

4051 Applications Library Newsletter

TEKTRONIX, INC.

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VOLUME 1 NUMBER 1

THE 4051 AND THE STANDARD INSTRUMENTATION INTERFACE

The technological advances that have brought the highly visible growth and increase in sophistication of the computer industry over the last ten years have had a parallel effect on measurement devices and instrumentation in general. The instrumentation of today is versatile and highly programmable and justifies the need for a general purpose interface standard. This need arose slowly and is now clearly upon us.

The importance of a standard to many customers is hard to over-estimate. It means that equipment built to comply with the standard should work together as a system.

Whether you want to monitor and analyze processes, or control processes, the Tektronix 4051 Graphic System has the capability built in. First on the list of the advantages the 4051 offers over former test and process controllers is that it has a new standardized, general-purpose, interface system (GPIB). It is at the forefront of a new era of instrument test measurement and process control.

Previously measurement devices were all analog in nature using panel meters to indicate values for measurements that had been made. Some devices that were inherently digital in nature (counters, for example) began appearing with easy-to-read digital displays (nixie tubes).

Once displays became digital, manufacturers began to supply output-only interfaces to allow the display readings to be transferred to recording devices such as digital strip printers. In this way the "numbers" from the instruments were permanently recorded with no need for anyone to record them. To perform computations with these numbers, still required someone to key them into a terminal or key punch and direct transfer of data from the instrumentation to the computer (sometimes via paper tape). A number of custom interfaces appeared which allowed specific instruments to output data to specific computers.



A device such as the frequency counter just discussed has an analog input and a digital output. From the standpoint of the digital information, the frequency counter may then be referred to as a "talk only" device.

"Listen only" devices also exist. Just as measurement devices can talk to a computer, those devices capable of generating stimuli or other signals may be programmed by a computer and are classified as listeners. A waveform generator is an example of such an instrument. A number of waveform generators exist having output frequencies and amplitudes which are programmable digitally via interfaces specific to the brand and model of instrument.

The 4051 may talk, listen, or control, according to its program and signals on the GPIB.

With the growing popularity of instruments with digital interfaces came an even greater number of interfaces with differing mechanical, electrical, and functional specifications. Some devices required two interfaces, one for input and one for output. A

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4051 APPLICATIONS LIBRARY NOW AVAILABLE

Tektronix has just announced the availability of a wide variety of user programs in its new 4051 Applications Library.

The new programs include Business Analysis, Sales Commission, Utilities and Graphics, to name a few.

The Library service is intended to save the time and expense of developing software that may already be available. Furthermore, it will provide a means for users to distribute copies of programs which they feel are worthwhile.

New programs are continually being added to the library and abstracts will be published in each issue of this newsletter.

Users with application programs are encouraged to submit them. In exchange for having a program included in the library, the user will receive a choice of 3 free programs, plus a blank tape in return for the tape submitted.

Please join us! Members will receive the monthly newsletter containing application notes, application program abstracts, programming tips, and an index of new programs submitted and approved during the previous month.

Documentation forms, submittal instructions and order forms will be mailed to all members.

Please fill out and return the attached membership card.

LET US HEAR FROM YOU

The Applications Library Newsletter is designed to provide general information and communications between 4051 users as well as abstracts of programs in the library.

To be effective, the Newsletter needs articles from customers in addition to the articles by Tektronix personnel. Your programming tips or discoveries while using the 4051 are of interest to other users.

Send a copy of your article to: Tektronix, Inc., "Applications Library Newsletter 60-369, PO Box 500, Beaverton, Oregon 97077.

Name This Newsletter

Tektronix is offering a copy of all the 4051 programs in the new Applications Library to the person who supplies the winning name for this newsletter.

Entries will be judged by a committee from Tektronix Engineering and Marketing. The winner will be chosen on the basis of originality and appropriateness to the purpose and contents of the newsletter.

All entries must be submitted no later than December 15, 1976, and the winner will be announced in the February issue.

First prize is a copy of all the 4051 library programs as of December 15, 1976.

Entries can be submitted to: "Application Newsletter Name Contest", PO Box 500, Beaverton, Oregon 97077. Applications Library 60-369.



