RGB
for
RamWorks®

Including ColorLink™ and Digital Prism™

APPLIED ENGINEERING®
A Division of AE Research Corporation
v1.0

Applied Engineering

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Monday through Friday

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RGB
for
RamWorks®

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Federal Communications Commission
Radio Frequency Interference Statement

Warning: The equipment described in this manual generates and uses radio frequency energy. If it is not installed and used properly (i.e. in strict accordance with these instructions), it may cause interference to radio or television reception.

FCC I.D. Number: **EYW 5QG AERGBOPT**

This equipment has been tested and found to comply with the limits for a class B computing device, pursuant to Subpart J, Part 15, of the FCC Rules. These rules are designed to provide reasonable protection against radio and television interference when operated in a residential installation.

If radio or television interference stops when you turn your computer off and resumes when it is turned back on, your computer, or one of its peripheral devices, is to blame. Turn the computer off, remove one of the peripheral devices, and turn the computer on. Continue this procedure until the source of the interference is isolated. Don't forget that the monitor is also a possible source of interference.

The effects of interference can be minimized or eliminated by one or more of the following measures:

- Reposition the receiver's antenna. Also make sure the antenna wires are making good electrical contact.
- Use a roof-mounted antenna rather than a "rabbit-ear" antenna or an antenna mounted in the attic.
- Make sure that all electical connections on the computer are secure and any shielded I/O cables are properly fastened.
- Move the computer farther away from the receiver.
- Plug the computer and receiver into separate electrical circuits.

If the interference persists, you should seek advice or service from your dealer or a reputable radio/television technician.

Applied Engineering is not responsible for any radio or television interference caused by unauthorized modifications to this equipment. It is the responsibility of the user to correct such interference.

Important note about shielded cables and connectors

This product was FCC certified under test conditions that included the use of shielded cables and connectors between system components. A shielded cable is one which uses a metallic wrap around its wires to reduce the potential effects of radio frequency interference. It is important that you use shielded cables and connectors properly to prevent the generation of interference.

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Even though Applied Engineering has tested the software and reviewed the documentation, Applied Engineering makes no warranty or representation, either express or implied, with respect to software, its quality, performance, merchantability, or fitness for a particular purpose. As a result, this software is sold "as is," and you, the purchaser, are assuming the entire risk as to its quality and performance.

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Applied Engineering cannot guarantee that you will receive notice of revisions to the software documentation or products described in this manual. Be sure to check with your dealer or Applied Engineering for information on possible updates.

Applied Engineering
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Carrollton, Texas 75006

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Technical Support: (214) 241-6069 9 AM - 5 PM (CST) Monday - Friday

(The Technical Support telephone lines cannot be accessed through the Sales department.)

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Applied Engineering Technical Support

If you have a technical question relating to an Applied Engineering product, please contact the dealer from whom you purchased the product. In the event that the dealer cannot answer your question, Applied Engineering has a staff of technicians dedicated to answering specific technical questions about Applied Engineering products and software. Technical Support representatives are available between the hours of 9 AM to 5 PM CST, Monday through Friday. The Technical Support telephone number is (214) 241-6069. Please call only this number for technical support as our sales office cannot transfer calls to the support lines.

The support representatives are experienced in many of the applications and uses of Applied Engineering products, but in order to provide a quick and effective answer to your question, they will need to know as much as possible about the hardware and software specifically related to your question. Please provide the technical support representative with the following information:

- The Applied Engineering product related to your question.
- The model and configuration of your computer (what peripherals are being used).
- If the question is related to an Applied Engineering memory expansion card, please provide the revision level, original memory configuration, and current memory configuration of the card.
- The name, version, and revision level of the software with which you are experiencing problems.
- The results of any test programs or diagnostics that you may have run.
- The results of any troubleshooting done by you or your dealer.

Most questions can be answered in one telephone conversation, but some may require research by the technical support representative. Please be sure to make a note of the representative's name just in case you need to call back with any additional information or follow-up on a previous question.

Applied Engineering
Technical Support
(214) 241-6069
9 AM to 5 PM (CST)
Monday Through Friday

Remember:
When all else fails, *read the instructions!*
...then call technical support .

ColorLink & Digital Prism

Welcome to a new world of exciting RGB color!

