data - 5 lines.

Envelope Detection - 24 lines.

These programs are part of a concept article which provides the background and theory of pulse analysis. While these programs are used as examples, they provide useable measurement routines. Reprinted from HANDSHAKE, Spring/Summer 1979.

5-200. Static Performance Testing of Digitizers

Instruments Required: None, but stored instrument data is required.

Software Packages Required: Graphics

Listing Length: 960 lines.

Using stored instrument data, this program computes the static performance of analog-to-digital converters or digitizers. It does this by estimating analog-to-digital transition points. A variety of static performance analysis options are provided.

5-210. Statistics Routines

Instruments Required: None.

Software Packages Required: Graphics.

Listing Length: 653 lines.

This package contains two programs, STAT and GRAPH.

The STAT program accepts either x data alone or both x and y data. It outputs the x and y data points, summary statistics for each, linear regression calculations for the x and y data, and tests for equal means and variances.

The GRAPH program allows selection of a confidence band for the straight-line curve fit. It gives you the choice of fitting the data to a linear, exponential, or power curve or simply plotting the points. You can select the graph limits or allow the machine to do the work. If the limits chosen by the machine are unacceptable, you can reselect them after being asked which curve to plot. If you wish, you can also display the data points as average values with associated error flags.

5-220. Swept-Frequency VSWR and Insertion Loss Measurements

Instruments Required: DPO, CP1100- or CP4100-Series Controller,
two 7A22 Differential Amplifier plug-ins,
7B80 Time Base plug-in, swept-frequency
generator, two directional couplers, two
square-law detectors.

Software Packages Required: DPO Driver with ENVDP0 Command and Graphics.

Listing Length: 1600 lines.

There are three programs in this package. The first acquires swept-frequency waveforms from a slotted line and then computes a swept frequency voltage standing-wave ratio (VSWR) from these waveforms. The second program acquires swept-frequency input and output voltages and computes insertion loss. The third program is a graphics routine for plotting the VSWR and insertion loss results.

5-230. System Frequency Response Compensation

Instruments Required: None, but stored instrument data is required,
and recommendations for acquiring that data are
given in the documentation.

Software Packages Required: Signal Processing.

Listing Length: 630 lines.

This program consists of two routines for compensating the output of a digitizing system for variations in frequency response. One routine characterizes the system digitizer and generates a correction filter. The other routine uses this software generated filter to compensate subsequent measurements made with the system. The documentation contains examples of program usage with an R7912 Transient Digitizer system.

5-235. Talking to the 7854 with TEK SPS BASIC

Instruments Required: 7854.

Software Packages Required: None.

Listing Length: Initialization routine - 11 lines

7854 waveform transfer to floppy - 28 lines

7854 waveform transfer and conversion to TEK SPS

BASIC format - 22 lines

7854 waveform transfer to floppy and retrieval to

7854 - 32 lines.

This program provides a series of routines to operate the 7854 with TEK SPS BASIC Software. Reprinted from HANDSHAKE, Winter 1980-81.

5-237. Threshold Level Plotting

Instruments Required: None.

Software Packages Required: None.

Listing Length: 56 lines.

This program produces a threshold plot to provide an indication of when a data level exceeds a predetermined threshold value. Reprinted from HANDSHAKE, Fall 1981.

5-240. Transistor Switching Parameters

Instruments Required: DPO.

Software Packages Required: DPO Driver and Graphics.

Listing Length: 58 lines.

This program acquires the input and output waveforms from a transistor switch and analyzes them to determine turn-on, turn-off, input rise and fall, output rise and fall, storage, and delay time. A similar program for DPO TEK BASIC is documented in application note no. AX-3481, "Measuring Transistor Switching Times with the DPO."

5-250. X-Y Plots With Autoscaling

Instruments Required: None.

Software Packages Required: Graphics.

Listing Length: 49 lines.

