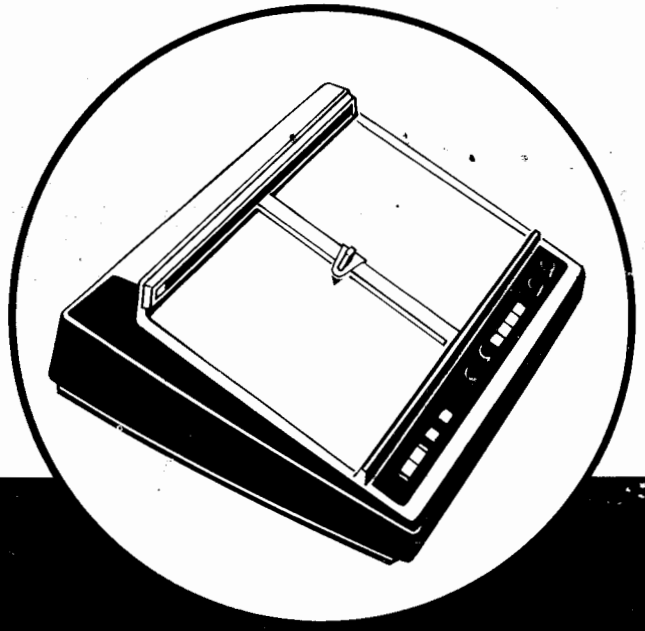
HP 7210A

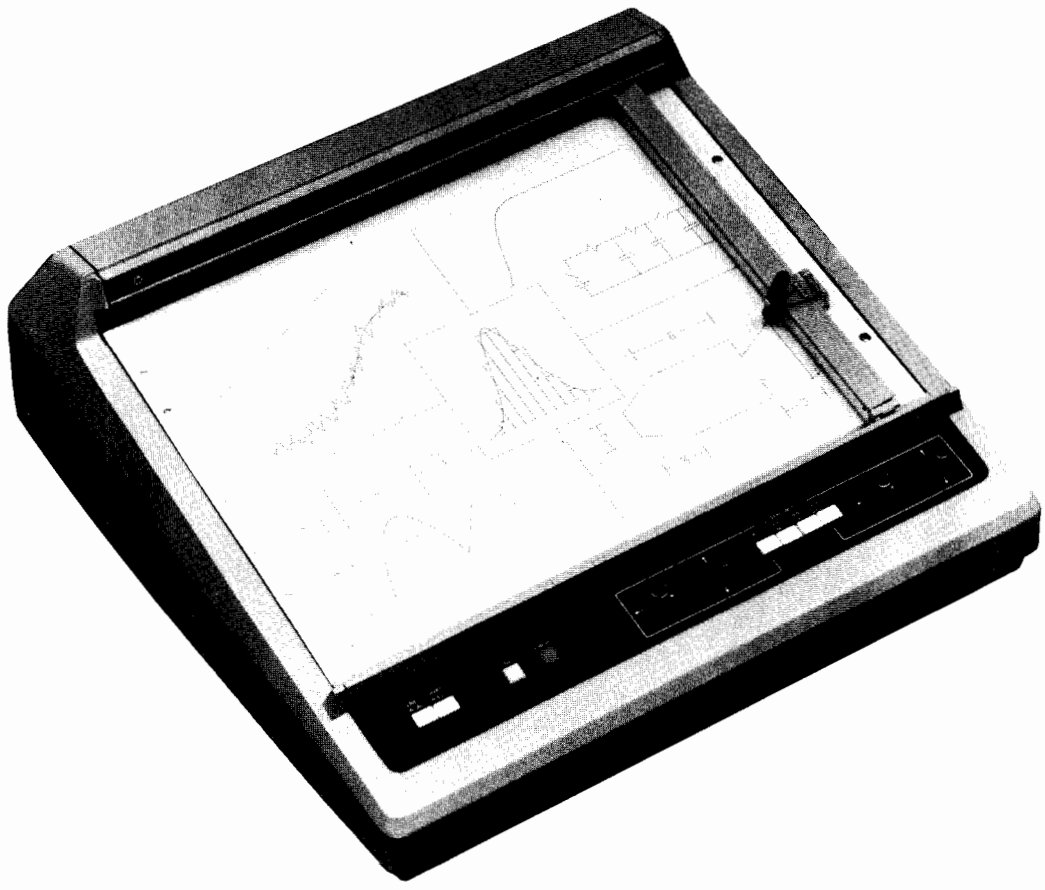


OPERATOR'S MANUAL

HEWLETT-PACKARD 7210A DIGITAL PLOTTER

HP 7210A

7210A DIGITAL PLOTTER



MARCH 1972

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INTRODUCTION

This manual provides general information pertaining to the operation of the Hewlett-Packard Model 7210A Digital Plotter with most computer systems. Other manuals, generally supplied with the system, provide the specific operating and programming information.

