UT "X"-2100A
Ultrasonic Measuring System

Installation and Operation Manual

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Rev. 1.0
July 1990
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</table>
Many people do not read this entire manual, and much of it can be reserved for reference. However, before installing the equipment in the field, connect the power as per page 30, plug the transducer into its connector behind the main panel, and proceed to the calibration section on page 34.

Familiarizing yourself with this procedure, and testing the equipment after it has been through shipment, can prevent difficulties in the field, save a lot of time, and produce optimal performance.
1.1 INTRODUCTION

The TN/Manning UT"X"-2100A family of wastewater level and flow ultrasonic measuring instruments consists of:

1. UTL-2102A Level Transmitter
2. UTF-2102A Flow Transmitter
3. UTC-2102A Flow Recorder and Totalizer

Enclosures conform to NEMA-4 specifications with a full window in the door for visual monitoring of readouts.

The instruments utilize solid state digital CMOS circuitry for reliability, accuracy, and noise immunity.

The transducer can be installed above any open channel flume, pipe, storage tank, etc., space permitting, where flow or level data is required. Figure 1-1 shows the relationship of the instruments in building block form. Figure 1-2 presents behavioral characteristics of ultrasound.

Time is measured from the first echo returned to the transducer to a cutoff time (zero or range). The time is digitized to a level. Flow is digitally derived from custom flow curves in Read Only Memory (EPROM). Available outputs include 01- mA to drive a recorder, and 1-5V and 4-20 mA for transmission.

1.2 UT"X"-2100A SYSTEM DESCRIPTION

1.2.1 UTL-2102A Level Transmitter

The UTL-21-2A Level Transmitter digitally computes the time of travel of the ultrasonic pulse from the liquid surface to a cutoff time (zero or range) and converts it to a digital equivalent of height. The digital to analog converter supplies the meter and outputs with an analog level signal. In addition to power and transducer input connections, the UTL-2102A has provisions for three or six optional level alarms.

1.2.2 UTF-21-2A Flow Transmitter

The UTR-2102A Open Channel Flow Transmitter senses liquid level in the same manner as the UTL-2102A Level Transmitter (Paragraph 1.2.1). Level data is digitally converted to an equivalent flow rate by a custom flow curve in Read Only Memory (EPROM) which is selected for the channel type being measured.
OPTIONS INCLUDE
CUSTOM FLOW CURVES, LEVEL/FLOW ALARMS, HEATER STRIP

FIGURE 1-1. ULTRASONIC SYSTEM BUILDUP
Page 2
Ultrasound pulses bounce off flat surfaces.

Uneven surfaces cause ultrasound pulses to scatter.

Wind conditions affect straight-line travel of pulses.

FIGURE 1-2. ULTRASOUND BEHAVIOR CHARACTERISTICS

Page 3
Flow rate is indicated in percent of maximum flow on the integral 0 to 100 percent precision meter on the face of the transmitter. A 0-1 mA signal proportional to flow drives the integral strip chart recorder. A 4-20 mA and 1-5V signal can be transmitted to operate a flow pace chlorinator or chemical feed equipment and to drive a total flow computer.

1.2.3 UTC-21-2A Flow Recorder and Totalizer

The UTC-2102A Flow Recorder and Totalizer functions in the same manner as the Flow Transmitter described in Paragraph 1.2.2. In addition, the unit provides total flow indication by means of a digital, non-resettable totalizer and permits driving a flow proportional sampler by means of a dry circuit contact closure in flow units from 10 to 9000 as set at the sample rate switch on the front panel.

1.2.4 Transducer (See Figure 1-2)

The Ultrasonic transducer functions as a transceiver in that it both transmits an ultrasonic pulse and receives the return signal (echo).

The transducer is a chemically inert sensor with a sealed in air temperature sensor. Pulses transmitted and echoes received are ultrasonics sound waves and are therefore subject to variations in velocity with variations in temperature (1% velocity with each 10°F variation). This variation in temperature is measured at the transducer and compensated for by the electronics from -40°F to 176°F (-40°C to 80°C).

