Position Calibration Targets

7 July 2008

Eric Hamilton

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[1] `$Header: d:/Binder2/Targets/RCS/Targets.tex,v 1.4 2008-07-07 08:24:43-07 Hamilton Exp Hamilton $`

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1 Calibration Grid[calibrationgrid]

To aid in determining the pointing accuracy of a Pan/Tilt/Dome a set of targets with calibrated 0.1^o and 0.01^o marks in pan and tilt have been developed for use at different distances from the unit being tested.

The method of calculating the angular distance required for 0.1^o movement at various distances away from the camera is:

$$\pi = 3.1415926$$

$$c = 2 \times \pi \times r$$

$$a = (c \times 12)/(360 \times 10)$$

Where:

- a = Arc of 0.1^o width in inches.
- c = Circumference of a circle.
- r = Radius of a circle in feet.
- 2 = Factor between diameter and radius of a circle.
- 10 = Conversion factor from whole degrees to tenths of a degree.
- 12 = Conversion factor from feet to inches.
- 360 = Degrees in a circle.

For example at 48 feet from the camera, 0.1^o of angular distance is 1.01 inch long. (Or 1.005300032 inch if more accuracy is needed.)

1.1 How to use the targets

The included targets in this note are designed for use at ranges of 2 to 11 feet in full foot increments and from 12 to 56 feet in even foot increments, between the camera and the target[3]. Each of the larger grids consists of a "large" and a "small" set of dots[4]. The large dots are 0.1^o apart and the small dots are 0.01^o apart. Each target has a central dot with the distance that the target is anticipated to be used at underneath. They also have four large sub-dots which are numbered from 1 to 4 for additional testing.

[2] `$Header: d:/Binder2/Targets/RCS/Targets.tex,v 1.4 2008-07-07 08:24:43-07 Hamilton Exp Hamilton $`

[3] Targets may be generated for other distances if needed.

[4] The smaller grids do not have the 0.01^o grids because the dots are too close together and tend to make a black box with no obvious dots in it.

1. More than one of these may be used at any one time. I.e. there may be two places that it is reasonable to point a camera at which may be on different walls, or other convenient surface, which may be at different, or the same, distances. Thus two targets would be used for the same series of tests.

2. When selecting a target to use it should be remembered that the distance to be used is the estimated distance from the camera's "pivot point". This may or may not be the front of the lens of the camera.

3. As a reasonably accurate indication of distance, it should be remembered that ceiling tiles are two feet on a side (some are two by four with a line down the middle). Over any reasonable distance any errors average out and the result is quite accurate. (Usually better than ±1inch.)

4. To easily calculate distance, count full tiles and double, or quadruple, their number. (Ceiling tiles being either 2 feet by 4 feet, or 2 feet by 2 feet in size.) The result is the distance between the camera and the target.

5. When using these targets, their accuracy improves somewhat when longer distances are used. The recommended distances to use with these targets are in the 40's of feet (40, 42, 44, 46 and 48).

6. If distances other than those provided in this set of foot distances are needed please let me know and I'll generate some more targets. I am only setup to generate targets on 8 $\frac{1}{2}$ by 11 inch paper in portrait format and in whole foot distances. I.e. no landscape formats, no metric distances and no "bigger" paper. (If it is important the distances (feet and inches, metric, etc.) for which the targets are generated at may be changed.)

7. When closer distances are needed than are provided by this set of targets, use the small grids and move the entire target 10× closer. I.e. use the 40 foot target at 4 feet. When this is done the small target is correct for the closer distance.

8. Always remember that custom targets are made on request. So a target may be made for almost any reasonable distance. The only limitations are the size of the paper and the resolution of the printer[5].

9. An accuracy of $\pm.1^o$ is interpreted to mean: "The unit will point to within $.1^o$ from where it is supposed to point. The pointing is to be within a square box that has equal length sides of $.2^o$ and the aiming point is to be in the center of the box. This is different than using a circle with a radius of $.1^o$."

A note on the accuracy of the targets

Accuracy in the generation of the grid is controlled by the quality of the printer used to print it out and the number of times that the individual target has been reproduced.

[5] And the attitude of the author!

The generated PDF file is correct, however the actual printing process sometimes introduces sizeing errors. When paper is wrapped around a drum, as it is with most laser printers, one surface is longer (one side is on the outside of the circle so its radius is slightly longer than the other side's is).

While the paper direction that is longitudinal to the cylinder is almost always "correct". This results in dimensions in one direction being somewhat better than those in the other direction.

To get an estimate of the amount of "printing error" that has been introduced to any given target, an inch rule has been provided on each edge of the target grid. If this inch rule is checked with an accurate machinist's ruler and indication of the dimensional errors that have been introduced to the copy at hand may be estimated. For almost all uses the introduced error may be ignored.

d	a	d	a	d	a	d	a
2	0.041887501	34	0.712087523	66	1.382287544	98	2.052487565
4	0.083775003	36	0.753975024	68	1.424175045	100	2.094375067
6	0.125662504	38	0.795862525	70	1.466062547	102	2.136262568
8	0.167550005	40	0.837750027	72	1.507950048	104	2.178150069
10	0.209437507	42	0.879637528	74	1.549837549	106	2.220037571
12	0.251325008	44	0.921525029	76	1.591725051	108	2.261925072
14	0.293212509	46	0.963412531	78	1.633612552	110	2.303812573
16	0.335100011	48	1.005300032	80	1.675500053	112	2.345700075
18	0.376987512	50	1.047187533	82	1.717387555	114	2.387587576
20	0.418875013	52	1.089075035	84	1.759275056	116	2.429475077
22	0.460762515	54	1.130962536	86	1.801162557	118	2.471362579
24	0.502650016	56	1.172850037	88	1.843050059	120	2.513250080
26	0.544537517	58	1.214737539	90	1.884937560	122	2.555137581
28	0.586425019	60	1.256625040	92	1.926825061	124	2.597025083
30	0.628312520	62	1.298512541	94	1.968712563	126	2.638912584
32	0.670200021	64	1.340400043	96	2.010600064	128	2.680800085

Table 1. Full Table of 0.1^o widths `[fulltable]`

d	a	d	a	d	a	d	a
2	0.042	34	0.71	66	1.38	98	2.05
4	0.084	36	0.75	68	1.42	100	2.09
6	0.126	38	0.80	70	1.47	102	2.14
8	0.168	40	0.84	72	1.51	104	2.18
10	0.209	42	0.88	74	1.55	106	2.22
12	0.251	44	0.92	76	1.59	108	2.26
14	0.293	46	0.96	78	1.63	110	2.30
16	0.335	48	1.01	80	1.68	112	2.35
18	0.377	50	1.05	82	1.72	114	2.39
20	0.419	52	1.09	84	1.76	116	2.41
22	0.461	54	1.13	86	1.80	118	2.47
24	0.503	56	1.17	88	1.84	120	2.51
26	0.545	58	1.21	90	1.88	122	2.56
28	0.586	60	1.26	92	1.92	124	2.60
30	0.628	62	1.30	94	1.97	126	2.64
32	0.670	64	1.34	96	2.01	128	2.68

