ORESU-H-80-001

OPERATIONS MANUAL

TIDE GUAGE SYSTEM

MOD. SL - 1A

November 1980

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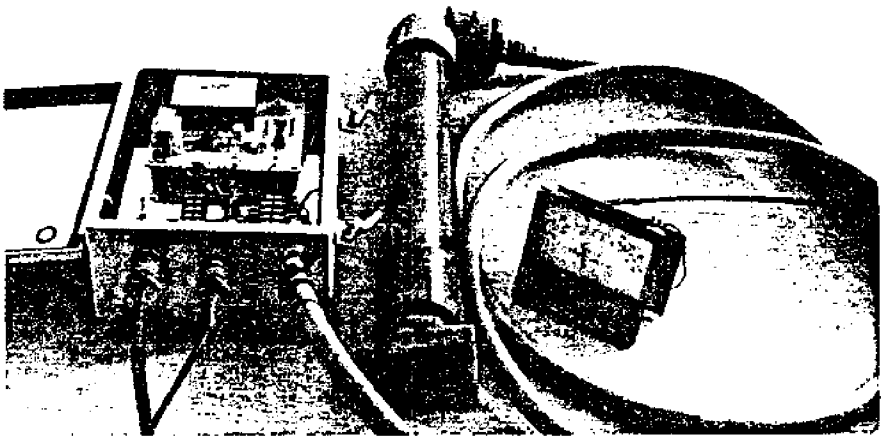
This work was supported by the National Oceanic and Atmospheric Administration's Sea Grant College Program under grant NA 79 AA-D-00106 to Oregon State University

INTRODUCTION

The Model SL-1A tide guage system was developed by Oregon State University for the U.S. Coast Guard so that several 13th Coast Guard District stations can have direct readout of tide level on the communicator's panel for their own operational use and for reporting to National Weather Service storm-surge forecasters in scheduled weather reports.

The tide guage is a Heathkit® Mod. MI-1031 fathometer, modified to produce an output voltage proportional to water depth. The transducer and electronics unit are mounted on the boatdock float; the output signal is transmitted via landline to a meter display on the communicator's panel. An adjustment in the electronics unit permits the meter to be read in sea level height relative to Mean Lower Low Water (ft.).

The submerged transducer unit should be kept free of marine growth by periodic cleaning; no other routine servicing is required.



Model SL-1A System

THEORY OF OPERATION

The electronics unit generates a 0.8 ms pulse of 200KHz energy 60 times per second, and the pulses enter the seawater thru the barium titanate transducer which is aimed at the seabed. Since the pulse travels at about 4,800 ft./sec. in seawater, and succeeding pulses must not overlap at the transducer, the maximum range of the system is about 40 ft. For 13th District stations, the maximum tide height, including storm surge, is less than +15 ft. MLLW; therefore, the system can be installed at any float location where the seabed is no deeper than about -20 ft. MLLW.

The transmitted pulse is reflected from the seabed, returns to the transducer, is amplified and then rectified and smoothed. Travel time (depth) is determined by a flip-flop which is turned on by the transmitter pulse and turned off by the received pulse. The flip-flop output is averaged and amplified in an operational amplifier which also has a bias adjustment to compensate for the seabed depth below MLLW. The op-amp output drives the display meter directly.

For readout stability, all circuits are supplied from well-regulated power supplies which are in turn driven by standard 110v., 60HZ, 1Ø commercial power.

EQUIPMENT

TRANSDUCER

The barium titanate transducer is housed in a threaded cast brass holder. The unit is attached to the dock float by means of a water-tight PVC pipe and fitting arrangement, Fig. 1, to protect both the sensor and its coax feed cable. The transducer unit has no adjustments and requires no servicing other than an occasional cleaning of the transducer face (growth on the face reduces effective transmitter power).

ELECTRONICS UNIT

Fig 2 is the electronics panel mounted in its enclosure; Figs 3a and 3b show the front and rear of the electronics panel. Electrical connections to the power source, the transducer and the display unit are at the bottom of the enclosure and are connected to the circuitry through two barrier strips on the electronics panel.

DISPLAY UNIT

Figs 4a and 4b shows the display meter that is to be mounted in the communicator's panel. A gain-adjust rheostat is mounted behind the meter, and is set during system calibration.

