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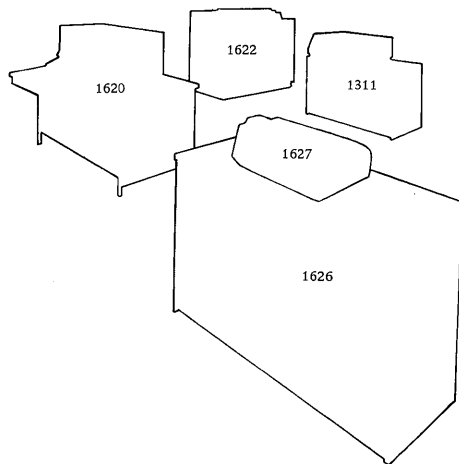
IBM 1627 Plotter

This publication describes the 1627 Plotter, Models 1 and 2. The 1627, in conjunction with the 1626 Plotter Control Unit, is capable of providing fully annotated graphs as an on-line function of a 1620 or 1710 System.

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IBM 1620 System with 1626 Plotter Control Unit
and 1627 Plotter, Model 1

INTRODUCTION

The IBM 1627 Plotter provides the user with an exceptionally versatile, reliable, and easy-to-operate 1620 plotting system. The plotter converts tabulated digital information into graphic form. Bar charts, flow charts, organization charts, engineering drawings, and maps are among the many graphic forms of data which can be plotted on the 1627 Plotter.

Two models of the 1627 are available, and the major characteristics are as follows:

- Model 1 - Plotting area: 11 inches by 120 feet, 1/100 inch incremental-step size, 18,000 steps/minute.
- Model 2 - Plotting area: 29 1/2 inches by 120 feet, 1/100 inch incremental-step size, 12,000 steps/minute.

More information on both models is given in Table 1 of the Appendix.

The 1620 Data Processing System, with the 1627, can be programmed to provide graphs that depict financial, scientific, or technical data. The 1627, attached to the 1710 Control System, can be used for trend recording and for presenting real-time graphic representation of computed variables relative to the process under control.

The 1626 Plotter Control Unit is the inter-connecting unit between the 1627 and the 1620 Central Processing Unit. The 1626 contains the translating and control circuits for the 1627. It also serves as a stand for the 1627. Either model of the 1627 can be attached to either 1620 Model 1 or Model 2.

To fully understand the following material, the reader should have a knowledge of the 1620 System as described in the following publications.
IBM 1620 Central Processing Unit (Form A26-5706)
IBM 1620 Input/Output Units (Form A26-5707)

OPERATION

Data from 1620 core storage is transferred serially (by digit) to the 1626 where it is translated into 1627 actuating signals. These signals are then converted into drawing movements by the 1627 Plotter.

The actual recording is produced by incremental movement of the pen on the paper surface (y-axis) and/or the paper under the pen (x-axis). The pen is mounted in a carriage that travels horizontally across the paper as viewed from the front of the plotter. The vertical plotting motion is achieved by rotation of the pin feed drum, which also acts as a platen (see Figure 1).

The drum and the pen carriage are bi-directional; i.e., the paper moves forward or backward, and the pen moves left or right. Control is also provided to lower or raise the pen to or from the paper surface. The pen remains in the "up" or "down" position until directed to change to the opposite status.

The drum and pen-carriage movements and the pen status are controlled by digits transferred to the 1626 Plotter Control Unit by a 1620 output instruction. Each digit is decoded into a directional signal and relayed to the 1627 Plotter. Each signal to the plotter causes a 1/100 inch incremental movement of the pen carriage and/or paper, or pen up or a pen down movement. The motion or action resulting from each digit in the output record is shown in Figure 2.