Applied Engineering RGB Extender Card Features

* 100 % compatible with Apple //e hardware for graphics and text modes
* Switch selectable four color text (blue, white, amber, or green) in either 40 or 80 column mode
* True RGB reproduction of Apple //e double density modes
* **Digital Prism** works with BOTH Apple compatible ***digital*** *and* IBM compatible ***digital*** RGB monitors.
* **ColorLink** works with BOTH Apple compatible ***analog*** *and* IBM compatible ***digital*** RGB monitors.

Choosing an RGB Monitor

One of the features of the Applied Engineering **ColorLink** is the ability to use it with both Apple compatible analog RGB monitors (such as the AppleColor™ RGB monitor for the IIGS) and IBM compatible digital RGB monitors. To facilitate use with both types of monitors, the **ColorLink** includes two connectors along the back edge.

One connector is the 15 pin connector found along the lower part of the back edge of the card. This connector is used for Apple compatible analog RGB monitors. It will not work with the older (dicontinued) Apple digital monitors. The connector is attatched via a ribbon cable to a 15 pin D-type connector which plugs directly into the cable of an Apple compatible analog RGB monitor.

The second connector is found along the upper part of the back edge of the card and has 9 pins. This connector is meant to be used with IBM compatible monitors. It is connected via a ribbon cable to a 9 pin D-type connector which will plug directly into the cable of an IBM compatible RGB monitor.

The **Digital Prism** also has two connectors found in the same locations--one for the IBM compatible digital RGB and the other for the Apple compatible digital RGB monitors.

When an order is placed for either RGB card, the customer will be asked to specify his/her choice of which ribbon cable (either Apple compatible 15 pin D-type, or IBM compatible 9 pin D-type) to be included in the shipment. If the second cable is also desired, there will be a ten dollar surcharge. If at anytime after the purchase of the **ColorLink** or the **Digital Prism** the owner desires to obtain the second cable, simply call Applied Engineering for the second cable at a cost of ten dollars.

Connecting the RGB Extender to RamWorks

Warning: Never attempt to remove or insert cards in any slot of the Apple //e while the power is turned on. Doing so could cause damage to both the Apple motherboard and the card.

1) Turn the power to the Apple //e OFF.

2) Remove the lid of the //e.

3) Remove the RamWorks card from the auxiliary slot.

4) Plug the ribbon cable connector onto the header on the RGB card. The plug should be oriented so that when the RGB card is lying with its solder side down, the ribbon cable will be extending upwards. This is true for either the Apple compatible or the IBM compatible cable.

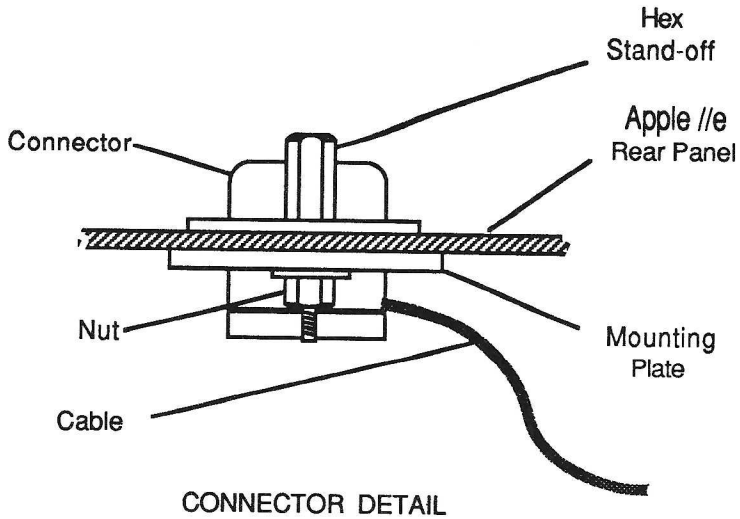
5) Plug the RGB card into its connectors on the RamWorks card. Notice that on the RamWorks card there are two sets of connectors, one set on the chip side of the card and one set on the solder side of the card. The set of connectors on the solder side is the one designed for the RGB extender. (The connectors on the chip side are for the RamWorks 512K or 2 Meg piggyback cards and are NOT compatible with the RGB card.) Align the RGB card and the RamWorks so that the the chip sides of each card face in the same direction. Line the connectors up so that all pins on the RGB card card will slide into a slot on the RamWorks card. Gently push the two together until they are mated and will not go any farther.