Fig 1

Transducer Housing

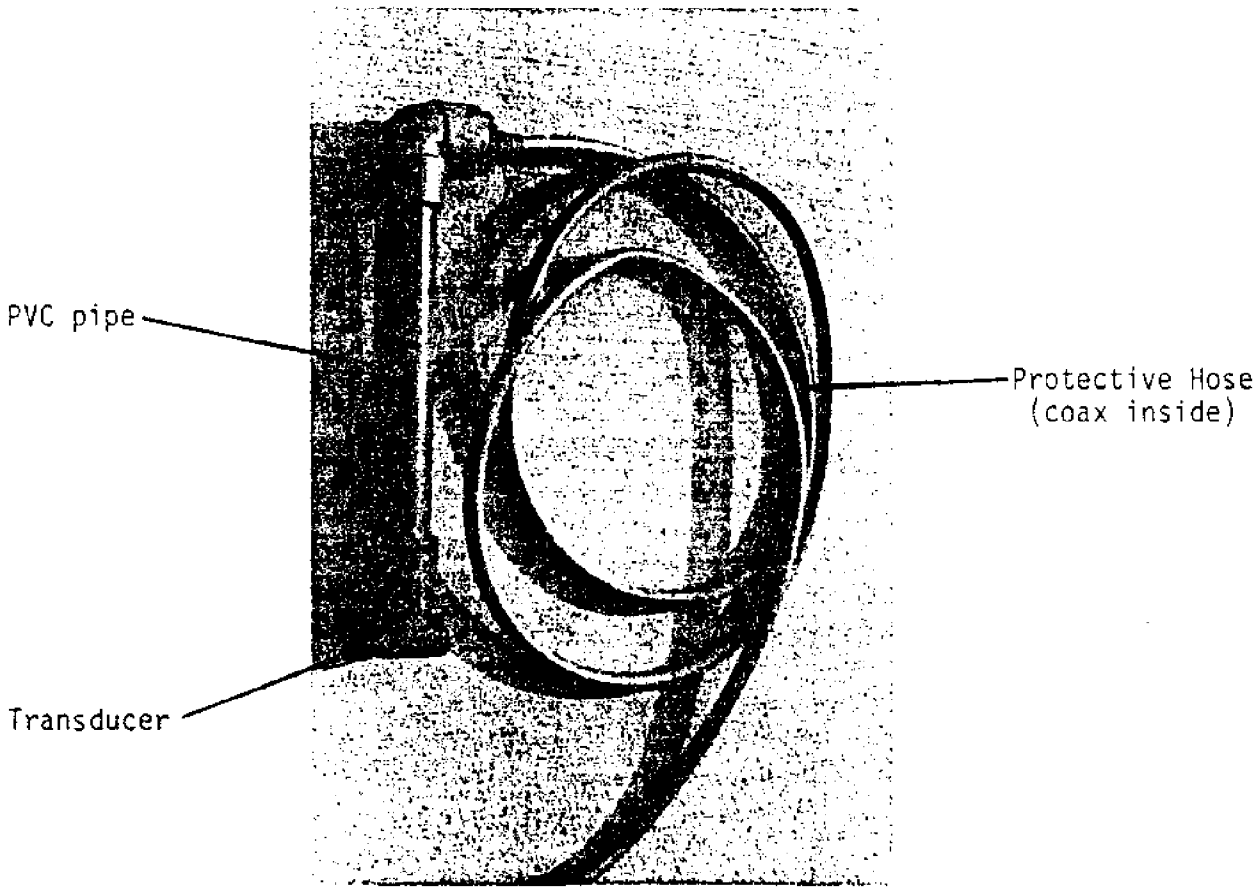
