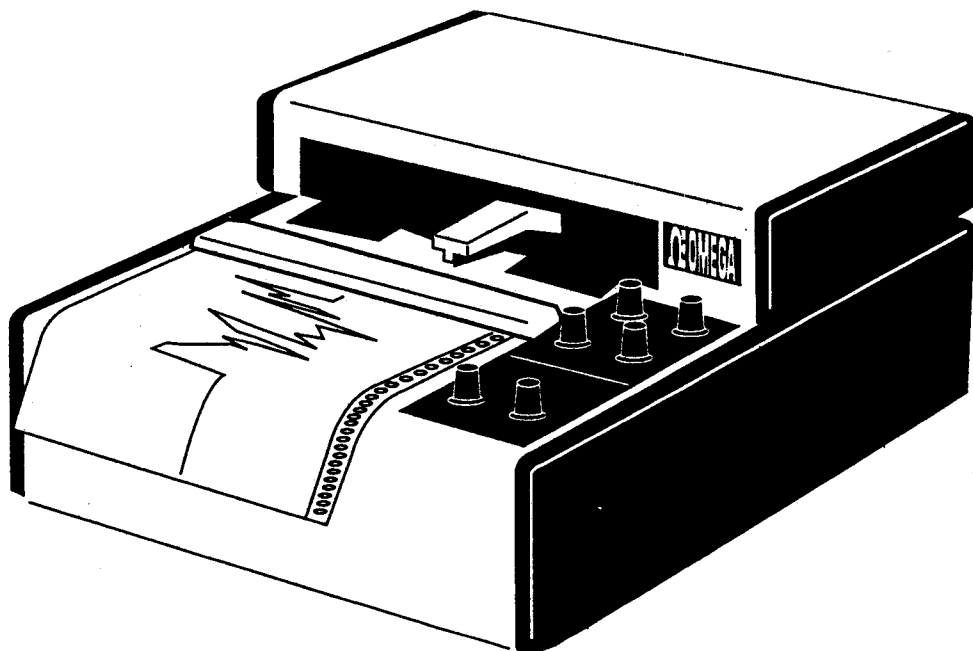


RD-1101

100 mm Flatbed Recorder



**Operator's Manual
M1602/0393**



WARRANTY

OMEGA warrants this unit to be free of defects in materials and workmanship and to give satisfactory service for a period of **13 months** from date of purchase. OMEGA Warranty adds an additional one (1) month grace period to the normal **one (1) year product warranty** to cover handling and shipping time. This ensures that our customers receive maximum coverage on each product. If the unit should malfunction, it must be returned to the factory for evaluation. Our Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective it will be repaired or replaced at no charge. However, this WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of being damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components which wear or which are damaged by misuse are not warranted. These include contact points, fuses, and triacs.

We are glad to offer suggestions on the use of our various products. Nevertheless OMEGA only warrants that the parts manufactured by it will be as specified and free of defects.

OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED.

LIMITATION OF LIABILITY: The remedies of buyer set forth herein are exclusive and the total liability of OMEGA with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the component upon which liability is based. In no event shall OMEGA be liable for consequential, incidental or special damages.

Every precaution for accuracy has been taken in the preparation of this manual, however, OMEGA ENGINEERING, INC. neither assumes responsibility for any omissions or errors that may appear nor assumes liability for any damages that result from the use of the products in accordance with the information contained in the manual.

RETURN REQUESTS / INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA ENGINEERING Customer Service Department. Call toll free in the USA and Canada: 1-800-622-2378, FAX: 203-359-7811; International: 203-359-1660, FAX: 203-359-7807.

BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, YOU MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OUR CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

FOR WARRANTY RETURNS, please have the following information available BEFORE contacting OMEGA:

1. P.O. number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems you are having with the product.

FOR NON-WARRANTY REPAIRS OR CALIBRATION, consult OMEGA for current repair/calibration charges. Have the following information available BEFORE contacting OMEGA:

1. Your P.O. number to cover the COST of the repair/calibration,
2. Model and serial number of product,
3. Repair instructions and/or specific problems you are having with the product.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. That way our customers get the latest in technology and engineering.

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100 MM FLATBED RECORDER

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SECTION 1 INTRODUCTION

1.1 GENERAL DESCRIPTION

The Model 1101 Recorder is a multi-range potentiometric, null balance servo recorder which will provide an accurate, permanent, graphic record of the input signal.

This graphic recorder may be used in many different applications in the medical, teaching and industrial fields where a precision instrument is of utmost importance.

This recorder measures dc voltage, current, temperature and a variety of other variables.

1.2 SPECIAL FEATURES

1.2.1 Remote Chart ON/OFF

Allows you to turn the chart on and off from a remote location when a contact closure is made or broken between CHART OSC OUT and CHART PROG of TB1 on the bottom panel.

NOTE

Remove the jumper between OSC OUT and CHART PROG for remote operation and reinstall it for normal operation.

1.2.2 Override Event Marker

Produces a $\pm 4\%$ (approximate) "glitch" in the analog pen trace when a contact closure is made between OVERRIDE EVENT MARK and SIG GND of TB1 on the bottom panel.

CAUTION

DO NOT connect to PWR GND terminal, as damage may occur.