6) While the power to the Apple //e is still OFF, carefully push the RamWorks card back into the auxiliary slot on the Apple //e motherboard. (If you need any further information about installing the RamWorks card, refer to the RamWorks user's manual.

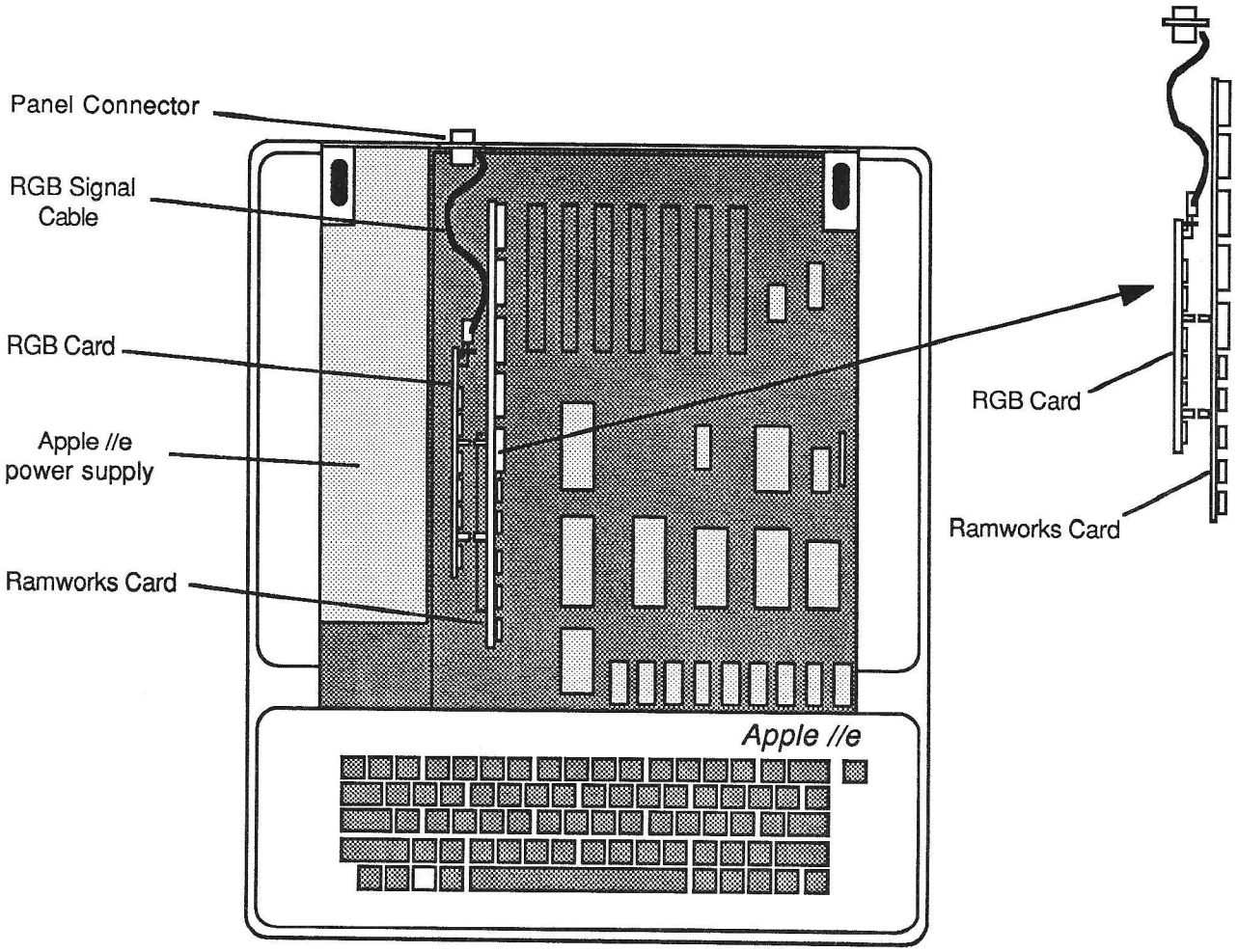
7) Route the video cable out of one of the holes in the back panel of the Apple //e's case. Use the mounting hardware, which consists of a flange and two screws, to mount the connector to the Apple's back panel. Connect this cable to the cable coming from the RGB monitor. Refer to diagrams on next page.

