

DataPlus™—A Revolutionary Applications Generator for DOS Hand-Held Computers

David Dean and Linda Dean

Abstract.—DataPlus allows the user to easily design data collection templates for DOS-based hand-held computers that mimic clipboard data sheets. The user designs and tests the application on the desktop PC and then transfers it to a DOS field computer. Other features include: error checking, missing data checks, and sensor input from RS-232 devices such as bar code wands, calipers, electronic balances, GPS receivers, laser rangefinders, and water quality transmitters. DataPlus is developed for the nonprogrammer, yet robust enough for the professional software developer. DataPlus was designed with natural resource data collection in mind.

For many years forest managers have been aware of the benefits of using hand-held computers. Their cost effectiveness, portability, ruggedness, speeding the time from field to data analysis, and improved data integrity are well known.

Through the years the hand-helds have evolved from proprietary operating systems to standard DOS operating systems. However, software is still a dilemma. Custom software can be costly, and time consuming, and it needs to be developed and supported by a programmer. Most standard DOS programs require large amounts of memory, have desktop applications in mind, and do not take small display sizes into consideration.

DataPlus eases the software dilemma. It is designed specifically for field data collection applications, taking into account the hand-held constraints. It is also developed for the nonprogrammer, but robust enough for the professional software developer.

DataPlus allows the user to easily design data-collection templates that mimic clipboard data sheets. It supports many features to customize your application including error checking of data and serial input from external devices. Since the applications generator is Windows-based, the data-collection templates are built using familiar, user-friendly setup screens. The templates resemble the rows, columns, and column headings used in PC spreadsheet programs. Once the application is defined and tested, the template setups are loaded into the hand-held computer for use in the field.

This paper describes the features of two versions of DataPlus. DataPlus For DOS and the newest version called DataPlus Professional. DataPlus Pro has everything that DataPlus For DOS offers but adds features that software developers and information systems managers will appreciate and have requested.

DATAPLUS FOR DOS OVERVIEW

DataPlus For DOS includes three separate programs:

1. Data collection software used with DOS-based hand-held computers.
2. A Windows-based applications generator for the PC. It is used to customize applications for the hand-held.
3. Communications software package, called DataPlus Host, used for transferring the collected data between the host computer and the remote hand-held.

DataPlus For DOS is compatible with most DOS-based IBM compatible hand-held computers. Supported display sizes range from 6 to 25 lines and from 20 to 80 columns. Two hand-held versions are included: one is for use with a 286 or greater processor and the other version is for 8088 or greater processors. Minimum hand-held hardware configurations include DOS 3.1 or greater, 540K of free RAM, and 500K of free disk space. Minimum hardware configurations for the PC include Windows 3.1 or greater, 4 Meg of RAM, and 3 Meg of free hard disk space.

DataPlus can be set up in a variety of ways, from basic to very complex, through the following features:

1. Provides one or two data levels for numeric or character columns.
2. Data entry types beyond keyboard such as serial devices and timers.
3. Facilitates automatic data entries to avoid repetitive keyboard input.
4. Facilitates data validation through a system of error checking.

President and Technical Services Manager and VP/
Marketing and Sales, respectively, Electronic Data
Solutions, Jerome, ID, USA, developer of DataPlus.

5. Ensures that data are entered by checking for missing data.
6. Presents data in a wide variety of ways according to the user's needs.
7. Allows the order in which data are entered to be controlled according to the data already entered.
8. Provides a variety of search methods.
9. Transfers data and applications between PC and hand-held computers through a direct or modem connection.
10. Stores data in Xbase style DBF formats.
11. Converts Xbase style DBF formats to ASCII files.
12. Allows testing of the application on the PC before using it in the field.

DEFINING AN APPLICATION

Data Format

Once a new application is named, the main screen shown in figure 1 will appear. First, the hand-held display size is set to match the display for the particular hand-held for which the application is being generated.

Next, there can be either one or two Data Levels depending on the type of data being collected. For a "one-to-many" relationship, Data Level 1 is general (header) information that applies to Level 2 data. Level 2 data is a detailed breakdown of data that applies to the general

information in Level 1. If general information is not required, one Data Level would be used. For this example, two Data Levels are selected. Total columns for each level are also set from the main screen.

After the number of columns is set for Data Level 1, the data format for Data Level 1 is defined by clicking on the Define Data Format button. The Data Format screen appears as in figure 2. The prompt can be up to 10 characters. The column size for character columns can be up to 30. Numeric columns can be as many as 15 including the decimal point. Once Data Level 1 settings are entered, the same procedure can be followed for Data Level 2. Editing can be done by using the Add, Insert, and Delete buttons.

