
1800-14 Terminal Emulator and Graphics Software

Instruction
Manual

LI-COR[®]

LI-1800/DOS
Interface Program
Instruction Manual

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Printing History

New editions of this manual will incorporate all material since the previous edition. The manual printing date indicates its current edition. The printing date changes when a new edition is printed.

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Information regarding program changes not covered in this manual can be found in an ASCII file named READ.ME on the diskette.

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General Information

Program Description

PC1800 is a program designed to interface the LI-COR LI-1800 Spectroradiometer with a computer having a DOS operating system, such as an IBM PC, XT, AT, PS/2, or compatible equipment. The program provides two types of interaction with the LI-1800:

1. Terminal emulation allows the computer to function as a 'dumb' terminal.
2. Data file management operates on LI-1800 data files stored on disk or in the memory of the LI-1800. The interactions are menu driven, and extend the data manipulation and analysis capabilities beyond those provided in the LI-1800 itself.

Hardware Requirements

LI-1800 Instrument Software: Version 4.00 or greater (LI-1800 serial number 139 or higher, or LI-1800UW serial number UW-103 or higher).

Computer Operating System: DOS 2.00 or greater.

Interface: RS-232C.

Memory: 640K bytes RAM required.

Graphics Driver: CGA, EGA, Hercules, ATT400, or VGA. (Graphics capabilities, or lack thereof, affect only the plotting portions of the PC1800 program).

NOTE: If you use a print spooler, be advised that some print spoolers will cause occasional data loss in RS-232C communications.

Connecting the LI-1800

The LI-1800 need not be connected to your computer for the 1800-14 program to function. Such would be the case when analyzing data previously transferred from the LI-1800. However, when data communications are required, the LI-1800 must be attached to your computer's serial (COM1 - COM4) port.

If you are unsure of which connector(s) on the back panel of your computer is for RS-232C communication, the program EQUIP might help. Refer to the Appendix of this manual.

Your computer's COM1 or COM2 port must be attached to the LI-1800 port marked TERMINAL. The LI-1800 terminal port is a 25-pin male connector configured as a DCE (data communications equipment) device. If your computer's RS-232C port is a 25-pin connector configured as DTE, the two devices should be connected with a straight-thru cable, such as a ribbon cable, that supports at least pins 2, 3, and 7.

Some computers, such as the IBM AT, use a 9-pin connector for the RS-232C interface. This requires that a special cable be used, wired something like this (available from LI-COR as part number 1800-04):

9-pin female connector (to IBM AT)		25-pin male connector (to LI-1800)	
1	←	Carrier Detect*	8
2	←	Receive Data	3
3		Transmit Data	→ 2
4		Data Terminal Ready*	→ 20
5		Signal Ground	7
6	←	Data Set Ready*	6
7		Request to send*	→ 4
8	←	Clear to Send*	5
9	←	Ring Indicator*	22

* = optional connection. Not needed for the LI-1800.

Do NOT use the 2232S cable supplied with the LI-1800 for use with its OUTPUT port. Even though it has a 9-pin connector on one end and a 25-pin connector on the other, it will not work for connecting an IBM AT to the LI-1800 terminal port.

Getting Started

Copy the 1800-14 Diskettes

The 1800-14 Terminal Emulator and Graphics Software is shipped on floppy disks (both 5 1/4 and 3 1/2" disks are included). The following files are included on the 1800-14 disks:

Program files

PC1800.EXE	1800-14 program file
EQUIP.EXE	An RS-232C interface diagnostics program
GCOPY.EXE	Accessory program for copying files from a disk file to a printer

Printer driver files

\$FX.BGI	Epson FX or compatible
\$LQ.BGI	Epson 24-pin or compatible
\$PP24.BGI	IBM Proprinter X24
\$IBMQ.BGI	IBM Quietwriter
\$TSH.BGI	Toshiba 24-pin
\$LJ.BGI	HP LaserJet
\$PJET.BGI	HP PaintJet (color)
\$PS.BGI	Postscript compatible printer (B/W only)
\$HP7470.BGI	HP Plotter size A paper (color)
\$HP7475.BGI	HP Plotter size A or B paper (color)
\$HP7550.BGI	HP Plotter size A paper (color)
\$HP7585.BGI	HP Plotter size A, B, or C paper (color)

Video driver files

CGA.BGI	CGA graphics
EGAVGA.BGI	EGA and VGA graphics
HERC.BGI	Hercules monochrome graphics
ATT.BGI	AT&T graphics

Other files

Colorimetry Analysis: A.ILM, D65.ILM, E.ILM, 10DEG.OBS,
2DEG.OBS

Sample data files: LAMP.DAT, ABS2.DAT, TRA2.DAT, RFL2.DAT,
ABS4.DAT, TRA4.DAT, RFL4.DAT

Postscript header file: GDHEAD.PS

Configuration file: PC1800.CFG

These files should be backed up in some manner:

Method 1: Copy the diskette to another diskette. One way is to type

```
A>copy *.* b:           Copy all files on A: drive to B: drive.
```

Method 2: Create a subdirectory on your hard disk, and copy the 1800-14 diskette to it. For example,

```
C:\>md li1800           Make a subdirectory 'LI1800'  
C:\>cd li1800           Change to subdirectory 'LI1800'  
C:\LI1800>copy a:*. *   Copy all files from A: to C:\LI1800
```

If all of the files on the 1800-14 diskettes are loaded onto a hard disk on your computer, they will occupy approximately 800K bytes of hard disk space. Keep in mind, however, that you only need to load those printer and video drivers which are required for your system. These driver files *must* be located in the same directory as the PC1800.EXE file.

As an example, if you are using a system with a VGA graphics monitor and an HP LaserJet printer, only two driver files are needed in your LI1800 subdirectory; \$LJ.BGI and EGAVGA.BGI.

If you wish to use the Postscript capabilities of your printer, the files \$PS.BGI and GDHEAD.PS will also need to be available in your LI1800 subdirectory.

Put the original 1800-14 diskettes away in a safe place.

Run the Program

Set the default DOS path to the directory in which the PC1800.EXE file is residing, and run the program by typing

```
PC1800 <Enter>
```

The program will start in color mode automatically if a color monitor is detected. If you have a color display, but the program does not automatically start in color mode, add the parameter `/C` after the program name:

```
PC1800/C <Enter>
```

If you do not want to run the 1800-14 program in color, add the parameter `/BW` after the program name.

After loading the program, the revision number will be displayed momentarily on the screen:

pc1800 ver 3.04	Model 1800-14
Terminal, Emulator and Graphics Software	
copyright LI-COR, INC. 1985, 1988-1991 920519	

followed by the main menu:

Config
Terminal
File Operations
Analyze/Display
Quit

If you have trouble loading the program, refer to *Memory Considerations* later in this section.

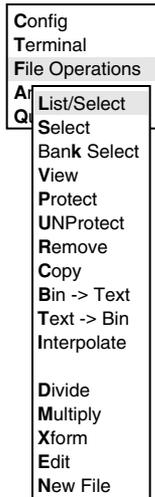
Using Menus

It is very simple to move between menus, as the following example demonstrates.

The Main menu has five choices. In this menu, and in others like it, selections are made in either of two ways:

- Move the highlighted box up and down with the cursor control keys (↑ and ↓) until the desired entry is highlighted, then press **Enter**
- or,
- Simply type the highlighted letter of the desired entry.