DESCRIPTION

The 7210A Digital Plotter is an output peripheral designed for use with computers and computer systems.

Accepting either Binary or BCD codes under full program control, and processing up to 20 coordinate pairs per second, the Plotter will quickly and accurately produce plots of your system data. A graph constructed with 0.2 inch (0.5 cm) increments will be drawn at the rate of 14 increments per second. The Plotter can be driven by either a computer or an intelligent terminal with typical operation requiring less than 250 16-bit words of memory.

Any sheet type graph paper up to 11 x 17 inches (27,9 x 43,2 cm) in size and with or without preprinted grids may be used. Front panel controls adjust the plot area to fit preprinted grids.

ACCESSORIES

EQUIPMENT SUPPLIED

Accessories and equipment supplied with each Model 7210A are listed below:

PART NO.	QTY	DESCRIPTION
07210-90000	2	Operating Manual
8120-1378	1	Power Cord
4040-0477	1	Dust Cover
5080-3605	1	Slidewire Cleaner
5080-3635	1	Slidewire Lubricant
5081-1190	Pkg of 3	Red Pens
5081-1191	Pkg of 3	Blue Pens
5081-1193	Pkg of 3	Black Pens
9270-1004	10 Sheets	Graph Paper (English)
9270-1024	10 Sheets	Graph Paper (Metric)

PENS AVAILABLE

DESCRIPTION	PART NUMBER
Package of 3 Red Pens	5081-1190
Package of 3 Blue Pens	5081-1191
Package of 3 Green Pens	5081-1192
Package of 3 Black Pens	5081-1193

ACCESSORIES (continued)

PLOTTING PAPER AVAILABLE

To gain maximum benefit from your Model 7210A Digital Plotter, you will want to use precision-ruled plotting paper. Hewlett-Packard Company offers a wide variety of papers, available through all field offices. These are 11 inches by 16.5 inches (28 cm by 42 cm) or 8.5 inches by 11 inches (21,6 cm by 28 cm) overall and are packaged 100 sheets per box.

	PLOT AREA	PART NO.
LINEAR	10 in. x 15 in. 25 cm x 38 cm 7 in. x 10 in. 18 cm x 25 cm	9270-1004 9270-1024 9270-1006 9270-1023
SEMI-LOG	10 in. x 2 cycle 10 in. x 3 cycle 2 cycle x 15 in. 3 cycle x 15 in.	9280-0159 9280-0160 9280-0169 9280-0168
LOG-LOG	2 cycle x 3 cycle 3 cycle x 2 cycle 3 cycle x 4 cycle	9280-0167 9280-0165 9280-0171
BLANK (W/SCALING POINTS)	10 in. x 15 in.	9280-0180

This graph paper, made for use with the Model 7210A Digital Plotter, is manufactured with rigid control over margin tolerances and alignment. This insures that vertical and horizontal lines drawn by the Plotter will always be parallel or perpendicular to the lines on the graph paper.

SERVICE CONTRACTS

Service Contracts are recommended for your 7210A Digital Plotter to ensure maximum operating life. For further information contact your local Hewlett-Packard Sales and Service Office listed in the back of this manual.

INSTALLATION

INITIAL INSPECTION

The Plotter was carefully inspected prior to shipment. It should be free of mars or scratches and in perfect operating condition, when received. Inspect the Plotter for physical damage and inventory the supplied accessories listed on page 1-1. If the Plotter is damaged or if a performance deficiency is indicated, file a claim with the carrier or contact your nearest Hewlett-Packard Sales and Service Office listed in the back of this manual.

ELECTRICAL INSPECTION

To verify proper operation of the Plotter refer to documentation supplied with your system.

GROUNDING REQUIREMENTS

To protect operating personnel, the National Electrical Manufacturer's Association (NEMA) recommends that the panels and cabinets of the computer system be grounded. The three-conductor power cables supplied provide this ground when plugged into the proper receptacle. The Model 7210A meets the International Electro-Technical Commission (IEC) specifications.

SHIPPING

Before returning the instrument for any reason, notify the local field sales office of the difficulty encountered, giving the model and serial number of the instrument. They will furnish shipping instructions. The following precautions should be taken when repackaging the Plotter.