Screen Define

The way data are displayed to the user on the hand-held can be modified using the Screen Define tab (fig. 3) from the Edit Standard or Advanced Setups button on the main screen. Line or Virtual screen types are available. A Line screen type format shows only one line of data at a time on the screen. The number of prompts and columns that can be viewed at one time is determined by the screen size. All information that will fit on the screen is displayed at one time. The rest of the data are displayed on subsequent screens. A Virtual screen type format presents

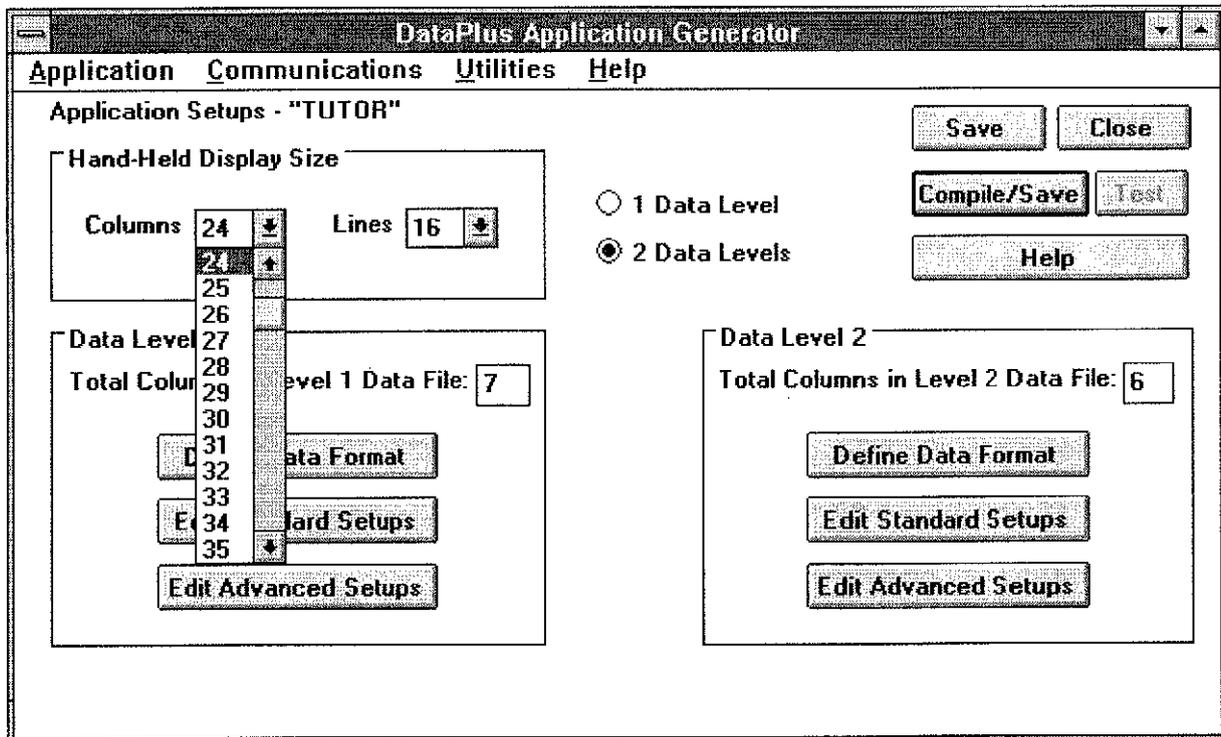


Figure 1.—DataPlus For DOS allows the application to be customized for the hand-held computer display size.