8) You may want to change the switch settings so don't put the lid back on your computer yet.

9) Insert the ProDOS disk, /RGB, supplied by Applied Engineering, into the boot drive. Now turn on the power and enjoy a whole new world of RGB color!



CONNECTOR DETAIL



Using the RGB Card

When you boot the /RGB disk after installing your **ColorLink** or **Digital Prism**, you should see on the screen a ProDOS startup message then the Applied Engineering startup message. If this is not what you see, then turn off the power and check to see that the card is properly installed and all of the cables are properly connected.

If the picture is rolling and not getting proper sync, check to see if you are using a monitor that requires the ribbon cable with the 9 pin D-type connector. If you are, you will want to try changing the SYNC SELECTION SWITCH which is one of the four dip switches located on the end of the RGB card closest to the keyboard of the Apple //e. The SYNC SELECTION SWITCH is switch 3 of the dip switches. When the SYNC SELECTION SWITCH is pushed so that it is down toward the side marked OPEN, NEGATIVE SYNC is selected. When the switch is flipped the other direction, POSITIVE SYNC is selected. Some monitors that use the 9 pin D-type connector use negative sync and some use positive sync. If your monitor will not properly sync up, try pushing the SYNC SELECTION SWITCH in the opposite direction.

When you get the proper messages, the first thing you will notice is that the RGB monitor displays the same thing as the regular video monitor, except that the RGB monitor displays it in a blue color. Except for the color, the screen format is the same as the regular Apple screen format: 24 lines of 40 characters each. If you do not like the screen text display color, you can change it to one of three other colors by using the Text Color Switches which are switches 1 and 2 of the dip switches. Only switches 1 and 2 of four dip switches will affect the text color. A table for the Text Color Switches is shown below.

Switch 1	Switch 2	Text Color
OFF	OFF	WHITE
OFF	ON	BLUE
ON	OFF	AMBER
ON	ON	GREEN

The settings on the Text Color Switches have no effect on the other operations of the RGB card; the Hi-Res RGB graphics will work the same no matter what the switch settings of the Text Color Switches. The switches are easy to access while the card is installed in the Apple and may be changed while the card is in operation. If you do not like the text displayed in blue, you can change the colors now.

Dip switch 4 is the COLOR MAPPING SWITCH. Some monitors which use the 9 pin D-type cable have different color maps than others. In order to get the proper colors on the screen, the switch might need to be switched in one direction or the other. If the colors you see on your screen do not look correct to you, try flipping the COLOR MAPPING SWITCH the other way.

Remember also that color names are a very subjective thing, and that different monitor manufacturers use different phosphors in their picture tubes. If the color names do not agree exactly with what you think they should be even after trying the COLOR MAPPING SWITCH in both directions, the problem might be in the type of phosphor used in the picture tube of the monitor you use.

Once you have the text colors set the way you like them, you can continue on with the Applied Engineering demonstration programs. To select a demo program, use the up and down arrow keys to select the demo you want, then press return. To return to the menu from one of the programs, simply press escape.

The **ColorLink** and **Digital Prism** work in both the 40 and 80 column modes. The following simple experiment will demonstrate both modes:

Control Q	
Control R	
Pr#0	40 column mode
PR#4	80 column mode

The Applied Engineering RGB Software

To allow you to use the card from Applesoft Basic, Applied Engineering has supplied with the RGB card, software that will extend the command set of Applesoft Basic. This command extension uses the ampersand hook described below.

Each of the extended commands used from Applesoft must be preceded by an ampersand (&) character. This ampersand character tells the Applesoft interpreter to use the Applied Engineering software to execute the command which follows.

On the disk is a binary executable file called B.RGB.HIRES. When this program is BRUN it will load the Applied Engineering RGB routines into memory and set the ampersand hook so that any command preceded by an ampersand character will be executed by the RGB software. This file (B.RGB.HIRES) can be moved to any other ProDOS disk and BRUN to provide the Applesoft extension for RGB. On the disk we supplied to you, the program called STARTUP will automatically run B.RGB.HIRES when the disk is booted. You will probably want to move this file to any disk which will be used primarily for RGB graphics.

The following is a list of the commands; their syntax and parameters.