Speeding Up the 4051

1. The multiplication operator (*) normally requires 6 milliseconds to multiply two numbers. But if the left operand is a "nice" binary number then it requires only 2 milliseconds.

e.g.

PI*3	6 ms.
3*PI	2 ms.
PI/2	8 ms.
0.5*PI	2 ms.

"nice" binary numbers:

1, 2, 3, 4, 5, 6, 7, ...
.5, .25, .125, .0625, .75, .625, ...

"bad" binary numbers:

.1, .2, .3, .4, .6, PI, e, ...

2. The concatenation operator (&) is not very "smart." If it is used for:

A\$=A\$&B\$

then "&" does not recognize that A\$ appears on both sides of the equation. Therefore, A\$ is copied into itself at 0.1 ms per character.

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4051 APPLICATIONS LIBRARY ABSTRACTS

Documentation and program listings of these programs may be ordered for \$15.00 each. Programs will be put on tape for an additional \$2.00 handling charge per program and a \$26.00 charge for the tape cartridge.

Please use the Applications Library Order Form.

BUSINESS ADMINISTRATION

ECONOMICS

ABSTRACT NUMBER: 51/00-0301/0

Title: *Average Elasticity of Demand*
Author: Kathy Thurman
Memory Requirement: 8K
Peripherals: None

ABSTRACT: This program will calculate average elasticity of demand within price intervals. Maximum revenue occurs at the elasticity index of 1.

The user is asked to input:

1. The number of unit prices to be considered.
2. The prices to be considered and the quantity demanded at each price.

The output is in the form of a table showing the quantity demanded and elasticity index for each price interval.

SECURITY/INVESTMENTS

ABSTRACT NUMBER: 51/00-0602/0

Title: *Required Bank Reserve*
Author: Kathy Thurman
Memory Requirement: 5.6K
Peripherals: None

ABSTRACT: This program will calculate the required bank reserve and will print a Statement of Reserve Position as of the close of any given business day. In addition it will print a table showing levels of demand deposits to $\pm 1\%$ of the actual demand deposits, the required reserve for each level, excess or deficiency of reserve, cumulative position and Federal funds value.

ANALYSIS

ABSTRACT NUMBER: 51/00-0701/0

Title: *Moving Average*
Author: Kathy Thurman
Memory Requirement: 8K
Peripherals: None

ABSTRACT: This program will calculate a moving average of any number of data items. The number of items included in each average may be any size. Averages are displayed serially and in a bar graph.

User is asked to input:

1. Title for the figures. This will be displayed both on the numeric printout of the averages and on the bar graph.
2. Number of data items to be averaged.
3. Number of data items to be included in each average.
4. All data to be averaged.

ABSTRACT NUMBER: 51/00-0702/0

Title: *Single Moving Averages With Graphics*
Author: Dennis R. Heckman
Memory Requirement: 13250—16500 bytes
Peripherals: 4662 Optional
4924 Optional

ABSTRACT: This program is designed to calculate forecasts on time series data corresponding to an intrinsic model

$$\xi_t = a_0(t) + \epsilon$$

where $a_0(t)$ is presumed to be a constant and ϵ represents random error. The program accepts data either from the keyboard or from magnetic tape. It allows modification of the data, produces plots or listings of the data, and using parameters selected by the operator produces tabular or graphic representation of the forecast computations.

The computation and plotting of all moving averages is uncentered. Centering the plots by selecting negative forecast intervals will result in erroneous computations.

ABSTRACT NUMBER: 51/00-0703/0

Title: *Double Moving Averages With Graphics*
Author: Dennis R. Heckman
Memory Requirement: 13800—17050 bytes
Peripherals: 4662 Optional
4924 Optional

ABSTRACT: This program is designed to calculate forecasts on time series data corresponding to an intrinsic model

$$\xi_t = a_0(t) + a_1(t) \cdot t + \epsilon$$

where $a_0(t)$ is presumed to be a constant, a_1 is presumed to be a constant value of increase or decrease, and ϵ represents random error. The program accepts data either from the keyboard or from magnetic tape. It allows modification of the data, produces plots or listings of the data, and using parameters selected by the operator produces tabular or graphic representation of the forecast computations.