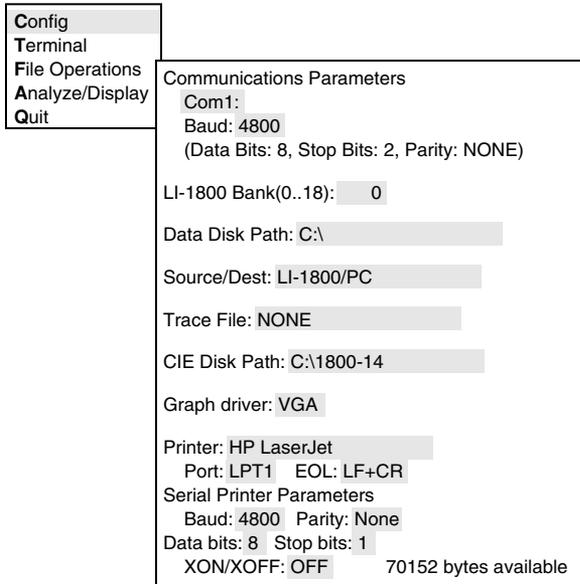
Now press **F** to see a second menu, that of the File Operations:



This menu contains a list of operations that can be performed on LI-1800 binary data files, such as viewing, copying, and transforming them.

To return to the Main menu, press **Esc**. Do so now. Press **Esc** anytime you wish to go back to the previous menu.

Now press **C** to access the Configuration menu, which is a slightly different type of menu:



The Configuration menu is different in that, rather than being a list of tasks, this menu is of a group of parameters whose values you can specify. Notice that when you push \uparrow or \downarrow , the highlighted box jumps to the next field. You will discover later that some of the fields have pre-set values from which you can select, and some of the fields require you to type in the entry.

Return to the Main menu now by pressing **Esc**.

In a Typical Session

1. The configuration menu should be accessed to define the source of the files to be operated on (either a particular RAM bank in the LI-1800, or a DOS path). Make sure that the bank entry in the configuration menu is set correctly. This applies when the LI-1800 is the source, and when the LI-1800 is the destination for the Copy routine. It does not affect the Terminal routine.

2. Use the List/Select option present on most of the menus to make a file list and select files on which you wish to operate. Subsequent selection changes can be accomplished using the Select option. If any changes are made to the list of all the files (new files added, or files deleted), the List/Select option should be re-done, since the PC1800's list is not updated automatically.

Memory Considerations

When the 1800-14 program is initially started, it will determine the amount of memory available and set itself up to leave a minimum of 70K bytes. If there is not enough memory to run the program, the message "NOT ENOUGH MEMORY TO RUN APPLICATION" appears.

After the PC1800 program has started, check the **Configuration Menu** to see how much RAM memory is remaining. The figure in the bottom right hand corner of the **Communications Parameters** window should read at least 70K bytes or more.

If you want to check the amount of available memory *before* starting the PC1800 program, use the DOS checkdisk command, by typing

```
C:>chkdsk <Enter>
```

The last item printed will indicate the amount of available memory. If there are less than 470K bytes remaining, the PC1800 program will not run. A minimum of 525K bytes are required for reliable operation. To increase the amount of RAM memory available, remove any memory-resident programs from the autoexec.bat and config.sys files, and reboot the computer.

Some Examples

Perhaps the best way to learn to use the PC1800 program is to follow along with some example exercises.

Plotting Files

This example plots some of the data files that are on the 1800-14 diskette. It is assumed that all of the files on the diskette have been copied to the DOS path C:\LI1800; if your installation is different, substitute the correct DOS path.

Part 1: Run the program, set the configuration to look on a disk for LI-1800 data files, and get a quick plot of each of three files.

Press

C:↵
CD LI1800↵
PC1800↵
C
↓↓↓↓
←

ESC
A
L

Discussion

1. Set the active drive to C:
2. Change the path to the LI1800 subdirectory.
3. Run the program.
4. Select the Configuration menu.
5. Move the cursor down to the Source/Dest entry.
6. Change from "LI-1800/PC" to "PC/LI-1800". This indicates that the source of the data files to be plotted is the PC, rather than the LI-1800.
7. Return to the main menu.
8. Select the Analyze/Display menu list.
9. List/Select files. The PC looks at the DOS path specified in the configuration menu for all .DAT files, which it assumes are LI-1800 binary data files. The name of each one found is included in a list. Once the list has been made, the Select routine is automatically entered; the file list is shown on the screen, and you are given the opportunity to select the files from the list on which you

wish to operate. The list should look something like this:

The screenshot shows a terminal interface with a main menu on the left and a sub-menu on the right. The main menu items are: Config, Terminal, File Operations, Analyze/Display, List/Select, Select, Bank Select, View, Graph, Integrate, PPF, Color, and Ratio. The 'List/Select' item is highlighted, and a sub-menu titled 'Select DATA Files' is open. This sub-menu contains a list of files with columns for file name, date, time, and description. The 'LAMP' file is highlighted. At the bottom of the terminal window, there are instructions: '↓-select/deselect F1-select all F2-deselect all'.

Select DATA Files			
ABS2	11/03	14:30	ABS P-19
ABS4	11/03	15:39	ABS NR55BR
LAMP	02/19	11:13	
RFL2	11/03	14:01	R P-19
RFL4	11/03	15:21	RFL NR55BR
TRA2	11/03	14:15	T P-19
TRA4	11/03	15:32	T NR55BR

↓-select/deselect F1-select all F2-deselect all

Press

↓↓↓↓↓

ESC

G

P

Discussion

10. Select these 3 files: ABS2, LAMP, and TRA2.
11. Complete the selection routine.
12. Select the graph menu.
13. Plot the files. Each of the selected files will be read, interpreted, and plotted on a graph.

After each plot, press **ENTER** to continue to the next file. Press **ESC** to return to the menu after you are done plotting the files.

Part 2: Plot these three files on the same graph.

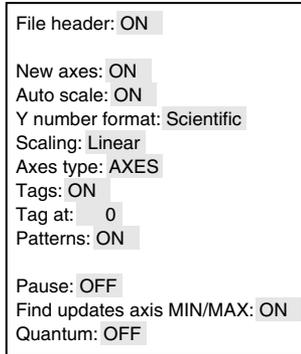
Press

F

C

Discussion

14. Find the wavelength and data value extremes of the three selected files. The results won't be seen until we view the X axis and Y axis parameter menus in steps 26 and 28.
15. Access the plotting control parameters:



←

↓

←

↓

←

↓

←

↓↓↓↓↓↓

16. Turn the file header OFF. This refers to the information put at the top of the plot when each curve is drawn. For the multiple curve graph, we will leave this off.
17. Change to New axes field.
18. Turn New axes OFF. This will prevent the screen from being cleared and new axes being redrawn for each curve. We will draw the axes once before plotting any curves.
19. Change to Auto scale field.
20. Auto scale OFF. When ON, this causes the axes parameters to automatically adjust to fit each new curve - a feature not wanted when doing multiple curves on the same graph.
21. Change to Y number format field.
22. Decimal format for Y numbers for this example.
23. Move cursor down to the Pause entry.

- ←
- ESC
- X
- ESC
- Y
- ↓
- 0
- ↓
- .5
- ↓
- .05
24. Change Pause to OFF. This will prevent the program from pausing after each curve is plotted.
 25. Leave the control parameter menu.
 26. Access the X axis parameter menu. The Last Find quantities reflect the wavelength limits of the 3 files searched as a result of the Find max/min command executed earlier. None of the X axis parameters need to be changed for this example.
 27. Exit the X axis parameter menu.
 28. Access the Y axis parameter menu. Again, the Last Find quantities are the limits found in the search of the 3 files done earlier. The values can be used as a guide for selecting the max, min, and tic parameters.
 29. Change to the MIN parameter.
 30. Set the minimum Y axis value to 0.
 31. Change to the MAX parameter.
 32. Set the maximum Y axis value to 0.5.
 33. Change to the MINOR TIC parameter.
 34. Set the tic interval to 0.05. The MAJOR TIC count we will leave at 2, meaning that every other tic will be labeled on the Y axis.

```

LABEL: Spectral Irradiance

Selected Files:
  MIN: 2.044E-03
  MAX: 3.090E-01
Last Find:
  MIN: 2.044E-03
  MAX: 3.090E-01

Current Y-Axis:
  MIN: 0.000E+00
  MAX: 5.000E-01

MINOR TIC: 5.000E-02
MAJOR TIC: 2

```

- ESC
35. Exit the Y axis parameter menu.