1. Remove the ink pen.

2. Secure the upper end of the carriage arm and pen carriage to the right side of the plotter with the bracket (5080-7834) supplied with the mainframe, to prevent movement while in transit.

3. If being returned for repair, do not send power cord, accessory kit, or other accessories.

4. Wrap the instrument in heavy paper or plastic and surround with three to four inches of shock-absorbing material to cushion and prevent movement inside the shipping container. The container should be sufficiently durable to prevent damage to the instrument during handling. If in doubt, request shipping carton (Part No. 09125-80210) from the nearest HP Sales and Service Office listed in the back of this manual.

OPERATION

The HP 7210A Digital Plotter provides finished plots of data supplied by a computer system.

THE PLOTTING PROCESS

The Plotter plots a graph by moving the pen to the point on the paper corresponding to the coordinates. As each new point is plotted, the Plotter moves the pen in a straight line from the old point to the new one. By controlling whether or not the pen is in contact with the paper at the time the pen moves, the graph can be a solid line, a dashed line, or a series of points. Different colors of pen are available and may be employed to superimpose several graphs on the same sheet of paper.

The Plotter can produce graphs as large as 10 inches in the Y (vertical) direction by 15 inches in the X (horizontal) direction (25 cm x 38 cm on metric paper).

The plotting paper is held to the platen (plotting surface) by an electrostatic hold-down mechanism, entirely free from clips or other mechanical means.

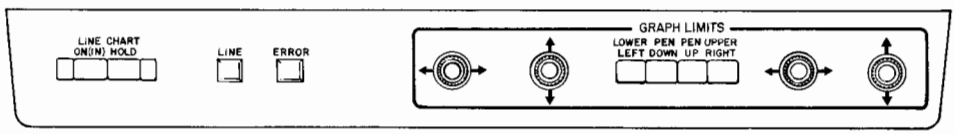
Before beginning a plot, the LOWER LEFT and UPPER RIGHT controls (these are the Graph Limit controls, see page 3-2) are adjusted to correspond to the overall size of the finished plot. This adjustment in no way affects the programmed relationship between the variables — only the physical size of the finished plot. The distance along the X axis determined by the Graph Limit controls is called the plotting range in X. A similar definition is made for Y.

Internally, the Plotter divides each plotting range into 10,000 discrete points. The coordinate information that passes to the Plotter is in terms of these points. For instance, to move the pen to the center of the graph, the system must instruct the Plotter to move the pen to the location corresponding to 5,000 points in the X plotting range and 5,000 points in the Y plotting range.

NOTE

The actual distances in inches of the plotting ranges are determined by setting of the Graph Limit controls.

PANEL CONTROLS



LINE — When depressed allows power to be supplied to Plotter.

CHART HOLD — When depressed activates electrostatic paper holddown. When released deactivates paper holddown and places unit in standby — a condition where unit is inactive.

PANEL CONTROLS (continued)

LINE Indicator — Lights when power is applied to Plotter.

ERROR Indicator — Lights when data coordinates outside range of Plotter are received, the pen has traveled into one of the mechanical limits, or the Plotter recognizes a data transfer format error which would cause improper data to be plotted. The computer will continue to calculate but the pen will lift and remain stationary until plot can continue.

GRAPH LIMITS

PEN DOWN — Lowers the pen; overriding the source input pen information while depressed.

PEN UP — Lifts the pen; overriding the source input pen information while depressed.

LOWER LEFT Controls — Enters (0000, 0000) allowing the position of lower left limit to be set anywhere in a 5 x 10 in. (12,7 x 25,4 cm) area of the lower left plotting surface. Controls, as indicated by arrows, adjust the lower left graph limit after depressing the LOWER LEFT pushbutton.

NOTE

Set LOWER LEFT controls before UPPER RIGHT controls. LOWER LEFT interacts with UPPER RIGHT.

UPPER RIGHT Controls — Enters (9999, 9999) allowing position of upper right limit to be set anywhere on the plotting surface to the right of and above lower left. Controls, as indicated by arrows, adjust the upper right graph limit after depressing the UPPER RIGHT pushbutton.

STANDBY

Standby is the condition in which the Plotter is inactive; the servos are muted, the pen is lifted, and the Plotter's arm may be moved freely. If CHART HOLD is depressed, the Plotter may be removed from Standby by command from the computer.

NOTE

When power is applied, the Plotter automatically is placed in Standby and remains in Standby as long as CHART HOLD is released.

The Plotter may be returned to Standby by releasing CHART HOLD.

PAPER POSITIONING

To position the paper, release the CHART HOLD switch. Place the paper against the bottom guide and the left edge paper stop. Depress the CHART HOLD switch and smooth the paper to the platen.