The computation and plotting of all moving averages is uncentered. Centering the plots by selecting negative forecast intervals will result in erroneous computations.

ABSTRACT NUMBER: 51/00-0704/0

Title: *Single Exponential Smoothing With Graphics*
Author: Dennis R. Heckman
Memory Requirement: 13300—16600 bytes
Peripherals: 4662 Optional
 4924 Optional

ABSTRACT: This program is designed to calculate forecasts on time series data corresponding to an intrinsic model

$$\xi_t = a_0(t) + \epsilon$$

where $a_0(t)$ is presumed to be a constant and ϵ represents random error. The program accepts data either from the keyboard or from magnetic tape. It allows modification of the data, produces plots or listings of the data, and using parameters selected by the operator produces tabular or graphic representation of the forecast computations.

ABSTRACT NUMBER: 51/00-0705/0

Title: *Double Exponential Smoothing With Graphics*
Author: Dennis R. Heckman
Memory Requirement: 13900—16900 bytes
Peripherals: 4662 Optional
 4924 Optional

ABSTRACT: This program is designed to calculate forecasts on time series data corresponding to an intrinsic model

$$\xi_t = a_0(t) + a_1(t) \cdot t + \epsilon$$

where $a_0(t)$ is presumed to be a constant, a_1 is presumed to be a constant value of increase or decrease, and ϵ represents random error. The program accepts data either from the keyboard or from magnetic tape. It allows modification of the data, produces plots or listings of the data, and using parameters selected by the operator produces tabular or graphic representation of the forecast computations.

ABSTRACT NUMBER: 51/00-0706/0

Title: *Triple Exponential Smoothing With Graphics*
Author: Dennis R. Heckman
Memory Requirement: 13600—17600 bytes
Peripherals: 4662 Optional
 4924 Optional

ABSTRACT: This program is designed to calculate forecasts on time series data corresponding to an intrinsic model

$$\xi_t = a_0(t) + a_1(t)t + a_2(t)t^2/2 + \epsilon$$

where $a_0(t)$ is presumed to be a constant, a_1 is presumed to be a constant value of increase or decrease, a_2 is presumed to be a constant value of acceleration or deceleration, and ϵ represents random error. The program accepts data

either from the keyboard or from magnetic tape. It allows modification of the data, produces plots or listings of the data, and using parameters selected by the operator produces tabular or graphic representation of the forecast computations.

ABSTRACT NUMBER: 51/00-0707/0

Title: *Single Weighted Averages With Graphics*
Author: Dennis R. Heckman
Memory Requirement: 13800—16700 bytes
Peripherals: 4662 Optional
 4924 Optional

ABSTRACT: This program is designed to calculate forecasts on time series data corresponding to an intrinsic model

$$\xi_t = a_0(t) + \epsilon$$

where $a_0(t)$ is presumed to be a constant and ϵ represents random error. The program accepts data either from the keyboard or from magnetic tape. It allows modification of the data, produces plots or listings of the data, and using parameters selected by the operator produces tabular or graphic representation of the forecast computations.

The computation and plotting of all moving averages is uncentered. Centering the plots by selecting negative forecast intervals will result in erroneous computations.

ABSTRACT NUMBER: 51/00-0708/0

Title: *Double Weighted Averages With Graphics*
Author: Dennis R. Heckman
Memory Requirement: 14400—17500 bytes
Peripherals: 4662 Optional
 4924 Optional

ABSTRACT: This program is designed to calculate forecasts on time series data corresponding to an intrinsic model

$$\xi_t = a_0(t) + a_1(t) \cdot t + \epsilon$$

where $a_0(t)$ is presumed to be a constant, a_1 is presumed to be a constant value of increase or decrease, and ϵ represents random error. The program accepts data either from the keyboard or from magnetic tape. It allows modification of the data, produces plots or listings of the data, and using parameters selected by the operator produces tabular or graphic representation of the forecast computations.

The computation and plotting of all moving averages is uncentered. Centering the plots by selecting negative forecast intervals will result in erroneous computations.