This program provides autoscaled plotting of two inputs for Nyquist plots, hysteresis data, mechanical stress vs strain, etc. Reprinted from HANDSHAKE, Fall 1977.

5-260. X-Y-Z Plots

Instruments Required: None.

Software Packages Required: Graphics.

Listing Length: 175 lines.

This program provides three dimensional or X-Y-Z plots of data. By adding this third dimension (Z), your measurement perception can be expanded. This is particularly useful in analyzing data which occurs intermittently or evolves with time. Reprinted from HANDSHAKE, Spring-Summer 1979.

4050-SERIES PROGRAM ABSTRACTS

6-5. Displaying 468 Waveforms

Instruments Required: 468 Oscilloscope
4662/4663 Plotter (optional)
Listing Length: 463 lines.

This program takes waveforms from the 468 Oscilloscope and displays them on the 4050-Series screen. Header information for Channel 1 and 2 and/or Add, Volts/Div, Time/Div, Trigger Point, Max Volts, and Min Volts is printed above the waveform. Waveforms can be saved to tape and redisplayed from tape. Output can be to the screen or a plotter with a reference scope grid. Waveforms displayed from tape are displayed as dots. This program is listed as Abstract #51/00-6125/0 in the 4050-Series Program Library.

6-10. Faster 7912AD Data Transfers

Instruments Required: 7912AD Programmable Digitizer,
4050R01 Matrix ROM (for 4051 only)
Listing Length: 16 lines.

This program provides a method of making fast data transfers between the 7912AD Programmable Digitizer and a 4050-Series Graphics Controller. Reprinted from HANDSHAKE, Fall/Winter 1979.

6-20. Graphing Waveforms With Full Graticule

Instruments Required: 4050R07 Signal Processing ROM Pack.
Listing Length: 147 lines.

This program provides graphing of digitized signals with a full graticule. Reprinted from HANDSHAKE, Winter 1978-79.

6-30. Graphing Waveforms With Tic-Marked Axes

Instruments Required: 4050R07 Signal Processing ROM Pack.
Listing Length: 49 lines.

This program graphs digitized waveforms. A full graticule is not displayed; only a set of tic-marked axes. Reprinted from HANDSHAKE, Fall/Winter 1979.

6-31. Listing 7854 Programs on the 4052

Instruments Required: 7854 Digitizing Oscilloscope.
Listing Length: 78 lines.

There is a difference between the format of programs transferred from the 7854 over the GPIB and the format of programs displayed on the 7854 CRT. The GPIB transfer format is designed to duplicate the way programs are entered from the 7854 Waveform Calculator. The CRT display format is simplified for easier reading. This program converts a 7854 program from the GPIB transfer format to the screen list format and displays it on the 4052 screen. Reprinted from HANDSHAKE, Fall 1982.

6-32. Phase Measurements Using the DC 5009 or DC 5010

Instruments Required: DC 5009 or DC 5010 Programmable Universal Counter
Listing Length: 66 lines.

This subroutine provides phase measurement capability using either the DC 5009 or DC 5010 Universal Counter Timer. The subroutine checks that the signal amplitude and signal frequency are within range and that the reference and input signals are the same frequency. The program automatically switches output data ranges between 0 to 360 degrees and -180 to +180 degrees.

6-35. Making the Most of Your Interrupts

Instruments Required: None.

Listing Length: Not Applicable.

This program provides the building blocks to help you use interrupts in your programs. While some program examples are given, the actual interrupt routines will need to be written by the user. Reprinted from HANDSHAKE, Winter 1981/82.

6-36. Semiconductor Switch Testing

Instruments Required: 7854 Digitizing Oscilloscope
7S12 TDR/Sampler

Listing Length: Loading 7854 program from 4052 - 12 lines.

Acquiring semiconductor switch waveforms - 55 lines.

Reading 7854 processing results into 4052 - 15 lines.

