APRIL 15, 1986/$15.00

Spring Peripherals Handbook

Mini-Micro Systems
THE MAGAZINE FOR COMPUTER SYSTEMS INTEGRATION
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Problem-Solving Handbook

Product Reference File

SECOND APRIL ISSUE

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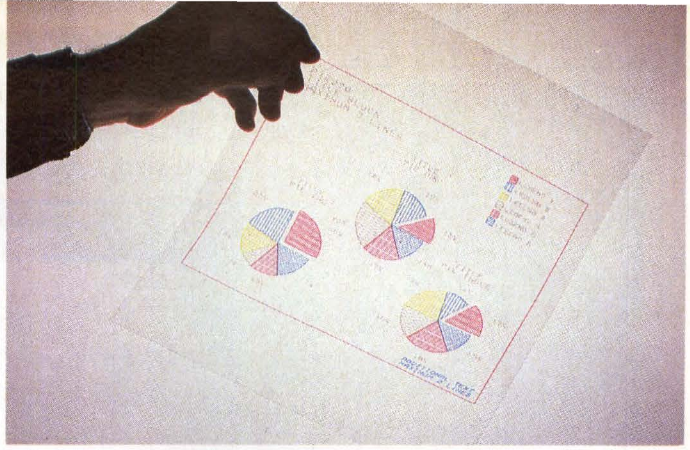

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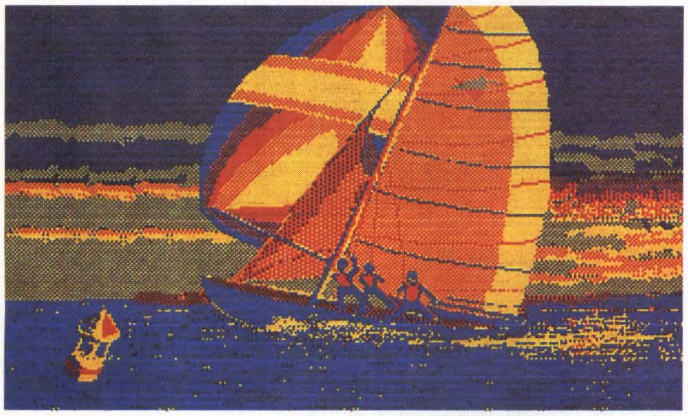
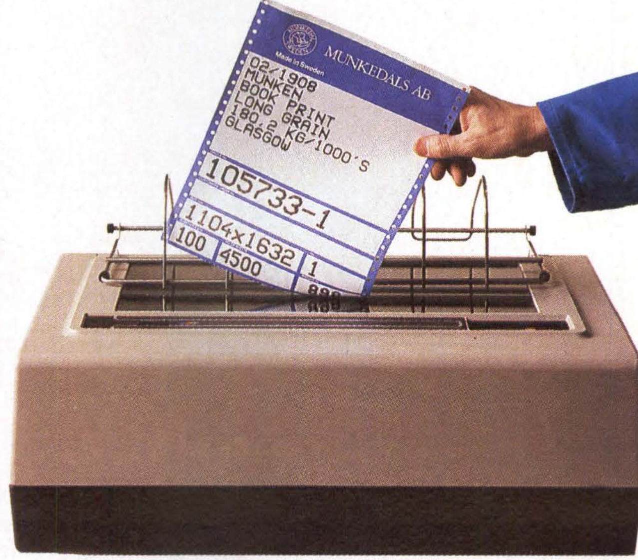


The 148-column width gives you full color pictures from your screen dumps and CAD systems.



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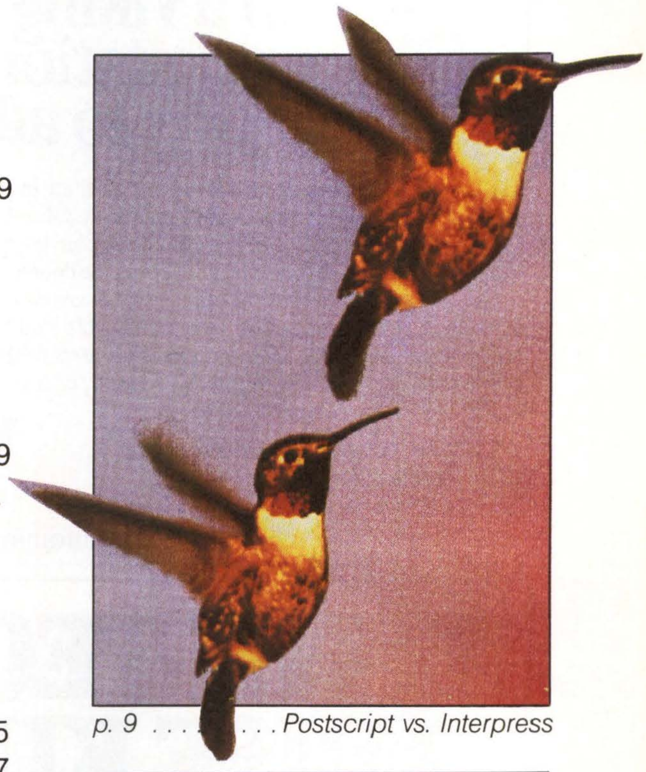
PRODUCT GUIDES

DEPARTMENTS



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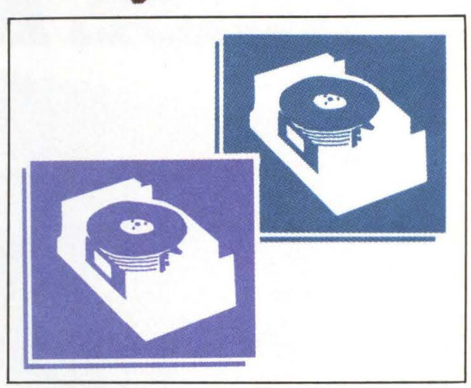

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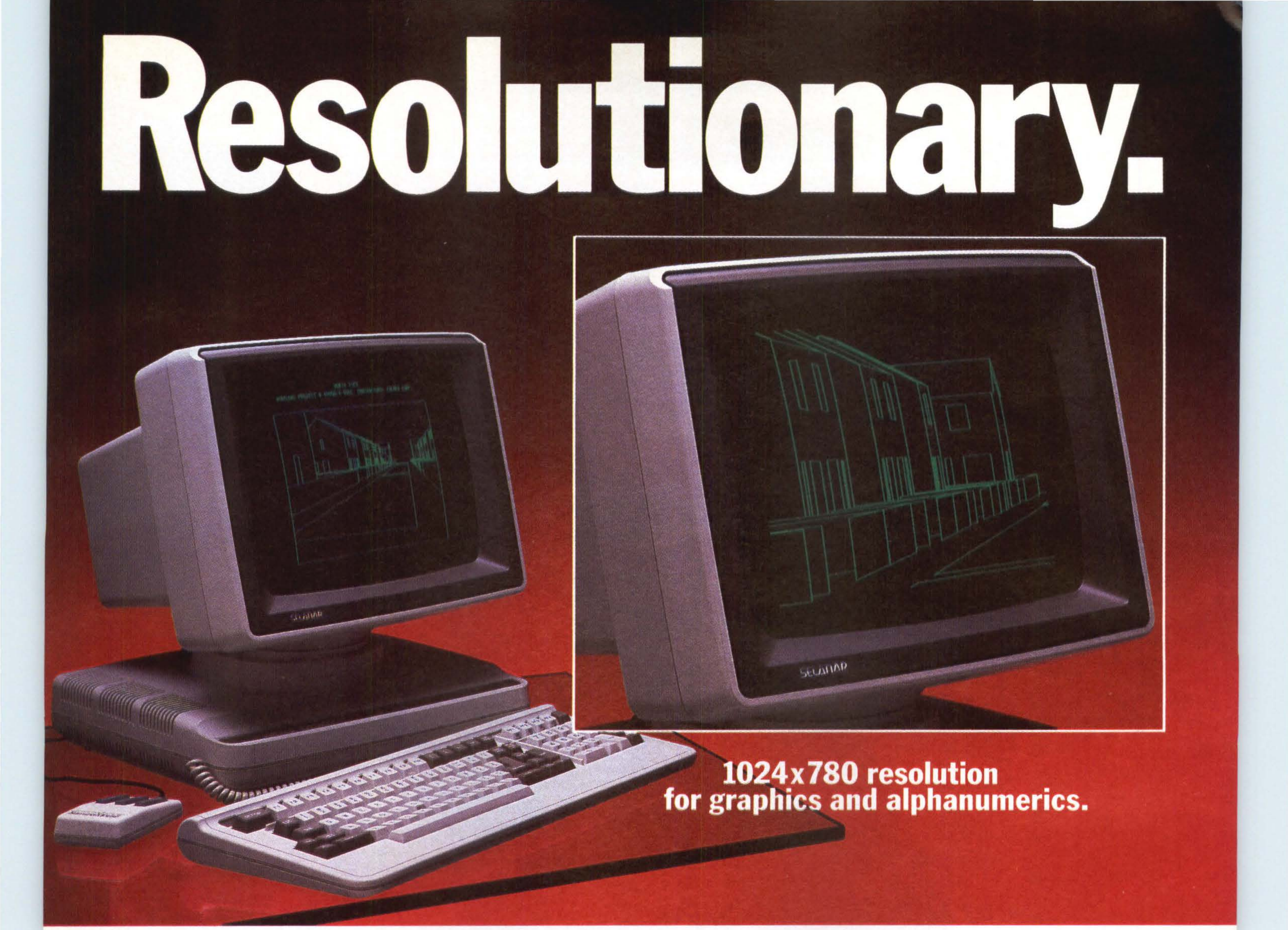

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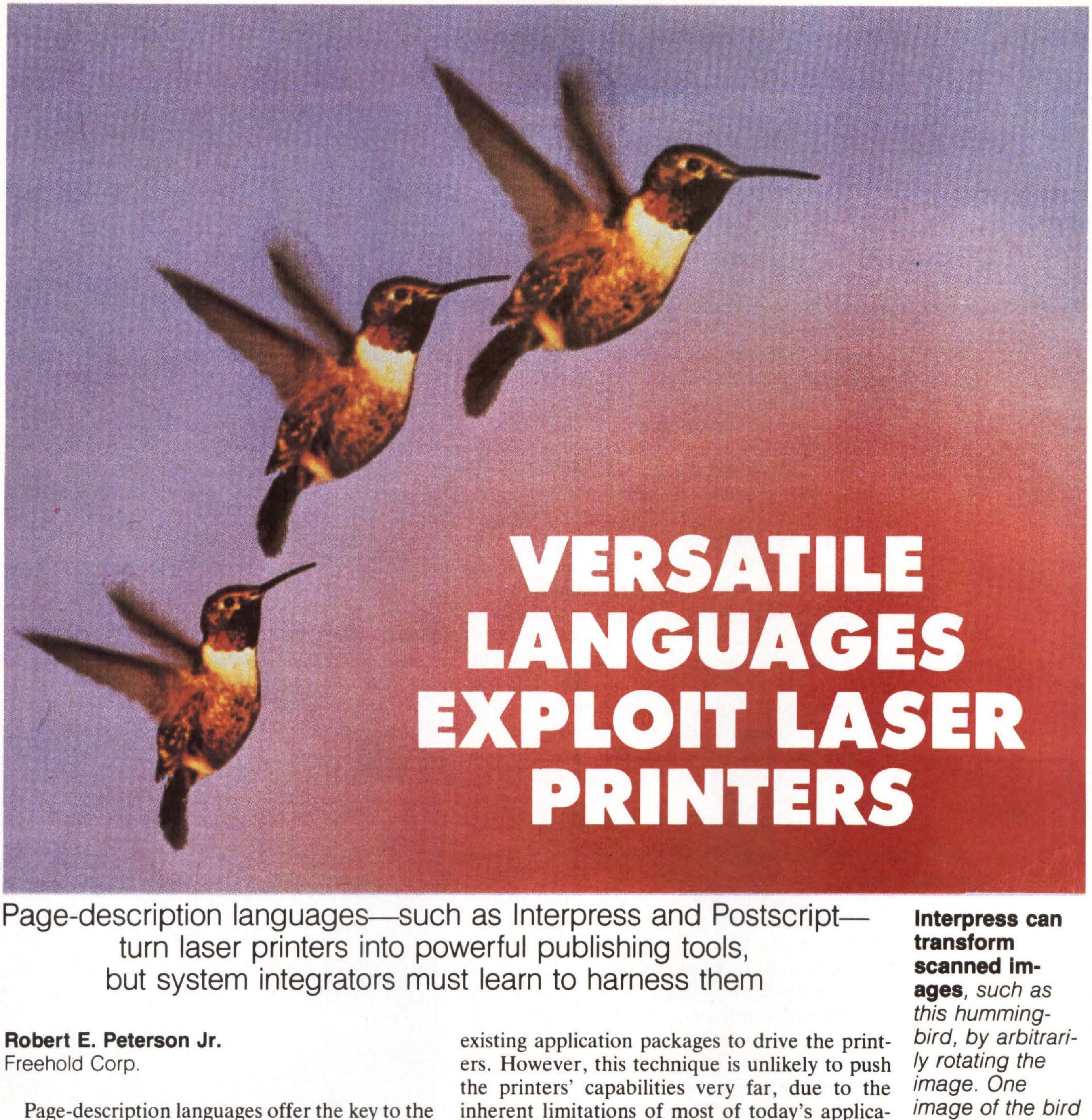


VERSATILE LANGUAGES EXPLOIT LASER PRINTERS

Interpress can transform scanned images, *such as this hummingbird, by arbitrarily rotating the image. One image of the bird has been scaled and rotated to create all three, while the background was added graphically.*

Page-description languages—such as Interpress and Postscript—turn laser printers into powerful publishing tools, but system integrators must learn to harness them

Robert E. Peterson Jr.
Freehold Corp.

Page-description languages offer the key to the power and versatility of laser printers and other high-resolution hard-copy devices. By learning how to use the languages, system integrators obtain control of a dazzling array of printing capabilities.

The power to manipulate a printer's output has traditionally rested in the hands of applications developers. And these developers will eventually offer many programs to take full advantage of the 300 or more dots per inch (dpi) available from laser printers. For the time being, however, users will find few such applications on computer store shelves.

System integrators are responsible for enabling users to tap the laser printers' power. You can do this in two ways. The simplest is to adapt existing application packages to drive the printers. However, this technique is unlikely to push the printers' capabilities very far, due to the inherent limitations of most of today's applications.

A more versatile method is to create software tools that give users easy access to the power of page-description languages. This approach essentially forces you to take on the job of applications programming, but the effort can pay off for markets that require powerful graphics and/or typographical functions.

Bear in mind that page-description languages aren't well-suited for end users. The languages should be thought of as a formalized set of printer interface commands rather than general-purpose programming languages. You can write programs in a page-description language very much as you would any high-level programming language, but that is not necessarily the most

System integrators can help users tap laser printers' power.

efficient way to generate page images.

The philosophies behind the two major page-description languages now available differ greatly in their allowances for direct programming. Postscript, from Adobe Systems Inc., Palo Alto, Calif., permits you to write graphics-producing programs with about the same effort as writing a BASIC or Pascal program. Interpress, from Xerox Systems Institute, Palo Alto, on the other hand, embodies the attitude that an application program should take responsibility for generating graphics, and the page-description language should concentrate on translating those graphics efficiently into a form printers can deal with.

These differences and others make the two languages difficult to compare directly. However, this article employs examples of direct graphics coding to demonstrate how the languages work. It is crucial to bear in mind that the code presented here does not truly indicate how you would use Interpress to build a system. The code simply shows the concept behind the language. In any case, this article does not endeavor to prove one language more powerful than another. The goal here is to demonstrate how the page-description languages work, and to outline some of their major differences in purpose.

There are also important differences in how the two companies market their languages. Adobe manufactures no printers but adapts Postscript to other concerns' machines for a fee and collects royalties for every Postscript-using printer sold. Xerox, in contrast, has placed Interpress in the public domain so that any manufacturer can implement the language in any printer at no cost for the language. Xerox also uses Interpress in its own printers.

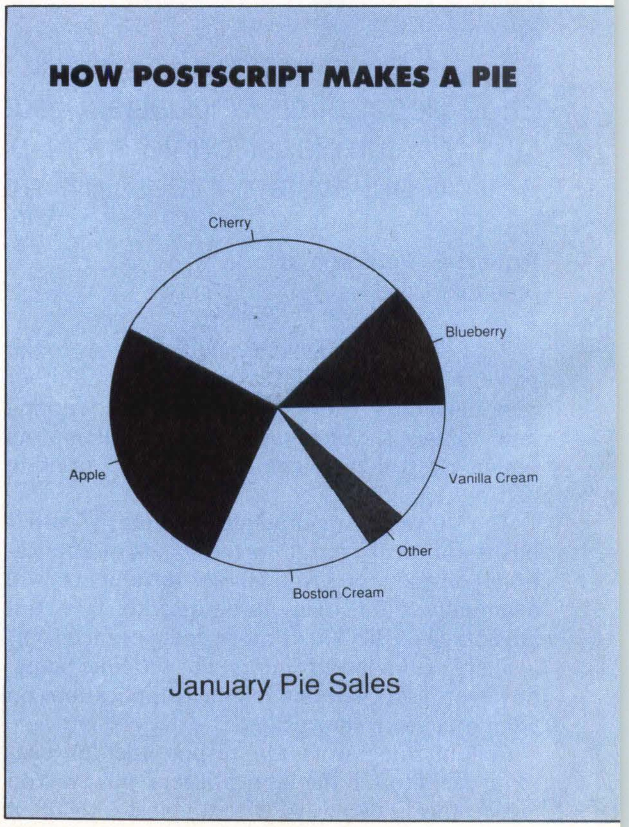
Adobe has implemented Postscript in several manufacturers' printers, including Apple Computer Inc.'s Laserwriter. Further, Adobe says it will implement the language for two dozen more output devices this year. So far, Xerox's Interpress is available only in Xerox printers, but even these machines do not yet offer the entire Interpress command set. Xerox reports, though, that several vendors have promised printers and/or systems that incorporate Interpress. The vendors include Burroughs Corp., Dataproducts Corp., Digital Equipment Corp., Imagen Corp. and Siemens Information Systems Inc.

Will Postscript's current lead in the market result in the language's establishment as the de facto standard? Maybe not. In this case, both Postscript and Interpress could be accepted as standards due to their philosophic differences.

The differences between the two languages grow out of the assumptions that underlie their projected use. Xerox assumes that most of the work done on high-resolution printers involves mostly text and must be produced rapidly. Monthly phone bills are an example of this type of application. While typical pages might include the local phone company's logo, some dividing lines and several sizes of typography, the primary goal is to print two or three pages per second. In this view, printer overhead must be kept to a minimum so the printer can run as fast as possible.

Adobe, on the other hand, is more concerned about overhead on the computer than on the printer. In fact, Adobe's approach places a great deal of the computational burden on the printer so as to off-load the host. This approach also stems from the company's belief that the same file should be able to drive different output devices—a 300-dpi laser printer or a 1,250-dpi typesetting machine, for example—without the host knowing the peripherals' capabilities. Any differences among the output devices should be

Fig. 1. Generating a basic pie chart *illustrates some of the functions of a page-description language. This image was printed on Linotype's Linotron 100 with a resolution of 1,270 dots per inch. Adobe Systems' Postscript code for producing the image illustrates how this language can integrate text and graphics.*



resolved within the devices and not in the host. If a document calls for a font that is not available in the target Postscript printer, for instance, the printer decides which available font will serve as a suitable substitute.

These philosophical differences derive from the two companies' primary markets. While Xerox's stable of printers includes the giant Model 9700, which produces pages at the blinding rate of 120 per minute, the fastest Adobe target printers run at 26 pages per minute. Xerox contends that, at the higher rates, printers cannot afford the time to handle much overhead; the documents to be printed should be prepared appropriately by the creating device.

Other contrasts between the two languages take an interesting twist when it comes to describing entire documents in addition to single pages. Xerox's customer base forces the company to pay attention to issues such as how a document will be bound (you can specify that a document is to be stapled, for instance) and in what order the pages will be printed. (Printing on both sides of each page, for example, might be expedited in a large printer by printing one side of several pages before cycling them back through to print the other side, or a printer might need to print pages in reverse order to stack them correctly). The latter consideration prompted Xerox to specify that every page described by Interpress must be independent.

Postscript allows page independence, but does not enforce it; a page can derive parameters, such as the specifications for a coordinate system, from other pages. The "other pages" are assumed to be previous pages so that the printer will have received the appropriate parameters. If that document goes to a printer that produces the pages out of order, though, the effort will fail.

How Postscript works

In addition to deciphering the philosophical issues, you must understand how page-description languages deal with typography, graphics and scanned images. The example of pie-chart generation (Fig. 1), involving both text and graphics demonstrates basic page-description language concepts.

The Postscript coding appears in three routines that construct individual pie slices, calculate the gray shade for each slice and then put the slices together. The program begins by allocating storage space in the printer for the necessary procedures. As with all Postscript routines, round brackets open and close the routine that constructs the slices. The routine, DrawSlice, also contains other information delimited by round brackets. It begins by specifying its four operands: the slice's label, starting angle, ending

```
/PieDict 24 dict def
PieDict begin
 /DrawSlice
  { /grayshade exch def
    /endangle exch def
    /startangle exch def
    /thelabel exch def

    newpath  0 0 moveto
      0 0 radius startangle endangle arc
    closepath
    1.415 setmiterlimit


    gsave
      grayshade setgray
      fill
    grestore
    stroke
    gsave
      startangle endangle add 2 div rotate

      radius 0 translate
      newpath
        0 0 moveto labelps .8 mul 0 lineto stroke
      labelps 0 translate
        0 0 transform
    grestore
    itransform
    /y exch def /x exch def
    x y moveto
    x 0 lt
      { thelabel stringwidth pop neg 0 rmoveto }
      if
    y 0 lt { 0 labelps neg rmoveto } if
    thelabel show
  } def

(January Pie Sales) 24 12
 [ [(Blueberry) .12 ]
   [(Cherry) .30 ]
   [(Apple) .26 ]
   [(Boston Cream) .16 ]
   [(Other) .04 ]
   [(Vanilla Cream) .12 ]
 ] 306 396 140 DrawPieChart
showpage


 /findgray
   { /i exch def /n exch def
     i 2 mod 0 eq
       { i 2 div n 2 div round add n div }
       { i 1 add 2 div n div }
       ifelse
   } def
end


/DrawPieChart
 { PieDict begin
    /radius exch def
    /ycenter exch def /xcenter exch def
    /PieArray exch def
    /labelps exch def /titleps exch def
    /title exch def

    gsave
      xcenter ycenter translate

      /Helvetica findfont titleps scalefont setfont
      title stringwidth pop 2 div neg radius neg
        titleps 3 mul sub moveto
      title show
      /Helvetica findfont labelps scalefont setfont
      /numslices PieArray length def
      /slicecnt 0 def
      /curangle 0 def

      PieArray

        { /slicearray exch def
          slicearray aload pop
          /percent exch def
          /label exch def
          /perangle percent 360 mul def
          /slicecnt slicecnt 1 add def
          label curangle curangle perangle add
            numslices slicecnt findgray DrawSlice
          /curangle curangle perangle add def
        } forall
      grestore
    end
 } def
```

Consider the languages as a formalized set of printer interface commands rather than general-purpose programming languages.

angle and gray shade. Later, the pie-drawing routine, DrawPieChart, specifies its operands as the pie's title, the title's point size, the slice labels' point size, an array containing slice sizes and names, the pie's X-Y center and the pie's radius.

The next small section of code, beginning with "newpath," creates a path in the shape of a pie slice. Once you have created such a path to define a shape, you can fill the shape and/or draw its outline. The Postscript operator used to create the slice's path is "arc." Starting from the origin (0,0), this command uses operands "radius," "startangle" and "endangle" to make a line segment as long as the value defined for the operand radius and to extend an arc across the angle specified by startangle and endangle. The operand "closepath" then creates the line segment needed to complete the slice. Finally, "setmiterlimit" prevents spikes from occurring on the slice's interior angles when the slice is outlined.

Next, the program fills the slice with the appropriate gray shade. First, though, you must save the current path with "gsave." After filling the slice, you restore its path and use "stroke" to outline the path.

The rest of DrawSlice draws the slice's label and its accompanying tick mark. To find the correct place for the label and tick mark, the "rotate" operator finds the center of the slice's arc and rotates Postscript's coordinate system counterclockwise so that the X axis coincides with the arc's center. "Translate" then shifts the origin out to the arc's center.

From this point, you can create the path that will be the tick mark. Because the coordinate system has been rotated and translated, you simply start at the origin (using "moveto") and make the tick mark 80 percent of the label's point size in length. The "stroke" operator places the tick mark on the X axis extending from the origin in a positive direction.

You can place the slice's label at the current origin, but, in the rotated coordinate system, the label would also come out rotated. Thus, you want to return to the previous unrotated system. Before doing that, however, you must save the rotated system. Using the operator "transform" on the rotated origin pushes the coordinates of the origin in device space onto Postscript's operand stack. Operand "grestore" returns you to the previous unrotated coordinate system, and "itransform" determines where the coordinates on the stack are in the current coordinate system. These coordinates are defined as Y and X.

Finally, some adjustments are made so that the label doesn't collide with the pie slice. Part of this procedure employs the "lt" operator, which returns the Boolean value "true" if the first operand from the stack is less than the second and "false" otherwise. Given the coordinates involved and the length of the label, Postscript thus determines where to place the label.