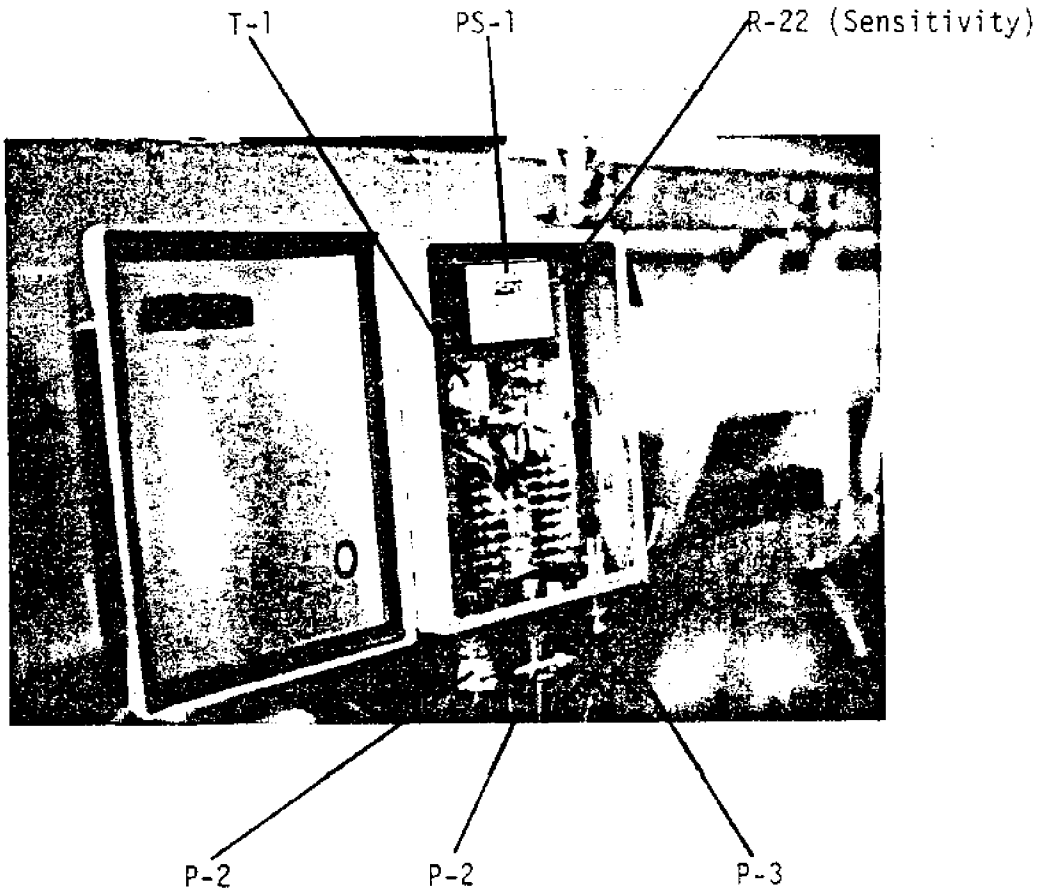
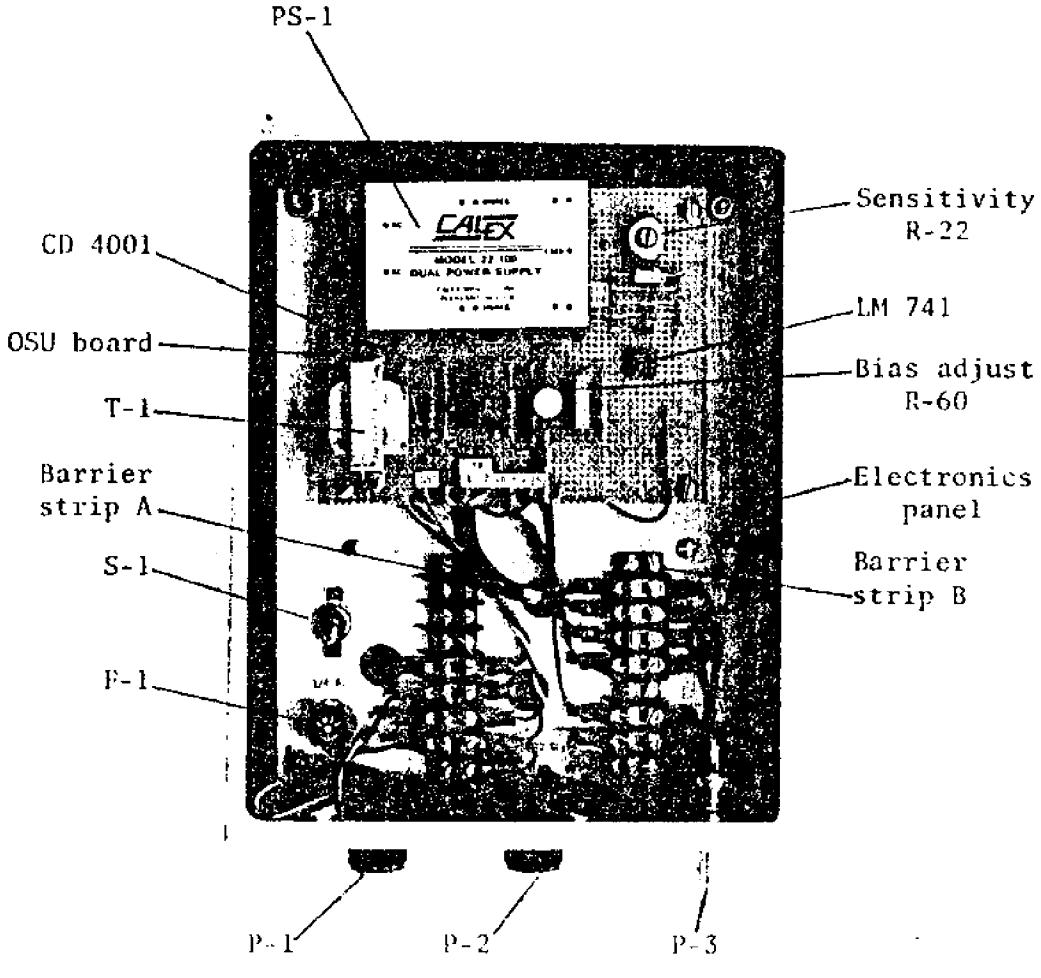