P

36. Plot the graph. Each curve will be added without erasing the display. Press **ESC** when done to return to the menu.

Terminal Mode

This example illustrates how to use your computer as a terminal to the LI-1800. It is assumed that the PC1800 program is running, and at the main menu. It is also assumed that the LI-1800 is powered OFF and connected.

Press

C
(if needed)

ESC

T

Discussion

1. Access the configuration menu.
2. If you are using the COM2 port, toggle the COM selector from 1 to 2 by pressing ←. Otherwise, leave it at 1.
3. Exit the configuration menu.
4. Connect the LI-1800 to the appropriate port on your computer with the proper cable.
5. Begin terminal mode. The message

resetting communications

will be displayed for 10-15 seconds, while the PC1800 program tries to communicate with the LI-1800 by sending a BRK, and awaiting the FCT prompt. If no response is forthcoming, the next message will be

turn OFF LI-1800 and Press ESC

ESC

6. When the LI-1800 is off. The message

turn ON LI-1800 and Press ESC

will then be displayed.

ESC

7. Power the LI-1800 ON, then press ESC. The following messages will then appear, the last being the LI-1800's software version:

waiting for the LI-1800 to self test

initializing communications with the LI-1800

(beep)

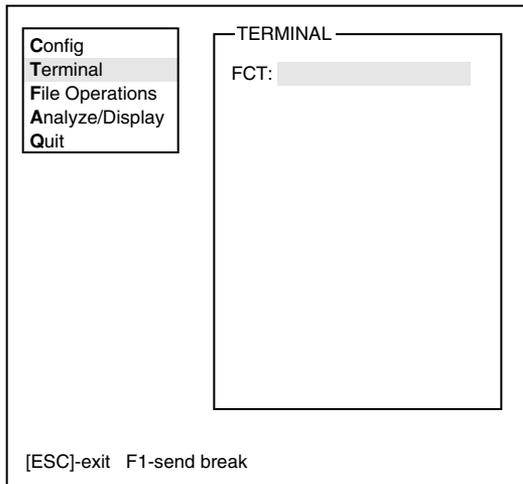
LI-1800.04.07

ESC

8. One last message will appear,

Initializing LI-1800 DC parameters

followed by the terminal mode display.



LI-1800 commands may now be sent to the LI-1800 by typing them on the keyboard. Typing errors may be corrected with →, ←, INS and Del before sending the command with the <Enter> key. A break condition is set by pressing the F1 key.

To return to the main menu, press **Esc**. Subsequent entries to terminal mode from the main menu will be much faster, provided you do not power off the LI-1800 in between entries.

Menu Reference

Definitions

Trace Window

Several of the PC1800's windows display results that you may wish to copy to a printer, or store in a disk file. Such windows are called Trace Windows, and can be identified by the inclusion of F3 - trace status at the bottom of the display.

[Esc]-abort [Enter]-next file F1-print status F3-trace status

Pressing **F1** accesses a small window in which you can toggle print status ON or OFF (use → or ←). If ON, when the trace window is exited (by pressing Enter) the information in the window will be printed to the system printer. Pressing **F3** accesses a window with 2 entries: Trace status, which can be toggled ON and OFF, and the Trace File name, which is the name of the file to which the trace window's contents will be copied when the trace window is exited (by pressing **Enter**), if Trace is ON. The trace file name can thus be defined anytime a trace window is active, as well as from the main configuration menu. Aborting from a trace window (pressing **Esc**) cancels any printing or trace operations for that display.

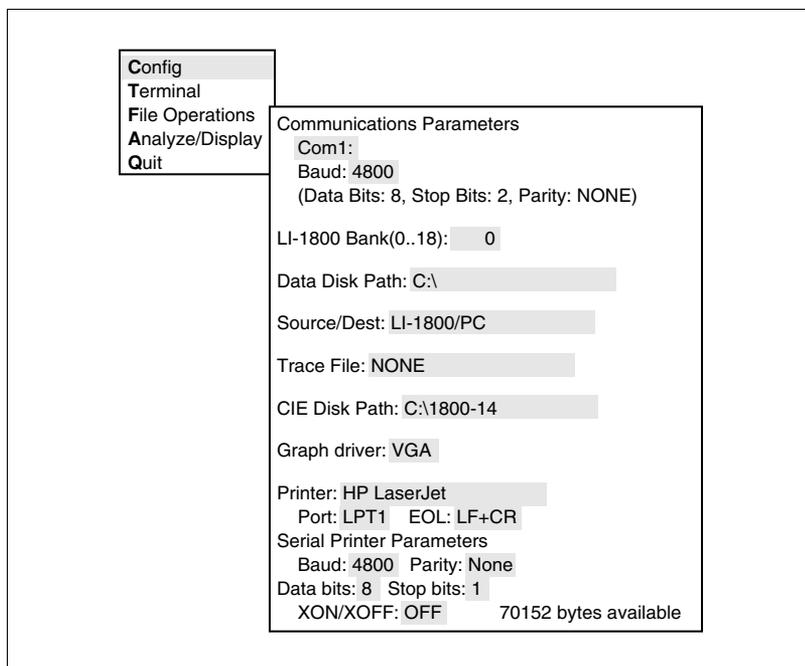
Binary Data Files

Files in the memory of the LI-1800 are binary data files. When the PC1800 program copies such files to a disk, those files are also binary data files, and have the suffix .DAT. Almost all of the operations of the PC1800 involving spectral data deal with binary data files. However, for these files to be viewed by a human, they need to be converted to ASCII format. There are two ways in which this can occur: there is a routine in the File Operations menu (Bin->Text) that creates an ASCII file (having the suffix .PRN) from a binary file. Secondly, the View routine shows interpreted binary data in a trace window. Refer to the trace window discussion above.

Overwriting Files

In the LI-1800, whenever you initiate an activity that will create a file and specify an existing file as the file to be created, you are given the opportunity to overwrite that file, or to abort the process. With the PC1800 program, however, the process is a bit different: you cannot overwrite an existing file, because the PC1800 changes the file name so that it will be a new file. In the case of DOS files, a number is appended to the name. For example, if the file LAMP.DAT is to be created and it exists already, then the file created will be named LAMP!000.DAT (or LAMP!001.DAT, etc.). If the file is to be in the LI-1800, the file is actually created in the computer, then downloaded to the LI-1800. If the downloaded filename already exists in the selected bank of the LI-1800's memory, then the name will be changed to the next highest #file, such as ##01.

The Configuration Menu



COM

Toggles between 1, 2, 3 and 4 (if installed). Specifies the RS-232C serial port on the computer to be used for communications with the LI-1800.

Baud

Toggles between 300, 1200, 2400, and 4800. Always use 4800, unless for some reason there seems to be difficulty at that rate. The baud rate on the LI-1800 is set automatically after power up when the terminal device sends a carriage return to the LI-1800. The PC1800 program takes care of this for you.

LI-1800 Bank (0..18)

Specifies the RAM bank of the LI-1800 to be used for file operations. This setting has no effect on Terminal mode.

Data Disk Path

Specifies the DOS path for all DOS file operations, with the exception of colorimetry data, which is specified in the **CIE Disk Path** entry. The path name can be up to 75 characters in length. If the path extends beyond the visible portion of the field, the characters will scroll to the left.

Source/Dest

Toggles between PC/LI-1800 and LI-1800/PC. The Source is where LI-1800 binary data files are to be found. The Destination is only used for the Copy routine, which copies files from the source to the destination.