1.2.3 Remote Chart Programming/TTL

The recorder chart drive system is designed to operate from an external frequency source, including TTL levels. The chart can be run at time rates other than those built into the recorder. This mode can be obtained by applying a pulse train (see below) to the CHART PROG and PWR GND terminals of TB1 on the bottom of the recorder.

NOTE

Remove the jumper between CHART PROG and OSC OUT for remote programming.

Pulse Train Specifications:

0 (low) state voltage is +0.5 Volts or less

1 (high) state voltage is +5 to +15 Volts maximum

Minimum pulse width is 100 microseconds

Chart Speed Formula:

$$\text{CHART SPEED} = \frac{F}{125 \text{ Hz}} \times S$$

F = External frequency in Hz

S = Selected chart speed

- When the external frequency is set to 125 Hz, the chart drive will run at the speeds marked on the front panel selector switch.
- If the external frequency is increased or decreased by 10% of the standard 125 Hz rate, the actual chart speed will be 10% faster or slower than the setting on the front panel selector switch.

EXAMPLE: The selector switch is set at 30 CM/MIN and the external frequency is changed to 137.5 Hz (a 10% increase). The chart will now run at 33 CM/MIN.

NOTE

Changing external frequency affects all selected speed rates by the same factor.

- The recommended maximum chart speed for “start/stop” operation is 30 CM/MIN. If the frequency is “swept” (no start/stop), it is possible to run faster than 30 CM/MIN; however, the sweep rate must be gradual enough to assure accurate mechanical tracking.

SECTION 2 INSTALLATION

2.1 UNPACKING

Remove the packing list and verify that all equipment has been received. If there are any questions about the shipment, please call the OMEGA Customer Service Department at 1-800-622-2378 or (203) 359-1660.

Upon receipt of the shipment, inspect the container and equipment for any signs of damage. Take particular note of any evidence of rough handling in transit. Immediately report any damage to the shipping agent.

NOTE

The carrier will not honor any claims unless all shipping material is saved for their examination. After examining and removing contents, save packing material and carton in the event reshipment is necessary.

If the recorder fails to operate properly, check all connections, cables and fuses. Ensure that all plug-in boards are firmly seated in place. Double check for “pilot error” before calling the factory direct or the local dealer from whom the instrument was purchased.

2.2 SET-UP PROCEDURE

2.2.1 Power Requirements

Recorders are shipped ready to operate on a nominal ac voltage of 155 Vac and 60 Hz. To convert to 230 Vac and 50 Hz, move a slide switch (inside the instrument) to the proper position and install the correct fuses (0.15a). See Figures 2-1 and 2-2 for access.

CAUTION

Disconnect the recorder from the ac power source and use caution in removing and replacing the bottom cover to prevent damage to internal wiring and electronic components.