Fig 2

Electronics Unit Mounted in Enclosure

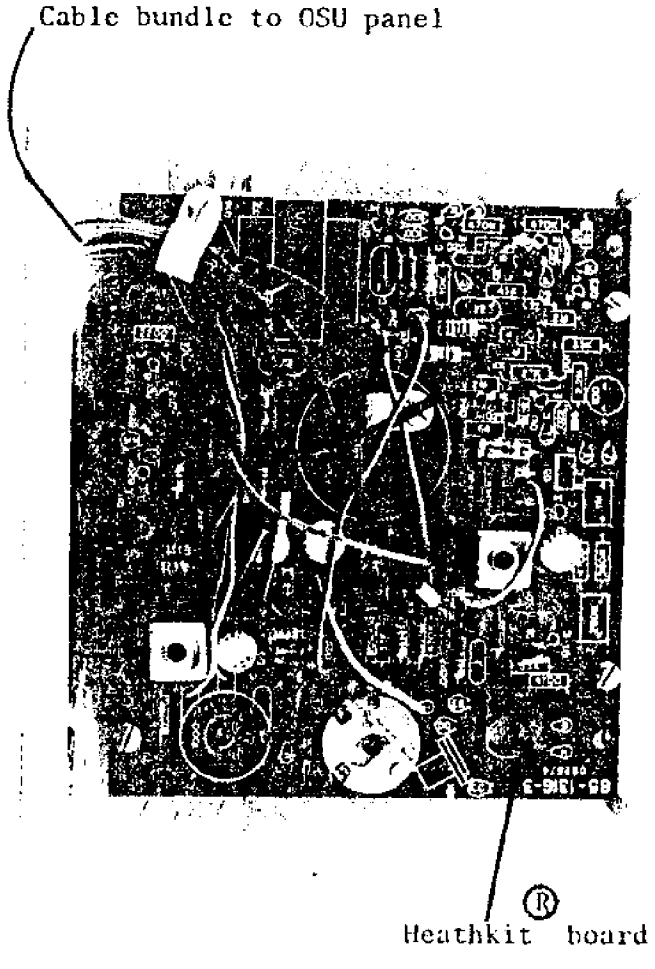




ENCLOSURE AND FRONT SIDE OF

ELECTRONICS PANEL

Fig. 3A



REVERSE SIDE OF

ELECTRONICS PANEL

Fig. 3B

Fig 4a

Front of Display Unit

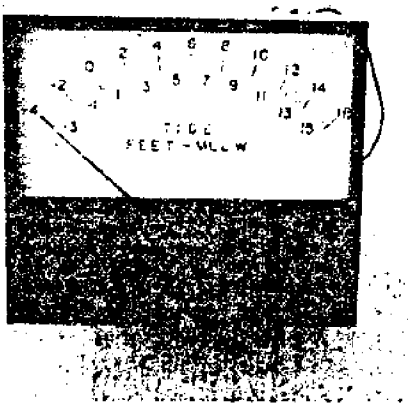
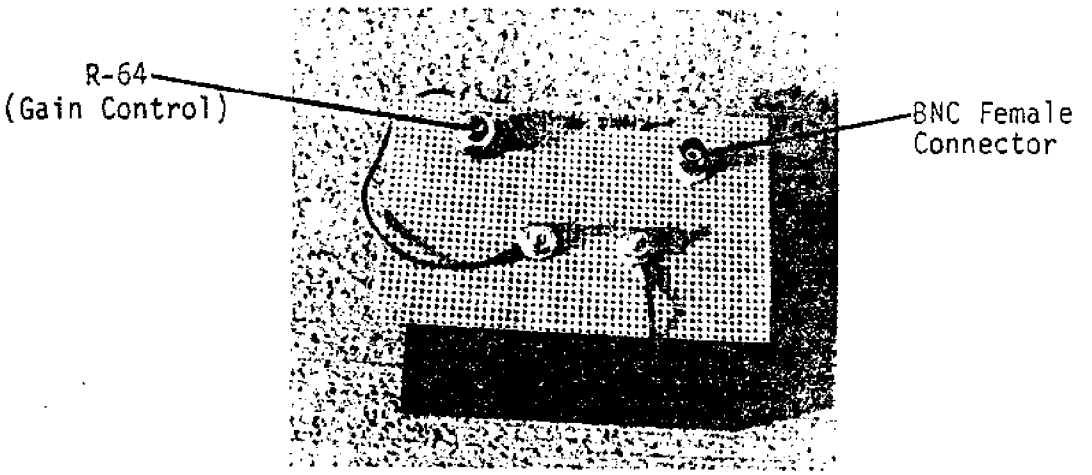


Fig 4b

Rear of Display Unit



INSTALLATION

TRANSDUCER UNIT

The protective PVC mounting for the transducer is attached to the float by four lag screws, and the position of the unit adjusted so that the transducer face is about one foot below the water surface. The coax feed cable is fed thru a protective 20 ft. coil of 3/4 inch garden hose to the electronics unit, to allow for float movement relative to the dock ramp.

ELECTRONICS UNIT

The electronics unit is normally mounted near a commercial power box on the ramp leading to the float, and as near as possible to the transducer unit. Four 1/4 in. mounting holes are provided in the enclosure for attachment to the ramp. Feed the power connector cable (P-1) to a commercial 110v, 60 Hz, 1Ø power socket; attach the transducer coax BNC, P-3, to the BNC connector at the bottom of the enclosure. Feed the P-2 coax to the nearest landline terminal box, and attach the two ends to an assigned pair, designating "ground" to the appropriate wire at the terminal block.

DISPLAY UNIT

Install the meter in an appropriate spot in the comm. panel; feed the RG-58U coax cable from the landline terminal box to the meter board mounted behind the meter and mate the BNC connectors provided. Connect the two leads at the terminal box to the assigned pair. Observe polarity of the landline; one wire must be designated "ground" from the meter all the way back to the electronics unit.