Trace File

The trace file name. The trace file name can also be accessed from any trace window.

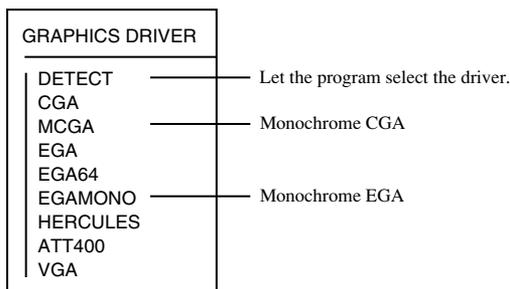
CIE Disk Path

This is the DOS path that the PC1800 program will search to find the .ILM and .OBS files needed for several of the colorimetry calculations. The path name can be up to 75 characters in length. If the path extends beyond the visible portion of the field, the characters will scroll to the left.

Graph Driver

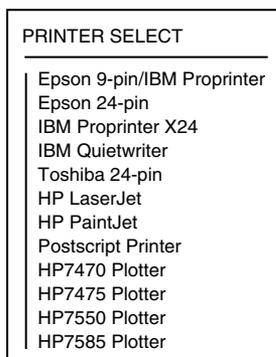
The PC1800 program selects the highest resolution driver that your hardware appears to support. Some computers which support multiple graphics drivers do not

acknowledge that fact when queried by the program. *Consult your computer's manuals before changing the default setting.* The list of drivers supported by the PC1800 is shown in the window below.



Printer

To see the list of available printers, scroll down to the Printer option and press **Enter**. Use the up or down arrow keys to access the desired printer, and press **Enter** to select that printer.



Scroll down to the Port option, and use the left and right direction arrows to toggle between **LPT1**, **LPT2**, **COM1**, or **COM2**. If you are connecting your printer to parallel communications ports 1 or 2, choose **LPT1** or **LPT2**. If you are connecting to serial communications ports 1 or 2 on your computer, choose **COM1** or **COM2**.

The parameters in this Configuration Menu are saved in the “PC1800.CFG” file when the program is exited.

When the PC1800 program is restarted, the configuration parameters will be loaded from this file. The “PC1800.CFG” file is saved in the subdirectory from which the 1800-14 program was started (this may be in a different location from where the “PC1800.EXE” file is located). This allows different users to create distinct configuration files, which can be accessed by starting the program from their own subdirectory. If you intend to do this, make sure that there is a DOS PATH command in your AUTOEXEC.BAT file that includes the appropriate PC1800 program subdirectory.

The Configuration Menu contains parameters for setting up a serial printer port. The serial printer port parameters are as follows:

Baud Rate - 110, 150, 300, 600, 1200, 2400, 4800, or 9600.

Parity - None, Even, or Odd.

Data Bits - 7 or 8 (Must be set to **8** for printing graphics).

Stop Bits - 1 or 2.

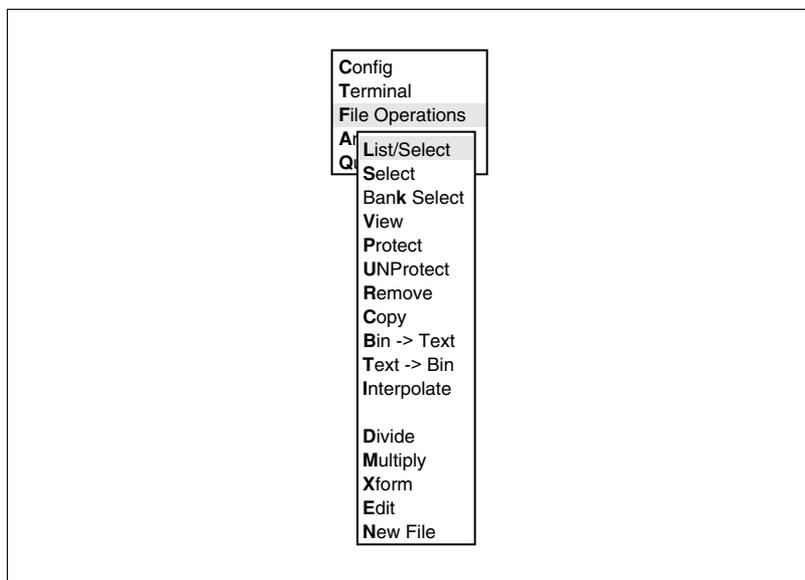
XON/XOFF - On or Off.

NOTE: If you have trouble printing text files to your serial printer, check to be sure that you have included a DOS MODE command (in your AUTOEXEC.BAT file, for instance) that redirects the printer output to the serial port. For example, type

```
MODE LPT1: = COM1: (or COM2)
```

to redirect the output from parallel port 1 to serial port 1 or 2.

The File Operations Menu



List/Select

The list of binary LI-1800 files is obtained from the Source device. If the source is the PC, then the names of all .DAT files are obtained from the DOS path specified in the **Data Disk Path**. If the source is the LI-1800, then the PC1800 program attempts to establish communication with the LI-1800 using the serial port specified (set in the configuration menu), to get the file list from the specified **Bank**. (**Source**, **Data Disk Path**, **COMx**, and **Bank** are all in the configuration menu). Once the file list has been made, the **Select** routine is automatically accessed.

Select

The file list is shown, and 1 or more files may be selected:

Select DATA Files			
ABS2	11/03	14:30	ABS P-19
* ABS4	11/03	15:39	ABS NR55BR
LAMP	02/19	11:13	
* RFL2	11/03	14:01	R P-19
RFL4	11/03	15:21	RFL NR55BR
TRA2	11/03	14:15	T P-19
TRA4	11/03	15:32	T NR55BR

↓-select/deselect F1-select all F2-deselect all

Press **Enter** to select a file (marked with *), or to de-select a selected file. The following operations are directed toward **selected** files: View, Protect, UNProtect, Remove, Copy, Bin->Text, Text->Bin, Interpolate, Integrate, PPF, Color, Ratio, and Plot.

Bank Select

The **Bank Select** option allows you to access any LI-1800 memory bank, and to change the source/destination parameters, if desired.

LI-1800 Bank (0..18):	0
Source/Dest:	PC/LI-1800

View

Converts selected binary files to ASCII format, and shows them in a trace window.

```
LAMP
"FILE:LAMP"
"REM:                "
"LIMS: 300-1100NM"
"INT: 1NM"
"DATE:02/19 11:13"
"MIN: 300NM 2.044E-03"
"MAX: 900NM 2.453E-01"
300 2.044E-03
301 2.130E-03
302 2.216E-03
303 2.302E-03
304 2.388E-03
305 2.474E-03
306 2.560E-03
307 2.646E-03
308 2.732E-03
309 2.818E-03
310 2.904E-03
311 3.004E-03
▼ 312 3.104E-03
```

[Esc]-abort [Enter]-next file F1-print F3-trace F5-PRN status

This is a trace window, so the print status and trace status keys are present. In addition, F5 accesses an ON/OFF toggle that if ON, causes the file to be written to a .PRN file having the same name as the binary file. This is equivalent to the results of the **Bin->Text** routine described below. Note that a .PRN file differs from the trace file in that the .PRN file holds only the ASCII format of one LI-1800 data file, whereas the trace file can contain any combination of computation results, ASCII formatted files, and other output that is "traceable". The window is scrollable, and the Home, End, PgUp, ↓, ↑ and PgDn keys function like you would expect them to.

Protect

Changes selected files' remarks field to give them protected status. This is done by adding ** to the front of the remarks. Protected files cannot be erased or changed.

UNProtect

Removes ** (if present) from the front of files' remarks fields, thus removing their protected status.

Remove

Removes selected files (if unprotected) from the source.

Copy

Copies selected files to the destination device. Source and destination are set in the Configuration menu.

