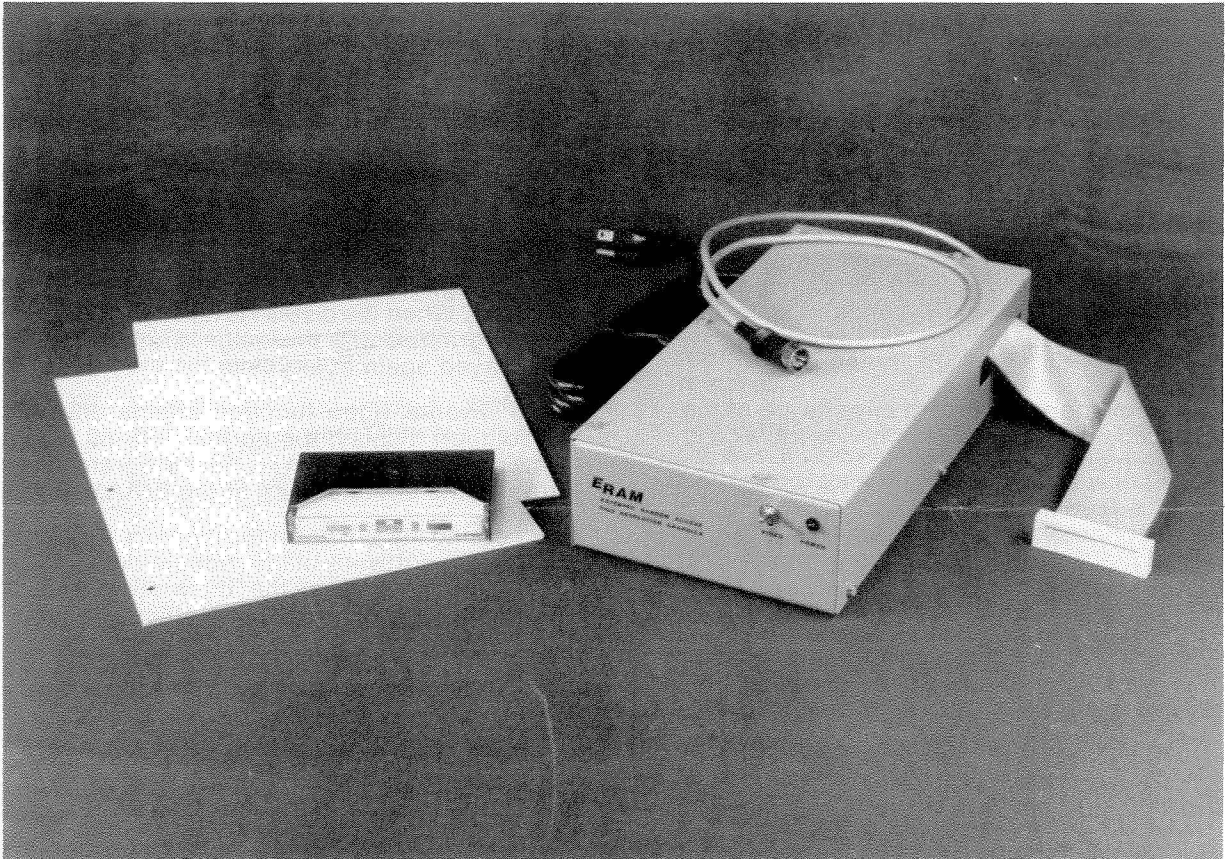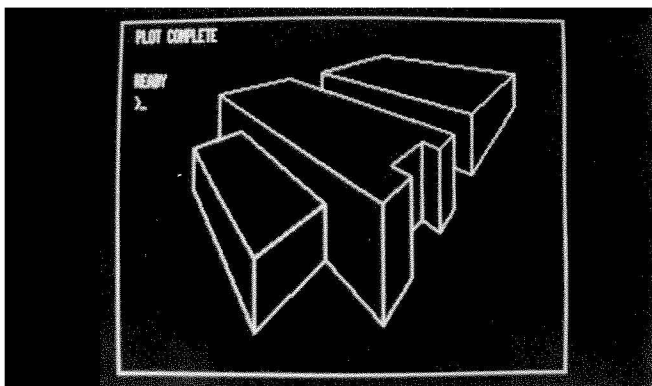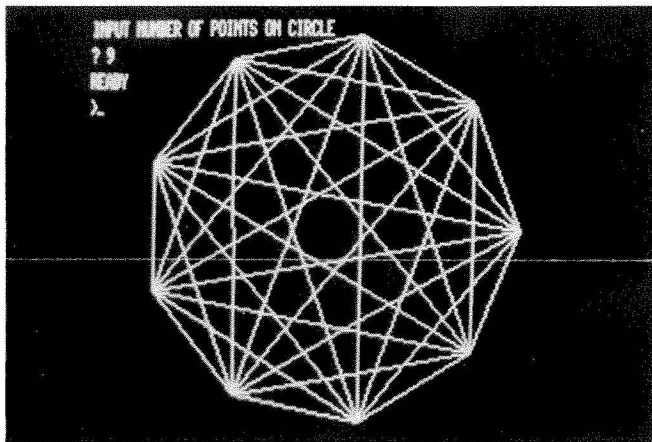# HIGH RESOLUTION GRAPHICS FOR TRS-80*