The rest of the pie-chart-generating program continues in the same vein. There are a few other interesting procedures, however. Note in the middle of the routine DrawPieChart, for instance, that Helvetica has been specified for

```
-- Things between double dashes are comments --
-- Source File: Pie.interpress --

BEGIN
-- Preamble -- {
    Xerox xcl-1-1 Modern-bold 3 MAKEVEC FINDFONT
    10 SCALE MODIFYFONT 0 FSET
    Xerox xcl-1-1 Modern-bold 3 MAKEVEC FINDFONT
    20 SCALE MODIFYFONT 1 FSET
    }
-- Page 1 -- {
    1 5 --priorityImportant-- ISET

-- Set up transformation --
    31/87874 SCALE CONCATT
        -- work in units of 72 to the inch --
    306 396 TRANSLATE CONCATT
        -- origin at center of page --

-- Do the filled segments --
    4/5 SETGRAY
    0 0 MOVETO 100 LINETOX
    16643/179 74987/2037 9185/126 34022/497 ARCTO
    1 MAKEOUTLINE MASKFILL
    3/5 SETGRAY
    0 0 MOVETO 9185/126 34022/497 LINETO
    -16005/1277 27680/279 -15423/176 10165/211 ARCTO
    1 MAKEOUTLINE MASKFILL
    2/5 SETGRAY
    0 0 MOVETO -15423/176 10165/211 LINETO
    -13505/142 -7231/234 -6557/154 -65419/723 ARCTO
    1 MAKEOUTLINE MASKFILL
    3/10 SETGRAY
    0 0 MOVETO -6557/154 -65419/723 LINETO
    9293/1480 -29841/299 6805/127 -20095/238 ARCTO
    1 MAKEOUTLINE MASKFILL
    7/10 SETGRAY
    0 0 MOVETO 6805/127 -20095/238 LINETO
    4207/66 -46539/604 16256/223 -37034/541 ARCTO
    1 MAKEOUTLINE MASKFILL
    0 SETGRAY
    0 0 MOVETO 16256/223 -37034/541 LINETO
    16643/179 -50249/1365 100 0 ARCTO
    1 MAKEOUTLINE MASKFILL
```

Fig. 2. The Interpress code *for producing Fig. 1 takes a different tack than that employed in the Postscript version. The code shown here is a human-readable form of the real Interpress token sequence, which consists of hexadecimal values only.*

both the title of the chart and the slice labels. You can just as easily specify any other of the 13 fonts available in Postscript printers. (The number of possible fonts has recently been expanded by 45.) This doesn't mean that every Postscript printer will have all the fonts, but the printer will automatically make a substitution if your choice is not currently resident.

Note, too, that the array at the program's end is actually an array of arrays containing the labels and size percentages for the slices. Another part of the program (starting with "/perangle") converts the percentages into degrees of angle. This portion of Postscript performs general-purpose math, as does the procedure described earlier that locates the middle of a slice's arc. Further, the routine "findgray" selects gray shades for each slice so that no adjacent slices have the same shade. Other procedures in the program—such as the one that uses "lt" to help position the slice labels—employ logical operators.

These computational features are absent from Interpress because Xerox believes that such operations should be handled by a page's creator. Avoiding this overhead on the printer allows it to run faster. One of the prices you pay for this speed is the inability to write an Interpress program that will, say, choose the slices' gray shades for the user. (Of course, Xerox never intended for you to write programs in Interpress anyway.) If you want to automatically choose gray shades, you must construct an application program that will do it, then pass the results to the printer in Interpress code.

Both Postscript and Interpress might be accepted as standards due to their philosophic differences.

```
-- Do the short lines pointing to the text --
   1 SETGRAY -- black color --
   2 15 --strokeWidth-- ISET
   2 16 --strokeEnd-- ISET
   16643/179 74987/2037 31194/305 9678/239
    MASKVECTOR
   -16005/1277 27680/279 -3295/239 10695/98
    MASKVECTOR
   -13505/142 -7231/234 -19354/185 -4181/123
    MASKVECTOR
   9293/1480 -29841/299 9131/1322 -14162/129
    MASKVECTOR
   4207/66 -46539/604 4207/60 -22969/271
    MASKVECTOR
   16643/179 -50249/1365 24137/236 -16076/397
    MASKVECTOR

-- Do the lines between sectors --
   0 0 100 0 MASKVECTOR
   0 0 9185/126 34022/497 MASKVECTOR
   0 0 -15423/176 10165/211 MASKVECTOR
   0 0 -6557/154 -65419/723 MASKVECTOR
   0 0 6805/127 -20095/238 MASKVECTOR
   0 0 16256/223 -37034/541 MASKVECTOR

-- Do the circular outline --
   100 0 MOVETO -100 0 100 0 ARCTO
    MASKSTROKECLOSED

-- Do the text --
   0 SETFONT
   33895/317 13928/329 SETXY <Blueberry> SHOW
   -49485/1087 13463/118 SETXY <Cherry> SHOW
   -9189/67 -11703/257 SETXY <Apple> SHOW
   4282/593 -17593/141 SETXY <Boston Cream> SHOW
   27269/372 -13115/133 SETXY <Other> SHOW
   26838/251 -17532/335 SETXY <Vanilla Creme> SHOW
   1 SETFONT -710/9 -160 SETXY <January Pie Sales>
    SHOW
   }

END

-- 966 Bytes --
-- no Errors, no Warnings--
```

How Interpress works

A "written encoding" form of an Interpress program (Fig. 2) that generates the same pie chart shown in Fig. 1 differs greatly from the Postscript coding. The form of the code that an Interpress printer expects to see is a sequence of hexadecimal values. Unlike Postscript, which employs operators and operands made up of ASCII characters, Interpress operators and operands are made up of tokens. Each numerical token represents a command. One of the values of this approach is that you can send tokens to a printer much faster than you can send ASCII-based words.

Because Interpress is not designed for direct coding, the program shown in Fig. 2 is a brute-force method. For example, the code specifies the coordinates to follow in drawing the complete six-piece pie chart. If the user wants to create a seven-piece pie, for instance, the program would have to be significantly modified.

As noted earlier, one approach to using a page-description language is to design an application program that interfaces between the user and the language. This method is particularly appropriate in Interpress' case. The application would essentially be a program that generated another program in Interpress and would also display the desired image on a screen. You can do this with an existing application, but translating it to the page-description language is likely to be clumsy, despite Interpress' versatility.

Along the same lines, when you use a page-description language to code an image directly, you have no guarantee that the user's display system will graphically show what the image looks like—unless you make specific provisions for translating the page-description language code to a form the display system understands. Without this translation, you must write the code and print it to see what you made.

Fig. 3. Color can be specified *in both Postscript and Interpress. This Interpress image was created and produced on a commercially unavailable Xerox printer, but it shows transformation capabilities you can take advantage of now, as well as color capabilities you can plan for the future.*

There are a number of important points to notice in the Interpress coding. First, in the Preamble, you define the fonts you want to use and their sizes. The operator "MAKEVEC" makes a vector out of the character strings represented by each font. It's interesting to note, too, that Interpress not only provides different fonts for the Roman alphabet (the characters you're reading now are from the Roman alphabet), but also furnishes a way to represent every character in every major language. Interpress assigns a 16-bit code to each character in languages such as Chinese and the katakana representation of Japanese.

In the section that handles the creation and filling of the pie, the "SETGRAY" operators do just what they purport to do based on the specific operands given for each pie slice. The "MOVETO" and "LINETO" operators work as they do on a pen plotter: the former moves to a set of coordinates, and the latter draws lines between coordinates.

The operators "MASKFILL" and "MASKVECTOR" rely on an Interpress concept of how marks are placed on a page. For an area fill or outline, Interpress pushes a mark through the defined pattern onto the page. The pattern can represent a line, a shape or a set of typographic characters, and the mark can be solid black, a gray shade or a color.

This program was written in the recently released Interpress version 3.0. However, the only operator used in this program that has not been available in version 2.1 is "ARCTO." This operator draws an arc through the coordinates given. In addition to this capability, version 3.0 incorporates features such as dashed lines and outlined (rather than bit mapped) fonts. The latter permits more flexibility in transformations.

Get ready to add color

Using Interpress, you can manipulate characters as well as use multiple colors (Fig. 3). The characters used in the figure were created especially for this example, but you could do the same manipulations using a standard font. As with many dazzling Xerox products, you can't buy the printer that produced this image; the machine is at the Xerox Palo Alto Research Center (PARC). But the Interpress provisions are in place to handle color when printer manufacturers, including Xerox, are ready to market machines based on page-description languages.

Color introduces some new challenges to page-description languages that will take some careful definitions to work out. One issue is whether the printer should produce "artificial" colors, such as you might see in silk-screened art, or photographic colors (see figure on first page of article). This consideration can be summed up in the question: What color do you mean when you say "green?" Although the figure was also generated on a Xerox PARC machine that you can't buy, it shows how a scanned four-color image can be scaled (only one hummingbird image was used to create all three birds in the image) and arbitrarily rotated. A straightforward algorithm handles the transformation from the page's orthogonal coordinate system.

A more immediate event to look forward to than color availability is the implementation of the full Interpress command set. With the introduction of version 3.0, Xerox divided Interpress into three Sets to meet the requirements of different printing applications. The Commercial Set handles text, fonts and scanned images; the Publication Set adds some features that help produce office and technical publications; and the Professional Graphics Set includes the gray-scale elements for process color, rotation of text and graphics at any angle and image clipping in any shape. So far, Xerox has implemented only the Commercial Set, but it has plans to introduce the other two Sets later this year or early next year.

Some critics have knocked earlier versions of Interpress for characteristics such as a lack of flexibility in transforming fonts. Many of these objections stemmed from the specific implementations evaluated, however, and not from inherent Interpress limitations. Xerox's main problem

Fig. 4. A series of straightforward scaling operations *makes text appear to stretch and contract in these Postscript images produced on Linotype's Linotron 100. Included here are graphics, font characters and scanned images.*

seems to be slow implementation rather than any barriers in the language itself.

Adobe also provides for color with two Postscript models: hue-saturation-brightness and red-green-blue. Operators are available in the language to switch between the two models according to the NTSC video standard.

Until color hard copy attains a higher priority level on users' wish lists, however, dealing well with monochrome applications will be more important. For example, consider the possibilities of an image combining font characters, graphics (the background grid) and scanned images (Fig. 4). There is really only one scanned image in the figure, because one hand image was given a negative skew to reverse it and thus create the other hand. The hands' thumbs were handled separately so they could overlay the first and last characters.

To alternately stretch and compress the text, the characters were scaled appropriately. Note the "shadows" behind the characters, which are the same characters greatly skewed.

Capabilities such as these are transforming the way people think about graphics. The system integrators and application developers who think about such things in creative and practical ways will come to dominate the surging market in high-resolution printing. □

ACKNOWLEDGEMENTS

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Robert E. Peterson Jr. is vice president of Freehold Corp., Santa Cruz, Calif. With a background in both electronics design and magazine work, he specializes in marketing assistance and writing services for high-technology companies.

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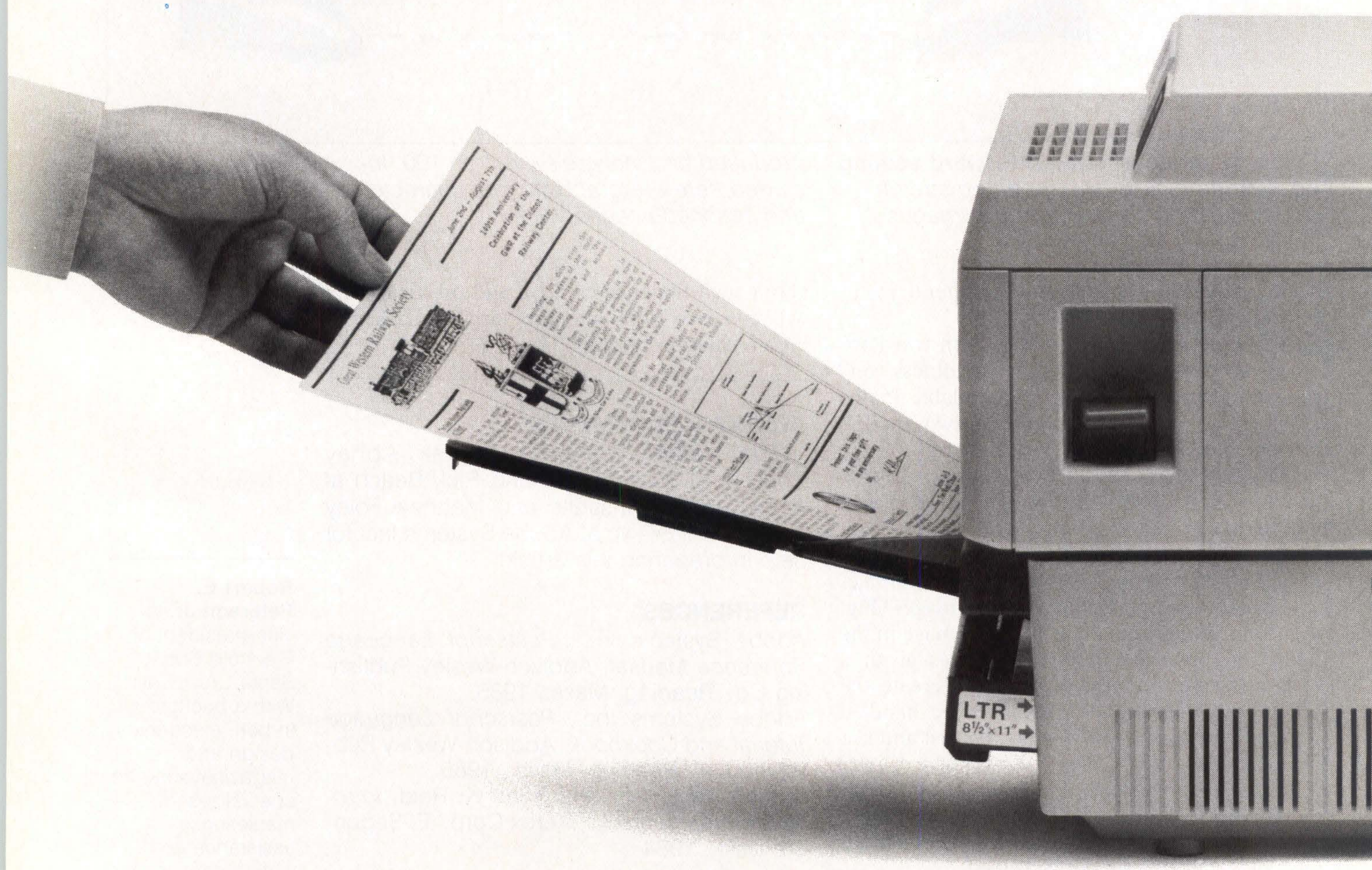

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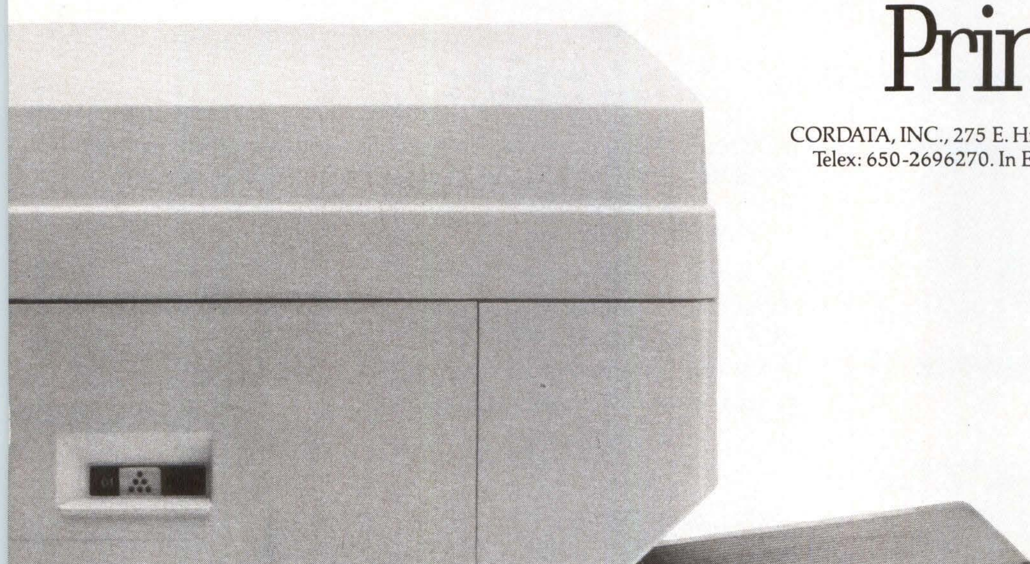

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DRIVERS FREE USERS FROM DEVICE DEPENDENCE

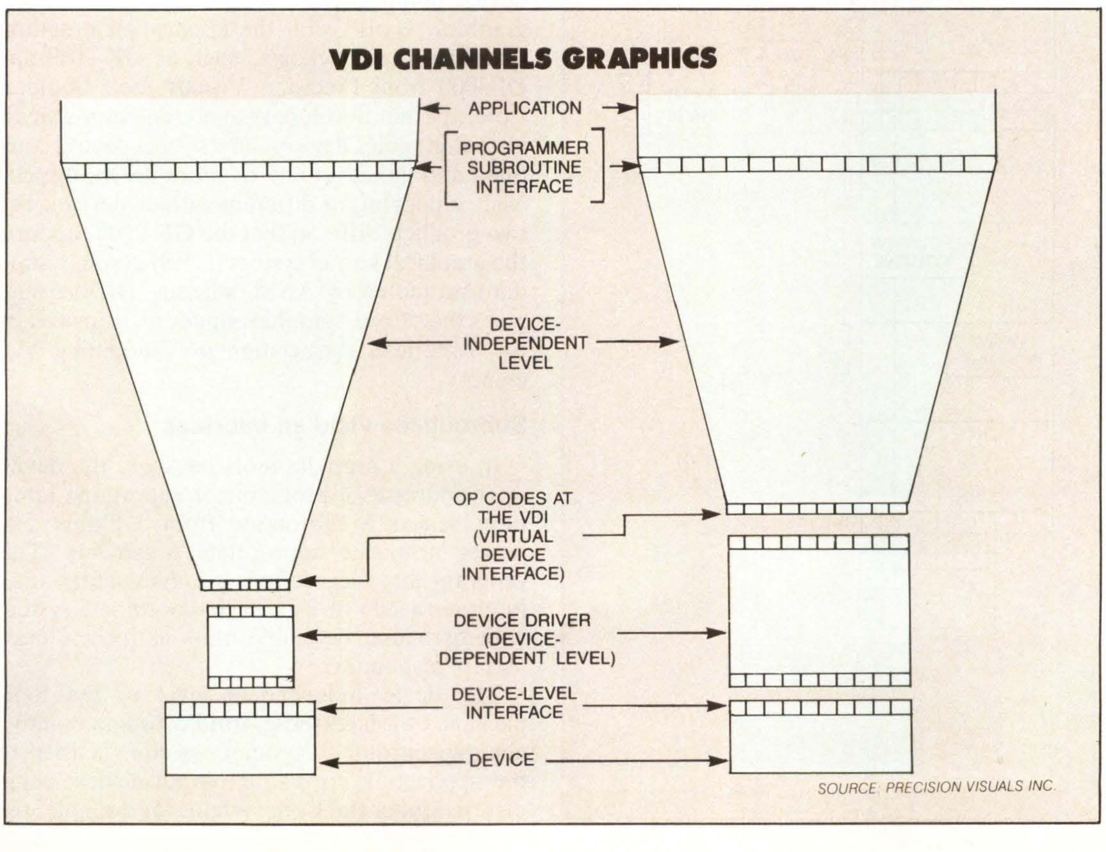
Device drivers provide graphics applications with peripheral independence and system integrators with a clearer route to completed applications

Jeff Scott, Precision Visuals Inc.

So long as system integrators employ terminals, pen plotters, film recorders and other graphics-display devices that have different performance characteristics, device drivers will serve as an essential part of many graphics applications. Device drivers reside beneath the application code, translating device-independent requests into device-dependent control sequences.

To access the driver, program developers often write software to address a virtual graphics device. This programmer interface is then translated into a set of codes passed across a virtual device interface (VDI) to the device driver. The size of the VDI proves critical: If it is too small, it acts as a bottleneck by requiring more software overhead at the device-independent level; if too large, it requires the support of complex drivers.

The device driver, which is usually divided into distinct modules, converts the application



Application requests *made through the programmer subroutine interface are translated at the VDI into a number of opcodes, which are then passed to the device driver. A large VDI is less of a bottleneck, but it requires a more robust device driver capable of supporting more hardware intelligence.*

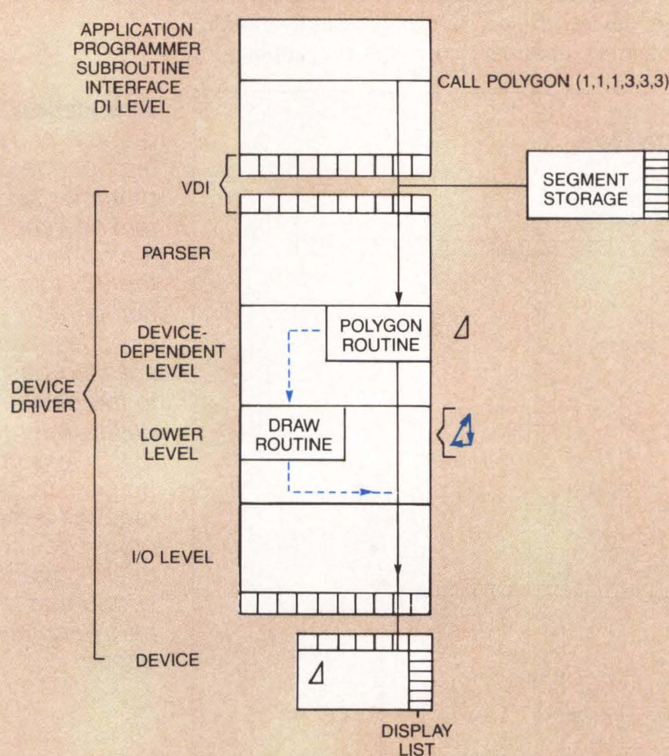
program's graphic request into a device-specific command string and routes it from the host computer to the output device. How these graphics requests are handled by the driver depends on whether they can be accessed as a hardware feature or must be simulated in software.

Device drivers facilitate graphics

A device driver translates a device-independent graphics request into a command string capable of generating the image on a specific device. For example, the POLYGON subroutine defines a triangle in world coordinates, which are translated by the driver into device-specific coordinates.

If the target device has a hardware polygon mode, the parameters are passed directly to the device, which creates the image in firmware. Otherwise, the request is shunted to a routine in the driver that "parses" the triangle into three individual lines, creating the equivalent image using software methods.

DRIVERS DRAW A POLYGON



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Graphics applications abound

Device drivers vary greatly in their complexity and sophistication. Simple drivers are often built into such basic software applications as word processing and electronic spreadsheets. The UNIX TERMCAP facility, which determines how UNIX interfaces with terminals, supports a number of devices at the operating-system level.

But it is in the realm of graphics applications that device drivers undergo the acid test. Relatively simple, full-screen text applications usually require only that the driver load the cursor, directing it to any X-Y-coordinate position. These drivers must clear the screen or a single line and support a limited number of attributes—reverse field, half-intensity, underline, etc.

Graphics-applications programmers, by contrast, face a bewildering number of choices: selection of foreground and background colors; filling polygons with solid colors or patterns; and repositioning, enlarging, shrinking and rotating images. A single graphics application may be called upon to operate monochrome and color displays, eight-pen plotters and raster printers, and mouse or graphics tablets as well as the function keys on several terminals.

One well-established approach to achieving device independence is to utilize a library of graphics "tools" with the application program. Graphics-tools packages, such as GK-2000 and DI-3000 from Precision Visuals Inc., Boulder, Colo., permit developers to address non-specific virtual-graphics devices. The source code is compiled and linked to one or more device drivers, each supporting a different output device. The two products differ in that the GK-2000 supports the graphical kernel system (GKS) graphics standard promoted by ANSI, whereas DI-3000 supports the "Core" graphics standard promoted by the American Association of Computing Machinery.

Subroutines yield an interface

In using a graphics-tools package, the developer addresses a programmer subroutine interface, selects a subroutine from a library and passes it to the appropriate arguments. This program interface defines graphics information in either a 2-D or 3-D world-coordinate system with such user-definable units as inches, ergs, meters or pounds.

The device-independent level of the tools package translates these world coordinates into a generic-coordinate system, specific neither to the application nor to the output devices being driven. Under the Core system, for example, the

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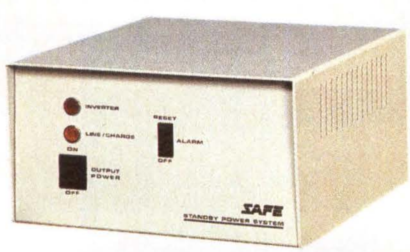

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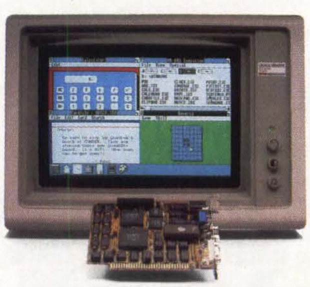

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virtual coordinate space extends from (-1.0,-1.0) to (1.0,1.0).

The device driver translates these virtual device coordinates into device-specific coordinates e.g., 1,024 by 1,024 for many raster devices, 8,500 by 11,000 for an 8.5-by-11-inch plotter, etc.

VDI is the borderline

The VDI becomes important in designing a device driver. It constitutes the borderline between the device-independent code and the device-dependent driver.

The VDI used by Precision Visuals includes opcodes (operational codes) that set color and line style, define color tables, initialize devices and accept current coordinate positions from input devices. About 80 opcodes are defined, although only 50 to 60 are generally used in most drivers.

The VDI can be a bottleneck because the full range of subroutine calls available to the programmer must be reduced to a set of opcodes that can be accepted by the driver.

The number of opcodes making up the VDI determines how "device intelligent" the driver is and, hence, how wide the bottleneck. But trade-offs exist in both directions—the optimal VDI is neither too large nor too small.

The smaller the VDI, the more software overhead emerges at the device-independent level. Consider, as an extreme example, a VDI consisting of just the four most universal opcodes: DRAW, COLOR, TEXT and MOVE. These basic graphics building blocks map directly onto five counterpart programmer-subroutine calls.

If, then, the VDI contained no opcode to support a terminal's hardware text capability, a request for a large font size on a plotter would not be translated into the command string necessary to produce that font on the device. Instead, fonts would be created from data files residing at the device-interface level and then implemented through a succession of pen moves and draws. Software simulation accomplishes this but does so much more slowly. In effect, VDI tends to treat an intelligent device as a dumb one.

Vendors make decisions

The advantage of a small VDI is that it permits vendors and integrators to write new drivers easily and quickly. Small VDIs make the most sense in a traditional mainframe installation where high-speed response is not critical. But, as vendors build more hardware capability into graphics devices, the VDI must be enlarged to allow the driver to use those resources.

By the same token, the larger the VDI, the more demands placed on the driver. Theoretically, as many subroutine calls at the programmer-interface level as possible should have an equivalent VDI opcode. But there is a limit to a VDI's potential growth. At some point, a large VDI requires a driver that is too unwieldy to write

In graphics applications, device drivers undergo the acid test.

