OPERATING AND SERVICE MANUAL

7044A/7045A X-Y RECORDER

SERIAL PREFIX: 1827A (7044A)
1845A (7045A)

This Operating and Service Manual applies to HP Model 7044A X-Y Recorders having Serial Prefix 1827A and HP Model 7045A X-Y Recorders having Serial Prefix 1845A.

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1-1. DESCRIPTION.

2. BASIC FRAME.

1-3. The Hewlett-Packard Models 7044A and 7045A X-Y Recorders are designed for the laboratory user to plot cartesian coordinate graphs from dc electrical information. The 7044A or 7045A will satisfy the needs of the user seeking reliability and dependability. The 7045A instrument features high speed capability and rapid acceleration to accurately record high-frequency and fast-moving input signals. It also offers a RESPONSE switch which allows the user the choice of a fast or slow response. Both models are equipped with the newly designed, continuous duty, aluminum framed dc servo motor; the X-axis of the 7045A contains the larger, faster motor. This design concept avoids overheating or wear if the pen is driven out of scale for an indefinite time. Other features found on the 7044A and 7045A include 10 calibrated dc input ranges in each axis from 0.5 mV/in. (0.25 mV/cm) to 10 V/in. (5 V/cm), TTL Remote Control, and a Rear Connector. Arbitrary full scale voltage ranges may be established with a variable input attenuator in conjunction with the calibrated dc ranges. A trouble-free Autogrip electrostatic hold-down platen capable of holding chart paper up to 11 x 17 inches and the standard European A3 size, a disposable pen with four color choices, and plastic coated wirewound balance potentiometer are also provided on both models. Latest circuitry design and assembly techniques have also been incorporated into both models, thereby reducing failure and maintenance time. Additionally, both instruments can be equipped with such options as Time Base, Event Marker, or Metric Scaling. See Figures 1-1 and 1-2 depicting the standard 7044A and 7045A models.

1-4. MODEL – MANUAL INFORMATION.

1-5. This manual is applicable to the Model 7044A with a serial prefix of 1827A and the Model 7045A with a serial prefix of 1845A. The serial prefix is the first four digits and a letter of a two-part, ten-item serial number (0000A-00000) used to identify each Hewlett-Packard instrument (see Figure 1-3). Should any change to this manual be necessary, a new serial prefix will be assigned to the changed model and a change sheet (Manual Change) will be supplied defining the differences between the changed model and the one described within this manual. Other corrections due to any errors that existed when this manual was printed will be provided. This type of change, called Errata, also appears on the change sheet (Manual Change). For additional information pertaining to this instrument, or other

Figure 1-3. Instrument Identification

Hewlett-Packard instruments, contact the nearest Hewlett-Packard Sales/Service Office. The addresses are tabulated on the last two pages of this manual.

1-6. SPECIFICATIONS.

1-7. Table 1-1 lists the specifications and accessories supplied or available with this recorder. Figure 1-4 illustrates the outside dimensions of the 7044A and 7045A models. Option specifications are defined beginning in paragraph 1-9 and Table 1-2.

1-8. OPTIONS.

1-9. Optional features available for the two models are specified in Table 1-2. The following paragraphs describe these features which may be built into or combined with this instrument. Table 1-3 contains the specifications of the options.

1-10. TIME BASE – OPTION 001

1-11. Six speeds from 0.5 sec/in. to 100 sec/in. are available for both models in either the X or Y-axis. In the 7045A model, however, with the addition of the RESPONSE switch, the selection of the X or Y-axis time base sweep speed automatically results in the SLOW response of that selected axis; the other axis is not affected and operates normally. (May be ordered only at time of recorder purchase.) See Figure 1-5.


1-13. A remotely controlled event marker, installed at the top of the Y arm, identifies significant events in a recording sequence by making an upward deflection in the margin at
Section 1

Figure  Model 7044A $X^*$ Recorder

Figure  Model 7045A $X-Y$ Recorder
TABLE 1-I: SPECIFICATIONS (Continued)

REAR CONNECTOR

Connects Event Marker and TTL.
Provides X and Y inputs and pen lift TTL controls.
Supplies START and RESET remote capability.
TTL and Rear Connector provide Autogrip and Servo Standby capability on Model 7044A. Additionally, X and Y response on Model 7045A.