This two-part article describes semiconductor switch testing with the 7854, 7S12, and the 4052. Part I describes the concepts of acquiring the test waveforms. Part II discusses processing the acquired waveforms. Programs are provided for program transfer from the 4052 to the 7854, acquiring the test signals with the 7854, and reading these results into the 4052. Reprinted from HANDSHAKE, Spring/Summer 1982.

6-36A. Subroutine to Convert Values to Engineering Notation

Instruments Required: None.

Listing Length: 38 lines.

This routine converts values from scientific notation to engineering notation with the standard prefixes such as m for milli, u for micro, K for Kilo, etc. Reprinted from HANDSHAKE, Fall 1982.

6-37. Terminal Routine

Instruments Required: None.

Listing Length: 42 lines.

This program sets up a 4050 Desktop Computing System to operate as a terminal for use with the 4041 System Controller.

6-40. Transferring 468 Oscilloscope Waveforms from the 4924 to the 4050 Series

Instruments Required: 4924 Digital Cartridge Tape Drive

Listing Length: 79 lines.

The GPIB-compatible 4924 makes an excellent external storage device for the 468 digital Storage Oscilloscope. But 468 data is output in binary format, so the tapes cannot be read directly into the 4050 Series Graphic Computing System from its internal tape drive. The solution is to read the tape from the 4924 into the 4050 through the GPIB using this program. Reprinted from Techniques, Vol. 5, No. 2.

6-45. Using a DM 5010 to Automate AA 501 Readings

Instruments Required: DM 5010 Programmable Digital Multimeter
AA 501 Distortion Analyzer

Listing Length: 58 lines.

This program provides a method to automatically monitor the output of the AA 501 Distortion Analyzer with the DM 5010 Programmable Digital Multimeter. This allows the AA 501 measurement results to be acquired via the GPIB. This is accomplished through the rear interface connections on the AA 501 and DM 5010.

6-50. Utility Programs for the 492P

Instruments Required: 492P Spectrum Analyzer
4662/4663 Plotter (optional).
Listing Length: 1286 lines.

This program provides several utility routines to control the 492P Spectrum Analyzer with the 4052. Routines included are direct control of the 492P over the GPIB, waveform receive or transmit with single keystroke, rapid spectrum analysis, 492P command syntax tutorial, total harmonic distortion demonstration, and utility programs to duplicate tapes. This program is listed as Abstract #51/00-6124/0 in the 4050-Series Program Library.

6-60. Waveform Processing and Documentation with the 7854

Instruments Required: 7854 Oscilloscope.
Listing Length: 252 lines.

This program duplicates the 7854 Oscilloscope display on the 4052 Graphic Computing System screen. Once the waveform is transferred to the 4052, it can be stored on tape or copied on a hard copy unit. Reprinted from Techniques, Vol. 4, No. 8.

4040-SERIES PROGRAM ABSTRACTS

7-40. DEC 10/4041 Upload or Download

4041 Options Required: None.

Other Instruments Required: None.

Listing Length: Download - 86 lines.

Upload - 66 lines.

These two programs allow uploading and downloading software and data between a Digital Equipment Corporation DEC 10 Computer and a 4041.

7-50. Displaying Text on the 7854

4041 Options Required: None.

Other Instruments Required: 7854 Oscilloscope.

Listing Length: 28 lines.

This subprogram displays short program lines on the 7854 using the 7854 text mode. Text is limited to 12 lines and 40 characters.

7-70. Graphing 4041 System Controller Arrays

4041 Options Required: None.

Other Instruments Required: Tektronix 4025 or 4025A Computer
Display Terminal

Listing Length: 53 lines.

This program graphs a standard one-dimension 4041 array on the 4025 or 4025A screen. The array is graphed onto an eight-by-ten division grid, or graticule, and the data is automatically scaled to fill the grid vertically. Reprinted from HANDSHAKE, Fall 1982.

7-80. Listing 4041 Programs on a Printer

4041 Options Required: Second GPIB and RS-232C, Option 01
Keyboard, Option 31

Other Instruments Required: None.

