

INTERFACE DEVELOPMENTS FOR AN ISC 309
INTECOLOR 8001 TERMINAL AND A HEWLETT-PACKARD
9835A DESK-TOP COMPUTER SYSTEM

by

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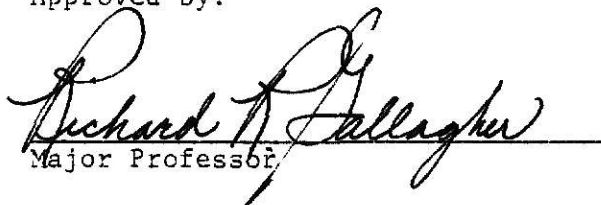
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TABLE OF CONTENTS

	Page
LIST OF FIGURES	iv
LIST OF TABLES.	v
LIST OF EXAMPLES.	vi
LIST OF TERMS	vii
SECTION	
I INTRODUCTION	1
II BRIEF REVIEW OF APPLICATION.	3
III INTERFACE HARDWARE	4
3.A Intecolor 8001 Terminal Interface Hardware	4
3.B Hewlett-Packard 98036A Serial Interface.	6
IV PROGRAM DESCRIPTION AND RUN INSTRUCTIONS	8
4.A Intecolor Receiver Program, REC	8
4.B Intecolor Continuous Print Program, PRNT3	10
4.C HP9835A Color-Shade Plot Program, PLOT12	12
4.D HP9835A 3-Dimensional Plot Program, 3DPLT1.	13
4.E HP9835A Data Array Storage Program, MANUAL	14
4.F Intecolor Alternative Console Input Device Program, CONS2.	14
V PROGRAM LISTING.	16
5.A Intecolor Receiver Program, REC, Listing.	16
5.B Intecolor Continuous Print Program, PRNT3, Listing	19
5.C HP9835A Color-Shade Plot Program, PLOT12, Listing	20
5.D HP9835A 3-Dimensional Plot Program, 3DPLT1, Listing	23
5.E HP9835A Data Array Storage Program, MANUAL, Listing	26
5.F Intecolor Alternative Console Input Device Program, CONS2, Listing	27
VI FUTURE DEVELOPMENTS.	28
VII REFERENCES	30
VIII ACKNOWLEDGEMENTS	31

APPENDIX

Appendix 1	Partial Listing of Control and Escape Codes on the Intecolor 8001 Terminal	A1-1
Appendix 2	CRT Display of the Intecolor 8001 Terminal	A2-1
Appendix 3	X-Y Plot and Vector Modes on the Intecolor 8001 Terminal.	A3-1
Appendix 4	I/O Status Byte of the Intecolor 8001 Terminal	A4-1
Appendix 5	Machine Language Routines Found in the Intecolor 8001 Terminal's ROM.	A5-1
Appendix 6	Sample Data Arrays and Their Plots	A6-1

LIST OF FIGURES

Figures	Page
A.1 Character Space Coordinate System	A2-2
A.2 Arrangement of the CRT Composite Status Word.	A2-4
A.3 Arrangement of the CRT Character Word	A2-4
A.4 Block Arrangement of a Character Space with the Corresponding Bits from the CRT Character Word.	A2-4
A.5 Block Coordinate System	A3-3
A.6 Appearance of Character Space During Example A.4.	A3-4
A.7 Appearance of Character Spaces During Example A.5	A3-4
A.8 I/O Status Byte Arrangement	A4-2
A.9 Character Plot of Impedance Data OFF/CE in Linear Scale	A6-3
A.10 Character Plot of Impedance Data OFF/CE in Pseudo-Log Scale.	A6-4
A.11 Character Plot of Data Set PYRMD in Linear Scale.	A6-6
A.12 Character Plot of Data Set PYRMD in Pseudo-Log Scale	A6-7
A.13 Character Plot of Data Set TRY in Linear Scale.	A6-8
A.14 Character Plot of Data Set TRY in Pseudo-Log Scale.	A6-9
A.15 3-Dimensional Plot of Impedance Data OFF/CE in Pseudo-Log Scale.	A6-10
A.16 3-Dimensional Plot of Data Set PYRMD in Linear Scale.	A6-11
A.17 3-Dimensional Plot of Data Set TRY in Linear Scale.	A6-12

LIST OF TABLES

Tables	Page
3.1 First RS-232C Port Connector Pin Assignments	5
3.2 Second RS-232C Port Connector Pin Assignments.	5
3.3 Cable Signals for the HP98036A Option 001 Cable	7
A.1 Partial List of Control Codes.	A1-2
A.2 Partial List of Escape Codes	A1-3
A.3 Color Codes for the CRT Composite Status Word.	A2-5
A.4 List of Logical Devices.	A4-1
A.5 Bit Codes for the Physical Devices	A4-3
A.6 Memory Location of the I/O Status Byte and JMP Addresses for Drivers.	A4-4
A.7 Data Array Components of the Impedance Data OFF/CE	A6-2
A.8 Data Array Components of the Data Set PYRMD.	A6-5
A.9 Data Array Components of the Data Set TRY.	A6-5

LIST OF EXAMPLES

Examples	Page
A.1 Positioning the Intecolor Terminal's Cursor	A2-1
A.2 Changing the Composite Status Word.	A2-5
A.3 Plotting Points on the Intecolor Terminal	A3-1
A.4 Plotting Points in a Character Space on the Intecolor Terminal.	A3-1
A.5 Drawing Lines by Vector Plot on the Intecolor Terminal.	A3-2
A.6 Explanation of Initial I/O Status Byte.	A4-1

LIST OF TERMS

- 3-D Plot - A 3-dimensional plot of a data array on the Intecolor Terminal.
- 3DPT1 - The HP 9835A 3-Dimensional Plot Program.
- ASC II - Abbreviation for USA Standard Code for Information Interchange.
- BAUD - Data transfer rate, one bit per second.
- Bit - Binary digit, either 1 or 0.
- Buffer - A storage circuit used to compensate for a difference in the time of transmitting and receiving information from one device to another.
- Byte - A sequence of 8-bits.
- Character Byte - Byte which is passed from HP Computer to Intecolor Terminal.
- Character Code - The 8-bit word that contains the ASC II code for a specific character.
- Character Line - The line in which a character space is located.
- Character Plot - A hardcopy of a color-shade plot.
- Character Position - The position in a line where a character space is located.
- Character Space - The location which a character occupies on the Intecolor Terminal's CRT screen.
- Character Word - Contains the 7-bit ASC II code for a specific character space. The A7 bit of this word defines the character height as normal or double. In plotting, this word defines the combination of plot blocks within a character space.
- Color-Shade Plot - A plot on the Intecolor Terminal's CRT of a data array. The color of a character space in this plot represents a range of values in the data array.
- Composite Status Word - This word defines for a specific character space its background color, foreground color, foreground blink and whether the character word defines an ASC II character or that the character word specifies plotting information.
- Control Code - The character code which is required to be sent to the Intecolor Terminal to obtain a specific Control command.

Control Command - A command that affects the Intecolor Terminal's Operation.

CPU - Central Processing Unit, the 8080 microprocessor in the Intecolor Terminal.

CPU Operating System - An operation mode on the Intecolor Terminal. While in this mode the operator can enter a machine language program from the Intecolor's Keyboard.

CPU O.S. - CPU Operating System.

CRT - Cathode Ray Tube, refers to the display on the CRT's screen.

Driver - A machine language routine that controls communications between the Intecolor Terminal and a Physical Device.

EPROM - Erasable/Programmable Only Memory. A field programmable read only memory chip in which the data content of each memory cell can be altered more than once.

Escape Code - The character code (following the character code 27) which is required to be sent to the Intecolor Terminal to obtain a particular Escape command.

Escape Command - A command that affects the Intecolor Terminal's Operations.

FCS - File Control System on the Terminal.

HP 9835A - Hewlett-Packard 9835A Desk-Top Computer.

HP Computer - Hewlett-Packard 9835A Desk-Top Computer.

Intecolor Terminal - The ISC Intecolor 8001 Color Graphs Terminal.

ISC - Intelligent Systems Corporation.

I/O Status Byte - This byte, located in the Terminal's memory, tells the Terminal where the physical devices are located to handle the four logical devices.

Logical Devices - A device that handles specific functions in the Intecolor System.

MANUAL - HP 9835A Data Array Storage Program.

MROM - Mask Programmed Read Only Memory in which the data content of each cell is determined during manufacture, the data content thereafter is unalterable.

MRTFE - An Intecolor program that can make hardcopies of the Terminal screen on the Xerox 1710 Teletype.

OFF/CE - The impedance data array.

- Physical Device - The location and specific type of device that handles the logical device functions.
- PLOT12 - The HP9835A Color-Shade Plot Program.
- Plot Block - A specific area in a character space which is used in making plots.
- PRNT3 - Intecolor Continuous Print Program.
- PSW - Processor Status Words, contents of register A and condition flag register of the 8080 microprocessor.
- PYRMD - A data array in which the component values vary like the surface of a pyramid.
- RAM - Random-Access Memory is a memory that permits access to any of its address locations in any desired sequence with similar access time to each location.
- REC - The Intecolor Receiver Program.
- ROM - Read Only Memory is a memory in which the contents are not intended to be altered during normal operation.
- Routine - A program that performs a specific operation.
- Teletype - Decwriter II Teletype.
- Terminal - Intecolor Terminal.
- TMS - Texas Instruments Microprocessor Series of chips.
- TRY - A 2 x 2 data array, used as an example in this report.
- Word - The group of bits occupying one storage location in memory. It is treated by the microprocessor as an instruction, operand, or a quantity. In this report the length of a word is 8-bits.

I INTRODUCTION

This report details the efforts in the development of a software/hardware interface between an Intelligent Systems Corporation Intecolor 8001 Color Graphics Data Terminal and a Hewlett-Packard 9835A Desk-Top Computer. The interface will provide a means of displaying data transmitted either alphanumerically or graphically from the HP Computer. The data can be graphically displayed either in a color-shade plot or in a 3-dimensional plot.

To be displayed graphically, data must be oriented in a row and column array form so that the data sets can be properly processed by the HP 9835A Computer. Information on the construction of the graphical display of a data set is then passed from the HP 9835A Computer to the Intecolor Terminal at a bit rate of 9600 BAUD. This is accomplished by utilizing the HP 98036A Serial I/O Interface and one of two RS-232C serial ports on the Intecolor Terminal.

After the data set is displayed on the CRT of the Intecolor Terminal instructions from the HP 9835A Computer allows the Intecolor Terminal to store the display on a floppy diskette. The Intecolor Terminal controls a dual floppy disk drive which can store programs, arrays, displays or data files on a 96K byte floppy diskette. Once a display is stored on a floppy diskette it can be recalled by the Intecolor Terminal when directed to do so by the HP 9835A Computer. If the selected display is a color-shade plot, instructions can be given to the Intecolor Terminal to print a hardcopy of the display on a Decwriter II Teletype operating at a bit rate of 300 BAUD.

Briefly, this report contains a discussion of the Intecolor 8001 Terminal applications, how to initialize and run the programs, a listing of programs and associated documentation, possible future developments and an Appendix which examines hardware and software characteristics of the Intecolor Terminal. The Appendix also contains several hardcopies of color-shade plots and 3-dimensional plots.

II BRIEF REVIEW OF APPLICATION

The software/hardware interface developed for this report permits the Intecolor 8001 Terminal to be used as a display device for the HP 9835A Computer. Additionally the Intecolor Terminal can store on and recall displays from a floppy diskette when the proper sequence of character bytes are received from the HP Computer. With two RS-232C ports the Intecolor Terminal can receive data from the HP Computer on one RS-232C port and transmit the display to a Decwriter II Teletype on the other RS-232C port.

An Intel 8080 microprocessor, with ROM and RAM memories and various I/O chips, controls the Intecolor Terminal. The programability of the microprocessor makes the Terminal very flexible. The software written for the Interface transmits to the Intecolor Terminal's CRT the data received from the HP Computer. When the proper sequence is received from the HP Computer the software will store or recall a display from a floppy diskette located in the Intecolor Terminal's Disk Drive. Additionally, the display could be printed out on the Decwriter II Teletype when the software receives the proper sequence from the HP Computer.

The HP Computer plot programs take a data array stored on tape cartridge and then develop either a Color-Shade Plot or a 3-D Plot of the data array on the Intecolor Terminal. The plot programs can also send the proper sequence of characters that instruct the Intecolor Terminal software to store, recall, or make a hardcopy of the displays of the data arrays.

III INTERFACE HARDWARE

3.A Intecolor 8001 Terminal Interface Hardware

Communications between the Intecolor 8001 Terminal and an external device (such as the HP 9835A Computer) can be done through serial, 8-bit parallel or 24-bit parallel ports. The interface developed for this report used two RS-232C ports with female RS-232C connectors. A TMS 5501 Multifunction Input/Output Controller¹ moves data between the Terminal's 8080 microprocessor and external devices through the TMS 5501 internal data bus, input port and output port. Each RS-232C port is connected to a separate TMS 5501 Controller. Both TMS 5501 Controllers are located on the CPU, EPROM, MROM and I/O Module Board (i.e., CPU Board) inside the Intecolor Terminal. The receiver and transmitter buffers of the TMS 5501 Controllers are capable of holding only one 8-bit character byte at a time. The bit rate of the TMS 5501 Controllers can be varied from 110 to 9600 BAUD.

See Table 3.1 and 3.2 for a listing of pin assignments for the RS-232C ports.

It should be noted that if the HP 98036A Serial I/O Interface bit rate is set at 9600 BAUD and is connected to the first RS-232C port then any data transmitted from the HP 9835A Computer will be displayed on the Intecolor Terminal's CRT screen. The software that performs this transfer is located in ROM. The Terminal will also respond to the Escape and Control commands and to any File Control System (FCS) commands while in FCS. The Terminal will not respond to BASIC commands while in BASIC or CPU commands while in the CPU Operating System.

¹See Appendix C in Ref. 1 and Ref. 2 for details about the TMS 5001 Controller.