GENERAL SPECIFICATIONS

Writing Mechanism: Servo actuated ink pen.
Writing Area: 10 in. x 15 in. (25 cm x 38 cm).
Paper Holdown: Autogrip electric paper holdown grips charts 11 in. x 16.5 in. and standard European size A3 (29.7 cm x 42 cm) or smaller. Special paper not required.
Pen Lift: Electric (Remote, via contact closure, or TTL level).
Power: 100, 120, 220, or 240 volts ac +5% -10%, 48 to 440 Hz; 7044A, 135 VA; 7045A, 175 VA
Weight: Net, 30 lb (13.7 kg); shipping 42 lb (19.1 kg).

Figure 1-4. Model 7044A/7045A Dimension Drawing
TABLE 1-1 SPECIFICATIONS

Performance Specifications

Input Ranges: 0.5, 1, 5, 10, 50 mV/in.; 0.1, 0.5, 1, 5, 10 V/in. (metric calibration available in 0.25, 0.5, 2.5, 5, 25 mV/cm; 0.05, 0.25, 0.5, 2.5, 5 V/cm).

Type of Input: Floating, 500 Vdc or peak ac maximum. Polarity reversal switch located on front panel, guard internally connected. Inputs through front panel 5-way binding posts or optional rear connector.

Input Resistance: 1 megohm constant on all ranges.

Common Mode: 110 dB dc and 90 dB at 50 Hz and above with 1 k ohm between HI and LO terminals.

CMR Voltage Applied between ground and LO, and attenuator on most sensitive range. On other ranges, CMR decreases 20 dB per decade step in attenuation.

Slew Rate: 7044A – 20 in./sec (50 cm/sec) minimum.
7045A – Fast Response, 30 in./sec (76 cm/sec) minimum;
Slow Response, 15 in./sec (36 cm/sec) typical.

Acceleration (Peak):
7044A – Y-axis, 1000 in./sec² (2540 cm/sec²);
X-axis, 500 in./sec² (1270 cm/sec²).

7045A – (Fast Response Only) Y-axis 3000 in./sec² (7620 cm/sec²);
X-axis 2000 in./sec² (5080 cm/sec²).

Typical Performance Limits

Accuracy: ±0.2% of full scale (includes linearity and deadband) at 25°C. Temp Coefficient ±0.01% per °C.

Range Accuracy: ±0.2% of full scale ±0.2% of deflection (includes linearity and deadband) at 25°C. Temp Coefficient ±0.01% per °C.

Deadband: 0.1% of full scale.

Overshoot: 7044A – 2% of full scale (maximum).
7045A – 1% of full scale (maximum).

Zero Set: Zero may be placed anywhere on writing area or electrically off scale up to one full scale from zero index.

Environmental (Operating): Meets HP Class B which includes 0°C to 55°C and <95% RH (40°C).

TTL Remote Control

Operating Levels: Contact closure (0.2 mA) to ground or TTL levels.

Logic (0): Between –0.5 Vdc and +0.4 Vdc.
Logic (1): Between +2.4 Vdc and 5.5 Vdc.
2-1. INTRODUCTION.

2-2. This section provides information for incoming inspection, installation, storage, and shipping of the 7044A and 7045A X-Y Recorders. Also included is the information required to field install and/or modify options for the two models.

2-3. INCOMING INSPECTION.

2-4. MECHANICAL CHECKS.

2-5. Inspect the instrument for mechanical damage, scratches, dents, or other defects. Also check the cushioning materials for signs of severe stress.

2-6. ELECTRICAL CHECKS.

2-7. The electrical performance of the instrument should be verified upon receipt. Performance checks, suitable for incoming inspection as well, are presented in Section V.

2-8. DAMAGE CLAIMS.

2-9. If the instrument is damaged in transit, or fails to meet specifications upon receipt, notify the carrier and the nearest Hewlett-Packard office immediately. A list of field offices is conveniently located in the back of this manual. Retain the shipping carton and padding material for the carrier's inspection. The field office will arrange for replacement or repair of your instrument without waiting for claim settlement against the carrier.

2-10. STORAGE.

2-11. When the instrument is to be stored for a period of time, the disposable pen and the event marker cartridge (if Option 002 is installed) should be removed and the upper part of the carriage arm clamped to the right side of the instrument to prevent damage during handling. Flush event marker ink lines out with water. Seal the instrument in moisture-proof covering with desiccant and repackage in a container similar to the original factory carton.

2-12. SHIPPING.

2-13. 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 recorder:

a. Remove disposable pen and event marker assembly (Option 002 if installed).

b. Clamp the upper end of carriage arm and pen carriage to the right side of recorder with shipping clamp (HP Part No. 07040-60921) to prevent movement while in transit.

c. Wrap instrument in heavy paper or plastic and surround with three to four inches of shock-absorbing material to cushion and prevent movement inside shipping container. Container should be sufficiently durable to prevent damage to instrument during handling. If in doubt, request a shipping carton from nearest Hewlett-Packard Sales/Service Office.