Put code into skeleton drivers

Skeleton device drivers are supplied by vendors to system integrators wishing to target an unsupported device. Such drivers consist of source code in which the device-specific information has been omitted. To the integrator falls the task of filling in the blanks.

In customizing a skeleton driver, a system integrator's best chances for success are with those supporting low- to medium-end devices. More complex device drivers, particularly those that support 2-D or 3-D display lists, local hidden-line removal, wire-frame shading, and enhanced input capabilities, should be approached more gingerly. In the long run, it may be better to ask the graphics-tools vendor to write such a driver, rather than undertake it yourself.

A few rules of thumb can make the process easier:

- Be certain that the hardware or firmware interface is stable. If the manufacturer is still tinkering at this level, your driver will soon become obsolete.
- Be familiar enough with the device-independent programmer interface so that you know what kinds of device features you are trying to support. You should know the driver's programming language and should understand the structure at both ends of the driver—the virtual device interface (VDI) and the device-level interface.
- Know what layers of the driver you will be working on. With Precision Visuals Inc. drivers, most modification takes place at the "lower level," which constructs the command strings sent to the device. For ports to non-supported computers, significant portions of the I/O layer must also be written.
- Work incrementally and from the bottom up. First, make sure that the hardware features purportedly on the device actually work the way the documentation says they will. Then, patch the desired features into the driver, write some test application code, and exercise the feature, starting with the most fundamental capabilities and branching out from there.
- Develop a set of trustworthy quality-assurance tests and run them, before you commit development effort to the application. That way, graphics interface problems are much easier to note and resolve.

Too large a VDI requires a driver that is too unwieldy to write and too wasteful of computer resources.

and too wasteful of computer resources.

For example, imagine that a terminal manufacturer has incorporated the hardware to draw the symbol for an electrical transformer on the screen—a useful feature in a few applications, but otherwise superfluous. Should the programmer interface contain a subroutine—and the VDI an opcode—to support it? If so, the driver of every device, including those not supporting the feature would have to simulate it in software—hardly a practical arrangement.

A vendor designing a customized VDI must, therefore, find a middle ground. The nucleus of every VDI is composed of the capabilities shared by all devices. The vendor must go on from there to determine what additional capabilities to put into the devices. The hardware capability of polygon fill, for example, is not supported by most plotters but is becoming a standard feature of many raster terminals.

In designing device drivers, Precision Visuals' philosophy is to support a given feature in hardware wherever possible and to simulate it in software whenever practical. In those rare instances where software simulation is impractical, the request is ignored unless hardware can support it.

Much effort has gone into standardizing the VDI. If hardware behaved uniformly, no device driver would be needed. It is unlikely that situation will evolve in the near future—not because software developers wouldn't support it, but because hardware manufacturers, anxious to differentiate their products from the competition, would never tolerate it.

Drivers' levels differ

The purpose of all device drivers is to translate device-independent requests from the application into command structures that can be understood by the target device. Precision Visuals accomplishes this translation by dividing the driver architecture into four distinct layers:

- The parser layer that serves as a traffic cop, passing VDI opcodes to appropriate parts of the driver
- The device-dependent layer that converts device-independent commands into device-dependent commands
- The "lower level" layer that constructs device-dependent command strings meaningful to the target device
- The I/O level that sends the device-dependent commands to the device.

To illustrate the interrelationship between these four layers, consider a program request to draw a line from a given starting point to the center of a display screen on a typical 1,024-by-1,024 raster terminal.

The programmer begins in application-specific, world-coordinate space. If this space extends from (0,0) in the bottom, left-hand corner to (100,100) at the upper left, the DI-3000 graphics-tool command is JDRAW (50,50).

DI-3000 then maps the (50,50) coordinates into virtual coordinates (0,0) and sends the re-

Text interface eases device integration

Although the virtual device interface (VDI) has simplified the manner in which device drivers link peripherals to a graphics system, it is only one solution. A method developed by Visual Engineerig Inc., San Jose, Calif., provides an alternative to the VDI and eliminates the need for a programmer.

The technique, called GraphCap, converts a textual file of human-readable, device protocol commands into machine-independent control modules that can be accessed by the application at run time.

GraphCap is modeled after the Berkeley UNIX Version 4.2 utility called "termcap." Termcap allows any program to do screen-oriented, alphanumeric, device-independent text. Programs such as spreadsheets and word processors use this capability.

Essentially, GraphCap describes how information is to be positioned on the graphics device. Moreover, it allows for the definition of complex output devices, such as an eight-pen color plotter. Additionally, attribute bundles are included for proper colors, shades and patterns.

One of the design goals was to accommodate newer devices. Using standard device-driver techniques requires that a programmer develop a new, and frequently complex, driver that isn't necessarily portable across various machine architectures. To achieve the necessary portability for the UNIX environment, as well as flexibility to add new devices, Visual Engineering also developed the Basic Graphics Utility Language (BGUL). With it, adding a new device is simply a matter of using the proper BGUL syntax and defining the parameters. For example, if the plotter has 10 pens, the statement Ncolor=#10:\ will do the trick. Similarly, with color thermal printers, changing colors is as easy as stating the proper escape code.

Even though the text protocol segments may look different for each device added, the essential backbone structure of a GraphCap file is standard, thus eliminating diverse approaches to linking devices.

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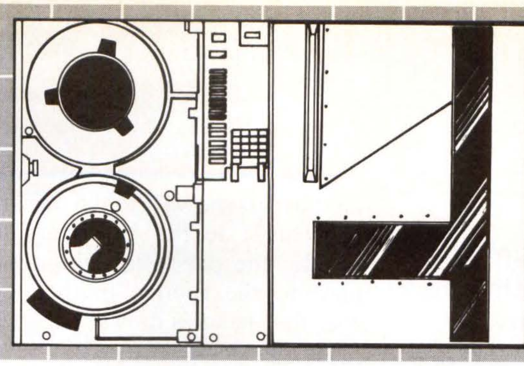

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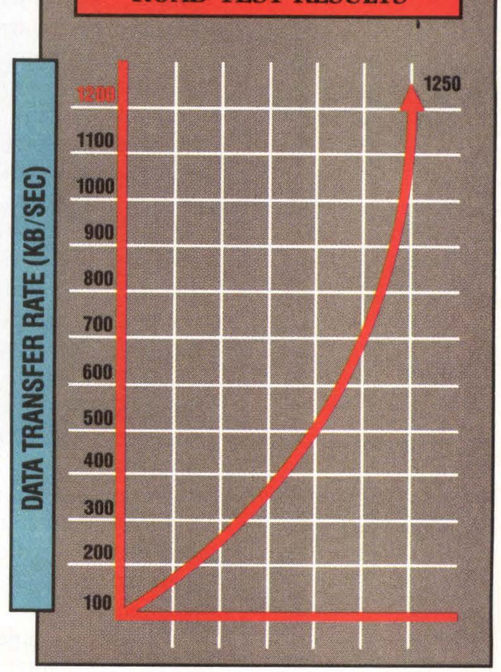
ROAD TEST RESULTS



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CIRCLE NO. 13 ON INQUIRY CARD

OEM MARKETING/3N, Louisville, Colorado 80028-0001 USA (303) 673-4066

Sometimes requirements for software simulation are so complex that it makes more sense to isolate the simulation code outside the driver.

quest across the VDI to the parser layer. Because the request to the VDI contains a "DRAW" opcode, the parser level simply passes the request to the routine in the device-dependent layer that handles draws.

At the device-dependent level, the virtual coordinates (0,0) are translated into device-dependent coordinates on the raster device: (511,511). These coordinates are then passed to a lower level routine designed for draw commands, which prepares the appropriate command string and passes it to the I/O level.

The I/O level sends the command string through the host machine to the device, taking into account the operating system and computer dependencies. The I/O layer differs from the layers above in that it is device-independent but host-machine dependent. As a result, the entire driver can be ported from, say, a Digital Equipment Corp. VAX-11/750 to an IBM Corp. Model 4381 by simply modifying or interchanging this bottom layer.

How to produce polygons

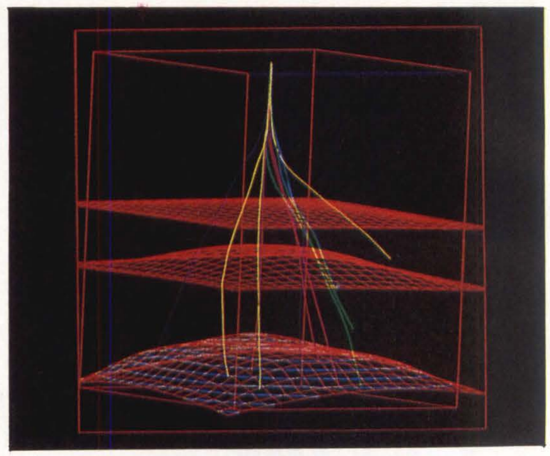
A simple line drawing represents one of the most fundamental tasks performed by a device driver. A more complex task is drawing a polygon. In DI-3000, for example, the routine JPOLGN (X,Y,...Nth) defines a move to the first point (X), a line to the following point and a final line from the Nth point back to the first point.

Some output devices understand what a polygon is, i.e., they have an explicit polygon mode that accepts an array of vertices and automatically connects them. Other devices lack this intelligence—the creation of a polygon in this case amounts to only a set of independently drawn lines, constructed in software. Hence, the request to draw a triangle is handled by the driver in one of two ways, depending on the type of device it is supporting.

If a polygon mode is available on the device, the driver translates the request into a series of command strings to implement the image in hardware. Otherwise, the request is shunted to a separate routine within the device-dependent level, which processes the request into three separate draw commands that the device can understand.

Sometimes the requirements for software simulation are so complex that it makes more sense to isolate the simulation code outside the driver. This is the case when dealing with retained segments.

Retained segments are designated portions of a graphics display (e.g. the symbols, menu items and objects) that are assigned an identification number and can be manipulated on the screen as



Graphics device drivers *give rise to products like the DI-3000 graphics system from Precision Visuals. Here an application for the petro-chemical industry displays alternative drilling paths.*

independent graphics entities. Most high-end graphics terminals and workstations incorporate a display list, i.e., a dedicated area of local memory in which retained segments are stored and transformed. This allows the user to rotate, move or enlarge retained segments.

In cases where a hardware display list is present, retaining a segment in the display list is straightforward. The program opens a segment, passes graphics coordinate sets to the driver and closes the segment. The driver, in turn, stores the coordinates in the display list of the device.

But, what if the program requests a retained segment on a device lacking a display list? In this case, the driver relies solely on a device-independent data structure known as segment storage, which resides on the host computer. When the driver receives the opcode request to open a retained segment, it passes control one level up to an external routine, which performs the tasks in software.

Segments escape their limits

Segment storage represents the limit of what is usually simulated in graphics software. But there are graphics tasks that lie beyond this limit. Hidden line removal, for example, and the shading of wire-frame images—both required in solid-modeling applications—are so complex to calculate that software simulation is impractical. For this reason, neither the GKS standard nor the Core system dedicates a subroutine for these types of tasks.

For such complex requirements, as well as for other tasks proprietary to specific devices, a device driver may have a series of escape functions. This code pops the application out of the more limited graphics capabilities of the driver and into the proprietary function. Escape functions are numbered and are applicable only to a given device. If an escape function is passed to a different device, the driver ignores the request. Escape functions allow the device-independent programmer safe, predictable access to desirable, but non-standard, device features.

Vendors balance trade-offs

System integrators derive two principle benefits from a graphics-tools package: productivity and device independence. The program developer can concentrate on the application, not the intricacies of a particular graphics device. Existing applications can support new graphics devices, with little or no modification, simply through installation of a new device driver.

There is a trade-off, however. Device drivers, even intelligent ones, require some software overhead. As applications become more demanding, the system integrator walks a tightrope between being locked into a device on one side and sacrificing too much performance on the other.

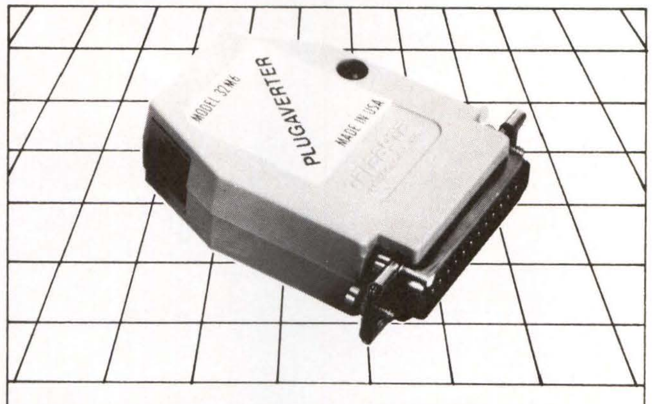
This is not to say, however, that drivers cannot be made more efficient. One technique is to shield the device from redundant application-program requests—e.g. repeated requests to change a displayed color to red, or for pen moves to reach some specified point. Such requests are filtered out by maintaining within the driver a set of status flags, which serve as reference points.

But redundancy trapping is only a beginning. The biggest challenge in driver architecture is still in providing device independence with only negligible reduction in performance—even in highly interactive engineering and design applications. Achieving this goal will require new techniques that are only now beginning to emerge. □

Device drivers, even intelligent ones, require some software overhead.

Jeff Scott is the engineering product manager at Precision Visuals Inc., Boulder, Colo. He holds a bachelor of arts degree in information systems design and development from the University of Colorado at Boulder.

Interest Quotient (Circle One)
High 754 Medium 755 Low 756



NOW HIGH DOESN'T HAVE TO BE

For years, choosing a high-capacity drive was a hard decision…a hard disk decision. But the hard disk monopoly on high capacity has just been shattered. Introducing 3.3 MB and 6.6 MB flexible drives and 12 MB intelligent cartridge disk drives from Kodak.

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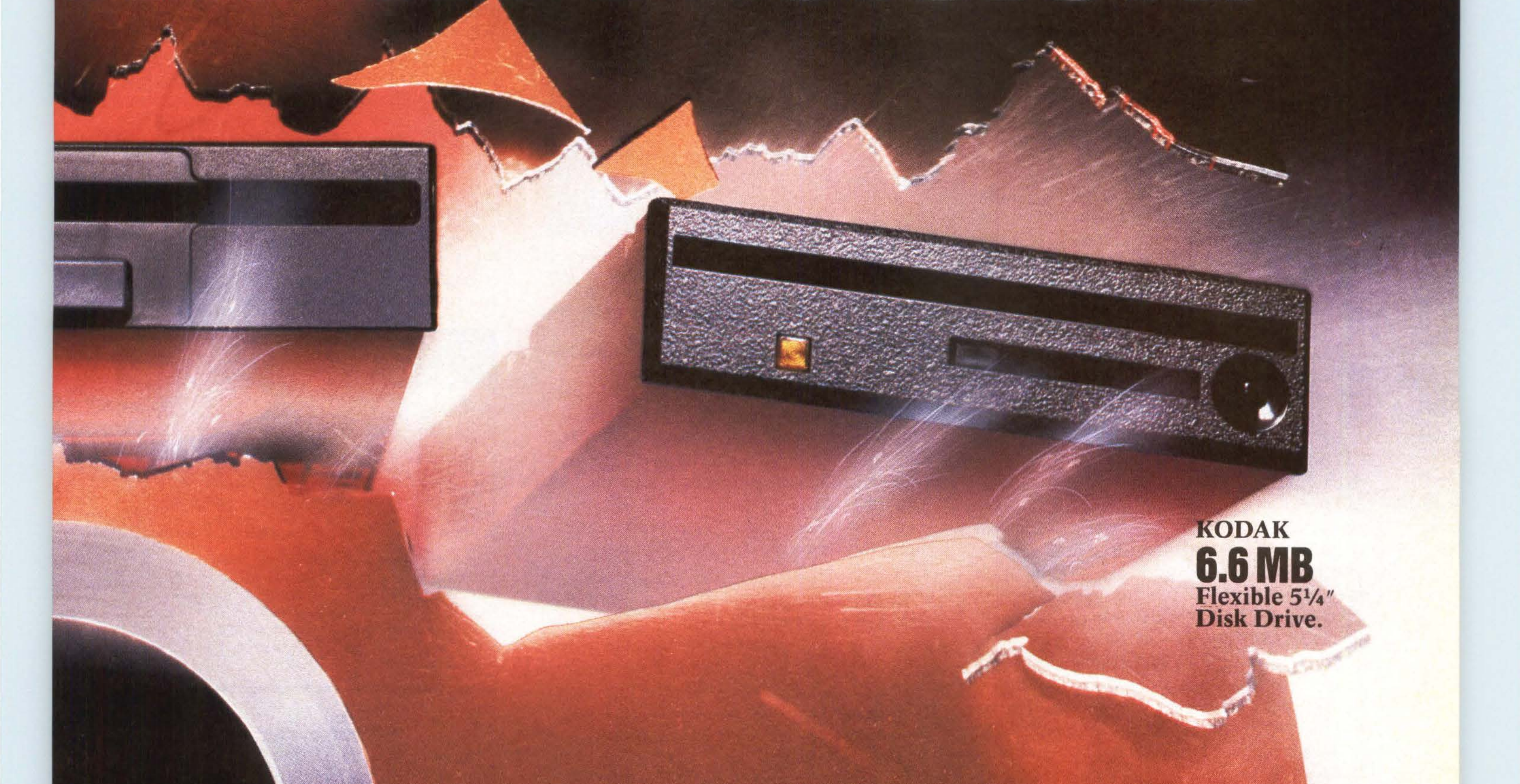
Advanced servo-embedded technology gives Kodak's 3.3 MB and 6.6 MB units capacity and performance unprecedented in flexible drives. Specially preformatted Verbatim media tells the head exactly which track it's over. This accurate track positioning lets us increase track density and still get reliable data transfer. In fact, this is the *only* reliable way of getting multi-megabytes of data storage from a flexible disk drive.

Kodak drives give you new levels of speed, too. The 3.3 and 6.6 units access and transfer 3 to 6 MB of data in the same time that conventional flexible drives handle only 1 MB. Both drives offer 3 ms track-to-track access and dynamic ramp stepping for fast random access and a transfer rate of 500 Kbit/sec.

Downward read capability puts these drives in a league by themselves. They automatically read any files that have been recorded on standard PC- or AT-type 5¼-inch media. That means there's no need for expensive overhauls of existing software or files.

CAPACITY A HARD DECISION.



The intelligent 12 MB cartridge disk drive completes Kodak's powerful family. This advanced peripheral delivers hard disk performance with the convenience of media removability.

It features reliable servo-embedded technology, fast 75 ms average access time, and an embedded controller with SCSI interface. These built-in extras let you eliminate expensive and time-consuming testing and integrating of individual components.

And the 12 MB 5¼-inch media comes in a shock-resistant hard cartridge that protects precious data while it's out of the drive.

CIRCLE NO. 15 ON INQUIRY CARD

But the most surprising thing about Kodak disk drives is that they squeeze all their capacity and performance into a half-height, 5¼-inch format.

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If you'd like more information about Kodak's advanced disk drives, call 1-716-724-5887 or write to Peripheral Systems Products, Dept. MMS, Mass Memory Division, Eastman Kodak Company, 343 State Street, Rochester, New York 14650.

Visit us at Spring Comdex—(Atlanta) Booth No. 1728

First new 1/4 inch cartridge since 1971

If you *don't* have data worth preserving, then the reasons for buying Cartrex's new 1/4-inch, high performance, virtually error-free tape cartridge won't mean anything.

But, if you are one of the many 1/4-inch tape cartridge users that assume 3M's cartridges just *have* to be "good enough" for today's high performance tape drives, read these simple facts to understand why that isn't true anymore.

Why a new cartridge

With the significant increases in tape drive capacity, system reliability demands a tighter tolerance cartridge. Most tape drive users aren't aware that all of the tensioning, tolerance, and data reliability issues are virtually all a function of the tape cartridge.

When 3M announced its cartridge in 1971, it was designed for a low capacity tape drive with less than 3 megabytes—2.88 to be exact. The tape was low in density—1600 bits per inch with only 4 tracks and 300 feet of tape.

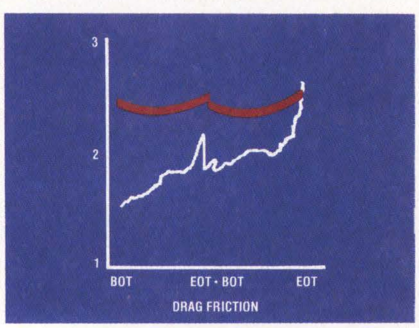
The tolerances required for the tape drives of the early 1970's were fine for then, but today's tape drives require much tighter tolerance. Today's tape cartridges must work with drives that have 9 or more tracks and bit densities as high as 12,000 bits per inch on 600 feet of tape. That means capacity increases of 2,000 percent packed into the same cartridge.

The reasons that yesterday's cartridge technology simply won't work properly in today's high capacity drives is inherent in the cartridge design. The three culprits that make cartridge tolerances so important are fluctuating tape tension, redeposit nodules, and instantaneous speed variations (or ISV).

Tape Tension

Tape tension at the read-write head is important because the tape drive's electronics expect data to arrive at a constant rate. Consistent tape tension is a function of the cartridge tensioning mechanism. The new Cartrex cartridge tensioning design, based on a mechanical differential between two stiff belts, provides very predictable results. The historic 3M design—used by 3M and DEI—uses an elastic belt coupled with drag friction at the rear pulley to create tension. The accompanying graph shows the significant improvement the Cartrex cartridge design offers over the conventional design.

The new Cartrex 1/4-inch tape cartridge is the first new tape cartridge design in almost a decade and a half. Tape drive manufacturers now have a new cartridge technology which allows them to advance today's and tomorrow's drive performance.



The Cartrex cartridge provides predictable and stable tension. Compare it to the tension variation of the conventional cartridge design. The consistent Cartrex tension virtually eliminates data errors and data loss from head-to-tape separation and redeposit nodules that can occur with fluctuating, low-to-high tension performance.

Redeposit Nodules

Redeposit nodules are the insidious flakes of tape media that break off from the edges of the tape and get dragged to the edge of the read-write head. If the tension is low, or becomes low when the tape starts or reverses, the flakes slide past the edge, get smeared across the head, and reduce its ability to read data.

The free play in the two tape reels combined with the tape guides are the primary culprits in creating these redeposit nodules. As the tape enters the guide from the tape pack, the tape guide aligns the tape by balancing the tension at the edges of the tape. Uneven edge tension not only causes media to flake off causing redeposit nodules, but data is lost due to the "coining" or "scalloping" effect.

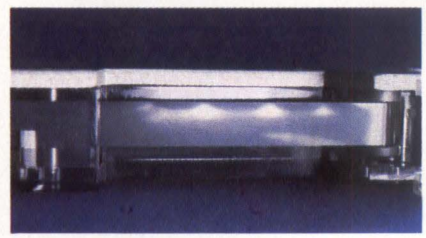
Cartrex eliminated the cause of the tape coining or scalloping with a barrel-shaped roller placed in front of the tape guide. The roller positions the tape and drops the edge tension to zero. By using this roller, the possibility of media flaking off and creating redeposit nodules is virtually eliminated.

Instantaneous Speed Variation (ISV)

Instantaneous speed variation is exactly what it sounds like—small, instantaneous changes in tape speed as it crosses the tape head. At slow tape speeds and low bit densities—like the 1971 standard of 30 inches per second and 1,600 bits per inch—ISV wasn't as big a problem. At that time, the bits were crossing the head at 48,000 bits per second.

Today, however, the story has changed. Ninety inches per second and 8,000 bits per inch mean that 720,000 bits cross the head every second. A 1,500% increase. As you may have guessed, 1971 speed fluctuations in the 48,000 bits per second range made reading data difficult for tape drive electronics. But today, when the electronics have to guess whether or not the bit rate of 720,000 bits per second is accurate, the electronics can become overwhelmed.

The Cartrex tensioning mechanism relieves the overload placed on the electronics with respect to ISV. The longitudinally stiff belts ensure tension at all times. The stiff belt overpowers variations that exist with the 3M elastic belt cartridges. The barrel roller guides, in addition to reducing the edge pressure to zero, tend to dampen out any residual ISV effects.



High speed tape seldom enters tape guides parallel to the top and bottom, even with improvements to the tape reel hub designs. The edge pressures which result create "scalloping" or "coining" on the tape. The effect is data loss due to head-to-tape separation, flaking media that smears across the head, and "redeposit nodules" that create hard errors.

Never a Single Issue

Your tape drive seldom has the luxury of dealing with an isolated problem. It's usually a combination of ISV, redeposit nodules, and tension problems all together. Now you understand why Cartrex developed a modern cartridge alternative.

Where to get it

Not only has Cartrex improved on the industry's 15 year old technology, they have done it for a competitive price.

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CIRCLE NO. 16 ON INQUIRY CARD

SYSTEM INTEGRATORS' NOTEBOOK

Tips that make dollars and sense

DISK FORMATS FOR YOUR FILES

Carl Warren, Western Editor

A list of flexible disk formats, including the number of file-allocation tables (FAT), sector size and reserved sectors, can be helpful, especially if you're trying to figure out which is the best format for your application.

Have you solved a hardware or software integration problem lately? *Mini-Micro Systems'* readers would like to hear about it. We pay up to $100 for each published solution. Contact: Carl Warren, Western Editor, *Mini-Micro Systems,* Cahners Publishing Co., Suite 109, 2041 Business Center Drive, Irvine, Calif. 92715 (714) 851-9422 or MCI-Mail ID 270-5505.