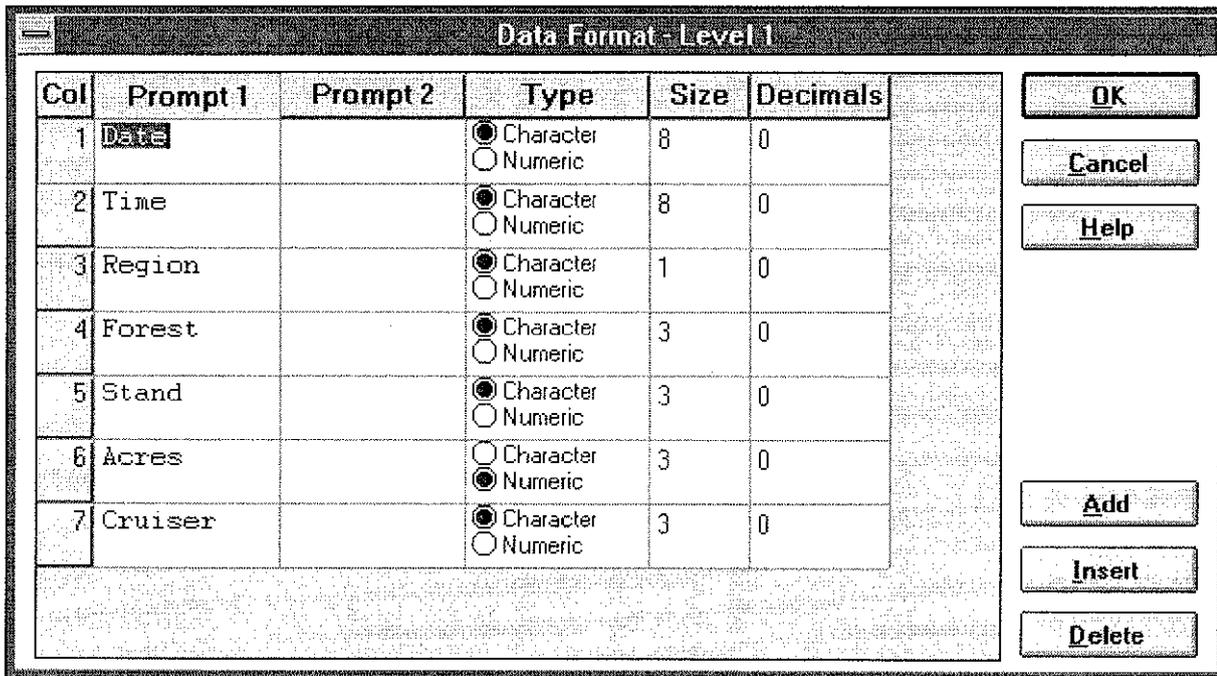


Figure 2.—Data format is defined for header information using DataPlus For DOS.

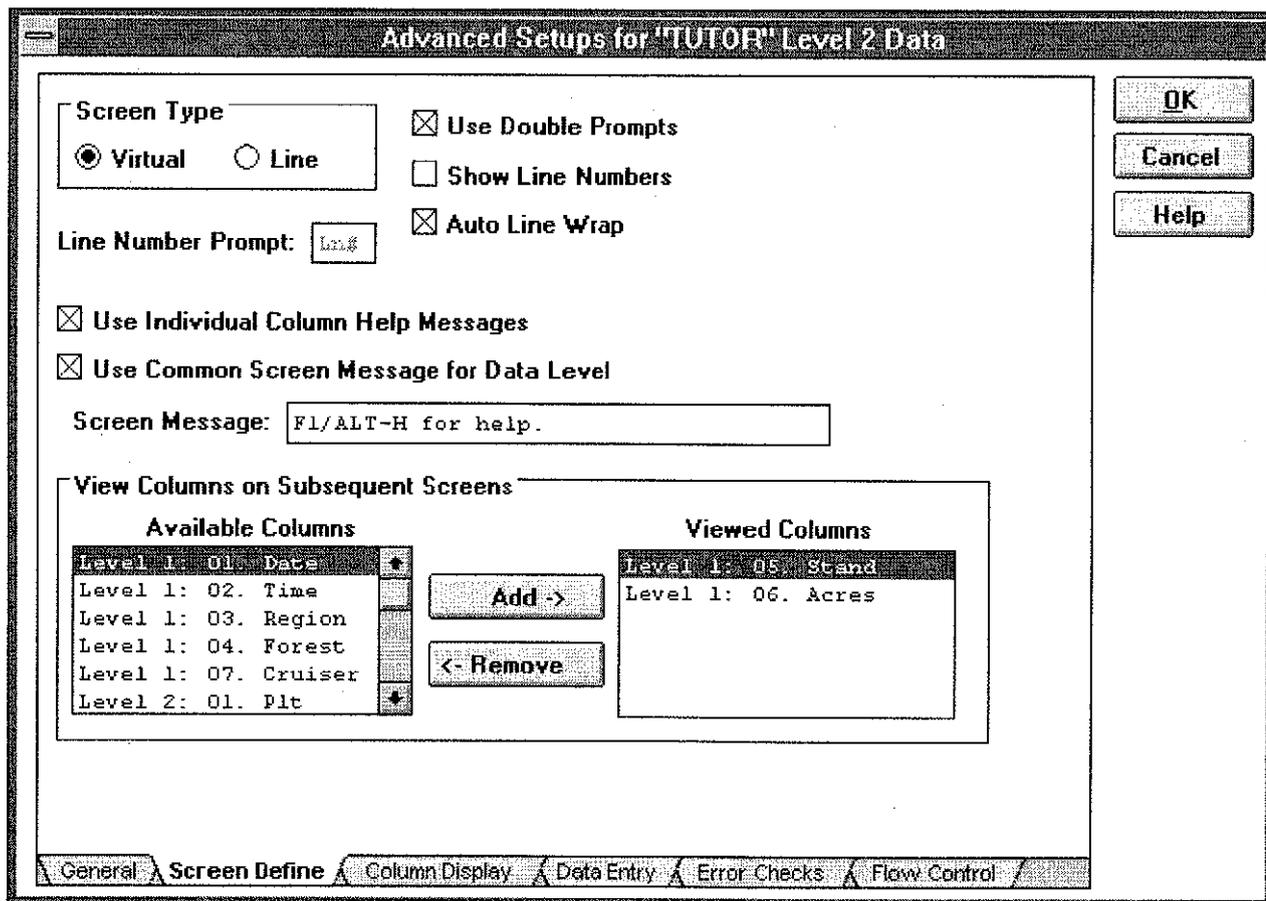


Figure 3.—Using DataPlus For DOS, Screen Define options allow specific columns from previous screens to be viewed on subsequent screens.

data in lines and columns. As many lines and columns that will fit on the screen at one time are presented together. The screen becomes a virtual window into the data that moves around with the cursor. Other Screen options that can be defined include:

1. Double lined prompts.
2. Auto line wrap. When enabled, the cursor automatically advances (wraps) to the next or previous line.
3. Show a particular column on subsequent screens.
4. Help messages can be defined for each column.
5. Columns can also be set to view only or be hidden to prevent user input.
6. Column data can be clipped to view a certain length with a slider window for data input.