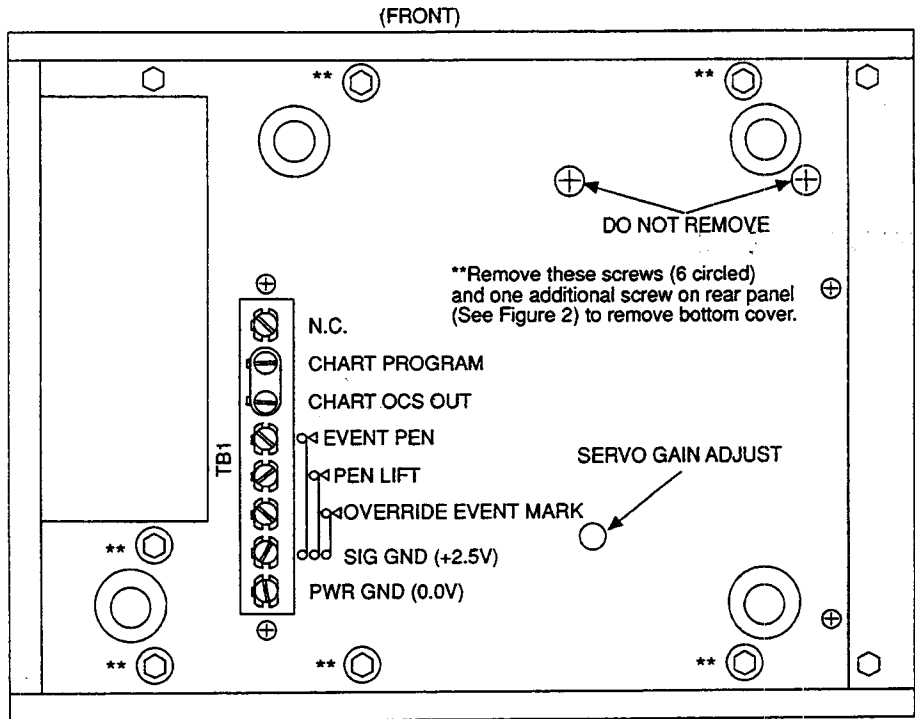


Figure 2-1. Bottom Panel

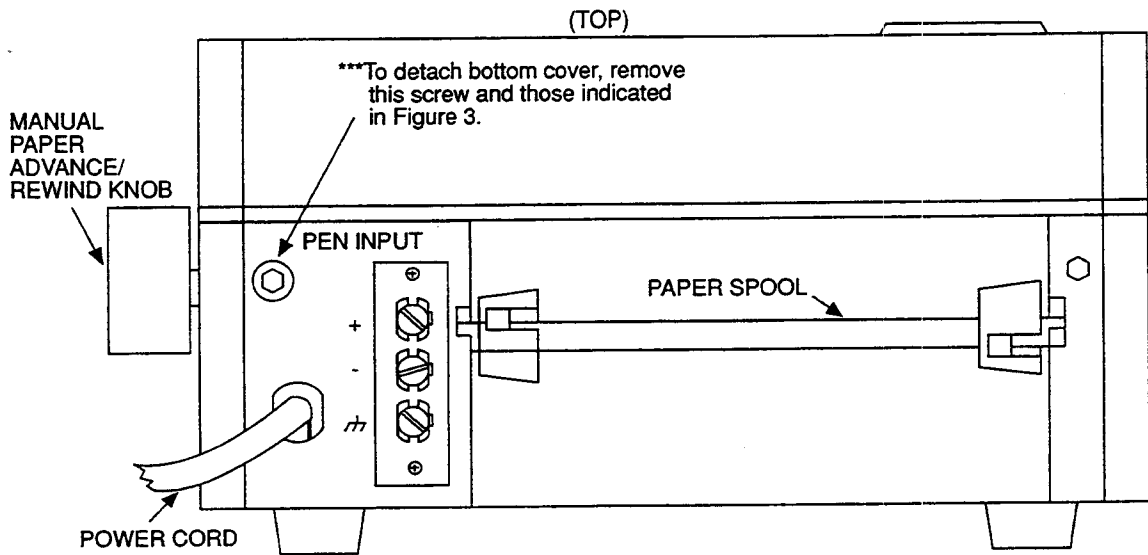


Figure 2-2. Rear Panel

2.2.2 Installing the Chart Paper (See Figures 2-2 and 2-3)

1. Place the REC/STBY switch in the STBY position.
2. Place the CM/MIN-OFF-CM/HR switch in the OFF position.
3. Turn the power ON and place the pen in the LOAD position using the ZERO control (fully clockwise).
4. Remove the masking tape from a new roll of paper and fold the free end of the paper into an 8 inch long "V".
5. Install the Paper Feed Spool. This item is taped to the rear of the recorder for shipping.
6. Load the chart paper into the rear of the recorder.
7. Feed the "V" through the space between the paper hold-down and the chassis using the manual paper advance/rewind knob to assist loading.
8. Check for proper hole and slot engagement with the sprockets to ensure that the paper is not cocked. The chart grids should be parallel with the paper tear-off bar, and the paper should move smoothly forward and backward with the manual advance/rewind knob.

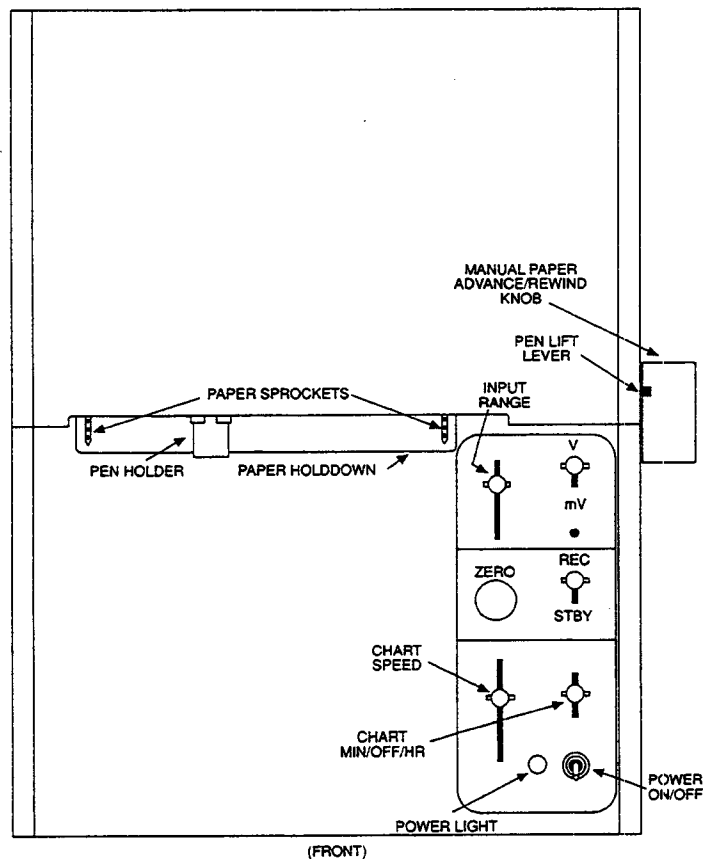


Figure 2-3. Front Panel Controls

2.2.3 Installing the Pen

With the pen holder in the LOAD or UP position, remove the cap from the pen and slide the pen into the holder as far as possible.

2.2.4 Grounding

For best performance, the green (or green and yellow) ground wire in the power cord for the recorder and the signal source should share a common "water pipe" ground. The green (green and yellow) wire in the power cord is connected to the recorder ground (↗) (chassis), but not to the signal input. If the signal input does not have a third wire in its power cord, or if the instrument is not grounded, connect a wire between the recorder ground (↗) terminal and the chassis of the signal source.