CALIBRATION

To calibrate the unit, determine 1) the depth of the seabed below the float with a leadline and 2) the tide level at that time (from local tide table or NOS guage). Turn power switch S-1 ON. With multimeter on 2 volt or greater scale, set R60 so that the negative BIAS VOLTAGE at TP-4 on the OSU board is:

-[Depth at float (ft.) - Tide level (ft.)] X .12 = BIAS VOLTAGE

[If depth at float is 14 ft, tide height is + 4 ft MLLW, V=-(14-4).12 =-1.2v.]

With oscilloscope (sweep 2ms/cm, vert. gain 5v./cm), observe RECEIVER OUTPUT at TP-2 on the OSU board; adjust SENSITIVITY CONTROL, R22 on the OSU board so that a steady +8.5v. pulse is obtained (lo gain will give intermittent received pulses, too high gain will give spurious pulses walking thru steady received pulse). Note that the transmitter pulse is not seen at TP-2 because of the blanking circuit on the Heathkit® board. Time from leading edge of transmit pulse to leading edge of received pulse is t(ms.)=.4 x depth (ft.), or depth (ft.) = 2.4 x t (ms.).

Leave the circuit in operation, close and latch the enclosure and go to the display meter at the comm. panel. Adjust GAIN CONTROL, R-64, to give proper tide level reading on the meter.

This completes the calibration sequence. Observe operation of the system for several days at various tide levels, and adjust GAIN CONTROL slightly, if required.

OPERATION

Once the calibration cycle is completed and the enclosures secured, tide readings may be taken directly from the display meter without further attention to the electronics.

SERVICING

The transducer underwater face and cast housing should be cleaned of marine growth as needed, to assure consistent system operation. Development testing has shown that cleaning every three months is necessary, and a monthly cleaning is desirable. The system electronics require no routine servicing.

TROUBLE SHOOTING

Fig. 5a is the wiring diagram of the electronics unit, Fig. 5b is the wiring diagram for the OSU board and Fig. 5c is the wiring diagram of the modified Heathkit® board. Table I lists field replaceable components not identified on the schematic; Table II is a trouble-shooting guide for field maintenance. Trouble shooting requires a multimeter and any low frequency (1MHz bandwidth) oscilloscope with adjustable sweep speed.