Bin->Text

Selected files are read, interpreted, and the data written to ASCII files of the same name having a .PRN suffix. These files are written to the current **Data Disk Path** regardless of the source device. If the file already exists, then !000 (or !001, etc) is appended to the name to make it unique.

Text->Bin

The **Data Disk Path** is searched for .PRN files. You are shown a list of their names, and given the opportunity to select one or more for conversion to .DAT files. All files thus selected are then converted, and written to the **Data Disk Path**. The file name consists of the LI-1800 file name contained in the header of the file, and a .DAT suffix (e.g. LAMP.DAT). If such a file already exists, then !000 (or !001, etc) is added to the name (e.g. LAMP!000.DAT).

Interpolate

Files that you select are interpolated to a different wavelength interval.

LAMP
1
2
5
10

<- File name being interpolated

<- Current interval is default

[Esc] - abort [Enter] - Interpolate

Divide

Create a new file by dividing two other files. You are asked to select the numerator file from the file list:

Numerator			
ABS2	11/03	14:30	ABS P-19
ABS4	11/03	15:39	ABS NR55BR
LAMP	02/19	11:13	
RFL2	11/03	14:01	R P-19
RFL4	11/03	15:21	RFL NR55BR
TRA2	11/03	14:15	T P-19
TRA4	11/03	15:32	T NR55BR

[Esc]-abort [Enter]-select file

Position the cursor on the file to be used for the numerator and press **Enter**. You are then shown the file list again, and asked to select the denominator file.

Denominator			
ABS2	11/03	14:30	ABS P-19
ABS4	11/03	15:39	ABS NR55BR
LAMP	02/19	11:13	
RFL2	11/03	14:01	R P-19
RFL4	11/03	15:21	RFL NR55BR
TRA2	11/03	14:15	T P-19
TRA4	11/03	15:32	T NR55BR

[Esc]-abort [Enter]-select file

Finally, the result file's name and remarks are entered using a window like that shown below, with the numerator and denominator file header information shown at the top:

Numerator:	
FILE:	LAMP 02/19 11:13
LIMS:	300NM-1100NM
INT:	1NM
Denominator:	
FILE:	ABS4 11/03 15:39 ABS NR55BR
LIMS:	390NM-1100NM
INT:	2NM
NAME:	NONE
REMARK:	**
LOW:	390
HIGH:	1100
INTERVAL:	2

[Esc]-abort [Enter]-divide files

The wavelength range and interval may be modified. When **Enter** is pressed, the files are divided, and the new file is created. The file name 'NONE' is reserved to indicate that the operation should be cancelled. **Esc** will also abort the operation. When the file is created, the file list is *not* updated. If the file source is the LI-1800, the resulting file will be uploaded to the selected RAM bank.

Multiply

Create a new file by multiplying two other files. The sequence of events is just like that of Divide, shown above. The file list is *not* updated.

Xform

Create a new file from the transform $C = aA + bB + c$. A, B, and C are files, and a, b, and c are numeric constants. The A file and B file are selected from the file list, followed by

```

A File:
  FILE: LAMP    02/19  11:13
  LIMS: 300NM-1100NM
  INT:  1NM

B File:
  FILE: TRA2    11/03  14:15  T P-19
  LIMS: 390NM-1100NM
  INT:  2NM

NAME: NONE
REMARK: **
LOW: 390
HIGH: 1100
INTERVAL: 2

A-File multiplier: 1.000E+00
B-File multiplier: 1.000E+00
Offset: 0.000E+00

```

[Esc]-abort [Enter]-transform files

Put the desired result file name, remarks, and wavelength information in the appropriate fields, and also the desired values for the numeric constants of the transformation. When all fields are as you wish them to be, press **Enter**. The file list is *not* updated.

Edit

Edit the data (but not the wavelengths) in an unprotected file. The file is selected from the file list,

EDIT FILE			
ABS2	11/03 14:30	ABS P-19	
ABS4	11/03 15:39	ABS NR55BR	
LAMP	02/19 11:13		
DIVI	09/16 15:09	**	

[Esc]-abort [Enter]-select file

and the data portion is shown in a scrollable window. Use the cursor control keys to position the cursor on the data

to be changed, and type the new value. Do not press **Enter** until you are done making all of your changes.

LAMP
LIMS: 300-1100NM
INT: 1NM
DATE: 2/19 11:13
MIN: 300NM 2.044E-03
MAX: 900NM 2.453E-01
NAME: LAMP
REM: 8.537E-02
300: 9.040E-02
301: 9.313E-02
302: 9.766E-02
303: 1.013E-01
304: 1.037E-01
305: 1.077E-01
306: 1.112E-01
307: 1.172E-01
308: 1.206E-01
309: 1.242E-01
310: 1.293E-01
▼ 311: 1.293E-01

[Esc]-abort [Enter]-stores edited file

The filename and remarks can also be changed with the Edit option. Select the file(s) which you wish to modify and type in the new filename and/or remarks, if desired.

NOTE: If the filename and remarks fields are edited, the old file is deleted, and the edited information is stored under the new filename. The renamed file will not appear on the file list (List/Select option) until the next time List/Select is accessed.

New File

Create a new file, and enter all of its data by hand. The file name, remarks, and wavelength information is entered via the following menu:

CREATE FILE PARMS	
NAME:	NONE
REMARK:	**
LOW:	300
HIGH:	1100
INTERVAL:	1

[Esc]-abort [Enter]-Proceed

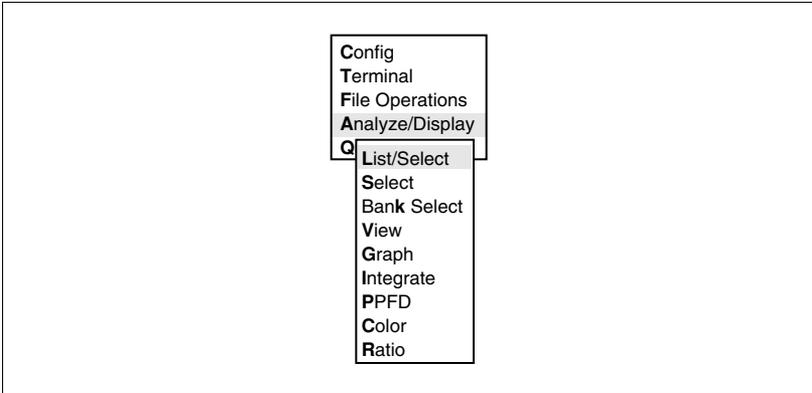
The file name 'NONE' is reserved to mean that the operation should be cancelled. The data is entered in a mode similar to the last menu in the Edit routine.

FILE: FNEW	
300:	0.000E+00
310:	0.000E+00
320:	0.000E+00
330:	0.000E+00
340:	0.000E+00
350:	0.000E+00
360:	0.000E+00
370:	0.000E+00
380:	0.000E+00
390:	0.000E+00
400:	0.000E+00
410:	0.000E+00
420:	0.000E+00
430:	0.000E+00
440:	0.000E+00
450:	0.000E+00
▼ 460:	0.000E+00

[Esc]-abort [Enter]-stores new file

The file list is *not* updated.

The Analyze/Display Menu



List/Select, Select, Bank Select, View

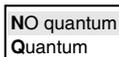
As described under File Operations section.

Graph

Graphical operations on selected files (page 37).