In case of large common-mode signals, particularly 120 Hz, connect the recorder ground (↗) terminal to the source of the common-mode signal, or to the negative (-) recorder input terminal.

CAUTION

DO NOT connect the POWER GROUND (PWR GND) terminal to either the SIGNAL GROUND (SIG GND) (-) or the CHASSIS GROUND (↗) terminal, as damage to the recorder may occur.

2.2.5 Input Signal Connections (See Figure 2-2)

This instrument requires a dc voltage input. Signal sources with current outputs will require a shunt resistor across the + and - input terminals. Use Ohms Law to compute the proper value for a given input range.

The formula is:

$$R = \frac{E}{I}$$

Where:

E is the recorder span (range) selected in Volts
I is the maximum current signal to be recorded in Amps
R is the resistance of the shunt resistor in Ohms.

1. Make the following electrical connections:

Signal source Positive to recorder (+) terminal.
Signal source Negative to recorder (-) terminal.

2. Right hand zero is standard on this recorder. However, either right or left hand zero may be used.
 - a. Positive going input signals:
 1. For RIGHT hand zero, adjust pen to the right side of the chart with the zero control. The pen will now drive to the left.
 2. For LEFT hand zero, adjust pen to the left side of the chart with the zero control. Reverse the input signal connections on the rear of the recorder (POSITIVE input to (-) terminal and NEGATIVE input to (+) terminal). The pen will now drive to the right.
 - b. Negative going input signals:
 1. For RIGHT hand zero, adjust pen to the right side of the chart with the zero control. Reverse the input signal connections on the rear of the recorder (POSITIVE input to (-) terminal and NEGATIVE input to (+) terminal). The pen will now drive to the left.
 2. For LEFT hand zero, adjust pen to the left side of the chart with the zero control. Connect the signal input with the POSITIVE to (+) and the NEGATIVE to (-). The pen will now drive to the right.

2.2.6 Recording Procedure (See Figures 2-1 and 2-3)

Be sure that the chart paper and pen are properly installed and the recorder is plugged into the proper ac source (corresponding to the voltage conversion slide switch inside the recorder). Perform the following steps for routine recording:

1. Check that the REC/STBY switch is in the STBY position and the power is ON.
2. Set the REC/CAL switch to REC.
3. Set the INPUT RANGE and mV/V switch to the desired input range (span).
4. Set the CHART SPEED and CM/MIN-OFF-CH/HR switch to the desired chart speed.
5. Adjust pen to the proper zero position using the ZERO control.
6. Set the REC/STBY switch to REC and proceed with your recording.

NOTE 1: When switching from one input range (span) to another, check the pen zero and adjust if necessary.

NOTE 2: Be sure that the OSC OUT and CHART PROG terminals of the Terminal board TB1 (on bottom of recorder) are jumpered together, unless remote chart control is used. Otherwise the chart drive WILL NOT function.

2.2.7 Manual Paper Advance/Rewind

To manually position the paper as desired at any time, use the advance/rewind knob on the right side of the recorder.

SECTION 3 OPERATION

3.1 GENERAL THEORY

The dc input signal to the recorder is first filtered, then amplified by the preamplifier to a level which is less susceptible to noise and interference. This conditioned signal is then applied to the pulse servo amplifier, which continuously compares it to the feedback signal developed by the servo potentiometer.

- The difference between these two signals is a positive or negative error signal that is amplified and used to drive the servo motor, which is coupled to the servo potentiometer, in a direction as to reduce the error signal to zero.
- Since the recorder pen is mechanically coupled to the servo motor and servo potentiometer, its position on the chart represents an accurate and continuous record of the input signal (See Figure 3-1).

3.1.1 Pen Drive System

A dc servo motor is used to control the servo potentiometer and recorder pen by means of a gear driven servo drum assembly.

- The pen is attached to a drive cable which is wrapped around and secured to the drum.
- As the drum rotates, the pen is moved across the chart proportionately to the amount of drum rotation.

This recorder uses a patented pulse modulated servo to achieve greater accuracy, linearity and less deadband than conventionally driven recorders.