ABSTRACT NUMBER: 51/00-0709/0

Title: *Petroleum Risk Analysis I*
Author: Dennis R. Heckman, T. A. Peters
Memory Requirement: 12000—14000+ bytes
Peripherals: 4662 Optional

ABSTRACT: The probabilistic nature of drilling for petroleum has long been recognized by oil men. Only with the advent of electronic computational machines, however, have petroleum engineers had sufficient calculating speed to perform the considerable mathematical steps necessary for a statistical approach.

The Risk/Analysis program is such an approach. Basically, it is a Monte Carlo simulation of an undiscounted net profit model which is driven by random numbers operating on cumulative probability distributions of basic data parameters.

This program treats nine petroleum reserve variables stochastically, giving each a triangular distribution based on three values supplied by the users: minimum, most likely, and maximum. For example, porosity might be known to vary within a range of 15% to 25%, but most likely will be near 18%. These values will be input to the Risk Analysis program. The individual porosity used for each iteration will be that calculated with a random number from the cumulative probability distribution defined by the three values.

The other stochastic variables are net pay, area, oil or gas recovery factor, oil or gas saturation, oil formation volume factor or P/Z, gas liquid ratio, oil price, and gas price. Single valued inputs are investment, working and net interests, operating costs, production tax rates, and reservoir temperature.

Operation of the program is simple and straight-forward. The program requests data to be supplied. Corrections or changes (such as that for sensitivity analysis) can be made simply by writing over the value(s) in the machine. Output can be a graphical or tabular record of undiscounted net profit versus cumulative probability of achieving same.

ABSTRACT NUMBER: 51/00-0710/0

Title: *Petroleum Economic Analysis I*
Author: Dennis R. Heckman, T. A. Peters
Memory Requirement: 12400—13800 bytes
Peripherals: 4662 Optional

ABSTRACT: Economic analysis of buying or selling petroleum production or of drilling development wells, is easily accomplished with this program. Fifteen single-valued variables are entered, along with a series of annual oil and gas predicted sales volumes. Results are annual cash flows, cumulative present worths, a rate-of-return on the investment, and a profit-to-investment ratio.

The user decides whether the property is to be evaluated in oil or gas. This decision is necessary because cost depletion and operating cost is calculated on the basis of oil or gas production.

ABSTRACT NUMBER: 51/00-0711/0

Title: *Petroleum Water Influx I*
Author: Dennis R. Heckman, T. A. Peters
Memory Requirement: 15000—16800 bytes
Peripherals: 4662 Optional

ABSTRACT: Estimation of water influx into a petroleum reservoir from an adjacent aquifer is an important calculation to the petroleum engineer. This program permits computation of that influx as a function of time and pressure, for limited or infinite aquifers. The program utilizes the unsteady-state application due to Hurst and Van Everdingen. Additionally, the Brunsetal correlations of dimensionless flow rates with dimensionless time are included.

The proper correlation equations to be used will depend on the value of R_a/R_r ratio which is input. There is a different upper limit to dimensionless flow rate for each of the limited values of R_a/R_r ratio.

ABSTRACT NUMBER: 51/00-0712/0

Title: *Oil Reserves*
Author: Dennis R. Heckman, T. A. Peters
Memory Requirement: 5100—6700 bytes
Peripherals: 4641 Printer-Optional

ABSTRACT: A petroleum engineering program for the determination of oil-in-place and the total amount of recoverable oil in a reservoir. The reservoir may be a water drive or a gas drive (depletion). Input required includes both reservoir volume and formation properties (rock, fluid, and gas factors). Individual variables may be changed and a new solution obtained without entering all variables.

ABSTRACT NUMBER: 51/00-0713/0

Title: *Gas Reserves*
Author: Dennis R. Heckman, T. A. Peters
Memory Requirement: 5250—6500 bytes
Peripherals: 4641 Printer-Optional

ABSTRACT: A petroleum engineer's program for the determination of total in-place gas and total recoverable gas in a reservoir. Features include calculations based upon reservoir size and geologic characteristics. Multiple solutions may be derived without re-entry of all variables. The reservoir pressure base may be chosen for different states of the Federal Power Commission's base.