Table 2. Rounded Values of 0.1^o widths`[roundedvalues]`

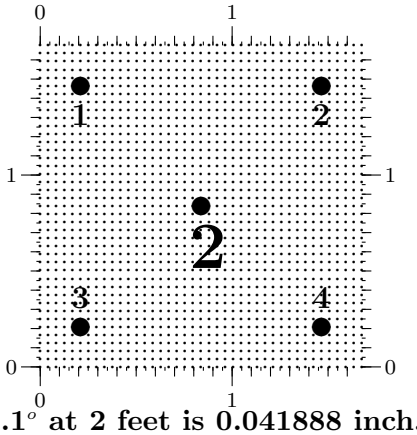

Figure 1. **0.1^o at 2 feet is 0.041888 inch.**`[ 2feet]`

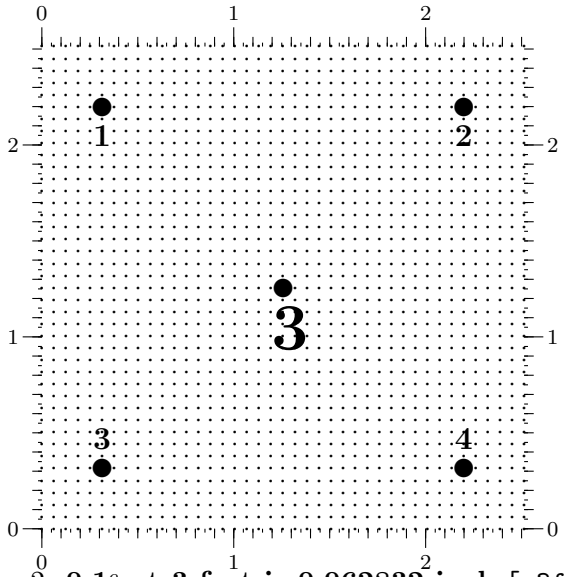

Figure 2. **0.1^o at 3 feet is 0.062832 inch.**`[ 3feet]`

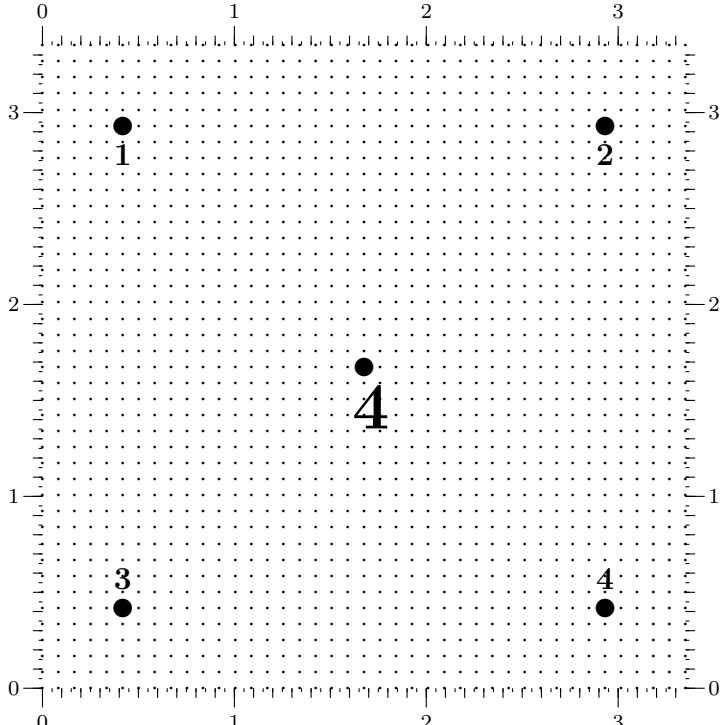

Figure 3. **0.1^o at 4 feet is 0.083776 inch.**`[ 4feet]`

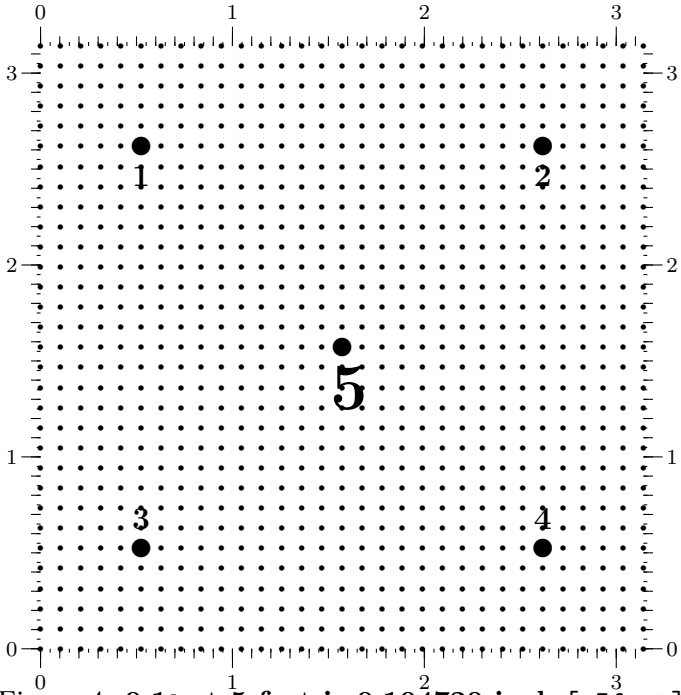

Figure 4. **0.1^o at 5 feet is 0.104720 inch.**`[ 5feet]`

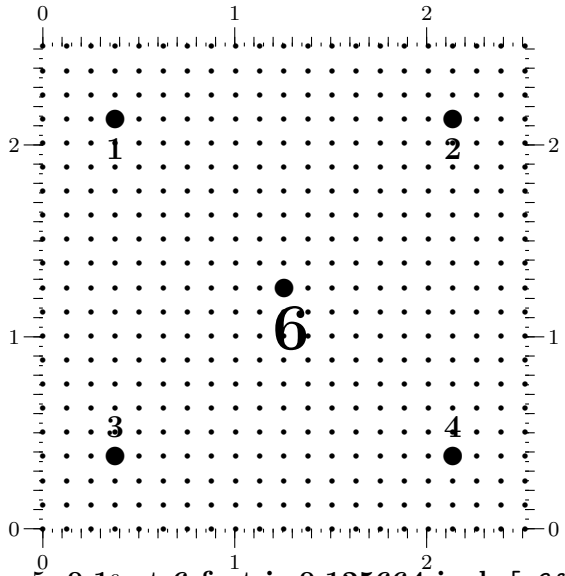

Figure 5. **0.1^o at 6 feet is 0.125664 inch.**`[ 6feet]`

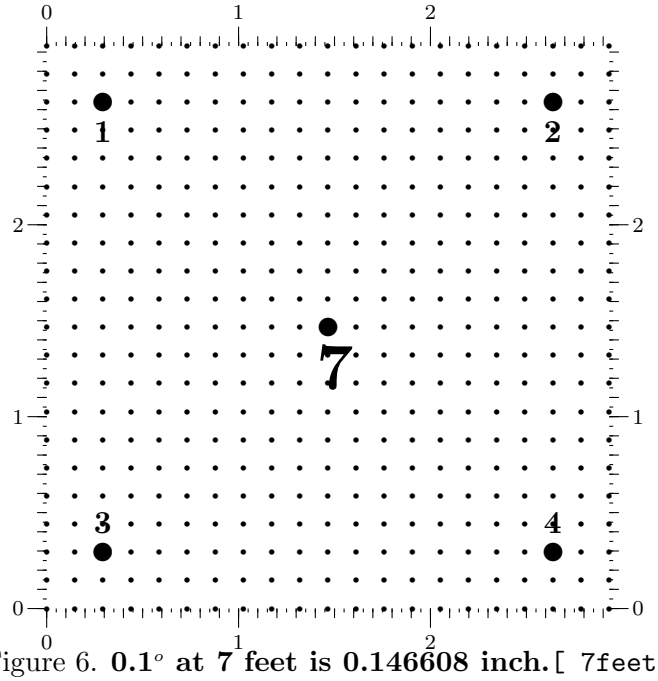

Figure 6. **0.1^o at 7 feet is 0.146608 inch.**`[ 7feet]`

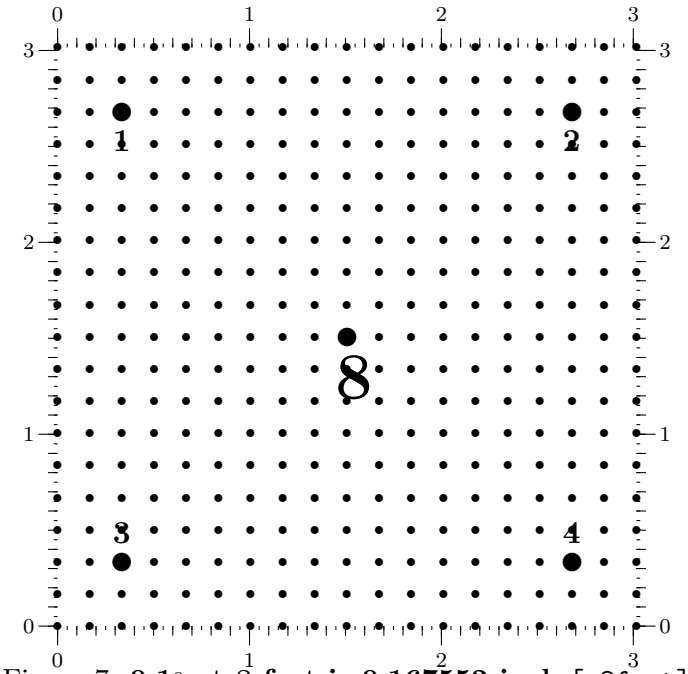

Figure 7. **0.1° at 8 feet is 0.167552 inch.** `[ 8feet]`

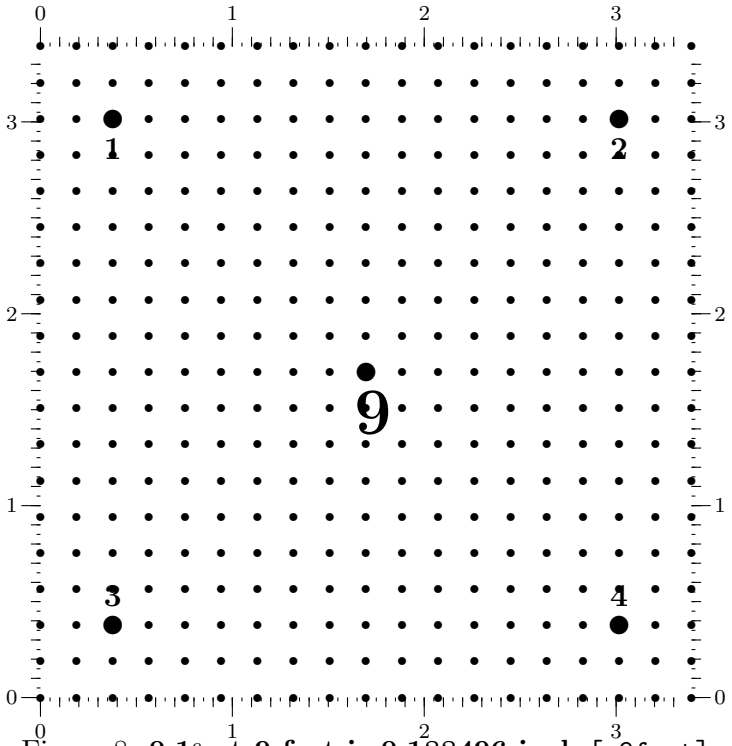

Figure 8. **0.1^o at 9 feet is 0.188496 inch.**`[ 9feet]`

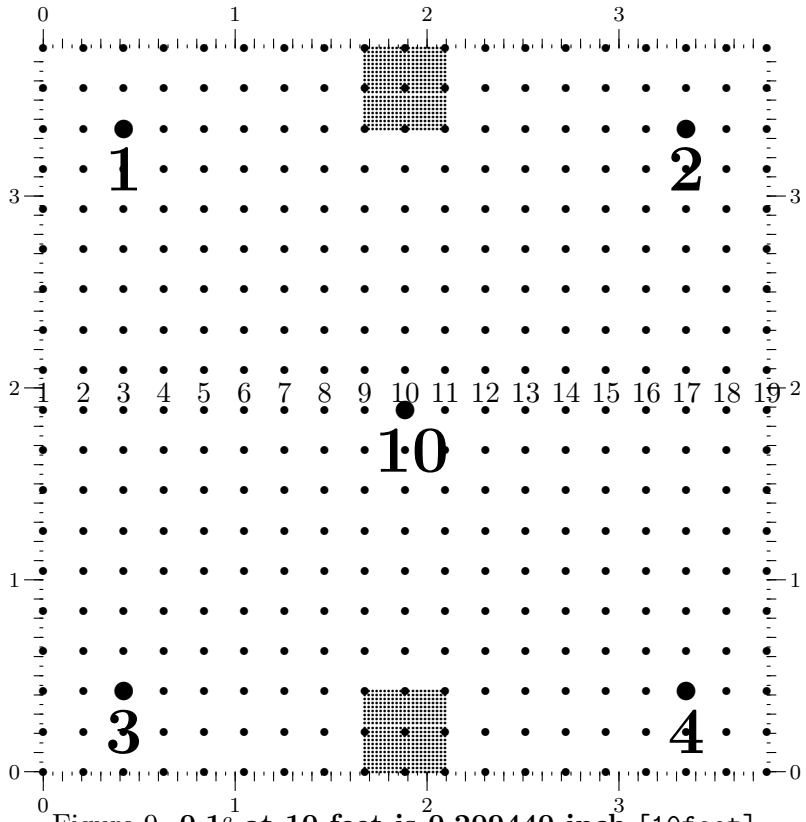

Figure 9. **0.1^o at 10 feet is 0.209440 inch.** `[10feet]`

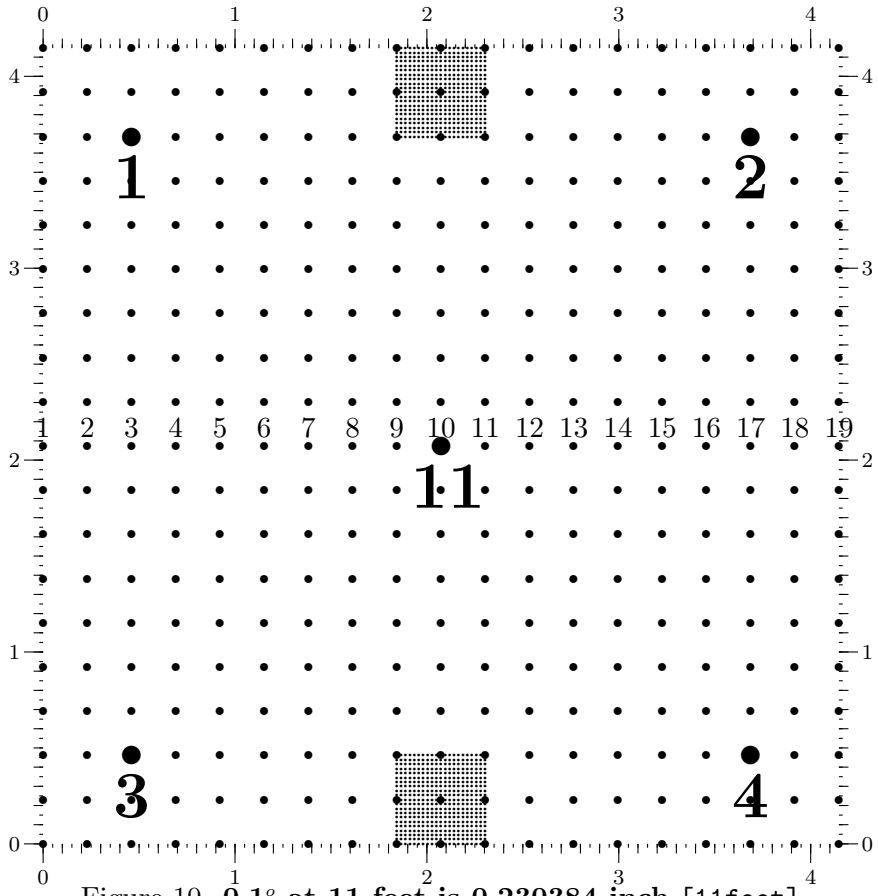

Figure 10. **0.1° at 11 feet is 0.230384 inch.** `[11feet]`

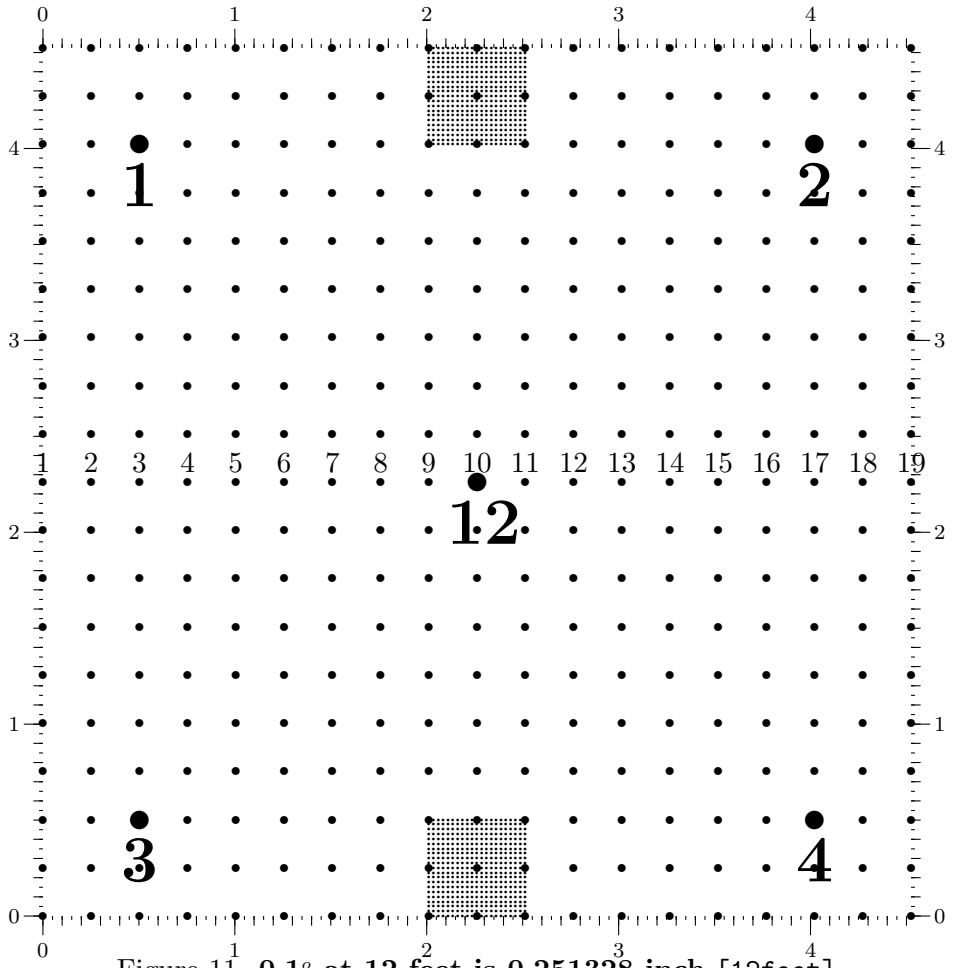

Figure 11. **0.1° at 12 feet is 0.251328 inch.** `[12feet]`

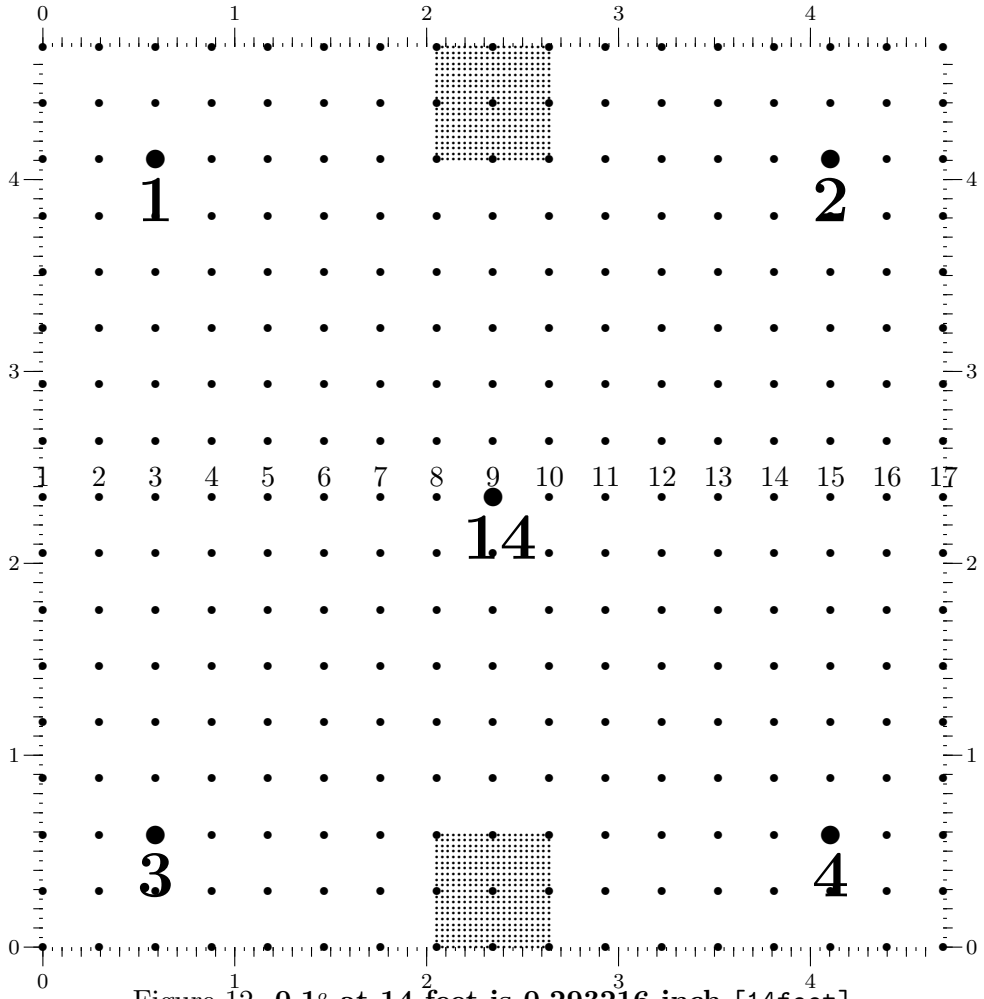

Figure 12. **0.1^o at 14 feet is 0.293216 inch.** `[14feet]`

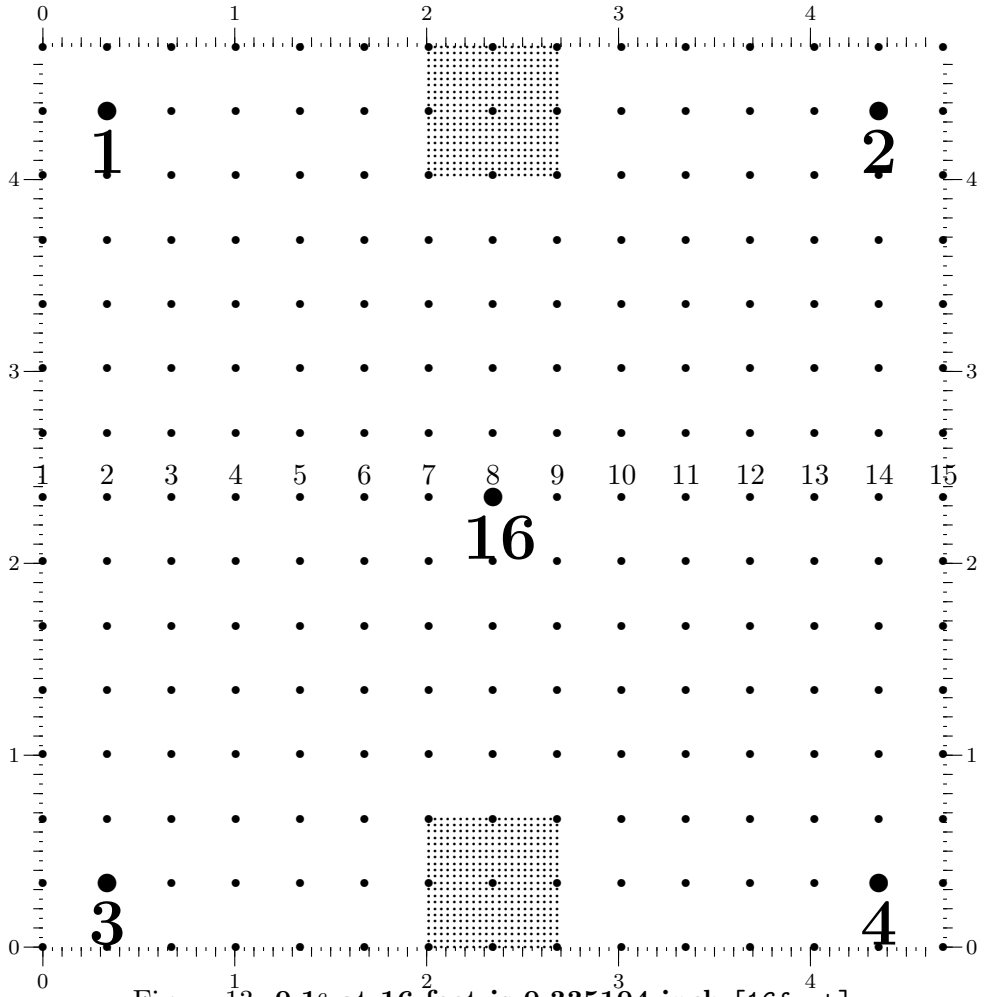

Figure 13. **0.1° at 16 feet is 0.335104 inch.** `[16feet]`

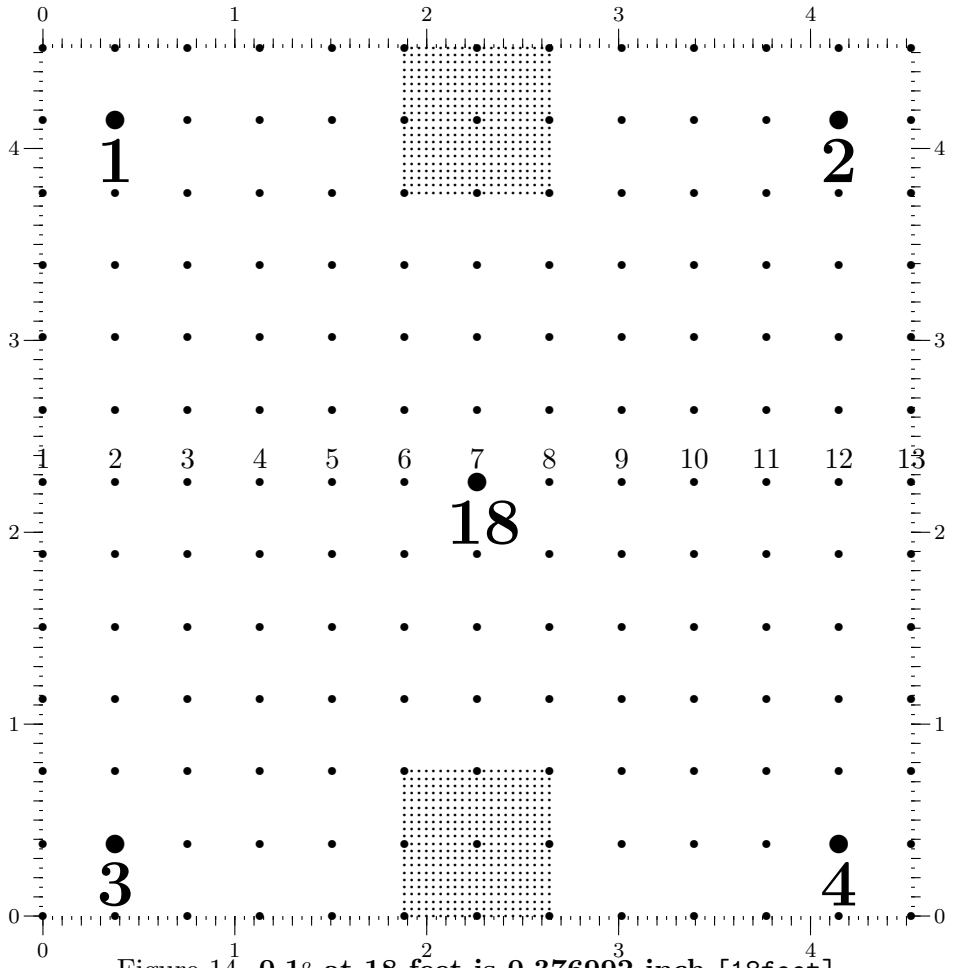

Figure 14. **0.1° at 18 feet is 0.376992 inch.** `[18feet]`

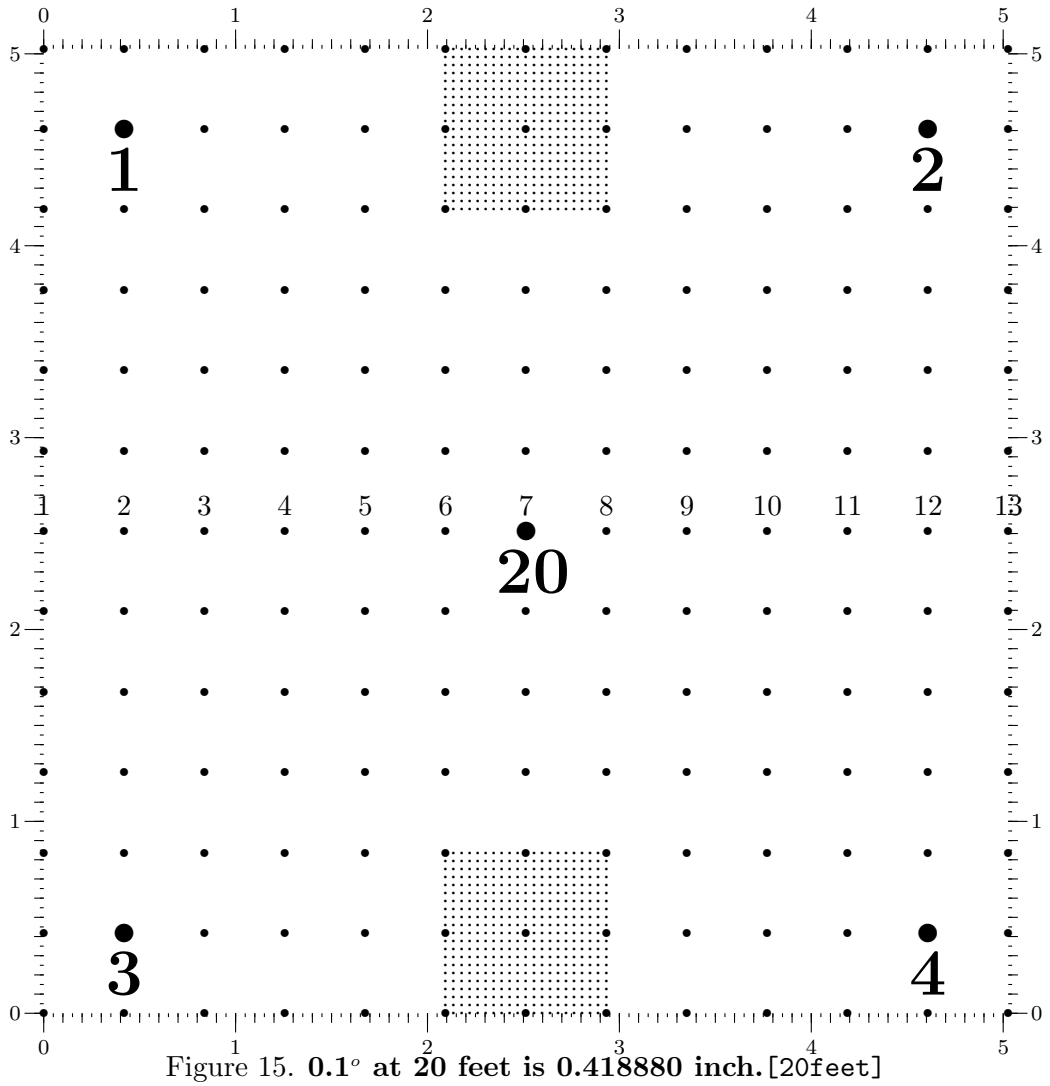

Figure 15. **0.1° at 20 feet is 0.418880 inch.** `[20feet]`

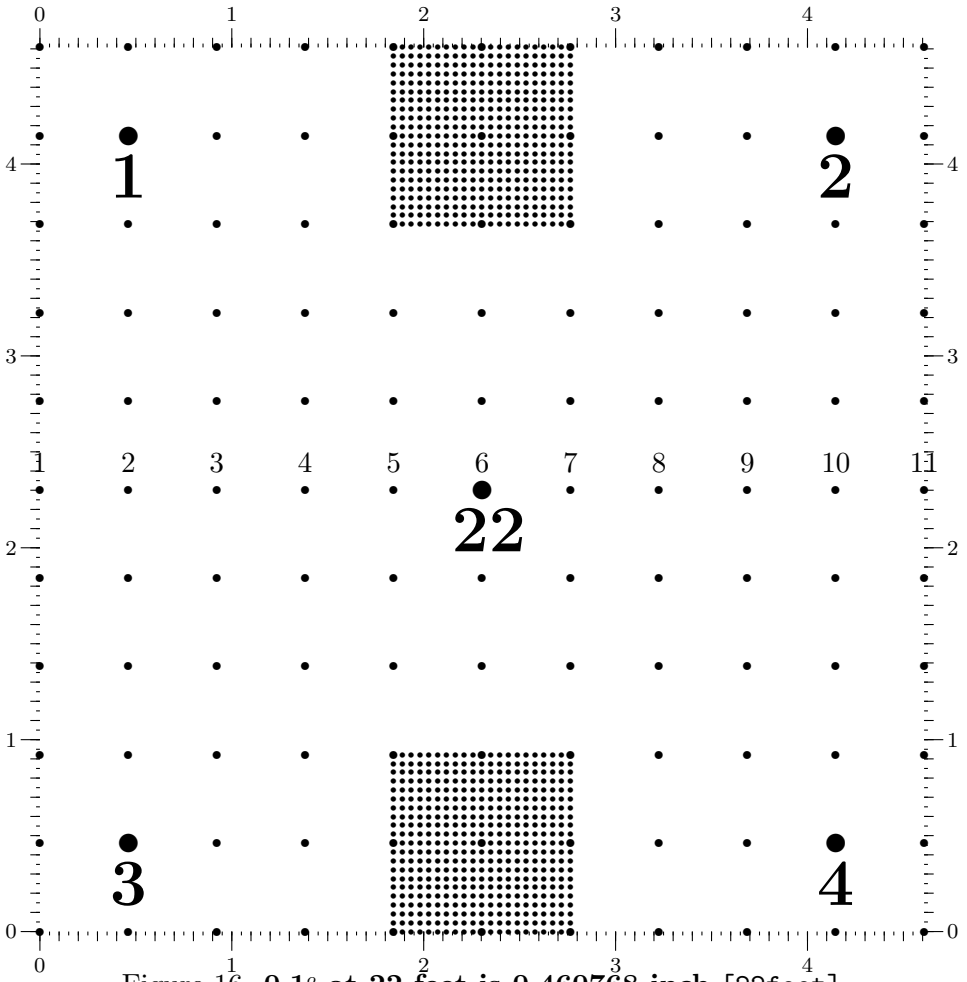

Figure 16. **0.1° at 22 feet is 0.460768 inch.** `[22feet]`

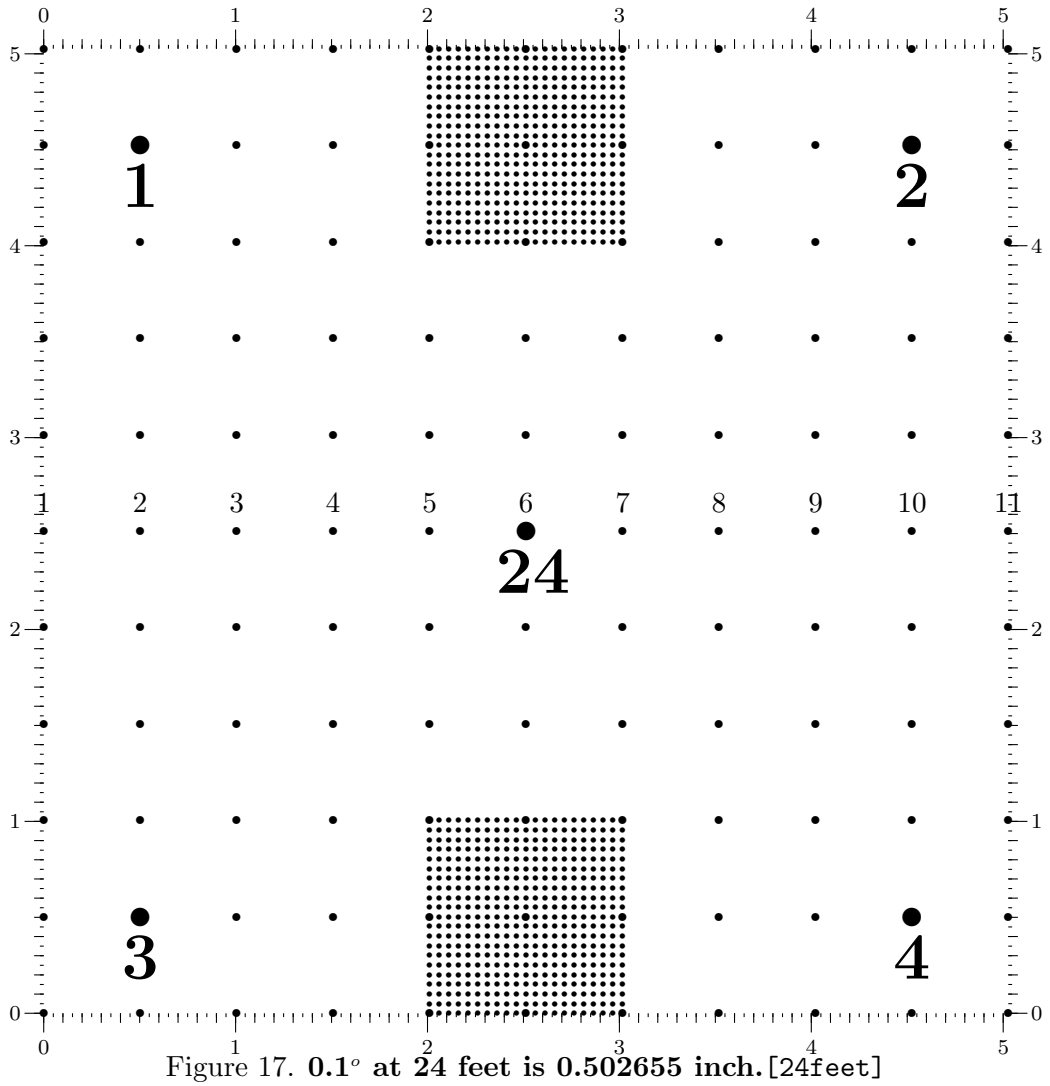

Figure 17. **0.1° at 24 feet is 0.502655 inch.** `[24feet]`

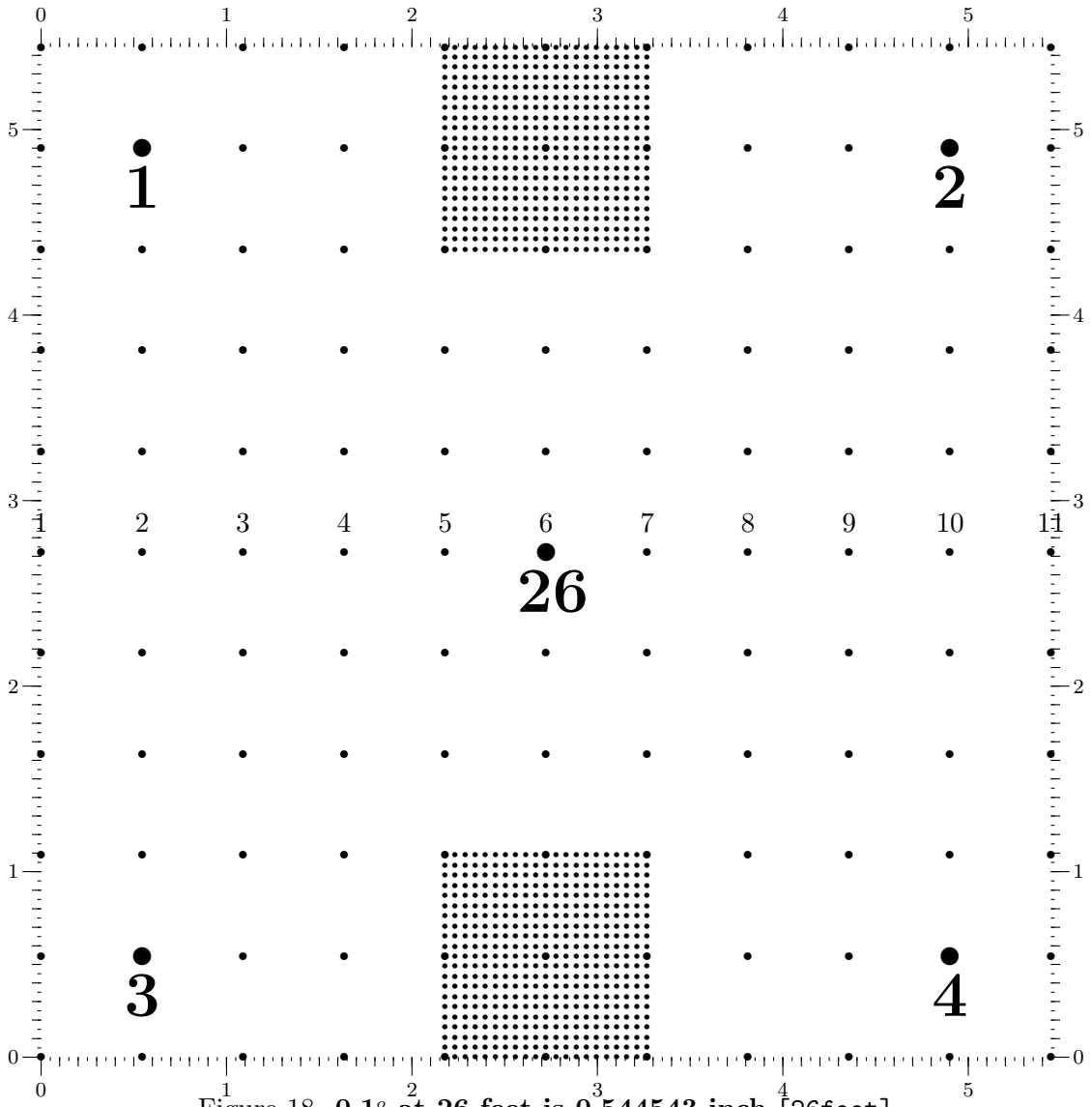

Figure 18. **0.1° at 26 feet is 0.544543 inch.** `[26feet]`

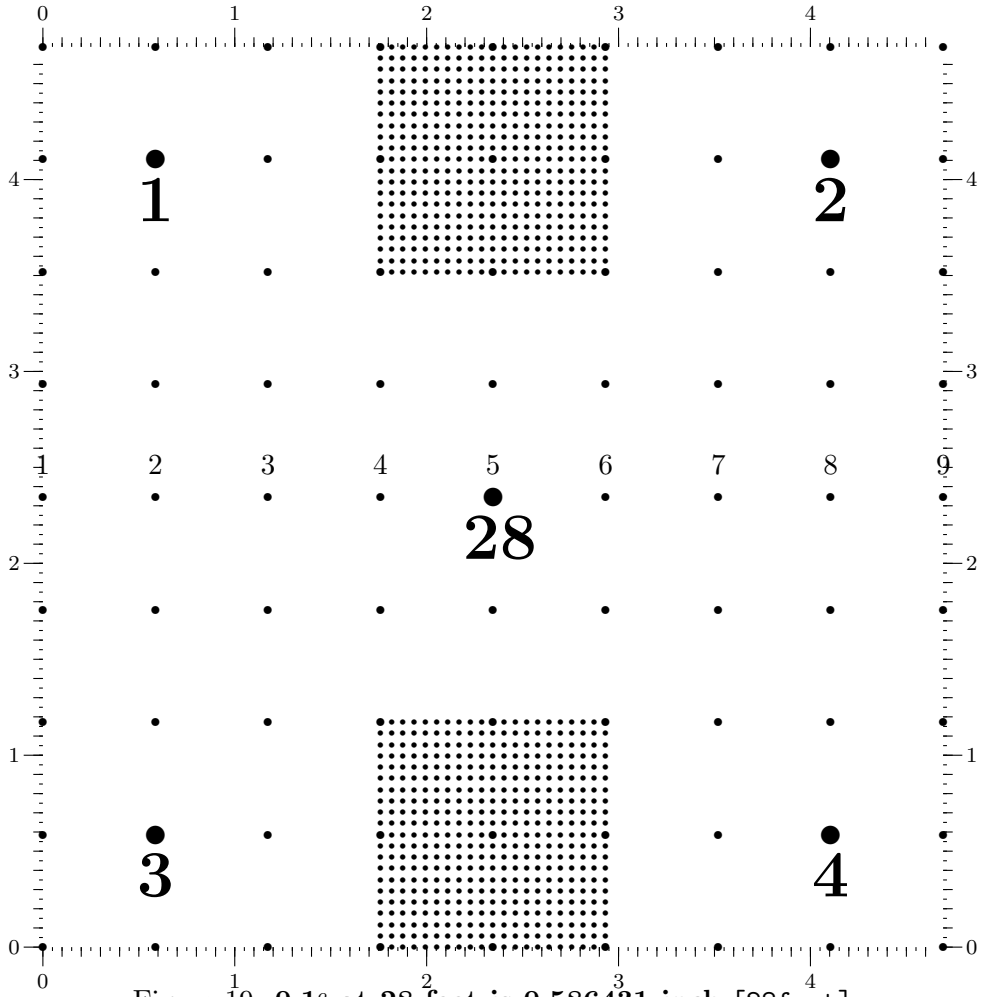

Figure 19. **0.1° at 28 feet is 0.586431 inch.** `[28feet]`

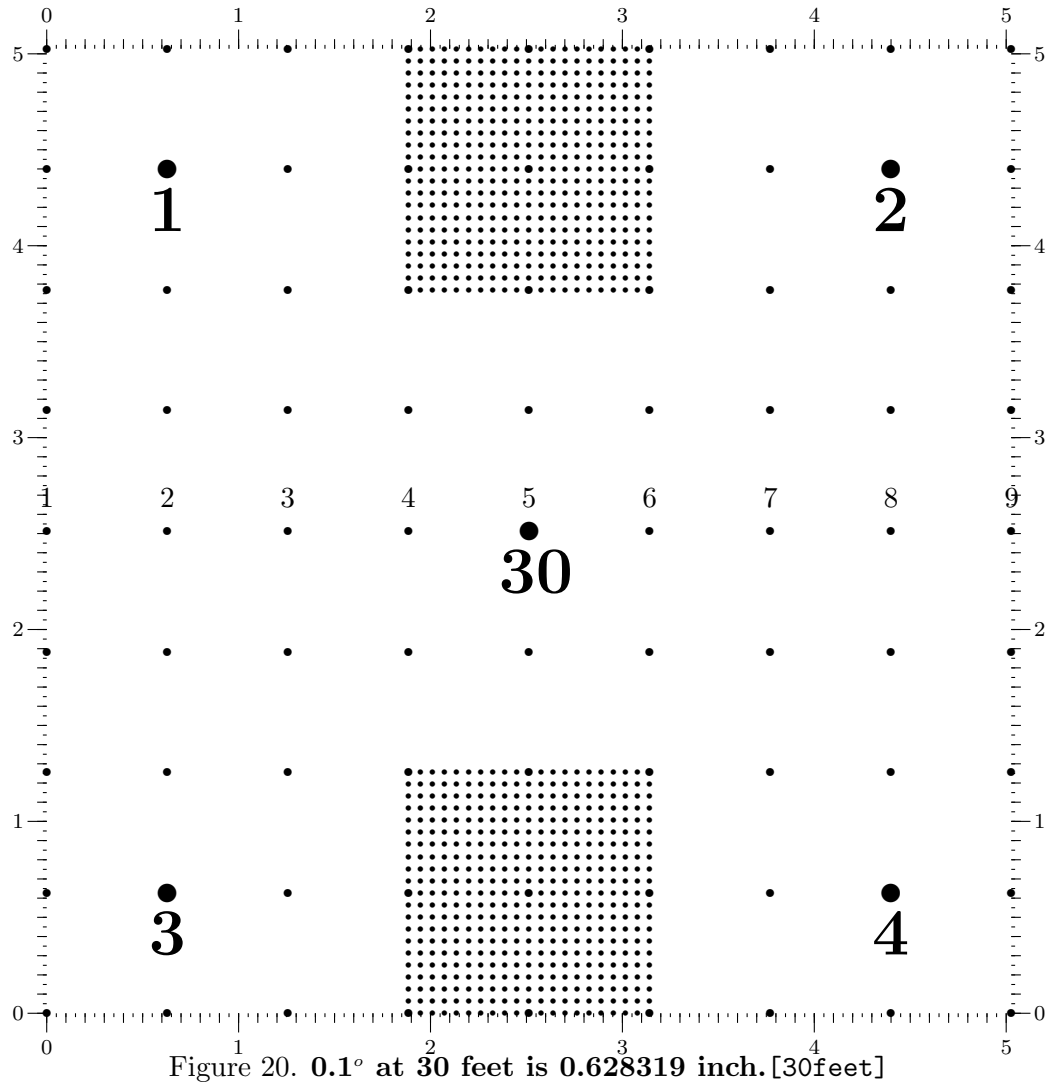

Figure 20. **0.1° at 30 feet is 0.628319 inch.** `[30feet]`