Listing Length: 51 Lines.

7-80. Listing 4041 Programs on a Printer

4041 Options Required: Second GPIB and RS-232C, Option 01

Keyboard, Option 31

Other Instruments Required: None.

Listing Length: 51 Lines.

The 4041 has built-in hard copy capability that can produce program listings 20 characters wide. However, you may want wider format listings as they appear on a terminal. This program produces formatted program listings on a printer attached to the optional Comm Port.

7-100. Making the Most of Your Interrupts

4041 Options Required: None.

Other Instruments Required: None.

Listing Length: Not Applicable.

This program provides the building blocks to help you use interrupts in your programs. While some program examples are given, the actual interrupt routines will need to be written by the user. Reprinted from HANDSHAKE, Winter 1981/82.

7-140. Programmable Digital Delay

4041 Options Required: None.

Other Instruments Required: MI 5010 Programmable Multifunction
Interface

50M30 Digital Input/Output Card

DD 501 Digital Delay

Listing Length: 24 lines.

This program describes a technique for programmable digital delay using the MI 5010/50M30 to set the delay of the DD 501 Digital Delay unit under programmable control.

7-180. Waveform Acquisition and Display with the 492P

4041 Options Required: None.

Other Instruments Required: 492P Spectrum Analyzer.

Listing Length: 173 lines.

This program acquires waveforms using the 492P Spectrum Analyzer and displays them on a 4010 Terminal or a 4052 Option 1 Desktop Computing System.

7-200. Writing Signal Processing Routines for the 4041 System Controller

4041 Options Required: None.

Other Instruments Required: None.

Listing Length: Maximum - 12 lines.

Minimum - 12 lines.

Mean - 9 lines.

RMS - 9 lines.

Crossing Points - 35 lines.

Integration - 12 lines.

Differentiation - 12 lines.

These routines are part of an article which discusses how to write signal processing routines. The concepts of user-defined functions and subprograms are discussed. Then, user-defined functions are provided for finding maximum, minimum, mean, RMS, and crossing for arrays. Subprograms are described for array integration and differentiation. Reprinted from HANDSHAKE, Winter 1981/82.

7-210. 4041/RSX-11M File Transfer Program

4041 Options Required: Option 1, Second GPIB and RS-232C

Other Instruments Required: None.

Listings Length: 90 lines.

This program transfers files from the 4041 to an RSX-11M system or from RSX to the 4041.

7854 STAND-ALONE PROGRAM ABSTRACTS

8-10. Amplitude Comparison in dB

7854 Options Required: None.

Other Instruments Required: None.

Listing Length: 6 lines.

This program calculates the difference, in dB, between an input and an output waveform. The program is arranged so that only one probe is used to connect the signal to the 7854, thus minimizing probe-to-probe errors. After acquiring the input voltage, the program stops; after repositioning the probe, the program is restarted by again pressing RUN. At end of execution, magnitude difference (in dB) is displayed in the X register.

8-20. Area of X-Y Display

7854 Options Required: None.

Other Instruments Required: None.

Listing Length: 15 lines.

This program computes the area of an X-Y display from two time-related waveforms. Since the standard AREA command calculates only the area under the operational waveform (OPW), a program such as this one is necessary to compute area of X-Y displays.

8-30. Averaging Waveforms

7854 Options Required: None.

Other Instruments Required: None.

Listing Length: 11 lines.

This program enables you to measure and process the actual waveforms that make up an "averaged" waveform. This is not possible by simply using the "AVG" key. Substituting AQS for AQR will allow you to average single-shot waveforms.

After each waveform is acquired, you have the opportunity to measure or process before the next acquisition.

Applications include: 1) Calculating information about the sample of waveforms making up an averaged waveform. 2) Averaging processed waveforms rather than processing an averaged waveform.

8-40. Building Waveforms

7854 Options Required: None.

Other Instruments Required: None.