PAYROLL

ABSTRACT NUMBER: 51/00-0801/0

Title: *Sales Commission Projection*

Author: Kathy Thurman

Memory Requirement: 2.2K

Peripherals: None

ABSTRACT: In response to values for variables input by the user, this program will print a table for the number of months specified (up to 12) showing the following projections:

1. Monthly base salary
2. Monthly commissions
3. Total monthly pay package
4. Monthly sales
5. Total sales to date

Payroll as a percent of sales is also computed as is total salary plus commission for the period specified.

SCIENTIFIC

MATHEMATICS

ABSTRACT NUMBER: 51/00-5501/0

Title: *Plane Triangle Solutions*

Author: Dan Taylor

Memory Requirement: 16K

Peripherals: None

ABSTRACT: *Plane Triangle Solutions* is an interactive program which graphically demonstrates the relationship between sides and angles of a triangle.

The user enters any three of the three sides and three angles of a triangle. The program solves for the unknown sides and/or angles and prints their values. It then draws the triangle with the sides and angles labeled with their values.

ABSTRACT NUMBER: 51/00-5502/0

Title: *Circle Solutions*

Author: Dan Taylor

Memory Requirement: 8K

Peripherals: None

ABSTRACT: *Circle Solutions* is an interactive program which graphically demonstrates the relationship between a sector and its circle.

The user enters any two of the angle, radius, chord, or arc of a sector. The program solves for the unknowns and prints their values. It then draws the circle and the sector and labels the portions of the sector.

UTILITY

GENERAL

ABSTRACT NUMBER: 51/00-8001/0

Title: *List Program's Statement Types*

Author: Brian Diehm

Memory Requirement: Minimum Configuration

Peripherals: None

ABSTRACT: This program reads a tape file containing a BASIC program and prints an alphabetized list of all the statement types used in that program, together with the number of occurrences of each statement type. Then the list is sorted in decreasing order by number of occurrences and reprinted. The program first asks the user which tape file contains the program to be analyzed. Then, after reading the file, the alphabetized list of statement types is printed, with the count of the occurrences of each type. This is followed by a total of the number of statements in the analyzed program. Provision is made to allow processing of several files, combining the results into one list.

ABSTRACT NUMBER: 51/00-8002/0

Title: *List Program's Variables*

Author: Brian Diehm

Memory Requirement: Minimum Configuration

Peripherals: None

ABSTRACT: This program reads a tape file containing a BASIC program and prints an alphabetized list of all the variables used in that program. The program first asks the user which tape file contains the program to be analyzed. Then, after reading the file, two alphabetized lists of variables are printed on the screen. The first list gives all of the numeric variables' names, the second list gives all the string variables' names. Provision is made to allow processing of several files, combining the results into one list.

MISCELLANEOUS

CAPABILITY

ABSTRACT NUMBER: 51/00-9001/0

Title: *Hand Calculator*

Author: Brian Diehm

Memory Requirement: 16K

Peripherals: None

ABSTRACT:

INTRODUCTION

A. This program allows the 4051 to be used in a manner similar to several hand-held calculators currently on the market, specifically those operating in reverse "Polish" notation with a 4 place operational stack.

B. The input to the program is completely accomplished by use of the function keys. Input is interactive with the user; just like a hand-held calculator.

C. Output is placed on the screen. As each new display is presented, it is written on the screen below the previous one. Also, a record of the input keys is provided on the screen.

ABSTRACT NUMBER: 51/00-9003/0

Title: *Truncation Utility*
Author: Judy Peterman
Memory Requirement: 8K
Peripherals: None

ABSTRACT: This program illustrates a one-line process which allows the user to truncate a number to a specified number of digits (not the number of digits to the right of the decimal point—the **total** number of significant digits). It can be used to avoid round-off error or to prepare for a PRINT USING format.

GRAPHICS**ABSTRACT NUMBER: 51/00-9502/0**

Title: *Neat Tics and Axis Labeling*
Author: Dan Taylor, Kathy Thurman
Memory Requirement: 2.3K
Peripherals: None

ABSTRACT: This program is a subroutine designed to be used with a user program. The subroutine prepares the screen for a user graph by:

1. Calculating "neat" tic lengths
2. Setting the WINDOW
3. Setting the VIEWPORT
4. Drawing an axis and labeling the tic marks. The axis is drawn through user data value 0 (or data min if 0 is not in the WINDOW). Tic labels always appear to the left and bottom of the screen.