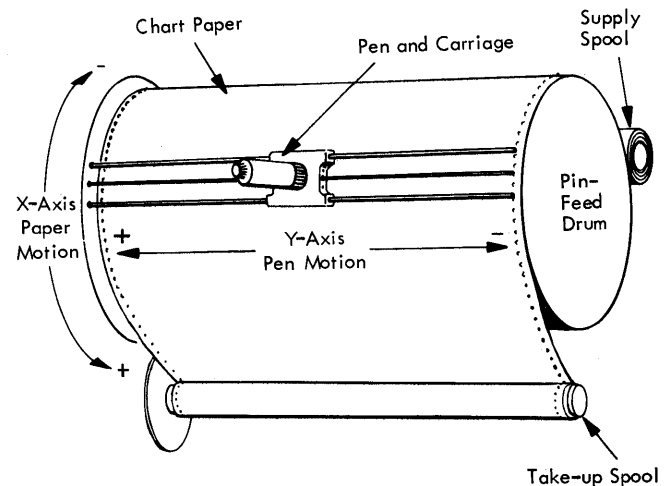


Figure 1. Paper and Pen Motions

The plotter operation is controlled by any of the following instructions:

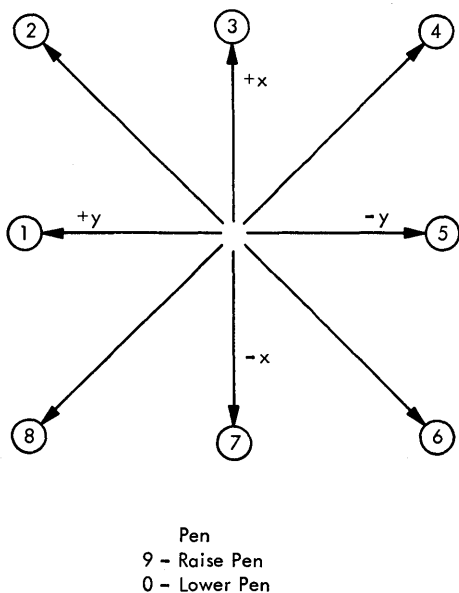
- Dump Numerically, operation code 35
- Write Numerically, operation code 38
- Write Alphamerically, operation code 39

The P-address of the instruction defines the high-order core storage position of the output record. The plotter is selected by Q₈Q₉ digits of 02.

The output records are terminated by a record mark (≡) or group mark (≡) for operation codes 38 and 39.

The Dump Numerically operation terminates with the output of the last position of a core storage module, i.e., the operation stops following the output of the data at address 19999, 39999, or 59999.

Positive or negative numerical characters, except minus zero, in either one-digit numerical form or two-digit alphameric form may be used in the output record. The use of other characters can cause either conflicting commands or no command to be sent to the plotter. Only the absolute value of the digit is translated for a plotter signal; that is, the sign does not affect the direction of plotter action (see Appendix).



NOTE: The encircled numerical figures are the 1620 characters that correspond to the indicated direction of plotting movement as viewed from the front of the plotter. Normally, graphs are plotted so that their horizontal axes are, in reality, the X axis as shown above.

Figure 2. Output Record Control Digits

OPERATION MODES

An output record of 3's or 7's produces a paper movement by the plotter along the x-axis. An output record of 1's or 5's produces a pen movement by the plotter along the y-axis. The digits 2, 4, 6, or 8 in an output record produce simultaneous motion of paper and pen which results in a diagonal movement (see Figure 2). The distance moved diagonally is 1.4 times a horizontal or vertical movement.

Single Character (Overlap) Mode

The P-address of a write instruction can refer to any size record, but by using single-character records, each successive increment can be computed while the previous increment is being drawn. In this manner, 1620 computation instructions for the next increment or other processing are "overlapped" with plotting operations.

For example, a Write Numerically instruction and a data record consisting of the digit five followed by a record mark (5≡) produces the result shown in Figure 3. This operation requires 3.3 milliseconds (ms) for the 1627, Model 1, or 5 ms for the 1627, Model 2. However, the 1620 CPU is not held up, but proceeds to the next instruction, 300 microseconds (μsec) after the write plotter instruction is initiated (300 μsec , 1620 Model 1; 200 μsec , 1620 Model 2).

If a second 1620 plotter instruction is attempted before completion of a previous plotter operation, the 1620 waits until the plotter can accept the next command. Plotter instructions occurring more

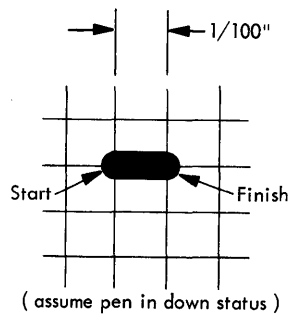


Figure 3. Plotter Result for Data of 5≡

than 3.3 ms apart operate the 1627, Model 1, plotter properly but at less than the maximum rate of 300 increments a second. Both models require 100 ms for pen status change (0 or 9 in the output record).