Table 3.1 First RS-232C Port Connector Pin Assignments

Pins Number		Signal
CPU Board Connector P1	RS-232C Connector	
1,14	1	Ground
5	2	Received Data from E.D.*
3	3	Transmitted Data to E.D.*
7	4	
7	5	Clear to Send to E.D.* (12 V)
7	6	Data Set Ready to E.D.* (12 V)
1,14	7	Signal Ground
16	8	Carrier Defect to E.D.*
18	9	Receiver Response Control from E.D.*
20	10	Receiver Response Control from E.D.*
22	11	---
24	12	Transmitted Data (TTL) to E.D.*
26	13	---
2	14	---
4	15	Receiver Acknowledge to E.D.*
6	16	---
8	17	---
10	18	---
12	19	---
17	20	Data Terminal Ready from E.D.*
--	21	---
19	22	---
21	23	---
23	24	---
25	25	---

Table 3.2 Second RS-232C Port Connector Pin Assignments

Pins Number		Signal
CPU Board Connector P2	RS-232C Connector	
19	2	Receive Data from E.D.*
23	3	Transmit Data to E.D.*
10	7	Signal Ground

*External Device

3.B Hewlett-Packard 98036A Serial Interface²

The HP 98036A Serial I/O Interface with Option 001 cable allows asynchronous communication between the HP 9835A Computer and external communication devices. The Interface provides a data transmitter and receiver with either RS-232C or 20 mA current loop drivers. The bit rate of the Interface can be varied from 75 to 9600 BAUD.

The transmitter and receiver buffers are capable of holding only one 8-bit character byte at a time. The Interface, if it is set up properly, can interrupt a running program on the HP Computer.

Table 3.3 is a listing of the pin assignments on the RS-232C male connector located at the opposite end of the cable connected to the Interface.

²Ref. 3 contains more details and run instructions for this interface.

Table 3.3 Cable Signals for the HP 98036A Option 001 Cable

Pin Number	Signal Name
1	Ground
2	Transmitted Data to E.D.*
3	Received Data from E.D.*
4	Request to Send to E.D.*
5	Clear to Send from E.D.*
6	Data Set Ready from E.D.*
7	Signal Ground
8	Carrier Detect from E.D.*
9	---
10	---
11	Special Purpose to E.D.*
12	Secondary Carrier Detect from E.D.*
13	---
14	---
15	Transmitter Clock from E.D.*
16	---
17	---
18	---
19	Secondary Request to Send to E.D.*
20	Data Terminal Ready to E.D.*
21	---
22	Ring Indicator from E.D.*
23	Data Rate Select to E.D.*
24	---
25	Special Test to E.D.*

*External Device

IV PROGRAM DESCRIPTION AND RUN INSTRUCTIONS

4.A Intecolor Receiver Program, REC

PURPOSE:

The REC Program takes the 8-bit serial data from the HP 9835A Computer through the second RS-232C port and sends it to the console output of the Intecolor Terminal, which is normally the CRT. This program can also store the display appearing on the CRT screen on a floppy diskette or make a hard copy of the display on a Decwriter II Teletype. In addition, a recall of the stored display from the floppy diskette is possible.

The REC program is divided into two segments. One segment is written in BASIC and the other is written in machine language.

INITIALIZE AND RUN INSTRUCTIONS:

1. Connect to the second RS-232C port the line from the HP 98036A Serial Interface. The bit rate on the HP 98036A Serial Interface must be set at 9600 BAUD. This is accomplished by adjusting with a screwdriver the bit rate dial, located in a hole on the side of the Interface, so that the dot on the dial is next to the number 1.
2. Connect to the first RS-232C port the line from the Decwriter II Teletype. Turn the Teletype on, set the bit rate to 300 BAUD and make certain that the Teletype is in the LINE mode.
3. Turn on the Intecolor Terminal. The OFF/ON switch is located on the bottom right of the Terminal when facing the rear of the Terminal. After sufficient warm up time for the Terminal there will appear on the Intecolor CRT screen the message:

"YOU ARE NOW IN THE 8001 CRT MODE"

4. Type: `[ESCAPE]`¹ W

Terminal response: BASIC 8001 ...

MAXIMUM RAM ADDRESS?

- Type: 65529 `[RETURN]`²

Terminal response: 24339 BYTES FREE

READY

5. Insert with label side up one of two diskettes marked as either HP Interface or HP3 into the left hand floppy disk drive unit and close the cover.

6. Type: LOAD? "REC `[RETURN]`

Terminal response: READY

The highest version number of the program REC.BAS found on the diskette will be loaded into BASIC memory from the diskette.

7. Type: RUN `[RETURN]`

Terminal response: READY TO RECEIVE DATA

The program will first check to see if the machine language segment is present in memory. If it is not, the program will load it into memory. The program is now in the receive mode and is awaiting data or instructions from the HP 9835A.

8. If, for any reason, one desires to terminate program REC from the Intecolor Terminal then:

Type: `[CPU RESET]`

Terminal response: YOU ARE NOW IN THE 8001 CRT MODE

¹The brackets `[ ]` contain the name of a specific key.

²This sequence of keys initializes BASIC and clears the BASIC memory; thus, the program in BASIC memory is lost. If `[ESCAPE]` W is accidentally typed, then type `[ESCAPE]` E to re-enter BASIC without initialization so that the BASIC program will not be lost.

[CPU RESET] initializes the Terminal so that it is in the 24 line mode with the visible foreground color green and the visible background color black.

9. To re-enter BASIC without losing the BASIC program and have the Terminal in the 48 line mode then:

Type: [BLINK/A7 OFF]³ [ESCAPE] E

Terminal response: READY

4.B Intecolor Continuous Print Program, PRNT3

PURPOSE:

The PRNT3 Machine Language Program provides a Decwriter II (or any other standard printer that operates at 300 BAUD) hard copy of the characters being printed on the CRT of the Intecolor Terminal. The exceptions to the simultaneous printing of characters on the Terminal's CRT and Decwriter II are characters entered from the keyboard while in BASIC or the CPU operating system.

INITIALIZE AND RUN INSTRUCTIONS:

1. Connect to the first RS-232C port the line from the Decwriter II Teletype. Turn the Teletype on, set the bit rate to 300 BAUD, and make certain that the Teletype is in the LINE mode.
2. BASIC requires initialization at least once after the Intecolor Terminal is turned on.⁴ Note that the PRNT3 Program does not alter any BASIC program. However, after running, the PRNT3 Program jumps to BASIC.

³See Appendix 2 to see why [BLINK/A7 OFF] changes the Terminal from 24 line mode to 48 line mode.

⁴See Step 4 of REC Program Instructions on how to initialize BASIC.

3. Type: `[ESCAPE] D`

Terminal response: `FCS>`

`[ESCAPE] D` puts the Terminal in the File Control System (FCS). While in FCS the operator can store and recall machine programs and displays.

4. Insert with label side up, either the HP Interface or HP3 diskette into the left hand floppy disk drive unit and close the cover.

5. Type: `RUN PRNT3 [RETURN]`

Terminal-Teletype response: `READY`

The terminal is now in BASIC. Any output from a BASIC program as a result of a print statement will now be typed simultaneously on the Intecolor Terminal's CRT and the Decwriter II Teletype. Also, the listing of any BASIC program will cause the program to be printed on the CRT and Teletype. One should note that characters do not appear as fast as they did before running PRNT3 because the Teletype requires more time to type out a character than the CRT does for display purposes. All Terminal outputs, while in CPU operating system or FCS are printed by the Teletype.

If the Terminal resets itself or if the operator presses one of the following sequences of keys: `[ESCAPE] W`, `[ESCAPE] P`, or `[CPU RESET]` then the PRNT3 Program must be run again to put the Terminal in the Continuous Print Mode. Since the PRNT3 Program is still present in the Terminal memory continue to step 6.

6. Type: `[ESCAPE] P` or `[ESCAPE] 0`⁵

Terminal response: `INTECOLOR 8001 CPU OPERATING SYSTEM...`

⁵Note: `[ESCAPED] P` initializes the I/O Byte and the second RS-232C port bit rate and the terminal enters the CPU Operating System. `[ESCAPE] 0` enters the CPU Operating System without initialization.

Type: GFF00 [RETURN]⁶

Terminal response: READY

This sequence restores the Terminal to the continuous print mode.

4.C HP 9835A Color-Shade Plot Program, PLOT12

PURPOSE:

Given a data array with non-negative elements this program will generate a color-shade plot on the Intecolor Terminal. This program also instructs the Intecolor Terminal to store or make a hard copy of the Terminal's CRT and to recall a stored display from a diskette.⁷

INITIALIZE AND RUN INSTRUCTIONS:

- 1,2. Use the same procedure as Steps 1 and 2 of the REC Program instructions. (See Section 4.A).
3. Turn the HP 9835A Computer on by a switch on the right side, near the back, of the computer. When the computer is warmed up, this statement will appear on the CRT:
"HP 9835A READY FOR USE"
4. Insert the tape cartridge marked as Quest into the tape drive located on the upper left of the HP Computer's keyboard.
5. Type: [LOAD] "PLOT12" [EXECUTE]
While the program is being loaded in, a small square will appear on the lower right hand portion of the HP Computer's CRT screen.⁸

⁶FF00 is the memory location of the Program PRNT3 in Hexadecimal.

⁷In order to do all this, the REC Program must be running on the Intecolor. See Section 4.A.

⁸When this light appears it means the computer is busy and will not respond to the keyboard except for [CONT'L] [STOP] which is equivalent to [RESET].

6. Type: **[RUN]** and follow the instructions given in the program.

When the program is run for the first time, the Quest tape cartridge must remain in the tape drive. This permits the special function keys to be loaded by the program.

7. Ignore the instruction to insert the IP Data tape since the data arrays are stored on the Quest tape cartridge.

Note: When running this program, a second time, press **[KEY 2]** to avoid loading the special function keys. This will permit the Quest tape cartridge to be removed from the tape drive and the program will still run.

4.D HP9835A 3-Dimensional Plot Program. 3DPLT1

PURPOSE:

Given a data array with non-negative elements this program will generate a 3-dimensional plot on the Intecolor Terminal. This program also instructs the Intecolor Terminal to store a display on diskette or recall a stored display from a diskette.⁹

INITIALIZE AND RUN INSTRUCTIONS:

- 1,2, 3,4. Use the same procedure as steps 1,2,3,4 of the PLOT12 Program instructions. (See Section 4.C).

5. Type **[LOAD]** "3DPLT1" **[EXECUTE]**

- 6,7. Use the same procedure as steps 6,7 of the PLOT12 Program instructions. (See Section 4.C).

Note: **[KEY 0]**, a special function key, can instruct the Intecolor to print out the 3-D plot on the Decwriter II Teletype. However, the

⁹The Intecolor REC Program must be running for this program to work, see Section 4.A.

hardcopy will not reproduce the lines of the 3-D plot since the character word for a character space can define the combination of plot blocks within that character space.¹⁰

4.E HP9835A Data Array Storage Program, MANUAL

PURPOSE:

This program takes a data array entered from the HP 9835A Computer keyboard and stores it. The number of rows and columns of the array which are in file are also stored on a tape cartridge. The data array can now be used in the HP 9835A plot programs (see Sections 4.D and E) and displayed on the Intecolor Terminal.

INITIALIZE AND RUN INSTRUCTIONS:

- 1,2. Use the same procedure as steps 1,2,3,4 respectively of PLOT12 Program
- 3,4. Instructions (See Section 4.C).
5. Type: "MANUAL"
6. Type:

Then follow the instructions given by the program.

4.F Intecolor Alternative Console Input Device Program, CONS2

PURPOSE:

This program permits the HP9835A Computer to communicate with the Intecolor microprocessor. After running this program the HP9835A replaces the Intecolor Keyboard as the Console Input Device. This means one could enter, for example, a BASIC program on the Intecolor directly from the HP9835A.

INITIALIZE AND RUN INSTRUCTIONS:

- 1,2 Use the same procedure as steps 1,3,4,5 of the REC Program instructions.
- 3,4. (See Section 4.A).

¹⁰Explanation in Appendix 2.

5. Type: `[ESCAPE]` D
 Terminal response: FCS>
 Type: `[RUN]` CONS2 `[RETURN]`
 Terminal response: READY

The Intecolor Terminal is now in BASIC with the HP 9835A on the second RS-232C port as the Console Input Device. Any input from the HP 9835A appears on the Terminal's CRT. Any operation which can be done from the Intecolor keyboard can now be handled by the HP 9835A.

6. When entering FCS the usual terminal response "FCS>" does not appear nor does the input from the HP 9835A. But the terminal still responds to all FCS commands and prints out the results and error messages on the Intecolor CRT. To get the Terminal back to BASIC send Escape character code (i.e., 27) twice and the terminal will be back in BASIC.

7. To enter the CPU O.S. one should follow these instructions:

Send from HP 9835A: `[ESCAPE]` 0

Terminal response: YOU ARE NOW IN THE CPU OPERATING SYSTEM

The input from the HP 9835A will be displayed along with any response from the Intecolor Terminal. To get back to BASIC the operator must run the CONS2 Program again. This can be done by the following instruction:

8. Send from HP 9835A: GF200 `[RETURN]`

Terminal response: READY

The Intecolor Terminal is now back in BASIC.