& DG

This command is used to turn on the RGB card. If this command is not used the RGB routines will still draw on the double Hi-Res screen, but because the RGB card is turned off, nothing will appear on the RGB screen. This command requires no parameters.

& CLEAR

This command is used to clear the screen. When the RGB card is turned on with the & DG command, the screen is not cleared; this will sometimes result in garbage on the screen and will sometimes display the last picture that was on the screen. Use the & CLEAR to clear the screen to black. This command requires no parameters.

& TEXT

This command is used to shift back and forth between the text and graphics screens on the RGB card. The RGB card will display both modes of text (40 column and 80 column) in addition to the RGB graphics. If you were in 40 columns before you went to RGB graphics, & TEXT will return you to 40 columns; if you were in 80 columns, then you will return to 80 columns. This command requires no parameters.

& HUE = x

This command is used to set the color which will be plotted on the screen by the next plot command (& DOT AT or & LINE TO) or to set the color of the screen's background (& BKGND). Once the color is set using & HUE= it will remain that color until you change it. The parameter x may be a numeric literal (a number), an Applesoft variable, or a valid arithmetic expression. The allowed range is <0 to 15> which corresponds to the colors as shown below:

0 = BLACK	8 = BROWN
1 = RED	9 = ORANGE
2 = DARK BLUE	10 = LIGHT GREY
3 = LAVENDER	11 = PINK
4 = DARK GREEN	12 = GREEN
5 = GREY	13 = TAN
6 = BLUE	14 = AQUAMARINE
7 = LIGHT BLUE	15 = WHITE

So, & HUE = 1 wil plot a red line or dot or set the background of the screen red if used in conjunction with the proper command.

& BKGND

This command is used to change the color of the background. The screen will be cleared to the last color chosen using the & HUE= command. Please note that anything on the screen will be be cleared. This command works like the & CLEAR command except that it clears the screen to the last chosen color instead of black. There are no required parameters

& BRUSH

Sets the line width to 4 for 16 color plotting.

& DOT AT x,y

This command is used to plot a dot of the chosen color (chosen using & HUE=). The parameters x and y can be numeric literals, Applesoft variables, or valid arithmetic expressions. The allowed range of x is <0 to 139> and the allowed range of y is <0 to 189>.

& LINE TO x, y

This command draws a line in the present color from the last point plotted to the location specified by x, y. The range and type of the parameters is the same as that for the & DOT AT command.

& LOAD <fname>

This command is used to load a picture from the disk to the RGB screen. <fname> is the name of the file to be loaded and it may be either a string literal or a string variable.

& PEN

This command set the line width to 1 for 560 dot horizontal resolution.

& SAVE <fname>

This command is used to save a picture from the RGB screen to a disk file. <fname> is the name which will be given to the disk file which is created and it may also be a string literal or a string variable.

All of the commands listed above may be used either from the immediate execution mode or in an Applesoft Basic program. To use the commands from immediate mode (i.e. when you have the Applesoft prompt, "]") simply type an ampersand character (&) and the command plus any required parameters. To use the commands from BASIC, simply put an ampersand as the first character in the command line and then use the command, with any necessary parameters of course.

Beagle Graphics Note

The Applied Engineering &LOAD and &SAVE commands use a file format which is compatible with the format specified by Apple Computer Inc.; however, a program sold by Beagle Bros. Software called, Beagle Graphics, uses a different file format.

If you wish to load a picture in the Beagle Graphics format, use the following commands from Applesoft Basic:

```
100 POKE -16299,0
110 PRINT CHR$(4)"BLOAD PICTURE.AUX"
120 POKE -16300,0
130 PRINT CHR$(4)"BLOAD PICTURE"
```

If you wish to save a picture in the Beagle Graphics format:

```
100 POKE -16299,0
110 PRINT CHR$(4)"BSAVE PICTURE.AUX,A$2000,L$2000"
120 POKE -16300,0
130 PRINT CHR$(4)"BSAVE PICTURE,A$2000,L$2000"
```

Of course, the file name can be anything you want it to be, but you must remember to include the .AUX extension after the file name which follows the POKE -16299,0. This convention must be used if the file is to be readable by the Beagle Graphics program.

Sample Programs

Studying these sample programs will help you to better understand the relationship of the two commands & DOT AT and & LINE TO.