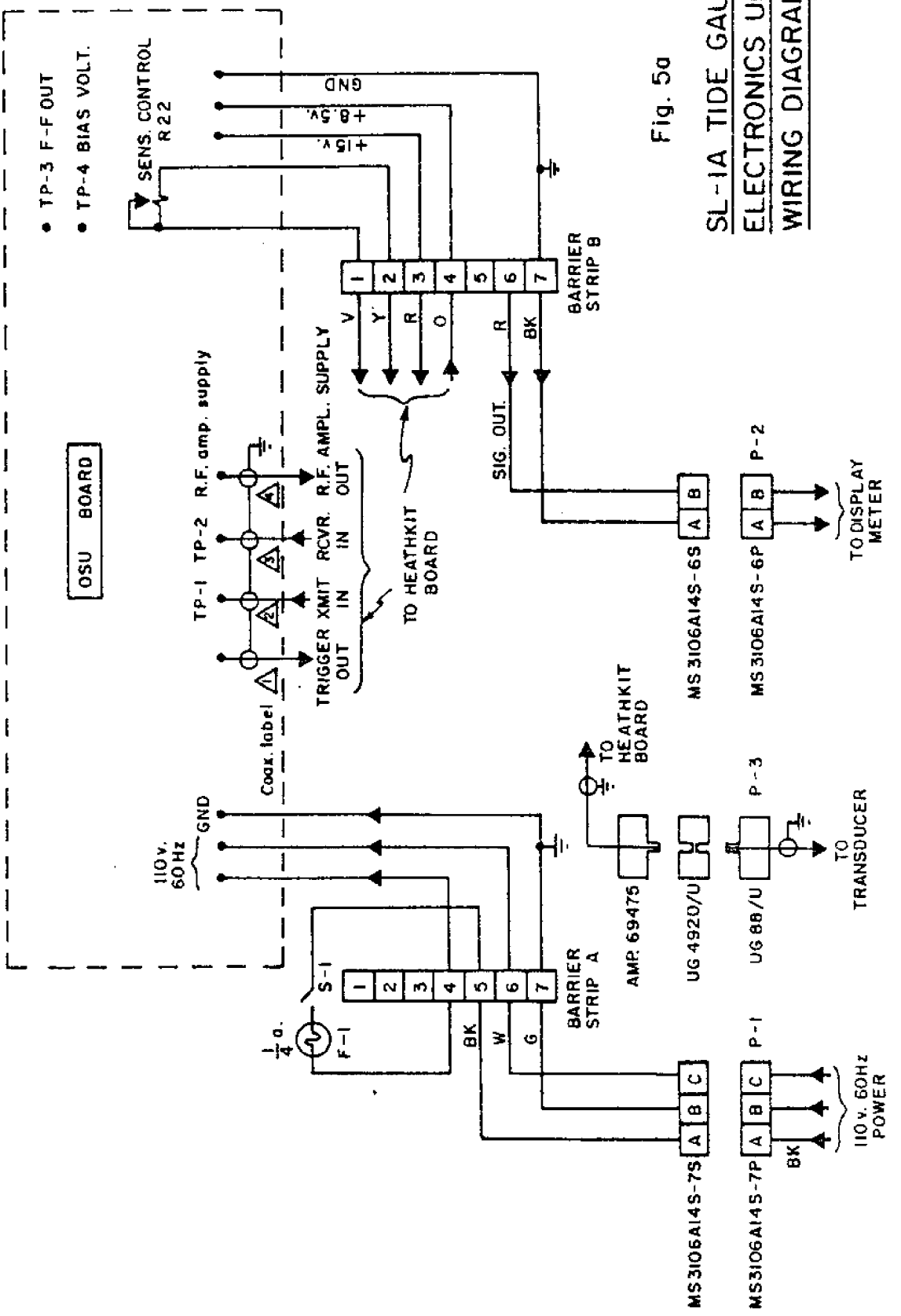
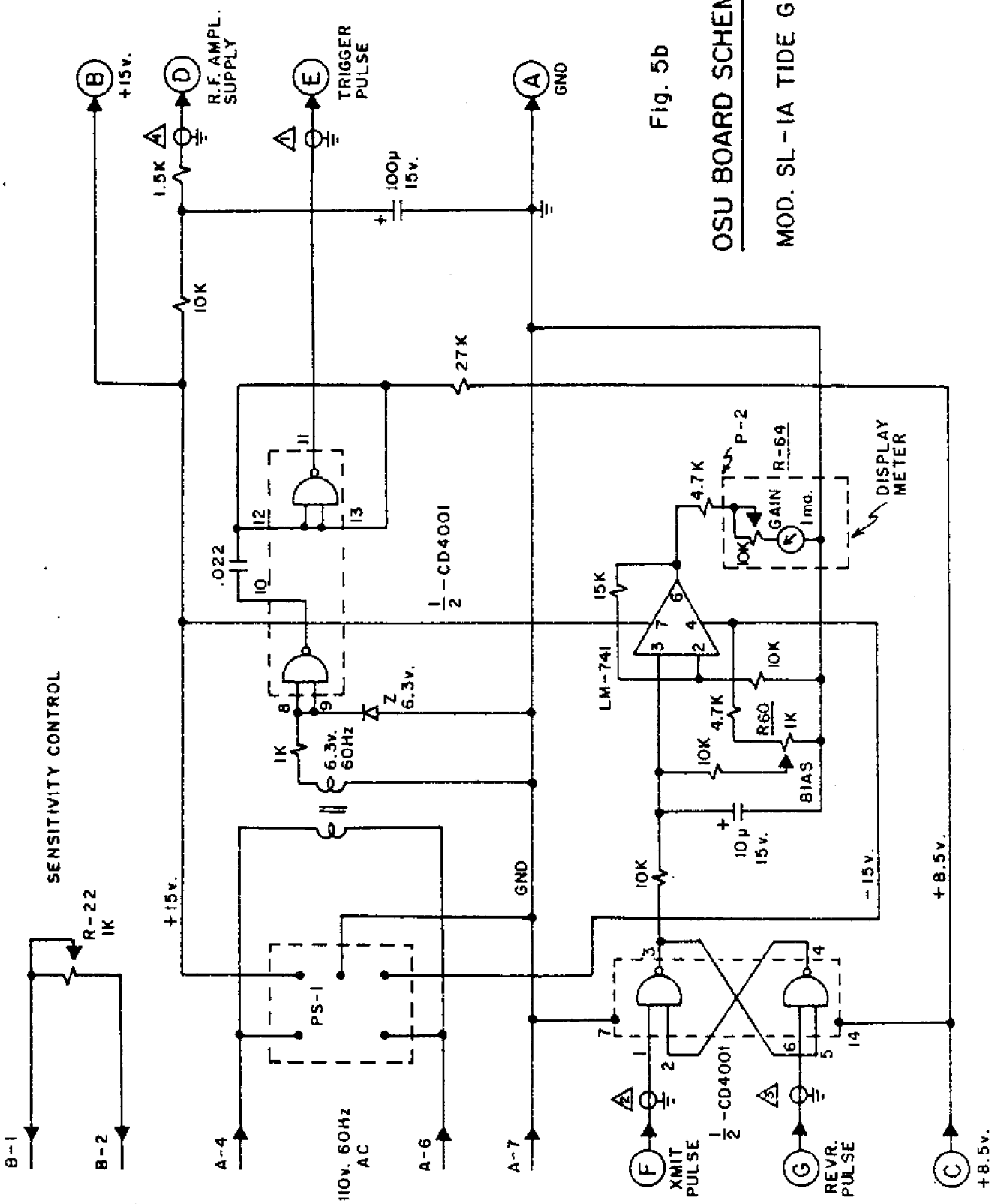