2-14. RECORDER INSTALLATION.

2-15. MECHANICAL INSTALLATION.

2-16. The instrument is equipped with built-in rack mounting brackets for placing in a standard 19-inch cabinet. Four screws (two on each side) are used for easy installation. Feet and side trim panels are provided for bench type operation. Remove side trim panels before rack mounting. See Figure 2-1.

Figure 2-1. Recorder Installation
TABLE 1-2. OPTIONS

<table>
<thead>
<tr>
<th>OPTION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>001</td>
<td>Time Base X or Y</td>
</tr>
<tr>
<td>002</td>
<td>Event Marker (Electric)</td>
</tr>
<tr>
<td>006</td>
<td>Metric</td>
</tr>
</tbody>
</table>

Figure 1-5. Time Base – Option 001

the top of the chart paper. The cartridge-type pen is actuated by a remote contact closure. (May be field installed.) See Figure 1-6.

Figure 1-6. Event Marker – Option 002


1-15. Metrically scaled and calibrated version of either instrument is provided. (May be ordered only at time of recorder purchase.)

1-16. ACCESSORIES.

1-17. Included in the standard Accessory Kit are a package of red and blue disposable pens, slidewire cleaner, and a one-ampere fuse (for 250V operation) or a two ampere fuse (for 115V operation). Additional accessories are added when certain options are added.

TABLE 1-3. OPTION SPECIFICATIONS

<table>
<thead>
<tr>
<th>TIME BASE – OPTION 001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweep Rates: Six selectable rates from 0.5 through 100 sec/in. (0.25 through 50 sec/cm). X or Y axis. TTL sweep indication is provided.</td>
</tr>
<tr>
<td>Accuracy: ±1% full scale at 25°C (±0.1% degrees C maximum).</td>
</tr>
<tr>
<td>Linearity: ±0.5% full scale at 25°C (to 0.04%/degrees C maximum).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EVENT MARKER – ELECTRIC – OPTION 002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marking Area: Upper margin aligned with X-axis position.</td>
</tr>
<tr>
<td>Excursion: Approximately 0.05 inch.</td>
</tr>
<tr>
<td>Ink Capacity: 0.45 cc cartridge, writing distance 500 ft minimum.</td>
</tr>
<tr>
<td>Control: Remotely by contact closure to ground or TTL logic control.</td>
</tr>
</tbody>
</table>
SECTION III
OPERATING INSTRUCTIONS

3-1. OPERATING REQUIREMENTS.

3-2. GENERAL.

3-3. The basic function of the Models 7044A and 7045A X-Y Recorders is to produce a cartesian coordinate graph showing the relationship between two variable functions. Slowly varying dc signals representing these functions are applied to the input terminals of the respective X and Y axis of the recorder and its controls adjusted so that the resulting graph will cover the desired region of the graph.

CAUTION

Before attempting to operate the instruments, the user should become familiar with the input requirements and various control functions as outlined in the following paragraphs.

3-4. CONTROLS, CONNECTORS, AND INDICATORS.

3-5. The front and rear panel controls, connectors, and indicators are depicted and explained in Figures 3-2 and 3-3. The 37-pin rear connector is depicted in Figure 3-4.

3-6. ELECTRICAL REQUIREMENTS.

3-7. OPERATING POWER.

3-8. The ac power supplied to the models should be either 100, 120, 220 or 240 Vac, 48 to 440 Hz, single phase. Two voltage selector switches located on the underside of the instrument on the connector panel must be set to correspond to the available supply voltage. A 1.5-ampere time delay fuse is used for 100 or 120V operation and a 3/4-ampere time delay for 220 or 240V. The power cord furnished with the instrument complies with National Electric Code requirements only when used for 115V operation. For 230V operation, the power cord must be replaced or modified. To modify the cord, replace the male plug with a NEMA configuration plug for 230V operation. Refer to Figure 3-1.

3-9. INPUT SIGNALS.

3-10. The recorder's input terminals (HI and LO), located on the front panel, must be supplied with varying dc signals. These signals should vary at a rate within the response capabilities of the instruments and have amplitudes within their scale ranges or an erroneous recording may result. It is possible to have an excessive amount of ac noise present in the input signals, thereby resulting in recorder response becoming oscillatory and inaccurate. It is important that the side of the signal with the lowest impedance to ground side is connected to the LO input terminal of the instrument. If this results in the recorder axis moving in the wrong direction, reset POLARITY switch to +RT or -RT for X-axis or to +UP or -UP for the Y-axis. If excessive normal mode noise is present on the input signals, an external filter(s) may be necessary.