Here is a short program which will draw random colored dots on the RGB screen:

```
100 & DG
110 & CLEAR
120 & BRUSH
130 & HUE=RND(111)*15
140 & DOT AT RND(111)*139,RND(222)*189
150 GOTO 130
```

In line 100 we use the & DG command to turn on the RGB card. In line 110 we use the & CLEAR command to clear the RGB screen. Line 120 sets the line width to 4. Line 130 sets the color to a random number between 0 and 15. Remember that the Applesoft random number generator returns a random number between 0 and 1. Multiplying this by 15 will yield a number between 0 and 15 (after truncation to make it an integer quantity). Line 140 plots a dot in the chosen color at a random location. Note that the first coordinate (X coordinate) is between 0 and 139 and that the second coordinate (Y coordinate) is between 0 and 189. Line 150 simply puts us in an infinite loop. To terminate this program, hit reset or use a **Control-C**.

Now we will change the program a little so that it draws random colored lines instead of random colored dots. The program looks like this:

```
100  & DG
110  & CLEAR
120  & BRUSH
125  & DOT AT 69,94
130  & HUE=RND(111)*15
140  & LINE TO RND(111)*139,RND(222)*189
150  GOTO 130
```

You will note that this program looks a lot like the previous one except for the addition of line 125 and the change of the command in line 140 from & DOT AT to & LINE TO. The addition of line 125 is for the purpose of giving the & LINE TO command a place to start when drawing the first line. Subsequent lines are drawn from the last plotted point, which in this case is the position the last & LINE TO command was given as its parameter. The net result is that the program creates a sequence of random lines that are connected "head to tail" to give a random "path" around the screen. Again, terminate by reseting or by pressing Control-C.

The third example program will give a random set of lines that are not connected as the last ones were; each line in this program has its own starting and ending points.

```
100  & DG
110  & CLEAR
115  & DOT AT 69,94
120  & BRUSH
130  & HUE=RND(111)*15
140  & DOT AT RND(111)*139,RND(222)*189
145  & LINE TO RND(333)*139,RND(444)*189
150  GOTO 130
```

This program differs from the first one only in the addition of the line numbered 145. It draws a line from the point plotted in line 140 with the & DOT AT command to the position specified by the parameters. It is different from the second program in that it insures that each line has its own starting point, it does not use the ending point of the last line drawn.

An RGB Tutorial

What is RGB ?

RGB is a type of graphics system that provides a much sharper image than the regular Apple II graphics display. The letters RGB stand for Red-Green-Blue and refer to the way in which the electron guns in the picture tube of the monitor are controlled. Recall that a picture tube has three electron guns, one for each of the additive primary colors red, green, and blue. In the regular Apple II graphics system the signal to a color graphics monitor is an NTSC composite video signal, which means that the information for control of all three electron guns has been combined

into one signal. In the RGB system, the information for the three guns is sent on separate wires (one for each electron gun) to the RGB monitor. Thus, because of incompatible signaling standards, to use the RGB card you must have an RGB monitor.

Double Hi-Res on the Apple //e

In order to understand how the RGB card produces images on the RGB monitor, we must first understand how the Apple Hi-Res and double Hi-Res modes work.

Hi-Res graphics on the Apple II and II Plus has a resolution of 280H x 192V when viewed on a monochrome (black and white) monitor. Each horizontal row on the Apple II and II Plus shows 280 dot positions. Each of the dot positions on the screen represents one bit of information in the computer's memory. Each horizontal row of 280 dots is created from the information in 40 bytes of the computer's memory. You might wonder how 40 bytes of eight bits each makes 280 dots per row instead of 320 dots per row. The answer lies in the fact that only seven bits per byte are actually displayed on the screen. The eighth bit in each byte is used for special purposes discussed later in this chapter.

The Apple //e has many improvements over the Apple II and II Plus,one of which is the double Hi-Res graphics mode. This mode allows you to have a monochrome resolution of 560H x 190V. In order to get 560 dot positions per horizontal row, we need extra bytes of memory for the extra information on the screen. The Apple //e was designed so that extra memory in an auxiliary bank plugged into the auxiliary connector could be interleaved with the regular Hi-Res display memory. The Applied Engineering RamWorks card gives you the needed memory. For the Apple //e in double Hi-Res every other byte used for screen display (every other seven dots) comes from either the main or auxiliary memory.