Data Entry Types

To ease the task of entering data, DataPlus For DOS makes available two types of data entries that are defined for each column of each Data Level. Auto Data Entry Types are data entries that the hand-held enters automatically, and User Data Entry Types are the methods by which data can be entered into the hand-held. Standard and Advanced Auto Data Entry Types include:

1. Auto Copy. Data are copied forward from the cell above.
2. Auto Increment. Adds one to the value from the previous line in the same column.
3. Auto Date and Time. Reads the date and time from the hand-held's internal time clock.
4. Auto Line Number. Stores a line number for the current line.
5. Auto Random Number. Generates a random number with a definable limit.
6. Auto Increment Repeat. Data are incremented or decremented by a specific value.
7. Auto Preload. Default data are stored into the column.

User Data Entry Types are listed as follows:

1. Keyboard. Data are entered from hand-held keyboard.
2. Number in Character Field. Allows entering of numbers larger than 15 digits or if leading zeros are required.
3. Manually entered date and time information.
4. View Only. Used when the data should not be edited by the user.
5. Serial Port. DataPlus supports a full array of serial communication parameters to accommodate bar code scanners, electronic balances, GPS receivers, laser rangefinders, and water quality transmitters, to list a few.
6. Elapsed Time. Facilitates timed studies with 25 timers that can run simultaneously.
7. Fractional Time. Facilitates timed studies with separate columns for start and stop times.

Error Checking

The Error Check functions are used to check data as they are being entered into the hand-held. It is sometimes called data validation or data filtering. The two types of Error Check Types are Range and List File. Both have user override options.

Range Checks can be set for both numeric and character columns (fig. 4). The value entered by a user in a numeric column must be greater than or equal to a defined minimum value and less than or equal to the specified maximum value. For a character column, the entry string length must be greater than or equal to the specified value.

A standard List File Check is composed of one column of data used to compare against the user's input. This can be a List File of valid numbers or strings. There are two options for lists:

1. Sorted/Unsorted.
2. Translated/Not Translated.

The default List type is Sorted in ascending, alphabetical, or numeric order. Unsorted is used if the list is to be grouped by category.

With hand-held computers, it is often much more efficient to key numbers instead of letters. Selecting a Translated list allows a code to be created which the computer translates into more meaningful data in the storage file. A Translated list can have three columns. The first column has the element used to check against the user input. The second column has the data that will actually be stored in the file. A description can be used in a third column for the code or abbreviation in the other columns.

The **F2** key on the hand-held may be pressed if the user desires to view the range or list check parameters. To be able to enter data outside the valid error checks, the Allow User Override box should be checked. If the user input data are out of the present range or list, a warning will alert the user that the data are outside the acceptable limits and entry must be confirmed with a **Y** or **N**. Otherwise, the user will not be allowed to input the data.

The Advanced error checks are relational checks—comparing input in one column based on data entered into a different column.

1. Range, Column Min Check Type—If the input value of data entered into a column falls within the absolute minimum and maximum, the input value must be greater than or equal to the data from the Source Column. For example, in log scaling operations, the small-end diameter of a log should be less than or equal to the large-end diameter of the same log. The large-end diameter column is checked that its diameter was greater than or equal to the small end diameter column.