Listing Length: 12 lines.

This program builds a waveform based on the positions of CRS 1 and VZ\$ (vertical position), both of which are set manually. The program can be used to manually build a waveform based on a real-time waveform which is being displayed on screen. Each time the RUN button is pressed, the program draws a vector between the point defined by VZR and CRS 1 and the point at which RUN was previously pressed.

Applications: 1) Building "limit" waveforms to compare with an acquired waveform. 2) Building ideal waveforms to test programs.

8-45. Correlation

7854 Options Required: None.

Other Instruments Required: None.

Listing Length: 22 lines.

An auto-correlation or cross-correlation function is created for two waveforms if the two waveforms are, respectively, identical or different. The function is calculated for positive lags of one waveform with respect to the other. The cross-correlation function for negative lags can be created by simply transferring the memory locations of the two waveforms, and running the program again. The function is normalized to be within the range of plus one and minus one.

8-50. Characteristic Impedance (Z_0) from TDR Display

7854 Options Required: None.

Other Instruments Required: 7S12 TDR/Sampler Plug-In.

Listing Length: 3 lines.

This simple program calculates the characteristic impedance, Z , of a transmission line from its reflection coefficient (p). Reflection coefficient is determined by using a 7S12 Time Domain Reflectometer (TDR) plug-in with the 7854. Cursor 1 defines the reference impedance (50 ohms) and cursor 2, the unknown impedance.

8-55. Data Logging Using the 7D13A With the 7854

7854 Options Required: None.

Other Instruments Required: 7D13A Digital Multimeter.

Listing Length: 15 Lines.

The 7D13A plug-in can be used in conjunction with the 7854 to monitor DC voltage, resistance, DC current, or temperature over time. The 7854 can process data obtained by the 7D13A and construct a graph or waveform much like a chart recorder. A timing loop in the 7854 provides flexibility for setting the sample rate or time between samples and a graph may contain as many as 1024 points. Once the graph is complete, the 7854 can perform mathematical operations on the graph to provide information such as maximum, minimum, mean, peak-to-peak, mid, etc. Cursors enable the user to determine the value of each point on the graph or the difference between any two points. Applications include instrument or component environmental characterizations.

8-57. Delay Measurements

7854 Options Required: None.

Other Instruments Required: None.

Listing Length: Computing Delay - 34 lines.

Generating Test Waveform - 12 lines.

This program computes the delay between the 50% points on two digitized waveforms. An auxiliary program is included to generate a test waveform with a precise amount of delay to verify the accuracy of this program. Reprinted from HANDSHAKE, Winter 1981/82.

8-60. Envelope Mode

7854 Options Required: Option 2D for Maximum Points Per Waveform.

Other Instruments Required: None.

Listing Length: 25 lines.

This program is an envelope mode for the 7854. It is suitable for recording maximum and minimum voltage excursions from a reference waveform over time. Suggested program modifications are included to adapt this program to the specific application.

8-65. Finding Propagation Delay

7854 Options Required: None.

Other Instruments Required: None.

Listing Length: Simultaneous Acquisition of Input and Output

Waveforms - 3 lines.

Propagation Delay with Signal Averaging - 3 lines.

Using the Smooth Function to Increase Measurement

Accuracy - 4 lines.

Using the Cursors to Measure Propagation Delay - 12 lines.

This series of programs provides four methods of measuring propagation delay through a device under test. The first program provides a simple delay measurement. The second program averages the signal to get an even distribution of points on a transition to improve accuracy. The third program adds smoothing to eliminate aberrations for better location of the 50% points. The fourth program allows the cursors to be positioned manually on waveforms with a lot of ringing or overshoot where smoothing cannot be used.

8-70. Gain and Phase Measurements

7854 Options Required: None.

Other Instruments Required: None.

Listing Length: 14 lines.

This program measures the gain and phase differences between an input and output signal of an amplifier.