3-11. GROUNDING.

3-12. For optimum performance, the center prong of the ac power cord must be grounded. When operating from ungrounded power sources, secondary grounding method is mandatory.

3-13. OPERATING PRECAUTIONS.

3-14. SERVO.

3-15. To avoid unnecessary wear on the balance potentiometers and other mechanical parts, place the SERVO toggle switch in STANDBY when not recording.

3-16. If the input voltage exceeds the range setting, the pen will move quickly to one end of its travel and strike the drive mechanism stop. The motor will stop, protecting the recorder against damage until the input signal returns to an oscular value.

3-17. RESPONSE SWITCH.

3-18. On the 7045A, position RESPONSE toggle switch in SLOW position. This permits making prerecording span and zero adjustments without the pen and arm driving against the stops at full slewing speed. This position also enables the user to record slow input signals or reduce the speed of the instrument.

3-19. OPERATING INSTRUCTIONS.

3-20. CONNECT POWER.

3-21. Set the power voltage selector switch, located on the underside of the instrument, to either 100, 120, 220, or
2-17. COOLING.

2-18. Cooling is provided by convection. The location of mounting of the instrument must ensure adequate air circulation.

2-19. OPTION INSTALLATION/CONVERSION.

2-20. These two models may be equipped with options which can increase the versatility and application to special operating requirements. The following paragraphs describe those options that can be installed or modified in the field.


2-22. Installation is accomplished for either model per the instructions accompanying Event Marker Kit, Part Number 07044-60001.
1. **VOLTAGE SELECTOR SWITCHES**: These two switches are positioned to correspond with the AC line input voltage. Any voltage of 100, 120, 220, or 240 volts AC.

2. **POWER CORD RECEPTACLE**: Use the power cord provided with the recorder.

3. **FUSE HOLDER**: For line fuse:
   - 7045A: 100 or 120 volts, 1.5 AT (P/N 2110-0304), 750 mAT (P/N 2110-0360)
   - 7044A: 100 or 120 volts, 1 AT (P/N 2110-0007), 500 mAT (P/N 2110-0202)

4. **REAR CONNECTOR**: A 37-pin connector for the input of all signals except power. A mating connector is supplied in the accessory kit.

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240V ±5-10% depending on the available power source. Connect the power cord between the power receptacle and the power source.

3-22. **ENERGIZE RECORDER**.

3-23. Place the LINE toggle switch to the ON position. This will furnish power to the recorder.

3-24. **INSTALL PAPER**.

3-25. Place chart paper on the recording platen and align the left edge with the paper stop. To energize the platen, place CHART toggle switch to HOLD.

3-26. **INSTALL PEN**.

3-27. The disposable pen is pushed into the notched holder located on the scale, and twisted clockwise to lock in holder.

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**CAUTION**

The disposable pen incorporates a precision writing tip. Care must be taken not to damage this tip during pen changing or other handling. Writing by hand on any surface may damage pen tip. Use pen only in pen holder on recorder.

3-28. **SET VERNIER CONTROL**.

3-29. Vernier control enables operator to adjust recorder sensitivity to any value between fixed ranges. It is often used to adjust the recorder sensitivity to align with actual function to be measured — not necessarily voltage (i.e., 100 lbs/in., 20 dB/in.).

3-30. **CONNECT INPUTS**.

3-31. Connect the signal inputs to each axis through the front input terminals using open wires or banana connectors.

3-32. **ZERO SET**.

3-33. Connect the input signals to the recorder and adjust the zero position so that the resulting graph will cover the desired area on the paper.

3-34. **LOWER PEN**.

3-35. Lowering the pen for recording purposes is accomplished by positioning the PEN toggle switch to RECORD. When TTL is installed, pen lowering is energized by level changes to less than +0.4 Vdc. Changing level to between +2.4 and +5.5 volts will raise the pen.
1. POLARITY SWITCHES (-RT +RT, -UP, +UP). Two toggle switches; one for the X-axis and the other for the Y-axis; provide polarity reversal.

2. RESPONSE SWITCH (7045A ONLY). A two-position toggle switch labeled SLOW and FAST. Use SLOW position for making prerecording adjustments, and also, if desired, record slow incoming signals or reduce speed of instrument.

3. ZERO CONTROLS. A control in each axis for adjusting the pen’s zero position on the chart.

4. ZERO CHECK SWITCHES. A pushbutton switch to verify the zero setting of either the X or Y axis. When depressed, the input signal is disconnected and the pen returns to its zero position.