ILLEGIBLE DOCUMENT

**THE FOLLOWING
DOCUMENT(S) IS OF
POOR LEGIBILITY IN
THE ORIGINAL**

**THIS IS THE BEST
COPY AVAILABLE**

V PROGRAM LISTING

5.A Intecolor Receiver Program, REC, Listing

The REC Program consists of two segments. One segment is written in BASIC and the other is written in machine language. The REC Program can store or recall a display from a floppy diskette or make a hardcopy of the display.

```

10 REM Program REC.BAS:02
12 ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
13 REM Programmer Robert R. Bruckman; May 17, 1980
14 :
15 :
16 : REM Needs the program REC.PRQ to operate
20 REM Will take data from HP9835A on the 2nd RS-232C Port and then send it
25 REM to the console output device (i.e., the CRT).
27 :
30 P=-24575: N=-2560: REM A001 and F600 hex
45 :
50 : REM See if machine portion of program is in memory
60 IF PEEK(N)=62 AND PEEK(N+1)=64 THEN 80
70 PLOT27:PRINT'DLOA REC':PLOT27:PLOT27: REM Loads machine portion of program
80 PLOT 27: PLOT 75: REM Put INTECOLOR in roll up mode
83 :
85 : REM Set up JMP address of the machine portion of the program
90 POKE P:0: POKE (P+1),246
100 PRINT'READY TO RECIEVE DATA'
110 PLOT 8: REM Home the cursor
120 X=CALL(0): REM Calling the machine portion of the program
130 IF X=27 THEN END
150 IF X=7 GOTO 300
160 IF X<>6 THEN END
190 :
200 REM SUBROUTINE TO STORE THE DISPLAY
210 GOSUB 400
220 PLOT27:PRINT'DSAVE0:'A$;'.DIS:1 8000-9D5F':PLOT27:PLOT27
230 GOTO 120
270 :
300 REM SUBROUTINE TO RECALL THE DISPLAY
310 GOSUB 400
315 PLOT 12: REM Erase Page
320 PLOT27:PRINT'DLOA0:'A$;'.DIS':PLOT27:PLOT27
330 GOTO 110
390 :
400 REM SUBROUTINE TO GET NAME OF DISPLAY
405 REM Name stored in memory (starting memory location F644 hex) by machine
407 REM portion of program
410 A$=""
420 N1= -2492: REM F644 hex
430 FOR I=N1 TO N1+6
435 A=PEEK(I): IF A=239 THEN 460
440 A$=A$+CHR$(A)
450 NEXT I
460 PLOT8
470 RETURN

```

Page 2: REC Program, Machine Language Segment

ADDRESS	OPCODE	CHR	ADDRESS	MNEUMONIC	PAGE 1
F600	3E 40	(DQ)	REC.PRG	MVI	A,9600 BAUD
F602	D3 15	(S)		OUT	#2 Rate Reg
F604	CD 12 F6	(M v)	Loop1	CALL	Get Byte
F607	FE EF	(~o)		CPI	Flag
F609	CA 20 F6	(J v)		JZ	Change Mode
F60C	CD 09 01	(M)		CALL	Console Out
F60F	C3 04 F6	(C v)		JMP	Loop1
F612	DB 13	(C)	Get Byte	IN	#2 Status
F614	FE 3C	(~C)		CPI	Got Byte?
F616	C2 12 F6	(B v)		JNZ	Get Byte
F619	DB 10	(C)		IN	#2 Serial Port
F61B	C9	(I)		RET	
F61C	00	()		NOP	
F61D	00	()		NOP	
F61E	00	()		NOP	
F61F	00	()		NOP	
F620	CD 12 F6	(M v)	Change Mode	CALL	Get Byte
F623	FE 1B	(~)		CPI	Escape
F625	CA 3C F6	(J v)		JZ	Ret Basic
F628	FE 04	(~)		CPI	Hardcopy
F62A	CA 50 F6	(J v)		JZ	Print
F62D	47	(G)		MOV	B,A
F62E	21 44 F6	(IDv)	Get Name	LXI	H,Storage
F631	CD 12 F6	(M v)	Loop2	CALL	Get Byte
F634	77	(w)		MOV	M,A
F635	23	(#)		INX	H
F636	FE EF	(~o)		CPI	Flag
F638	C2 31 F6	(B1v)		JNZ	Loop2
F63B	78	(x)		MOV	A,B
F63C	47	(G)	Ret Basic	MOV	B,A
F63D	97	()		SUB	A
F63E	C3 53 2C	(CS,)		JMP	To Basic
F641	00	()		NOP	
F642	00	()		NOP	
F643	00	()		NOP	
F644	46	(F)	Storage	MOV	B,M
F645	49	(I)		MOV	C,C
F646	52	(R)		MOV	D,D
F647	53	(S)		MOV	D,E
F648	54	(T)		MOV	D,H
F649	34	(4)		INR	M
F64A	EF	(o)		RST	5
F64B	00	()		NOP	
F64C	00	()		NOP	
F64D	00	()		NOP	
F64E	00	()		NOP	
F64F	00	()		NOP	
F650	3E 04	(D)	Print	MVI	A,300 BAUD
F652	D3 05	(S)		OUT	#1 Rate Reg
F654	21 00 30	(I)		LXI	H,Display Reg
F657	CD 89 F6	(M v)		CALL	CRLLF
F65A	7E	(~)	Loop3	MOV	A,M
F65B	CD 0C 01	(M)		CALL	Punch Out
F65E	DB 13	(C)		IN	#2 Status
F660	FE 3C	(~C)		CPI	Got Byte?
F662	C2 75 F6	(Buv)		JNZ	Next Char
F665	DB 10	(C)		IN	#2 Serial Port
F667	FE 1B	(~)		CPI	Escape

Page 3: REC Program, Machine Language Segment

ADDRESS	OPCODE	CHR	ADDRESS	MNEUMONIC	PAGE 2
F669	C2 75 F6	(Buv)		JNZ	Next Char
F66C	CD 89 F6	(M v)		CALL	CR_LLF
F66F	CD 89 F6	(M v)		CALL	CR_LLF
F672	C3 04 F6	(C v)		JMP	Loop1
F675	23	(#)	Next Char	INX	H
F676	23	(#)		INX	H
F677	04	()		INR	B
F678	78	(x)		MOV	A,B
F679	FE 50	(*F)		CPI	Line End
F67B	CC 89 F6	(L v)		CZ	CR_LLF
F67E	7C	(I)		MOV	A,H
F67F	FE 9E	(~)		CPI	Display End
F681	C2 5A F6	(RZv)		JNZ	Loop3
F684	C3 04 F6	(C v)		JMP	Loop1
F687	00	()		NOF	
F688	00	()		NOF	
F689	3E 0D	(>)	CR_LLF	MVI	A,Carriage Return
F68B	CD 0C 01	(M)		CALL	Punch Out
F68E	3E 0A	(>)		MVI	A,Line Feed
F690	CD 0C 01	(M)		CALL	Punch Out
F693	06 00	()		MVI	B,Zero
F695	C9	(I)		RET	

SYMBOL TABLE

SYMBOL	VALUE
--------	-------

#1 Rate Res	05
#2 Rate Res	15
#2 Serial Port	10
#2 Status	13
300 BAUD	04
9600 BAUD	40
CR_LLF	F689
Carriage Return	0D
Change Mode	F620
Console Out	0109
Display Res	8000
Display End	9E
Escape	1B
Flag	EF
Get Byte	F612
Get Name	F62E
Got Byte?	3C
Hardcopy	04
Line End	50
Line Feed	0A
Loop1	F604
Loop2	F631
Loop3	F65A
Next Char	F675
Print	F650
Punch Out	010C
REC.PRG	F600
Ret Basic	F63C
Storage	F614
To Basic	CC53
Zero	00

5.B Intecolor Continuous Print Program, PRNT3, Listing

The PRNT3 Program allows simultaneous printing of characters on the Intecolor Terminal CRT and the Decwriter II Teletype.

ADDRESS	OPCODE	CHR	ADDRESS	MNEUMONIC	PAGE 1
FF00	3E 04	(>)	PRNT3	MVI	A,300 BAUD
FF02	D3 05	(S)		OUT	#1 Rate Res
FF04	21 B7 9E	(17)		LXI	H,List Jump Address
FF07	3E C3	(>C)		MVI	A,JMP
FF09	77	(w)		MOV	M,A
FF0A	23	(#)		INX	H
FF0B	3E 25	(>Z)		MVI	A,List Address Low Byte
FF0D	77	(w)		MOV	M,A
FF0E	23	(#)		INX	H
FF0F	3E FF	(>)		MVI	A,List Address High Byte
FF11	77	(w)		MOV	M,A
FF12	3E C2	(>B)		MVI	A>New I/O Status Byte
FF14	32 AA 9E	(2*)		STA	I/O Status Addrs.
FF17	3E 1B	(>)		MVI	A,Escape
FF19	CD 09 01	(M)		CALL	Console Out
FF1C	3E 45	(>E)		MVI	A,'E'
FF1E	CD 09 01	(M)		CALL	Console Out
FF21	00	()		NOP	
FF22	00	()		NOP	
FF23	00	()		NOP	
FF24	00	()		NOP	
FF25	F1	(a)	List Address	POP	PSW
FF26	F5	(u)		PUSH	PSW
FF27	C3 80 04	(C)		JMP	OUT Console, #1 Serial, Return

S Y M B O L T A B L E

SYMBOL	VALUE
#1 Rate Res	05
'E'	45
300 BAUD	04
Console Out	0109
Escape	1B
I/O Status Addrs.	9EAA
JMP	C3
List Address	FF25
List Address High Byte	FF
List Address Low Byte	25
List Jump Address	9EB7
New I/O Status Byte	C2
OUT Console #1 Serial Return	0480
PRNT3	FF00

5.C HP 9835A Color-Shade Plot Program, PLOT12, Listing

The PLOT12 Program generates a color-shade plot on the Intecolor Terminal's CRT. Also the PLOT12 Program can instruct the Intecolor Terminal to store or recall a display and to print a character plot of the display on the Decwriter II Teletype.

```

10  ! ----- Program PLOT 12 ----- !
20  !
30  ! Programmer Robert R. Bruckman, May 17, 1980
40  !
50  LOAD KEY "DISKEY"                      ! Loads User's Keys in
60  !
70  Key2:                                   ! KEY2 starts the program here
80  !
90  PRINTER IS 16
100 PRINT PAGE,"PROGRAM:      PLOT12";LIN(1)
110 PRINT "PURPOSE:      VISUALIZE IMPEDANCE FILES USING COLOR GRAPHICS OF THE"
120 PRINT "      INTECOLOR DATA TERMINAL";LIN(1)
130 PRINT "THE FOLLOWING KEYS CAN BE USED WHILE THIS PROGRAM IS RUNNING";LIN(1)
140 PRINT "KEY0: Causes the INTECOLOR to Jump to the hardcopy routine where"
150 PRINT "      the screen of the INTECOLOR is printed out on the teletype"
160 ! !!!!! KEY0 contains: -Clear line WRITEBIN 11; 239,4 -Execute !!!!! !
170 PRINT LIN(1);
180 PRINT "KEY1: Either stops the INTECOLOR receiver program and returns it to"
190 PRINT "      BASIC or stops the hardcopy routine and returns the"
200 PRINT "      INTECOLOR to the receiver program";LIN(1)
210 ! !!!!! KEY1 contains: -Clear line WRITEBIN 11;239,27 -Execute ! !!!!!
220 PRINT "KEY2: If the PLOT12 program has already been run once pressing"
230 PRINT "      this key will avoid loading the keys in again";LIN(1)
240 ! !!!!! KEY2 contains: -Clear line RUN Key2 -Execute !!!!! !
250 PRINT "KEY3: This key will cause you to Jump to the portion of the program"
260 PRINT "      that can recall and stores displays on the INTECOLOR"
270 ! !!!!! KEY3 contains: -Clear line RUN Key3 -Execute ! !!!!!
280 OPTION BASE 1
290 DIM B$(21),Z(25,25),X(25,25),Inc(25),Color(6),Char(6)
300 DISP "INSERT DATA TAPE AND PRESS CONTINUE"
310 PAUSE
320 DISP " "
330 ASSIGN "FILES" TO #2
340 PRINTER IS 16
350 ON END #2 GOTO 390
360 FOR I=1 TO 21
370   READ #2:B$(I)
380 NEXT I
390 PRINT LIN(1),"AVAILABLE FILES:      ";B$(2),"      ";B$(12)
400 FOR I=3 TO 11
410   PRINT "      ";B$(I),"      ";B$(I+10)
420 NEXT I
430 OFF END #2
440 INPUT "WHICH FILE WOULD YOU LIKE?";A$
450 ASSIGN "FILES" TO #2
460 ON END #2 GOTO 510
470 FOR I=1 TO 21
480   READ #2:C$
490   IF A$=C$ THEN 530
500 NEXT I
510 PRINT "PLEASE ENTER A FILE NAME FROM THIS LIST"
520 GOTO 440

```

Page 2: PLOT12 Program

```

530 ASSIGN A$ TO #1
540 READ #1;R,C
550 REDIM Z(R,C),Inc(C),X(R,C)
560 READ #1;X(*)
570 INPUT "Do you want a PSEUDO-LOG or LINEAR graph (P/L)? ";G$
580 Max=0
590 IF G$="L" THEN MAT Z=X ! Equating matrices Z & X
600 IF G$="L" THEN 630
610 MAT Z=X+(1) ! Matrix Z= matrix X + 1 to each element
620 MAT Z=LGT(Z) ! Taking the log base 10 of each element
630 FOR I=1 TO R ! Find the maximum value of the elements of matrix Z
640 FOR J=1 TO C
650 Max=MAX(Max,Z(I,J))
660 NEXT J
670 NEXT I
680 Scale=6/Max
690 MAT Z=Z*(Scale) ! Values vary from 0 to 6
700 MAT Z=Z+(1) ! Values vary from 1 to 7
710 Cs=INT(76/(C-1))
720 Rs=INT(40/(R-1))
730 MAT READ Color
740 DATA 32,56,16,8,24,48 ! Blue, White, Green, Red, Yellow, Cyan
750 MAT READ Char
760 DATA 32,126,58,43,33,42 ! space, tilde, :, +, !, *
770 RESTORE 760
780 RESTORE 740
790 PRINT LIN(1)
800 DISP "Press 'CONTINUE' when INTERCOLOR is ready to receive data"
810 PAUSE
820 DISP "HP 9835A passing data"
830 PRINTER IS 11,WIDTH(80)
840 OVERLAP
850 WRITE BIN 11;255 ! Makes sure INTECOLOR is out of PLOT mode
860 WRITE BIN 11;15 ! Changes INTECOLOR from 24 to 48 line mode
870 WRITE BIN 11;6,2,12 ! Sets color=Green/Black and clears INTECOLOR screen
880 WAIT 100 ! Waits for the screen to clear
890 PRINT "DATA SET";CHR$(124);A$,R;" ROWS ";C;" COLUMNS"
900 PRINT RPT$("- ",Cs*(C-1)+3) ! Prints upper border
910 FOR I=1 TO R
920 FOR J=1 TO C
930 ! (difference between adjacent elements in a column)/(space between rows)
940 IF I<R THEN Inc(J)=(Z(I+1,J)-Z(I,J))/Rs
950 IF I=R THEN Inc(J)=0
960 NEXT J
970 IF I=R THEN Rs=1
980 FOR K=1 TO Rs
990 OUTPUT 11 USING "#,B";124; ! Prints left hand border
1000 FOR J=1 TO C-1
1010 ! (difference between adjacent elements in a row)/(space between columns)
1020 Inc2=(Z(I,J+1)-Z(I,J))/Cs
1030 FOR L=1 TO Cs
1040 T=INT(Z(I,J))
1050 IF T<1 THEN T=1 ! Making sure dimensions of Color & Char are
1060 IF T>6 THEN T=6 ! not exceeded
1070 OUTPUT 11 USING "#,B";6;Color(T);Char(T); ! Send color and character
1080 Z(I,J)=Z(I,J)+Inc2 ! Get the next value
1090 NEXT L
1100 Z(I,J)=Z(I,J)-Cs*Inc2 ! Restore original value
1110 Z(I,J)=Z(I,J)+Inc(J)
1120 NEXT J