Integrate

Integrates selected files. You have the option of applying a quantum transformation on the data,



followed by a menu in which you specify the wavelength limits desired for the integration:

```

ITG:
  FILE: ABS4  11/03 15:39 ABS NR55BR
  LIMS: 390NM-1100NM
  INT:  2NM
  LOW:  390
  HIGH: 1100

```

[Esc]-abort [Enter]-proceed

Pressing **Enter** will perform the integration, and display the results in a trace window:

```

FILE:ITG:
| "FILE:ABS4"
| "REM: ABS NR55BR
| "LIMS: 390-1100NM"
| "INT:  2NM"
| "DATE:11/03 15:39"
| "MIN: 1058NM 1.342E-01"
| "MAX: 390NM 7.851E-01"
| 2.149E+02 ————— the integral

```

[Esc]-abort [Enter]-next file F1-print status F3-trace status

Press **Enter** again to perform the integration on subsequent files selected earlier.

PPFD

Integrates selected files between 400 and 700 nm, after applying the quantum transformation. The results go into a trace window:

```

FCT:PPFD
| "FILE:LAMP"
| "REM:          (QNTM)" ——— "(QNTM)" appended
| "LIMS: 400-700NM"
| "INT:  1NM"
| "DATE:02/19 11:13"
| "MIN: 400NM 5.120E-03"
| "MAX: 700NM 1.185E+00"
| 1.672E+02 ————— the integral

```

Note that 'QNTM' is appended to the remarks shown in the file header if the quantum transformation is done. With PPFD the transformation is always done.

Color

Accesses the colorimetry command menu (page 43).

Ratio

Computes the ratio of the integrals over two wavelength intervals in each selected file. The quantum transform option is selected,

```
NO quantum
Quantum
```

after which the integration limits of the numerator and denominator are specified:

```
RATIO:
  FILE: LAMP 02/19 11:13
  LIMS: 300NM-1100NM
  INT:  1NM

NUMERATOR:
LOW: 300
HIGH: 1100

DENOMINATOR:
LOW: 300
HIGH: 1100
```

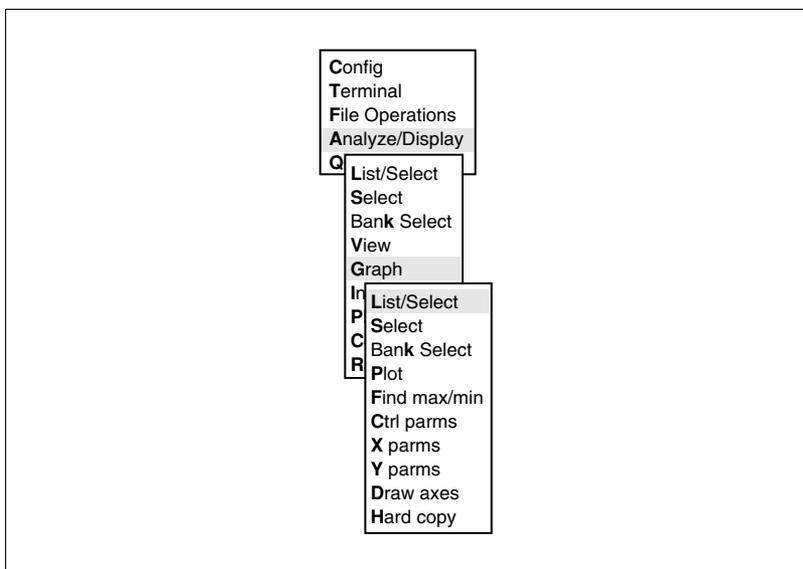
[Esc]-abort [Enter]-continue

The results are shown in a trace window:

```
RATIO
"FILE:LAMP"
"REM:
"DATE:02/19 11:13
"INT: 1NM"
"NUMERATOR"
" LIMS: 300-1100NM"
" MIN: 300NM 2.044E-03"
" MAX: 900NM 2.453E-01"
"DENOMINATOR"
" LIMS: 300-1100NM"
" MIN: 300NM 2.044E-03"
" MAX: 900NM 2.453E-01"
RESULT: 1.000E+00 — the ratio
```

[Esc]-abort [Enter]-next file F1-print status F3-trace status

Analyze/Display - Graph



List/Select, Select, Bank Select

As described under File Operations section.

Plot

Plots the selected files using the parameters in the Control Parameters (Ctrl parms) menu.

Find max/min

Searches the selected files to determine the overall maximum and minimum of wavelength and spectral data. The results are put in the X and Y axes parameter menus (X parms and Y parms).

Ctrl parms

There are 12 plotting control parameters; each field has preselected values (e.g. ON / OFF) toggled by pressing ← or →.

File header: ON
New axes: ON
Auto scale: ON
Y number format: Scientific
Scaling: Linear
Axes type: AXES
Tags: ON
Tag at: 0
Patterns: ON
Pause: OFF
Find updates axis MIN/MAX: ON
Quantum: OFF

File header

ON or OFF. Determines whether or not the file header information is written at the top of the graph for the last curve plotted.

New Axes

ON or OFF. Determines whether or not the graphics space is cleared and new axes drawn for each curve plotted. This must be OFF for multiple curve plots.

Auto scale

ON or OFF. Determines whether or not the axes parameters (max, min, tic interval) should be calculated based on the range of the data in the curve.

Y number format

Scientific (1.23E-03) or Decimal (0.00123) format for the Y axis tic labels.

Scaling

Linear or Log scaling for Y axis. Remember that for a log scale, the minimum value of the axis must be greater than zero.

Axes type

AXES or GRID.

Tags

ON or OFF. Toggle this option to choose whether or not to place labels (i.e., A, B, C, D, etc.) for each data file that is plotted on a graph.

Tag at

If your data files converge at the end of the plots, it may be difficult to place several tags at that location. The Tag at option allows you to choose any wavelength (at a less congested location, for example) on a graph at which to place the tags. Enter "0" to place the tags at the right edge of the plots (the default location).

Patterns

ON or OFF. Turns line patterns of a plot ON or OFF. If turned off, all plots appear as solid lines (in color with a color monitor).

The postscript printer driver is *not* compatible with the line pattern generator in the 1800-14 program. Because of this, the postscript driver will use shades of gray instead of patterns.

To use shades of gray, it is necessary to turn the Patterns parameter ON in the Control Parameters window of the Analyze/Display Main Menu, Graph Sub-menu. When you print the plot, turn the Color option in the Graphics Printer Parameters dialog box to Color. The plot will print with different shades of gray. Turning either of these selections off will cause the printer to use solid black lines.

Pause

ON or OFF. Determines whether or not the program pauses after drawing each curve. If it pauses, the graphics display remains visible until a key is pressed.

Find updates axes MIN/MAX

ON or OFF. Determines whether or not the Find routine automatically forces the X and Y axes parameters to adjust to the found limits.

Quantum

ON or OFF. Determines whether or not the quantum transformation is performed on data being plotted.

X parms, Y parms

Size parameters for the axes. When the Find max/min option is executed, the PC1800 program searches the selected files for the minimum and maximum values which will be plotted on the X and Y axes on the resulting graph.

The results of the Find max/min option are displayed in the X and Y parms menu options under two headings; the "Selected Files" and "Last Find" headings. The "Selected Files" heading shows the minimum and maximum values found for *all* data points in the selected files. The "Last Find" heading shows the maximum and minimum values for the wavelength range which was selected under the "Current X Axis" option in the Control Parameters option.

X axis:

LABEL: Wavelength (nm)	
Selected Files:	
MIN:	300
MAX:	1100
Last Find:	
MIN:	300
MAX:	1100
Current X-Axis:	
MIN:	300
MAX:	1100
MINOR TIC:	100
MAJOR TIC:	2

Y axis:

LABEL: Spectral Irradiance	
Selected Files:	
MIN:	2.044E-03
MAX:	3.090E-01
Last Find:	
MIN:	2.044E-03
MAX:	3.090E-01
Current Y-Axis:	
MIN:	0.000E+00
MAX:	5.000E-01
MINOR TIC:	5.000E-02
MAJOR TIC:	2

Draw axes

Clears the graphics display, and draws the axes according to the parameters specified in the Ctrl parms, X parms, and Y parms menus. **Esc** returns to the menu.