Multiple Character Record (Nonoverlap) Mode

When a record in core storage consists of more than one character, only the last character can be overlapped with processing. For example, a record consisting of 05555922077779 ≠ is translated as follows: lower pen, move pen four increments in the -y direction, raise pen, move two increments diagonally (+x, +y), lower pen, move drum four increments in the -x (paper-up motion) direction, raise pen. The plotter result is shown in Figure 4.

In the foregoing example, both models of the 1620 interlock (wait for the plotter). The duration is approximately 330 ms with the 1627 Model 1 Plotter, or approximately 350 ms with the 1627 Model 2 Plotter. These timings are computed as follows:

Output Record Characters	1627-1 Plotting Time	1627-2 Plotting Time
0	100 ms	100 ms
5555	13	20
9	100	100
22	7	10
0	100	100
7777	13	20
9	0.3*	0.3*
	333.3 ms	350.3 ms

*Approximately 99.7 ms available for 1620 processing before the 1627 can act on another plotting instruction.

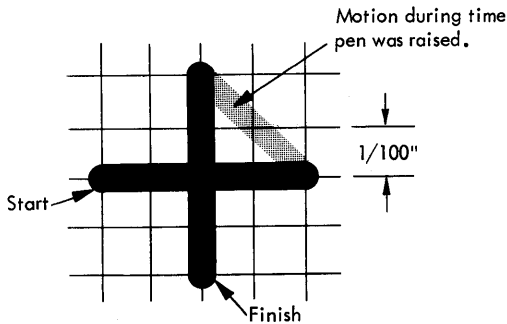


Figure 4. Plotter Result for Data of 05555922077779 ≠

1627 OPERATING CONTROLS

Seven operating controls and one Power On light are mounted on the front panels of the 1627 (Figures 5 and 6). A description of the function of each control follows:

POWER. This switch connects power from the 1626 Plotter Control Unit to the 1627. The switch operates only when the 1620 CPU mainline power switch is in the ON position. There is no "power-on delay" involved with the 1627 Power switch, i.e., the plotter can operate as soon as the switch is turned on.

CARRIAGE FAST RUN. This switch allows the pen carriage to be stepped rapidly to the left or right at the rate of 120 steps a second. The Carriage Fast Run switch is used to move the carriage to any desired area of the graph.

CARRIAGE SINGLE STEP. This switch allows the pen carriage to be moved in single-step increments (1/100 inch) either left or right. The Carriage Single Step switch permits the operator to accurately align the carriage along the y-axis of the chart.

DRUM FAST RUN. This switch allows the drum to move the paper rapidly up or down at the rate of 120 steps a second. The Drum Fast Run switch is used in conjunction with the Carriage Fast Run switch to position the pen to any desired area of the graph.