OPERATIONAL CAPABILITIES

In general, the Plotter performs one of two functions: pen maneuvers or position maneuvers.

Pen maneuvers are those in which the UP/DOWN position of the pen is specified by the input data and the pen status is changed accordingly. Pen control is accomplished through Command Lines to the Plotter processor.

Position maneuvers are those in which a location for the pen on the graph surface is specified by the input data. A straight line is drawn to the location during this operation. These maneuvers are given separate from the pen maneuvers. Position maneuvers are basically controlled by the same Command Lines; however, additional inputs and internal logic offer further flexibility. These capabilities, related to position maneuvers are discussed in this section.

1. Input Data Range.

   The 7210A is a first quadrant plotter. Locations on the platen correspond to positive integer values from 0 to 9999. The information input from the source must have the same magnitude range; however, in the Relative Coordinate Mode (a positioning technique described later), the input polarity may be positive or negative.

2. Numerical Code.

   The numerical position information is accepted in either binary or BCD 8421 codes. The binary information is handled in a 16-bit two's complement form. The BCD information is handled in a 17-bit sign and magnitude form. The choice of binary or BCD may be hard wired or selected by the Input Source. All magnitude information enters the Plotter on the same lines regardless of the code. Furthermore, the code for each position maneuver in a graph may be either BCD or binary.

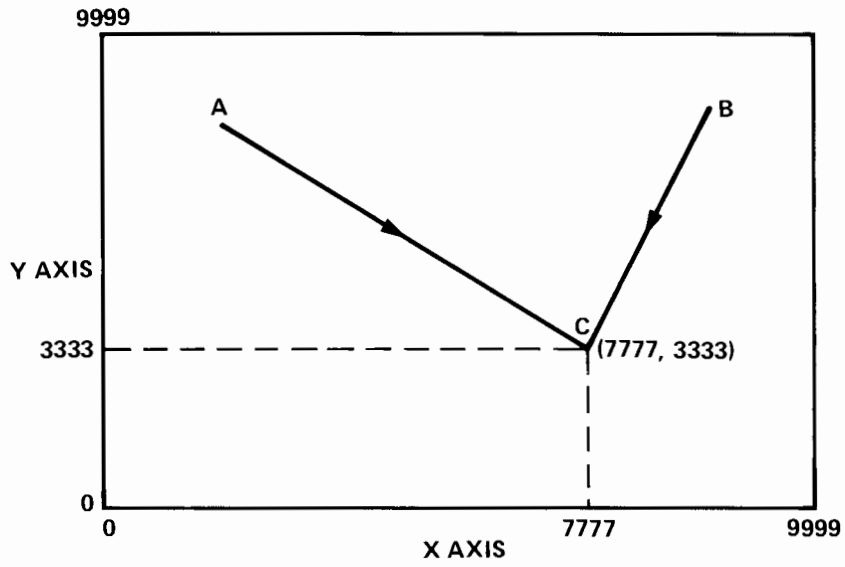
3. Position Mode.

   Position maneuvers may be performed in either of two modes: Absolute Coordinate or Relative Coordinate. Each mode offers some advantage over the other. The choice of mode may be hard wired or selected by the Input Source.

OPERATIONAL CAPABILITIES (continued)

a. Absolute Coordinate Mode.

Ease of use is offered by this mode, since it proceeds exactly as hand generated graphs are constructed on a cartesian coordinate system. The plotting surface may be represented as shown below:



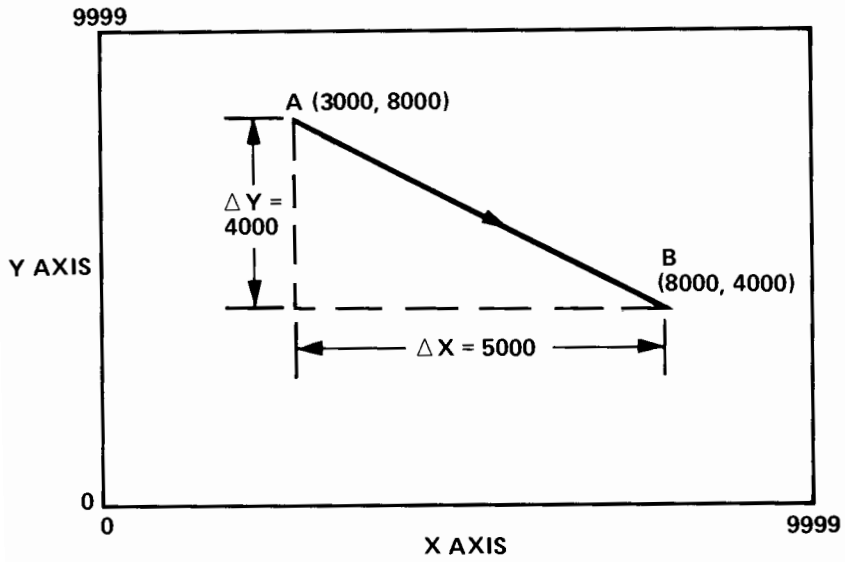
The length of each X and Y axis is divided into 10,000 equally-spaced points. Each corresponds to integer values from 0 to 9999 as shown. Points within the plotting surface are described by ordered pairs of these X and Y values.