Hard copy

Select this option to print your plot(s) to a printer. The printer and port listed are chosen at the Configuration

Menu. Choose the format for printing (Half page, Full page, or Landscape), the resolution at which to print (Low, Medium, or High), and print to your printer, or to a disk file.

NOTE: Files may not print properly if your printer does not have enough internal memory to process the data files. As an example, an HP LaserJet printer with 512K bytes of internal memory may be able to print graphics only at low or medium resolution. Older MX80 and IBM Graphics printers do not support quad density graphics, and therefore the High resolution option will not work with these printers.

Printing to a file

To print to a file, toggle the **Print to** option to “File”, and press **Enter**. You will be prompted to enter the path (where you want to send the file) and the name of the graph. For example, type `C:\PC1800\sample.grf` to send the file named “sample.grf” to your PC1800 subdirectory.

The standard DOS COPY command can then be used to send the file to the printer. It is possible, however, that DOS may transmit the file(s) faster than the printer can process it. The GCOPY.EXE program included on the 1800-14 diskettes is a modified DOS COPY command, which will slow the file transmission to the printer speed. It will also pause at the beginning of each page with plotter files, to allow the user to load paper into the plotter. The syntax for GCOPY is as follows (type GCOPY with no parameters for a brief help message):

```
gcopy FileType FileList port [:CommParm] [/X],
```

where

FileType = file output format

DM	Dot matrix printer
LJ	LaserJet or PaintJet
HP	HP plotter
PS	PostScript

FileList = list of file names to copy

port = LPT1, LPT2, COM1, or COM2 (not PRN or AUX)

CommParm = baud rate, parity, data bits, stop bits for the serial port:

baud rate	110, 150, 300, 600, 1200, 2400, 4800, or 9600
parity	None, Even, or Odd
data bits	7 or 8
stop bits	1 or 2

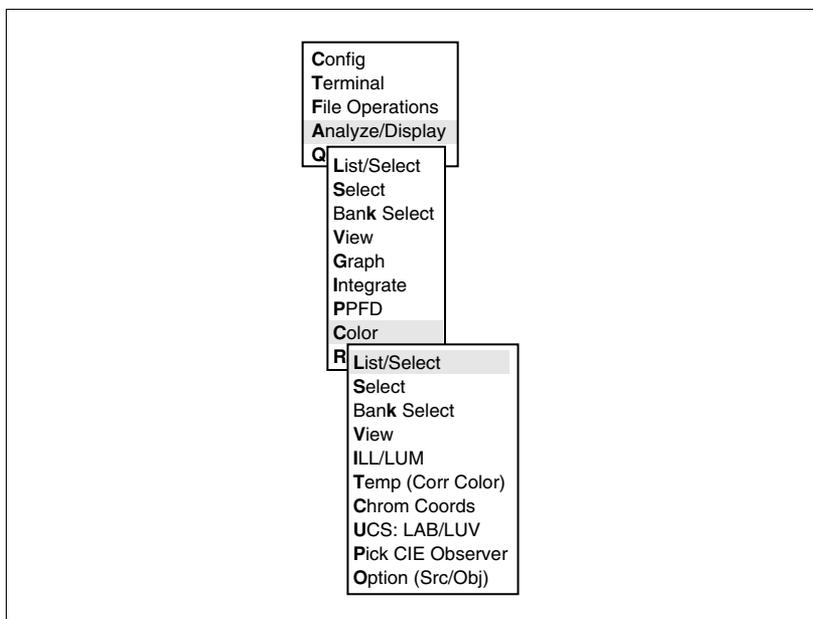
NOTE: If CommParm is omitted, GCOPY will not initialize the serial port. If any parameters are omitted from the list, the default values will be 2400, N, 8, 1.

/X = XON/XOFF handshaking on the serial port. If the file type is HP, the GCOPY command will also send the setup string to place the plotter in XON/XOFF mode. It will not send a setup string for other file types. You must enter CommParms if you use the **/X** option.

Examples

```
gcopy HP pc1800.grf COM1:4800,n,8,1
gcopy LJ *.grf LPT1
gcopy DM pc1.grf pc2.grf LPT1
```

Analyze/Display - Color



List/Select, Select, Bank Select, View

As described under File Operations section.

ILL/LUM

Computes the illuminance or luminance of selected files, and shows each in a trace window:

```
FCT: ILL/LUM
"FILE:LAMP"
"REM: "
"LIMS: 370-790NM"
"INT: 1NM"
"DATE:02/19 11:13"
8.734E+03
```

[Esc]-abort [Enter]-next file F1-print status F3-trace status

If the data file is not inclusive of 370nm through 790nm, the trace window will include the message WARNING: SHORT RANGE. The illuminance L is computed from

$$L = 683 \int_{370}^{790} S(\lambda) \bar{y}(\lambda) d\lambda$$

where $S(\lambda)$ is the spectral data in the data file. $\bar{y}(\lambda)$ is the 2° standard observer data contained in the file 2DEG.OBS.

The units of the integration depend upon the units of the data in the file.

Data File

W m⁻² nm⁻¹
 W cm⁻² nm⁻¹
 W m⁻² nm⁻¹ sr⁻¹
 W cm⁻² nm⁻¹ sr⁻¹

ILL/LUM units

Lux = lumens m⁻²
 Phots = lumens cm⁻²
 Nits = cd m⁻²
 Stilbs = cd cm⁻²

If output in footcandles (lum ft⁻²) is desired, divide the Lux value by 10.764.

Temp (Corr Color)

Correlated Color Temperature is defined as the temperature of the blackbody radiator whose perceived color most closely resembles that of the given (test data) selective radiator at the same brightness and viewing conditions. The currently accepted practice is to define Correlated Color Temperature as the temperature of the blackbody locus of points nearest the chromaticity of the test data when transformed onto the 1960 u,v chromaticity diagram. The actual calculations use the method of Robertson (1968) [Computation of correlated color temperature and distribution temperature, *J. Opt. Soc. Am.* **58**:1528-1535], and can provide temperatures between 1,667 °K and 100,000 °K. The distance D from the blackbody locus is also given in u, v units. If v is higher than the curve, D is positive. If v is lower than the curve,

D is negative. No limit on D is stipulated, but generally values above 0.01 are considered invalid.

For each selected file, the tristimulus values (X, Y, Z), the chromaticity coordinates (u and v), and color temperature and distance are computed and shown in a trace window:

FCT: CORR COLOR TEMP	
"FILE:LAMP"	"
"REM:	"
"LIMS: 370-790NM"	
"INT: 1NM"	
"DATE:02/19 11:13"	
X = 106.723 Y = 100.000 Z = 42.319	from Equations
u = 0.246235 v = 0.346085	(1) & (2)
TEMP(K) = 3125.7	
DISTANCE = 0.00021	

[Esc]-abort [Enter]-next file F1-print status F3-trace status

If the data file is not inclusive of 370nm through 790nm, the trace window will include the message WARNING: SHORT RANGE.

Chrom Coords

Chromaticity coordinates are calculated for either a source or an object.

(Option (Src/Obj) = Source)

For each selected file the tristimulus values (X, Y, Z) and related chromaticity coordinates (x, y, u, v, u', and v') are shown in a trace window.

```
FCT: CC 2° OBSERVER
"FILE:LAMP"
"REM: "
"LIMS: 370-790NM"
"INT: 1NM"
"DATE:02/19 11:13"
X = 106.723 Y = 100.000 Z = 42.319
x = 0.42853 y = 0.40154
u = 0.24623 v = 0.346085
u'= 0.24623 v'= 0.51913
```

from Equations
(1) & (2)

[Esc]-abort [Enter]-next file F1-print status F3-trace status

Y will always be 100 for source calculations. x and y are the original 1931 coordinates. u and v are the 1960 CIE coordinates, and u' and v' are the 1976 coordinates.