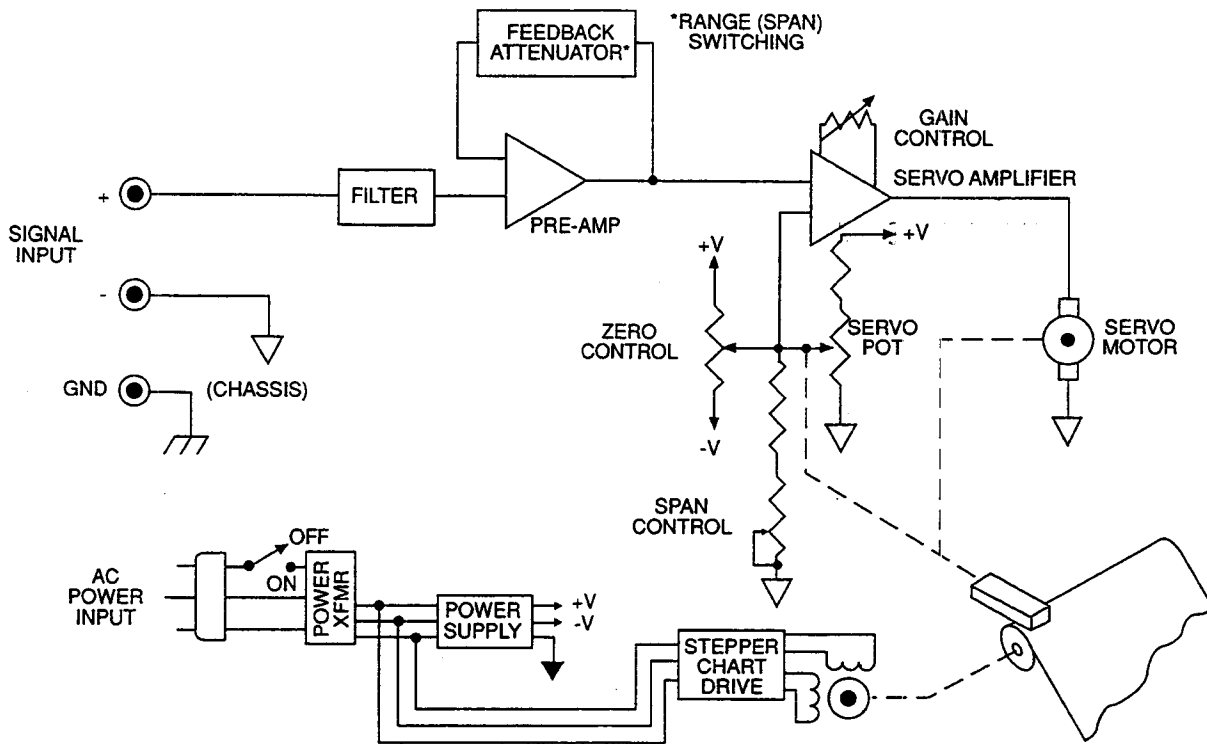


Figure 3-1. General Block Diagram

3.1.2 Chart Drive System

In this simple, reliable system, an internal crystal oscillator generates pulses which are divided by integrated circuit logic. The chart speed switch merely selects the appropriate pulse rate to drive the stepper motor at the desired speed. (The crystal frequency is not a function of line frequency, and chart speeds are therefore completely independent.)

3.1.3 DC Power Supply

Ac line voltage is reduced by stepdown transformers and converted to dc by solid state rectifiers and regulators. A stable dc voltage, generated by a voltage reference IC, is used as a reference for the servo potentiometer.

3.2 OPERATIONAL TIPS AND MAINTENANCE

- Chart paper and pens have been carefully matched for optimum writing and minimum "bleed". Substitutions could cause improper writing. Cover pen tips when not in use to prolong writing life.

NOTE

If the pen is left uncapped for long periods and dries out, revitalize it by dipping in water for a few seconds.

- Allow the recorder to warm up for about 30 minutes if high accuracy/stability recording is desired.
- For proper chart feed, apply firm tension on the paper roll and be sure the chart paper holes are properly aligned on the sprocket teeth.

- Clean the exterior surfaces of the recorder periodically by wiping with a soft, damp cloth.
- Use water to remove ink, etc.; DO NOT use solvents, as they may damage or destroy the finish.

SECTION 4 CALIBRATION

This recorder is designed to be simple, reliable, easy to maintain and repair. Therefore, the procedure presented here will be as simple, clear and brief as possible. For special problems, contact OMEGA.

4.1 POWER SUPPLY

There are no calibration adjustments in the power supply.

4.2 CHART DRIVE SYSTEM

The chart drive system has no calibration adjustments.

4.3 PEN DRIVE SYSTEM

The calibration covered in this section must be performed by a qualified technician. The technician must be aware of voltages which may cause an electrical shock.

1. PRELIMINARY SET-UP (See Figures 2-1, 2-2, 2-3 and 4-1)

- Turn the POWER switch to OFF.
- Set the REC/STBY switch to STBY.
- Turn the mV/V switch to V.
- Set the INPUT RANGE (Span) switch to 5.
- Turn the Chart MIN/OFF/HR switch to OFF.
- Set the CHART SPEED switch to 10.
- Remove the bottom cover retaining screws (7), to allow access to the calibration adjustments.
- Set all (3) internal adjustment potentiometers (pots) to mid-range.
- Set the front panel CAL pot to full counterclockwise.
- Check that the jumper is installed between the CHART PROG and OSC OUT terminals on TB1 on the bottom cover.

2. WARM-UP PROCEDURE

- Complete Step 1, Preliminary Set-Up, before beginning the warm-up procedure.
- Install paper and pen (if not previously done).
- Connect the power cord to a suitable power source. Turn the recorder ON.
- Allow a minimum warm-up time of 30 minutes before proceeding with calibration.
- Set the pen DOWN with pen lever.
- Adjust pen to approximately mid-scale using the ZERO control.
- Set chart MIN/OFF/HR switch to MIN.