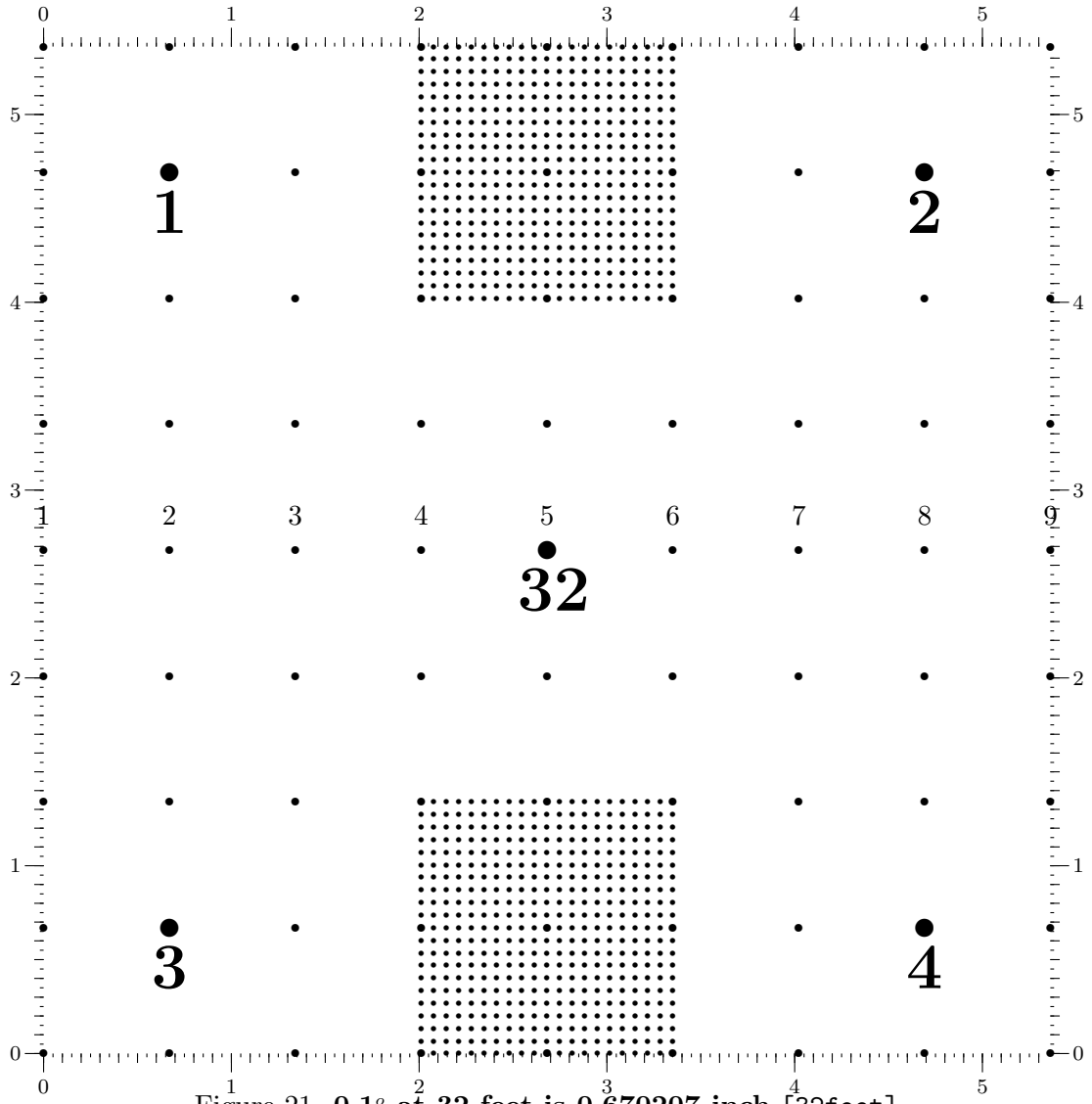

Figure 21. **0.1° at 32 feet is 0.670207 inch.** `[32feet]`

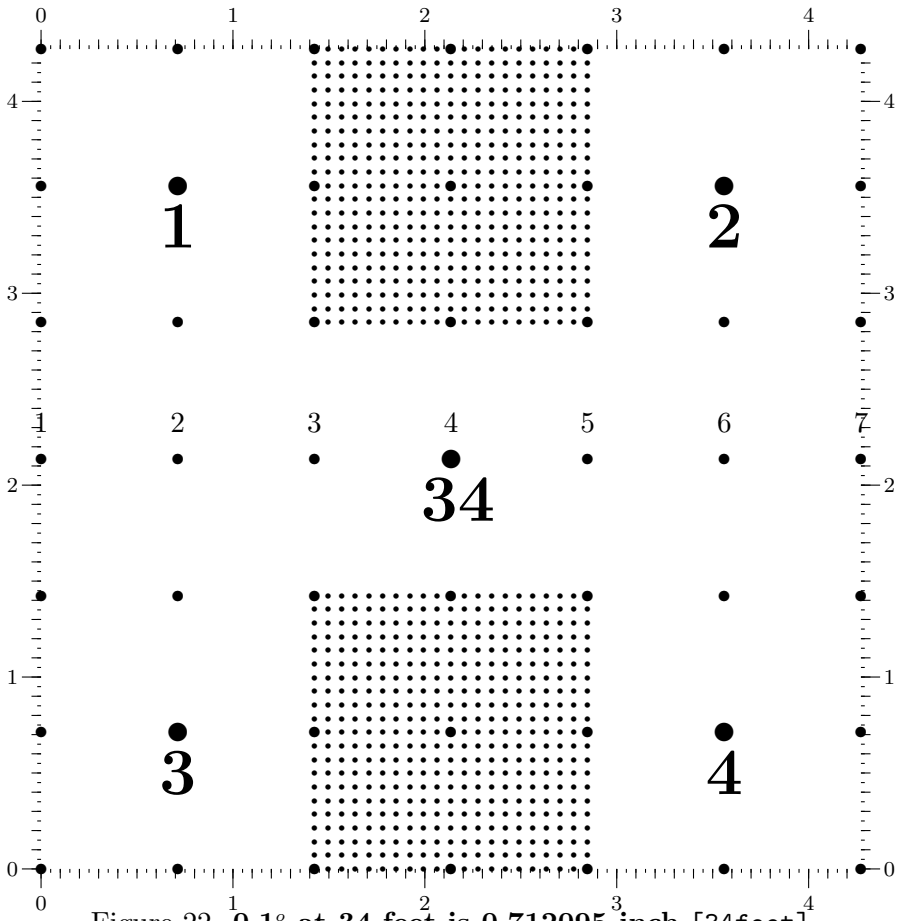

Figure 22. **0.1° at 34 feet is 0.712095 inch.** `[34feet]`

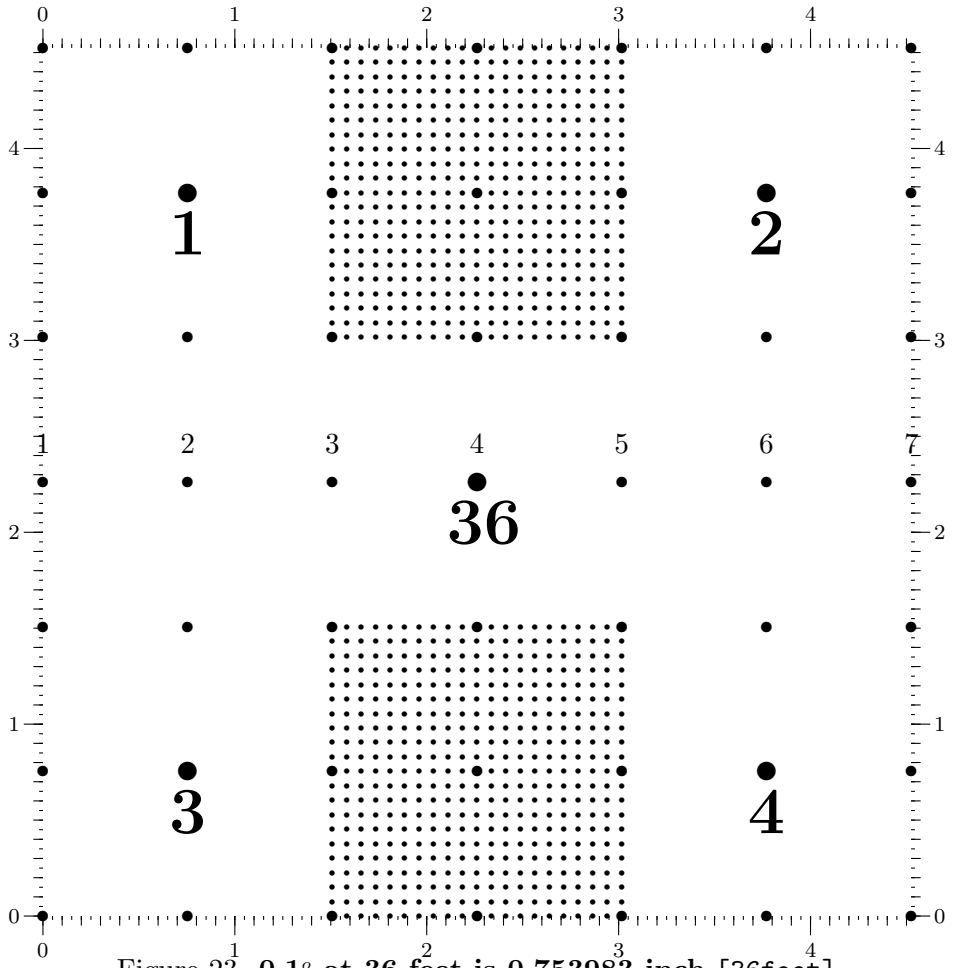

Figure 23. **0.1^o at 36 feet is 0.753983 inch.** `[36feet]`

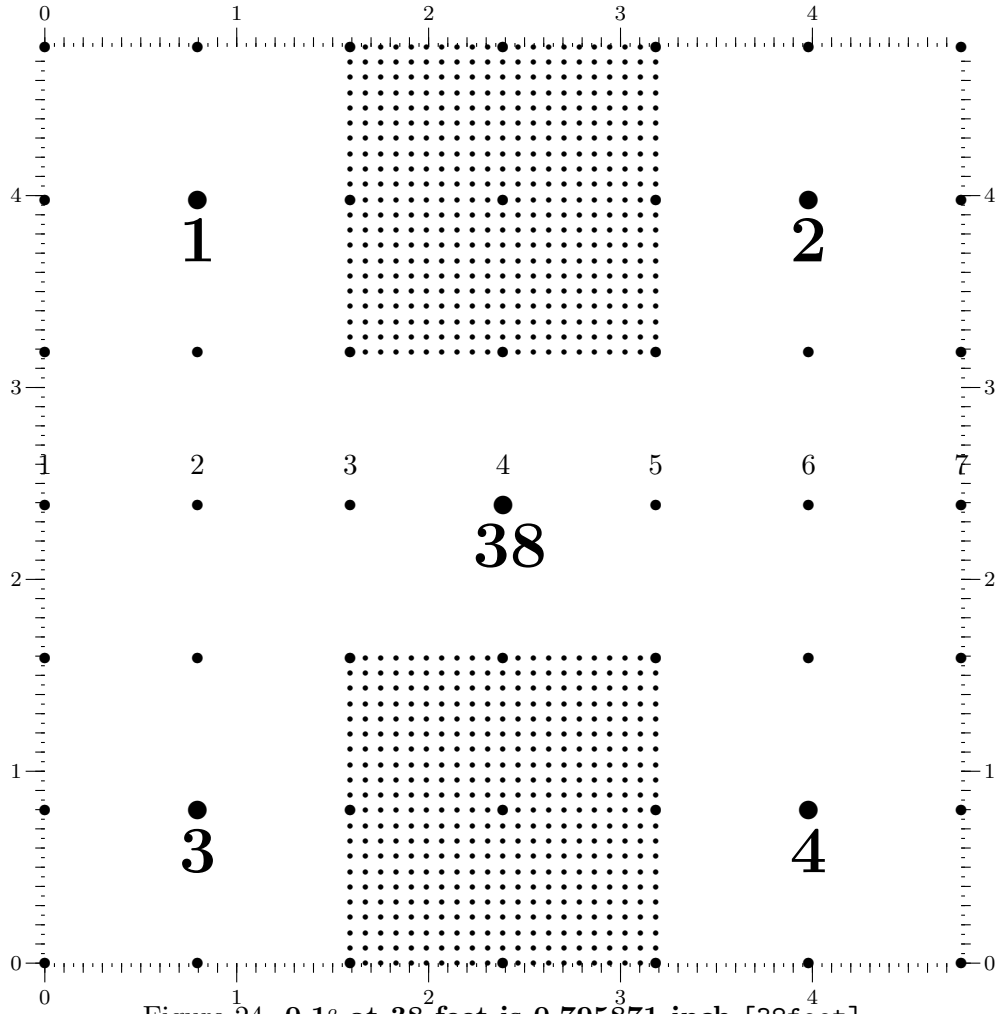

Figure 24. **0.1^o at 38 feet is 0.795871 inch.** `[38feet]`

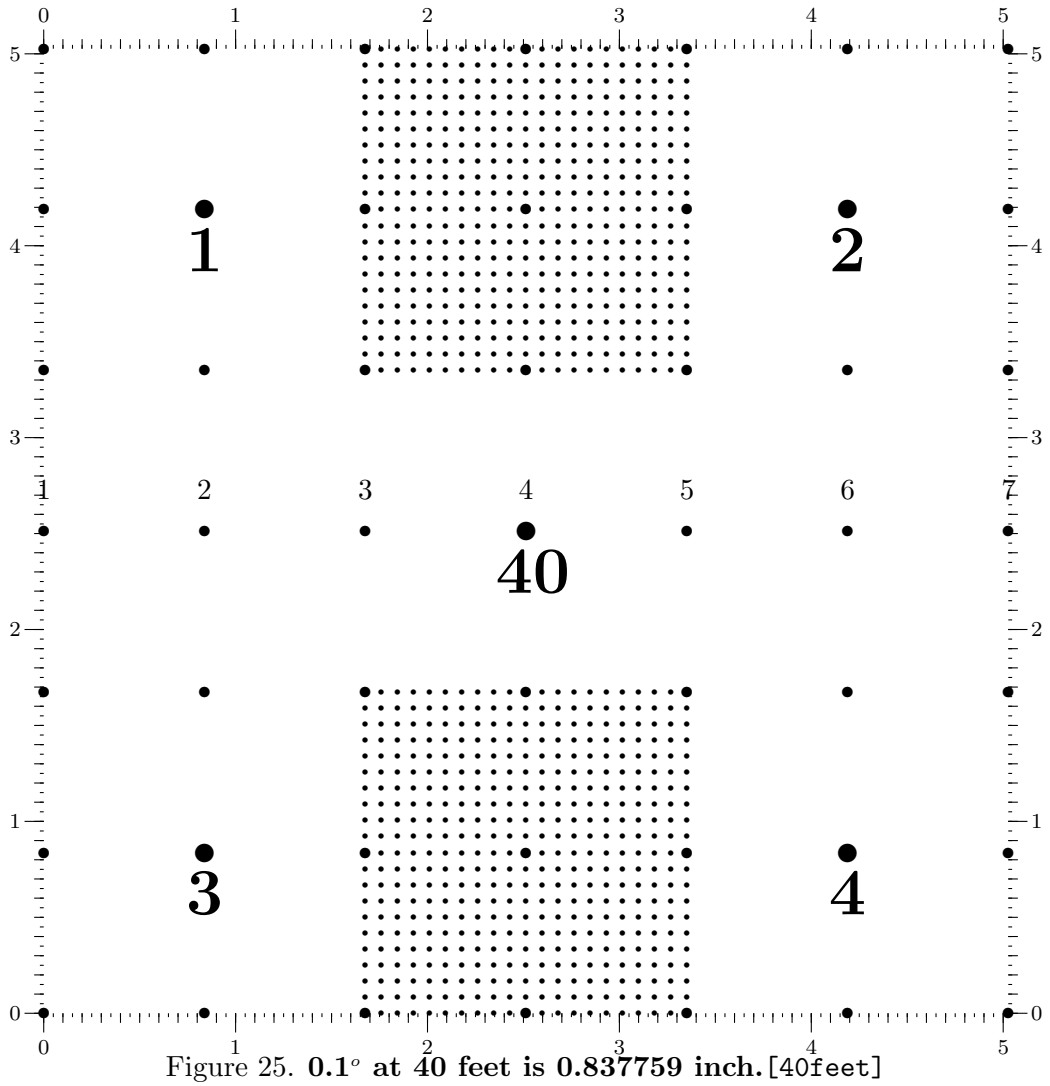

Figure 25. **0.1° at 40 feet is 0.837759 inch.** `[40feet]`

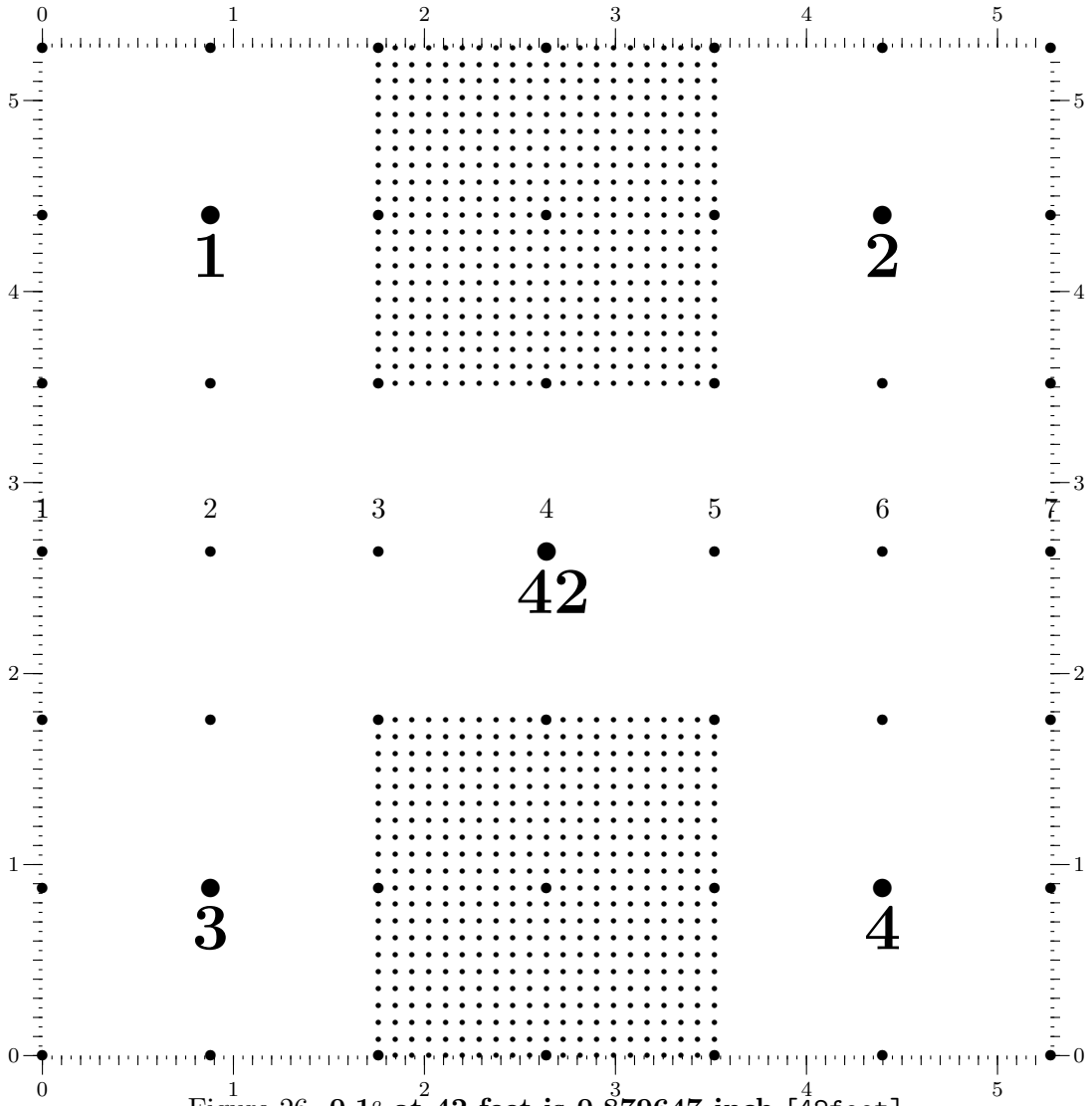

Figure 26. **0.1° at 42 feet is 0.879647 inch.** `[42feet]`

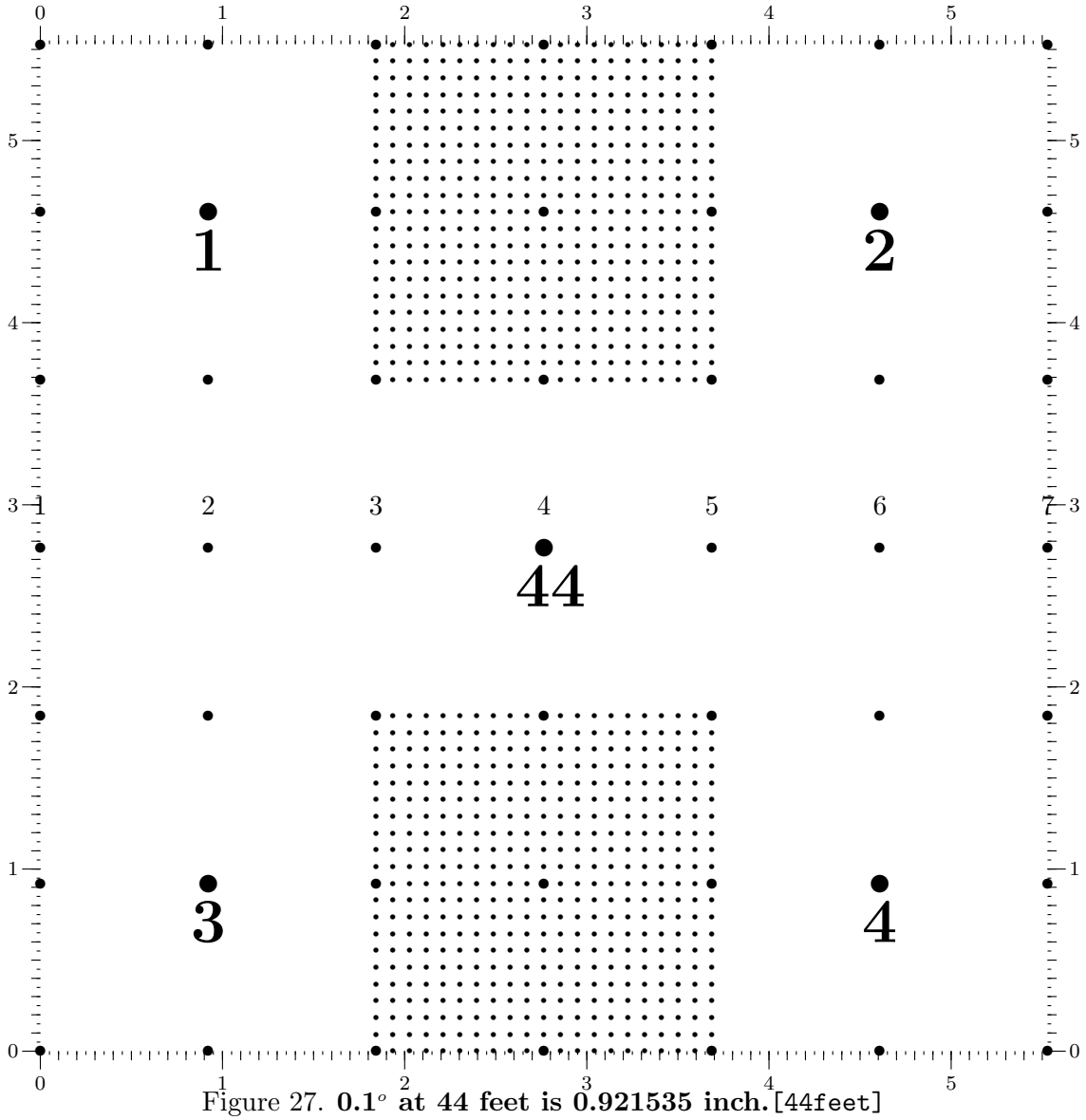

Figure 27. **0.1° at 44 feet is 0.921535 inch.** `[44feet]`

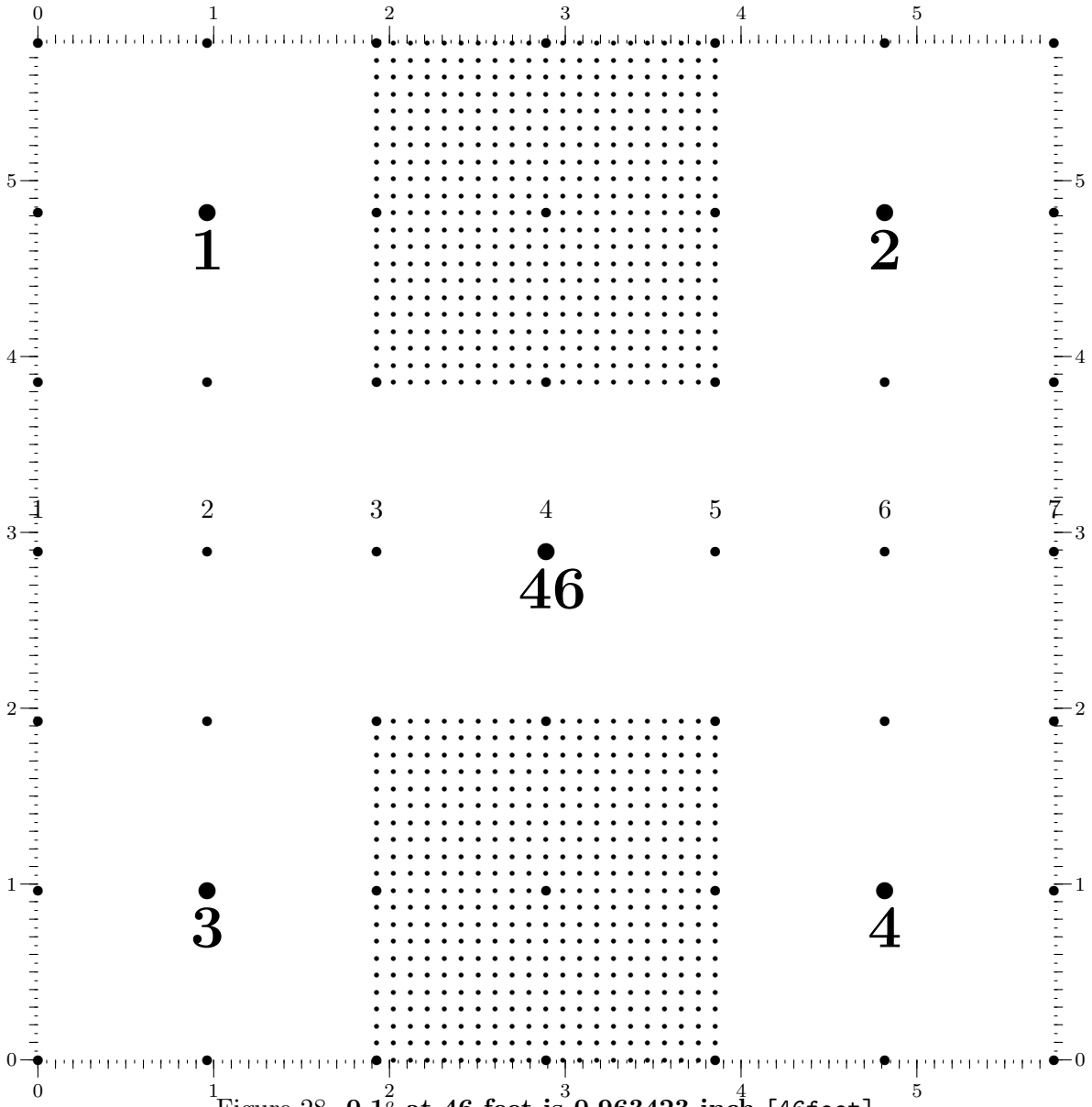

Figure 28. **0.1° at 46 feet is 0.963423 inch.** `[46feet]`

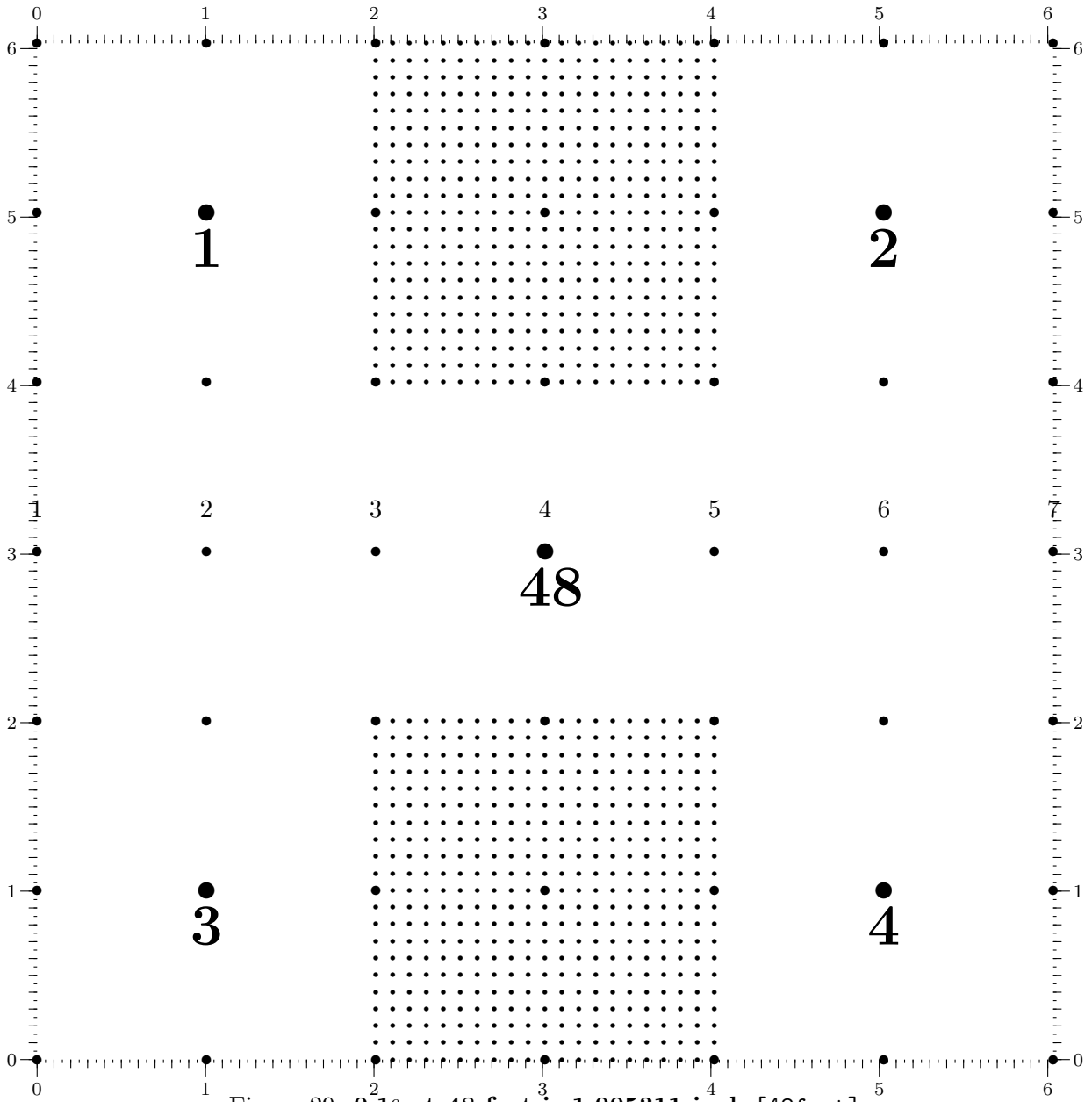

Figure 29. **0.1° at 48 feet is 1.005311 inch.** `[48feet]`

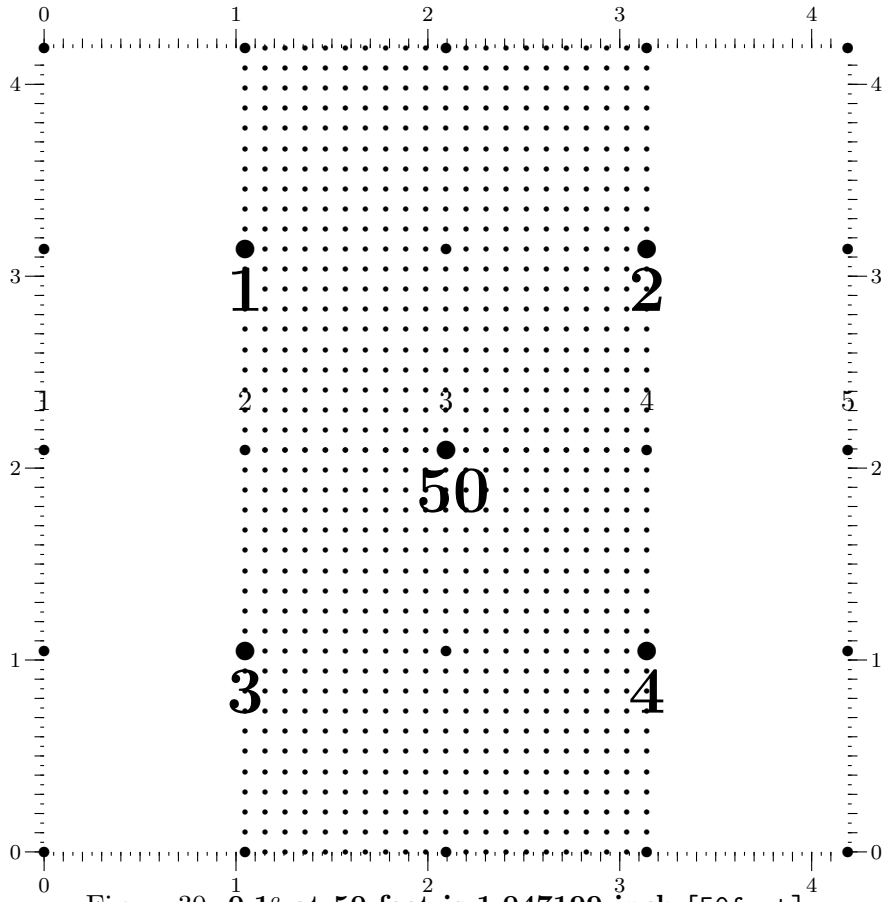

Figure 30. **0.1^o at 50 feet is 1.047199 inch.** `[50feet]`

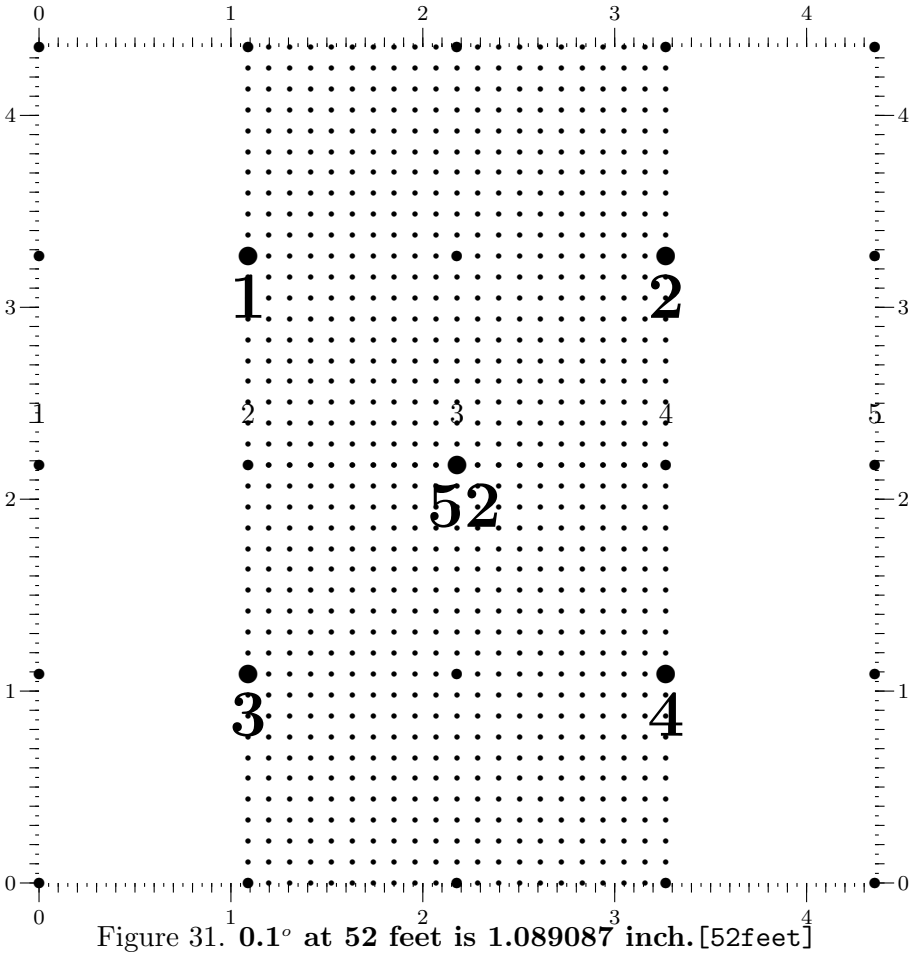

Figure 31. **0.1^{o} at 52 feet is 1.089087 inch.** `[52feet]`

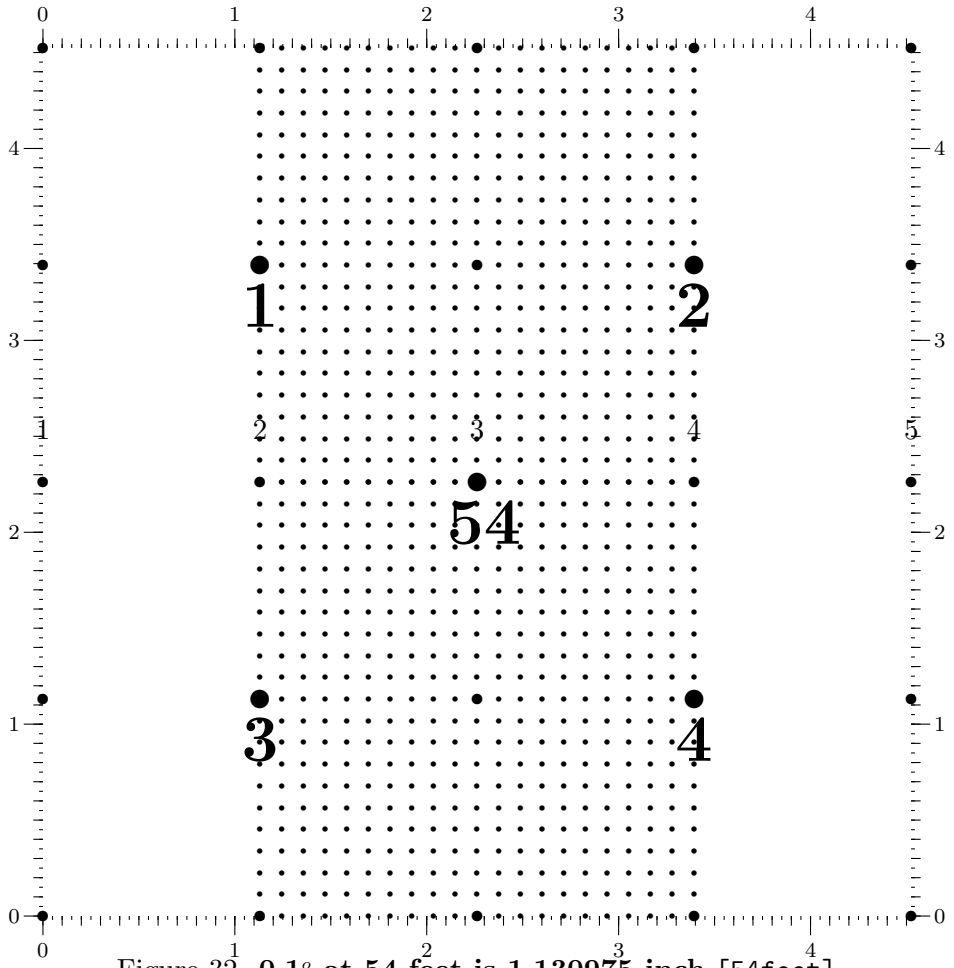

Figure 32. **0.1° at 54 feet is 1.130975 inch.** `[54feet]`

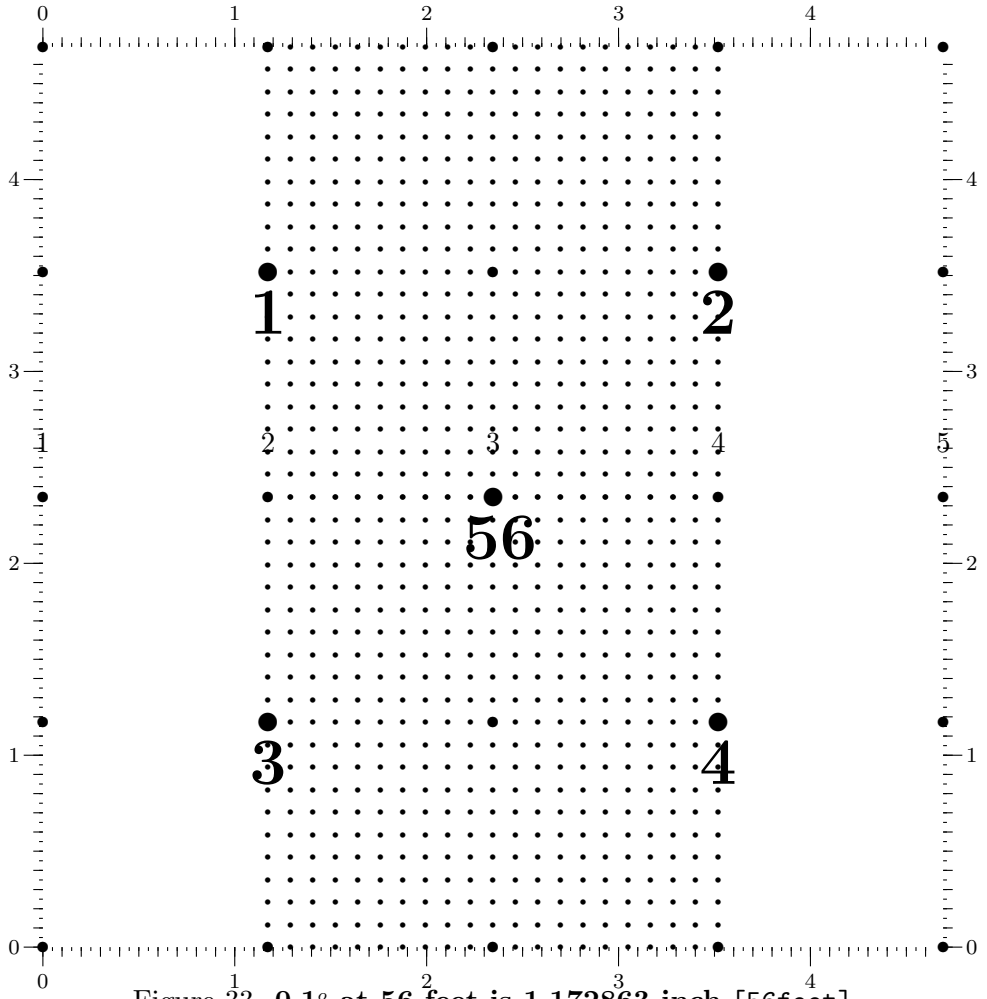

Figure 33. **0.1° at 56 feet is 1.172863 inch.** `[56feet]`

1.2 TgtGen.bas

A short program written in GW-BASIC was developed to generate the LaTeXplot files used in making the actual targets. Here it is.

```
 1  10 CLS: REV$ = "$Id: TgtGen.bas,v 1.2 2008-07-07 08:24:43-07 Hamilton Exp Hamilton $"
 2  20 REM $Header: d:/Binder2/Targets/RCS/TgtGen.bas,v 1.2 2008-07-07 08:24:43-07 Hamilton Exp Hamilton $
 3  30 PRINT REV$
 4  40 PRINT "Make calibration targets in LaTeX"
 5  50 '
 6  60 S$ = "\"
 7  70 PI = 3.1415962#
 8  80 FOOTTOINCH = 12
 9  90 DEGREESINCIRCLE = 360
10  100 TENTHS = 10
11  110 SMALL = 1: REM Used to suppress small grids on small grids
12  120 LARGE = 2: REM Used to enable small grids on large grids
13  130 '
14  140 INPUT "Write into which file (cr = test.inc)";OUTFILE$
