IRIS GRAPHICS 3024 COLOR INK JET PRINTER

SETTING COLOR VALUES

By using crystal-stimulated glass capillary nozzles, one million droplets of ink per second per color are generated on the IRIS 3000 series printer. Zero, one, two, three, or up to 31 of these droplets may be printed at any particular pixel location on the paper. Patented electronics control the charging/uncharging of the appropriate number of droplets. Uncharged droplets form a single dot of ink on the receiving media; charged droplets are deflected with high voltage into the waste system. See Figure 1, "IRIS Series 3000 Ink Jet Printer, Stimulated Nozzle."

Two techniques are available to the on-line system user on the IRIS 3000 series printer for controlling color. Both techniques specify the precise number of droplets of each color to be printed at every pixel location. The first technique (available on all systems) defines contrast and density for each of the four colors; a lookup table is constructed from the parameters. The second technique allows a host system to directly load the system's color lookup tables, overriding the internal computed tables.

Both techniques depend on 8 bit input color data and the current pixel location in a 4 by 4 matrix. The system tracks the current pixel's row and column location within this 4 by 4 matrix, and with that information, can define droplet patterns over the entire 0 to 255 input data range.

```
                        12-bit
8 bits (input data)     address    Color     value
                           --->    Lookup    --->    5 bits (number of
2 bits (row location)              Table              ink droplets,
2 bits (column location)                                0 to 31)
```

Method 1

With this method, at the start of a print, the system will compute and upload the color lookup table. The number of droplets to be printed at a particular pixel location depends on the following equation:

table value = (density/100.) * 31 * (data_value/256) ** contrast,

where table value = number of droplets to print,
density ranges from 0 to 100%, in 1% increments,
data_value ranges from 0 to 255,
contrast ranges from 1.0 to 2.5, in 0.1 increments.

This equation yields a whole number and a fraction. The system calculates the fraction as n/16; that is, the number of 16ths remaining.

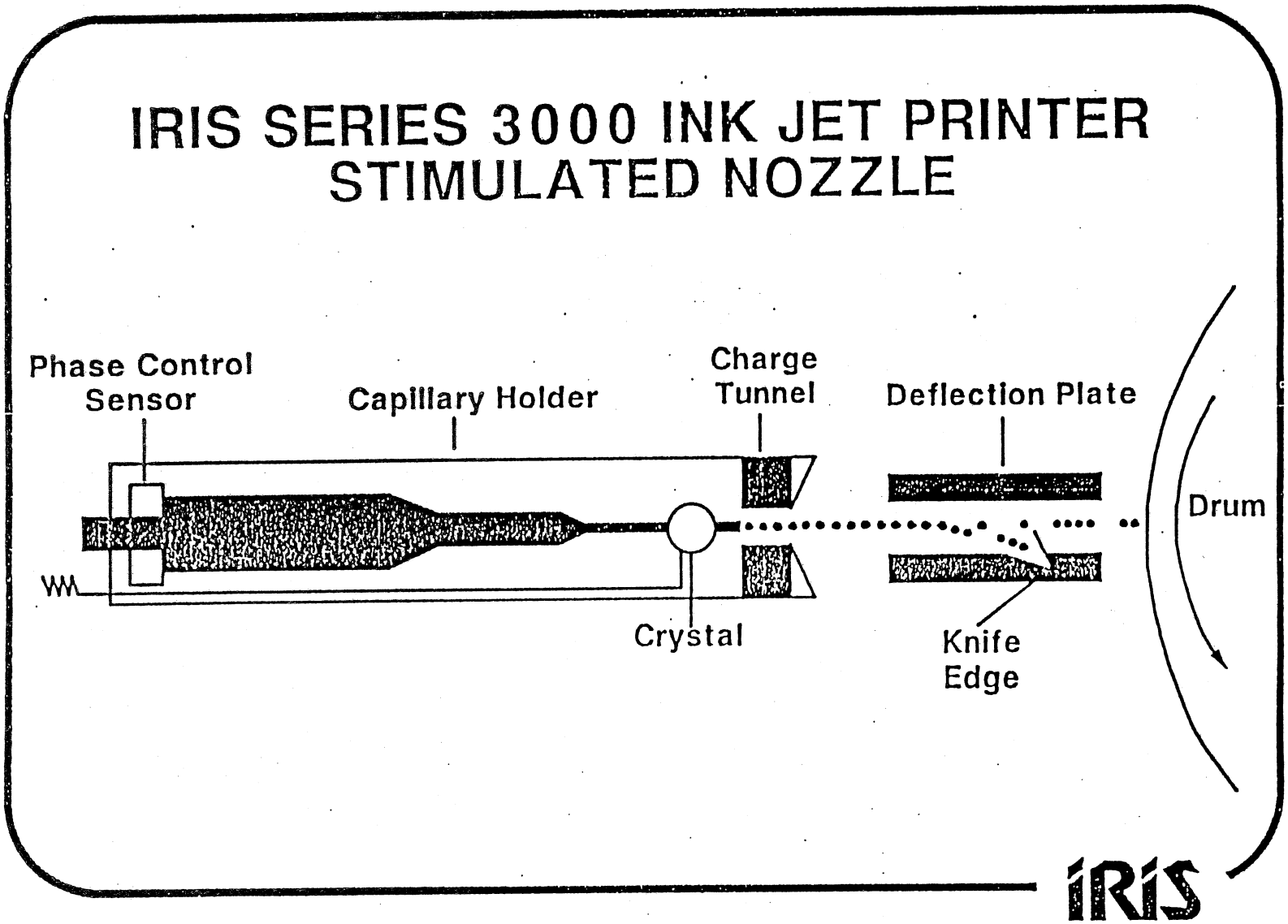
IRIS SERIES 3000 INK JET PRINTER
STIMULATED NOZZLE
Phase Control Sensor
Capillary Holder
Charge Tunnel
Deflection Plate
Drum
Crystal
Knife Edge
IRIS