ABSTRACT NUMBER: 51/00-9503/0

Title: *Linear Axis Labeling Routine*
Author: Steven Den Beste
Memory Requirement: 7.5K
Peripherals: None

ABSTRACT: This subprogram generates an L-shaped axis, with tics and label, covering any plot range; and places it anywhere on the screen. It requires 10 input variables, and passes back 8 of them to describe the plot exactly.

For orientation, a grid of points is generated within the plottable areas. A point is placed at the intersection of any two intersections; and at the intersection of any tic and zero, if zero is within range. (This is optional.)

ABSTRACT NUMBER: 51/00-9504/0

Title: *Log/Linear Axis Labeling Routine*
Author: Steven Den Beste
Memory Requirement: 8.1K
Peripherals: None

ABSTRACT: This subprogram generates an L-shaped axis with logarithmic or linear labeling on either axis, covering any range of values, and placed anywhere on the screen.

A pair of transformation functions are defined for user plot time.

PROGRAMMING HINTS—4051

continued from page 2

An alternative way to append B\$ to A\$ is to execute:

$$A\$ = \text{REP}(B\$, 1 + \text{LEN}(A\$), 0).$$

This is faster than $A\$ = A\$ \& B\$$ if $\text{LEN}(A\$) > 110$. If $\text{LEN}(A\$) = 60$ then REP is 20% slower. If $\text{LEN}(A\$) > 1000$ then REP is several times faster—the longer A\$ gets the more significant it becomes.

3. Use array commands whenever possible:

e.g.

```
DIM H(20), X(100), Y(100)
H=0
READ @33:H
DRAW X,Y
```

Array commands are usually 2-5 times faster than a FOR/NEXT loop.

4. Store numbers in binary tape files. Binary is 2-4 times faster than ASCII for numbers.
5. Use control characters to eliminate unnecessary lines of code such as:

```
L = PAGE
↑ = HOME
- (Control rubout) does a carriage return
and line feed = PRINT [with nothing
following]
```

The user saves space (10 bytes overhead/line) and time (0.5 ms overhead/line).

by Dan Taylor

IEEE Specs Available

Copies of IEEE 488-1975 Standard may be ordered by contacting:

IEEE Standards
 345 East 47 Street
 New York, N.Y. 10017

The official title of the publication is "IEEE Standard Digital Interface for Programmable Instrumentation — SHO4887" and the one copy price is \$10.00. Ten to fifty copies receive a 10 percent discount. The document is highly technical but is very useful to those who need it.

By Ken Cramer

multimeter could be such a listener/talker capable of being programmed by a computer-controller to a measurement setting of volts, dc and range of 100.00 full scale. The multimeter could then make a measurement and output the reading in a digital format for use by the computer.

The 4051 constitutes a universal tool for controlling sophisticated processes by continually acquiring and analyzing data before issuing new program instructions to its listeners.

EVENTS LEADING TO A STANDARDIZED INTERFACE

The traditional approach to interfacing such instrumentation has been to provide each device with specialized control, data, and status signal lines. This works well, but has resulted in as many interface solution techniques as there are design engineers. The net result was a dedicated interface structure for each device or instrument integrated into a system. This then led to the design of many interface adapters to accommodate the ever increasing variety of codes, formats, signal levels, logic conventions and timing protocols, to name only a few factors.

Initial attempts were made to standardize the inter-

faces from the perspective of the computer or controller. Such a solution proved too costly as more sophisticated instrumentation had many programmable inputs and many output lines and began to require as much as 100 interface signal lines. At this point both International and American instrumentation manufacturers began an effort toward a proper solution.

The needs of the entire instrumentation community are varied and one interface solution can not satisfy all requirements. It is the most frequent needs which required standardization.

The General Purpose Interface Bus (GPIB) of the 4051 Graphic System was designed as a convenient, easy to implement, and powerful communications link between the 4051 and compatible devices as well as a link between the devices themselves.

A Standard is Accepted

The applicable U.S. Standard is Standard Digital Interface for Programmable Instrumentation (IEEE STD 488-1975/ANSI Standard MC1.1-1975) that was adopted last year.

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