15  150 IF OUTFILE$ = "" THEN OUTFILE$ = "test.inc"
16  160 OPEN OUTFILE$ FOR OUTPUT AS #2
17  170 OPEN "status.log" FOR APPEND AS #3
18  180 PRINT #3,
19  190 PRINT #3,REV$
20  200 PRINT #3,DATE$,TIME$
21  210 PRINT #3,"Writing into ";OUTFILE$
22  220 '
23  230 REM STEPS        = Width in displayed dots, must be an even number
24  240 REM DOTSIZESMALL = Pixel size of "standard dots"
25  250 REM DOTSIZELARGE = Pixel size of "calibration dots"
26  260 REM RADIUS       = Distance from camera to target in feet
27  270 REM GRIDSIZE     = SMALL or LARGE, small suppresses the small grids
28  280 REM DOTSIN       = How far in from the corners to put the sub-marks
29  290 '
30  300 PRINT #2,"\clearpage"
31  310 PRINT #2,"\newcounter{spots}"
32  320 DOTSIN = 5
33  330 GRIDSIZE = SMALL
34  340 STEPS = 40
35  350 DOTSIZESMALL = 1
36  360 DOTSIZELARGE = 2
37  370 RADIUS = 2: GOSUB 1180
38  380 RADIUS = 3: GOSUB 1180
39  390 RADIUS = 4: GOSUB 1180
40  400 '
41  410 STEPS = 30
42  420 DOTSIZESMALL = 1
43  430 DOTSIZELARGE = 3
44  440 RADIUS = 5: GOSUB 1180
45  450 '
46  460 STEPS = 20
47  470 DOTSIN = 3
48  480 DOTSIZESMALL = 2
49  490 DOTSIZELARGE = 3
50  500 RADIUS = 6: GOSUB 1180
51  510 DOTSIN = 2
52  520 RADIUS = 7: GOSUB 1180
53  530 PRINT #2,"\clearpage"
54  540 '
55  550 STEPS = 18
```

```
 56  560 DOTSIZESMALL = 2
 57  570 DOTSIZELARGE = 4
 58  580 RADIUS = 8: GOSUB 1180
 59  590 RADIUS = 9: GOSUB 1180
 60  600 GRIDSIZE = LARGE
 61  610 RADIUS = 10: GOSUB 1180
 62  620 RADIUS = 11: GOSUB 1180
 63  630 RADIUS = 12: GOSUB 1180
 64  640 '
 65  650 STEPS = 16
 66  660 RADIUS = 14: GOSUB 1180
 67  670 '
 68  680 DOTSIN = 1
 69  690 STEPS = 14
 70  700 RADIUS = 16: GOSUB 1180
 71  710 '
 72  720 STEPS = 12
 73  730 RADIUS = 18: GOSUB 1180
 74  740 RADIUS = 20: GOSUB 1180
 75  750 PRINT #2,"\clearpage"
 76  760 '
 77  770 STEPS = 10
 78  780 DOTSIZESMALL = 3
 79  790 DOTSIZELARGE = 4
 80  800 RADIUS = 22: GOSUB 1180
 81  810 RADIUS = 24: GOSUB 1180
 82  820 RADIUS = 26: GOSUB 1180
 83  830 '
 84  840 STEPS = 8
 85  850 DOTSIZESMALL = 3
 86  860 DOTSIZELARGE = 4
 87  870 RADIUS = 28: GOSUB 1180