When the regular Apple Hi-Res graphics signal is applied to an NTSC color monitor (or a color TV set through a video modulator), an interesting thing occurs: the useful resolution is decreased to 140H x 190V. This occurs because of the way in which the NTSC monitor (or TV set) works. In effect, the color monitor "interprets" the signal such that every two dots represent one color dot. Since there are four possible combinations of two binary quantities (i.e. 00, 01, 10, 11) there are four possible colors that can be produced.

But wait. Doesn't Apple advertise the Apple II and II Plus as having six Hi-Res colors? Yes, they do, but what they didn't tell you is that there are certain restrictions to the use of the six colors. The Apple engineers figured out a way to use that eighth bit of every display byte to give the Apple II and II Plus a more versatile (and more confusing) color display. When the eighth bit of a byte is turned off, the four possible colors are black, white, violet, and green. When the eighth bit is turned on, the color choices are black, white, blue, and orange. You can see that you cannot mix green and blue or green and red in the same byte, nor can you mix violet and blue or violet and red in the same byte. (Remember, I said it was more confusing.)

With double Hi-Res graphics on the Apple //e you can now have a horizontal resolution of 560 dot positions on a monochrome monitor. When this signal is applied to an NTSC monitor, a doubly curious thing happens: while you might expect to get a horizontal resolution of 280 dots and get four colors, the horizontal resolution for color stays at 140 dots, but because the NTSC

monitor now "interprets" four dots as one color dot, you now have the possibility of 16 colors (there are 16 possible combinations of four binary quantities).

The video generation circuitry on the Apple //e motherboard changes the information in the Apple's Hi-Res display memory into an NTSC compatible video signal. It is the job of the circuitry on the RGB extender to convert this same information in the Apple's memory into the RGB signal (which is actually three signals for red-green-blue) and send this signal to the RGB monitor. Even though the RGB extender uses the same area in the Apple's memory for its display data, not all programs that use this area of memory for their display area will work with the RGB card. Recall that in explaining the command "& DG" in the section on the Applied Engineering software, we mentioned that if you did not use the & DG command the software would still draw on the Hi-Res screen, but no image would appear on the RGB monitor. This is because the RGB card card must first be turned on before it will convert the information in memory into an image. The same is true of commercially available software packages. If a program writes to the Hi-Res screen but does not turn on the RGB card, the RGB monitor will not display an image. (Dazzle Draw is an example of a commercially available program that will not work because it does not turn on the RGB card.) In order for an image to appear, two conditions must be met: 1) there must be information in the Hi-Res display area of the Apple's memory, and 2) the RGB card must be turned on. See Appendix B for information on turning the card on from assembly language.

Appendix A: RGB HIRES Routine Location

When the file B.RGB.HIRES on the disk named /RGB is run, it loads at $2000. The $ character in front of a number means that it is a hexidecimal number. This setup routine makes space between the ProDOS file buffers and the Basic Interpreter and then copies the Hi-Res software into that space. This space runs from $9200 to $99FF. The setup routine also installs the ampersand vector.

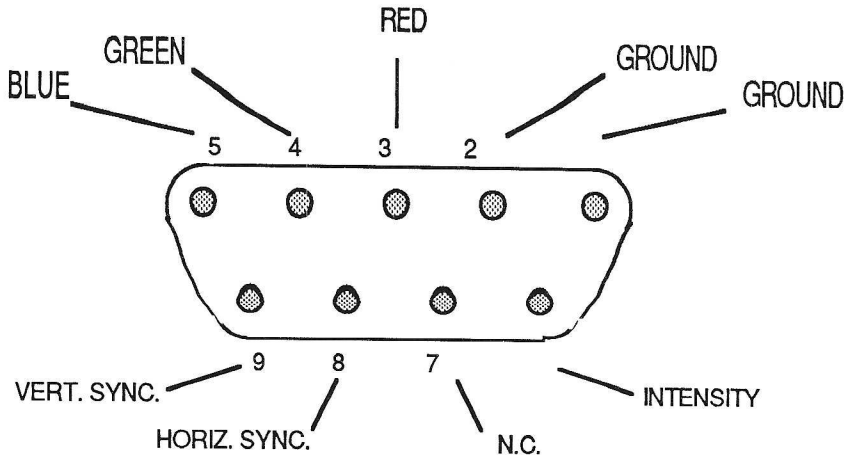
Appendix B: Using the RGB Extender From Assembly Language