```

Page 3: PLOT12 Program

```

1130   T=INT(Z(I,J))
1140   IF T<1 THEN T=1
1150   IF T>6 THEN T=6
1160                                     ! Send color 2 character of last column of data
1170   OUTPUT 11 USING "*,B":6;Color(T);Char(T)
1180   OUTPUT 11 USING "B":6;2;124      ! Print right hand border in Green/Black
1185   Z(I,J)=Z(I,J)+Inc(J)
1190   NEXT K
1200 NEXT I
1210 PRINT RPT$("-";Cs*(C-1)+3)
1220 IF G$="P" THEN PRINT "PSEUDO-LOG"
1230 IF G$="L" THEN PRINT "LINEAR"
1240 Ub=0
1250 FOR I=1 TO 6
1260   IF I=4 THEN PRINT CHR$(28);"SCALE DIVISIONS:"
1270   IF I=4 THEN WRITE BIN 11;26
1280   IF (I=2) OR (I=5) THEN WRITE BIN 11;26,26,26
1290   WRITE BIN 11;6,Color(I),Char(I),6,2,124
1300   Lb=Ub
1310   IF G$="P" THEN Ub=PROUND(10^(I/Scale)-1,-1)
1320   IF G$="L" THEN Ub=PROUND(I/Scale,-1)
1330   PRINT Lb;" to ";Ub
1340 NEXT I
1350 WRITE BIN 11;8
1360 PRINTER IS 16
1370 SERIAL
1380 PRINT "HP 9835A finished passing data."
1390 INPUT "Do you wish to change the type of graph for this data set? ",H$
1395 PRINT CHR$(13);RPT$(" ",33);CHR$(13)
1400 IF H$C1,11="Y" THEN 570
1410
1420 Key3:
1430                                     ! KEY3 starts program here
1440 INPUT "DO YOU WISH TO SAVE THE DISPLAY",H$
1450 IF H$C1,11<>"Y" THEN 1490
1460 INPUT "Input name less than 7 char. long ",N$
1470 WRITE BIN 11;239,6
1480 OUTPUT 11 USING "*,K";N$,CHR$(239)
1490 INPUT "DO YOU WISH TO RECALL A STORED DISPLAY? ",H$
1500 IF H$C1,11<>"Y" THEN 1560
1510 INPUT "NAME OF DISPLAY: ",N$
1520 WRITE BIN 11;239,7
1530 OUTPUT 11 USING "*,K";N$,CHR$(239)
1540 INPUT "DO YOU WISH TO RECALL ANOTHER STORED DISPLAY? ",H$
1550 GOTO 1500
1560 INPUT "HARDCOPY? ",H$
1570 IF H$C1,11="Y" THEN WRITE BIN 11;239,4
1590 INPUT "WOULD YOU LIKE TO PLOT ANOTHER DATA SET?",A$
1600 IF A$C1,11<>"N" THEN 300
1610 PRINT "INSERT PROGRAM TAPE AND PRESS CONTINUE"
1620 PAUSE
1630 WRITE BIN 11;239,27
1640 PAUSE
1650 LOAD "602"
1660 END

```

5.D HP 9835A 3-Dimensional Plot Program, 3DPLT1, Listing

The 3DPLT1 Program generates a 3-dimensional plot on the Intecolor Terminal's CRT. Also the 3DPLT1 Program can instruct the Intecolor to store or recall a display.

```

10  ! ----- Program 3DPLT1 -----
20
30  ! Programmer Robert R. Bruckman, May 17, 1980
40
50  LOAD KEY "DISKEY"                      ! Loads User's Keys in
60
70  Key2:                                ! KEY2 starts the program here
80
90  PRINTER IS 16
100 PRINT PAGE,"PROGRAM:      3DPLT1";LIN(1)
110 PRINT "PURPOSE:      VISUALIZE IMPEDANCE FILES USING 3-D PLOTS"
120 PRINT "              ON THE INTECOLOR DATA TERMINAL";LIN(1)
130 PRINT "THE FOLLOWING KEYS CAN BE USED WHILE THIS PROGRAM IS RUNNING";LIN(1)
140 PRINT "KEY0: Causes the INTECOLOR to Jump to hardcopy subprogram where"
150 PRINT "      the screen of the INTECOLOR is printed out on the teletype"
160 ! !!!!! KEY0 contains: -Clear line WRITEBIN 11; 239,4 -Execute ! !!!!!
170 PRINT LIN(1);
180 PRINT "KEY1: Either stops INTECOLOR main program and returns it to BASIC"
190 PRINT "      or stops the hardcopy subprogram and returns INTECOLOR to"
200 PRINT "      the main program";LIN(1)
210 ! !!!!! KEY1 contains: -Clear line WRITEBIN 11;239,27 -Execute ! !!!!!
220 PRINT "KEY2: If the program has already been run once pressing this key"
230 PRINT "      will avoid loading the keys in again";LIN(1)
240 ! !!!!! KEY2 contains: -Clear line RUN Key2 -Execute ! !!!!!
250 PRINT "KEY3: This key will cause you to Jump to the portion of the program"
260 PRINT "      that can recall and stores displays on the INTECOLOR"
270 ! !!!!! KEY3 contains: -Clear line RUN Key3 -Execute ! !!!!!
280 OPTION BASE 1
290 DIM B$(21),Z(25,25),X(25,25),D(160),Inc(25)
300 DISP "INSERT DATA TAPE AND PRESS CONTINUE"
310 PAUSE
320 DISP " "
330 ASSIGN "FILES" TO #2
340 PRINTER IS 16
350 ON END #2 GOTO 390
360 FOR I=1 TO 21
370   READ #2:B$(I)
380 NEXT I
390 PRINT LIN(1),"AVAILABLE FILES:      ";B$(2),"      ";B$(12)
400 FOR I=3 TO 11
410   PRINT "              ";B$(I),"      ";B$(I+10)
420 NEXT I
430 OFF END #2
440 INPUT "Which FILE would you like? ",A$
450 ASSIGN "FILES" TO #2
460 ON END #2 GOTO 510
470 FOR I=1 TO 21
480   READ #2:C$
490   IF A$=C$ THEN 530
500 NEXT I
510 PRINT "PLEASE ENTER A FILE NAME FROM THIS LIST"
520 GOTO 440

```

Page 2: 3DPLT1 Program

```

530 ASSIGN A$ TO #1
540 READ #1:R,C
550 REDIM Z(R,C),Inc(C),X(R,C)
560 READ #1:X(*)
570 MAT Z=X                                     ! Setting matrix Z equal to matrix X
580     ! Invert the rows so that original top row will appear at top of 3-D plot
590 FOR I=1 TO R
600     FOR J=1 TO C
610         X(I,J)=Z(R+1-I,J)
620     NEXT J
630 NEXT I
640 INPUT 'Do you want a PSEUDO-LOG or LINEAR graph (P/L)? ',G$
650 Max=0
660 IF G$='L' THEN MAT Z=X
670 IF G$='L' THEN 700
680 MAT Z=X+(1)
690 MAT Z=LOG(Z)
700 FOR I=1 TO R                                     ! Find maximum value of the elements in matrix Z
710     FOR J=1 TO C
720         Max=MAX(Max,Z(I,J))
730     NEXT J
740 NEXT I
750 Scale=30/Max
760 MAT Z=Z*(Scale)                                     ! Values of elements now vary from 0 to 30
770 Cs=INT(106/(C-1))
780 Xub=C*(C-1)+2
790 Rs=INT(20.4/(R-1))
800 Yub=5*Rs*(R-1)+2
810 Xlb=INT(Yub/2)
820 PRINT LIN(1)
830 PRINT 'Press 'CONTINUE' when INTECOLOR is ready to receive data'
840 PAUSE
850 PRINT LIN(1);'HP 9833A passing data'
860 PRINTER IS 11,WIDTH(30)
870 OVERLAP
880 WRITE BIN 11:255                                     ! Makes sure INTECOLOR is out of PLOT mode
890 WRITE BIN 11:15                                     ! Changes INTECOLOR from 34 to 48 line mode
900 WRITE BIN 11:6,2,12     ! Sets color=Green/Black and clears INTECOLOR screen
910 WAIT 100                                             ! Waits for the screen to clear
920 PRINT '3D PLOT, IN '
930 IF G$='L' THEN PRINT 'LINEAR'
940 IF G$='P' THEN PRINT 'PSEUDO-LOG'
950 PRINT ' SCALE, OF 'LIN(1)
960 PRINT 'DATA SET';CHR$(124),A$,R;' ROWS 'C;' COLUMNS'
970 WRITE BIN 11:2,Xlb,Yub+19,242,0,19     ! Draws left border by vector plot
980 WAIT 150     ! Waits for border to drawn by INTECOLOR
990 WRITE BIN 11:255,2,0,242,Xub,19     ! Draws bottom border by vector plot
1000 WAIT 150     ! Waits for border to drawn by INTECOLOR
1010 X=Xub+Xlb
1020 WRITE BIN 11:255,2,Xub,19,242,X,Yub+19 ! Draws right border by vector plot
1030 WAIT 150     ! Waits for border to drawn by INTECOLOR
1040 WRITE BIN 11:255,6,1,2     ! Sets color = Red/Black and enter plot mode
1050 YO=-1
1060 MAT D=(0)
1070 FOR I=1 TO R
1080     FOR J=1 TO C
1090         ! (difference between adjacent elements in a column)/(space between rows)
1100         IF I<R THEN Inc(J)=(Z(I+1,J)-Z(I,J))/Rs
1110         IF I=R THEN Inc(J)=0
1120     NEXT J

```

Page 3: 3DPLT1 Program

```

1130 IF I=R THEN Rs=1
1140 FOR K=1 TO Rs
1150   Y0=Y0+1
1160   Y1=5*Y0+20                                ! Calculate Y offset
1170   X=INT(1+Y0*2.5)                             ! Calculate X offset
1180   FOR J=1 TO C-1
1190     ! (difference between adjacent elements in a row)/(space between rows)
1200     Inc2=(Z(I,J+1)-Z(I,J))/Cs
1210     FOR L=1 TO Cs
1220       X=X+1                                    ! Calculate X coordinate
1230       Y=Z(I,J)+Y1                             ! Calculate Y coordinate
1240       IF Y<=D(X) THEN 1280
1250       D(X)=Y
1260       OUTPUT 11 USING "#,B";X,Y                ! Send coordinates of point
1270       ! NOTE X & Y are rounded to nearest integer value
1280       Z(I,J)=Z(I,J)+Inc2                       ! Get the next value
1290     NEXT L
1300     Z(I,J)=Z(I,J)-Cs*Inc2                       ! Restore original value
1310     Z(I,J)=Z(I,J)+Inc(J)
1320   NEXT J
1330   X=X+1
1340   Y=Z(I,C)+Y1
1350   IF Y<=D(X) THEN 1375
1360   D(X)=Y
1370   OUTPUT 11 USING "#,B";X,Y                    ! Send coordinates of last column point
1375   Z(I,J)=Z(I,J)+Inc(J)
1380 NEXT K
1390 NEXT I
1400 Y=Yub+19                                       ! Y coordinate of upper border
1410 FOR X=Xlb TO Xlb+Xub
1420   IF Y<=D(X) THEN 1440
1430   OUTPUT 11 USING "#,B";X,Y                    ! Send coordinates of point in upper border
1440 NEXT X
1450 WRITE BIN 11;255,8                           ! Exit plot mode, and home the cursor
1460 PRINTER IS 16
1470 SERIAL
1480 PRINT "HP 9835A is finished passing data";
1490 INPUT "Do you wish to change the type of graph for this data set? ",H$
1495 PRINT CHR$(13);RPT$( " ",33);CHR$(13);
1500 IF H$(1,1)='Y' THEN 640
1510
1520 Key3:                                         ! KEY3 starts program here
1530
1540 INPUT "DO YOU WISH TO SAVE THE DISPLAY",H$
1550 IF H$(1,1)='Y' THEN 1590
1560 INPUT "Input name less than 7 char. long ",N$
1570 WRITE BIN 11;239,6
1580 OUTPUT 11 USING "#,K";N$,CHR$(239)
1590 INPUT "DO YOU WISH TO RECALL A STORED DISPLAY? ",H$
1600 IF H$(1,1)='Y' THEN 1660
1610 INPUT "NAME OF DISPLAY: ",N$
1620 WRITE BIN 11;239,7
1630 OUTPUT 11 USING "#,K";N$,CHR$(239)
1640 INPUT "DO YOU WISH TO RECALL ANOTHER STORED DISPLAY? ",H$
1650 GOTO 1600
1660 IF H$(1,1)='Y' THEN INPUT "WOULD YOU LIKE TO PLOT ANOTHER DATA SET? ",A$
1670 IF A$(1,1)='N' THEN 300
1680 PRINT "INSERT PROGRAM TAPE AND PRESS CONTINUE"
1690 PAUSE
1700 WRITE BIN 11;239,27
1710 PAUSE
1720 LOAD "602"
1730 END

```

5.E HP 9835A Data Array Storage Program, MANUAL, Listing¹

This MANUAL program stores a Data Array, entered from the HP 9835A Computer keyboard, in the format required by the HP Computer plot programs.

```

10  OPTION BASE 1
20  PRINT PAGE,"PROGRAM:      MANUAL"
30  PRINT LIN(2),"PURPOSE:    TO MANUALLY INPUT IMPEDANCE DATA AND STORE"
40  PRINT "                      ON A TAPE CARTRIDGE"
50  REM TIM ANDERSON 9/25/79 RE-ENTER 11/8/79
60  DIM Imp(50,50)
70  INPUT "PLEASE ENTER THE MATRIX SIZE (ROW,COLUMN)?",R,C
80  PRINT PAGE,"YOU HAVE CHOSEN A 'R' BY 'C' MATRIX"
90  INPUT "DO YOU WISH TO CHANGE THIS SIZE?",A$
100 IF A$(C1,1)="Y" THEN 70
110 PRINT LIN(3),"PLEASE ENTER THE DATA BY ROWS AT THE ? PROMPT"
120 MAT INPUT Imp(R,C)
130 PRINT PAGE,"THE DATA YOU HAVE CHOSEN IS:"
140 PRINT
150 MAT PRINT Imp;
160 INPUT "DO YOU WISH TO CHANGE ANY OF THE DATA?",A$
170 IF A$(C1,1)="N" THEN 220
180 INPUT "WHICH POSITION DO YOU WISH TO CHANGE (ROW,COLUMN)?",R1,C1
190 INPUT "WHAT DO YOU WISH TO CHANGE IT TO?",M
200 Imp(R1,C1)=M
210 GOTO 130
220 INPUT "IS A CONVERSION NEEDED?",A$
230 IF A$(C1,1)="N" THEN 320
240 FOR I=1 TO R
250 FOR J=1 TO C
260 Imp(I,J)=FROUND(50/-55*Imp(I,J),-1)
270 NEXT J
280 NEXT I
290 PRINT PAGE,"THE DATA HAS BEEN CONVERTED TO:"
300 PRINT
310 MAT PRINT Imp;
320 INPUT "DO YOU WISH TO STORE THIS DATA ON TAPE?",A$
330 IF A$(C1,1)="N" THEN 500
340 INPUT "INSERT DATA TAPE CARTRIDGE AND ENTER A FILE NAME",A$
350 A$=A$(C1,6)
360 ASSIGN "FILES" TO #2
370 ON END #2 GOTO 440
380 FOR J=1 TO 20
390 READ #2:B$
400 IF A$<>B$ THEN 430
410 PRINT PAGE,"REPEATED FILE NAME! PLEASE RE-ENTER"
420 GOTO 340
430 NEXT J
440 I=(R*C+2)*8/256+1
450 CREATE A$,I
460 ASSIGN A$ TO #1
470 PRINT #1;R,C,Imp(*)
480 PRINT #2;A$
490 PRINT PAGE,"FILE '"A$;"' HAS BEEN STORED"
500 INPUT "DO YOU WISH TO INPUT MORE DATA?",A$
510 IF A$(C1,1)="Y" THEN 70
520 DISP "INSERT PROGRAM TAPE AND PRESS CONTINUE"
530 PAUSE
540 LOAD "602"
550 END

```

¹Used by permission of Tim Anderson, Kansas State University.