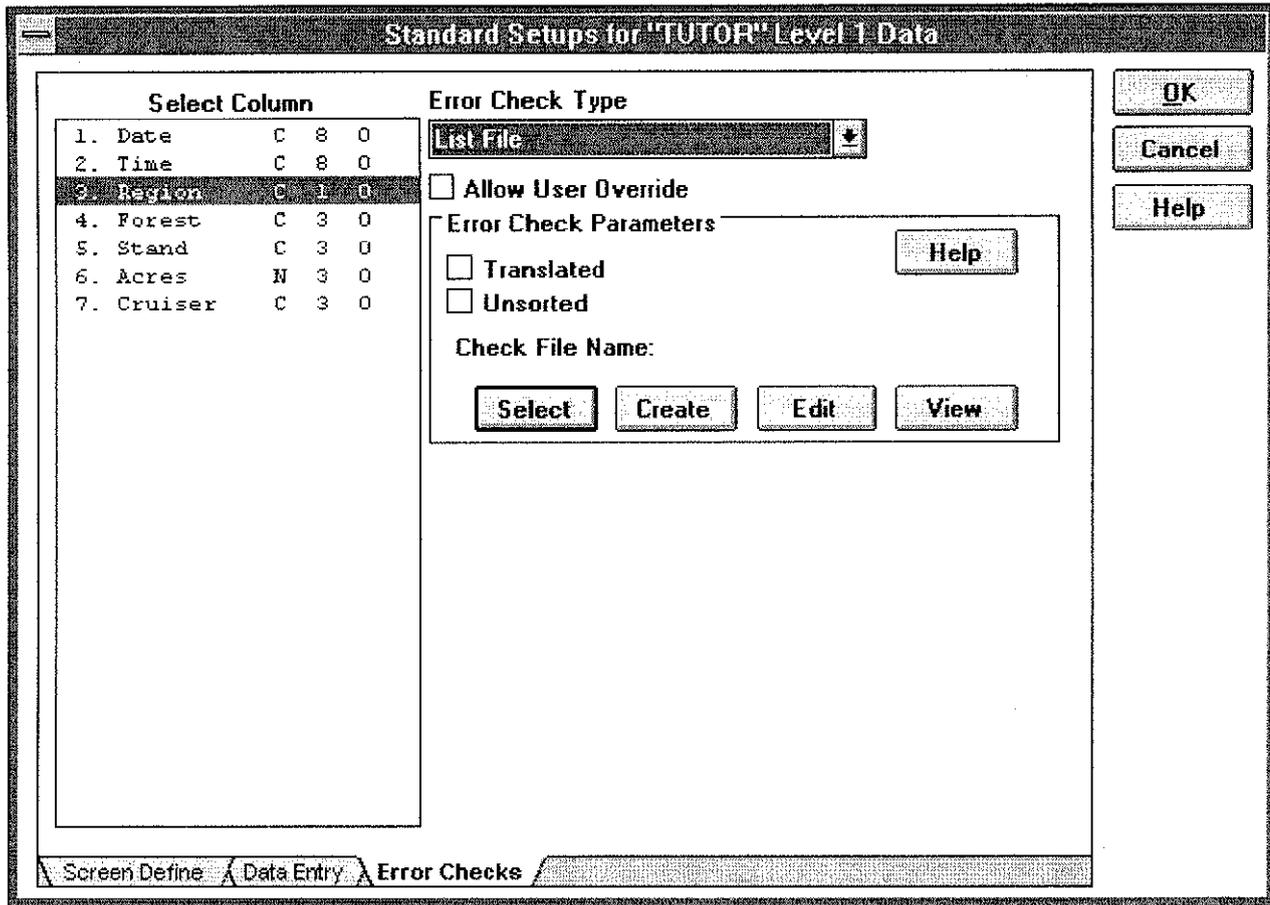


Figure 4.—Data integrity can be improved by using range and list error checking in DataPlus For DOS.

2. Range, Column Max Check Type—If the input value of data entered into a column falls within the absolute minimum and maximum, then the input value must be less than or equal to the data from the Source Column. For example, in log scaling operations, the net weight of a load of logs should not exceed the gross weight. The net weight could be compared to the gross weight making sure it does not exceed the gross weight.
3. Range, Column Min/Column Max Check Type—If the value of data entered for a column falls within the absolute minimum and maximum, then the input value must be greater than or equal to the data value from the first Source Column and less than or equal to the data value from the second Source Column. For example, an error check could be set up to ensure that the mid-diameter column is greater in diameter than the small-end diameter column and less in diameter than the large-end diameter column.
4. Range File, Column Range Check Type—Data input to this column must fall within a pre-defined minimum, maximum range based on the data from another Source Column. For example, if a fish has a certain length range, its weight will be limited to a

specific range. For each length, a different weight range is expected.

5. Range File, Two Column Range Check Type—Data entered into a column must fall within a pre-defined range based on the data from two other columns. For example, if a fish is in a certain length range and a certain girth range, it can be expected to fall in a certain weight range.

Flow Control

The Flow Control tab is used for defining movement within the data file based on data values.

1. List Jump Table. A Jump Table is based on data from a Source Column. The first column of the table is a Sorted List. If a data match is found for the Source Column, then a jump is performed to the column number value for the appropriate keystroke. For example, when cruising, a different height may be recorded based on the specific product. If the product is pulp, the height may be recorded as total height in feet, whereas for sawtimber, the height may be recorded as merchantable height based on the number of 8' or 16' logs. A jump table allows you to jump to

- the appropriate height column for the specific product.
2. Range Jump Table. If the data fall within a certain range and a pre-defined key is pressed, the cursor will move to the column specified in the table.
 3. Find First Empty. When moving from line to line, the cursor will stop when the first empty column is encountered up to a set limit. In forestry, this option is useful when entering all tree heights first and then going back to enter the diameters and defect data.
 4. Relating Error Check Files and Jump Tables to Lists & Ranges. DataPlus also supports functions to relate data in pre-defined columns to a list or range. Based on the relate results, a specific check file or jump table can be used. For example, each region in the USDA Forest Service has its own list of national forests. A Related List is made for the Forest column. The Forest column is related to the Region column. When the Region column has Region 1 entered in it, only national forests for that region are accepted or viewed.