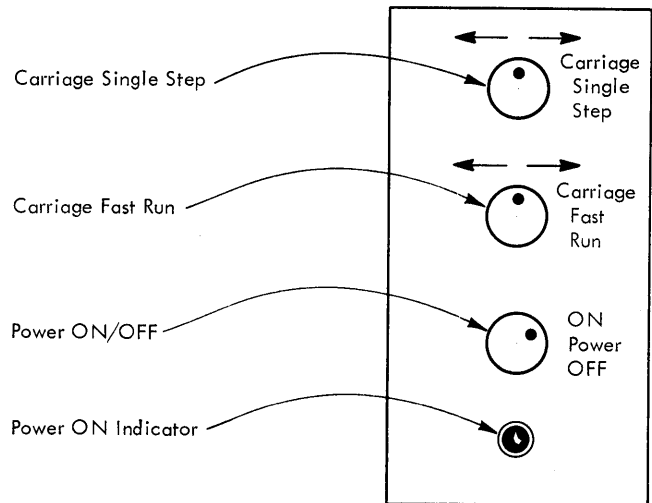


Figure 5. Left 1627 Controls

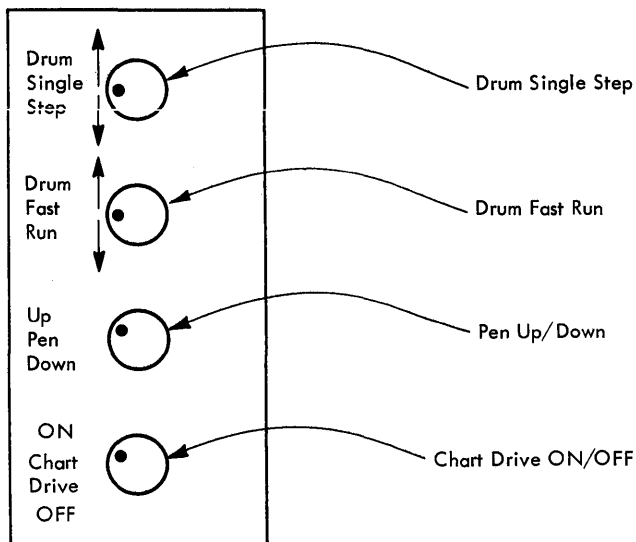


Figure 6. Right 1627 Controls

DRUM SINGLE STEP. This switch allows the drum to be rotated in single-step increments (1/100 inch) in either direction. The Drum Single Step switch is used in conjunction with the Carriage Single Step switch to permit the operator to accurately align the pen on a point or fixed coordinate on the graph.

PEN. This switch provides a means for manually raising the pen from the surface of the drum or lowering the pen to the drum.

CHART DRIVE. This switch allows the front and rear chart drives to be disabled. When recording on single sheets of graph paper, the Chart Drive switch should be in the OFF position. When recording on roll-paper this switch should be in the ON position.

VERNIER Control. Large size chart paper may vary in width due to high or low humidity. A vernier control is provided on the 1627, Model 2, to vary the size of the pen carriage increments. In this way, the pen traverse is adjusted to match the printed scale of the chart paper. The Vernier control knob is located at the left end of the drum above the switch panel. For work with non-scale paper, the control should be centered at the zero position. To properly adjust the vernier control for scaled graph paper, proceed as follows:

1. Use the reticle to accurately position the pen carriage over a vertical grid line near the right side.

2. Load 1's into the 1000 high-order positions of core storage. For example, load 1's from 18999 to 19999.
3. Move the pen carriage 1000 increments to the left using the data loaded in step 2 and a Dump Numerically instruction.
4. When the pen carriage completes its travel (this will be 10 inches from the starting position) use the vernier control to position the carriage directly over the 10th grid line from the starting position.

(In this explanation, one grid line per inch is assumed. Normally, graph paper is printed with two or more grid sizes.)

Operating Procedures

The operating procedures for the 1627 consist of installing the chart paper and pen assembly, performing an operation checkout, and aligning the carriage with the starting point of the graph. These procedures are described in the following paragraphs. When these procedures have been completed, the plotter will be ready for use.

Installation of Chart Roll Paper. To install a roll of chart paper in the plotter, proceed as follows:

1. Turn the Power switch to OFF.
2. Remove the pen assembly if it is presently installed. The pen assembly can be removed by loosening the knurled knob at the bottom of the pen holder and lifting the assembly out of the carriage.

CAUTION: Use care when handling the pen assembly. This assembly is manufactured to close tolerances for optimum performance.

3. Rotate the right rear chart spool by hand until the drive key is pointing upward.
4. Hold the new roll of chart paper so that the key slot in the core is pointing upward. Place the roll against the spring-loaded left rear idler spool and force the spool to the left.
5. Lower the paper roll into the paper well and slide the right end onto the drive spool. Make certain the drive key engages the key slot in the core.
6. Install a paper roll core on the two front spools below the drum, in the same manner as the paper roll.
7. Pull a short length of paper off the roll, slide the end under the carriage rods, tear-

bar, behind the core and fasten to the front side of the core with two or three short pieces of cellophane tape. Wind one or two turns of paper onto the core. Make certain the drum sprockets are properly meshed with the sprocket holes on both sides of the paper.