Interest Quotient (Circle One)
High 757 Medium 758 Low 759

CURRENT MS-DOS 1.xx - 2.xx DISK FORMATS

Disk type	Type code
single-density, single-sided, 8-inch	(SD128)
double-density, single-sided, 8-inch	(DD1024)
double-density, double-sided, 8-inch	(DD1024-2)
IBM Displaywriter system disk	(SD256)
IBM Displaywriter system disk	(DD256-2)
IBM PC 8-sector, single-sided	(IBM8)
IBM PC 9-sector, single-sided	(IBM9)
IBM PC 8-sector, double-sided	(IBM8-2)
IBM PC 9-sector, double-sided	(IBM9-2)
single-density, double-sided, 8-inch	(SD128-2)

FORMAT ATTRIBUTE TABLE

Type code	Max. no. entries in directory	Disk size (K bytes)	FAT*	Block sizes (bytes)	No. of reserved sectors	Sector size (bytes)	FAT ID	Tracks	Sectors/track	Max. no. reserved sectors	Min. total FAT size	Directory size	1st FAT size	2nd FAT size	1st directory	1st data block	Total sectors on disk	No. of heads
SD128	68	251	2	512	1	128	FE	77	26	1	6	17	1	7	13	30	2,002	1
DD1024	96	612	2	1,024	1	1,024	FE	77	8	1	1	3	1	2	3	6	616	1
DD1024-2	192	1,232	2	1,024	1	1,024	FF	77	8	1	2	6	1	3	5	11	1,232	2
SD256**	80	287	2	512	2	256	FA	77	15	17	4	10	2	6	10	20	1,155	1
DD256-2***	172	1,001	2	1,024	2	256	FB	77	26	54	6	20	2	8	14	34	4,004	2
IBM8	64	162	2	512	1	512	FE	40	8	1	1	4	1	2	3	7	320	1
IBM9	64	180	2	512	1	512	FC	40	9	1	2	4	1	3	5	9	360	1
IBM8-2	112	320	2	1,024	1	512	FF	40	8	1	1	7	1	3	5	10	640	2
IBM9-2	112	360	2	1,024	1	512	FD	40	9	1	2	7	1	3	5	12	720	2
SD128-2	68		2	512	4	128	FC	77	26	4	12	17	4	16	28	45	4,004	2

* FAT=file-allocation table

** 15-sector bias in BIOS

*** 52-sector bias in BIOS

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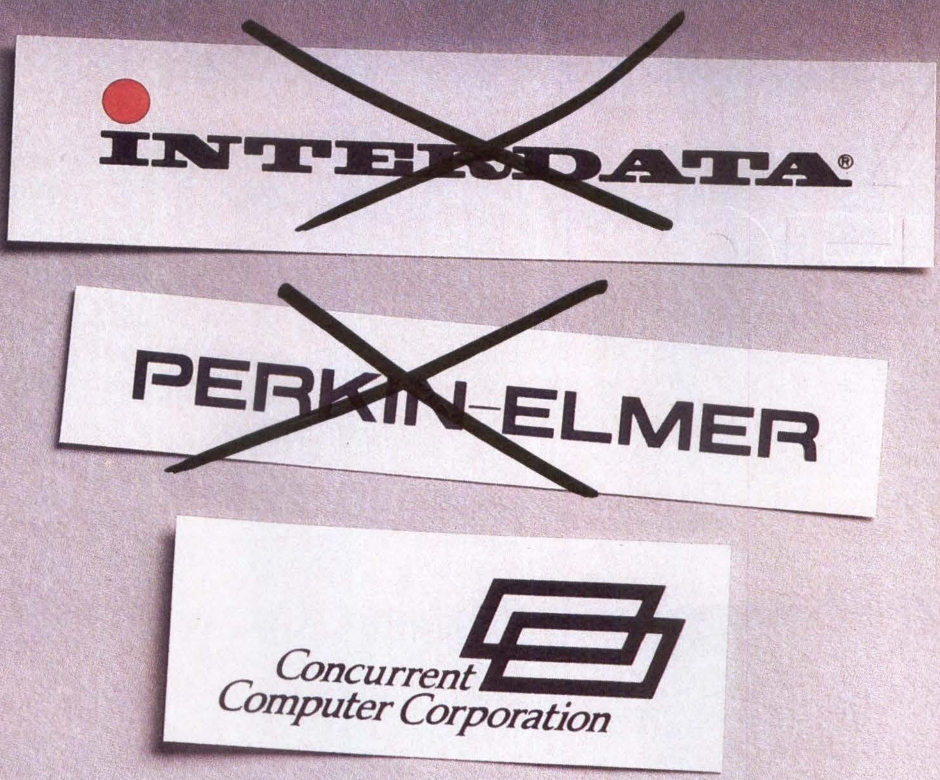
CIRCLE NO. 18 ON INQUIRY CARD

8-inch and larger rigid disk drives and subsystems

Company Model	Disk size (inches)	Capacity (M bytes) F=formatted U=unformatted	Average access time (msec)	Number of data surfaces	Number of read/write heads	Actuator type	Dimensions (H×W×D/inches)	Interface	Price $ (quantity)	Notes, features, options
ALPHA DATA INC. 20750 Marilla St., Chatsworth, CA 91311-4488, (818) 882-6500										**Circle 226**
Atlas 128/ Atlas 160	14	128/160 U	18	5	50	closed-loop rotary	7×19×23	SMD		includes power supply
Atlas 520	14	520 U	18	8	76	closed-loop rotary	7×19×23	SMD		includes power supply
CENTURY DATA SYSTEMS 1270 N. Kraemer Blvd., Anaheim, CA 92806, (714) 632-7500										**Circle 227**
AMS 315/ AMS 513 (subsystems)	14	315/514 U	25	10	19	linear	10.5×19×28	SMD	10,315-10,500/ 11,400-11,585(Q1); 5,540-5,700/ 6,100-6,260(Q500)	
AMS 571 (subsystem)	14	615	19	10	19	linear	10.5×19×28	SMD	13,000-13,100(Q1); 7,130-7,290(Q500)	
C2075	8	53.5 U (fixed) 26.7 U (removable)	32	6	6	linear	7×8.55×18.5	SMD, LMD	4,900(Q1); 3,640(Q500)	fixed/removable cartridge
C2120 (subsystem)	8	87.8 U (fixed) 35.1 U (removable)	32	7	7	linear	7×8.55×18.5	SMD, LMD	5,100(Q1); 4,060(Q500)	fixed/removable cartridge
C2400	8	408 U	15	12	24	linear	9×8.5×18.5	SMD	10,315-10,500(Q1); 5,540-5,700(Q500)	
C2476/C2600	8	476/613 U	15	12	20/24	linear	9×8.5×18.5	ESMD	11,300-11,485/ 13,100-13,290(Q1); 6,300-6,460/ 7,230-7,390(Q500)	
CHRISLIN INDUSTRIES INC. 31352 Via Colinas, #101, Westlake Village, CA 91362, (818) 991-2254										**Circle 228**
CI-1220-TF (subsystem)	8	2 F (removable)						RX02	2,445(Q1)	removable cartridge, Mitsubishi drive, dual controller, DMA
CI-1270-MT/ CI-1270-WF (subsystems)	8	70/70 F (fixed) 70/2 F (removable)						MSCP/ SMD	8,295/7,095(Q1)	fixed/removable cartridge; Priam drive; MT ¼-inch streaming tape backup, power supply; WF: dual 8-inch, 2M-byte flexible drive, power supply
CI-1340-MTA/ CI-1340-MTB (subsystems)	8	200/300 F (fixed) 70/70 F (removable)						MSCP	9,895/10,995(Q1)	fixed/removable cartridge; ¼-inch, 70M-byte streaming tape backup, power supply; Priam drive

8-inch and larger rigid disk drives and subsystems

Company Model	Disk size (inches)	Capacity (M bytes) F=formatted U=unformatted	Average access time (msec)	Number of data surfaces	Number of read/write heads	Actuator type	Dimensions (H×W×D/inches)	Interface	Price $ (quantity)	Notes, features, options
CI-1340-MT/ CI-1340-WF (subsystems)	8	130/140 F (fixed) 70/2 F (removable)						MSCP/ SMD	9,295/8,095(Q1)	fixed/removable cartridge; Toshiba drive; MT: ¼-inch, 70M-byte streaming tape backup, power supply; WF: dual 8-inch, 2M-byte flexible drive, power supply
CONTROL DATA CORP. 2200 Berkshire Lane North, Plymouth, MN 55441, (612) 553-4605										**Circle 229**
80231-60 (subsystem)	14	126 F (fixed)						modified SMD	15,425(Q1); 10,800(Q100)	includes power supply; controller
80270-10/ 80270-30	14	63/240 F (removable)						modified SMD	12,850/22,395(Q1); 9,000/15,675(Q100)	removable cartridge, includes power supply, controller
CONTROL DATA CORP. (OEM PRODUCT SALES) 8100 34th Ave. South, Minneapolis, MN 55440, (800) 828-8001										**Circle 230**
9710 RSD	9	82.9 U (removable)	27	5	5	closed-loop linear voice coil	10.2×8.5×24.25	SMD	5,680(Q1); 4,370(Q500)	removable cartridge
9715-160 FSD	9	165.9 U	30	10	10	closed-loop linear voice coil	10.2×8.5×24	SMD	5,735(Q1); 4,405(Q500)	
9715-340 FSD/ 9715-500 FSD	9	344/516 U	18	12	24	closed-loop linear voice coil	10.2×8.5×24	SMDE	7,495/8,430(Q1); 5,755/6,475(Q500)	thin-film heads
9720X EMD	8	368 U	18	10	10	closed-loop rotary voice coil	4.75×8.5×14.7	SMD	5,605(Q1); 4,305(Q500)	thin-film heads
DATAPOINT CORP. 9725 Datapoint Dr., San Antonio, TX 78284, (512) 699-7000										**Circle 231**
9348	9	67 F (removable)	27	5			10.2×8.5×29.9		14,500(Q1); 12,325(Q100)	removable cartridge
9349	9	266 F (fixed)	20	24			10.2×8.5×29.9		22,500(Q1); 19,125(Q100)	
9390 Disk System		120 F (removable)	30	5			36.2×22×36		35,160(Q1); 29,890(Q100)	removable cartridge, includes controller
FUJITSU AMERICA INC. (STORAGE PRODUCTS DIV.) 3055 Orchard Dr., San Jose, CA 95134, (408) 946-8777										**Circle 232**
M2284	14	168.6 U	27	5	10	closed-loop rotary	9.8×16.4×25.6	SMD	4,775(Q100)	opt. dual port
M2294/M2298	14	333.5/671.1 U	27	5	16	closed-loop rotary	9.8×16.4×25.6	SMD/ MSMD	5,800/7,045(Q100)	opt. dual channel
M2312K	8	84.4 U	20	7	7	closed-loop rotary voice coil	5×8.5×15	SMD	2,750(Q100)	opt. dual port
M2322K/ M2331KS	8	168.6 U	20	10/3	10/5	closed-loop rotary voice coil	5×8.5×15	SMD/ SMD, SCSI	3,300(Q100)	opt. dual port
M2333K/ M2333KS	8	337 U	20	10/6	10	closed-loop rotary voice coil	5×8.5×15	HSMD/ SMD, SCSI	4,300(Q100)	
M2350/ M2351/ M2361	10.5	474/474/689 U	18	6	20	closed-loop rotary voice coil	14×19×27/ 10.4×19× 27.6/ 10.4×19×30.3	MSMD/ MSMD/ HSMD	8,500/9,500(Q100)	parallel data transfer; M2351 has opt. dual port
HEWLETT-PACKARD CO. (DISC MEMORY DIV.) 11413 Chinden Blvd., P.O. Box 39, Boise, ID 83707, (208) 323-2290										**Circle 233**
7907A (subsystem)	8	41 F (fixed) 20.5 F (removable)					7.1×12.8×18.4	HP-IB, CS/80	12,500(Q1)	fixed/removable cartridge, Amcodyne 71105 drive, ruggedized, includes CS/80 controller



Some Things Never Change.

No matter who made it, Macrolink makes it better.

We've got the highest performance controllers made for the new generation of disks: SMD (3MB/sec), Optical, SCSI, and 5.25". We also have Tape adapters (800 to 6250 BPI, Cartridge & Streaming), Solid State Disk, Memory, Communications, and just about anything else you might need for your 3200 CPU. In fact, we build more Concurrent Computer compatible products than anyone else.

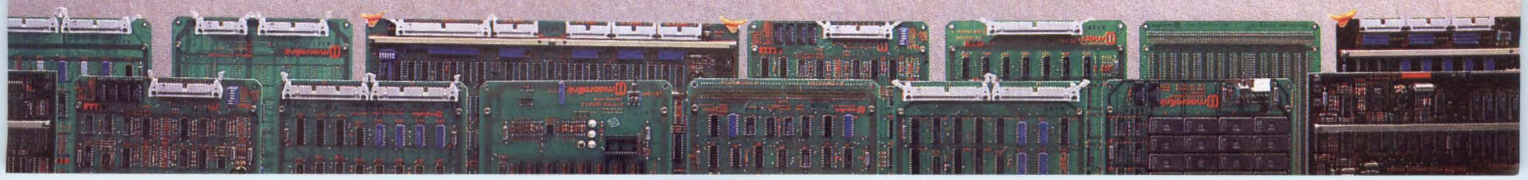
Call today for our catalog, and find out why OEMs and End Users make Macrolink their first choice. Service and installation is available world-wide, and from Concurrent Computer.

Not all the news comes from Oceanport, N.J.

CIRCLE NO. 19 ON INQUIRY CARD

macrolink® inc.

Macrolink Inc. 1500 N. Kellogg Drive, Anaheim, California 92807 Phone (714) 777-8800 TWX 910-591-1671



YOU ASKED FOR A FAST MULTIBUS H-SMD DISK CONTROLLER THAT WOULD ALSO OPTIMIZE YOUR SYSTEM'S PERFORMANCE

Rimfire 1200 design engineers Bill Winterstein and Tom Wicklund

WE RESPONDED WITH THE RIMFIRE 1200

FAST AND FLEXIBLE

We designed the Rimfire 1200 with your operating system in mind. A significant increase in throughput is gained through the implementation of a large segmentable cache (up to 32K). By means of a least-recently-used algorithm we cache frequently used files while looking ahead for next potential requests. Subsequent "cache hits" eliminate disk access time and related overhead. Thus, operating system bottlenecks are opened and you achieve the optimum integration of a disk controller in your system.

We then coupled this caching architecture with a high-speed dual DMA, fast enough to run up to four H-SMD disk drives (at 2.5 megabytes/second). This combination of high speed and intelligent data management places the Rimfire 1200 a step beyond older straight pipeline designs and into a new, higher performance generation of Multibus disk controllers.

Multibus and iRMX-86 are registered trademarks of Intel Corporation. UNIX is a trademark of AT&T. Rimfire, Tapemaster and Ciprico are all registered trademarks of Ciprico Inc.

Other Rimfire 1200 features include:

- 48 bit ECC
- Defect mapping of bad sectors or tracks
- Programmable head and cylinder skewing
- Zero latency track read
- Scatter/Gather read/write commands
- Reads flaw map from disk drive
- Statistics commands
- Driver support for UNIX III, V, 4.2, and iRMX-86

CIRCLE NO. 20 ON INQUIRY CARD

For information about our full line of Rimfire and Tapemaster products contact us at the following locations:

CIPRICO

Ciprico Inc.
2955 Xenium Lane
Plymouth, MN 55441
612/559-2034

European Office:
United Kingdom
Phone (0252) 712-011

. . . **where people listen–and respond.™**

8-inch and larger rigid disk drives and subsystems

Company Model	Disk size (inches)	Capacity (M bytes) F=formatted U=unformatted	Average access time (msec)	Number of data surfaces	Number of read/write heads	Actuator type	Dimensions (H×W×D/inches)	Interface	Price $ (quantity)	Notes, features, options
7911/7912/7914 (subsystems)	14	35/80/170 U 28.1/65.6/132.1 F	35.4/ 35.4/ 36.4	2/4/4	3/7/7	closed-loop rotary voice coil	28×14×28	HP-IB	10,300/11,300/ 13,850(Q1)	includes ¼-inch, 67M-byte tape cartridge backup; power supply; controller
7933H/7935H (subsystems)	14	480 U (removable) 404 F	24	13	13	closed-loop linear voice coil	32.5×21.7×32.8	HP-IB	25,200/27,800(Q1)	includes power supply, controller; 7935H: removable cartridge
HITACHI AMERICA LTD. (COMPUTER SALES & SERVICE DIV.) Circle 234 950 Elm Ave., San Bruno, CA 94066, (415) 872-1902										
DK812S/DK814S Series	8	170.1/340 U	25/20	3-10/ 5-10	3-10/ 5-10	closed-loop rotary voice coil	5.12×8.55×14.96	SMD/ ESMD		
DK815-5	8.8	525 U	18	14	14	closed-loop rotary voice coil	10.2×8.5×20	ESMD		
IBIS SYSTEMS INC. 5775 N. Lindero Canyon Rd., Westlake Village, CA 91362, (818) 706-2505										**Circle 235**
1400 (subsystem)	14	1416 U 1250 F						custom	71,500(Q1); 54,975(Q100)	includes internal power supply
IBM CORP. Old Orchard Rd., Armonk, NY 10504, (914) 765-1900										**Circle 236**
3380 Mod D	14	2521 F	15	30	60	linear rack and pinion	70.5×44.5× 32.1, 70.5×40×32.1	IBM S/370 channel		
3380 Mod E	14	5042 F	17	30	60		70.5×44.5×32.1, 70.5×40×32.1			
MEGAVAULT MEMORIES 6431 Independence Ave., Woodland Hills, CA 91367, (818) 884-7300										**Circle 237**
Vault Series 10 (subsystem)	8	80, 186, 212 U	25		3, 7, 8		6.82×14.03×22.25	SMD, SDSI, ANSI, ST506	3,300(Q1)	MegaVault MV212 drive; includes power supply
MILTOPE CORP. 1770 Walt Whitman Rd., Melville, NY 11747, (516) 420-0200										**Circle 238**
RDS 1602 (subsystem)	8	160 U (fixed) 134.8 F (removable)	26	10	10	rotary	17.47×19×25	SMD, Norden, Rolm, NTDS, military	52,000(Q1); 46,800(Q500)	removable cartridge; includes power supply, MIL specifications
RDS 4502 (subsystem)	8	45 U (fixed) 35.8 F (removable)	42	5	5	rotary	12.25×19×24	SMD, Norden, Rolm, NTDS, military	45,000(Q1); 40,500(Q500)	removable cartridge; includes power supply, MIL specifications
MITSUBISHI ELECTRONICS AMERICA INC. 991 Knox St., Torrance, CA 90502, (213) 515-3993										**Circle 239**
M4870F	8	251 U	20	12	12		10.2×8.5×29.33	SMD		includes power supply
NCR CORP. (OEM PRODUCTS) 3718 N. Rock Rd., Witchita, KS 67226, (316) 688-8510										**Circle 240**
6098 (subsystem)	8	40-400 F (fixed) 20 F (removable)	35.5- 43.45	10	4-10	rotary	29×9×27	SCSI		fixed/removable cartridge; 60M-byte, ¼-inch streaming tape backup
6099 (subsystem)	8, 9	275-1.6G F (fixed) 20 F (removable)	28.3- 43.45	12	4-24	linear voice coil or rotary	29×22×35	SCSI		fixed/removable cartridge; ½-inch streaming tape backup

8-inch and larger rigid disk drives and subsystems

Company Model	Disk size (inches)	Capacity (M bytes) F=formatted U=unformatted	Average access time (msec)	Number of data surfaces	Number of read/write heads	Actuator type	Dimensions (H×W×D/inches)	Interface	Price $ (quantity)	Notes, features, options
NORTHERN TELECOM INC. (MEMORY SYSTEMS DIV.) 100 Phoenix Dr., Ann Arbor, MI 48106, (313) 973-4692										**Circle 241**
8212X	8	350 U	21	12	12	closed-loop rotary	4.62×8.5×14.25	SMD, SCSI	5,300(Q1); 3,550(Q500)	embedded servo, voltage monitoring, 1.2M-bps transfer rate
8310	8	378 U	20	10	10	closed-loop rotary	4.62×8.5×14.25	SMD, SCSI	5,500(Q1); 3,650(Q500)	embedded servo, voltage monitoring, 1.9M-bps transfer rate
8312	8	563 U	21	12	12	closed-loop rotary	4.62×8.5×14.25	SMD, SCSI	7,565(Q1); 4,990(Q500)	embedded servo, voltage monitoring, 1.9M-bps transfer rate
PERTEC PERIPHERALS CORP. 9600 Irondale Ave., Chatsworth, CA 91311, (818) 882-0030										**Circle 242**
DX199/ DX265/DX332	8	199/265/332 U	22	6/8/10	6/8/10	rotary voice coil	4.62×8.55×14.25	ANSI, SMD, SCSI, ESDI	4,300/4,650/ 5,000(Q1); 3,150/3,400/ 3,650(Q500)	linear, switcher power supplies available
DX368/DX548	8	368/548 U	18/20	10/11	10/11	rotary voice coil	4.62×8.55×16.06	SMD	5,600/6,900(Q1); 4,150/5,100(Q500)	linear, switcher power supplies available
PRIAM CORP. 20 W. Montague Expwy., San Jose, CA 95134, (408) 946-4600										**Circle 243**
803/806/807/808	8	85.68/227/ 334/ 516 U	35/20/ 25/20	5/11/ 11/12	5/11/ 11/12	closed-loop linear voice coil	4.62×8.55×14.25	ANSI, Priam, SMD/ Priam, SCSI, SMD/ ESMD	3,950/5,200/ 6,200/7,000(Q1); 2,550/2,800/ 3,530/4,000(Q500)	
7050	8	70 U	45	5	5	closed-loop linear voice coil	4.63×8.55×14.25	SMD, Priam	3,750(Q1); 2,450(Q500)	
15450	14	158.5 U	46	3.5	7	closed-loop linear voice coil	6.9×16.6×20	Priam, SMD	5,225(Q1); 3,440(Q500)	
DT01-03/ DT01-06/DTI01-07 (subsystems)	8	75/160/292 F							7,995/9,995/ 12,995(Q1)	includes ¼-inch, 60M-byte tape cartridge backup
QUANTUM CORP. 1804 McCarthy Blvd., Milpitas, CA 95035, (408) 262-1100										**Circle 244**
Q2020/Q2030/ Q2040	8	21.33/32/42.66 U	60/60/65	4/6/8	4/6/8	rotary voice coil	4.5×8.55×14.25	SA1000	2,195/2,695/ 3,000(Q1); 1,475/1,775/ 2,075(Q500)	AC, DC power supply
RACET COMPUTES LTD. 1855 W. Katella, Suite 255, Orange, CA 92776, (714) 997-4950										**Circle 245**
PCMS-150 (subsystem)	8	199 U 160 F	22	6	6	rotary	28×11×28	SMD, SASI	16,500(Q1); 11,550(Q100)	Pertec drive; includes ½-inch, 150M-byte streaming tape backup, power supply, controller, system software
PCMS-250 (subsystem)	8	322 U 275 F	22	10	10	rotary	28×22×28	SMD, SASI	19,900(Q1); 20,900(Q100)	Pertec drive; includes ½-inch, 150M-byte streaming tape backup; power supply; controller system software

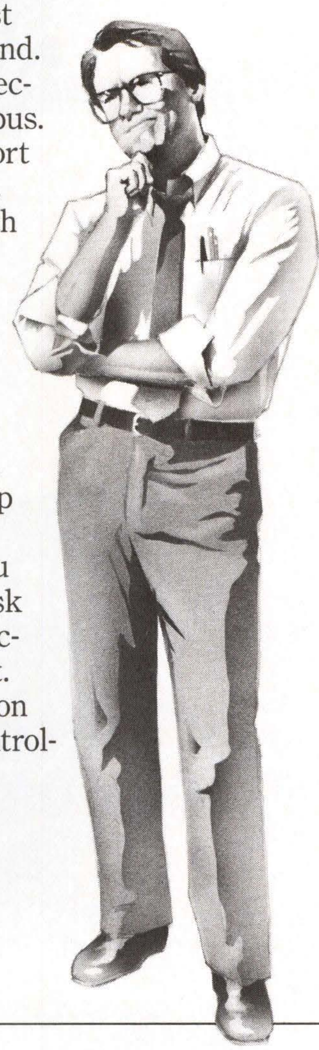
Does A True ESDI Controller Really Exist?

If today's claims and counterclaims leave you unsure of just what constitutes a true ESDI controller, you are not alone. Still, from all the confusion one fact is clearly emerging: simply put—*"a fully effective ESDI controller has to be one that allows your system to take maximum advantage of the SCSI bus."*

To achieve this, the controller must offer these performance features: A 64-Kbyte continuous circular buffer. Burst rates of 1.5 to 1.85 megabytes per second. Full through-parity, connector to connector. Capability to format while off the bus. Programmable sector sizes. Full support of write/verify commands. 48-bit ECC. And the ability to format the drive with redundant ID fields to increase error recoverability.

Any ESDI controller that does not offer at least these features will compromise your system. The ADSI D200 ESDI controller most assuredly provides all these features plus others, thereby enabling your system to live up to its fullest potential.

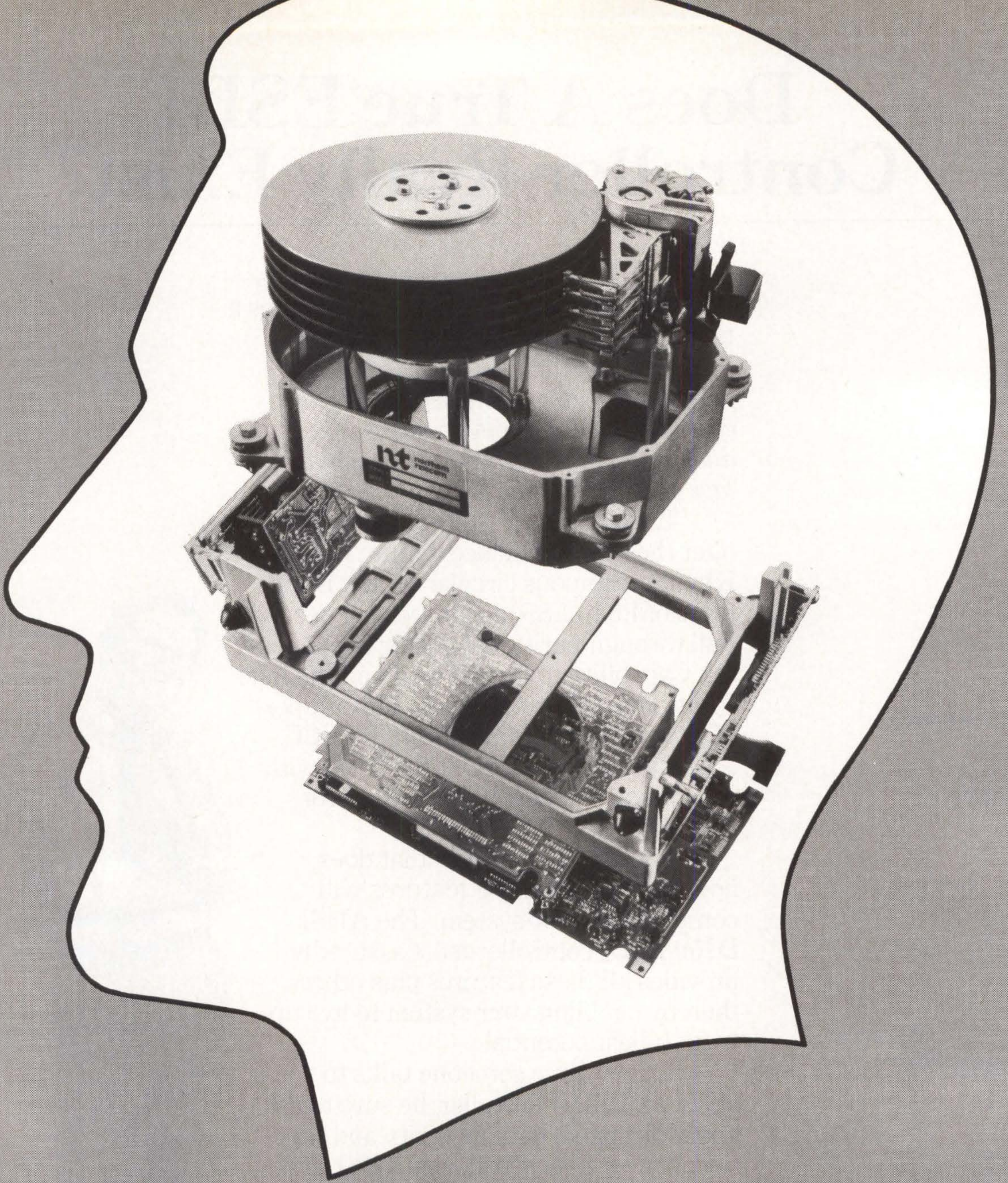
So next time someone talks to you about an ESDI controller, be sure to ask about its speed, data integrity and functionality. Or better still, ask ADSI first. Call 714-594-5858 for full information on the D200 and all our disk and tape controllers and VLSI custom chip sets.