DATAPLUS HAND-HELD SOFTWARE

After the DataPlus application is installed on the DOS hand-held, the user is provided with a menu system for collecting data and accessing hand-held utilities. The Collect Data menu option allows the user to enter field data as specified in the Applications Generator. DataPlus For DOS supports keystroke functions to speed cursor movement and navigation through data, and to provide run time functions. Erase Data deletes the data stored in the current application.

The hand-held transmits collected data to the PC and receives applications sent from the PC with the Communications menu option. It facilitates direct or modem connections. It supports standard communication protocol parameters.

The Applications option allows the user to select the desired DataPlus application. DataPlus can accommodate up to 256 applications.

The Utilities and Setup options allow for setting the clock, checking memory and drives, deleting applications, changing the display sizes for columns and rows, and setting passwords. A two-level password security system is available for erasing and data.

DATAPLUS HOST MODE

DataPlus Host is a program used specifically for communicating with hand-held computers to retrieve data. Typically, data are gathered in the field using DataPlus For DOS on a hand-held, then communicated to a "host"

PC running the DataPlus Host program. DataPlus Host takes care of the transfer and organization of the communicated data on the disk drive of the host computer.

DataPlus Host is a "stand-alone" program, meaning that it is a separate Windows program and not an internal part of the DataPlus Application Generator. This isolation between programs permits DataPlus Host to be used without having to depend on the DataPlus Application Generator; therefore, DataPlus Host may be receiving data from a remote hand-held at the same time as applications are being created or modified in the DataPlus Application Generator. An additional benefit of this independence is the relatively small size of the DataPlus Host program compared with the DataPlus Application Generator. This smaller size allows for more Windows applications to be open simultaneously when only DataPlus Host is required to be functioning. DataPlus Host will continue to monitor direct or modem connections at all times even while other Windows programs are running. It may therefore be "iconified" so it will not take up display space on your Windows screen, and still connect with remote hand-helds.

When a remote hand-held running DataPlus For DOS successfully connects with DataPlus Host to transfer its collected data, an automated log in procedure takes place. This procedure requires no user interaction because it is a conversation between the hand-held and the host PC. The hand-held informs DataPlus Host of the hand-held's unit ID and current application name. DataPlus Host then organizes the received data from the hand-held into the appropriate location on the hard drive of the host PC.

DATAPLUS PROFESSIONAL OVERVIEW

DataPlus Professional is an applications generator and program editor for DOS hand-held computers that is scheduled for release during fourth quarter of 1998. DataPlus Pro has everything that DataPlus For DOS offers but adds features that software developers and information systems managers will appreciate and have requested. Users can choose which version is right for their application.

What's New in DataPlus Pro?

DataPlus Pro consists of four separate programs including hand-held data collection software, a Windows 95 or NT compatible applications generator, the DataPlus Host, communications software package, and an additional program editor called DPCedit.

DataPlus Pro is compatible with most DOS-based IBM compatible hand-held computers. Supported display sizes range from 6 to 25 lines and from 20 to 80 columns. Two hand-held versions are included: one is for use with a 286

or greater processor and the other version is for 8088 or greater processors. Minimum hand-held hardware configurations include DOS 3.1 or greater, 640K of free RAM, and 500K of free disk space. Minimum hardware configurations for the PC include Windows 95 or NT, SVGA Graphics, 8 Meg of RAM, and 4 Meg of free hard disk space.

DataPlus Pro supports many new features to customize advanced applications as shown in figure 5. The major enhancements are:

1. Provides for up to four data levels with up to nine branches from each file and up to 26 independent sets of data for each application.
2. Facilitates the use of custom user programs to implement features not present such as calculations, report printing, data flow control, etc.
3. Expanded data entry types, constant data displays, error checks, missing data checks, and data formats.
4. Allows the order in which data are entered to be controlled according to the data already entered.
5. Extended BIOS support for power management.
6. Remap keys on hand-helds with limited keyboards.
7. Windows 95 and NT Compatible.

8. Improved interface for easier navigation to any part of the configuration process including toolbars and DataPlus Pro buttons.
9. Application version control for coordination of PC and hand-held application versions.

Custom User Programs

DataPlus Pro incorporates a program editor that greatly extends the flexibility of the product. This allows for advanced, customized features that include calculations, error checking, data flow control, report printing from the hand-held, and power management.

The programs are written in a "C" like programming language called DPC. A sample program is shown in figure 6. The code is compiled before loading into the hand-held to increase its execution speed in the field. The 11 types of user programs are:

1. Global level user programs. Accessed any time data are being collected within the application.
2. File level user programs. Accessed only while collecting data for the file the program is associated with.