The numerical input from the Input Source (integer values from 0 to 9999) instructs the pen to locate a position using a cartesian coordinate system on the above plotting surface. Regardless of past or present pen position, the pen will follow a straight line path to any point on the plotting surface specified by the Input Source.

If the pen is commanded to proceed to Point C (at 7777, 3333) from Point A or B, the results are as shown. Hence, a graph may be generated by constructing straight lines between a set of points described by a list of ordered pairs; each preceding point being the end point for the next line segment.

b. Relative Coordinate Mode.

Numerical processing time and storage space may often be saved through use of Relative Coordinate Mode plotting. In this mode, each new position is described relative to the last. The diagram below illustrates operation in this mode.



With pen at any Point A, the next pen position is described by the change or delta in the X axis (△X) and the delta in the Y axis (△Y). Numerical inputs from the Input Source define the delta X and delta Y to be used. Delta X and delta Y may be positive or negative. The path to the next point is a straight line. In the example shown, Point A is at 3000, 8000. For △X, △Y equals 5000, −4000 respectively, Point B equals 3000 + 5000, 8000 + (−4000) or 8000, 4000.

The input range of the numbers in the relative coordinate mode differs from that of the absolute mode in that input information may also be negative. The input range is integer values from −9999 to +9999. Binary numbers are entered in two's complement form (i.e. the sign information is in the last or most significant bit). BCD numbers are handled in sign and magnitude form.

Binary numbers greater in magnitude than 9999 are possible in the 16-bit input (only 14 are required to represent 9999). In the event a number larger than 9999 is received, the Plotter will resort to the Error Sequence described later. Furthermore, if the value of the absolute pen position is requested to fall outside the range from 0 to 9999 in either axis, the Plotter will again resort to the Error Sequence.

OPERATIONAL CAPABILITIES (continued)

This mode, although more complicated than the Absolute Coordinate Mode lends itself nicely to relative position information such as character generation. The character pattern may be output independent of offset and scaling used for the other data on a graph. In addition, incremental mode plotting techniques may be achieved by using the Relative Coordinate Mode and restricting the increment in both axes to a constant, the magnitude of which is dependent on the size of the increment desired.

4. Error Sequence.

   This sequence is a subroutine performed by the Plotter to indicate it has received some form of improper information. The possible errors that would force the Plotter to resort to this sequence are listed below:

   a. Oversized Relative Coordinate Mode or Absolute Coordinate Mode input. This condition may occur when a number greater in magnitude than 9999 is input to the Plotter in binary code (it is not possible in BCD code).

   b. Accumulated position due to Relative Coordinate Mode inputs lie outside the numerical positioning range. In Relative Coordinate Mode, the actual pen position must still remain within the numerical range of 0 to 9999. Position maneuvers are described in terms of delta moves in each axis, but the Plotter accumulates these inputs with present position to determine the next position. This mode would then allow the absolute position to sum to values outside the specified range.

   c. Incorrect formatting of data input. Information input to the Plotter is transmitted in four passes of a particular byte size. The Plotter uses the SYC (Synchronize) command line to determine which of the four passes it is receiving. If the Plotter finds these input passes out of sequence, it calls upon the Error Sequence.

      Upon detection of these conditions, the Plotter resorts to an Error Sequence as follows:

      1) Remains at the last properly described position.

      2) Lifts the pen. Lights the Error Indicator.

      3) Indicates error on the Format status line.

      4) Monitors the input lines for the next input which contains no errors. Performs this maneuver (Pen or Position).

      5) Indicates correct on the status line.

6) Performs a pen maneuver to conform with the last specified pen command.

7) Continues normal operation.

This sequence makes it obvious an error was encountered, and at what point in a plot it occurred.