UCS: LAB/LUV

A color coordinate system in which perceived color change always corresponds to uniform increments of coordinate change is a Uniform Color Space. Two systems are presently in use: the 1976 CIE $L^* u^* v^*$ coordinates (CIELUV) and the 1976 CIE $L^* a^* b^*$ coordinates (CIELAB). CIELUV is favored in the color reproduction industry, while CIELAB is favored in industries concerned with colorants in paints, plastics, and textiles. Uniform color space coordinates can be calculated for a source or for an object.

(Option (Src/Obj) = Source)

When computing uniform color space coordinates for a source, you are first asked to select the reference data file:

Select White Reference Source			
ABS2	11/03	14:30	ABS P-19
LAMP	02/19	11:13	
RFL4	11/03	15:21	RFL NR55BR
TRA4	11/03	15:32	T NR55BR

[Esc]-abort [Enter]-select file

The results are then shown in a trace window:

FCT: UCS	
"White Reference File:LAMP"	
"REM: "	
"DATE:02/19 11:13"	
X = 106.723 Y = 100.000 Z = 42.319	
u' = 0.246235 v' = 0.519127	from Equations (1) & (2)
"TEST SOURCE FILE:LAMP"	
"REM "	
"LIMS: 370-790NM"	
"INT: 1NM"	
"DATE:02/19 11:13"	
X = 15.723 Y = 12.771 Z = 1.969	
x = 0.51723 y = 0.41924	from Equations (2) & (3)
u = 0.29499 v = 0.35942	
u' = 0.29499 v' = 0.53913	
L* = 100.000	
u* = 0.000 v* = 0.000	from Equation (4)
a* = 0.000 b* = 0.000	

[Esc]-abort [Enter]-next file F1-print status F3-trace status

(Option (Src/Obj) = Object)

When computing uniform color space coordinates for an object, the illumination data must first be specified:

STD ILM FILE
is:A
A
D65
E

A = full radiator at 2856 °K.
D65 = approximate natural sunlight.
E = equal energy stimulus.

[Esc]-abort [Enter]-select file

The results are then shown in a trace window:

FCT: UCS	
"Std Illuminant: D65"	
X = 95.046 Y = 100.000 Z = 100.863	from Equations (1) & (2)
u' = 0.19784 v' = 0.46835	
"TEST SOURCE FILE:LAMP"	
"REM "	
"LIMS: 370-790NM"	
"INT: 1NM"	
"DATE:02/19 11:13"	
X = 11.872 Y = 11.739 Z = 5.602	from Equations (2) & (3)
x = 0.40547 y = 0.40248	
u = 0.23108 v = 0.34406	
u' = 0.23108 v' = 0.51609	
L* = 40.799	from Equation (4)
u* = 17.627 v* = 23.317	
a* = 4.798 b* = 23.539	

[Esc]-abort [Enter]-next file F1-print status F3-trace status

Pick CIE Observer

The CIE system uses two standard observer definitions: the 2° 1931 definition, which had minor revisions in 1971, is recommended for visual fields of 1 to 4°. The newer 1964 Supplementary Standard Colorimetric Observer is based on 10° fields, so should be used for fields greater than 4°. Chromaticity coordinates and Uniform Color Space can be based on either observer.

CIE Observer: 2° 1931

The 2° observer definition is always used for Correlated Color Temperature and Illuminance/Illuminance measurements (regardless of how the CIE Observer option is set), since these calculations are currently defined only for that data.

Option (Src/Obj)

Several of the colorimetry calculations depend upon whether the data file is a light source, or light reflected by an object. This option is determined by the setting of this field.

Color Computations For: SOURCE

Equation set (1):

$$K_s = \frac{100}{\int_{370}^{790} S(\lambda) \bar{y}(\lambda) d\lambda}$$

$$X = K_s \int_{370}^{790} S(\lambda) \bar{x}(\lambda) d\lambda$$

$$Z = K_s \int_{370}^{790} S(\lambda) \bar{z}(\lambda) d\lambda$$

$$Y = 100$$

Equation set (2):

$$x = \frac{X}{X + Y + Z}$$

$$y = \frac{Y}{X + Y + Z}$$

$$u = \frac{4X}{X + 15Y + 3Z}$$

$$v = \frac{6Y}{X + 15Y + 3Z}$$

$$u' = u$$

$$v' = 1.5 v$$

Equation set (3):

$$K_i = \frac{100}{\int_{370}^{790} I(\lambda) \bar{y}(\lambda) d\lambda}$$

$$X = K_i \int_{370}^{790} S(\lambda) I(\lambda) \bar{x}(\lambda) d\lambda$$

$$Y = K_i \int_{370}^{790} S(\lambda) I(\lambda) \bar{y}(\lambda) d\lambda$$

$$Z = K_i \int_{370}^{790} S(\lambda) I(\lambda) \bar{z}(\lambda) d\lambda$$

Equation set (4):

$$L^* = \begin{cases} 903.3 \frac{Y}{Y_r} & \text{for } \frac{Y}{Y_r} \leq 0.008856 \\ 116 \left[\frac{Y}{Y_r} \right]^{1/3} - 16 & \text{for } \frac{Y}{Y_r} > 0.008856 \end{cases}$$

$$u^* = 13 L^* (u' - u'_r)$$

$$v^* = 13 L^* (v' - v'_r)$$

$$F\left(\frac{X}{X_r}\right) = \begin{cases} 7.787 \left[\frac{X}{X_r} \right] + \frac{16}{116} & \text{for } \frac{X}{X_r} \leq 0.008856 \\ \left[\frac{X}{X_r} \right]^{1/3} & \text{for } \frac{X}{X_r} > 0.008856 \end{cases}$$

$$F\left(\frac{Y}{Y_r}\right) = \begin{cases} 7.787 \left[\frac{Y}{Y_r} \right] + \frac{16}{116} & \text{for } \frac{Y}{Y_r} \leq 0.008856 \\ \left[\frac{Y}{Y_r} \right]^{1/3} & \text{for } \frac{Y}{Y_r} > 0.008856 \end{cases}$$

$$F\left(\frac{Z}{Z_r}\right) = \begin{cases} 7.787 \left[\frac{Z}{Z_r} \right] + \frac{16}{116} & \text{for } \frac{Z}{Z_r} \leq 0.008856 \\ \left[\frac{Z}{Z_r} \right]^{1/3} & \text{for } \frac{Z}{Z_r} > 0.008856 \end{cases}$$

$$a^* = 500 \left[F\left(\frac{X}{X_r}\right) - F\left(\frac{Y}{Y_r}\right) \right]$$

$$b^* = 500 \left[F\left(\frac{Y}{Y_r}\right) - F\left(\frac{Z}{Z_r}\right) \right]$$

(Subscript r values are from the reference file).

APPENDIX

The EQUIP program.

The program `EQUIP.EXE` on the 1800-14 diskette is a diagnostic tool for RS-232C communications. The program simply shows the real time status of the major modem lines of the COM1 and COM2 ports (if found). Run it by typing `EQUIP`, and then press **Enter**. The display will show

PORT	CONFIGURED	RTS (4)	CTS (5)	DSR (6)	CD (8)	DTR (20)
====	=====	=====	=====	=====	=====	=====
COM1	4800,8,2,N	LOW	LOW	LOW	LOW	LOW

Pressing any key will stop the program, and return to DOS.

When the LI-1800 is connected to the COM1 or COM2 port and powered on, you should see the DSR line reading `HIGH`. If the line remains `LOW` with or without the powered up LI-1800 connected to your computer, then you've either connected the LI-1800 with the wrong type of cable, or you've connected it to the wrong port on your computer.

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