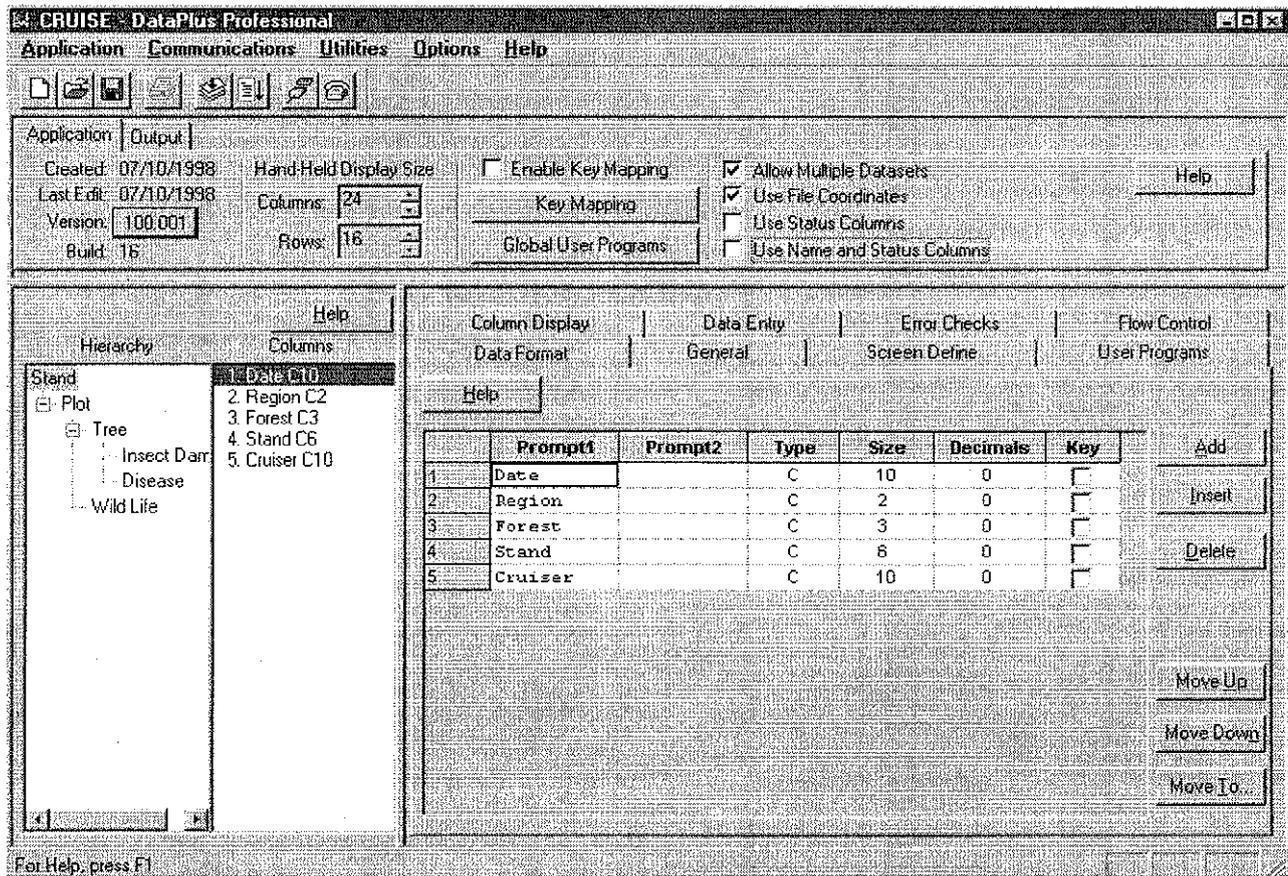


Figure 5.—DataPlus Pro offers features for advanced customization of applications.