5.F Intecolor Alternative Console Input Device Program, CONS2, Listing

The CONS2 program replaces the Intecolor keyboard as the Console Input Device with the device connected to the second RS-232C port.

ADDRESS	OPCODE	CHR	ADDRESS	MNEUMONIC	PAGE 1
F200	3E 40	(>0)	CONS2	MVI	A,9600 BAUD
F202	03 15	(S)		OUT	#2 Rate Res
F204	04 07	()		MVI	B,7 Bytes
F206	21 AA 9E	(!*)		LXI	H,I/O Byte Address
F209	11 1D F2	(r)		LXI	D,From Addr.
F20C	CD 60 01	(M')		CALL	Transfer
F20F	3E 1B	(>)		MVI	A,Escape
F211	CD 09 01	(M)		CALL	Console Out
F214	3E 45	(>E)		MVI	A,'E'
F216	CD 09 01	(M)		CALL	Console Out
F219	00	(O)		NOP	
F21A	00	()		NOP	
F21B	00	()		NOP	
F21C	00	()		NOP	
F21D	83	()	From Addr.	New I/O Byte.	
F21E	C3 28 F2	(C(r)		JMP	Con In
F221	C3 2C F2	(C,r)		JMP	Con Out
F224	00	()		NOP	
F225	00	()		NOP	
F226	00	()		NOP	
F227	00	()		NOP	
F228	CD AE 04	(M.)	Con In	CALL	In #2 RS232
F22B	F5	(u)		PUSH	PSW
F22C	F1	(a)	Con Out	POP	PSW
F22D	C3 0F 01	(C)		JMP	List Output

SYMBOL TABLE

SYMBOL	VALUE
#2 Rate Res	15
'E'	45
7 Bytes	07
9600 BAUD	40
CONS2	F200
Con In	F228
Con Out	F22C
Console Out	0109
Escape	1B
From Addr.	F21D
I/O Byte Address	9EAA
In #2 RS232	04AE
List Output	010F
Transfer	0160

VI FUTURE DEVELOPMENTS

Software and hardware are now being developed that will permit the HP 9835A Computer to collect data from experiments using the HP-IB Interface Bus and 16-Bit Parallel Interface. Data collected can be displayed on the Intecolor 8001 Terminal.

With the HP Computer Serial I/O Interface bit rate equal to 9600 BAUD and connected to the Intecolor Terminal's first RS-232C Port, the HP Computer can instruct the Terminal to load and run machine programs. The machine programs are loaded and run from the diskettes in the Intecolor Terminal's disk drive by the FCS¹ command:

RUN Name of Program [RETURN]

If the machine language program which is loaded and executed in this manner is similar to the Program CONS2 then the HP Computer will have nearly complete control over the Intecolor Terminal. While the HP Computer has this type of control over the Intecolor Terminal, machine language programs can be entered directly from the HP Computer. The programs so entered could instruct the Intecolor Terminal how to display data from the HP Computer or instruct the Terminal to collect data itself.

It would be possible, with modifications of the software, to allow the Terminal to collect data and pass the data to the HP Computer where the data are analyzed and processed. This is desirable since the working memory of the HP 9835A Computer (approximately 49K bytes) is greater than that of the Intecolor 8001 Terminal (approximately 20K bytes). After the

¹File Control System.

data are processed they can be returned to the Terminal where the data can be displayed or recorded.

VII REFERENCES

(Cited in Report)

1. Intecolor 8051 Desk Top Computer Manual, Intelligent Systems Corporation, Norcross, Georgia, 1975.
2. How to Use the 8001 CRT, Intelligent Svstems Corporation, Norcross, Georgia.
3. Hewlett-Packard Calculator Products Division, Hewlett-Packard 98036A Serial I/O Interface Installation and Service Manual, Hewlett-Packard Co., 1977, Part No. 98036-90000.

(Supporting Documents)

4. Hewlett-Packard Desk Top Computer Division, Assembly Development ROM, Hewlett-Packard Co., 1979, Part No. 09835-90083.
5. Hewlett-Packard Desk Top Computer Division, I/O ROM Programming, Hewlett-Packard Co., 1978, Part No. 09835-90060.
6. Hewlett-Packard Desk Top Computer Division System 35 Desk Top Computer: Operating and Programming, Hewlett-Packard Co., 1978, Part No. 09835-90000.

VIII ACKNOWLEDGEMENTS

The author would like to thank his major professor, Dr. Richard R. Gallagher, for his support and guidance throughout the author's master's research. The author also would like to thank the Department of Electrical Engineering at Kansas State University for the financial assistance received while enrolled as a graduate student. Thanks is also given to fellow graduate students John L. Schmalzel and Donald D. Gallagher for their assistance in developing the interface.

The author finally thanks his wife, Pamela, for her support and understanding.

APPENDIX

Appendix 1 Partial Listing of Control and Escape Codes on the Intecolor8001 Terminal

Control Codes¹ (see Table A.1):

To obtain the Control command from the Intecolor Keyboard, the operator must simultaneously press the control key and the designated key. In a BASIC program the desired Control command is obtained by

PLOT Control code

In a machine program the Control command is obtained by sending the Control code to the console output (normally the CRT).

Escape Codes² (see Table A.2)

To obtain the Escape command from the Intecolor Keyboard the operator must press the ESCAPE key, then the designated key. In a BASIC program the desired Escape command is obtained by the sequence

PLOT 27: PLOT Escape code

In a machine program the sequence:

1B Hex, Hex Escape code

must be sent to the console output to achieve the desired Escape command.

¹Ref. 1, pp. 12-16 of CRT Section.

²Ref. 1, pp. 17-24 of CRT Section.

Table A.1 Partial List of Control Codes

Control*	Character Dec.	Code Hex	Purpose
B	2	02	Enter Plot Mode, also enter X-Y Point Plot Mode at the same time.
C	3	03	Enter X-Y Cursor Mode, next two characters X (0-29) and Y (0-47).
F	6	06	Next Char. is Visible Composite Status Word.
H	8	08	Cursor Home.
J	10	0A	Line Feed.
L	12	0C	Erases CRT Screen.
M	13	0D	Carriage Return.
O	15	0F	Blink & A7 Off, 48 line mode and no blinking.
[	27	1B	Escape Code, has to be followed by code from Table A.2.
	32 ↓ 127	20 ↓ 7F	ASC II Character Set.
2	242	F2	Enter Vector Plot Mode.
.	255	FF	Plot Mode Escape.

*Control command can be obtained by simultaneously pressing [CONTROL] and the key in this column or by sending the character code to a RS-232C port.

Table A.2 Partial List of Escape Codes

Escape*	Character		Code**		Purpose
	Dec.	Hex	Dec.	Hex	
D	4	04	68	44	Enter File Control System (FCS).
E	5	05	69	45	Re-enter BASIC, program in BASIC RAM not destroyed.
O	15	0F	79	4F	Re-enter CPU O.S.
P	16	10	80	50	Initialize & Enter CPU O.S. I/O Status Byte & 2nd RS-232C Port are also initialized.
W	23	17	87	57	Initialize & transfer to BASIC.
[	27	1B	91	5B	Puts Terminal in the Visible Cursor Mode.

*Escape command can be obtained by pressing [ESCAPE] and then the key in this column or by sending sequence 27, character code to a RS-232C port.

**Note: the desired Escape command is obtained with either set of character codes.

Appendix 2 CRT Display of the Intecolor 8001 Terminal³

On the Intecolor Terminal CRT screen there are 48 data lines with 80 characters per line. This means there are 3840 character spaces on the CRT. The cursor can be directed to any particular character space by the sequences given in Example A.1. The character space coordinate system is shown in Fig. A.1.

Example A.1: Positioning the Intecolor Terminal's Cursor.

Either one of the following 3-word sequence will position the visible cursor anywhere on the Intecolor Terminal's CRT.

BASIC Program Sequence: PLOT 3: PLOT x: PLOT y

Sequence sent to RS-232C port: 3,x,y

x,y are the character and line positions of the character space.

The current cursor position and line position shift (i.e., the line located at the top of the CRT screen when the terminal is in the roll mode) are located in the following memory locations:⁴

9FCB Hex: character position.

9FCC Hex: line position.

9FCD Hex: line position shift.

Each character space requires two 8-bit words to determine what is displayed and in which colors. The memory that contains the 7680 memory locations needed for the entire CRT screen is known as the CRT refresh memory. The CRT refresh memory is located in memory locations from 8000 to 9DFF Hex.

³Ref. 1, pp. 10, 15, 19 of CRT section and pp. A-2, A-5, B-2.

⁴Ref. 1, p. 10 list these locations incorrectly.

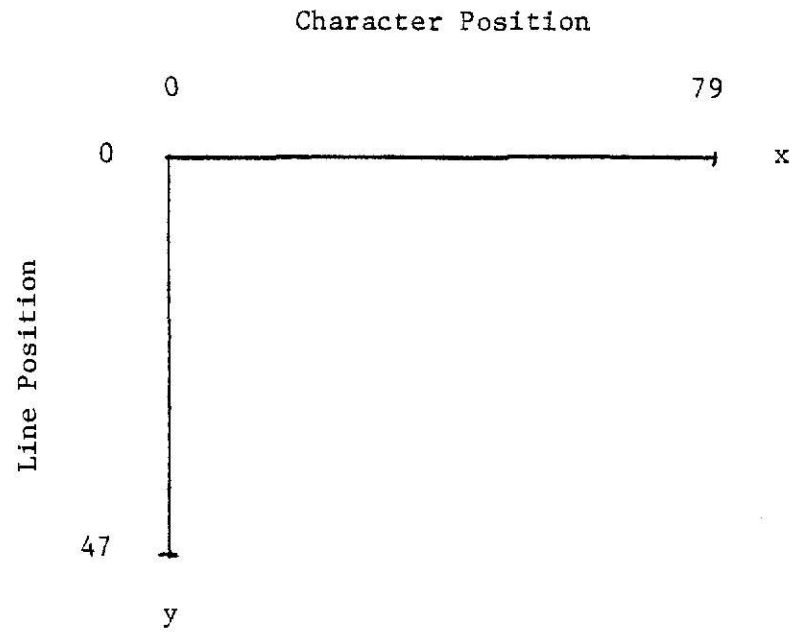


Figure A.1 Character Space Coordinate System

The first of the two 8-bit words (even memory locations) is known as the character word and the second 8-bit word (odd memory locations) is known as the composite status word. The composite status word is composed of the Plot-character Bit, the Foreground Blink bit, Background color code, and Foreground color code (see Fig. A.2). When the Plot-character Bit is 0 the character space displays either all or part of the character defined by the ASCII code in the character space's a character word (see Fig. A.3). If the Plot-character Bit is 1, the character space is broken into 8 plot blocks (see Fig. A.4). The color of each block depends on whether the corresponding bit in the character word is a 1 (implies foreground color) or a 0 (implies background color). If the Foreground Blink Bit is 1, then the foreground color of the character changes back and forth from black to the foreground color defined in the composite status word. The foreground and background color for each character space can be determined using Table A.3. If the A7 bit (in the character word) is off (i.e., A7=0) and the Plot-character Bit = 0, the character space will display the whole character, whose ASCII code appears in the character word. Since 48 lines of these characters can be displayed on the CRT this condition (A7 off) is known as the 48 line mode. If A7 is on (i.e., A7=1) and the Plot-character Bit = 0, then the character space will contain either the upper half (if line position is even) or the lower half (if line position is odd) of the ASCII character. Therefore, only 24 lines of these characters can be displayed on the CRT. This condition (A7 on) is known as the 24 line mode.

When changing the composite word for the next character (and for the characters which follow) one of the sequences in Example A.2 must be entered by the operator from the keyboard or RS-232C ports.

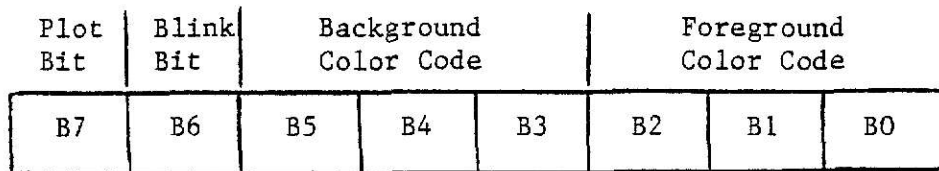


Figure A.2 Arrangement of the CRT Composite Status Word

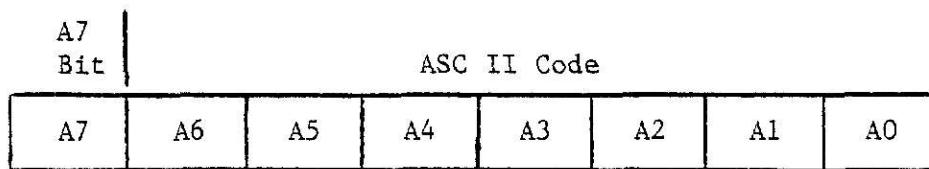


Figure A.3 Arrangement of the CRT Character Word

A0	A4
A1	A5
A2	A6
A3	A7

Figure A.4 Block Arrangement of a Character Space with the Corresponding Bits from the CRT Character Word

Table A.3 Color Codes for the CRT Composite Status Word.

Color	B5/B2	B4/B1	B3/B0	*
Black	0	0	0	
Red	0	0	1	
Green	0	1	0	
Yellow	0	1	1	
Blue	1	0	0	
Magenta	1	0	1	
Cyan	1	1	0	
White	1	1	1	

*Background
 color bits/Foreground
 color bits

Example A2: Changing the Composite Status Word.