1.3 SPECIFICATIONS AND CONTROLS (See Figure 1-3)

1.3.1 UTL-2102A Level Transmitter

1.3.1.1 Specifications

Enclosure (A1)
### LEGEND: FIGURE 1-3

<table>
<thead>
<tr>
<th>A1</th>
<th>Enclosures</th>
<th>D1</th>
<th>Input/Output Label, Connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>A2</td>
<td>Mounting Flanges</td>
<td>D2</td>
<td>Transducer connection, cable</td>
</tr>
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<td>A3</td>
<td>Dogs (Clamps) to secure cover</td>
<td>D3</td>
<td>Power connection</td>
</tr>
<tr>
<td>A4</td>
<td>Window</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A5</td>
<td>Serial tag with model number</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B1</td>
<td>Front Panel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B2</td>
<td>Meter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B3</td>
<td>Latch: CW to close, CCW to open</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B4</td>
<td>Power Switch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B5</td>
<td>Calibration door latch: Pull to</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>open, push to close</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Ultrasonic Board (Calibration Controls)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td>EPROM: (Channel shape, linear if</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td>level meter)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td>Meter switch; up: echo strength,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C4</td>
<td>down: level/flow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C5</td>
<td>Echo LED: off, normal; on: no echo</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C6</td>
<td>Range: sets zero</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C7</td>
<td>Span: sets max</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C8</td>
<td>Fuse AC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C9</td>
<td>Dampening switch: Down for</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>calibration; up for dampen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C10</td>
<td>Alarm trip points for alarms 1-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1</td>
<td>Input/Output Label, Connections</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D2</td>
<td>Transducer connection, cable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D3</td>
<td>Power connection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E1</td>
<td>Heater strip (for operation 32°F, 0°C)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E2</td>
<td>Fuse</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E3</td>
<td>Thermostat (Factory set)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F1</td>
<td>Alarms 4-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F2</td>
<td>Trip points</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F3</td>
<td>Connections (see D1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G1</td>
<td>Recorder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G2</td>
<td>Chart paper access: CCW open, CW close</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G3</td>
<td>Chart paper advance: up</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G4</td>
<td>Wire harness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H1</td>
<td>Flow Totalizer and Sampler Board</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H2</td>
<td>Total Flow readout (counter)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H3</td>
<td>Max flow input switch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H4</td>
<td>Sample rate switch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H5</td>
<td>Sample indicator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H6</td>
<td>Sampler connection: 24</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1/4 amp max</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H7</td>
<td>Sampler connection fuse</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1/4 amp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H8</td>
<td>Event marker connection</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Dampening Switch (C9)**
Permits dampening output circuits when measuring under noisy or turbulent conditions.

**Outputs (D1)**
- 4 to 20 mA, 600 ohms max
- 1 to 5 volts, 500 ohms min

**Meter Switch (C2)**
For monitoring echo strength on the meter. Located under calibration door in front panel (B5).
Lost Echo Compensation
Automatic circuit prevents lost echo from affecting outputs or alarms. Circuitry ignores lost signal and retains last valid reading.

Power (D3)
100 - 125 VAC, 50/400 Hz, 0.1 amp
200 - 250 VAC, 50/400 Hz, 0.1 amp
12 VDC (Battery), 0.4 amp average

Readouts (Level)
Front panel meter, mirrored scale, 0-100 percent (B2)
Light Emitting Diode (LED) indicates lost echo, insufficient gain, under range, over range (C3)
Strip chart recorder, if installed, provides continuous reading in percent of maximum height or flow (G1)

Connections (D1)
4-20 mA, 0 to 600 ohm load
1 - 5 volts, drives 500 ohms or more
Recorder drive, 0-1 mA @ 100 ohms
12 VDC (Battery)
110/220 VAC
Transducer coaxial cable

Temperature Range
Transducer: -40°F to 158°F (-40°C to 70°C)
Electronics:Enclosure: 32°F to 122°F (0°C to 50°C) ambient; -22°F to 122°F (-30°C to 50°C)
with heater strip installed

Accuracy
With max level at 25 in. (63.50 cm) from transducer, span 4 in. (10.2 cm) to 20 ft. (6.1 M):
± % full scale.

Dead Zone
21 in. (53.34 cm)

Range
25 in. to 21.8 ft. (63.4 cm to 6.65 m)

Span
4 in. to 20 ft. (10.2 cm to 6.1 m)
Measurement Rate
5.6 measurements per second (approx.)