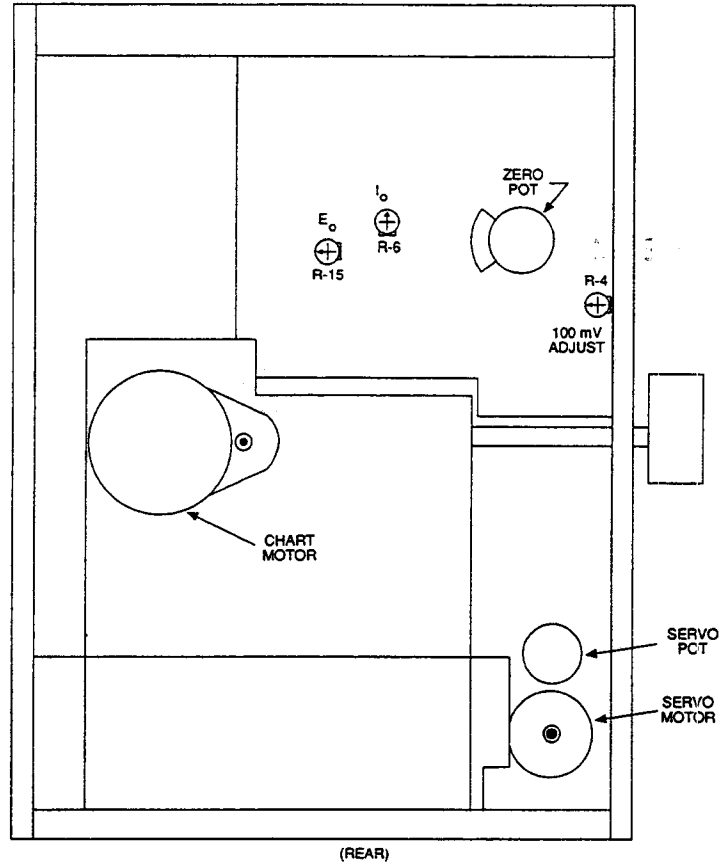


Figure 4-1. Calibration Controls

3. GAIN (See Figure 3)

The gain adjustment controls the servo loop gain, or "deadband", of the recorder. If set too high, the pen will "buzz". If set too low, the pen will be sluggish.

- a. Adjust the GAIN control (R-14) on the servo PCB clockwise until the pen "buzzes". Then turn the control counterclockwise until the "buzzing" just stops; add 1/16 turn.
- b. Recheck the adjustment by moving the pen over the full scale using the ZERO control. If the pen "buzzes" at any point, turn the GAIN control counterclockwise until the "buzzing" stops.

4. OFFSET (See Figure 5)

This adjustment reduces the zero shift between input ranges (spans) to a minimum value. Performing this adjustment requires you to switch the recorder input between a short and a high resistance.

- a. Perform Steps 1, 2 and 3 of the Calibration Procedure before making the Offset adjustments.
- b. Short the (+) and (-) input terminals on the rear panel.
- c. Set the REC/STBY switch to REC.
- d. Set the mV/V switch to mV.
- e. Set the pen to 50% on the chart using the ZERO control.
- f. Set the INPUT RANGE switch to 1.
- g. Return the pen to the setting in step "e" (50%) using the Eo (R-15) pot on the Control Panel PCB.

- h. Set the mV/v switch to V.
- i. Reset the pen to the setting in Step "g" (50%) using the Io (R-6) pot on the Control Panel PCB.
- j. Set the INPUT RANGE switch to 5.
- k. Repeat Steps "d" through "j" until minimum ($\pm 0.5\%$ maximum) pen movement is achieved.
- l. Set the INPUT RANGE switch to 1.
- m. Set the mV/V switch to mV.
- n. Set the pen to zero on the chart using the ZERO control.
- o. Remove the short from the (+) and (-) input terminals.

5. SPAN (RANGE) CALIBRATION (See Figures 1 and 5)

This provides adjustment of the recorder so that a calibrated full scale input signal will move the pen up to the full width of the chart.

- a. Perform Steps 1 through 4 of the Calibration Procedure before attempting to perform range calibration.
- b. Connect a 0.1% accuracy dc millivolt source to the (+) and (-) signal input terminals on the rear panel.
- c. Connect a Digital Voltmeter (DVM) to the Servo PCB connector P-1, Pin 1 (+) and Pin 4 (-). Set to the 200 mV range or equivalent.
- d. Reset the pen to zero $\pm 0.1\%$ with the ZERO control.
- e. Input a 1 mV $\pm 0.1\%$ signal and record the reading on the DVM (approximately 100 mV).
- f. Set the INPUT Range switch to 100.
- g. Reset the pen to zero $\pm 0.1\%$ using the ZERO control.
- h. Input a 100 mV $\pm 0.1\%$ signal and adjust R-4, on the Control Panel, for the same DVM reading obtained in Step "e".
- i. Adjust the CAL pot (R-26) on the Front Panel for a pen setting of $100 \pm 0.1\%$ on the chart.
- j. Set the REC/STBY switch to STBY.
- k. Remove the DVM.
- l. Set the REC/STBY switch to REC.
- m. Check all the other input ranges with appropriate inputs to insure range tracking calibration of $\pm 0.25\%$.
- n. Set the REC/STBY switch to STBY.
- o. Turn the recorder OFF and disconnect the power cord from the power source.
- p. Disconnect the dc millivolt source from the (+) and (-) input terminals.
- q. Carefully reinstall the bottom cover on the recorder.

The recorder is now calibrated and ready for normal recording.

SECTION 5 TROUBLESHOOTING

The modularity and simplicity of this recorder make it possible to isolate the problem area in many cases. Once you have done this, a quick call to OMEGA will provide needed advice or replacement parts.