ADSI ADAPTIVE DATA SYSTEMS INC.

Adaptive Data Systems, Inc.
2627 Pomona Blvd., Pomona, CA 91768
714-594-5858 • TLX 183771

CIRCLE NO. 21 ON INQUIRY CARD



FOR THE LATEST IN 8-INCH DISK DRIVES THERE'S ONLY ONE NAME YOU NEED TO REMEMBER: NORTHERN TELECOM.

At Northern Telecom's Memory Systems Division, we can give your computers the highest memory capacity available today. And even more tomorrow. How? It's simple. We're experts.

We have 17 years of design and manufacturing experience, and we're well-versed in all the latest disk drive technology. Take embedded servo. We pioneered it. With its precise track following, embedded servo minimizes improper registration and track runout. The result: High capacity *and* high reliability.

You'll find embedded servo in our Mercury family of 8-inch Winchester drives. You'll also find that no one else today can offer you such a complete range of 8-inch Winchesters, with capacities of 234, 378, and 563MB and SCSI or SMD interfaces.

Find out what we can do for you—today and tomorrow. Call us at 1-800-521-3278. With the help of our Mercury drives, your customers just might "forget" about the competition.

nt northern telecom

CIRCLE NO. 22 ON INQUIRY CARD

8-inch and larger rigid disk drives and subsystems

Company Model	Disk size (inches)	Capacity (M bytes) F=formatted U=unformatted	Average access time (msec)	Number of data surfaces	Number of read/write heads	Actuator type	Dimensions (H×W×D/inches)	Interface	Price $ (quantity)	Notes, features, options
PCMS-411 (subsystem)	14	513 U 411/ F	25	10	19	linear voice coil	28×13.5×29	SMD, SASI	24,900(Q1); 17,400(Q100)	Century Data Systems drive; includes ½-inch, 150M-byte streaming tape backup; power supply; controller; system software
SCIENTIFIC MICRO SYSTEMS INC. 339 N. Bernardo Ave., Mountain View, CA 94043, (415) 964-5700										**Circle 246**
FWT80004/ FWT80007/ FWT80008 (subsystems)	8	20/40/85 U 17.8/35/71.2 F	40	4/8/7	4/8/7	rotary	5.25×19×21	SA1000	6,100/7,000/ 7,900(Q1)	includes flexible drive backup, power supply, controller
STORAGE CONCEPTS INC. 31980 Airport Loop Dr., Costa Mesa, CA 92626, (714) 557-1862										**Circle 247**
Concept 15/ Concept 21 (subsystems)	10.5	474-948/ 474-4.9G F						SMD	41,000/42,000(Q1)	board-level controller with 1-2 Fujitsu M2350A drives; includes power supply
TECSTOR INC. 16161 Gothard St., Huntington Beach, CA 92647, (714) 842-0077										**Circle 248**
Series 3/3XX	14	315 U	29	10	20	rotary	10.5×19×28.2	SMD	10,130-12,000(Q1); 5,680-6,500(Q100)	includes power supply
Series 4/168, Series 4/330 (subsystems)	8	168/337 U	20	10	20	rotary	5.5×8.6×16.5	SMD/ ESMD	4,400-5,750(Q1); 3,450-4,550(Q100)	NEC D2257/D2268 drive
Series 4/520 (subsystem)	9	520 U	15	10	20	rotary	10.2×8.5×29	ESMD	9,600(Q1); 7,600(Q100)	NEC D2352 drive, includes power supply
TOSHIBA AMERICA INC. (DISK PRODUCTS DIV.) 3910 Freedom Circle, Suite 103, Santa Clara, CA 95054, (408) 727-3939										**Circle 249**
MK-182FB/ MK-184FB	8	83/116.1 U	18	5/7	5/7	rotary voice coil	5.1×8.5×15	SMD	2,345/2,455(Q100)	
MK-186FB/ MK-286FA/ MK-286FB	8	165.9/337.4 U	18	10	10	rotary voice coil	5.1×8.5×15	SMD/ ESMD/ HSMD	2,680/4,125(Q100)	

Information was solicited but not received from the following manufacturers:

Amcodyne Inc.
1301 South Sunset St.
Longmont, CO 80501
(303) 772-2601

Bull Peripherals Corp.
766 San Aleso Ave.
Sunnyvale, CA 94086
(408) 745-0855

Charles River
Data Systems
983 Concord St.
Framingham, MA 01532
(617) 626-1000

Data General Corp.
4400 Computer Dr.
Westboro, MA 01580
(617) 366-8911

Datrex Inc.
3536 W. Osborn Rd.
Phoenix, AZ 85019
(602) 272-9491

Digital Equipment Corp.
146 Main St.
Maynard, MA 01745
(617) 897-5111

Disc Tech One Inc.
849 Ward Dr.
Santa Barbara, CA 93111
(805) 964-3535

Eicon Research Inc.
1226 W. Broadway
Hewlett, NY 11557
(516) 374-6887

Harris Corp.
(Computer Systems Div.)
2101 Cypress Creek Rd.
Ft. Lauderdale, FL 33309
(305) 974-1700

Iomega Corp.
1821 W. 4000 South
Roy, UT 84067
(801) 778-1000

Modular Computer
Systems Inc.
P.O. Box 6099
Ft. Lauderdale, FL 33310
(305) 974-1380

National Semiconductor
Datachecker/DTS
1050 Stewart Dr.
Sunnyvale, CA 94086
(408) 749-7880

NEC Information
Systems Inc.
1414 Massachusetts Ave.
Boxborough, MA 01719
(617) 264-8000

Newbury Data
Recording Ltd.
Hawthrone Rd., Staines,
Middlesex, TW18 3BJ, England
(0784) 61500

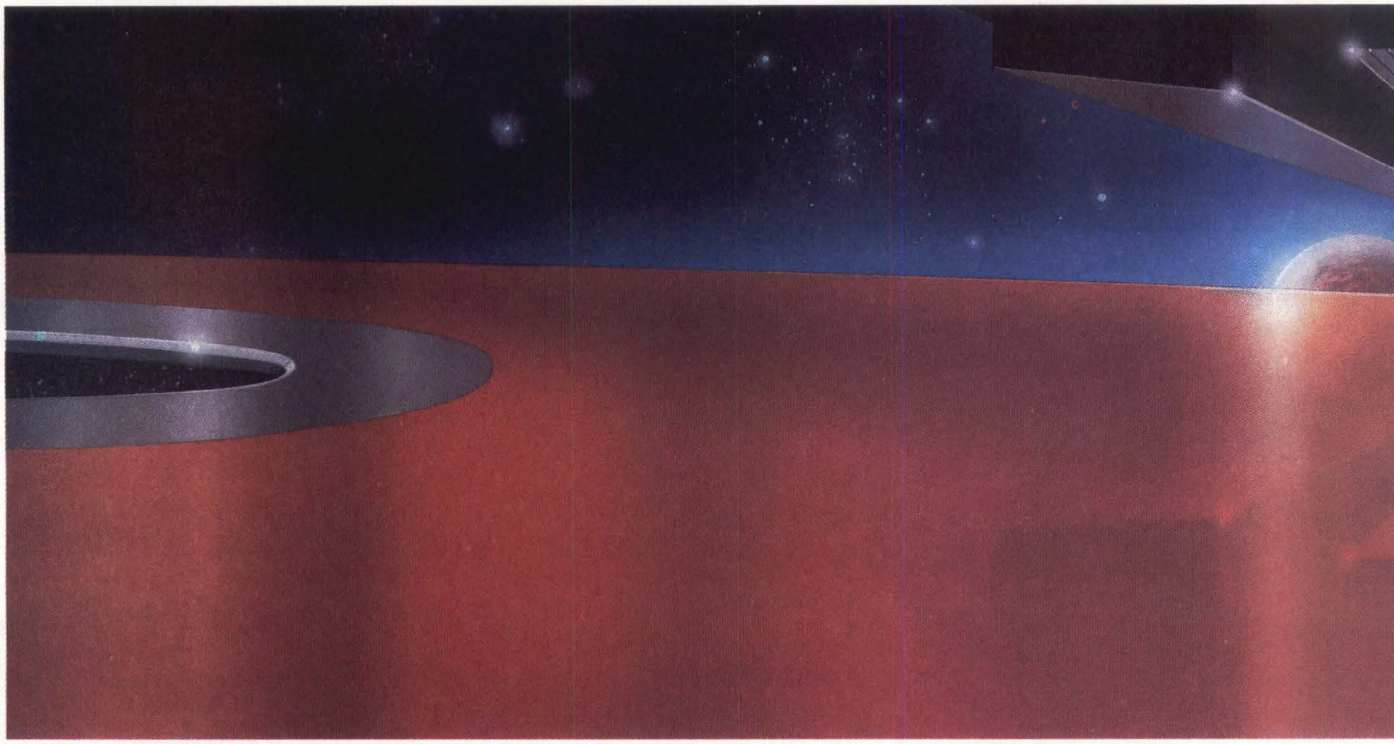
Qualogy Inc.
2241 Lundy Ave.
San Jose, CA 95131
(408) 946-5800

System Industries
1855 Barber Lane
Milpitas, CA 95035
(408) 942-1212

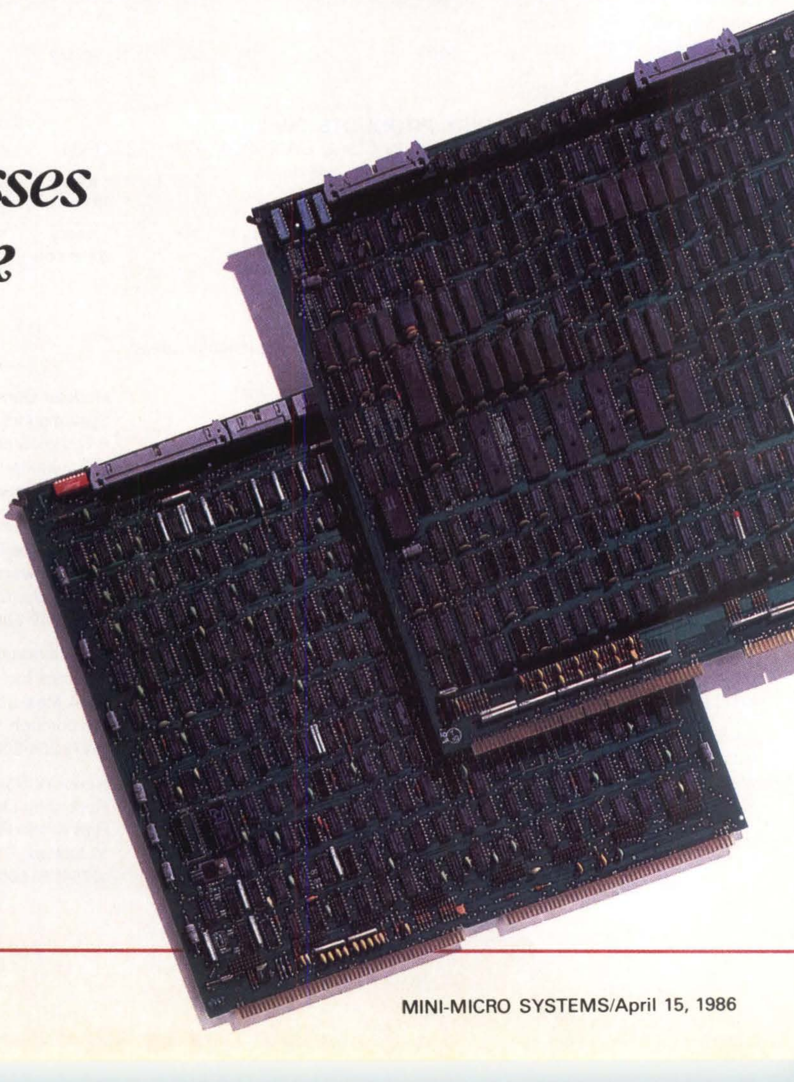
Tecmar Inc.
6225 Cochran Rd.
Cleveland, OH 44139
(216) 349-0600

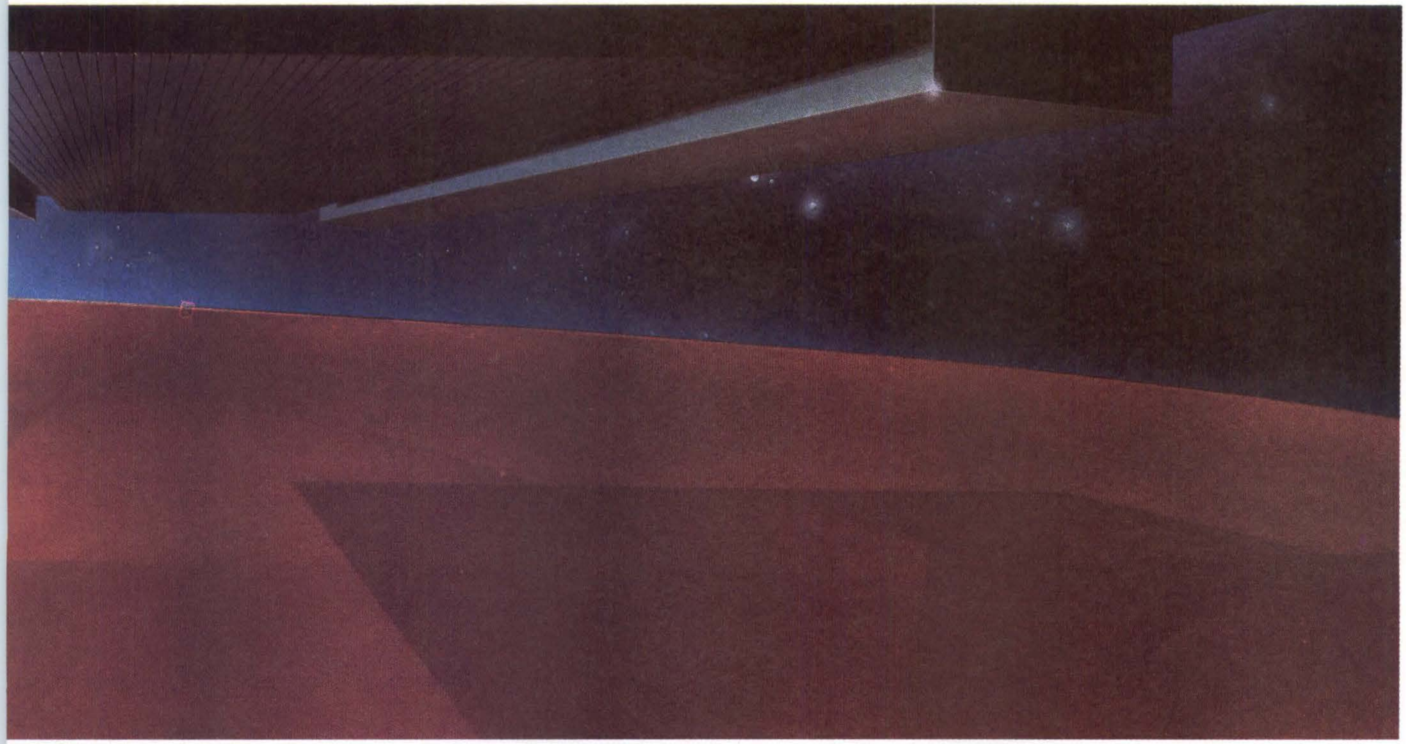
Vermont Research Corp.
Precision Park
North Springfield, VT 05150
(802) 886-2256

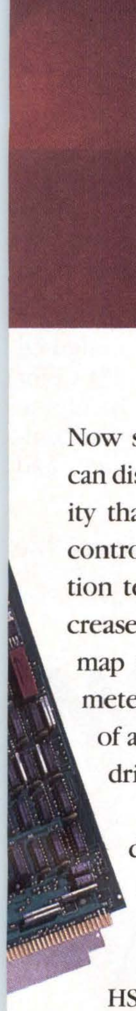
Wang Laboratories Inc.
One Industrial Ave.
Lowell, MA 01851
(617) 459-5000



Discover All The Addresses On Your Block







Now systems integrators using Data General minicomputers can discover significantly more addressable disk storage capacity than ever before through a new feature on Zetaco disk controllers: Virtual Mapping. This true block address translation technique yields higher formatted capacities (100% increase in some cases!) on popular SMD drives that ordinarily map out inefficiently under RDOS, AOS and AOS/VS parameters. All under true emulation without software patching of any kind! Zetaco lets you choose from a wider variety of drives, to exactly fit your subsystem needs.

Virtual Mapping is available now on our two new disk controllers: Model BMX-3, compatible with the high-speed Burst Multiplexor Channel on DG's MV series, and Model DC-297, designed for Data Channel interface on Nova & Eclipse. Both support up to four SMD and/or HSMD drives, with data transfer rates up to 2.5 MB/sec, so you can integrate the latest high speed technology.

Discover Zetaco, your link to tomorrow. Call or write for full details: Zetaco, Inc., 6850 Shady Oak Rd, Eden Prairie, MN 55344 U.S.A. (612) 941-9480. Telex 290975. Zetaco International, 9 High Street, Tring, Hertfordshire, HP23 5AH England. (44)44282-7011. Telex 827557.

ZETACO

The Link To Tomorrow.

AMT Office Printer™

Tired of juggling three or more separate devices to meet your printing needs? Confused about which technology—daisywheel, dot-matrix, plotter, ink-jet, thermal or laser—is right for you?

The *all-in-one AMT Office Printer* does the job of all these devices with superb print quality, speed, and the ability to mix text with multicolor high-resolution graphics. In fact, this exciting printer has set a new standard in functional versatility.

How can one printer do so much? With an ingenious print mechanism, unrivaled font, graphic and color flexibility, plus widespread hardware and software compatibility.

And the AMT Office Printer is applications-oriented. For *word processing*, there is letter- and memo-quality text, a font library with both fixed and proportionally-spaced fonts, scientific and technical character sets, and built-in features that italicize, color, bold, shadow, underscore, expand, center, and justify text. For *data processing*, there is high-speed, draft-quality text with up to 225 characters per line. For *business graphics, CAD/CAE plots, and other precision graphic applications*, there are full-color graphic modes providing resolutions up to 240V x 480H dots per inch. And for *technical applications*, there is software for custom font generation, plotter emulation, and VDI/GDI graphics compatibility.

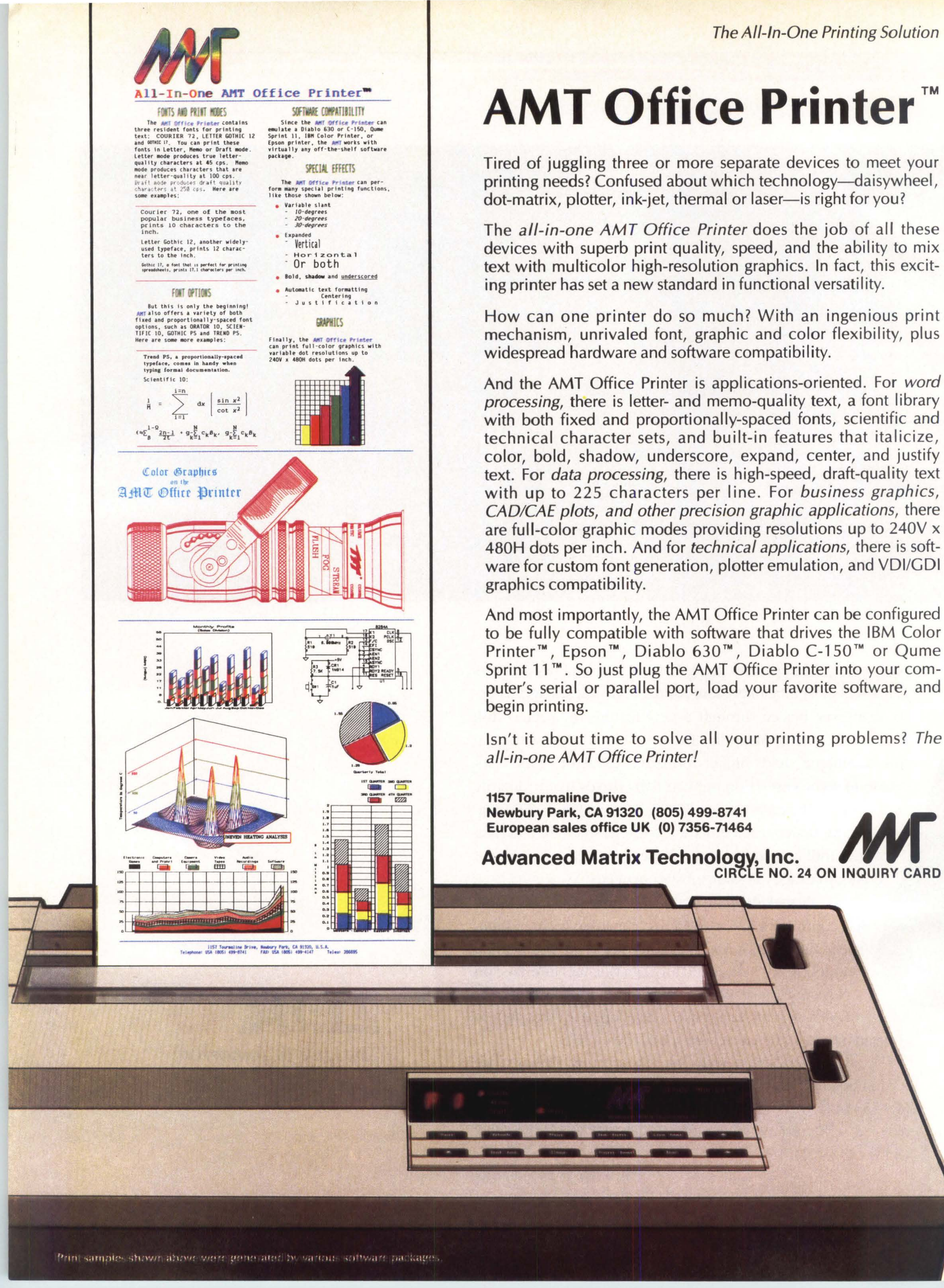
And most importantly, the AMT Office Printer can be configured to be fully compatible with software that drives the IBM Color Printer™, Epson™, Diablo 630™, Diablo C-150™ or Qume Sprint 11™. So just plug the AMT Office Printer into your computer's serial or parallel port, load your favorite software, and begin printing.

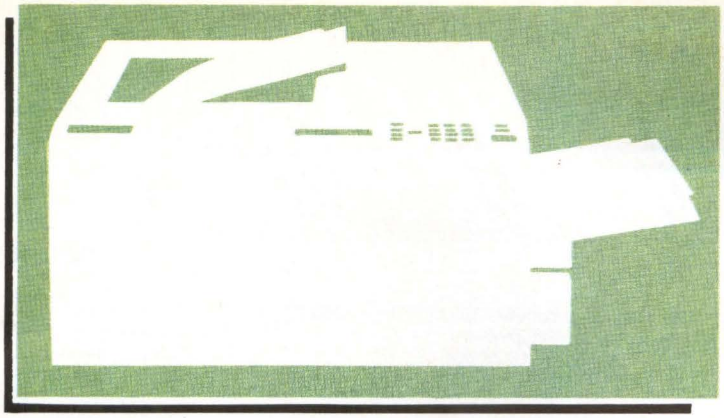
Isn't it about time to solve all your printing problems? *The all-in-one AMT Office Printer!*

1157 Tourmaline Drive
Newbury Park, CA 91320 (805) 499-8741
European sales office UK (0) 7356-71464

Advanced Matrix Technology, Inc.