8-80. Least Squares Estimation

7854 Options Required: None.

Other Instruments Required: None.

Listing Length: 38 lines.

This multiple regression program computes a least squares estimation of a dependent variable (1 WFM) as a function of a linear combination of two independent variables (2 WFM, 3 WFM). The resulting equation takes the form:

$$1 \text{ WFM} = a + b(2 \text{ WFM}) + c(3 \text{ WFM})$$

Simple regression is possible if 3 WFM is a constant. The program will then estimate 1 WFM as a function of 2 WFM.

Applications include understanding the relationship between phenomena, and predicting or estimating a dependent phenomenon.

8-85. Limit Waveforms from an Envelope Using the 7D20

7854 Options Required: Option 2D.

Other Instruments Required: 7D20 Programmable Digitizer.

Listing Length: 12 lines.

Although ideal for visual limit tests by an operator, envelope waveforms are not well suited for mathematical limit testing. This program will transform an envelope waveform from the 7D20 into its two halves: an upper limit waveform and a lower limit waveform. Mathematical testing routines can then be executed with subsequent acquisitions by using the 7854 or a controller.

8-90. Logarithmic Sweep Display

7854 Options Required: None.

Other Instruments Required: None.

Listing Length: 5 lines.

This program displays a waveform with respect to log-time, as in a log-frequency plot. The program generates a waveform which is the logarithm

of a linear ramp, then displays the input waveform versus the log ramp. Although the log ramp is not calibrated, actual time information can be obtained using the cursors and the HCRD command.

8-95. Logging Energy Calculations

7854 Options Required: None.

Other Instruments Required: None.

Listing Length: 23 lines.

This 7854 applications program is designed to aid engineering and technical people compute energy from a power cycle and log the results from a large number of samples. Previously this had to be done by hand using CRT storage scopes and calculators to construct an approximation of a power curve and compute the energy dissipated. The 7854 enables this process to be accomplished much faster and with a higher degree of accuracy. In this example, the energy value for each iteration (sample) is used to construct a graph of energy vs sample number. When the graph is completed (256 samples taken), the standard deviation is calculated.

8-97. Measuring Settling Time

7854 Options Required: None.

Other Instruments Required: None.

Listing Length: 16 lines.

The program analyzes noise or ringing on a given waveform and determines when the noise settles out to within one percent of the peak to peak value of the pulse.

This program may also be used for locating cursors for pulse parameter measurements like propagation delay and risetime.

8-99. Optical Fiber Backscatter Measurements Enhanced by 7854

7854 Options Required: None.

Other Instruments Required: Fiber optic measurement instruments.

Listing Length: Not applicable.

Some backscatter analysis can be done visually from the OTDR display. However, in many cases, both the speed and depth of analysis can be enhanced by using signal processing such as provided by the 7854 Oscilloscope. A flow chart illustrates the measurement process. Reprinted from HANDSHAKE, Fall 1982.

8-100. Period Measurements of Eight Cycles of a Waveform

7854 Options Required: None.

Other Instruments Required: None.

Listing Length: 13 lines.

This program measures the period of eight consecutive cycles of an input waveform. Each value is stored in the corresponding constant register; i.e., first period value in 1 CNS, second value in 2 CNS, etc.

8-110. Pulse Measurements with Cursor Positioning

7854 Options Required: None.

Other Instruments Required: None.

Listing Length: Risetime, 8 lines.

Pulse width, 8 lines.

Both of these programs are very similar in that they make a pulse measurement by positioning the cursors at 2 divisions before and after the first transition of the input waveform.

8-120. Pulse Symmetry Measurement

7854 Options Required: None.

Other Instruments Required: None.

Listing Length: 10 lines.

This program measures the area under a pulse, calculating both the area from peak to left 50% point and area from peak to right 50% point.

Application: Verifying symmetry of a pulse.

8-130. Reverse Waveform in Time

7854 Options Required: None.

Other Instruments Required: None.