8. Reinstall the pen assembly in the carriage.
9. Turn the Power switch to ON.

NOTE: The pen is down with power off, so the pen assembly should be installed with the carriage over an area outside the "recording area." If the pen does not raise when power is turned on, turn the Pen switch to DOWN, then to UP.

Installation of Single Sheet Graph Paper. Single sheets of graph paper may be used for plotting in place of the chart paper roll. To install a single sheet of graph paper, proceed as follows:

1. Set Power and Chart Drive switches to OFF.
2. Remove the pen assembly from the carriage.
3. Slide the graph paper sheet under the carriage rods onto the drum surface.
4. Fasten the top edge of the paper to the drum with two or three short pieces of cellophane tape. Rotate the drum by hand, keeping the paper smooth and flat against the drum surface. Fasten the bottom edge of the paper in the same manner as the top edge.
5. Reinstall the pen assembly in the carriage (see note under step 9 above).
6. Turn the Power switch to ON.

Removal of Chart Paper. The roll of chart paper or the single sheet of graph paper can be removed by reversing the installation sequence described above. If a single sheet of graph paper is used, any remaining tape adhesive should be cleaned from the drum surface with acetone or cleaning solvent.

Reticle Adjustment. An alignment reticle is provided to permit accurate alignment of the pen carriage to the chart paper. The reticle is inserted in place of the pen assembly in the carriage. By using the carriage and drum controls, the carriage can be moved to align the cross-hairs of the reticle with the desired starting position of the graph. When the reticle is removed and the pen assembly inserted into the carriage, the pen point is aligned to the position indicated by the cross-hairs. An alternate offset reticle

is provided which does not require removal of the pen. It is mounted on the pen carriage and the distance between the cross-hairs and pen point is exactly one inch on the x-axis.

Pen Assemblies. The components of the pen assembly are illustrated in Figure 7. Four different color ballpoint pens are supplied with the recorder: black, blue, red, and green. To assemble the pen, insert the pen desired into the plunger, then insert the pen and plunger into the holder and install the threaded cap. Align the key on the holder with the key slots in the carriage and press the pen assembly into the pen mounting. Tighten the knurled nut on the bottom of the pen assembly.

NOTE: The ballpoint pens used with the 1627 characteristically blot. Therefore it is recommended the pen tip be cleaned after each hour of use. Also, since the life span of the pen is approximately 5 to 7 hours of use, the user may wish to schedule replacement of a used pen before plotting critical projects.

Operation Checkout. The following procedure is recommended as an over-all check of the operation

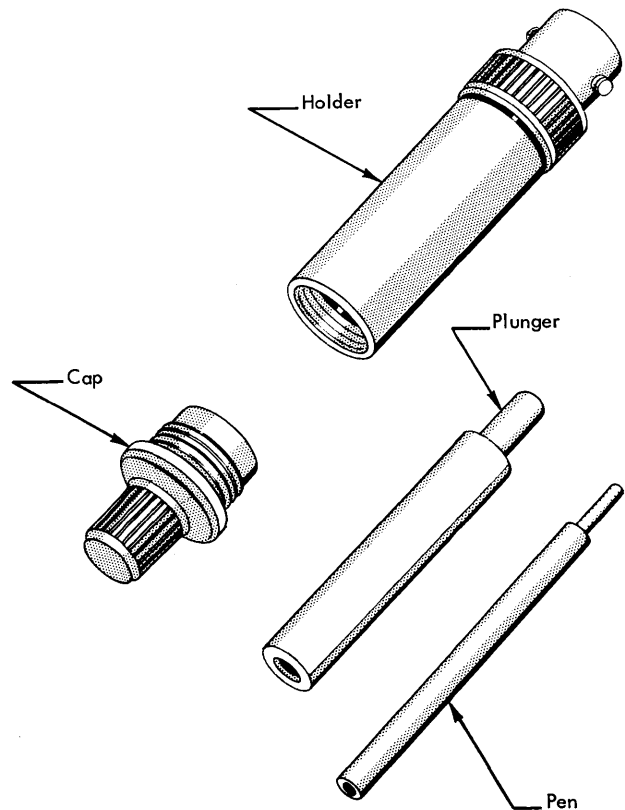


Figure 7. Pen Assembly Components

of the 1627 Plotter. This procedure should be performed prior to the start of automatic recording, and if the plotter is used infrequently, a checkout should be performed approximately once a week. Frequent cleaning is also advised, especially of the drum surface and carriage rails. They should be wiped with a clean soft cloth.