 88  880 RADIUS = 30: GOSUB 1180
 89  890 RADIUS = 32: GOSUB 1180
 90  900 '
 91  910 STEPS = 6
 92  920 DOTSIZESMALL = 3
 93  930 DOTSIZELARGE = 5
 94  940 RADIUS = 34: GOSUB 1180
 95  950 RADIUS = 36: GOSUB 1180
 96  960 RADIUS = 38: GOSUB 1180
 97  970 RADIUS = 40: GOSUB 1180
 98  980 RADIUS = 42: GOSUB 1180
 99  990 RADIUS = 44: GOSUB 1180
100  1000 RADIUS = 46: GOSUB 1180
101  1010 RADIUS = 48: GOSUB 1180
102  1020 '
103  1030 STEPS = 4
104  1040 DOTSIZESMALL = 3
105  1050 DOTSIZELARGE = 5
106  1060 RADIUS = 50: GOSUB 1180
107  1070 RADIUS = 52: GOSUB 1180
108  1080 RADIUS = 54: GOSUB 1180
109  1090 RADIUS = 56: GOSUB 1180
110  1100 PRINT #2,"\clearpage"
111  1110 '
112  1120 REM All done
113  1130 PRINT #3,"All done"
114  1140 PRINT #3,DATE$,TIME$
115  1150 PRINT "All done, quitting"
```

```
116  1160 END
117  1170 '
118  1180 REM Build the target
119  1190 FULLSIZE = STEPS * 100
120  1200 HALFFULLSIZE = FULLSIZE / 2
121  1210 SMALLGRIDY = FULLSIZE - 200
122  1220 SMALLGRIDX = HALFFULLSIZE - 100
123  1230 DOTS = STEPS + 1
124  1240 ARC = (2 * PI * RADIUS * FOOTTOINCH) / (DEGREESINCIRCLE * TENTHS)
125  1250 RIGHTNUMBER = FULLSIZE - (DOTSIN * 100)
126  1260 LEFTNUMBER = 100 * DOTSIN
127  1270 TOPNUMBER = RIGHTNUMBER
128  1280 BOTTOMNUMBER = LEFTNUMBER
129  1290 '
130  1300 ACTUALSIZE = ARC * FULLSIZE
131  1310 HALFACTUALSIZE = ARC * HALFFULLSIZE
132  1320 '
133  1330 PRINT #2,""
134  1340 PRINT #2,"\setcounter{spots}{0}"
135  1350 REM PRINT #2,"\clearpage"
136  1360 PRINT #2,"\begin{figure}"
137  1370 PRINT #2,"\begin{center}"
138  1380 PRINT #2,"\setlength{\unitlength}{.01in}"
139  1390 PRINT #2,"\begin{picture}(";ACTUALSIZE;",";ACTUALSIZE;") {"
140  1400 PRINT #2,""
141  1410 PRINT #2,"%\thicklines\put(0,0){\framebox(";ACTUALSIZE;",";ACTUALSIZE;"){}}\thinlines"
142  1420 PRINT #2,""
143  1430 '
144  1440 GOSUB 2250: REM Put out a ruler around the grid
145  1450 '
146  1460 REM Stick the distance at the center of it all along with its dot
147  1470 PRINT #2,"\put(";HALFACTUALSIZE;",";HALFACTUALSIZE;"){\circle*{10}}"