1.3.1.2 Controls (See Figure 1-3)

Front Panel (B4)
Power: BATT. -- OFF -- A.C. (3-position switch)

Interior (Under Calibration Door)
Dampening Switch (C9)
Range (Zero): 10-turn precision potentiometer (C5)
Span (Max): 10-turn precision potentiometer (C6)
Meter Switch: For monitoring level/flow or echo signal strength on meter (C2)

Fuse
AC Power: 0.1 amp Slo-blow (C7)
DC (Battery) Power: 3 amps (C8)

1.3.2 UTF-2102A Flow Transmitter

Specifications for the UTF-2102A Flow Transmitter are identical to those for the UTL-2102A Level Transmitter (see Paragraph 1.3.1) with the following additions:

Custom Flow Curves (EPROM) (C1)
A digital memory circuit (EPROM) is programmed for specific types of channels. Accuracy is one part in 256, or 0.39 percent, nonvariable with time, temperature, or voltage, selectable for channel type by a 16 position switch.

Readouts (G1)
Optional strip chart recorder provides continuous reading in percent of maximum flow rate (0-100%).

1.3.2.1 Controls

Controls for the UTF-2102A Flow Transmitter are identical to those for the UTL-2102A Level Transmitter (see Paragraph 1.3.1) with the following additions:

Recorder Pen
Zero Percent: Adjustable under small panel in recorder (G1)
100 Percent: Adjustable behind main control panel.

Custom Flow Curves
16 position switch accessible by opening the Front Panel (B1) and looking at the top righthand corner of the large PC board near the coax connector for the transducer cable.
The assignment of the switch positions is as follows:

<table>
<thead>
<tr>
<th>Switch Position</th>
<th>Curve</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Linear</td>
</tr>
<tr>
<td>1</td>
<td>Round Pipe</td>
</tr>
<tr>
<td>2</td>
<td>Half Round Pipe</td>
</tr>
<tr>
<td>3</td>
<td>Palmer Bowlus</td>
</tr>
<tr>
<td>4</td>
<td>Parshall</td>
</tr>
<tr>
<td>5</td>
<td>Contracted Rect. Weir 1.5/.667</td>
</tr>
<tr>
<td>6</td>
<td>V-Notch Weir</td>
</tr>
<tr>
<td>7</td>
<td>Rectangular Channel</td>
</tr>
<tr>
<td>8</td>
<td>Leopold Lagco</td>
</tr>
<tr>
<td>9</td>
<td>Cipoletti</td>
</tr>
<tr>
<td>10</td>
<td>Suppressed Rect. Weir</td>
</tr>
<tr>
<td>11</td>
<td>Reverse Linear</td>
</tr>
<tr>
<td>12</td>
<td>Reserved for Test</td>
</tr>
<tr>
<td>13</td>
<td>Custom</td>
</tr>
<tr>
<td>14</td>
<td>Custom</td>
</tr>
<tr>
<td>15</td>
<td>Custom</td>
</tr>
</tbody>
</table>

1.3.3 UTC-2102A Flow Recorder and Totalizer

Specifications for the UTC-2102A Flow Recorder and Totalizer are identical to those for the UTL-2102A Level Transmitter and UTF-2102A Flow Transmitter (see Paragraphs 1.3.1 and 1.3.2) with the following additions:

**Totalizer (Total Flow X10) (H5)**

6 digit, non-resettable; indicates total flow

**Totalizing Conditions**

- In Range, In Span -- Flow dependent
- Out of Range/Span:
  - Over Range (Surcharge) -- counts at maximum rate as if 100% flow.
  - Under Range -- No count
- Lost Echo -- Totalizer continues to count at rate of last valid reading.

**Maximum Flow Input (rate Multiplier) (H3)**

Three digit switch, 000-999

Accuracy: Totalizer Flow Tracks FROM within 0.5 percent.
1.3.4 Transducer Specifications

**Temperature Range**
-40°F to 158°F (-40°C to 70°C) (Operation and Storage)

**Frequency**
-40 KHz, Single Element

**Cable**
750 ft. (76 m) maximum, for additional lengths - consult factory.

**Air Temperature Compensation**
Sensing element potted with transducer (Temperature DC level sent to instrument with 40 KHz echoes through the coaxial cable.)