INTRODUCING E/RAM

A high performance professional graphics display system is now available for the TRS-80. Serious users of the remarkable TRS-80 Microcomputer System need no longer be hampered by a lack of high resolution graphics for their Level II machines. A system called "E/RAM" has been designed to be used directly with the TRS-80. E/RAM is a package consisting of plug-compatible hardware with companion software, which provides high speed, high resolution graphics functions.

The TRS-80 microcomputer is the most popular, most serviceable, most supported, and best documented personal sized computer on the market today. Engineers, scientists, educators, and other owners of the TRS-80 may now add the capability to create complex drawings directly on the TRS-80 video display. The resulting cost/performance ratio of this combination provides a truly remarkable computer graphics machine.

The E/RAM hardware is fully plug-compatible, requires no modifications to the TRS-80, uses the existing display monitor, and can be installed in minutes.

The E/RAM software is provided on cassette with its own relocating loader. The 825 byte graphics driver assembly language module may be loaded anywhere in memory that is convenient. The functions provided include provisions for clearing the screen, drawing lines at high speed, setting a point to off or on, reading a point on the screen, setting reverse video, or turning the display on or off.

HARDWARE DESCRIPTION

The E/RAM hardware was designed to be used directly with the TRS-80 microcomputer system. All necessary cables, connectors, and receptacles are provided, allowing easy connection to the TRS-80.

The unit is provided in a steel cabinet 2-1/2" high, 6" wide, and 12" deep. It contains its own transformer isolated, regulated power supply, so that no power is drawn from the TRS-80. A power on-off switch is included at the rear of the unit.

Only low power schottky integrated circuits are used on the high quality, plated-through printed circuit board. A gold plated 40-contact expansion card edge is provided for bus extension, so that other devices may be attached.

The dynamic memory integrated circuits are of the same type used in the TRS-80, to provide a low cost, reliable video memory.

INSTALLATION

The E/RAM hardware is plug compatible, can be installed in minutes, and requires no modifications to the TRS-80. The TRS-80 warranty is not affected.

The following simple procedure is performed to connect the E/RAM unit to any Model I, Level II TRS-80 system:

1. Remove power from the TRS-80.

2. Unplug the video cable from the TRS-80 keyboard.

3. Plug the video cable into the receptacle provided on the E/RAM unit.

4. Plug the video cable from the E/RAM unit into the video receptacle of the TRS-80 keyboard.

5. Connect the 40-pin flat ribbon cable connector from the E/RAM unit onto the expansion card edge connector of the TRS-80 keyboard or expansion interface.