5. Overscale Sequence.

This sequence is called upon when the numerical position is correct (within the range 0 to 9999), but the plotting surface has been located (through the front panel controls) such that the pen position falls off the platen. Numerical information is not in error so the Error Sequence is not called upon; however, it is advantageous to avoid erroneous lines along the margins and wasted time plotting offscale. The overscale sequence prevents these problems in the following manner:

Upon encountering the edge of the platen, the Plotter:

a. Lifts the pen.

b. Indicates set on the Clamp status line.

c. Continues to perform position maneuvers with pen up. At the end of each maneuver, detect if the pen has come on scale, away from the edge of the platen.

d. Lights the ERROR indicator.

When the pen is moving to a point away from the edge of the platen, the Plotter:

a. Indicates "clear" on the clamp status line.

b. Performs a pen maneuver to conform with the last specified pen command.

c. Resumes normal operation.

d. Clears ERROR indicator.

COMMAND STATEMENTS

The 7210A Digital Plotter is designed to easily interface with computer systems. Since the 7210A Plotter will be used with many varying computer systems, a single command statement cannot be defined. This section describes the types of command statements and how these statements are used to drive the Plotter. Typical command statements are defined and information needed to obtain a graph output is shown.

Two types of plotter statements are described; statements which directly drive the Plotter, and statements which call subroutines that drive the Plotter. For each type of statement, an example of use is given.

OUTPUT STATEMENTS

Output statements that pass information directly to the Plotter normally have a structure similar to other output statements in the language being used. The four items that must be considered when this type of statement is used are:

1. In what languages may the Plotter be called?
2. What is the structure of the statement?
3. What are the meaning and characteristics of the variables and/or constants used in the statement?
4. What output device number is assigned to the Plotter?

Table 4-1 gives a summary of typical output statements in FORTRAN and BASIC languages. A column is provided for the user to enter the specifications of the command statements used in a specific system language. These statements would be used in the same manner as any other output statement of the language. For example, consider the following program which draws a diagonal line on the graph from the lower left corner to the upper right corner:

```
C   PROGRAM TO DRAW A DIAGONAL LINE IN THE ABSOLUTE
C   PLOTTING MODE
      WRITE (11) -1, 1, 0, 0          locates pen at origin (lower left)
      WRITE (11) 1, 1, 9999, 9999     draws diagonal line to upper right
      END
```

It should be remembered that the data must be scaled prior to being sent to the Plotter. This can be done using the following scaling equation for the X coordinate and a similar equation for the Y coordinate.

COMMAND STATEMENTS (continued)

$$X_{scaled} = \frac{(X - X_{min})}{(X_{max} - X_{min})} (9999)$$

where X = arbitrary variable value
X_{max} = maximum value of variable
X_{min} = minimum value of variable
9999 = maximum value of data range.

Table 4-1. Structure of Plotter Command Statements

COMMAND CHARACTERISTICS	TYPICAL COMMAND	SPECIFIC SYSTEM COMMAND
Language	FORTRAN	
Structure of Command	WRITE (N) IPC, IMC, IX, IY	
Variable Meaning and Type	N Integer – Plotter Device Number	
	IPC Integer – Pen Control IPC ≤ -1 Pen Up IPC = 0 Point Plot IPC ≥ 1 Draw Line	
	IMC Integer–Plotting Mode IMC ≤ -1 Incremental Mode (Move thru displacement) IMC > 0 Absolute Mode (Move to point specified)	
	IX Integer X–coordinate data $0 \leq$ IX ≤ 9999 Absolute Mode $\|IX\| \leq 9999$ Relative Mode	
	IY Integer Y–coordinate data $0 \leq$ IY ≤ 9999 Absolute Mode $\|IY\| \leq 9999$ Relative Mode	
Language	BASIC	
Structure of Command	CALL (IPC, IMC, IX, IY) NOTE: This is a special command added to basic compiler	
Variable Meaning and Type	Variables are defined same as above	

SUBROUTINE CALL STATEMENTS

Use of the Plotter also may be accomplished at the subroutine level. This method is often used by incremental plotters since special codes are required to drive them. Although a special code is not needed by the 7210A, subroutines may be used. In some cases the same routines used to drive incremental plotters, may be modified to drive the 7210A. The modification is made in the subroutine that passes information to the Plotter. The routine is modified to pass the information to the 7210A driver. Table 4-2 lists a few of the subroutines which are available for incremental plotters.