In order to turn on the RGB extender from assembly language, the following instructions must be included in your program:

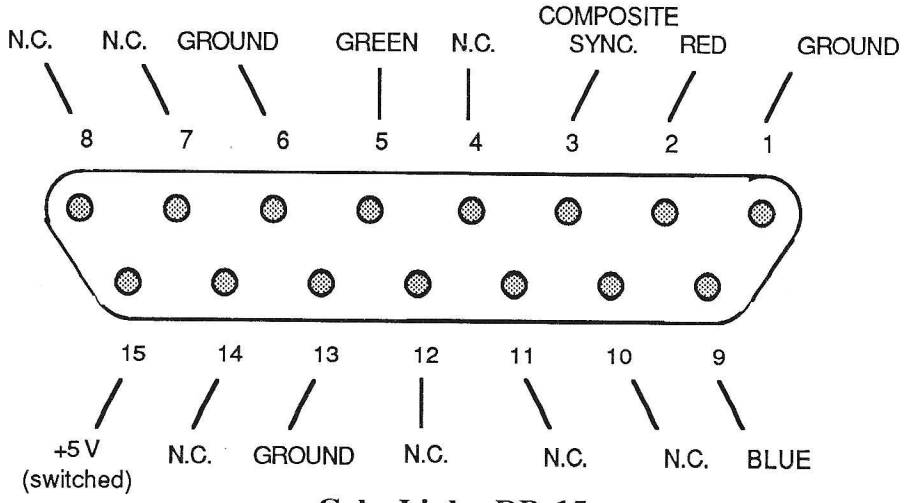
```
STA $C00D
LDA $C05E
LDA $C05F
LDA $C05E
LDA $C05F
LDA $C05E
```

These instructions must be used in this unbroken sequence. When this sequence of instructions has finished executing, the RGB card is turned on and will be using the Hi-Res display area to form an image on the RGB monitor.

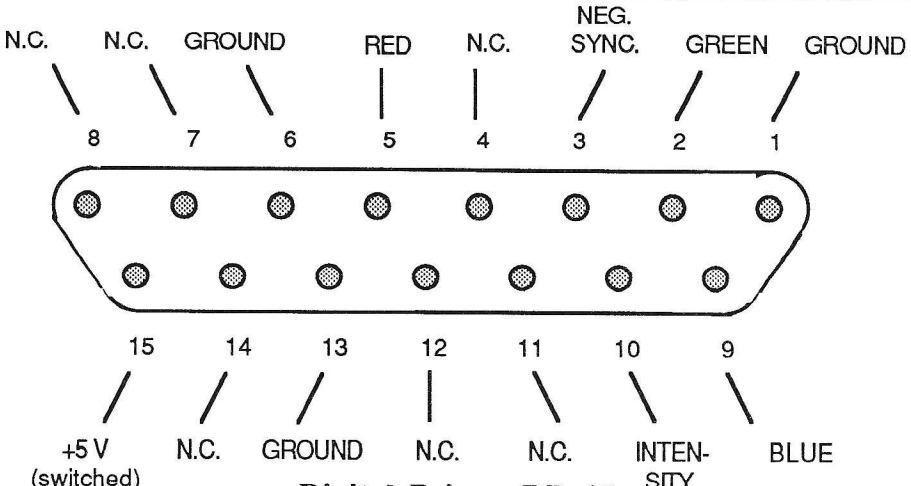
Appendix C: RGB Pinout Diagrams



ColorLink and Digital Prism DB 9
IBM Compatible Connector



ColorLink DB 15
Apple Compatible Analog Connector



Digital Prism DB 15
Apple Compatible Digital

TROUBLE SHOOTING

PROBLEM	SOLUTION
No image on the screen	Check and make sure that all cables are hooked up properly. Pay special attention to where the ribbon cable plugs into the header on the RGB card; make sure the cable points in the direction of the chips on the RGB card.
I get a syntax error when I use the RGB commands	Make sure that you have BRUN the file B.RGB.HIRES before you from BASIC try to use any of the ampersand commands. Also make sure you are using the commands with the correct parameters.
The screen flickers or rolls	Make sure that the cables are snuggly connected and that the horizontal and vertical hold on the RGB monitor are set to the proper positions.