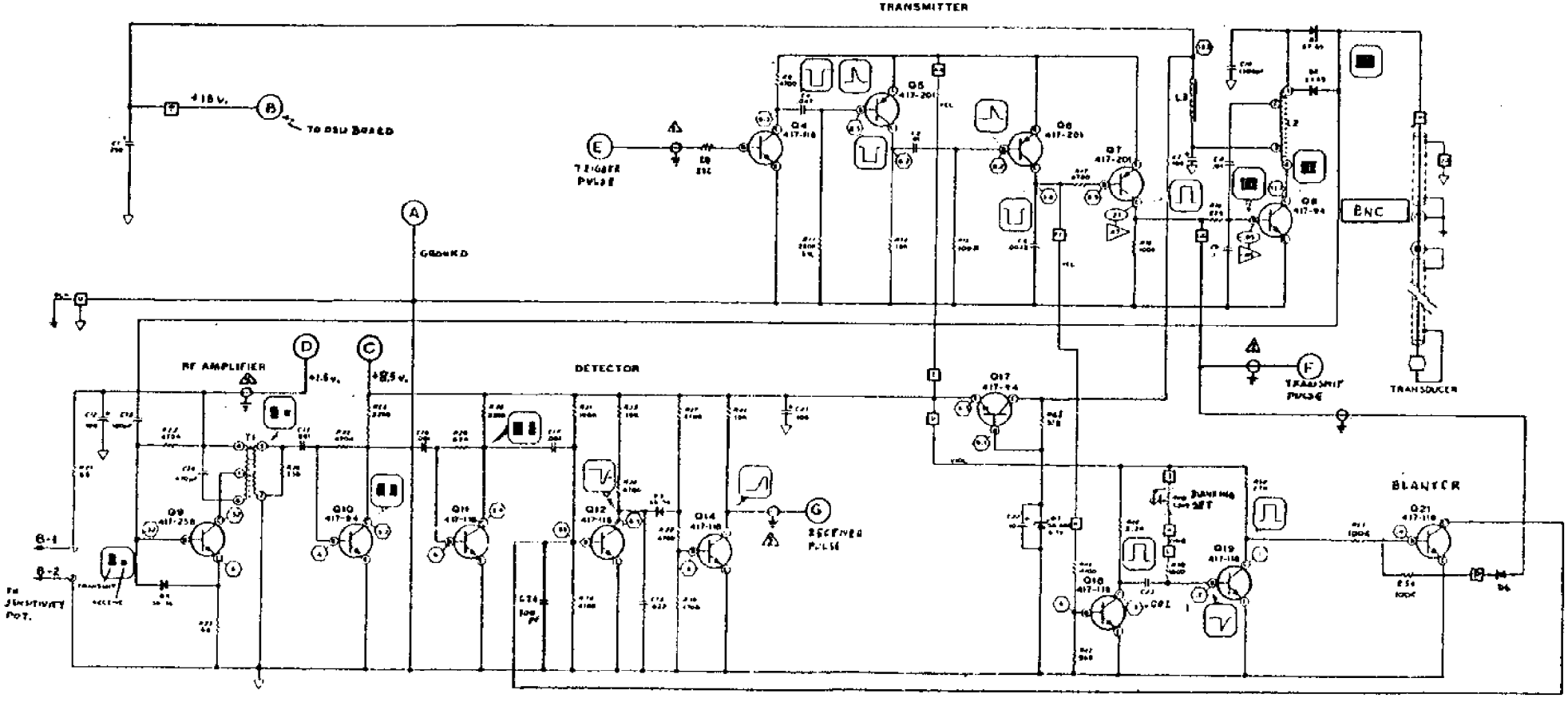