6. Connect the power cable from the E/RAM unit to a wall outlet.

7. Restore power to the TRS-80 and turn the power switch on the E/RAM unit to "ON".

The entire installation procedure is given above to illustrate the ease of connecting E/RAM to any Model I TRS-80. If other devices are connected to the expansion card edge on a particular system, there is no problem, because E/RAM provides an expansion card edge, which simply extends the bus for the use of other devices.

OPERATION

E/RAM contains its own 6,144 byte video memory, which provides a 256 wide, by 192 high matrix display of independent graphic elements. The TRS-80 can address, set, or reset any of the 49,152 dots involved, to create complex images on the TRS-80 video monitor. These high resolution images are syncronized with the normal TRS-80 screen display and appear on the monitor with the normal TRS-80 video.

A switch is provided on the E/RAM unit to turn the high resolution graphics on or off. The appearance of the high resolution display is also under program control. When the display is turned off under manual or program control the image is retained and can be displayed again at any time.

The inverse video function affects only the high resolution display, the normal TRS-80 video is not inverted. This function is under program control and inverts the entire screen of the E/RAM display.

Accessing the E/RAM video memory should be done using the software utility module described below. This software does all the "bit twidling" necessary to draw lines, plot points, and otherwise control the display. However, all functions of the E/RAM hardware may be controlled directly from BASIC programs using the "POKE" and "INP" instructions. Operation of the interface between the TRS-80 and E/RAM is fully described in the Hardware User's Manual supplied with the unit.

Several switch options and adjustments are accessible when the cover is removed. An 8-position DIP switch is located on the printed circuit board which allows selection of different display widths, and vertical positions on the screen. Different port addresses may also be selected, if required. Potentiometers are also accessible for adjusting horizontal position and vertical stability. These switches and adjustments are factory preset and should normally not require changes. However, the Hardware User's Manual provides details on making these switch selections and adjustments.