Listing Length: 7 lines.

Occasionally, it may be desirable to reverse a waveform in time for display or calculation. This program may be used to reverse a waveform with respect to time.

8-140. Risetime, 20% to 80% Levels

7854 Options Required: None.

Other Instruments Required: None.

Listing Length: 7 lines.

This program positions the cursors to the 20% and 80% points on an input step waveform. It is useful for applications which require 20%-80% risetime instead of the 7854's built in 10%-90% RISE command.

8-150. Running Maxima and Minima

7854 Options Required: None.

Other Instruments Required: None.

Listing Length: 9 lines.

This program continually acquires a signal, finding the minimum and maximum value and updating max and min stored in 1 CNS and 2 CNS. In other

words, the program keeps a running maximum and minimum of the input waveform. The program loops indefinitely until stopped manually.

The primary application is unattended monitoring of a signal.

8-160. Simultaneous XY and YT

7854 Options Required: None.

Other Instruments Required: None.

Listing Length: 17 lines.

You can easily display a waveform versus another in XY on the 7854. This program, however, will allow you to display the waveform in time simultaneously.

If you turn on one or both cursors, each will alternate between the XY and YT waveforms as the cursor(s) are moved. You can then see where on the YT waveform you are on the XY (within one point).

The cursor readout will function in its normal XY fashion. Time measurements on the YT waveform have to be done visually as long as you remain in XY, or you can press HCRD.

8-170. Standard Normal Distribution and One-Sided Probability Test

7854 Options Required: None.

Other Instruments Required: None.

Listing Length: 14 lines.

This program allows you to perform a one-tail probability test for a sample of measurement observations. For example, a right tail test computes the probability that the sample mean would be as large as observed, given the value of the population mean (that you would have expected to observe). Conversely, a left tail test computes the probability that the sample mean would be as small as observed.

A typical application would be manufacturing quality control where samples are periodically tested against a standard. The computation of the standard normal distribution (lines 001 thru 005) can be lifted out and the remaining program employed as a subroutine. You can also use the distribution to construct other statistical routines.

8-180. Storing Data as a Waveform and Standard Deviation

7854 Options Required: None.

Other Instruments Required: None.

Listing Length: 22 lines.

The standard deviation(s) is a measure of the spread of a distribution about its mean. This program computes "s" for a sample of n measurements which have been stored as 1 WFM. In this particular program, the measurement of interest is P-P. It could, however, be any desired parameter.

Applications: 1) Describing in statistical terms the spread of measurements from a sample of waveforms. 2) Establishing limits for testing purposes.

8-190. Time Jitter Measurement

7854 Options Required: Option 2D required for 1024 points per waveform.

Other Instruments Required: None.

Listing Length: 12 lines.

This program measures the amount of time jitter contained in a positive or negative transition (step).

8-200. User-Definable Keys

7854 Options Required: None.

Other Instruments Required: None.

Listing Length: 17 lines.

Using a very simple technique, it is possible to assemble a series of programs or routines, and access any single one with only two keystrokes. The numeric keypad on the 7854 Waveform Calculator can be overlayed with new definitions. By pressing an integer key and then pressing RUN, that routine defined by that key will be executed. An overlay template drawing is included should you desire to make one.

Using this technique, an operator can then be concerned with virtually only the numeric keypad while running through the desired series of measurement tasks.

APPLICATION NOTES

40AX-4614, External Storage for the 468 Digital Storage Oscilloscope

This application note describes use of the Tektronix 4924 Digital Cartridge Tape Drive to store waveform data from the 468 Digital Storage Oscilloscope.

42AX-4416, GPIB Communication with the 7854

This application note demonstrates interfacing of the 7854 over the GPIB to a 4052 Graphic Computing System and the 4924 Tape Drive. The discussion is supported by a variety of programs for transferring data, waveforms, text, and programs between devices.