5. RANGE SWITCHES. A selector switch for each axis allowing the selection of 10 calibrated positions.

6. VERNIER CONTROL. A vernier control in each axis for multiplication of input range setting; overlaps two adjacent calibrated ranges.

7. LINE SWITCH. A two-position toggle switch; OFF and ON; that controls the application of the ac line voltage to the recorder.

8. CHART SWITCH. A two-position toggle switch; RELEASE and HOLD; that controls the chart holding function of the Autogrip table.

9. SERVO SWITCH. A two-position toggle switch; STANDBY and ON; that controls servo actuation for both axes.

10. PEN SWITCH. A two-position toggle switch; LIFT and RECORD; that controls the lowering and raising of the pen.

11. INPUT TERMINALS. Two input terminals are available for each axis. They are labeled HI and LO and will accept either open wire or banana plug connectors.

12. TIME BASE – OPTION 001. One control knob for the selection of six sweep speeds in either axis. To determine the axis, place toggle switch from OFF to X or Y, then select sweep using sweep rate knob. RESET/START toggle switch stops sweep cycle, lifts pen, and resets pen to original starting position when placed in RESET; in START position, drops pen, sweeps pen across chart at selected rate.

CAUTION

The input signal is not disconnected from the axis that has sweep. Although this input no longer affects that axis, to avoid accidentally overloading the input, remove the signal from the axis in sweep.

Figure 3: Control Panel – 7044A and 7045A
SECTION IV

THEORY OF OPERATION

4-1. GENERAL.

4-2. PURPOSE.

4-3. The theory of operation for the Models 7044A and 7045A X-Y Recorders is explained in the following paragraphs detailing the models' important circuits. In addition, the Time Base Circuitry, Option 001, is also described. Simplified block diagrams of the standard instruments are presented in Figures 4-1 and 4-2.

4-4. CIRCUIT DESCRIPTION.

4-5. PREAMPLIFIER (X AND Y AXES).

4-6. The Preamplifier consists of Q1, IC1, and their associated components. It is a dc amplifier that has a gain set by switch S2A. The sensitivity at the output of the preamplifier is 60 mV/inch.

4-7. SLIDEWIRE BUFFER AMPLIFIER (X AND Y AXES).

4-8. IC3 (7044A/7045A X-Axis) or IC4 (7045A Y-Axis) is connected in a unity gain configuration and is connected to the Slidewire Wiper. It provides a high input impedance to the Slidewire Wiper.

4-9. SERVO AMPLIFIER (X AND Y AXES).

4-10. The Servo Amplifier consists of IC4 (7044A/7045A X-Axis) or IC5 (7045A Y-Axis) and its associated components. The Servo Amplifier sums current from three sources; the Preamplifier output, the Slidewire Buffer Amplifier output, and the Zero Control Wiper.

4-11. POLARITY SWITCH (X AND Y AXES).

4-12. The Polarity Switch, S1, determines whether IC2 (7044A/7045A X-Axis) or IC3 (7045A Y-Axis) and its

Figure 4-1  Model 7044A X and Y Axes/7045A X Axis Simplified Block Diagram
millisecond delay. The output of IC3 goes to pin 9 of IC2B; the output pin 8 of IC2B drives Q4, thus actuating relays L4 and L5, and muting the X and Y servo amplifiers for 100 milliseconds. Ferrite beads L6 and L7 are transient suppressors for reed relay switch S3. L6 and L7 prevent voltage transients from triggering IC3 during CHART HOLD/RELEASE switching to IC1C.

4-20. CIRCUIT DESCRIPTION – OPTIONS.

4-21. TIME BASE – OPTION 001

4-22. INTEGRATOR. The ramp for the sweep is generated by an Electronic Integrator consisting of Q1, IC7, and their associated components. When S1 relay is opened, C2 is charged from the operational amplifier AR3. This generates a linear ramp voltage that is applied to the X or Y axis amplifier. When S1 is closed, C2 is discharged and the sweep is reset.

4-23. CONTROL CIRCUITRY. The TTL gates IC1 (A, B, C, D) and IC2 (A, B, C, D) provide start, reset, and pen drop control functions. IC2A, IC2B; and IC2C gates form a NAND-LATCH flip-flop which holds the time base in either sweep or reset mode by controlling S1 through Q3. Gates IC1D and Q4 and their associated circuitry form a one-shot multivibrator with a one-second time delay that fires every time a reset command is given. This holds off the sweep from being re-started before the X-axis has returned to zero. When the sweep is ready to be started, a logic level appears at the output of gate IC2D.