CIRCLE NO. 24 ON INQUIRY CARD





Line/page printers

Company Model	Print method	Print speed	Characters per line	Simultaneous copies	Forms width (inches)	Interfaces (protocols)	Price $ (quantity)	Notes, features, options
ADVANCED TECHNOLOGIES INTERNATIONAL 2041 Mission College Blvd., Suite 163, Santa Clara, CA 95054, (408) 748-1688								**Circle 298**
LaserPRINT 2670	laser (page printer)	26 ppm	programmable	none		RS232C; Centronics, Dataproducts parallel (X-on/X-off; DTR; ETX/ACK; Diablo 630; NEC 3550; DEC LN01; Epson FX80, MX80; Wang 5573; Dataproducts; up to 19.2K bps)	11,400(Q1)	bit-mapped, block, raster graphics; diagnostics; power paper puller; variable forms unit; noise level less than 55 dB(a)
AMERICAN COMPUTER HARDWARE CORP. 2205 S. Wright St., Santa Ana, CA 92705, (714) 549-2688								**Circle 299**
ACB-300/ ACB-600/ ACB-1000	band (line printer)	300/650/1025	132, 136	6	3-16	RS232C, Centronics, Dataproducts (X-on/X-off, DTR, up to 19.2K bps)		self-test, noise level 60 dB(a)
AC-2230/ AC-2260/ AC-2290	drum (line printer)	300/600/900 lpm	132, 136	6	4-16.75	RS232C, Centronics, current loop, Dataproducts (X-on/X-off, DTR, up to 19.2K bps)		self-test
AC-5200/AC-5600	ion deposition	60/90 ppm		none		RS232C, Centronics, Dataproducts (X-on/X-off, DTR, up to 19.2K bps)		graphics, bar codes
AT&T TELETYPE CORP. 5555 Touhy Ave., Skokie, IL 60077, (312) 982-2286								**Circle 300**
40	belt (line printer)	220-300 lpm	80-132	6	4-15	RS232C, current loop, SSI (X-on/X-off, DTR, up to 4800 bps)	4,485-7,630(Q1)	diagnostics, opt. controller
447	band (line printer)	600-1000 lpm	132	6	3-16	RS232C, Centronics, Dataproducts (110-19.2K bps, X-on/X-off, DTR, ETX/ACK)	10,995-14,995(Q1)	
BULL PERIPHERALS CORP. 766 San Aleso, Sunnyvale, CA 94086, (408) 745-0855								**Circle 301**
6050	non-impact magnetographic (page printer)	50 ppm	programmable	1-99		Dataproducts	30,000(Q1)	
6090	non-impact magnetographic (page printer)	90 ppm	programmable	1-99		Dataproducts	55,000(Q1)	
CENTRONICS DATA COMPUTER CORP. One Wall St., Hudson, NH 03051, (603) 883-0111								**Circle 302**
Linewriter 400	band (line printer)	400 lpm	132-136	6	4-18	RS232C, RS422, RS423, RS449, Centronics, Dataproducts		noise level 55 dB(a)
Linewriter 800	band (line printer)	800 lpm	132-136	6	4-18	RS232C, RS422, RS423, RS449, Centronics, Dataproducts		noise level 55 dB(a)
Lineprinter 1200	band (line printer)	1200 lpm	132-136	6	4-18	RS232C, RS422, RS423, RS449, Centronics, Dataproducts		noise level 55 dB(a)

Line/page printers

Company Model	Print method	Print speed	Characters per line	Simultaneous copies	Forms width (inches)	Interfaces (protocols)	Price $ (quantity)	Notes, features, options
CIE TERMINALS INC. 2505 McCabe Way, Irvine, CA 92714, (714) 660-1421								**Circle 303**
CI-300+	impact matrix (line printer)	85-300 lpm	200	6	3.5-16	Centronics parallel, RS232C serial, Dataproducts (ACK/NAK, 19.2K bps)	4,495(Q1)	bar codes, dual microprocessors with RAM and ROM; opt. synch data communications protocols
CI-600+	impact matrix (line printer)	170-600 lpm	200	6	3.5-16	Centronics parallel, RS232C serial, Dataproducts (ACK/NAK, 19.2K bps)	6,795(Q1)	bar codes, dual microprocessors with RAM and ROM; opt. synch data communications protocols
LIPS 10	laser (page printer)	10 ppm		none		Centronics parallel, RS232C serial	3,495(Q1)	graphics and forms generation, industrial graphics
CONCEPT TECHNOLOGIES INC. P.O. Box 5277, Portland, OR 97208, (503) 684-3314								**Circle 304**
ConceptWriter	laser (page printer)	8 ppm		none		RS232C, Centronics (X-on/X-off, DTR, 9600 bps)	4,495(Q1)	bit-mapped graphics
CORDATA (FORMERLY CORONA DATA SYSTEMS INC.) 275 E. Hillcrest Dr., Thousand Oaks, CA 91360, (805) 495-5800								**Circle 305**
CP-300	laser (page printer)	8 ppm	programmable	none		IBM PC-compatible buses (1.8M bps, Epson)	3,395(Q1)	color printing
DATA GENERAL CORP. 4400 Computer Dr., Westboro, MA 01580, (617) 366-8911								**Circle 306**
4300 Series Band Printers	band (line printers)	230, 300, 460, 600 lpm	132	6	3-16	parallel	8,700-13,300(Q1)	
4373/4374	band (line printer)	890/1200 lpm	132	6	4-16.75	parallel (proprietary)	28,500/ 27,000(Q1)	diagnostics, power paper stacker, acoustic cabinet
4557/4558	laser (page printer)	8 ppm	132	none		RS232C, RS422A (proprietary)	3,500/ 5,995(Q1)	4558 has graphics
DATAPOINT CORP. 9725 Datapoint Dr., San Antonio, TX 78284, (512) 699-7000								**Circle 307**
9257	band (line printer)	300 lpm	132		3-16	RS232C	9,500(Q1); 8,075(Q100)	acoustic cabinet
9258	band (line printer)	600 lpm	132		3-16	RS232C	13,000(Q1); 11,050(Q100)	acoustic cabinet
9660	laser (line printer)	1300 lpm	programmable			RS232C	47,500(Q1); 40,375(Q100)	
DATAPRODUCTS CORP. 6200 Canoga Ave., P.O. Box 746, Woodland Hills, CA 91365-0764, (818) 887-8000								**Circle 308**
B-1000/BP-1500/ BP-2000	band (line printer)	1100/1500/2000 lpm		6	3-16/ 3.5-18.75	Dataproducts parallel (up to 19.2K bps)	13,200/ 22,500/ 30,000(Q1)	self-test, acoustic cabinet
LB-300/LB-600	band (line printer)	330/660 lpm		6	3-16	Dataproducts parallel (up to 19.2K bps)	4,995/ 6,795(Q1)	direct access VFU, universal power supply
LZR-2630/ 2650/2655	laser (page printer)	up to 26 ppm		none		RS232C, Dataproducts, Centronics	14,900/ 17,900-19,900(Q1)	
DELPHAX SYSTEMS 35 Pacella Park Dr., Randolph, MA 02368, (617) 961-2312								**Circle 309**
S3000/S6000/2490	ion deposition (page printer)	30/60/90 ppm				Centronics, Dataproducts, S600 has optional Dataproducts, IBM 3211 emulation		diagnostics, page counter; opt. base cabinet/opt. DFU/OEM print engine, continous speed paper
FUJITSU AMERICA INC. 3055 Orchard Dr., San Jose, CA 95134, (408) 946-8777								**Circle 310**
M3040/M3041	band (line printer)	300/600 lpm	132, 136	6	3-17	RS232C, Centronics, Dataproducts (up to 19.2K bps)	6,435/ 7,735(Q1); 3,600/ 4,250(Q100)	noise level under 55 dB(a)
M3042/M3043	band (line printer)	900/1200 lpm	132, 136	6	3-17	RS232C, Centronics, Dataproducts (up to 19.2K bps)	11,635/ 15,860(Q1); 6,750/ 8,100(Q100)	noise level under 55 dB(a)

Line/page printers

Company Model	Print method	Print speed	Characters per line	Simultaneous copies	Forms width (inches)	Interfaces (protocols)	Price $ (quantity)	Notes, features, options
GENERAL BUSINESS TECHNOLOGY INC. 1891 McGaw Ave., Irvine, CA 92714, (714) 261-1891								**Circle 311**
3220LP	band (line printer)	720 lpm	132, 198	6	4-16.75	IBM System /34, /36, /38 (twin-ax)	11,500(Q1)	diagnostics, acoustic cabinet
3310LP	band (line printer)	450 lpm	132, 198	6	4-18	IBM System /34, /36, /38 (twin-ax)	8,800(Q1)	diagnostics, acoustic cabinet
6630XP	laser (page printer)	8 ppm	up to 198	none		IBM System /34, /36, /38, Displaywriter, 327X (twin-ax)	4,995(Q1)	diagnostics, raster graphics
GENERAL OPTRONICS CORP. 2 Olsen Ave., Edison, NJ 08820, (201) 549-9000								**Circle 312**
Holoscan 28	laser (page printer)	28 ppm	275, programmable	none		RS232C, Centronics, Dataproducts (X-on/X-off; DTR; ETX/ACK; Diablo 630; Qume Sprint II; NEC Spinwriter; Epson MX80, FX80; 19.2K bps)	14,500(Q1); 8,500(Q100)	bit-mapped, raster, vector graphics; diagnostics
GENICOM CORP. One General Electric Dr., Waynesboro, VA 22980, (703) 949-1000								**Circle 313**
4410	impact matrix (line printer)	300 lpm	programmable	6	3-16.54	RS232C, Centronics, Dataproducts, Printronix (ANSI X3.64, Printronix, 500K bps)	6,195(Q1)	line drawing; block, raster graphics
4440	impact matrix (line printer)	600 lpm		6	3-16.54	RS232C, Centronics, Dataproducts, Printronix (ANSI X3.64, Printronix, 500K bps)	7,795(Q1)	line drawing; block, raster graphics
5010	laser (page printer)	10 ppm		none		(Diablo 630, IBM Graphic Printer, Hewlett-Packard Laser Jet)	3,000(Q1)	bit-mapped graphics
HARRIS CORP. (COMPUTER SYSTEMS DIV.) 2101 W. Cypress Creek Rd., Ft. Lauderdale, FL 33309, (305) 974-1700								**Circle 314**
PB 4337	band (line printer)	600 lpm	132, 136, programmable	6	3-17	RS232C (X-on/X-off, 19.2K bps)	14,000(Q1)	self-diagnostics
PL 4508	laser (page printer)	8 ppm		none		RS232C (RTS/CTS, X-on/X-off, 19.2K bps)	7,495(Q1)	bit-mapped, raster, vector graphics; self-diagnostics
PM 4430	impact matrix (line printer)	300 lpm	132, 176, 220, programmable	6	3-16	RS232C (19.2K bps)	12,960(Q1)	raster graphics
HETRA COMPUTER AND COMMUNICATIONS INDUSTRIES INC. P.O. Box 970, Melbourne, FL 32901, (305) 723-7731								**Circle 315**
3024	laser (page printer)	24 ppm	programmable	none		RS232C, Centronics, RS422, RS423, Dataproducts, MIL-188-114 (X-on/X-off, DTR, DSR, ETX/ACK, 19.2K bps)	21,500(Q1)	diagnostics; communications graphics scanner; raster, vector graphics
3100	band (line printer)	600 lpm	132-136	6	3.5-18	RS232C, Centronics, RS422, RS423, Dataproducts, MIL-188-114 (X-on/X-off, ACK/NAK, 19.2K bps)	12,000(Q1)	diagnostics, power paper puller, variable forms unit, acoustic cabinet
3300	band (line printer)	1200 lpm	132-136	6	3.5-19	RS232C, Centronics, RS422, RS423, Dataproducts, MIL-188-114 (X-on/X-off, ACK/NAK, 19.2K bps)	24,000(Q1)	diagnostics, power paper puller, variable forms unit, acoustic cabinet
HEWLETT-PACKARD CO. (BOISE DIV.) 11311 Chinden Blvd., Boise, ID 83707, (208) 323-6000								**Circle 316**
LaserJet/LaserJet Plus	laser (page printer)	8 ppm				RS232C, RS422/RS232C, RS422, Centronics (X-on/X-off, up to 19.2K bps)	2,995/ 3,995(Q1)	raster graphics/bit-mapped, raster graphics
2563A/2564B	impact matrix (line printer)	300/600 lpm	66-120	6	3-16.7	RS232C, RS422A, Centronics, Dataproducts, IEEE 488 (X-on/X-off, ETX/ACK, ENQ/ACK, DTR, up to 19.2K bps)	5,780/ 9,995(Q1); 3,930/ 6,597(Q100)	raster graphics; opt. bar codes

Line/page printers

Company Model	Print method	Print speed	Characters per line	Simultaneous copies	Forms width (inches)	Interfaces (protocols)	Price $ (quantity)	Notes, features, options
HP 2689A	laser (page printer)	45 ppm		none	6.5-12.7	(IBM 3211)	99,950(Q1)	diagnostics
HONEYWELL INFORMATION SYSTEMS INC. 65 Walnut St., Wellesley, MA 02181, (617) 431-6000								**Circle 317**
PPSII	electrostatic (page printer)	140-210 ppm					265,000-325,000(Q1)	diagnostics
PPSIII	ion deposition (page printer)	90 ppm					280,000-350,000(Q1)	diagnostics
IMAGEN CORP. 2650 San Tomas Expwy., Santa Clara, CA 95052-8101, (408) 986-9400								**Circle 318**
8/300	laser (page printer)	8 ppm		none		RS232C, Centronics, Dataproducts (X-on/X-off, DTR, Centronics, XNS, TCP-IP, up to 19.2K bps)	8,950(Q1)	color printing, bit-mapped graphics
12/300	laser (page printer)	12 ppm		none		RS232C, Centronics, Dataproducts (X-on/X-off, DTR, Centronics, XNS, TCP-IP, up to 19.2K bps)	15,800(Q1)	bit-mapped graphics, color printing
24/300	laser (page printer)	24 ppm		none		RS232C, Centronics, Dataproducts (X-on/X-off, DTR, Centronics, XNS, TCP-IP, up to 19.2K bps)	29,950(Q1)	bit-mapped graphics, color printing
KENTEK INFORMATION SYSTEMS INC. 6 Pearl Ct., Allendale, NJ 07401, (201) 825-8500								**Circle 319**
K-2	belt (page printer)	12 ppm	programmable	none		RS232C, RS422, Centronics (X-on/X-off; Diablo 630; Epson MX80; Tektronix 4014, PLOT 10; up to 38.4K bps)	7,995(Q1)	self-diagnostics; bit-mapped, vector, raster graphics; opt. envelope feeder
MANNESMANN TALLY CORP. 8301 S. 180th St., Kent, WA 98032, (206) 251-5500								**Circle 320**
MT660	impact matrix (line printer)	600 lpm		6	4-16	RS232C, RS422, Centronics, Dataproducts parallel (X-on/X-off, BUSY/READY, ENQ/ACK, ETX/ACK, ACK/NAK, up to 19.2K bps)		dot-addressable graphics, diagnostics
MT 690	impact matrix (line printer)	900 lpm		6	4-16	Dataproducts parallel, Centronics (X-on/X-off, BUSY/READY, ENQ/ACK, ETX/ACK, ACK/NAK, up to 19.2K bps)		dot-addressable graphics, diagnostics
MILTOPE CORP. 1770 Walt Whitman Rd., Melville, NY 11747, (516) 420-0200								**Circle 321**
HSP 3609-212A	impact matrix (line printer)	400 lpm	80, 132	3		RS232C; Centronics; Dataproducts; MIL-STD 188, 1397 NTDS, 1397 ANEW (up to 9600 bps)	21,000(Q1); 19,500(Q100)	dot-addressable graphics, acoustic cabinet
TP 2000	thermal matrix (line printer)	160 lpm	80	none		RS232C; Centronics; Dataproducts; MIL-STD 188, 1397 NTDS, 1397 ANEW (up to 9600 bps)	8,500(Q1); 8,000(Q100)	dot-addressable graphics, acoustic cabinet, power paper puller
TP 3000	thermal matrix (line printer)	1000 lpm	80, 132	none		RS232C; Centronics; Datproducts; MIL-STD 188, 1397 NTDS, 1397 ANEW (up to 19.2K bps)	17,900(Q1); 17,000(Q100)	dot-addressable graphics, acoustic cabinet
NEC INFORMATION SYSTEMS 1414 Massachusetts Ave., Boxborough, MA 01719, (617) 264-8000								**Circle 322**
LC-800	non-impact (page printer)	8 ppm		none		serial, parallel (up to 19.2K bps)	2,995(Q1)	bit-mapped graphics

CIRCLE NO. 25 ON INQUIRY CARD

Our belief in distinctive features endures in our latest VT220 emulator.

Geisha.

With whitened face and elegant kimono. In the past, she was a fashion innovator. Now she is a curator of tradition.

It is our respect for such features that leads us directly to the CIT 224 terminal, a product renowned for distinctive features.

You can, if you wish, take the CIT 224 directly from its carton and employ it anywhere you'd use a DEC VT220.

The moment you begin using it, however, the CIT 224 makes a grand leap from mere compatibility to clear superiority. Because, as you would expect, we designed it with many features not found in the DEC terminal.

There is our larger 14-inch display. Two more inches on a tilt and swivel monitor with 10 x 16 character cells,

gives you greater resolution and character definition. Not to mention less strain on your eyes after a long day.

The CIT 224 delights many users with twice as many function keys. It also has eleven set-up screens—four more than the competition.

But there is yet one more feature that DEC has found impossible to craft into their terminals. CIE Terminals reliability. It is our dedication to reliability that helps us keep our warranty repair incidents under one percent. And keeps our prices so fiercely competitive.

And that may just be the most distinctive, most beautiful feature of all.

CIE TERMINALS

Where craftsmanship is still a tradition.

CIE Terminals, Inc., 2505 McCabe Way, Irvine, CA 92714-6297. 1-800-624-2516

CIRCLE NO. 26 ON INQUIRY CARD

Line/page printers

Company Model	Print method	Print speed	Characters per line	Simultaneous copies	Forms width (inches)	Interfaces (protocols)	Price $ (quantity)	Notes, features, options
NEWBURY DATA INC. 2200 Pacific Coast Hwy., Suite 208, Hermosa Beach, CA 90254, (213) 372-3775								**Circle 352**
8650	impact matrix (line printer)	300 lpm	226, programmable	5	4-15.31	RS232C, current loop, Centronics (X-on/X-off, DTR, ETX/ACK, ENQ/DLE, Centronics 350, ANSI, 50-9600 bps)	3,800(Q1)	self-test, acoustic cabinet, noise level less than 55 dB(a)
8905/8926	impact matrix (line printer)	110/150 lpm	220, programmable	5	4-15.31	RS232C, Centronics, current loop (X-on/X-off, DTR, ETX/ACK, 9600 bps)	1,800/ 2,400(Q1)	color printing, self-test, block graphics/color printing, block graphics, noise level less than 45 dB(a)
8933/8935	impact matrix (line printer)	150/120 lpm	220, programmable	5	4-15.31	RS232C, Centronics, current loop ((X-on/X-off, ETX/ACK, Diablo 630, ANSI, 50-9600 bps)	3,800/ 3,500(Q1)	self-test
OASYS (OFFICE AUTOMATION SYSTEMS INC.) 4640 Jewell St., San Diego, CA 92109, (619) 483-9200								**Circle 323**
LaserPro 805-C/ LaserPro 805-R	laser (page printer)	8 ppm	80-187, programmable	none		Centronics parallel, RS232C (X-on/X-off, DTR, ETX/ACK, 300-19.2K bps)	3,295/ 3,795(Q1)	limited vector graphics, page counter
LaserPro 810-C/ LaserPro 810-R	laser (page printer)	8 ppm	80-220, programmable	none		Centronics parallel, RS232C (X-on/X-off, DTR, ETX/ACK, 300-19.2K bps)	4,995(Q1)	bit-mapped, block graphics; page counter
LaserPro 820-C/ LaserPro 820-R	laser (page printer)	8 ppm	80-220, programmable	none		Centronics parallel, RS232C (X-on/X-off, DTR, ETX/ACK, 300-19.2K bps)	5,995(Q1)	bit-mapped, block graphics
OUTPUT TECHNOLOGY CORP. E. 9922 Montgomery, Spokane, WA 99206, (800) 468-8788								**Circle 324**
OT-700	impact matrix (line printer)	200 lpm	68, 81, 116, 136, 163, 226	6	3-16	RS232C, Centronics (X-on/X-off, ETX/ACK, DTR, up to 9600 bps)	1,795(Q1)	bit-mapped graphics
OT-700e	impact matrix (line printer)	200 lpm	68, 81, 116, 136, 163, 226	6	3-16	RS232C, Centronics (X-on/X-off, ETX/ACK, DTR, up to 9600 bps)	1,995(Q1)	bit-mapped graphics
OT-777	impact matrix (line printer)	200 lpm	68, 81, 116, 136, 163, 226	6	3-16	IBM System /34, /36, /38 (X-on/X-off, ETX/ACK, DTR, IBM System 3X, up to 9600 bps)	3,195(Q1)	bit-mapped graphics
PARADYNE CORP. 8550 Ulmerton Rd., Largo, FL 33540, (813) 530-2000								**Circle 325**
8360 Page Printer	ion deposition (page printer)	60 ppm	225, programmable			IBM channel	54,000(Q1)	
PRINTRONIX INC. 17500 Cartwright, Irvine, CA 92713, (714) 863-1900								**Circle 326**
L150	impact matrix (line printer)	80, 150, 200 lpm		6		Centronics	3,995(Q1)	raster graphics; opt. Dataproducts, RS232C, IBM 3287
LP20	laser (page printer)	20 ppm		none		Centronics, Dataproducts	11,995(Q1)	opt. RS232C
MV150B	impact matrix (line printer)	200 lpm		6		Centronics	3,745(Q1)	raster, block graphics
QMS INC. P.O. Box 81250, Mobile, AL 36608, (205) 633-4300								**Circle 327**
KISS	laser (page printer)	6 ppm	programmable	none		RS232C, Centronics, (up to 19.2K bps, X-on/X-off, DTR, RTS)	1,995(Q1)	bit-mapped graphics

Line/page printers

Company Model	Print method	Print speed	Characters per line	Simultaneous copies	Forms width (inches)	Interfaces (protocols)	Price $ (quantity)	Notes, features, options
LASERGRAPHIX 800/1200/2400	laser (page printer)	8/12/24 ppm	programmable	none		RS232C, current loop; Centronics; Dataproducts; IBM 3271, 3272, 3274 A&B, 3276, System/34,/36,/38, synch 2780, 3780; Burroughs; Sperry DCT-1000; (up to 19.2K bps, X-on/X-off, ETX/ACK, DTR, BUSY, ACK, SNA SDLC, BSC)	7,995/ 19,995/ 29,995(Q1)	vector, business, bit-mapped, plot/pixel graphics; opt. Tektronix 4010, 4014 emulation; bit-mapped graphics are optional on LASERGRAPHIX 2400
SmartWriter	laser (page printer)	8 ppm	programmable	none		RS232C, Centronics (up to 19.2K bps, X-on/X-off, DTR, RTS)	3,850(Q1)	bit-mapped graphics, supports ANSI X3.64 graphics
RICOH CORP. 5 Dedrick Place, W. Caldwell, NJ 07006, (201) 882-2000								**Circle 328**
4080 R	laser (page printer)	8 ppm	programmable	none		RS232C, Centronics (DTR, ETX/ACK)	4,000(Q1); 3,000(Q100)	raster graphics
WANG LABORATORIES INC. One Industrial Ave., Lowell, MA 01851, (617) 459-5000								**Circle 329**
5573	band (line printer)	300 lpm	up to 132	6	3-16	proprietary	9,000(Q1)	
5574-1	band (line printer)	600 lpm	up to 132	6	3-16	proprietary	15,000(Q1)	
LPS8	laser (page printer)	8 ppm	80-158	none		proprietary	5,000(Q1)	
XEROX CORP. 101 Continental Blvd., El Segundo, CA 90245, (213) 607-2143								**Circle 330**
4045	laser (page printer)	10 ppm				RS232C, Centronics 100, Dataproducts 2260 (X-on/X-off, DTR, ETX/ACK, up to 9600 bps)	4,995(Q1); 3,750(Q100)	bit-mapped, raster graphics

Information was solicited but not received from the following manufacturers:

Apple Computer Inc.
20525 Mariani Ave.
Cupertino, CA 95014
(408) 996-1010

Canon USA Inc.
One Canon Plaza
Lake Success, NY 11042
(516) 488-6700

Diconix Inc.
3800 Space Dr.
Dayton, OH 45414
(513) 259-3100

Digital Equipment Corp.
146 Main St.
Maynard, MA 01745
(617) 897-5111

Ferix Corp.
48571 Milmont Dr.
Fremont, CA 94538
(415) 659-0800

IBM Corp.
900 King St.
Rye Brook, NY 10573
(914) 934-4839

Minolta Corp.
101 Williams Dr.
Ramsey, NJ 07446
(201) 825-4000

NCR Corp.
3718 N. Rock Rd.
Wichita, KS 67226
(316) 688-8536

Philips Peripherals Inc.
385 Oyster Point Blvd.
So. San Francisco, CA 94080
(415) 952-3000

Printacolor Corp.
2830 Peterson Place
Norcross, Ga 30071
(404) 448-2675

Printer Systems Corp.
9055 Comprint Ct.
P.O. Box 6020
Gaithersburg, MD 20877
(301) 258-5060

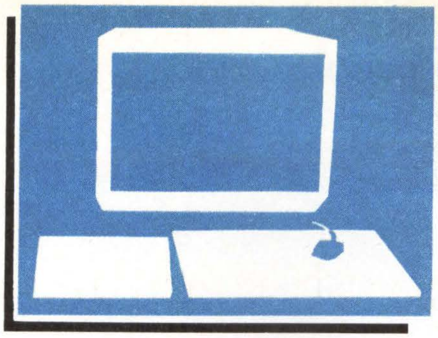
QMS Inc.
P.O. Box 81250
Mobile, AL 36689
(205) 633-4300

Quadram Corp.
One Quad Way
Norcross, GA 30093
(404) 923-6666

Siemens Communications
Systems Inc.
240 E. Palais Rd.
Anaheim, CA 92805
(714) 991-9700

Talaris Systems Inc.
5160 Carroll Canyon Rd.
P.O. Box 261580
San Diego, CA 92126
(619) 587-0787