Figure 1.

If the value of the remainder (number of sixteenths) is greater than or equal to the matrix value at the row and column location, the whole number plus one is loaded into the table. If the value of the remainder is less than the matrix value at the row and column location, the whole number is loaded. The 4 by 4 matrix scheme is modeled on an ordered dither technique (utilized in binary printing technologies):

16	8	14	6
4	12	2	10
13	5	15	7
1	9	3	11

Appendix 1 illustrates several examples.

When printing each pixel, a table address is constructed of the incoming data values and the row and column location to be printed, and the table value is used to control the number of ink droplets printed.

Method 2

This technique, available on on-line systems only, allows the user to override the internally generated tables discussed above and to be in full control of the printer's color lookup table. In particular, if the graph below illustrates a desired map of input data values (0 to 255) to output number of droplets (0 to 31), then a color lookup table can be built to accomodate this mapping.

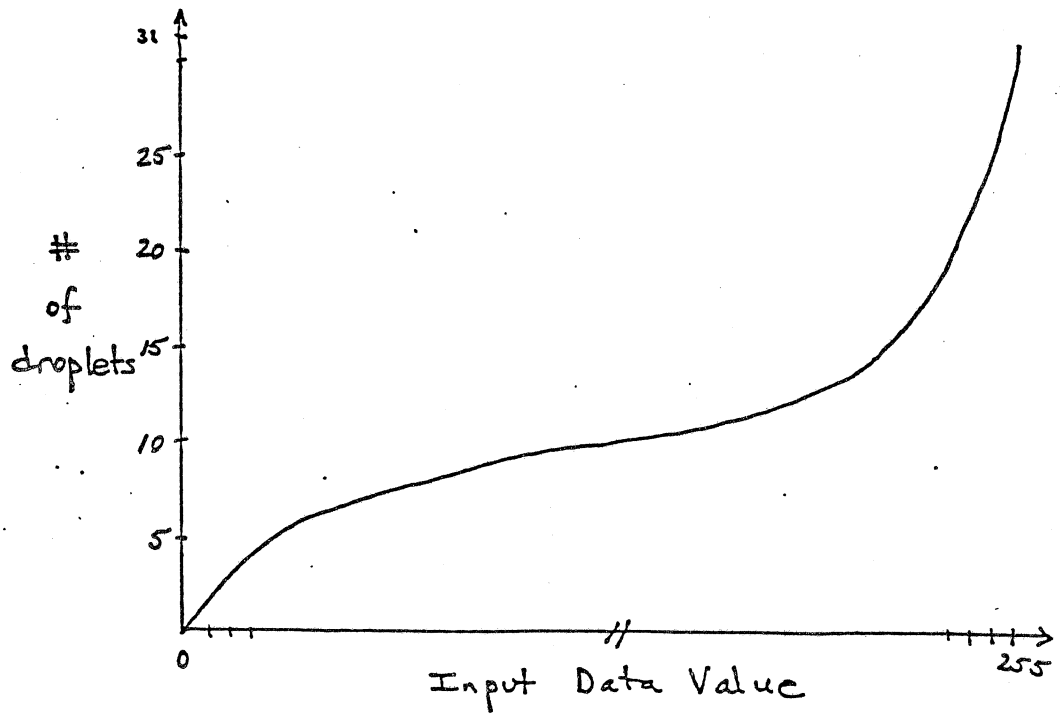

Figure 2.

For purposes of constructing the color lookup table, the 4 by 4 matrix is represented in the following sequence:

```
raster      |
line        |
direction   |
            |   0    4    8   12
                1    5    9   13
                2    6   10   14
                3    7   11   15
```

The color lookup table itself may be viewed as 16 bytes "wide" and 256 bytes "long." The 256 bytes represent incoming data values (0 to 255). There is a color look-up table for each of the four colors, cyan, magenta, yellow and black. Each table is 4096 bytes in size (16 * 256).

```
                    Matrix Location
              0  1  2  3  4  ...  14  15

Input      0
 Data      1
Value      2
           .      # of droplets to print
           .
           .
         254
         255
```

The 16 bytes wide represent the 16 locations in the 4 by 4 matrix shown above. The table values themselves represent the number of droplets to be printed for a particular input value, row and column location.