From Keyboard: [CONTROL] F, New Composite Status Word
 To RS-232C Port: 06, New Composite Status Word

Appendix 3 X-Y Plot and Vector Modes on the Intecolor 8001 Terminal⁵

Since each character space on the Intecolor Terminal's CRT screen can be divided into 8 blocks for plotting purposes (see Appendix 2) there are 30,720 blocks on the CRT screen. Each block can be specified by its X-Y coordinates as shown in Fig. A.5.

The X-Y Plot Mode is entered when the Intecolor Terminal receives the character byte 02 (this is the same as a CONTROL B from the keyboard). The two bytes following the 02 are the X-Y coordinates. The Terminal remains in the X-Y Plot Mode until the Terminal receives a 255 character byte (see Example A.3).

Example A.3: Plotting Points on the Intecolor Terminal.

Input from RS232C port	Explanation
02	Enter Plot Mode
07, 17	Plot point (7, 17)
08, 36	Plot point (8, 36)
255	Escape Plot Mode

When a point is plotted, the block color is changed to the foreground color in the composite status word. Note, if more than one point (or block) is plotted in a character space then all blocks have the foreground color of the last block plotted (see Example A.4). Figure A.6 shows how the character space appears after a few of the steps in Example A.4.

Example A.4: Plotting Points in a Character Space on the Intecolor Terminal

Step	Input	Explanation
1	06 01	Foreground = red, background = black
2	02	Enter Plot Mode

⁵Ref. 1, pp. 25-27 in CRT section and Appendix and Ref. 2, pp. 4.01-4.09.

**THIS BOOK
CONTAINS
NUMEROUS
PAGES WITH
THE ORIGINAL
PRINTING ON
THE PAGE BEING
CROOKED.**

**THIS IS THE
BEST IMAGE
AVAILABLE.**

3	00 00	First point plotted
4	01 01	Second point plotted
5	255	Escape Plot Mode
6	06 02	Foreground = green, background = black
7	01 03	Third point plotted
8	255	Escape Plot Mode

The Vector Plot Mode draws a line between the last two points plotted (see Example A.5). Note: It takes about 34 ms to draw a 100 element vector; therefore, a delay is required in putting data through a RS-232C port while the terminal is drawing a vector. Figure A.7 shows how the character spaces appear after a few of the steps in Example A.5.

Example A.5: Drawing Lines by Vector Plot on the Intecolor Terminal.

Step	Input	Explanation
1	06 04	Foreground = blue, background = black
2	02	Enter Plot Mode
3	00 00	Plots point (0,0)
4	242	Enter Vector Plot Mode
5	03 01	Draws line between points (0,0) and (3,1), enters Plot Mode
6	242	Enter Vector Plot Mode
7	01 03	Draws line between points (3,1) and (1,3), enters Plot Mode
8	255	Exit Plot Mode

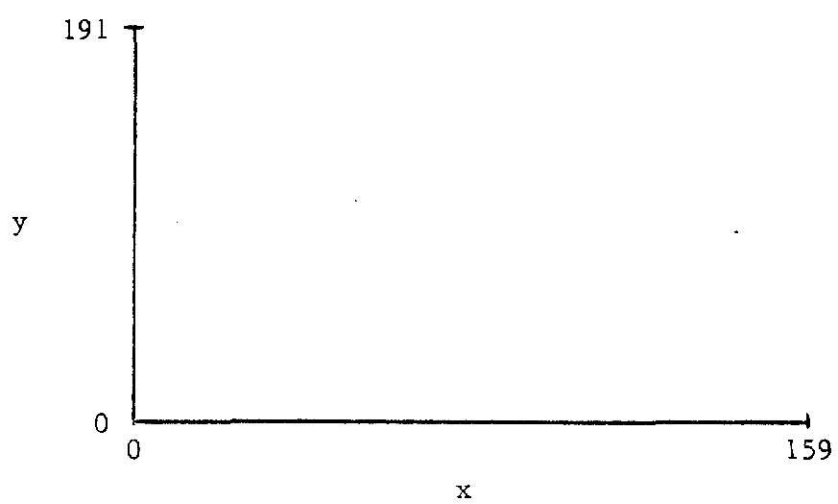


Figure A.5 Block Coordinate System

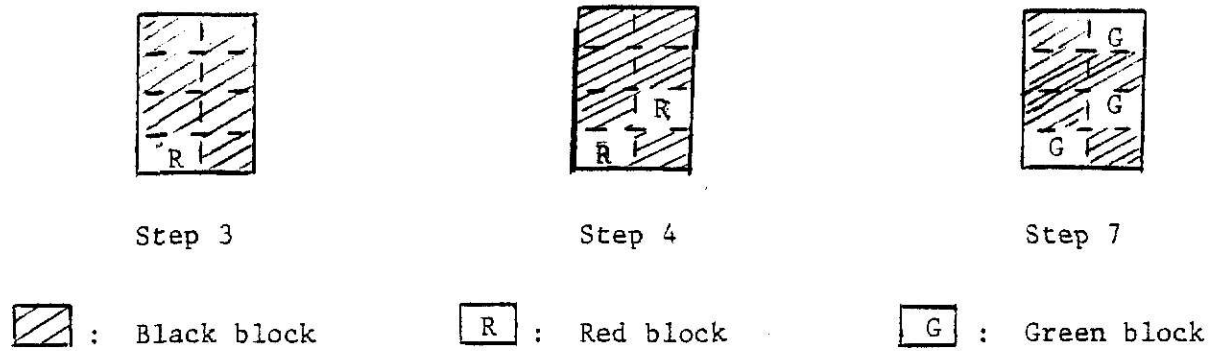


Figure A.6 Appearance of Character Space During Example A.4

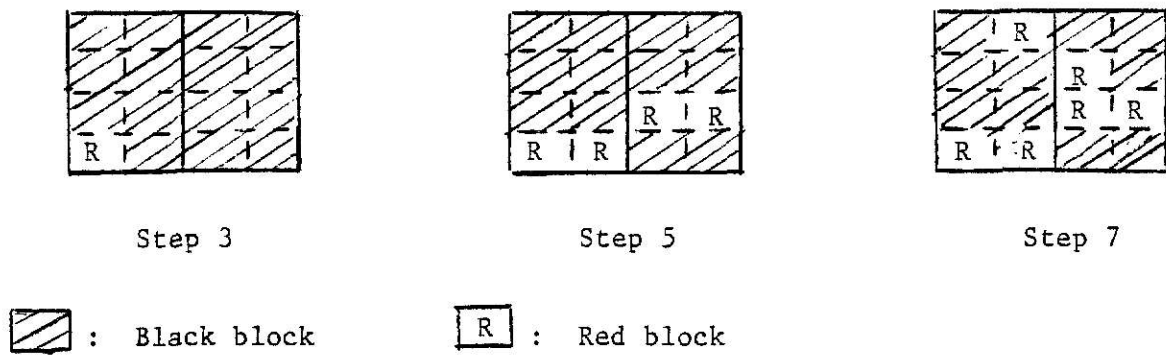


Figure A.7 Appearance of Character Spaces During Example A.5

Appendix 4 I/O Status Byte of the Intecolor 8001 Terminal⁶

The I/O Status Byte tells the Terminal where the physical devices are located to handle the four logical devices. The I/O byte structure is shown in Fig. A.8. Table A.4 contains a list of logical devices.

Table A.4 List of Logical Devices

LIST:	A character oriented output only device which accepts a character and records it on some external medium in readable form.
WRITE: (or Punch)	Same as LIST Device, but records it on some external medium not necessarily in readable form.
READER:	A character oriented input only device which transfers data on command and signals the program when there is no more data.
CONSOLE:	An interactive, character oriented device used for both input and output.

The exact location of the physical device for each one of the logical devices is listed in Table A.5. When the Intecolor Terminal is turned on the I/O Status Byte is initialized to 82 Hex. Using Figure A.8 and Tables A.4 and A.5, one can determine the physical devices being used. (See Example A.6)

Example A.6: Explanation of Initial I/O Status Byte.

I/O Status Byte = 82 Hex = 1000 0010 binary

Bits Code

C7 C6 = 10 ⇒ List Device = CRT

C5 C4 = 00 ⇒ Punch Device = 1st RS-232C Port

C3 C2 = 00 ⇒ Reader Device = 1st RS-232C Port

C1 C0 = 10 ⇒ Console Device Output = CRT

Input = Keyboard

⁶Ref. 1, pp. 5-7, 10-11 of CPU section.

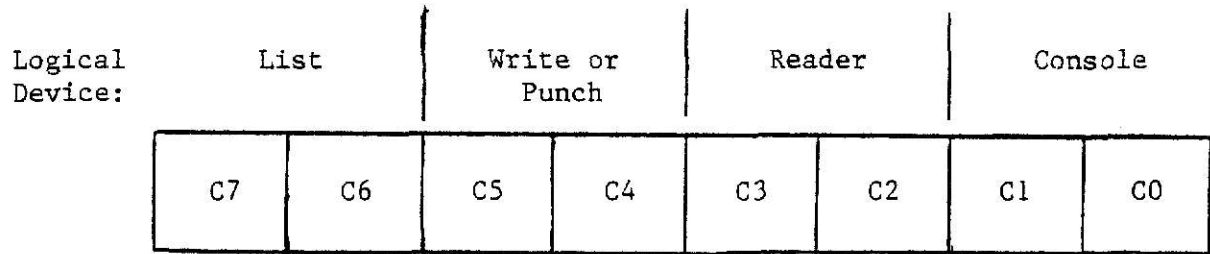


Figure A.8 I/O Status Byte Arrangement

Table A.5 Bit Codes for the Physical Devices

Logical Device	I/O Status Byte Bits		Physical Devices
List	C7	C6	
	0	0	1 st RS-232C Port
	0	1	2 nd RS-232C Port
	1	0	CRT
	1	1	User's List Device
Write or punch	C5	C4	
	0	0	1 st RS-232C Port
	0	1	2 nd RS-232C Port
	1	0	CRT
	1	1	User's Punch Device
Reader	C3	C2	
	0	0	1 st RS-232C Port
	0	1	2 nd RS-232C Port
	1	0	CRT
	1	1	User's Punch Device
Console	C1	C0	
	0	0	1 st RS-232C Port
	0	1	2 nd RS-232C Port
	1	0	Console Output = CRT
	1	1	Console Input = Keyboard
			User's Console Device

Whenever a User's Device is used there must be a machine language program, called a driver, to either transmit a character byte to or receive a character byte from the User's Device. The memory location of the I/O Status Byte and the drivers' JMP addresses are listed in Table A.6.

Any input driver routine that receives a character byte from an external device must leave the character byte in Register A. Any output driver routine must transmit the character byte off the top of the stack to the external device. Examples of driver routines are given in the listing of the Intecolor PRNT3 and CONS2 Programs (see Sections 5.B and 5.F).

Table A.6 Memory Location of the I/O Status Byte and JMP
Addresses for Drivers⁷

Memory Location	Use
9EAA Hex	I/O Status Byte
9EAB Hex	JMP to User's CONSOLE INPUT Driver Address
9EAE Hex	JMP to User's CONSOLE OUTPUT Driver Address
9EB1 Hex	JMP to User's READER Driver Address
9EB4 Hex	JMP to User's WRITE Driver Address
9EB7 Hex	JMP to User's LIST Driver Address

⁷Note: Ref. 1 list these locations incorrectly.

Appendix 5 Machine Language Routines Found in the Intecolor 8001
Terminal's ROM.

This Appendix contains a partial listing of the machine language routines found in the Intecolor Terminal's ROM. Some of these routines are used in the Intecolor machine language programs listed in Section V.

Name: Console Output⁸

Call Address: Either 0109 or 04F1 Hex

Purpose: Transmits a character byte, passed from the calling program
in register A, to the device selected for console output.

Name: List Output⁸

Call Address: Either 010F or 041C Hex

Purpose: Transmits a character byte passed from the calling program
in register A, to the device selected for list output.

Name: Punch Output⁸

Call Address: Either 010C or 040A Hex

Purpose: Transmits a character byte passed from the calling program
in register A, to the device selected for punch (or write)
output.

Name: Transfer

Call Address: Either 0160 or 0540 Hex

Purpose: Transfer a number of character bytes from one set of consecutive memory locations to another set of consecutive memory locations. The number of character bytes transferred is in register B, the starting "from" memory location is

⁸Ref. 1, pp. 7-9.

register pair D and the starting "to" memory location is
in register pair H.

Name: Out Console and Punch

Jump Address: 0480 Hex⁹

Purpose: Transmits a character byte located on top of the stack,
to the devices selected for console and punch output.

Name: In 1st RS-232C Port

Call Address: 04A0 Hex

Purpose: Transmit to the calling program in register A the
character byte received on the 1st RS-232C port.

Name: In 2nd RS-232C port

Call Address: 04AE Hex

Purpose: Transmits to the calling program in register A the
character byte received on the 2nd RS-232C port.

Name: Out 1st RS-232C Port

Jump Address: 04DA Hex

Purpose: Transmits a character, located on top of the stack,
to the 1st RS-232C port.

Name: Out 2nd RS-232C Port

Jump Address: 04E5 Hex

Purpose: Transmits a character, located on top of the stack
to the 2nd RS-232C port.

⁹The programs listed with a Jump Address can not be called directly. The character byte in register A and the condition flags register can be put on top of stack by the assembly command PUSH PSW. The assembly command POP PSW moves the top of stack to register A and condition flag register.

Name: From BASIC¹⁰

Call Address: 25A2 Hex

Purpose: When the machine language program, which is called by BASIC using the instruction Y=CALL(X), calls this routine the value of X is placed in the registers D (high byte) and E (low byte).

Name: To BASIC¹⁰

Jump Address: 2C53 Hex

Purpose: When the machine language program, which is called by BASIC using the instruction Y=CALL(X), jumps to this routine the registers A (high Byte) and B (low byte) are placed in the variable Y. Then the BASIC program will continue on the line following the CALL statement.

¹⁰See Documentation Number ISC 149-278 of Application Programs.

Appendix 6 Sample Data Arrays and Their Plots

The character plots are the hardcopy version of the color-shade plots made by the REC and PLOT12 programs.

The data array for the impedance data OFF/CE is a result of measuring the impedance between two guard ring electrodes, located off-set on opposite sides of a rectangular aquarium filled with water, as a balloon is moved about in the water. This data array is listed in Table A.7 and the character plots of the data array are shown in Figure A.9 and A.10.

The data array for the PYRMD data set was made so that the 3DPLT1 program could make a 3-dimensional plot of a pyramid on the Intecolor Terminal's CRT. This data array is listed in Table A.8 and the character plots of the data array are shown in Figures A.11 and A.12.