Table 4-2. Plotter Subroutines

SUBROUTINE	MEANING	SPECIFIC DEFINITION
CALL AXIS (PARA1, . . . PARAK)	Draws axis on paper	
CALL SCALE (PARA1, . . . PARAN)	Sets scale of plot	
CALL LINE (PARA1, . . . PARAI)	Draws line on graph	
CALL SYMBOL (PARA1, . . . PARAJ)	Draws symbols on graph	
CALL PLOT (IPC, IMC, IX, IY)	Passes data to plotter	
OTHERS		

SUBROUTINE CALL STATEMENTS (continued)

The following is part of a program that uses subroutines to interface with the Plotter:

```
C   PROGRAM USING SUBROUTINES TO DRIVE THE HP7210A
C   PLOTTER

    CALL AXIS (X1, X2, X3,  X4)
    CALL SCALE (J1, J2, X5, X7, J5)
    DO 20 I = 1, 20
    CALL LINE (XD (I), YD (I) )
 20 CONTINUE
    CALL SYMBOL (X6, Y6, A)
    END

    SUBROUTINE AXIS (A1, A2, A3, A4)
    : : : :
    : : : : :
    END

    SUBROUTINE SCALE (I1, I2, X1, Y2, I3)
    : : : : : :
    : : : : : :
    END

    SUBROUTINE LINE (X, Y)
    : : : : :
    : : : : :
    END

    SUBROUTINE SYMBOL (X, Y, A)
    : : : : :
    : : : : :
    END

    SUBROUTINE PLOT (IPC, IMC, IX, IY)
    : : : : :
    : : : : : :
    END
```

In order to use the Plotter, languages and types of Plotter calls that are available must be known. Following this, the structure of the call and the number of the output device assigned to the Plotter must be determined. The data is structured, scaled, and then graphically presented on the 7210A Plotter.

PREVENTIVE MAINTENANCE

The Model 7210A must be properly maintained to obtain accurate, trouble-free operation. Proper maintenance includes periodic lubrication, performance checks, and visual and electrical checks. In accordance with good maintenance procedures for all precision instruments, your Plotter should be protected from dust by covering when not in use.

The Plotter should be cleaned at regular intervals determined by type of operation, local air contamination and climatic conditions.

The electrostatic platen should be cleaned as needed. Need for cleaning is indicated by the paper sliding easily or by the table appearing dirty. Clean the electrostatic platen as follows:

1. Remove the pen and paper from the recorder.

2. Carefully select a soap for cleaning. A mild liquid soap is preferable. Do not use any product with abrasives or corrosive chemicals.

3. Also be careful in selecting a cleaning cloth. Use a soft cloth that will not scratch the surface but will readily absorb water.

4. Saturate the cloth in warm, soapy water. Wring the cloth until the majority of the water has been removed.

5. Wipe the table surface clean with this damp cloth.

CAUTION

NEVER LET WATER STAND ON THE PLATEN.

6. Wipe any moisture from surface.

7. Allow a few minutes to dry before recording.

BALANCE SLIDEWIRE MAINTENANCE

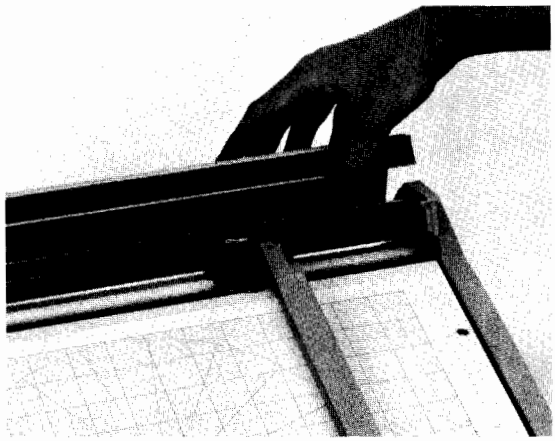
Irregular or "jumpy" plots on a properly adjusted recorder may indicate worn or dirty balance slidewire or wipers. Slidewires should be cleaned at least every six months.

BALANCE SLIDEWIRE MAINTENANCE (continued)

X–AXIS SLIDEWIRE ACCESS

To gain access to the X–axis slidewire, the rear hood of the Model 7210A must be removed.

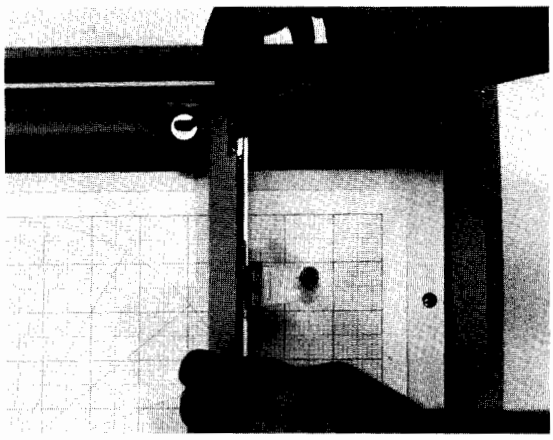
1. Turn the two screws securing the hood one full turn counterclockwise.
2. Remove the hood.