148  1480 PRINT #2,"\put(";HALFACTUALSIZE+10;",";(HALFACTUALSIZE)-10;"){\makebox(0,0)[t]{\Huge\bf";RADIUS;"}}"
149  1490 '
150  1500 REM Now stick out the four sub spots
151  1510 '
152  1520 PRINT #2,"\put(";ARC*LEFTNUMBER;",";ARC*TOPNUMBER;
153  1530 PRINT #2,"){\circle*{10}}": REM 1
154  1540 '
155  1550 PRINT #2,"\put(";ARC*RIGHTNUMBER;",";ARC*TOPNUMBER;
156  1560 PRINT #2,"){\circle*{10}}": REM 2
157  1570 '
158  1580 PRINT #2,"\put(";ARC*LEFTNUMBER;",";ARC*BOTTOMNUMBER;
159  1590 PRINT #2,"){\circle*{10}}": REM 3
160  1600 '
161  1610 PRINT #2,"\put(";ARC*RIGHTNUMBER;",";ARC*BOTTOMNUMBER;
162  1620 PRINT #2,"){\circle*{10}}": REM 4
163  1630 '
164  1640 REM Put out the sub marker numbers
165  1650 IF GRIDSIZE = LARGE THEN 1790
166  1660 PRINT #2,"\put(";ARC*LEFTNUMBER;",";(ARC*TOPNUMBER)-10;
167  1670 PRINT #2,"){\makebox(0,0)[t]{\large\bf 1}}"
168  1680 '
169  1690 PRINT #2,"\put(";ARC*RIGHTNUMBER;",";(ARC*TOPNUMBER)-10;
170  1700 PRINT #2,"){\makebox(0,0)[t]{\large\bf 2}}"
171  1710 '
172  1720 PRINT #2,"\put(";ARC*LEFTNUMBER;",";(ARC*BOTTOMNUMBER)+10;
173  1730 PRINT #2,"){\makebox(0,0)[b]{\large\bf 3}}"
174  1740 '
175  1750 PRINT #2,"\put(";ARC*RIGHTNUMBER;",";(ARC*BOTTOMNUMBER)+10;
```

```
176  1760 PRINT #2,"){\makebox(0,0)[b]{\large\bf 4}}"
177  1770 GOTO 1920
178  1780 '
179  1790 REM Large size grids
180  1800 PRINT #2,"\put(";ARC*LEFTNUMBER;",";(ARC*TOPNUMBER)-10;
181  1810 PRINT #2,"){\makebox(0,0)[t]{\Huge\bf 1}}"
182  1820 '
183  1830 PRINT #2,"\put(";ARC*RIGHTNUMBER;",";(ARC*TOPNUMBER)-10;
184  1840 PRINT #2,"){\makebox(0,0)[t]{\Huge\bf 2}}"
185  1850 '
186  1860 PRINT #2,"\put(";ARC*LEFTNUMBER;",";(ARC*BOTTOMNUMBER)-10;
187  1870 PRINT #2,"){\makebox(0,0)[t]{\Huge\bf 3}}"
188  1880 '
189  1890 PRINT #2,"\put(";ARC*RIGHTNUMBER;",";(ARC*BOTTOMNUMBER)-10;
190  1900 PRINT #2,"){\makebox(0,0)[t]{\Huge\bf 4}}"
191  1910 '
192  1920 PRINT #2,""
193  1930 '
194  1940 REM Here put out the grids, small first
195  1950 IF GRIDSIZE = SMALL THEN 2080
196  1960 PRINT #2,"% Upper Small Grid"
197  1970 PRINT #2,"\put(";ARC*SMALLGRIDX;",";ARC*SMALLGRIDY;"){\multiput(0,0)(0,";ARC*10;"){21}{"