The data array for the TRY data set is just a 2 x 2 matrix and shows how the HP 9835A Computer plot programs generate values between data array components. The data array is listed in Table A.9 and character plots of the data array are shown in Figures A.13 and A.14.

Figures A.15, A.16 and A.17 are hardcopies of the 3-dimensional plots of the impedance data OFF/CE, the data set PYRMD and the data set TRY respectively. These hardcopies of the Intecolor Terminal's CRT were made by a program, called MRTFE, on a Xerox 1710 Teletype. This program was supplied with the Intecolor Terminal and Xerox 1710 Teletype system. The MRTFE Program can, unlike the REC Program, can make hardcopies of the plot blocks.

Table A.7 Data Array Components of the Impedance Data OFF/CE

Row \ Column	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	0	0	0	0	0	0	.9	1.4	3.2	5.5	11.4	30	139.1	990.9	1709.5	308.6	31.4	8.2
2	0	0	0	0	0	0	.9	1.8	2.7	5	9.5	20	52.3	116.8	134.1	65.9	19.5	5.9
3	0	0	0	0	0	0	.5	1.4	2.3	4.1	6.4	11.4	18.2	26.8	26.4	17.7	7.7	4.1
4	0	0	0	0	0	.5	.9	1.8	2.3	3.6	4.5	6.4	8.6	9.5	9.1	5.9	3.6	2.3
5	0	0	0	0	.5	1.4	1.8	1.8	2.7	2.7	3.6	4.1	4.1	5.5	4.5	3.2	2.3	.9
6	0	0	0	.5	.5	1.4	1.8	2.7	2.7	3.2	3.2	3.6	3.2	3.2	2.3	1.4	.9	.5
7	0	0	.5	.9	1.4	2.3	3.6	3.6	4.1	3.6	3.6	3.2	2.7	1.8	1.4	.9	.5	0
8	0	0	.5	1.8	3.2	5	6.4	6.8	5.9	5	4.1	3.6	2.3	2.3	.9	.9	0	0
9	0	0	1.8	3.6	7.3	11.8	14.5	13.6	10.9	7.7	5	3.6	1.8	1.4	1.4	0	0	0
10	0	.9	2.7	9.1	20.9	37.3	44.5	38.2	24.1	13.2	6.8	3.6	2.3	.9	.5	0	0	0
11	0	1.4	5	19.5	72.3	165.9	195.5	65.5	65.9	23.2	9.5	4.5	2.7	1.4	.9	0	0	0

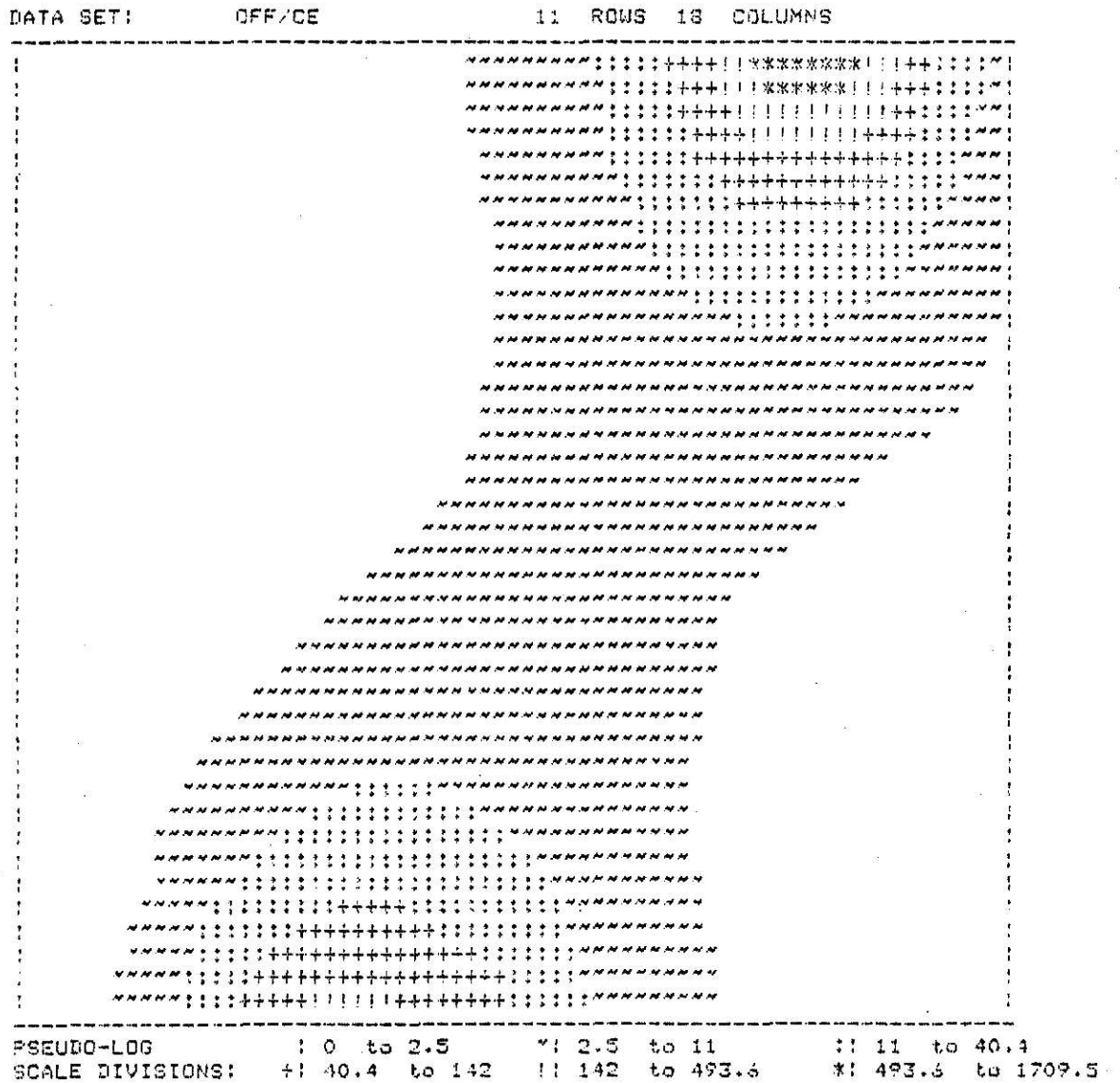


Figure A.10 Character Plot of Impedance Data OFF/CE
 in Pseudo-Log Scale

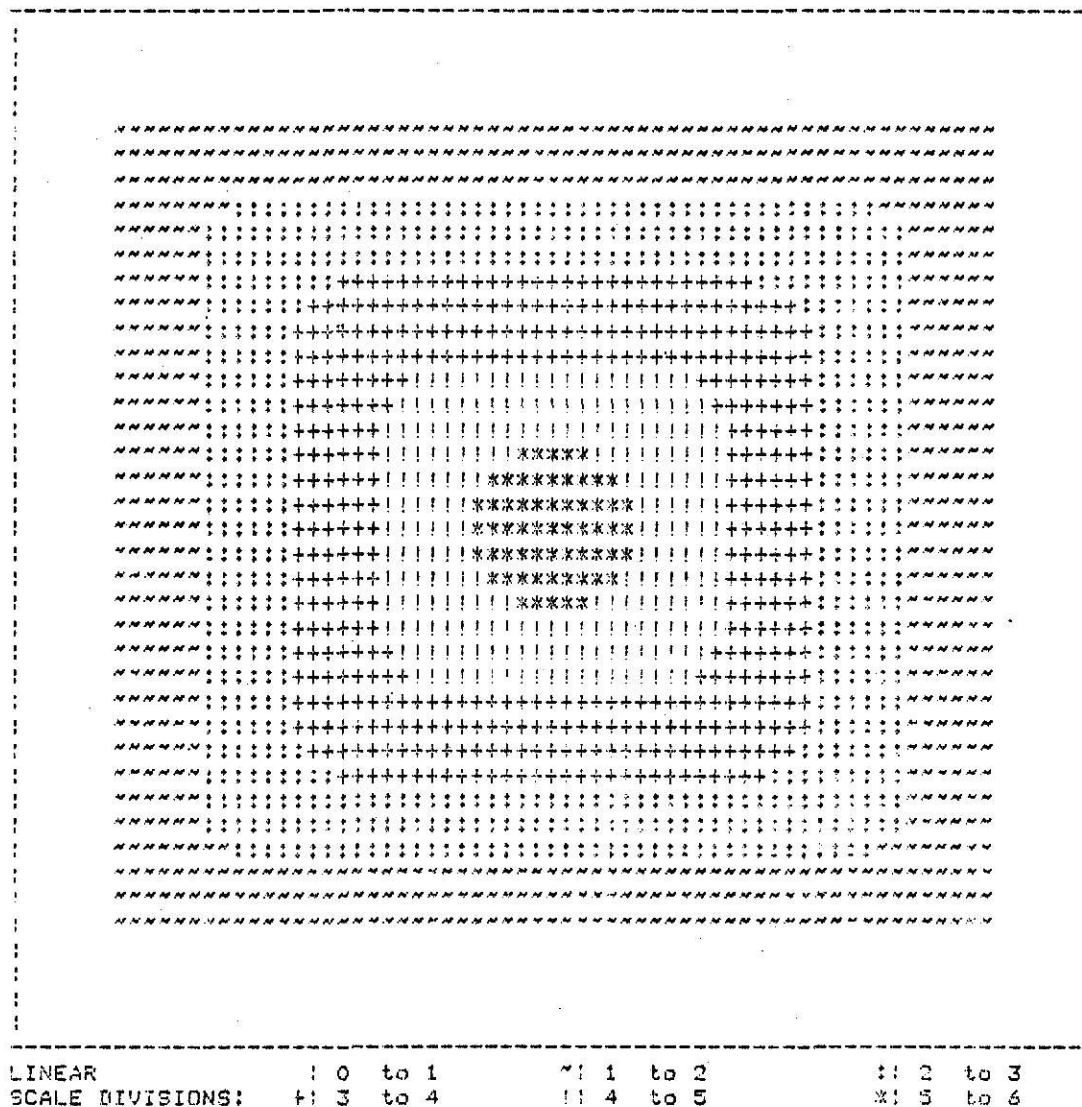
Table A.8 Data Array Components of the Data Set
PYRMD

Column Row	1	2	3	4	5	6	7	8	9	10	11
1	0	0	0	0	0	0	0	0	0	0	0
2	0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	0
3	0	1.2	2.4	2.4	2.4	2.4	2.4	2.4	2.4	1.2	0
4	0	1.2	2.4	3.6	3.6	3.6	3.6	3.6	2.4	1.2	0
5	0	1.2	2.4	3.6	4.8	4.8	4.8	3.6	2.4	1.2	0
6	0	1.2	2.4	3.6	4.8	6	4.8	3.6	2.4	1.2	0
7	0	1.2	2.4	3.6	4.8	4.8	4.8	3.6	2.4	1.2	0
8	0	1.2	2.4	3.6	3.6	3.6	3.6	3.6	2.4	1.2	0
9	0	1.2	2.4	2.4	2.4	2.4	2.4	2.4	2.4	1.2	0
10	0	0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	0
11	0	0	0	0	0	0	0	0	0	0	0

Table A.9 Data Array Components of the Data Set TRY

column row	1	2
1	0	10
2	10	0

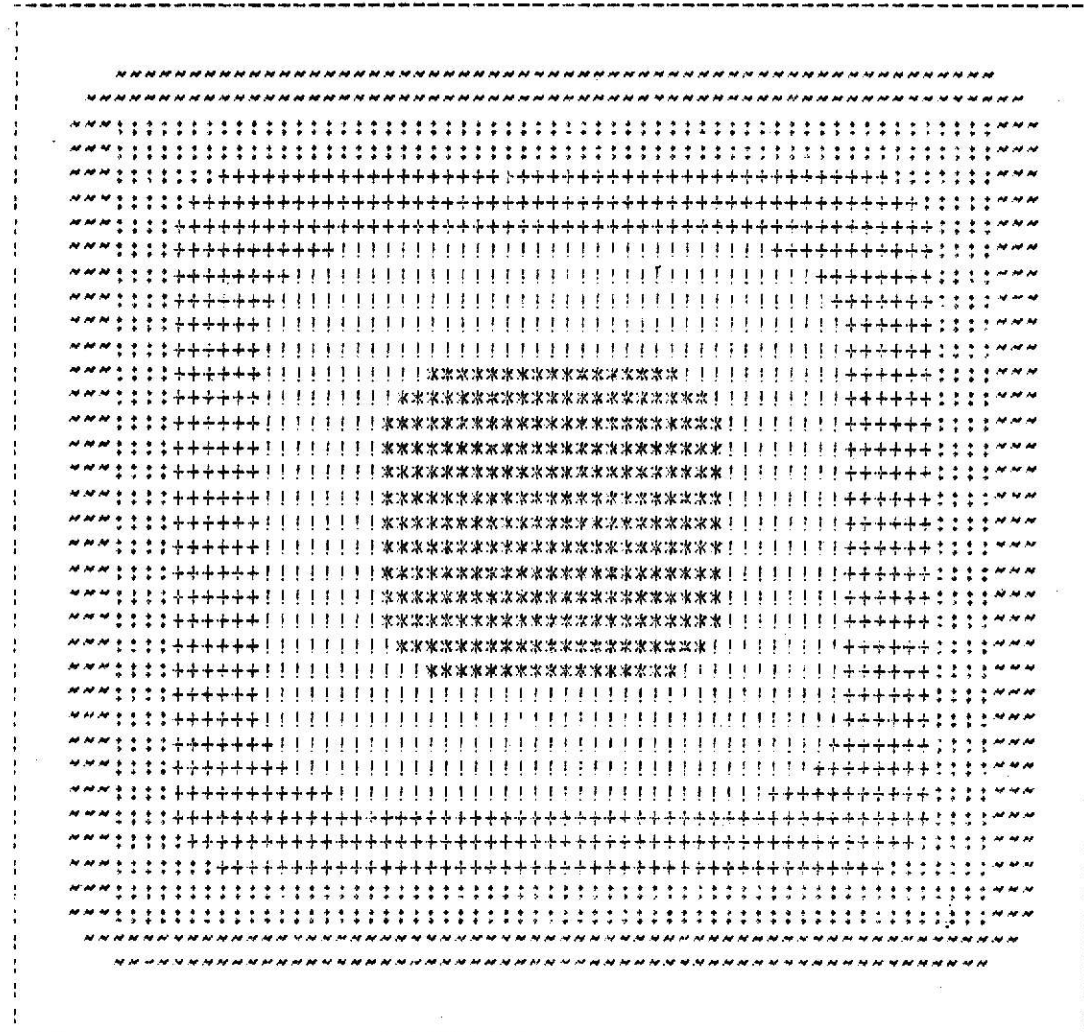
DATA SET: PYRMD 11 ROWS 11 COLUMNS



DATA SET:

PYRMD

11 ROWS 11 COLUMNS



PSEUDO-LOG | 0 to .4 ~| .4 to .9 || .9 to 1.6
 SCALE DIVISIONS: +| 1.6 to 2.7 || 2.7 to 4.1 *| 4.1 to 6

Figure A.12 Character Plot of Data Set PYRMD in
Pseudo-Log Scale

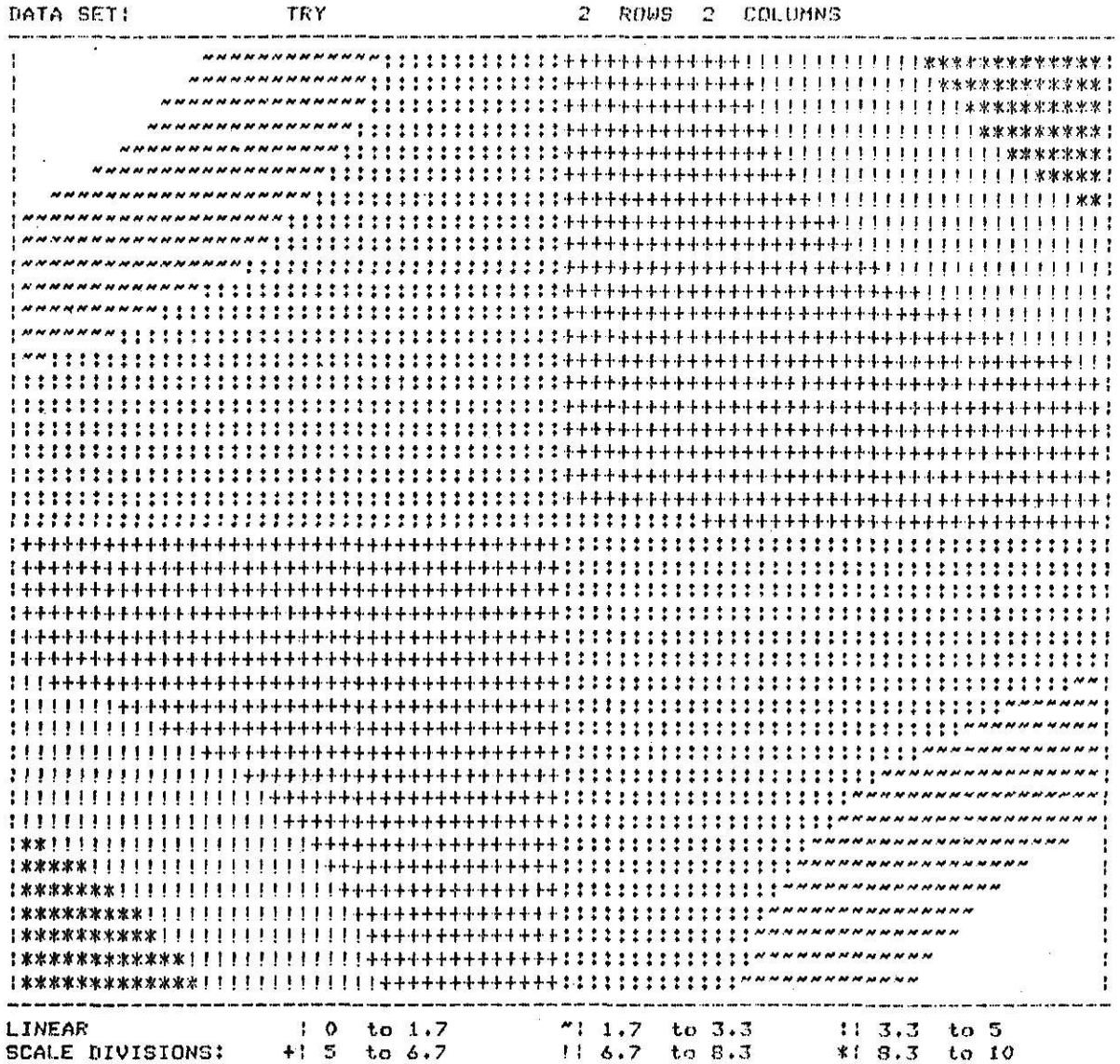


Figure A.13 Character Plot of Data Set TRY in Linear Scale

[illegible]

Figure A.14 Character Plot of Data Set TRY in Pseudo-Log Scale

3D PLOT, IN PSEUDO-LOG SCALE, OF

DATA SET³

OFF/CE

11 ROWS 18 COLUMNS

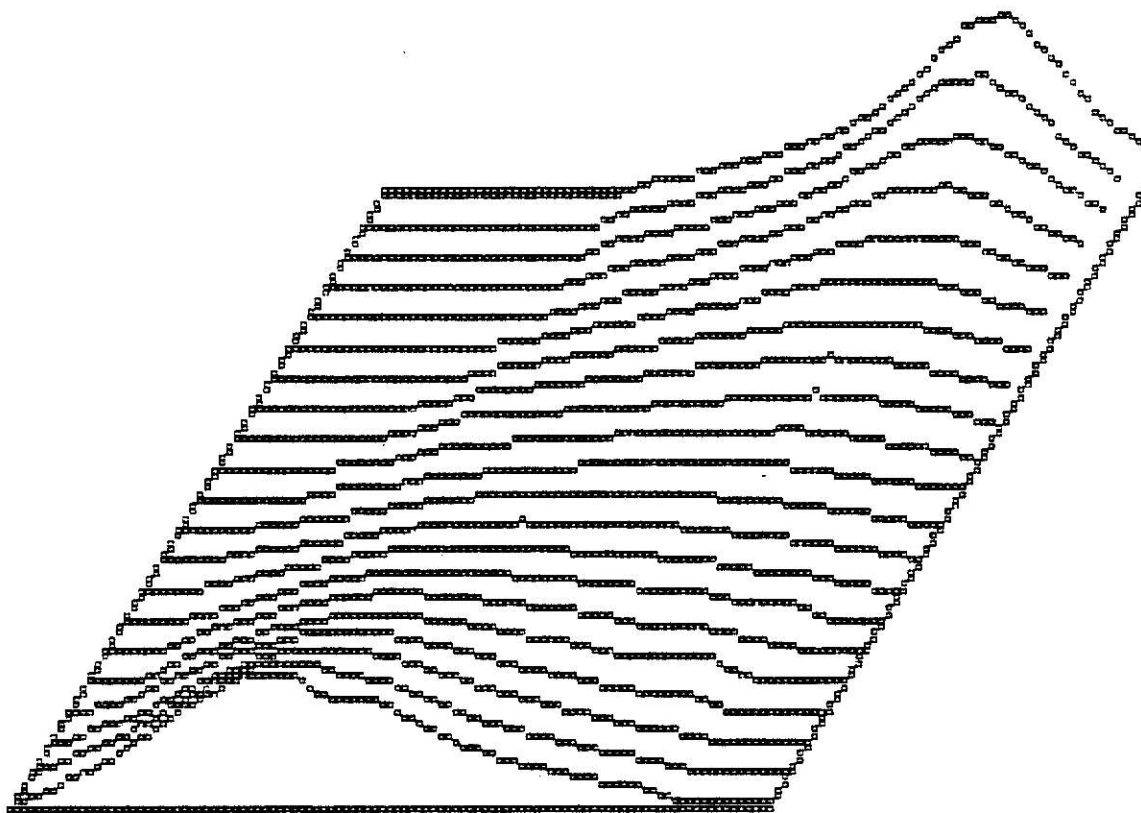


Figure A.15 3-Dimensional Plot of Impedance Data OFF/CE in Pseudo-Log Scale (Refer to Fig. A.10 for corresponding character plot of this data array)

3D PLOT, IN LINEAR SCALE, OF
DATA SET^R

PYRMD

11 ROWS 11 COLUMNS

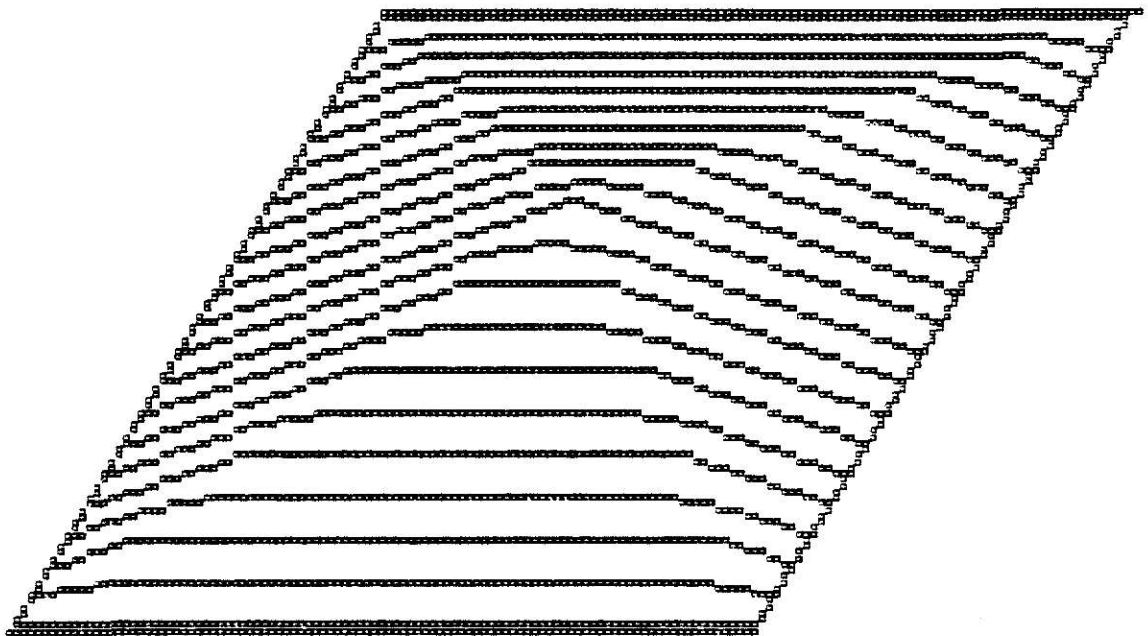


Figure A.16 3-Dimensional Plot of Data Set PYRMD in
Linear Scale (Refer to Fig. A.11 for correspond-
ing character plot of this data array)

3D PLOT, IN LINEAR SCALE, OF

DATA SETⁿ

TRY

2 ROWS 2 COLUMNS

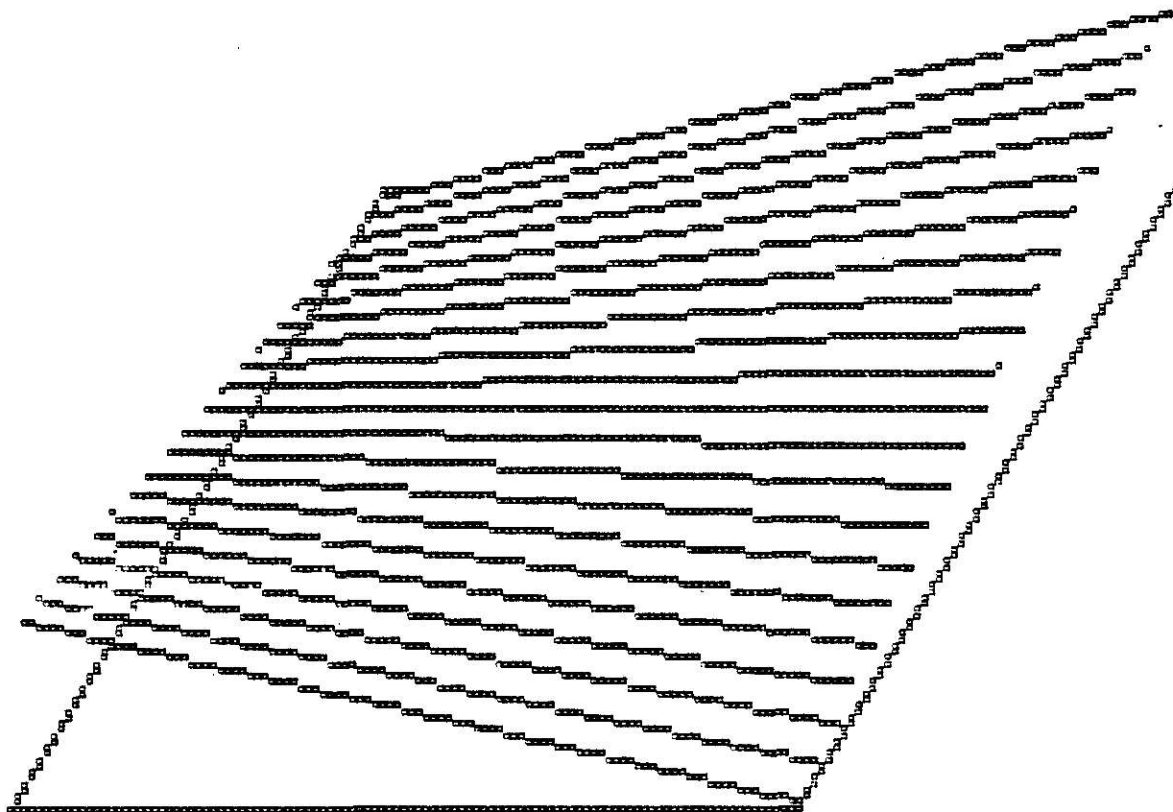


Figure A.17 3-Dimensional Plot of Data Set TRY in Linear Scale (Refer to Fig. A.13 for corresponding character plot of this data array)

INTERFACE DEVELOPMENTS FOR AN ISC
INTECOLOR 8001 TERMINAL AND A HEWLETT-PACKARD
9835A DESK-TOP COMPUTER SYSTEM

by

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AN ABSTRACT OF A MASTER'S REPORT
submitted in partial fulfillment of the
requirements for the degree

MASTER OF SCIENCE

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1980

ABSTRACT

The development of a hardware/software interface between an Intelligent Systems Corporation (ISC) Intecolor 8001 Color Graphics Data Terminal and a Hewlett-Packard (HP) 9835A Desk-Top Computer is described. After the analysis and proper formatting of data sets are accomplished by the HP Computer the interface permits the results to be displayed on the Intecolor Terminal's CRT. These transmitted data sets and associated displays can be stored on or recalled from the Intecolor Terminal's floppy diskette drive. Also included is the developed software documentation that permits the Intecolor Terminal to make a hardcopy of the display on a Decwriter II teletype.