While it is impossible to think of every problem possibility, the following chart will give you suggestions on how to solve the most common recorder problems.

5.1 ANALOG SECTION

SYMPTOM

Pilot light does not light and recorder inactive.

PROBABLE CAUSE

1. Ac power source disconnected
2. Fuse(s) blown (inside).
3. Conversion switch in wrong position

REMEDY

1. Connect ac power source.
2. Replace fuse(s)
3. Check switch (inside).

Pilot light is on, but recorder is inactive.

1. Signal input leads disconnected
2. Gain set too low
3. Defective pulse servo PCB
4. Defective servo motor
5. Connectors on control panel not connected

1. Check input connections.
2. Adjust gain. Access hole on bottom.
3. Replace pulse servo PCB.
4. Contact OMEGA.
5. Remove bottom cover and reconnect.

Excessive deadband

1. Gain set too low
2. Excessive common-mode signal
3. Recorder ground not connected to signal source ground
4. Pen drive cable too loose
5. Pen carriage dragging on slide rod

1. Adjust gain. Access hole on bottom.
2. Connect ground terminal to common-mode source.
3. Provide common ground for 3rd wire in power cords.
4. Contact OMEGA.
5. Contact OMEGA.

Noise on pen trace

1. Noisy input signal
2. Extremely noisy power line
3. Gain too high
4. Recorder ground not connected

1. Check signal source.
2. Check power line.
3. Adjust gain. Access hole on bottom.
4. Provide common ground for 3rd wire in power cords.

SYMPTOM	PROBABLE CAUSE	REMEDY
Pen trace has isolated steps.	<ol style="list-style-type: none"> 1. Pen carriage slide rod dirty 2. Pulse servo gain too low 3. Defective servo motor 4. Defective servo potentiometer 	<ol style="list-style-type: none"> 1. Contact OMEGA. 2. Adjust gain. Access hole on bottom. 3. Contact OMEGA. 4. Contact OMEGA.
Pen will stop moving but will catch up if physically pushed.	<ol style="list-style-type: none"> 1. Defective servo motor 	<ol style="list-style-type: none"> 1. Contact OMEGA.
Pen writes poorly.	<ol style="list-style-type: none"> 1. Ink supply depleted 2. Pen tip dried out 	<ol style="list-style-type: none"> 1. Replace pen. 2. Revitalize by dipping in water for a few seconds.

5.2 CHART DRIVE SECTION

SYMPTOM	PROBABLE CAUSE	REMEDY
Chart drive inoperative	<ol style="list-style-type: none"> 1. Loose or defective connections 2. Missing jumper 3. Defective chart drive motor 4. Defective stepper chart drive circuit 5. Gear train binding 	<ol style="list-style-type: none"> 1. Check stepper/control panel connections. 2. Install between OSC OUT and CHART PROG on TB1. 3. Contact OMEGA. 4. Contact OMEGA. 5. Contact OMEGA
No chart drive in a particular chart speed	<ol style="list-style-type: none"> 1. Defective component on circuit board 	<ol style="list-style-type: none"> 1. Contact OMEGA

SECTION 6 SPECIFICATIONS

6.1 SPECIFICATIONS

GENERAL

1. Number of Channels: One
2. Chart Width: 100mm Writing Width

- | | |
|----------------------------|-------------------------------------------------------------------------------------------------------------------|
| 3. Writing Method: | Disposable fiber tipped pen with self contained ink supply |
| 4. Accuracy: | Deadband: less than $\pm 0.1\%$.
Linearity: less than $\pm 0.5\%$.
Repeatability: less than $\pm 0.1\%$. |
| 5. Zero Adjust: | Continuous +100% to -100% |
| 6. Power Requirements: | 115/230 Vac $\pm 10\%$, 50/60 Hz,
Single phase |
| 7. Wattage: | 17.5 watts max |
| 8. Fuse: | 115 vac - 3AG Slo-Blo 0.3a (2)
230 Vac - 3AG Slo-Blo 0.15a (2) |
| 9. Line Filter: | Grounded electrostatically shielded power transformer |
| 10. Weight: | 6.5 lbs. (3Kg) |
| 11. Dimensions: | 8.6" (21.9cm) W (incl. knob) x 4.4"
(11.2cm) H x 10.5" (26.7cm) D |
| 12. Accessories Furnished: | Pen(s); One roll chart paper;
Operators Manual; Paper Feed Spool;
Two 0.15a Fuses (230 Vac operation) |

SERVO SYSTEM

- | | |
|-------------------------|--------------------------------------------------------------------------------------------------------|
| 1. Pen Drive: | Patented (U.S. Patent No. 4,146,828)
Pulse Modulated System |
| 2. Input Type: | Single Ended, Floating |
| 3. Input Impedance: | 2.5 megohms, fixed |
| 4. Input Filtering: | Filters noise above 3 Hz |
| 5. Full Scale Response: | Less than 0.4 seconds |
| 6. Full Scale Spans: | 12 switch selectable:
(Ranges) 1mV, 10mV, 100mV, 1V
2mV, 20mV, 200mV, 2V
5mV, 50mV, 500mV, 5V |
| 7. Overshoot: | None. System critically damped |
| 8. Zero Shift Tempco: | Less than 0.1% per degree C |