198  1980 PRINT #2,"\put(0,0){\multiput(0,0)(";ARC*10;",0){21}{\circle*{";DOTSIZESMALL;"}}}"
199  1990 PRINT #2,"}}"
200  2000 PRINT #2,""
201  2010 PRINT #2,"% Lower Small Grid"
202  2020 PRINT #2,"\put(";ARC*SMALLGRIDX;",0){\multiput(0,0)(0,";ARC*10;"){21}{"
203  2030 PRINT #2,"\put(0,0){\multiput(0,0)(";ARC*10;",0){21}{\circle*{";DOTSIZESMALL;"}}}"
204  2040 PRINT #2,"}}"
205  2050 PRINT #2,""
206  2060 '
207  2070 REM Now the main grid
208  2080 PRINT #2,"% Main Grid"
209  2090 PRINT #2,"\put(0,0){\multiput(0,0)(0,";ARC*100;"){";DOTS;"}{"
210  2100 PRINT #2,"\put(0,0){\multiput(0,0)(";ARC*100;",0){";DOTS;"}{\circle*{";DOTSIZELARGE;"}}}"
211  2110 PRINT #2,"}}"
212  2120 PRINT #2,"}"
213  2130 '
214  2140 IF GRIDSIZE = SMALL THEN 2190
215  2150 PRINT #2,"\put(0,";(HALFACTUALSIZE)+(20*ARC);
216  2160 PRINT #2,"){\multiput(0,0)(";ARC*100;",0){";DOTS;
217  2170 PRINT #2,"}{\addtocounter{spots}{1}\makebox(0,0)[b]{\arabic{spots}}}}"
218  2180 '
219  2190 PRINT #2,"%\rcspicturerev{\$RCSfile: TgtGen.bas,v $}"
220  2200 PRINT #2,"\end{picture}"
221  2210 PRINT #2,USING "&caption{&bf 0.1&degree& at ## feet is ##.######
inch.&label{##feet}}";S$;S$;S$;S$;RADIUS;ARC;S$;RADIUS
222  2220 PRINT #2,"\end{center}"
223  2230 PRINT #2,"\end{figure}"
224  2240 RETURN
225  2250 '
226  2260 REM This routine puts an inch ruler around the grid
227  2270 '
228  2280 CNTLONGLINES = INT((ACTUALSIZE+.5)/100)+1
229  2290 IF CNTLONGLINES > ACTUALSIZE THEN CNTLONGLINES = INT((ACTUALSIZE+.5)/100)
230  2300 CNTSHORTLINES = INT((ACTUALSIZE+.5)/10)+2
231  2310 IF CNTSHORTLINES*10 > ACTUALSIZE THEN CNTSHORTLINES = CNTSHORTLINES - 1
232  2320 CNTSHORTERLINES = INT((ACTUALSIZE+.5)/5)+1
233  2330 IF CNTSHORTERLINES*20 > ACTUALSIZE THEN CNTSHORTERLINES = CNTSHORTERLINES - 1
234  2340 '
```

```
235  2350 PRINT #2,
236  2360 PRINT #2,"% Horizontal line, bottom"
237  2370 PRINT #2,"\put(0,0){\multiput(0,0)(100,0){";CNTLONGLINES;"}{\line(0,-1){10}}}"
238  2380 PRINT #2,"\put(0,0){\multiput(0,0)(10,0){";CNTSHORTLINES;"}{\line(0,-1){5}}}"
239  2390 PRINT #2,"\put(0,0){\multiput(0,0)(5,0){";CNTSHORTERLINES;"}{\line(0,-1){2}}}"