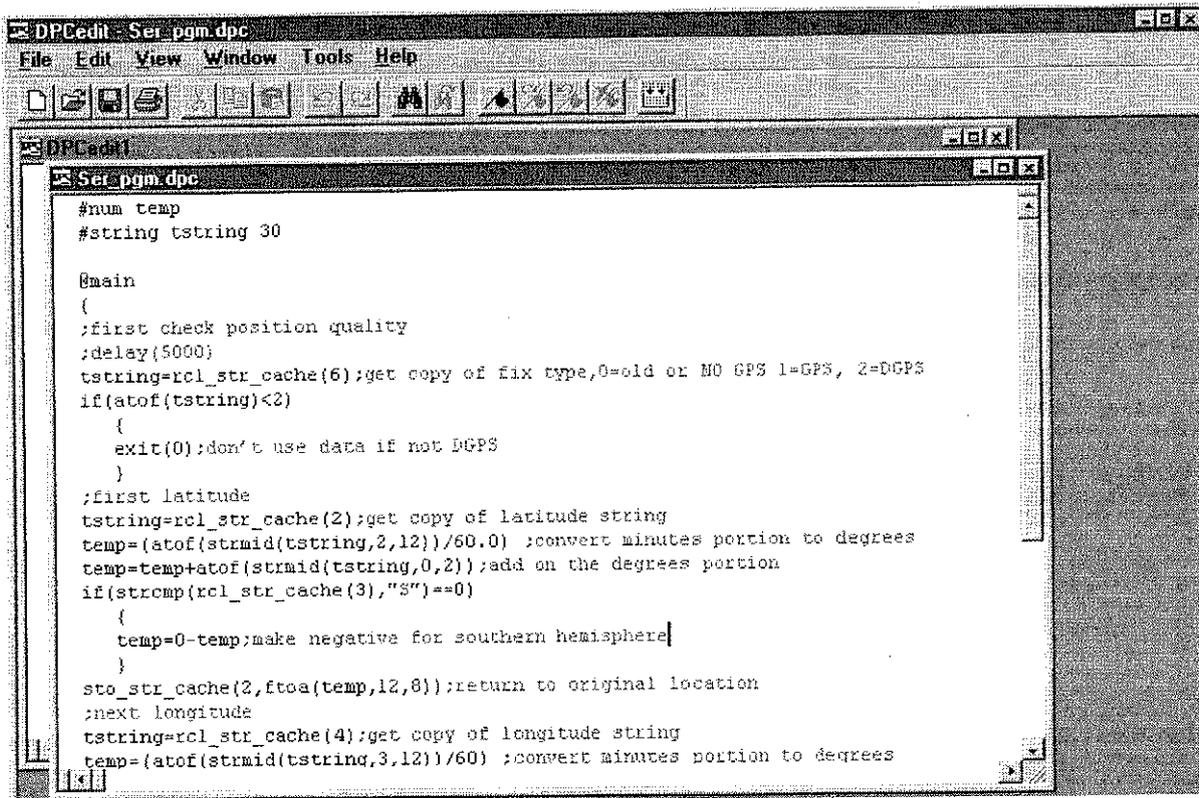


Figure 6.—With the built-in program editor in DataPlus Pro, the user can write custom programs for calculations, report printing, and data flow control.

3. Data level entry user program. Runs when the file is first opened for data collection.
4. Data level advance user programs. Runs when advancing to child (a branch) data files.
5. Data level retreat user programs. Runs when returning to the parent data file.
6. Sibling jump user programs. Runs when jumping to a sibling data file (a data file of a different branch from the same parent data file).
7. Column change user programs. Runs when moving from column to column within the same data file.
8. Line change user programs. Runs when moving from line to line within the same data file.
9. Data entry user programs. There can be a separate data entry program for each column in each file. They can run before user entry, after user entry, or instead of user entry.
10. Error check user programs. There can be a separate error check program for each column in each file. They can run before standard error checks, after standard error checks, or instead of standard error checks.
11. Serial port data entry user programs. The incoming data can be manipulated or validated before using.

Power Management

Any field computer is effective only as long as the battery lasts. Hand-helds with extended BIOS capabilities can take advantage of the more robust power management available in DataPlus Pro. Interrupt calls are configured for the specific hand-held for power-saving features that are called as needed for CPU idle, return from CPU idle, and turning COM ports on and off. Up to two interrupts can be called for each port. This allows COM ports to be turned on and off and allows light pen power to be turned on and off when the serial ports are opened and closed. Two external programs or system calls can be executed when DataPlus Pro first starts and up to two when exiting the program. In addition to power-saving features, the external programs can be used for other functions, such as DOS "MODE" calls or time out functions.

Missing Data Checks

DataPlus Pro contains expanded missing data checks. Missing data checks can be enabled or disabled to check for required data in each file. If the missing data check finds a column with required data not entered, an audible warning is sounded and the cursor moves to that column for data entry. The following options are available:

1. Check the current data line when advancing to the next data line.
2. Check the current data line when either advancing to the next data line or backing up to the previous data line.
3. Check the current data line before advancing to the next data level.
4. Check the current data line before jumping to a sibling data level.
5. Check all lines in the current data file before retreating to the parent data level using the F4 key.
6. Check all lines in the current data file when the ESC key is pressed to retreat to the parent data level.

COMPATIBLE DOS HAND-HELD FIELD COMPUTERS

Both versions of DataPlus have been tested to run on these DOS hand-held computers:

1. Juniper Systems Pro2000
2. DAP PC9000, PC9500, & PC9800
3. Husky FS/2, FS/3, & FS/GS
4. Hewlett Packard HP200LX
5. Paravant RHC-44E
6. CMT PC-5L

CONCLUSION

Both DataPlus versions were developed by Electronic Data Solutions in Jerome, Idaho. Electronic Data Solutions has specialized in catering to the data recording applications in natural resource markets for the last 12 years. Since DataPlus For DOS and DataPlus Pro are economically priced at \$249 and \$595, respectively, they give all data collection specialists a revolutionary new software tool.

For more information and to download demonstration software, contact us at our web site: www.elecdata.com.

DataPlus is a recognized trademark of Electronic Data Solutions. All other trademarks are registered or recognized trademarks of their respective owners.

ACKNOWLEDGMENT

The following people reviewed this manuscript: Mike Duppong, Programmer, Electronic Data Solutions, Jerome, ID, USA; and Pam O'Dell, Office Manager, Electronic Data Solutions, Jerome, ID, USA.