SOFTWARE DESCRIPTION

The software provided with the E/RAM graphics system is a very powerful set of assembly language routines which are callable from BASIC, FORTRAN, and Assembly Language programs. They provide the primitive functions necessary to communicate with the E/RAM hardware without having to do "bit twidling".
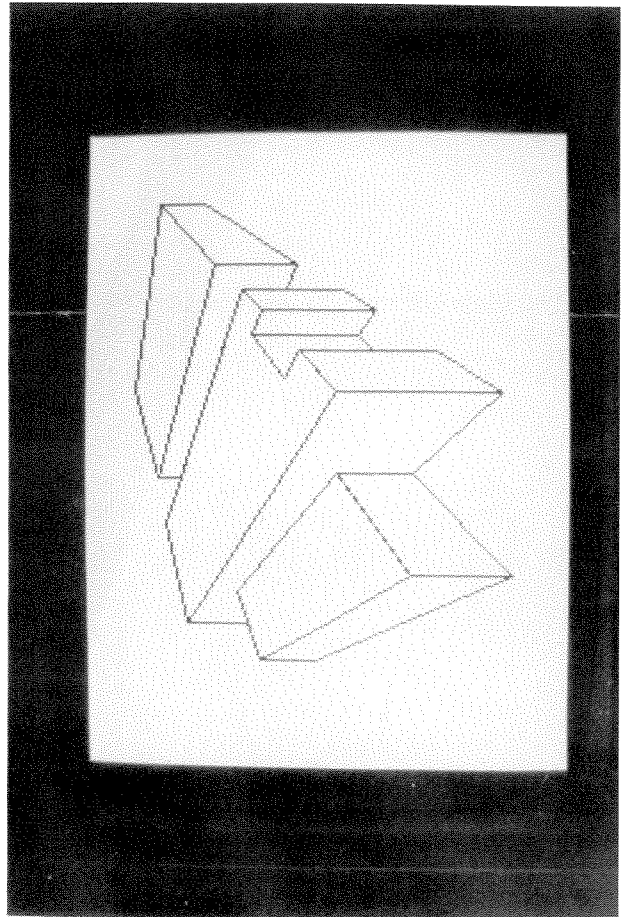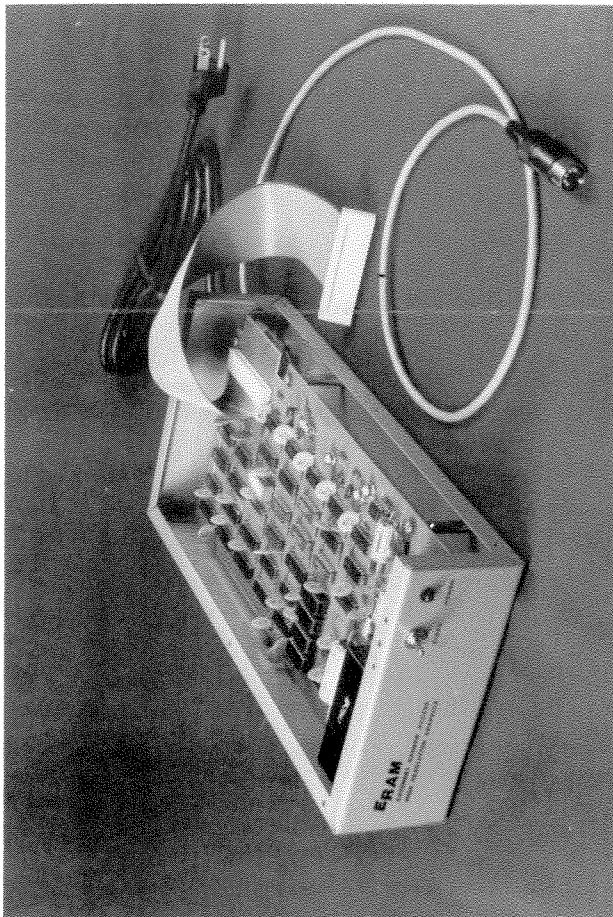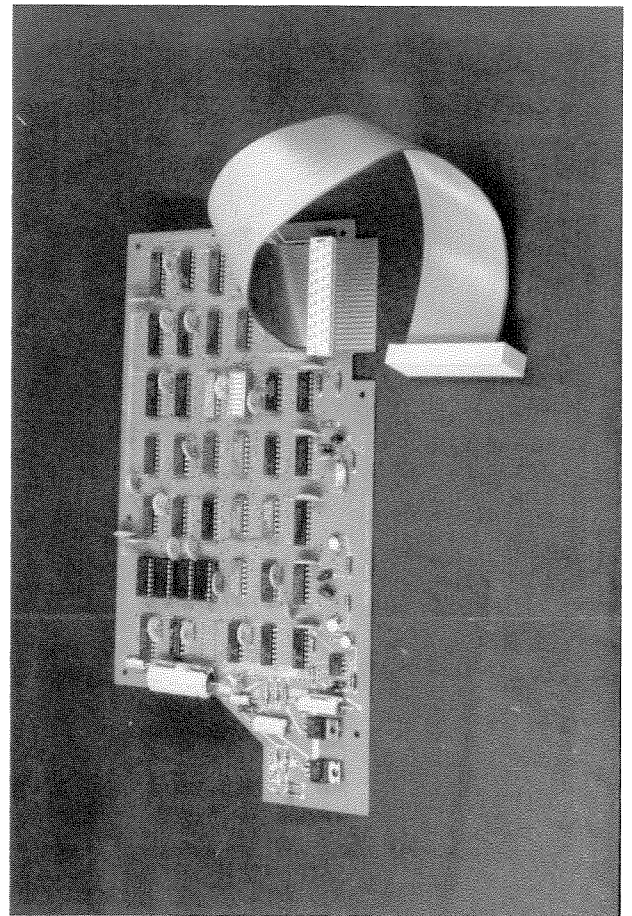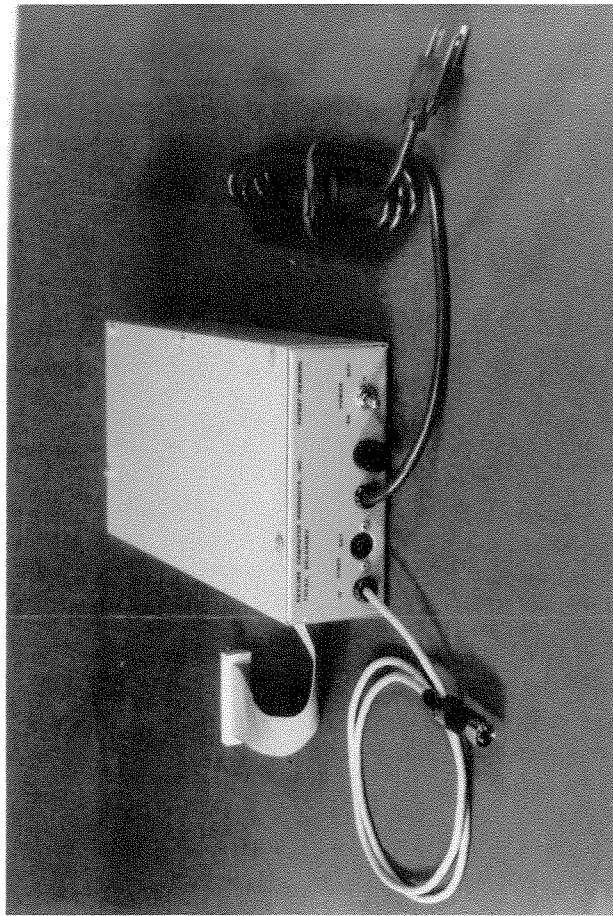
The functions provided include provisions for clearing the screen, setting reverse video, setting a point "on" or "off", reading a point, drawing a line, and setting the high resolution display "on" or "off".