240  2400 '
241  2410 PRINT #2,"\setcounter{numbers}{0}"
242  2420 PRINT #2,"\put(0,0){\multiput(0,-14)(100,0){";CNTLONGLINES;"}"
243  2430 PRINT #2," {\makebox(0,0)[t]{\scriptsize{\arabic{numbers}\addtocounter{numbers}{1}}}}}"
244  2440 '
245  2450 PRINT #2,"% Horizontal line, top"
246  2460 PRINT #2,"\put(0,";ACTUALSIZE;"){\multiput(0,0)(100,0){";CNTLONGLINES;"}{\line(0,1){10}}}"
247  2470 PRINT #2,"\put(0,";ACTUALSIZE;"){\multiput(0,0)(10,0){";CNTSHORTLINES;"}{\line(0,1){5}}}"
248  2480 PRINT #2,"\put(0,";ACTUALSIZE;"){\multiput(0,0)(5,0){";CNTSHORTERLINES;"}{\line(0,1){2}}}"
249  2490 '
250  2500 PRINT #2,"\setcounter{numbers}{0}"
251  2510 PRINT #2,"\put(0,";ACTUALSIZE;"){\multiput(0,14)(100,0){";CNTLONGLINES;"}"
252  2520 PRINT #2," {\makebox(0,0)[b]{\scriptsize{\arabic{numbers}\addtocounter{numbers}{1}}}}}"
253  2530 '
254  2540 PRINT #2,"% Vertical line, left side"
255  2550 PRINT #2,"\put(0,0){\multiput(0,0)(0,100){";CNTLONGLINES;"}{\line(-1,0){10}}}"
256  2560 PRINT #2,"\put(0,0){\multiput(0,0)(0,10){";CNTSHORTLINES;"}{\line(-1,0){5}}}"
257  2570 PRINT #2,"\put(0,0){\multiput(0,0)(0,5){";CNTSHORTERLINES;"}{\line(-1,0){2}}}"
258  2580 '
259  2590 PRINT #2,"\setcounter{numbers}{0}"
260  2600 PRINT #2,"\put(0,0){\multiput(-12,0)(0,100){";CNTLONGLINES;"}"
261  2610 PRINT #2," {\makebox(0,0)[r]{\scriptsize{\arabic{numbers}\addtocounter{numbers}{1}}}}}"
262  2620 '
263  2630 PRINT #2,"% Vertical line, right side"
264  2640 PRINT #2,"\put(";ACTUALSIZE;",0){\multiput(0,0)(0,100){";CNTLONGLINES;"}{\line(1,0){10}}}"
265  2650 PRINT #2,"\put(";ACTUALSIZE;",0){\multiput(0,0)(0,10){";CNTSHORTLINES;"}{\line(1,0){5}}}"
266  2660 PRINT #2,"\put(";ACTUALSIZE;",0){\multiput(0,0)(0,5){";CNTSHORTERLINES;"}{\line(1,0){2}}}"
267  2670 '
268  2680 PRINT #2,"\setcounter{numbers}{0}"
269  2690 PRINT #2,"\put(";ACTUALSIZE;",0){\multiput(12,0)(0,100){";CNTLONGLINES;"}"
270  2700 PRINT #2," {\makebox(0,0)[l]{\scriptsize{\arabic{numbers}\addtocounter{numbers}{1}}}}}"
271  2710 '
272  2720 PRINT #2,""
273  2730 RETURN
```

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