Toshiba Corp.
1-1 Shibaura,
1-Chome, Minatoku
Tokyo, 105, Japan
(03) 457-3219



Graphics terminals

Company Model	Display size (diagonal), color	Display resolution (in pixels)	Screen format columns × lines (matrix character size)	Interfaces (protocols)	Emulations	Unit price $	Notes, features, options
ACCEL INC. 13231 Champions Forest Dr., Houston, TX 77069, (713) 440-1507							**Circle 250**
Pathfinder	19-inch; 16-, 256-color; 4096-color palette	1024 × 800	132 × 80	RS232C, Ethernet (X-on/X-off)	DEC VT100, Tektronix 4115	4,490	arc, circle/rectangle generation; polygon fill; 4 or 8 bit planes; rackmount; RGB video output; diagnostics
ADAGE INC. One Fortune Dr., Billerica, MA 01821, (617) 667-7070							**Circle 251**
3000	19-inch; 16.7-million-color palette	1024 × 1024	(7 × 9)	RS232C		20,900	arc, circle/rectangle generation; concave polygons; 32 bit planes; Q-bus, Unibus compatible; rackmount; RS170, R5343 video output
6080	19-inch; 256-color, 4096-color palette	1024 × 1024		RS232C	IBM 5080	18,000-22,000	8 bit planes, VMEbus compatible, start-up diagnostics
AED INC. 440 Potrero Ave., Sunnyvale, CA 94086, (408) 733-3555							**Circle 252**
Colorware 512	19-inch; red, 256-color, 16.7-million-color palette	512 × 483		RS232C (X-on/X-off)		9,045	8 bit planes, Q-bus compatible, rackmount, RGB video output; opt. printer, mouse
Colorware 767	19-inch; green, 256-color, 16.7-million-color palette	767 × 575		RS232C (X-on/X-off)		11,095	8 bit planes, Q-bus compatible, rackmount, RGB or NTSC video output; opt. printer, mouse
Colorware 1024/1280	19-inch; green, 256-color, 16.7-million-color palette	1024 × 768 1280 × 1024		RS232C (X-on/X-off)	(1280) DEC VT100, Tektronix 4014	13,295/ 17,950	8 bit planes, Q-bus compatible, rackmount, RGB video output, opt. printer, mouse/8 bit planes, Q-bus compatible, 4 serial ports; opt. mouse
ANN ARBOR TERMINALS INC. 6175 Jackson Rd., Ann Arbor, MI 48103, (313) 663-8000							**Circle 253**
Ambassador GXL/ GXL+Plus	15-inch, green	768 × 600	80 × 60 (7 × 9)	RS232C (X-on/X-off)	ANSI X3.64	3,090/ 3,590	arc, circle/rectangle generation; polygon fill; Tektronix 4010, 4014 compatible; rackmount; diagnostics; programmable keys, vector graphics; GXL+Plus has Greek, math and user-defined character set
APPLIED DIGITAL DATA SYSTEMS INC. (ADDS) 100 Marcus Blvd., Hauppauge, NY 11787, (516) 231-5400							**Circle 254**
XK1/XK19	14-inch, green/ 19-inch, green	1024 × 780	80 × 25 12 × 16	RS232C (X-on/X-off, DTR)	DEC VT100; Tektronix 4010, 4014; TeleVideo 925	2,695/ 3,795	zoom; pan; scroll; line, arc, circle generation; pie chart; rubber banding; block and pattern fill; 1 bit plane; self-test
X5A	14-inch; 16-color, 4096-color palette	512 × 390	80 × 25 (12 × 16)	RS232C (X-on/X-off)	DEC VT100; Tektronix 4010, 4014; TeleVideo 925	3,295	zoom; pan; scroll; line, arc, circle generation; pie chart; rubber banding; block and pattern fill; 4 bit planes; self-test
ASEA INDUSTRIAL SYSTEMS INC. P.O. Box 372, Milwaukee, WI 53201, (414) 785-3242							**Circle 255**
Tesselator 7800	16-inch; 16-color, 512-color palette	720 × 336	120 × 56 (6 × 6, 9 × 6, 9 × 9, 12 × 9, 18 × 15)	RS232C (ADLP-10)		7,980	bar chart, 1 bit plane, diagnostics, built-in modem, foreign language version

Graphics terminals

Company Model	Display size (diagonal), color	Display resolution (in pixels)	Screen format columns × lines (matrix character size)	Interfaces (protocols)	Emulations	Unit price $	Notes, features, options
Tesselator 8010	13-, 16-, 19-, 25-inch; 16-color, 64-color palette	720 × 336	120 × 56 (6 × 6, 9 × 6, 9 × 9, 12 × 9, 18 × 15)	RS232C, RS422 (ADLP-10; X.25 level 2, LAP, LAPB)		9,675	bar chart, 1 bit plane, RS170 video output, built-in modem, printer buffer, foreign-language version
AT&T 555 Touhy Ave., Skokie, IL 60077, (312) 982-2000,							**Circle 256**
5620	15-inch, green		132 × 24	RS232C	AT&T 4410		
AYDIN CONTROLS 414 Commerce Dr., Ft. Washington, PA 19034, (215) 542-7800							**Circle 257**
Aycon 2320	13-, 19-inch; 256-color, 256-color palette	640 × 480	80 × 98 (5 × 7, 10 × 14)	RS232C	Aycon 15	8,100	vector graphics; text polymarkers; 8 bit planes; RGB, RS170 video output; GFK graphics language; 19-inch is rackmount
Aycon 5215	13-, 19-, 25-inch; red, green, blue, yellow, orange, cyan, magenta, white; 8-color	512 × 256	80 × 48 (5 × 5, 7 × 9)	RS232C (X-on/X-off)	Intecolor 80016	3,100	RGB video output, 19-inch is rackmount
Tribune 2010	19-inch; 256-color, 4096-color palette	1024 × 1024	80 × 48	RS232C		9,300	pan, zoom, rubber banding, windowing, scaling, 8 bit planes, RGB video output
CALCOMP 2411 W. La Palma, Anaheim, CA 92801, (714) 821-2000							**Circle 258**
Vistagraphic 4500MV	19-inch; 16-, 256-color; 4096-color palette	1280 × 1024	128 × 73 (10 × 14, 14 × 18, 21 × 27)	DRVIIW (proprietary)	DEC MicroVAX 2	31,695	marker, polymarkers, line, polyline, polygon, arc and text perimeters
Vistagraphic 4500XT	19-inch; 16-, 256-color; 4096-color palette	1280 × 1024	128 × 73 (10 × 14, 14 × 18, 21 × 27)	RS232C (proprietary)	DEC PDP-11, VAX	33,740	marker, polymarkers, line, polyline, polygon, arc and text perimeters
CHROMATICS INC. 2558 Mountain Industrial Blvd., Tucker, GA 30084, (404) 493-7000							**Circle 259**
CX 1280/CX 1536	19-inch; 1.7-million-color, 16.7-million-color palette	1280 × 1024/ 1536 × 1152	programmable	RS232C, Centronics (X-on/X-off)	DEC VT100	34,995/ 24,995	up to 24 bit planes, Multibus compatible, rackmount, trackball, joystick, light pen, mouse
CIFER PLC Avroway, Bowerhill, Melksham, Wiltshire, SN12 9TP, England, (0225) 706361							**Circle 260**
T5/3842	12-inch; amber, green/ 15-inch; amber, green	1056 × 390	132 × 25 (13 × 16)	RS232C (X-on/X-off, DTR)	DEC VT52, VT100, VT220; Tektronix 4010, 4014		2 bit planes, rackmount, diagnostics, foreign-language version
DATAMEDIA CORP. 11 Trafalgar Square, Nashua, NH 03063, (603) 886-1570							**Circle 261**
ColorScan	13-inch; 8-color, 64-color palette	480 × 640	132 × 24 (7 × 9)	RS232C, current loop (X-on/X-off)	ADDS Regent 25; DEC VT100, VT131; Lear Siegler ADM 3A; Hazeltine 1420; Tektronix 4010, 4014, 4027		arc, circle, polygon, vector drawing; area fill; 1 bit plane; RGB video output; diagnostics; printer buffer
ERICSSON INFORMATION SYSTEMS AB S-16398 Stockholm, Sweden, (4687) 520000							**Circle 262**
System 11-DU1110/System 11-DU1112	15-inch, amber	800 × 576	80 × 24 (8 × 16)	twinax/CCITT V.24	IBM 5251-11		opt. printer
EVANS & SUTHERLAND 580 Arapeen Dr., Salt Lake City, UT 84108, (801) 582-5847							**Circle 263**
PS 300 Family	19-inch, 1800-color	8192 × 8192		RS232C, DEC parallel, IEEE 488	DEC VT100; IBM 3250, 3278, 5080; Tektronix 4014	40,000 plus	3D, diagnostics; opt. color raster display

Graphics terminals

Company Model	Display size (diagonal), color	Display resolution (in pixels)	Screen format columns × lines (matrix character size)	Interfaces (protocols)	Emulations	Unit price $	Notes, features, options
GENISCO COMPUTERS CORP. 3545 Cadillac Ave., Costa Mesa, CA 92626, (714) 556-4916							**Circle 264**
HS30/HS50/HS60	19-inch; green; 16-, 4096-color; 16.7-million-, 4096-color palette	1280 × 1024	160 × 1024 (8 × 12)	DMA, RS232C, RS422 (X-on/X-off)	DEC VT100		polymarker, polygon, curves, 4-12 bit planes, rackmount, RGB video output, diagnostics
GRAPHON CORP. 1901 S. Bascom Ave., Campbell, CA 95008, (408) 371-8500							**Circle 265**
GO-230	14-inch, green	1024 × 390	80 × 24, 132 × 24 (13 × 15)	RS232C, RS423 (X-on/X-off, DTR)	DEC VT52, VT100, VT220; Tektronix 4010, 4015	1,295	rectangle area fill, vectors, points, printer port
GO-240	14-inch, green	1024 × 390	80 × 24, 132 × 24 (13 × 15)	RS232C, RS423 (X-on/X-off, DTR)	DEC VT52, VT100, VT220, ReGIS; Tektronix 4010, 4015	1,895	arc, circle generation; 2 bit planes; pan; zoom; 3 communications ports
GO-250	14-inch, green	1024 × 780	80 × 24, 132 × 24 (13 × 15)	RS232C, RS423 (X-on/X-off, DTR)	DEC VT52, VT100, VT220, ReGIS	2,495	arc, circle generation; 2 bit planes; pan; zoom; 3 communications ports
HEWLETT-PACKARD CO. (ROSEVILLE TERMINALS DIV.) 8020 Foothills Blvd., Roseville, CA 95678, (916) 786-8000							**Circle 266**
2393A	12-inch, green	640 × 400, 512 × 390	80 × 27 (7 × 11)	RS232C, Centronics, HP-IB (X-on/X-off, ENQ/ACK)	DEC VT100; Tektronix 4010, 4014; HP 2623A	2,095	polygon fill, rectangle generation, rubber banding, line drawing, italics, double-high/double-wide characters
2397A	12-inch; 8-color, 64-color palette	640 × 400, 512 × 390	80 × 27 (7 × 11)	RS232C, Centronics, HP-IB (X-on/X-off, ENQ/ACK)	DEC VT100; Tektronix 4010, 4014; HP 2623A	3,095	polygon fill, rectangle generation, rubber banding, 3 bit planes, RGB video output, foreign-language version, self-test
HMW ENTERPRISES INC. 604 Salem Rd., Etters, PA 17319, (717) 938-4691							**Circle 267**
9081/9209	19-inch; green, red, blue, yellow, magenta, cyan, black, white	384 × 480	80 × 48 (5 × 7, 5 × 14)	RS232C, current loop (X-on/X-off, ASCII asynch)	ADDS 980, DEC VT100, ISC 8001G	5,000/ 7,000	arc, circle/rectangle generation; opt. rackmount, RGB video output, printer buffer and ports
9083-5/9203/9204	13-inch; red, green, blue, yellow, magenta, cyan, black, white	384 × 480	80 × 48 (5 × 7)	RS232C, current loop (X-on/X-off, ASCII)	ADDS 980, DEC VT100, ISC 8001G	3,995/ 5,500/ 7,600- 10,850	arc, circle, rectangle generation; 9204 approved for Class I & II, Div. 1 & 2 hazardous environment
IMLAC CORP. New England Industrial Center, 150 A St., Needham, MA 02194, (617) 449-4600							**Circle 268**
8000	19-inch, green	2048 × 2048	80 × 50	RS232C (X-on/X-off)	Tektronix 4014	17,325	calligraphic, bit pad; opt. light pen, Multibus compatible
INTECOLOR CORP. 225 Technology Park/Atlanta, Norcross, GA 30071, (404) 449-5961							**Circle 269**
6114	19-inch; 8-color, 4096-color palette	1024 × 768	96 × 48 (10 × 16)	RS232C, Centronics (X-on/X-off, asynch)	DEC VT100, Tektronix 4014	5,895	arc, circle/rectangle; points; polyline; super pixel; pattern generation; 3 bit planes
6120	19-inch; 64-color, 256,000-color palette	1024 × 768	96 × 48 (10 × 16)	RS232C, Centronics (X-on/X-off, asynch)	DEC VT100, Tektronix 4014	6,495	arc, circle/rectangle; points; polyline; super pixel; pattern generation; 6 bit planes
INTEGRAPH CORP. One Madison Industrial Park, Huntsville, AL 35807, (205) 772-2000							**Circle 270**
DSP055-Interact	19-inch; 256-color, 16-million-color palette	1280 × 1024	80 × 40, 160 × 80 (16 × 24, 8 × 12)	RS232C, RS432 (X-on/X-off, RTS/CTS)	DEC VT100, Tektronix 4014	48,000	zoom, pan; rotate; arc, circle, ellipse, curve generation; synch modem support
DSP071-InterPro 32	15-inch; 64-color, 4096-color palette	1184 × 884		RS232C (X-on/X-off)	DEC VT100, VT220; IBM 327X series; Tektronix 4105	20,000	arc, circle, curve generation; window clipping; vector and raster test; polygon fill

Graphics terminals

Company Model	Display size (diagonal), color	Display resolution (in pixels)	Screen format columns × lines (matrix character size)	Interfaces (protocols)	Emulations	Unit price $	Notes, features, options
ITT QUME 2350 Qume Dr., San Jose, CA 95131, (408) 942-4000							**Circle 271**
QVT-311GX	14-inch; monochrome, 4 shades of grey	640 × 480	80 × 34 (8 × 14)	RS232C (X-on/X-off)	DEC VT100, VT125; Tektronix 4010, 4014	1,995	arc, circle, polygon fill, 2 bit planes
QVT-511GX	14-inch, 8-color, 64-color palette	480 × 360	80 × 30 (6 × 12)	RS232C, Centronics (X-on/X-off)	Tektronix 4105, ANSI X3.64	2,995	arc, circle, polygon fill, 3 bit planes
KEL INC. 400 West Cummings Park, Woburn, MA 01801, (617) 933-7852							**Circle 272**
J1014/J1014C	14-inch; green, monochrome/ 14-inch, 8-color palette	1024 × 780	146 × 64 (5 × 7, 10 × 14)	RS232C, current loop, Centronics (X-on/X-off, DTR)	DEC VT100; Tektronix 4010, 4014	2,595/ 4,950	vector, circle, rectangle fill, digitizer tablet, mouse, J1014C has 4 bit planes
J1019C	19-inch, 8-color palette	1024 × 780	146 × 64 (5 × 7, 10 × 14)	RS232C, current loop, Centronics (X-on/X-off, DTR)	DEC VT100; Tektronix 4010, 4014	6,750	vector, circle, rectangle fill, 4 bit planes, digitizer tablet, mouse
J2014C	14-inch; 16-color, 64-color palette	640 × 480	80 × 24	RS232C, current loop, Centronics (X-on/X-off, DTR)	DEC VT100; Tektronix 4107, 4109	4,950	vector, circle, arc, polygon fill, 4 bit planes, zoom, pan digitizer tablet, mouse
KEYNOTE COMPUTER PRODUCTS INC. 145 Columbia St., West, Waterloo, Ontario, N2L 3L2, Canada, (519) 884-3440							**Circle 273**
KD220	14-inch; green, amber	512 × 240	24 × 132 (6 × 9)	RS232C, current loop (X-on/X-off, CTS, DTR)	DEC VT220; Tektronix 4010, 4014	695	4 bit planes, self-diagnostics, international character sets, programmable function keys, APL
KD500G	12-inch; green, amber	512 × 240	24 × 80 (6 × 9)	RS232C, current loop (X-on/X-off, CTS, DTR)	DEC VT100, Tektronix 4010	595	4 bit planes, self-diagnostics, international charater sets, programmable function keys, APL
LEAR SIEGLER INC. (DATA PRODUCTS DIV.) 901 E. Ball Rd., Anaheim, CA 92805, (714) 778-3500							**Circle 274**
7105/7107	13-inch; 16-color, 4096-color palette	640 × 480	80 × 24 (7 × 8)	RS232C (X-on/X-off)	DEC VT100; Tektronix 4010, 4014	2,995/ 3,995	arc, circle/rectangle generation; polygon and pie segment drawing; opt. mouse
LEENSHIRE LTD. Moorside Rd., Winnall, Winchester, Hampshire, S023 7RX, England, (0962) 64175							**Circle 275**
VCT6925	14-inch, 64-color	512 × 256	80 × 32 (9 × 9)	RS232C (X-on/X-off)	DEC VT52, VT100	4,340	circle, rectangle generation; rackmount
VCT6928	14-inch; 64-color	1024 × 780	80 × 48 (12 × 8)	RS232C (X-on/X-off)	DEC VT52, VT100; Tektronix 4010, 4014	5,593	circle, rectangle generation; polygon fill; rackmount
LEXIDATA CORP. 755 Middlesex Turnpike, Billerica, MA 01865, (617) 663-8550							**Circle 276**
2400/2410	19-inch, monochrome/ 19-inch; amber, green, red, blue, white; 16-color, 4096-color palette	1280 × 1024	160 × 85 (7 × 9, 14 × 18, 21 × 27, 28 × 36)	RS232C	DEC VT100; Tektronix 4014, PLOT 10	6,295/ 9,295	1 bit plane, tilt, swivel, joystick, 4 user-defined workspaces/ 4 bit planes, tilt, swivel, joystick, 4 user-defined workspaces
LUNDY ELECTRONICS & SYSTEMS INC. One Robert Lane, Glen Head, NY 11545, (516) 671-9000							**Circle 277**
GTC-327	14-inch; 8-color, 4096-color palette	640 × 480	34 × 80	RS232C	Tektronix 4027	4,100	arc, circle, polygon, string macro generation; 3 bit planes
UltraGraf III	19-inch, 256-color, 16.7-million-color palette	1024 × 1024		RS232C, 16-bit parallel			up to 16 bit planes, multi-window
MATROX ELECTRONIC SYSTEMS LTD. 1055 St. Regis Blvd., Dorval, Quebec, H9P 2T4, Canada (514) 685-2630							**Circle 278**
GXT-1000	19-inch; 16-color, 4096-color palette	1024 × 768	80 × 25 (7 × 9)	RS232C (X-on/X-off)	DEC VT100	14,175	arc, circle, rectangle fill; 4 bit planes, multibus compatible; RGB video output; diagnostics; opt. rackmount

Graphics terminals

Company Model	Display size (diagonal), color	Display resolution (in pixels)	Screen format columns × lines (matrix character size)	Interfaces (protocols)	Emulations	Unit price $	Notes, features, options
MEGATEK CORP. 9645 Scranton Rd., San Diego, CA 92121, (619) 455-5590							**Circle 279**
9200 Series	19-inch; 64-, 4096-color; 16.7-million-color palette	3072 × 2304, 3072 × 576	128 × 24 (8 × 12)	RS232C, Centronics (X-on/X-off)	DEC VT100	39,000	points, lines, meshes, polygon fill, 12 bit planes; opt. rackmount
Whizzard Series	19-inch; 16-color, 4096-color palette	4096 × 4096, 1024 × 1024, 512 × 512	132 × 24 (8 × 12)	DEC Unibus, PDP-11; Harris; Data General (X-on/X-off)	DEC VT100, Tektronix 4014	23,000	4 bit planes, Unibus compatible, zoom, pan, surface fill; opt. rackmount
METHEUS CORP. P.O. Box 1049, Hillsboro, OR 97123, (503) 640-8000							**Circle 280**
Omega 300	15-, 19-inch; 16-color, 16.7-million-color palette	1024 × 768	128 × 48 (up to 8 × 16)	RS232C, IEEE 488 (X-on/X-off)	Tektronix 4010, 4014	8,950	arc, rectangle, polygon generation; polygon, rectangle fill; 4 bit planes
Omega 400/500	15-, 19-inch; 256-color, 16.7-million-color palette	1024 × 768/ 1280 × 1024	128 × 48 (up to 8 × 16)/ 160 × 64 (up to 8 × 16)	RS232C, IEEE 488 (X-on/X-off)	Tektronix 4010, 4014	11,950/ 16,950	arc, rectangle, polygon generation; polygon, rectangle fill; 8 bit planes
Omega 2300/2400	15-, 19-inch; 256-color, 16.7-million-color palette	1024 × 768	128 × 48 (up to 8 × 16)	RS232C, IEEE 488 (X-on/X-off)	DEC VT100	14,450/ 17,450	segmented display list, hierarchy, editing, polylines, pixels, 4 bit planes, 2400 has 8 bit planes
Omega 2500	14-, 19-inch; 256-color, 16.7-million-color palette	1280 × 1024	160 × 64 (up to 8 × 16)	RS232C, IEEE 488 (X-on/X-off)	DEC VT100	19,950	segmented display list, hierarchy, editing, polylines, pixels, 8 bit planes
MODGRAPH INC. 56 Winthrop St., Concord, MA 01742, (617) 371-2000							**Circle 281**
GX-1000	15-, 19-inch; monochrome	1024 × 780	132 × 30 (5 × 7)	RS232C, current loop (X-on/X-off, DTR, CTS)	DEC VT52, VT100; Lear Siegler ADM 3A; Tektronix 4010, 4014	2,195-3,495	line, arc, circle, rectangle fill; 1 bit plane; built-in diagnostics
GX-1105	14-, 19-inch; 16-color, 4096-color palette	1024 × 768	132 × 24	RS232C, Centronics (X-on/X-off, DTR, CTS)	DEC VT100, Tektronix 4105	4,995-7,995	line, circle, rectangle, polygon fill; 4 bit planes; built-in diagnostics; foreign-language version
NEWBURY DATA RECORDING LTD. Hawthorne Rd., Staines, Middlesex, TW18 3BJ, England, (0784) 61500							**Circle 282**
9510	14-inch; amber, green	1024 × 2600	35 × 80 (5 × 7)	RS232C, current loop (X-on/X-off, DTR)	TeleVideo 950; Tektronix 4010, 4014	800	2 bit planes
NEW GEA CORP. 335 Oser Ave., Hauppauge, NY 11788, (516) 434-8400							**Circle 283**
NWX235/ NWX237	19-, 25-inch; 16-color, 4096-color palette/19-, 25-inch; 4096-color, 16.7-million-color palette	1024 × 1024/ 1280 × 1024	128 × 60	RS232C, RS422	DEC VT100, IBM 3270, Tektronix 4014	17,500/ 27,500	arc, circle/rectangle generation; zoom; pan; rubber banding; polygon fill; 4 bit planes; rackmount; RGB video output/arc, circle/rectangle generation; 16 bit planes; rackmount; RGB video output
NORTHWEST DIGITAL SYSTEMS P.O. Box 15288, Seattle, WA 98115, (206) 524-0014							**Circle 284**
GP-29	14-inch; green, amber	1024 × 500	132 × 49 (8 × 10)	RS232C (X-on/X-off)	DEC VT52, VT100, VT220; Tektronix 4010, 4014	1,695	pan, zoom, vector, erase, area erase, area fill, seed fill, arc drawing, 2 bit planes
GP-220	14-inch; green, amber	1024 × 780	132 × 50, 132 × 66 (8 × 15)	RS232C (X-on/X-off)	DEC VT52, VT100, VT220; Tektronix 4010, 4014	2,195	pan, zoom, vector, erase, area erase, area fill, seed fill, arc drawing, 4 bit planes
PLESSEY PERIPHERAL SYSTEMS 277 Park Ave., New York, NY 10172, (212) 752-4441							**Circle 285**
PT 100G	14-inch; amber, green	1024 × 780	132 × 48	RS232C (X-on/X-off)	DEC VT100, Tektronix 4014	1,295	arc, circle/rectangle generation; polygon fill; zoom; DEC compatible; printer port

Graphics terminals

Company Model	Display size (diagonal), color	Display resolution (in pixels)	Screen format columns × lines (matrix character size)	Interfaces (protocols)	Emulations	Unit price $	Notes, features, options
PRIME COMPUTER INC. Prime Park, Natick, MA 01760, (617) 655-8000							**Circle 286**
PW153/PW200	19-inch, 16-color/ 19-inch, 8-color	1152 × 860		RS232C/ RS232C, RS343		18,750/ 61,000- 106,000	
PSITECH INC. 18368 Bandilier Circle, Fountain Valley, CA 92708, (714) 964-7818							**Circle 287**
GTC 314/GTC 327	13-inch; 8-color, 4096-color palette	512 × 480 640 × 480	85 × 48 (6 × 10)/ 80 × 34 (8 × 14)	RS232C (X-on/X-off, RTS/CTS)/ RS232C (X-on/X-off)	DEC VT52, VT100; Lear Siegler ADM 3A; Tektronix 4010/ Tektronix 4010, 4027	2,895/ 4,200	circle, vectors, strings, block move, polygon fill, 3 bit planes/arc, circle, vectors, strings, polygon fill, 3 bit planes
GTC 329A	13-, 15-, 19-inch; 16-color, 4096-color palette	512 × 480	85 × 48 (6 × 10)	RS232C (X-on/X-off)	DEC VT52, VT100; Lear Siegler ADM 3A; Tektronix 4010	5,300	circle, vectors, strings, block move, 4 bit planes; opt. mouse, digitizer
GTC 600 Series/ VME3	13-, 15-, 19-inch; 8-color, 4096-color palette	640 × 480	80 × 32 (8 × 15)	RS232C (X-on/X-off, RTS/CTS)/ RS232C, VMEbus (X-on/X-off, RTS/CTS)	DEC VT100/ Tektronix 4115	6,925- 8,150/ 6,200	vectors, panel segments, 3 bit planes/vectors, polygons, 3 bit planes, VMEbus compatible, diagnostics, RS343 video output
RASTER TECHNOLOGIES INC. Two Robbins Rd., Westford, MA 01886, (617) 692-7900							**Circle 288**
One/10	13-inch; 256-color, 16.7-million-color palette	640 × 480	80 × 24 (5 × 7)	RS232C (X-on/X-off)	DEC VT100, Tektronix 4014	6,925	10 bit planes
One/75	19-inch; 256-color, 16.7-million-color palette	1280 × 1024	80 × 24 (5 × 7)	RS232C, DMA (X-on/X-off)	DEC VT100, Tektronix 4014	16,300	bit slice, 8 bit planes
RCA DATA COMMUNICATIONS PRODUCTS New Holland Ave., Lancaster, PA 17604, (800) 722-0094							**Circle 289**
VP4801/ VP5801	12-inch, green	640 × 510	80 × 24 (6 × 8)	RS232C, Centronics (ASCII asynch)	DEC VT52; Lear Siegler ADM 3A, ADM 5; TeleVideo 910	498/798	built-in modem, printer port; VP5801 has 1 bit plane
SAI TECHNOLOGY 4224 Campus Point Court, San Diego, CA 92121-1513, (619) 452-9150							**Circle 290**
Plasmascope Series 5000	8-inch, orange	512 × 512	80 × 50 (5 × 7, 7 × 9)	RS422	Intel		vectors, dots, circles, rectangles, arcs, ellipses, scrolling, split screen, Multibus compatible
Plasmascope Series 7000	orange	256 × 512	(5 × 7, 7 × 9)	RS422	Intel		vectors, dots, circles, rectangles, arcs, ellipses, scrolling, split screen, Multibus compatible
SEIKO INSTRUMENTS USA INC. 1623 Buckeye Dr., Milpitas, CA 95035, (408) 943-9100							**Circle 291**
GR-1104	14-inch; 8-color, 512-color palette	1024 × 780	80 × 48 (12 × 16)	RS232C, Centronics (X-on/X-off, ENQ/ACK, DTR)	DEC VT100, Tektronix PLOT 10	4,350	arc, circle, line, rectangle generation; 4 bit planes; Multibus compatible
GR-2414	20-inch; 1024-color, 16.8-million-color palette	1024 × 1280	134 × 64 (10 × 14)	RS232C (X-on/X-off, ENQ/ACK, DTR)	Tektronix PLOT 10	15,950	arc, circle, line, rectangle generation; 10 bit planes; Multibus compatible
SOUTHWEST TECHNICAL PRODUCTS CORP. 219 W. Rhapsody, San Antonio, TX 78216, (512) 344-0241							**Circle 292**
X-12	12-inch, green	246 × 198	123 × 66 (5 × 7, 7 × 9)	RS232C, Centronics (X-on/X-off, DTR)		1,495	arc, circle/rectangle generation; polygon fill; 1 bit plane; diagnostics
SPECTRAGRAPHICS CORP. 10260 Sorrento Valley Rd., San Diego, CA 92121, (619) 450-0611							**Circle 293**
DS1080/DS1500	19-inch; 16-, 256-color; 16.8-million-, 4096-color palette	1024 × 1024		RS232C, Centronics/ Centronics	IBM 3270, 5080/ IBM 3250, 3270, 5080; DEC VT100	16,400/ 27,300	polygon fill, zoom, pan, up to 8 bit planes, diagnostics/polygon fill, pan, zoom, up to 12 bit planes