Fig. 5a

SL-1A TIDE GAUGE
ELECTRONICS UNIT
WIRING DIAGRAM


OSU BOARD SCHEMATIC
MOD. SL-1A TIDE GAUGE
Fig. 5b
B +15v.
D R.F. AMPL. SUPPLY
E TRIGGER PULSE
A GND
1.5K
100µ 15v.
10K
27K
.022
1/2 - CD4001
4.7K
P-2
R-64
GAIN
1 ma.
DISPLAY METER
15K
LM-741
10K
4.7K
R60
1K
BIAS
10µ 15v.
Z 6.3v.
1K
6.3v. 60Hz
SENSITIVITY CONTROL
R-22 1K
+15v.
GND
-15v.
+8.5v.
PS-1
B-1
B-2
A-4
A-6
A-7
110v. 60Hz AC
1/2 - CD4001
F XMIT PULSE
G REVR. PULSE
C +8.5v.



MODIFIED

SCHEMATIC OF THE HEATHKIT® MODEL MI-1031 DELUXE DEPTH SOUNDER

FOR USE AS A

TIDE GUAGE

Fig. 5c

SCHEMATIC NOTES

1. ALL RESISTORS ARE 1/2 WATT UNLESS MARKED OTHERWISE. RESISTOR VALUES ARE IN OHMS (K = 1000, M = 1,000,000).
2. ALL RESISTORS ARE 10% UNLESS MARKED OTHERWISE.
3. ALL CAPACITOR VALUES ARE IN µf UNLESS MARKED OTHERWISE.
4. REFER TO THE CHASSIS PHOTOGRAPH AND CIRCUIT BOARD X-RAY VIEW FOR THE PHYSICAL LOCATION OF PARTS.
5. ▽ THIS SYMBOL INDICATES A GROUND CONNECTION.
6. THE FOLLOWING SYMBOLS INDICATE A DC VOLTAGE MEASUREMENT TAKEN WITH A HIGH IMPEDANCE VOLTMETER. ALL VOLTAGE MEASUREMENTS WERE TAKEN WITH ONLY A ZERO FLASH AND RETURN FLASH ON THE DIAL, THE SENSITIVITY CONTROL AT MINIMUM, THE ALARM CONTROL AT MINIMUM, AND WITH AN INPUT SUPPLY VOLTAGE OF 25.8 VDC. VOLTAGES MAY VARY ±20%.
   - ⬭ VOLTAGE TAKEN WITH RANGE SWITCH IN 40 MODE.
   - ▷ VOLTAGE TAKEN WITH RANGE SWITCH IN 240 MODE.
   - ○ VOLTAGE TAKEN WITH RANGE SWITCH IN EITHER 40 OR 240 MODE.
7. ⎍ THIS SYMBOL INDICATES THE APPROXIMATE WAVEFORM TO BE SEEN WITH AN OSCILLOSCOPE AT THE POINT INDICATED.
8. ⬠ THIS SYMBOL INDICATES A DIRECT ELECTRICAL CONNECTION WITH ANOTHER POINT HAVING THE SAME LETTER(S) AND IN THE SAME DIRECTION SHOWN BY THE ARROW.
9. ⊢ THIS SYMBOL INDICATES CLOCKWISE ROTATION OF A CONTROL WHEN VIEWED FROM THE KNOB END.
10. - - - THIS LINE REPRESENTS A MECHANICAL CONNECTION BETWEEN THE POINTS INDICATED.
11. □ THIS SYMBOL INDICATES A LETTERED CIRCUIT BOARD CONNECTION POINT.

TABLE I

COMPONENT LIST

Tide Guage SL-1A

(not identified on schematic)

Enclosure, JIC	Hoffman, A1008CHAL
Transducer	Heath, 473-6
M-1, Meter	API/LFE, 1ma., N500030000
PS-1, Power supply	CALEX Mod. 22-100, ± 15 v. regulated @ 100 ma.
T-1, Transformer	110v./6.3v. @ .3a. Allied, 502-0100
IC-1	Fairchild, CD4001
IC-2	Fairchild, UA741
R-22, 1K Pot.	Ohmite, CLU1021
R-64, 10K Pot.	Ohmite, CLU1031
Q4, 11, 12, 14, 18, 19, 21	2N3393
Q5, 6, 7	X29A829
Q8, 10, 17	2N3416
Q9	TIS87
D2, 3	IN 4002
D4, 5, 6	IN 4149

TABLE II

TROUBLE-SHOOTING GUIDE

Tide Guage SL-1A

SYMPTOM	CHECK
Display meter reading -	Meter polarity reversed, bias setting too high (TP-4), blanker circuit (Q-21) inoperative, no transmitter pulse (TP-1), transducer cable not connected or shorted, no trigger pulse (⚠), CD 4001 failed
Offscale left	
Offscale right	bias setting too low (TP-4), receiver inoperative (TP-2) Q-9 thru Q-14
Meter at mechanical zero	P-1 not connected, F-1 blown, S-1 off, PS-1 failed (no ± 15v., or +8.5v.), meter or landline cable or P-3 open/not connected, LM 741 failed
Meter readings high or low	check bias setting (TP-4), redo calibration procedure
No trigger pulse at ⚠	S-1 off, F-1 blown, CD 4001 failed, P-1 not connected, PS-1 failed
No transmitter pulse at TP-1	no trigger pulse at ⚠, Q-4 to Q-8 failed, PS-1 failed
No receiver pulse at TP-2	no transmitter pulse at TP-1, Q-9 to Q-14 failed, transducer not connected or not pointing at seabed, Q-21 shorted
No flip-flop output at TP-3	no transmitter pulse at TP-1, no receiver pulse at TP-2, CD 4001 failed
Transmit/receive pulses OK, but TP-3 flip-flop output is constant at ~ 1 ms.	blanker circuit Q-18, Q-19 inoperative (residual transmit trailing edge turns CD 4001 off prematurely)
No output from LM 741 meter ampl.	LM 741 failed, PS-1 failed, P-1 not connected, S-1 off, F-1 blown
No ± 15v. supply	PS-1 failed or shorted, P-1 not connected, S-1 off, F-1 blown
No + 8.5v. supply	PS-1 failed or shorted, P-1 not connected, S-1 off, F-1 blown, Q-17 failed
No bias voltage (TP-4)	R-60 at bottom, -15v. supply failed (PS-1)
No gain control with R-64	Display meter circuit open/short (landline open, P-2 not connected, landline shorted)