Checkout Procedure.

1. Install the chart paper and install the pen assembly in the carriage.
2. Turn the Power and Chart Drive switches to the ON position. Turn the Pen switch to the DOWN position.
3. Turn the Drum Fast Run switch to the up position and check that the pen traces a vertical line.
4. Turn the Pen switch to the UP position and check that the pen lifts off the paper surface.
5. Turn the Pen and Drum Fast Run switches to the down positions, and check that the pen retraces the line drawn in step 3.
6. Turn the Carriage Fast Run switch to the left position and check that the pen traces a horizontal line. When the carriage reaches its limit of travel, turn the Carriage Fast Run switch to the right, and check that the pen retraces the horizontal line.
7. Alternately operate the Carriage Single Step and Drum Single Step switches. Check that both the carriage and drum move only one step each time one of the switches is operated.
8. With the carriage positioned near the right side, set the Carriage Fast Run switch to the left position and Drum Fast Run to the down position. Allow the pen carriage to run until it reaches the left side, then turn both switches to the off (center) position. Check that the pen traces a 45° line. Operate the Drum Single Step switch several times in the same direction. Set the Drum Fast Run switch to the up position and the Carriage Fast Run switch to the right. When

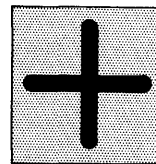
the carriage reaches the right side, turn both switches off. Check that the pen traces another 45° line and that the lines are parallel.

9. Repeat step 8, changing the switch settings to produce two 45° lines at right angles to the first two.

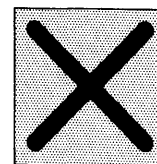
PROGRAM CHECKOUT ROUTINE

It will prove useful to include a program checking routine within a program designed for plotter use. This routine will be used when "debugging" the program initially, however, it can be retained for checkout of the system at any time. The program check will provide a graphic representation to replace the feedback checks used in other output units.

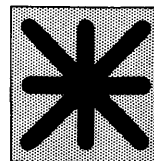
The logic of a program check is simple: (1) plot a plus symbol (+) at the start of the program (outside the graph area), and (2) return to this location at the end of the program to superimpose an X over the plus symbol. Refer to Figure 8 for example.



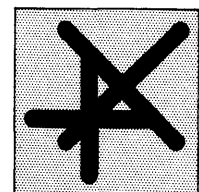
Step 1.



Step 2.



Final Result
Properly Aligned



Final Result
Improperly Aligned

Figure 8. Program Checkout Technique

APPENDIX

Table 1. 1627 Characteristics

Speed	x, y Increments	Model 1 18,000 Steps/Min	Model 2 12,000 Steps/Min
	Pen Status Change	600 Operations/Min	600 Operations/Min
Increment Size		1/100 Inch	1/100 Inch
Chart Paper	Width	12 Inches	31 Inches
	Plotting Width	11 Inches	29 1/2 Inches
	Length	120 Feet	120 Feet
	Sprocket Hole Dimensions	.130 Inch Dia on 3/8 Inch Centers	.188 Inch Dia on 1 Inch Centers

Table 2. Proper Output Characters

Numerical Character Op Code 35 or 38	Alphameric Character Op Code 39	Plotter Action
0	70	Lower Pen
1, $\bar{1}$	71, 51	+y Increment
2, $\bar{2}$	72, 52	+x, +y Increment
3, $\bar{3}$	73, 53	+x Increment
4, $\bar{4}$	74, 54	+x, -y Increment
5, $\bar{5}$	75, 55	-y Increment
6, $\bar{6}$	76, 56	-x, -y Increment
7, $\bar{7}$	77, 57	-x Increment
8, $\bar{8}$	78, 58	-x, +y Increment
9, $\bar{9}$	79, 59	Raise Pen



International Business Machines Corporation
Data Processing Division
112 East Post Road, White Plains, N. Y. 10601