Refer to the separate document "IRIS Interface Specification" for the details of downloading color tables from host systems.

Notes

The actual maximum number of droplets available per pixel location is dependent on drum speed and resolution, according to the following equation:

$$\text{maximum number of droplets/pixel} = \frac{1{,}000{,}000 \text{ droplets/second}}{\text{drum speed (inches/second)} * \text{resolution (pixels/inch)}}$$

The system will not check for consistency among variables. If the color lookup table requests more droplets than are possible, the system will print the maximum physically available.

sja <<created - 10/15/87>>

Appendix 1

Sample Calculations -- Method 1
Using Density and Contrast Values to Calculate Color Lookup Table Values

Drum speed = 150 inches/second (for maximum available number of
Resolution = 240 pixels/inch droplets = 27.8)

Cyan density = 40%
Magenta density = 80%
Yellow density = 50%
Black density = 40%

Contrast, all colors = 1.5

table value = (density/100.) * 31 * (data_value/256) ** contrast,

Input Value	Number of Droplets			
	Cyan	Magenta	Yellow	Black
255	12 5/16	24 10/16	15 6/16	12 5/16
Row, Column				
1,1	12	24	15	12
1,2	12	25	15	12
2,3	13	25	16	13
3,2	13	25	16	13
4,4	12	24	15	12

Input Value	Number of Droplets			
	Cyan	Magenta	Yellow	Black
150	5 8/16	11 1/16	6 15/16	5 8/16
Row, Column				
1,1	5	11	6	5
1,2	6	11	7	6
2,3	6	11	7	6
3,2	6	11	7	6
4,4	5	11	7	5

Representative cyan color lookup table values:

		Matrix Location																
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	(table value)
Input Data Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	•																	
	10	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0 1/16
	•																	
	80	2	2	2	3	2	2	2	2	2	3	2	2	2	2	2	2	2 2/16
	•																	
	150	5	6	5	6	6	5	6	5	5	6	5	6	5	6	5	6	5 8/16
	•																	
	254	12	12	12	13	12	12	12	12	12	13	12	13	12	12	12	12	12 3/16
	255	12	13	12	13	12	12	13	12	12	13	12	13	12	12	12	12	12 5/16