The routines are provided on cassette in a relocatable form. Therefore they may be loaded into any desired RAM location to move them out of the way of other software products which may be in use.

The E/RAM Software User's Manual supplied with each unit gives full details on loading, setting up, and using the software with various TRS-80 configurations.

DESCRIPTION OF THE ROUTINES

The functions made available to the user are listed below. The number of the routine is used in USR calls to designate the corresponding routine:

NUMBER	FUNCTION
0	INIT - Initializes the graphics software package. Sets the X-Y values of the current and new positions to (0,0), the drawing mode to WHITE, video mode to NORMAL, and enables the display. The address of the Graphics Communications Area (GCA) is returned.
1	CLEAR -All positions in the video memory are set to zero (off).
2	WHITE - Sets the drawing mode to write as opposed to clear. Drawing in this mode sets points on in NORMAL video and off in REVERSE video.
3	BLACK - Sets the drawing mode to clear as opposed to write. Drawing in this mode sets points off in NORMAL video and on in REVERSE video.
4	REVERSE - Sets the hardware to reverse video.
5	NORMAL - Sets the hardware to normal video.
6	PLOT - Sets the point on the screen designated by the current position to on in the WHITE mode, or off in the BLACK mode.
7	READ - Reads a point on the screen corresponding to the current position coordinate values. If the point is set, a "1" is returned. If reset, a "0" is returned.
8	LINE - Draws a line on the display from the current position to the new position, then replaces the current position with the new position value.
9	INHIBIT - Causes the display to be blanked from the screen. The video memory is not disturbed.
10	SHOW - Causes the display to appear (opposite of 9).

LOADING THE ROUTINES

Loading the E/RAM graphics module is a simple matter. As an example, when a Model I, Level II, 16K machine is powered up, and the question:

MEMORY SIZE? ____

appears on the screen, the user would type in 31942, in order to reserve 825 bytes of memory above BASIC.

The user would then "CLOAD" and "RUN" the program from the cassette supplied with the unit. When the program is started, a question mark appears on the screen. The relocating loader is requesting the starting location desired.