- | | |
|----------------------------|--------------------------------------------------|
| 9. Calibration: | Front panel all ranges (with external reference) |
| 10. Overrange Protection: | Approximately 6 seconds after + or - overrange |
| 11. Override Event Marker: | Standard — Approximately $\pm 4\%$ spike |
| 12. Pen Lift: | Manual external lever |

CHART DRIVE SYSTEM

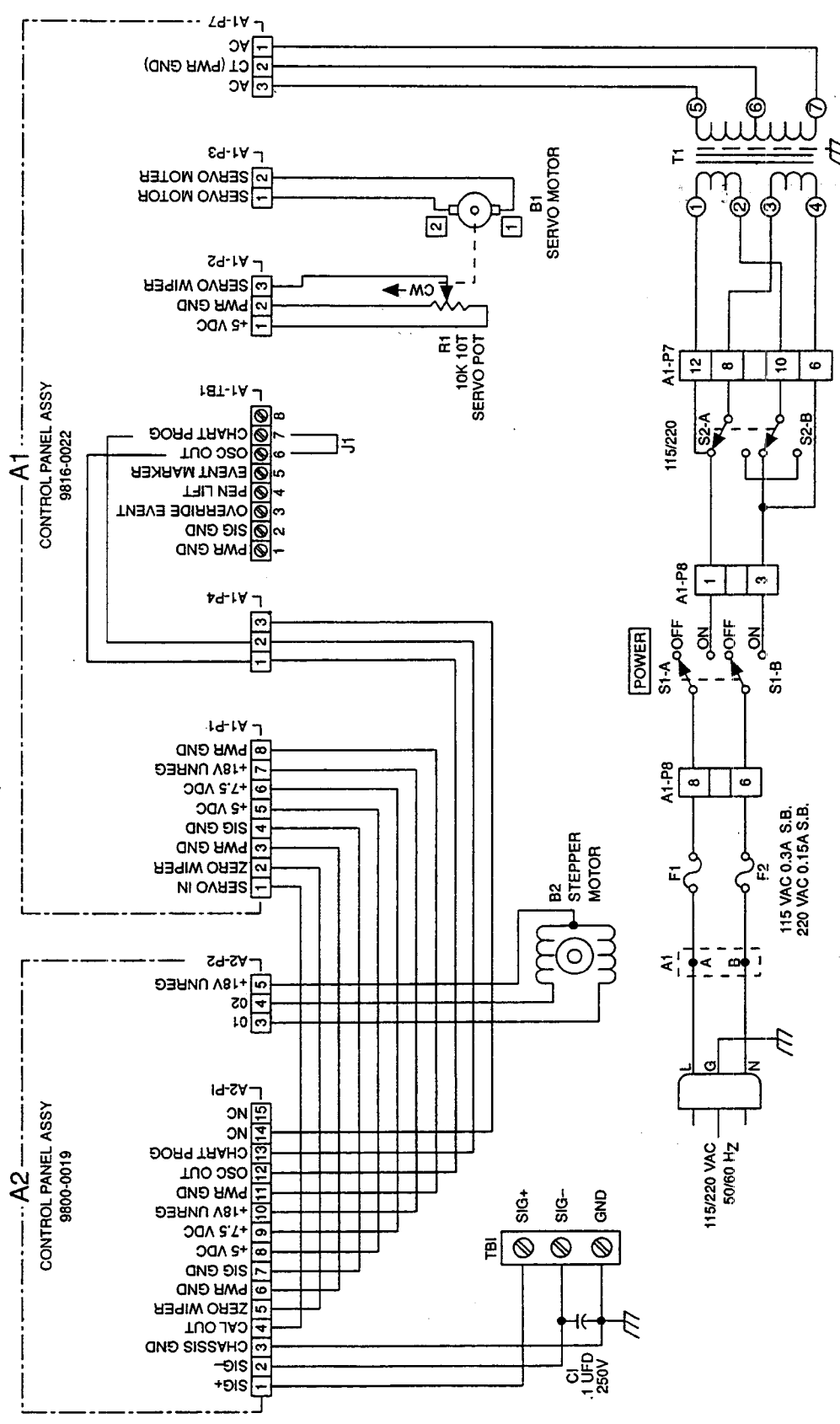
- | | |
|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Chart Drive: | Two phase stepper motor |
| 2. Chart Speeds: | 16 switch selectable metric: 1, 2, 3, 6, 10, 15, 20 and 30 cm/min and cm/hr.
Note: Chart speeds are whole number reciprocals to facilitate use in sec/cm and min/cm ranges. |
| 3. Chart Speed Accuracy: | Greater than 99.97%. |
| 4. Chart Programming: | Contact closure of TTL/CMOS |
| 5. Paper Reverse: | Manual external knob |

6.2 ACCESSORIES

CHART PAPER	PART NO.
Paper, 100mm Chart, Roll	0100-0011
PENS	
Pen, Short, Green	0100-0108
Pen, Short, Black	0100-0107
Pen, Short, Red	0100-0106
Pen, Short, Blue	0100-0105

6.3 REPLACEMENT PARTS

Pulse Servo PCB Assembly	9816-0022
Control Panel PCB Assembly	9800-0019
Spring, Pen Carriage	9001-0385
Cable, Pen Drive	6030-0001
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