42AX-4682, Introduction to 7854 Oscilloscope Measurement and Programming Techniques

The fundamentals of using the 7854 as a stand-alone tool for waveform digitizing and processing are introduced. Discussions include the basics of waveform storage, cursor measurements, and measurement programming with the Waveform Calculator. Automation of pulse analysis is used as the programming example.

42AX-4862, Automating Spectrum Analysis with the 7854

This application note discusses use of the Tektronix 7L-series of plug-in spectrum analyzers with the 7854 Oscilloscope. Background information on spectrum analyzers is given and the advantages of combining the spectrum analyzer with a waveform digitizer are discussed. To demonstrate some of the advantages, several example programs for spectrum analysis are given. These include routines for computing total harmonic distortion, automating spectral comparisons, and finding impulse bandwidth for EMI measurements.

45AX-3336, Windowing to Control FFT Leakage

Windowing is a technique used to control the leakage that may occur when the fast Fourier transform (FFT) is used to transform waveforms to the frequency domain. This application note describes leakage and the various window shapes that can be used to control it.

45AX-3481, Measuring Transistor Switching Times with the DPO

Transistor turn-on, turn-off, delay, and storage times cannot be specified exactly. Precise data can only be obtained by measurements on individual switching transistors. This application note tells how to acquire switching waveforms and lists a DPO and WDI TEK BASIC program for computing switching times.

45AX-3810, Automating Swept RF Measurements

Swept-frequency measurements of coaxial cables are the only way to go since Revision E to MIL-C-17. This application note provides detailed procedures for competitively obtaining excellent throughput and accuracy with an automated test system based on the TEKTRONIX Digital Processing Oscilloscope.

45AX-3903-1, Keeping Pace with Changing Needs in Optical Fiber Evaluation

This Concept Note covers basic optical fiber measurements that can be made with a TEKTRONIX Digital Processing Oscilloscope System. Numerical aperture, spectral attenuation, pulse spreading, transfer function and impulse response analyses, and swept-frequency measurements are covered in the note.

45AX-4011, Spectrum Analysis Systems

The Spectrum Analyzer has long been recognized as the most accurate and most versatile instrument for making a wide variety of RF component measurements. But what about documentation of the results? What about the computations involved? This concept note describes how a Digitizing Oscilloscope system can be used to provide automatic spectrum acquisition, analysis, and report generation.

99AX-4607, TEKTRONIX Codes and Formats for GPIB Instruments

The various concepts and philosophies followed by Tektronix in implementing the IEEE-488 standard instrument interface (GPIB) are discussed in this application note. Included is a discussion of TEK Codes and Formats, the additional standard used by Tektronix to assure consistent and friendly communication between Tektronix instruments and instrument controllers.

99W-5243, Nonlinear Least-Squares Using the Gauss-Newton and Marquardt Algorithms

Experimental data generally suffers from random errors, or noise, generated within the process or produced in the act of measuring the data. The least-squares method is one approach to estimating the parameter values that is relatively insensitive to noise.

99W-5244, An Overview of Disk System Testing

Waveform processing systems offer greater speed and reliability for many standard disk-system testing measurements. This technical note provides an overview of the system and some of the tests that can be made with a waveform processing system.

TECHNICAL NOTES

TN-0000, Digital Acquisition and Analysis of the Electroencephalogram

Frequency domain analysis of electrical activity in the brain has been applied by researches since they were first able to measure and display the electroencephalogram (EEG). This technical note describes application of a Digitizing Oscilloscope system to these measurements.

TN-0003A, Alternative Methods of Measuring Optical Fiber Attenuation with the Digital Processing Oscilloscope

This note reviews the alternative methods of the fiber attenuation measurement and demonstrates the Tektronix solution to these various measurement requirements.

TN-0004A, A Review of Error Reduction Methods for Optical Fiber Transmission Measurements

This note includes a summary of an optical fiber measurement system, error sources, signal acquisition considerations, and a good list of applicable fiber optics references.

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