Graphics terminals

Company Model	Display size (diagonal), color	Display resolution (in pixels)	Screen format columns × lines (matrix character size)	Interfaces (protocols)	Emulations	Unit price $	Notes, features, options
SPERRY CORP. Townshipline and Jolly Rd., Blue Bell, PA 19424, (215) 542-4011							**Circle 294**
SVT 1120	14-inch, green	1056 × 300, 800 × 300	132 × 24, 80 × 24 (7 × 11, 5 × 9)	RS232C, CCITT V.24		795-895	foreign-language version, self-test
SVT 1210/ SVT 1220	12-inch, green	1056 × 250, 800 × 250	132 × 24, 80 × 24 (7 × 9)	RS232C (X-on/X-off)	DEC VT52/ DEC VT220	495/895	DEC graphics characters
TANDBERG DATA INC. 1590 S. Sinclair, Anaheim, CA 92806, (714) 978-6771							**Circle 295**
TDV2230S	15-inch; green, b&w	720 × 336	80 × 25 (9 × 14)	RS232C, RS422, current loop (X-on/X-off, DTR)	DEC VT100	1,795	arc, circle generation; 1 bit plane, built-in modem, foreign-language version, printer buffer
TDV2441	15-inch; green, b&w	800 × 600	132 × 36 (10 × 22)	RS232C, RS422, current loop, Centronics (X-on/X-off)	DEC VT220, ANSI X3.64		windowing, pan, 2 bit planes, mouse
VG SYSTEMS INC. 21300 Oxnard St., Woodland Hills, CA 91367, (818) 346-3410							**Circle 296**
VG 8250	21-inch, 16-color	1024	100 × 68	IBM channel (SDLC)	IBM 3250	22,000	digitizers, plotters
VG 9250	19-inch; 16-color, 4096-color palette	1024 × 1024	100 × 68	IBM channel (SDLC)	IBM 3250, 5080	25,000	circle generation, polygon fill, 4 bit planes
WICAT SYSTEMS INC. 1875 South State St., Orem, UT 84058, (801) 224-6400							**Circle 297**
MG8000	14-inch, green	300 × 400	80 × 24	RS232C (X-on/X-off)	DEC VT52	2,360	arc, circle, ellipse generation; polygon fill; 2 bit planes
WIT	14-inch; 16-color, 4096-color palette	840 × 480	80 × 30	RS232C (X-on/X-off)	DEC VT52	6,150	arc, circle, ellipse generation; polygon fill; 2 bit planes

Information was solicited but not received from the following manufacturers:

Burroughs Corp.
Burroughs Place
Detroit, MI 48232
(313) 972-7350

Colorgraphic
Communications Corp.
2379 John Glenn Dr.
P.O. Box 80448
Atlanta, GA 30366
(404) 455-3921

Control Data Corp.
(OEM Product Sales)
P.O. Box O
Minneapolis, MN 55440
(612) 853-8100

Dacoll Ltd.
Dacoll House, Gardener's Lane,
Bathgate, W. Lothian
EH48 ITP, Scotland
(0506) 56565

Data General Corp.
4400 Computer Dr.
Westboro, MA 01580
(617) 366-8911

Digital Engineering Inc.
640 Bercut Dr.
Sacramento, CA 95814
(916) 447-7600

Human Designed
Systems Inc.
20 Pickering St.
Needham, MA 02192
(617) 449-6446

IBM Corp.
900 King St.
Rye Brook, NY 10573
(914) 934-4822

ID Systems Corp.
6175-W Shamrock Ct.
Dublin, OH 43017
(614) 766-0440

Japan Computer Corp.
Mabuchi LK Bldg.
Higashi Kanda
2-6-9 Chiyoda-Ku
Tokyo, 101, Japan
(03) 864-8111

Lanpar Technologies Inc.
85 Torbay Rd.
Markham, Ontario
L3R 1G7, Canada
(416) 475-9123

Liberty Electronics
625 Third St.
San Francisco, CA 94107
(415) 543-7000

Micro-Term Inc.
512 Rudder Rd.
St. Louis, MO 63026
(314) 343-6515

Techex Ltd.
Roundways, Elliott Rd.
W. Howe Industrial Estate
Bournemouth, Dorset
BH11 8JJ, England
(0202) 571181

Tektronix Inc.
P.O. Box 1000
Wilsonville, OR 97070
(503) 685-3617

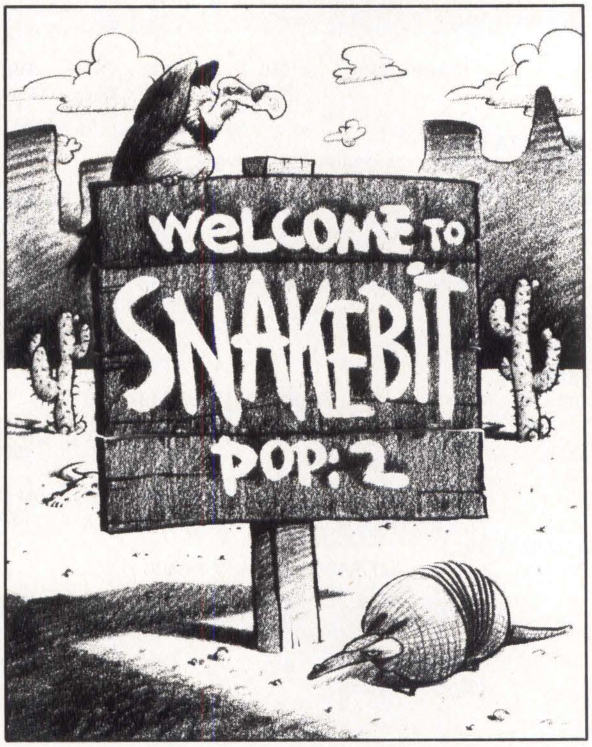
Telex Computer
Products Inc.
6422 E. 41st St.
Tulsa, OK 74135
(800) 331-2623

Thomas Engineering Co.
2440 Stanwell Dr.
Concord, CA 94520
(415) 680-8640

Vector Automation Inc.
Village of Cross Keys
Baltimore, MD 21210
(301) 433-4200

Visual Technology Inc.
1703 Middlesex St.
Lowell, MA 01851
(617) 459-4903

EVEN IF YOU'VE NEVER HEARD OF IT, WE'LL TAKE IT THERE.



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See P. 71 for Mini-Micro Marketplace

Monitors

Company Model	Display size (diagonal), color	Phosphor number	Input signals	Display resolution (pixels)	Vertical refresh (Hz)	Price $ (quantity)	Notes, features, options
AMDEK CORP. 2201 Lively Blvd., Elk Grove Village, IL 60007, (312) 364-1180							**Circle 331**
Color 600	13-inch, two 16-color palettes	P22, standard	TTL	640 × 240	60 Hz, non-interlaced	599(Q1)	16-MHz bandwidth; cabinet; FCC, UL approved; opt. tilt, swivel; non-glare screen
Color 722	13-inch; 16-color, 64-color palette	P22, standard	TTL	720 × 240, 720 × 350	60 Hz, non-interlaced	799(Q1)	25-MHz bandwidth; cabinet; FCC, UL approved; opt. tilt, swivel
Video 300GIA	12-inch, green or amber	P31/P134, standard	NTSC		60 Hz, non-interlaced	179(Q1)	18-MHz bandwidth; cabinet; FCC, UL approved
AYDIN CONTROLS 414 Commerce Dr., Ft. Washington, PA 19034, (215) 542-7800							**Circle 332**
8815	13-inch, infinite colors	P22	RGB	1024 × 1024		2,300(Q1)	40-MHz bandwidth, cabinet
8830/8831	19-inch, 16-color	P22	RGB, TTL	640 × 480		2,300/2,450(Q1)	25-MHz bandwidth, cabinet
8835/8836	19-inch, infinite colors	P22	RGB	1280 × 1024		3,050/3,200(Q1)	40-MHz bandwidth, cabinet
8864/8865	19-inch, infinite colors	P22	RGB	1280 × 1024		4,200/4,350(Q1)	100-MHz bandwidth, cabinet
C. ITOH DIGITAL PRODUCTS INC. 19750 S. Vermont Ave., Torrance, CA 90502, (213) 327-2110							**Circle 333**
CM1000/ CM2000	13-inch, 16-color		NTSC, TTL/TTL	640 × 240	non-interlaced	499/599(Q1)	15-MHz bandwidth; opt. tilt, swivel
C. ITOH ELECTRONICS INC. 5301 Beethoven St., Los Angeles, CA 90066, (213) 306-6700							**Circle 334**
CD-52011	19-inch; red, green, blue	B22, standard	RGB	1280 × 1024	60 Hz, non-interlaced	3,000(Q1); 2,300(Q100)	120-MHz bandwidth, bare chassis
ICM-14	14-inch; red, green, blue	B22, standard	TTL	720 × 374	60 Hz, non-interlaced	924(Q1); 805(Q100)	25-MHz bandwidth, bare chassis, tilt, half-tone
QCD-1455AR	14-inch; red, green, blue	B22, standard	RGB	720 × 790	60 Hz, non-interlaced	924(Q1); 828(Q100)	50-MHz bandwidth, bare chassis, tilt, non-glare screen
CONRAC DIVISION (CONRAC CORP.) 600 N. Rimsdale Ave., Covina, CA 91722, (818) 966-3511							**Circle 335**
7111C19	19-inch, infinite colors	P22, standard	RGB	1024 × 768	30-60 Hz; interlaced or non-interlaced	2,525(Q1)	25-MHz bandwidth; cabinet; FCC, UL, CSA approved
7211C19	19-inch, infinite colors	P22, standard	RGB	1280 × 1024	30-60 Hz; interlaced or non-interlaced	3,745(Q1)	40-MHz bandwidth; cabinet; FCC, UL, CSA approved
7351C19/ 7400C19	19-inch, infinite colors	P22, standard	RGB	1280 × 1024	60 Hz, non-interlaced	3,310(Q1)	110-MHz bandwidth; cabinet; FCC, UL, CSA approved; 7400C19 has Sony Trinitron CRT
CORDATA (FORMERLY CORONA DATA SYSTEMS INC.) 275 E. Hillcrest Dr., Thousand Oaks, CA 91360, (805) 495-5800							**Circle 336**
Color Monitor	14-inch, 16-color	B22	RGB, NTSC, TTL	640 × 480	non-interlaced	895(Q1)	cabinet

Monitors

Company Model	Display size (diagonal), color	Phosphor number	Input signals	Display resolution (pixels)	Vertical refresh (Hz)	Price $ (quantity)	Notes, features, options
HONEYWELL INFORMATION SYSTEMS INC. 200 Smith St., Waltham, MA 02154, (617) 895-6000							**Circle 337**
DMU 0793	12-inch; monochrome, amber		NTSC	640 × 200	60 Hz, non-interlaced	175(Q1)	cabinet; FCC, UL, CSA approved
DMU 0794	12-inch; amber, monochrome		TTL	720 × 350	50 Hz, non-interlaced	275(Q1)	acid etch
DMU 0795	13-inch, 16-color		RGB	640 × 200	60 Hz, non-interlaced	595(Q1)	dark glass
ITT INFORMATION SYSTEMS 2350 Qume Dr., San Jose, CA 95131, (408) 945-8950							**Circle 338**
Monochrome Display	13.5-inch; green, amber	standard, long persistence	TTL	720 × 348	50 Hz, non-interlaced	225(Q1)	non-glare screen, tilt, swivel
Color Graphics Monitor	13.5-inch, 16-color	standard	TTL	640 × 200	60 Hz, non-interlaced	545(Q1)	tilt, swivel
Dual Frequency	13.5-inch; green, amber, 16 monochrome shades	standard, long persistence	TTL	640 × 200, 320 × 200	50-60 Hz, non-interlaced	275 (Q1)	tilt; swivel; non-glare, etched screen
MICRO DISPLAY SYSTEMS INC. 1310 Vermillion St., Hastings, MN 55033, (800) 328-9524							**Circle 339**
401/402	15-inch, white	standard		720 × 990/ 728 × 1008, 640 × 200	60 Hz, non-interlaced	1,395/1,795(Q1)	100-MHz bandwidth, cabinet, FCC approved, tilt, swivel
MICROTOUCH SYSTEMS INC. Ten State St., Woburn, MA 01801, (617) 935-0080							**Circle 340**
ENHANCED Touch	13-inch; 16-, 64-color		RGB, TTL	350 × 640	50-60 Hz, interlaced	1,945(Q1); 1,445(Q100)	
MONO Touch	12-inch; amber, monochrome		NTSC, TTL	240 × 640	50-60 Hz	1,145(Q1); 795(Q100)	
NTSC Touch	13-inch, 16-color		RGB, NTSC	480 × 640		1,895(Q1); 1,375(Q100)	
MICROVITEC INC. 1943 Providence Court, College Park, GA 30337, (404) 991-2246							**Circle 341**
895 DN	14-inch, infinite color	long persistence	RGB		48-74 Hz, interlaced	995(Q1)	cabinet, FCC approved, direct etch
901 DI	14-inch, 16-color	B22, standard	TTL	930 × 550	48-74 Hz, interlaced	845(Q1)	40-MHz bandwidth, plastic cabinet, FCC approved, anti-glare screen
945 CN	20-inch, color	B22, long persistence	NTSC	1365 × 870	48-74 Hz, interlaced	1,995(Q1)	40-MHz bandwidth, metal cabinet, anti-glare screen
MONITERM 5740 Green Circle Dr., Minnetonka, MN 55343, (612) 935-4151							**Circle 342**
VX-Series	19-inch; white, green, amber, orange	P4, standard	TTL	1500 × 1500	60 Hz, non-interlaced	1,330(Q1), 850(Q100)	up to 200-MHz bandwidth; cabinet; CSA, TUV, UL, FCC approved; opt. tilt, swivel
MONITRON CORP. 1450 Seareel Lane, San Jose, CA 95131-1566, (408) 263-9777							**Circle 343**
EK Series	5- to 19-inch, monochrome	standard, long persistence	TTL	up to 1280 × 1024	up to 180 Hz, interlaced, non-interlaced		up to 180-MHz bandwidth; rackmount; CSA, UL approved
CL9140	14-inch, 4096-color	standard, long persistence	RGB	640 × 480	30 Hz, interlaced, 60 Hz non-interlaced		rackmount; CSA, UL approved
MOTOROLA DISPLAY SYSTEMS 1299 E. Algonquin Rd., Schaumburg, IL 60196, (312) 576-7700							**Circle 344**
HS4000/3000 Series	12-, 15-inch; white, green, monochrome	P4, P31, P39	TTL	1050 × 512	47-63 Hz, non-interlaced		dark glass, acid etch
MD1500/1700 Series	7-inch; white, green, monochrome	P4, P31; standard	TTL	650 × 290	47-63 Hz, non-interlaced		22-MHz bandwidth
MD3570/3970 Series	12-inch; white, green, monochrome	P4, P31, P39	TTL	800 × 320	47-63 Hz, non-interlaced		25-MHz bandwidth

Monitors

MONITORS

PANASONIC CO. (DIV. OF MATSUSHITA ELECTRONIC CORP. OF AMERICA) — Circle 345
One Panasonic Way, Secaucus, NJ 07094, (201) 348-7000

Company Model	Display size (diagonal), color	Phosphor number	Input signals	Display resolution (pixels)	Vertical refresh (Hz)	Price $ (quantity)	Notes, features, options
CTF-1465 R	14-inch, color		RGB, TTL	80 × 25		749(Q1)	
CTF-1495 R/ CTF-2095 M	20-inch, color		RGB, TTL	80 × 25		699/499(Q1)	
CTH-2690 R	26-inch, color		RGB, TTL			1,300(Q1)	

PRINCETON GRAPHIC SYSTEMS — Circle 346
601 Ewing St., Bldg. A, Princeton, NJ 08540, (609) 683-1660

Company Model	Display size (diagonal), color	Phosphor number	Input signals	Display resolution (pixels)	Vertical refresh (Hz)	Price $ (quantity)	Notes, features, options
HX-9E	9-inch; 16-, 64-color	standard	NTSC	640 × 350, 640 × 200	60 Hz, non-interlaced	750(Q1)	non-glare screen, tilt, swivel
HX-12E	12-inch; 16-, 64-color	standard	RGB	640 × 350, 640 × 200	60 Hz, non-interlaced	785(Q1)	non-glare screen
SR-12P	12-inch, 4096-color	standard	RGB	640 × 480, 640 × 400		999(Q1)	non-glare screen

QUADRAM CORP. — Circle 347
One Quad Way, Norcross, GA 30093, (404) 923-6666

Company Model	Display size (diagonal), color	Phosphor number	Input signals	Display resolution (pixels)	Vertical refresh (Hz)	Price $ (quantity)	Notes, features, options
Amberchrome	12-inch; amber, monochrome	P134	TTL	720 × 350	50 Hz, non-interlaced	250(Q1)	
Quadchrome II	14-inch, 16-color	standard	TTL	640 × 200	60 Hz, non-interlaced	499(Q1)	
Quadscreen	17-inch; b&w, monochrome	P4	TTL	968 × 512	60 Hz, non-interlaced	1,995(Q1)	split screen, cable, software

SYSTEMS RESEARCH LABORATORIES INC. — Circle 348
2800 Indian Ripple Rd., Dayton, OH 45440-3696, (513) 426-6000

Company Model	Display size (diagonal), color	Phosphor number	Input signals	Display resolution (pixels)	Vertical refresh (Hz)	Price $ (quantity)	Notes, features, options
2106-13-AF	13-inch; red, green, blue	standard, long persistence	RGB, TTL	1024 × 768	60 Hz; interlaced, non-interlaced	4,200(Q1); 3,024(Q100)	100-MHz bandwidth, FCC Class A approved
2106-19-AF	19-inch; red, green, blue	standard, long persistence	RGB, TTL	1280 × 1024	60 Hz; interlaced, non-interlaced	4,200(Q1); 3,024(Q100)	100-MHz bandwidth, rackmount or cabinet, FCC Class A approved
2142-19	19-inch; red, green, blue	standard	RGB, TTL	1280 × 1020	60 Hz; interlaced, non-interlaced	4,500(Q1); 3,240(Q100)	100-MHz bandwidth, ruggedized

TATUNG CO. OF AMERICA INC. — Circle 349
2850 El Presidio St., Long Beach, CA 90810, ((213) 637-2105, (213) 979-7055

Company Model	Display size (diagonal), color	Phosphor number	Input signals	Display resolution (pixels)	Vertical refresh (Hz)	Price $ (quantity)	Notes, features, options
CM-1322	13-inch; red, green, blue; 16-color	B22, standard	TTL	640 × 200	50-60 Hz, non-interlaced	679(Q1); 318(Q500)	12-MHz bandwidth; cabinet; FCC Class B, UL, CSA approved; dark glass
CM-1376	13-, 22-inch; green, amber; 4096-color palette	B22, standard	RGB	640 × 480	50-60 Hz, non-interlaced	999(Q1); 499(Q500)	25-MHz bandwidth; cabinet; FCC Class A, UL, CSA approved; dark glass
CM-1380	13-inch; green, amber; 16-color, 64-color	B22, standard	RGB	640 × 350, 640 × 200	50-60 Hz, non-interlaced	849(Q1); 425(Q500)	20-MHz bandwidth; cabinet; FCC Class B, UL, CSA approved; dark glass

TECMAR INC. — Circle 353
6225 Cochran Rd., Solon, OH 44139, (216) 349-0600

Company Model	Display size (diagonal), color	Phosphor number	Input signals	Display resolution (pixels)	Vertical refresh (Hz)	Price $ (quantity)	Notes, features, options
811400/ 811401	13-inch; red, green, blue; 16-color	long persistence	TTL	720 × 480, 640 × 400	58-62 Hz, interlaced	789(Q1)	20-MHz bandwidth; FCC, UL approved; non-glare screen

TTX GROUP — Circle 350
366 Paseo Sonrisa St., Walnut, CA 91789, (714) 595-6146

Company Model	Display size (diagonal), color	Phosphor number	Input signals	Display resolution (pixels)	Vertical refresh (Hz)	Price $ (quantity)	Notes, features, options
1201 A/G	12-inch; green, amber	P31, standard	NTSC		non-interlaced	195(Q1)	20-MHz bandwidth; CSA, FCC approved
1221	12-inch, 16-color	standard	RGB	680 × 240	non-interlaced	589(Q1)	18-MHz bandwidth; CSA, FCC approved
1421	14-inch, 16-color	standard	RGB	720 × 240	non-interlaced	629(Q1)	18-MHz bandwidth; CSA, FCC approved; anti-glare screen

XTRON COMPUTER EQUIPMENT CORP. — Circle 351
19 Rector St., New York, NY 10006, (800) 854-4450

Company Model	Display size (diagonal), color	Phosphor number	Input signals	Display resolution (pixels)	Vertical refresh (Hz)	Price $ (quantity)	Notes, features, options
AA12	12-inch, amber	long persistence	NTSC	1000 × 350	non-interlaced	119(Q1)	FCC approved, 4-way tilt and swivel, non-glare screen, dark glass

Monitors

Company Model	Display size (diagonal), color	Phosphor number	Input signals	Display resolution (pixels)	Vertical refresh (Hz)	Price $ (quantity)	Notes, features, options
IA12C	12-inch, amber	long persistence	TTL	1000 × 350	50 Hz	169(Q1)	20-MHz bandwidth, FCC approved, 4-way tilt and swivel, non-glare screen, dark glass
HR14C	14-inch, 16-color	long persistence		720 × 400		599(Q1)	20-MHz bandwidth, FCC approved

Information was solicited but not received from the following manufacturers:

Amtron Corp.
2260 De la Cruz Blvd.
Santa Clara, CA 95050
(408) 748-8500

Audiotronics Corp.
7428 Bellaire Ave.
Hollywood, CA 91605
(818) 765-2645

Datacopy Corp.
1215 Terra Bella Ave.
Mountain View, CA 94043
(415) 965-7900

Dynax Inc.
6070 Rickenbacker Rd.
City of Commerce, CA 90040
(213) 727-1227

Electrohome Ltd.
809 Wellington St. North
Kitchener, Ontario
N2G 4J6, Canada
(519) 744-7111

Hitachi Corp.
of America Ltd.
50 Prospect Ave.
Tarrytown, NY 10594
(914) 332-5800

IBM Corp.
(Entry Systems Div.)
P.O. Box 1328-C
Boca Raton, FL 33432
(305) 998-2000

Ikegami Electronics
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37 Brook Ave.
Maywood, NJ 07607
(201) 368-9171

Mitsubishi Electronics
America Inc.
991 Knox St.
Torrance, CA 90502
(213) 515-3993

NEC Home Electronics
USA Inc.
1401 Estes St.
Elk Grove Village, IL 60007
(312) 228-5900

Sanyo Electric Inc.
1200 W. Artesia Blvd.
Compton, CA 90220
(213) 537-5830

Sharp Electronics Corp.
10 Sharp Plaza
Paramus, NJ 07652
(201) 265-5600

Sony Corp. of America
16450 W. Bernardo Dr.
San Diego, CA 92127
(619) 487-8500

Taxan Corp.
18005 Cortney Ct.
City of Industry, CA 91748
(818) 810-1291

Tektronix Inc.
P.O. Box 1000
Wilsonville, OR 97070
(503) 685-3617

Toshiba America Inc.
1101-A Lake Cook Rd.
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(312) 945-1500

Zenith Radio Corp.
(Systems & Components Group)
1000 Milwaukee Ave.
Glenview, IL 60025
(312) 391-7733

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Dallas, TX 75234
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270 St. Paul St.
Denver, CO 80206
(303) 388-4511

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18818 Teller Ave.
Irvine, CA 92715
(714) 851-9422

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Sherman Building, Suite 100
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San Jose, CA 95128
(408) 243-8838

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Elan Marketing Group
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P.O. Box 84
1013 Vienna
Tel: 43-222-663012

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Elan Marketing Group
13 Haifa St., P.O. Box 33439
Tel Aviv
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7-2-8 Minamiaoyama
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Donald H. Shapiro
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132 Hsin Yi Road, Sec. 2
Taipei
Tel: 3932718
Telex: 24177 FC Trade

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5th Floor, Suite 10
Chesham House
136 Regent St.
London W1R 5FA
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Telex: 267653

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Tel: 46-8-677243

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