Y–AXIS SLIDEWIRE ACCESS

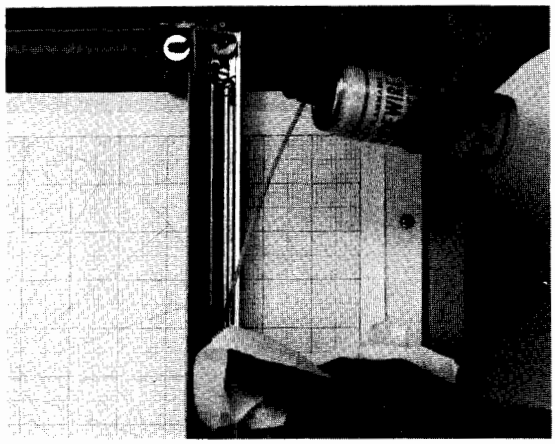
To gain access to the Y–axis slidewire, the rear hood must also be removed.

1. Remove the rear hood as described above.
2. Lift the pen holder up out of the way of the slidewire cover.
3. Turn the black plastic tab on the pen lift assembly one-quarter turn counterclockwise. This will free the slidewire cover.
4. Tilt the slidewire cover up, exposing the Y–axis slidewire.



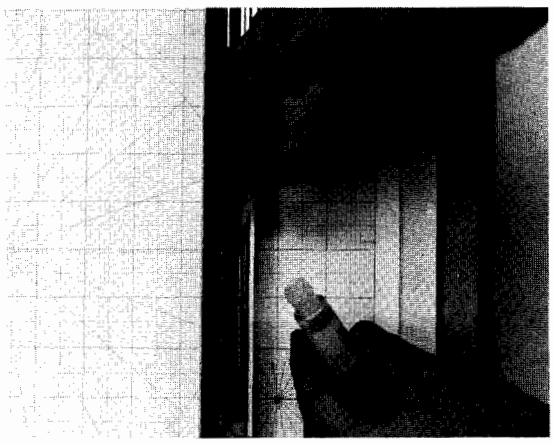
SLIDEWIRE CLEANING

To clean the slidewire, turn LINE switch off, then spray the entire slidewire with Slidewire Cleaner (Part No. 5080-3605). Move the carriage arm or pen carriage rapidly through several full-scale excursions. Again spray the wiper with Slidewire Cleaner. Saturate a Kimwipe or cotton swab with Slidewire Cleaner. Rub the slidewire (mandrel and return strip) with the moistened tissue or swab. Repeat the cleaning procedure until there is no stain on the tissue, then clean once more to ensure that all contaminants have been removed.



SLIDEWIRE LUBRICATION

After cleaning, the slidewire (mandrel and return strip) must be lubricated sparingly with Slidewire Lubricant (Part No. 5080-3635). This lubrication will reduce wear and chemical contamination of the balance slidewire assembly. After completion of cleaning and lubrication, re-install the Y slidewire cover and rear hood.



APPENDIX A

Plotting Area:	Front panel scaleable from 0 x 0 to 10 x 15 in. (25,4 to 38,1 cm).
Paper Size:	Any size up to 11 x 17 in. (27,9 x 43,2 cm).
Plotting Maneuvers:	Pen or Position. Pen and Position maneuvers are independent commands.
Vector Generation:	Automatic. A command to perform a position maneuver will cause the Plotter to traverse a straight line path at any specified point on the platen.
Vector Length:	Limited only by the plotting area.
Vector Speed:	6.7 to 12 in./sec (17 to 30,5 cm/sec). The speed is dependent upon the slope of the line, but independent of vector length. Plotter will process over 20 vectors/sec within given velocity limits.
Numerical Code:	Position data is received in BCD (8421) or Binary.
Plotting Modes:	Absolute, relative (rectangular coordinate system).
Numerical Resolution:	1/10,000 (0.01%).
Plot Accuracy:	Better than 0.04 inch (0,10 cm) in 15 inches (38,1 cm).
Resettability:	0.007 inch (0,18 mm) maximum.
Writing Method:	Ink, disposable pens.
Power:	100 V, 115 V, 200 V, or 230 V $\pm$10% (choice of four positions at rear panel) 48 to 66 Hz, 100 watts.
Weight:	Net 40 lb (18,1 kg); shipping 52 lb (23,6 kg).

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