The user in this example would then type in 31943, and the program would continue running. When the load is complete, the message "LOAD ENDED" appears.

After the load operation is complete, a program may be written which accesses the routines by making use of the BASIC USR function. For the machine in the example, the following BASIC instructions would be executed to set up the USR function:

POKE 16526, 199
POKE 16527, 124

The user would then be able to "CALL" the graphics functions desired by the BASIC USR instruction in the form:

R=USR (routine number)

where the "Routine number" is a number corresponding to a routine in the graphics module. The value supplied to the variable "R" is used to return information from the graphics routines as required.

The loading procedure for configurations other than the one in the example is explained fully in E/RAM Software User's Manual supplied with the unit. The TRS-80 BASIC Reference Manual also supplies more details about reserving memory, and using the USR function.

USING THE ROUTINES

The display format consists of 256 columns and 192 rows of dots or points which can be turned on or off to form graphic images. The columns are assigned X values of from 0 to 255, and the rows are assigned Y values of from 0 to 191, when communicating with the E/RAM graphics package. The zero values of both X and Y are located in the upper left of the display.

Before X-Y coordinates can be given to the graphics routine, the address of the Graphics Communications Area (GCA) must be obtained with a function "0" USR call. For example, if U=USR(0) is executed, the variable U will contain the address of the GCA.

Once the GCA address is obtained, the X-Y values of the current and new positions can be given to the graphics module by using the "POKE" instruction with fixed offsets. These offsets are defined as follows:

OFFSET	USE
+6	Current X
+8	Current Y
+10	New X
+12	New Y

The following program is an example of plotting a point and drawing a line:

```
10 POKE 16526,199  SET UP THE USER FUNCTION
20 POKE 16527,124
30 U=USR(0)        INIT AND RETURN THE GCA
40 POKE U+6,100    SET CURRENT X VALUE
50 POKE U+8,100    SET CURRENT Y VALUE
60 P=USR(6)        PLOT THE POINT
```

The point at location (100,100) is turned "on". To draw a line from this point to location (50,50) the program would continue:

```
70 POKE U+10,50    SET THE NEW X VALUE
80 POKE U+12,50    SET THE NEW Y VALUE
90 L=USR(8)        DRAW THE LINE
```

SERVICE

Factory service is available should the E/RAM graphics hardware ever require repair. A 90-day parts and labor warranty is given with each unit. A service manual containing a theory of operations section, logic diagrams, and parts list is available to E/RAM owners, and may be purchased separately.

E/RAM SPECIFICATIONS

TYPE OF GRAPHICS: Video raster scan dot-matrix. **OUTPUT:** Syncronized video, added to external source, (American standard non-interlaced). **RESOLUTION:** 256 columns by 192 rows of graphic elements. **EXTERNAL CONTROLS:** Video ON/OFF switch and power ON/OFF switch. **INTERNAL CONTROLS:** DIP switches to select vertical position, horizontal width, and port address. Potentiometers to adjust vertical stability, horizontal centering, and system clock. **CABLING:** One DIN receptacle for video output. One DIN plug with 3-conductor cable, 3' long, for video input. One 12" 40-conductor flat cable with female card edge connector for address, data, and control signals. One 40-contact card edge connector for expansion. **POWER REQUIREMENTS:** 120 VAC, 50/60 HZ. **SIZE:** 2-1/2" high, 6" wide, 12" deep.

PRICES

The complete E/RAM package is available for $349.95, and includes case, power supply, cables, software cassette, and complete documentation for user's.

The set of hardware and software user's manuals supplied with the unit is available for $10.00, which is applicable toward the purchase of the E/RAM package.

The E/RAM Hardware Service Manual, containing a theory of operation section, parts list, logic diagrams and schematics is available for $15.00.

An E/RAM Systems Programmer's Guide should become available soon. Contact your dealer for information.

DELIVERY

Contact your dealer for current delivery information.

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