1.4 Optional Equipment

1.4.1 The chart on the next page shows optional equipment for each of the instruments making up the UT"X" Ultrasonic Measuring System. For information regarding connections, adjustments and calibration of optional equipment (if installed) refer to Section III, Paragraph 3.3.
<table>
<thead>
<tr>
<th>Feature</th>
<th>UTL 2102A</th>
<th>UTF 2102A</th>
<th>UTC 2102A</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Alarms</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>6 Alarms</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Heater Strip</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Recorder</td>
<td>x</td>
<td>x</td>
<td>Standard</td>
</tr>
<tr>
<td>Flow Proportional Sampler Drive</td>
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<td></td>
<td>x</td>
</tr>
<tr>
<td>Recorder with Event Market</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Transducer Bracket</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>
SECTION II

THEORY OF OPERATION

2.1 PULSED ULTRASOUND THEORY

Pulsed ultrasound behaves exactly like audible sound, with speed varying with temperature, but the frequency (Hz) is above hearing range.

Like normal sound, ultrasound is unaffected by gravity. It will travel in a straight line until contacting a reflective or absorbing surface.

Resolving ability of ultrasound is limited by its wavelength. The 40 KHz pulse, expanded, appears thus:

Amplitude (envelope) detection detects when the echo is a certain strength.

NOTE: When measuring small spans (less than 12 inches) with weak or varying echoes, it may appear that the distance is changing. This can result in a ragged line on the recorder but averages out in the totalizer.
ULTRASOUND APPLICATIONS

TN/Manning Ultrasonic Transmitters and Recorders measure the time from the first echo returned to a cut-off time (zero or range). The units can be calibrated to reflect this time measurement in inches, feet, etc., or metric equivalent indications, as shown below:

If the distance being measured changes one foot, the time change is approximately 2 ms. However, with a small span the units can measure distance changes as small as 3/100 inch.

Since ultrasonic signals tend to widen with distance, producing progressively weaker echoes, an Integral Time Compensated Gain (TCG) automatically increases sensitivity. To minimize loss of signal strength the Transducer should be installed close to the surface being measured (see Section III, Paragraph 2.1.2).

2.2 UT"X"-2100A GENERAL SYSTEM THEORY

NOTE: Upper case letters A through M serve as locators for coordinating text with sections of the Schematic and Block Diagram, Figures 2-1A, 2-1B and 2-2.

A, B, C, and D provide regulated power to the unit, C pulses the Transducer, E amplifies the returned echoes, F produces a voltage representing transducer (air) temperature which corrects H. H generates a string of pulses representing flow level. G gates the pulses into I, which utilizes the EPROM to load
FIGURE 2-2. UT "X" SYSTEM BLOCK DIAGRAM
data into a latch. K generates the analog signal, L standardizes the outputs, and M drives level alarm relays. J indicates the status of the first echo detected.

2.2.1 Philosophy

AC or DC power input to A flows into B as DC. B’s oscillator drives a switching circuit in A to bring the unregulated voltage up to 20 volts for D and 360 volts in C.

D provides continuous +15 volts to the master oscillator B, the latch in I, and the outputs in K, L, and M.

B&G clock C to pulse the transducer. E amplifies the signals returned from the transducer (38-42 KHz). E also increases its gain as a function of the time elapsed since the transducer was pulsed to compensate for the weakened strength of the distant echoes. The detected echoes go to G, which captures the first echo returned after a 2.8 ms delay. This delay blanks the ringing produced in the transducer.

G’s detected echo sets a latch in H which allows the pulses from the span oscillator to enter the counter in I. The range one shot resets the latch in H. The span oscillator is set to produce 256 counts in the time between detection of an echo from the 100% level or flow distance and the end of the range one shot’s timing out. The range one shot is set to stop the count at the time where an echo would be received from the 10% level or flow. Thus, an echo returned from zero level nets zero counts, an echo from 50% level nets 128 counts, 75% 192 counts, etc. F provides a voltage to H proportional to temperature at the transducer; this changes the range one shot time and span VCO to eliminate air temperature errors in the level.

The count in U20, I, represents the level, and is the address for the EPROM - U11. The output from the EPROM (the same as U20 if a linear Curve is used) is loaded into U23, 21, and 24, but only if an echo is received (if not, U20 is reset and counts again). The output of the latch always represents the last valid reading.

K generates an analog equivalent of the 8 bit work in I’s latch via an R-2R network. This analog signal drives the output amplifiers in L and the alarm amplifiers in M.
2.3 TOTALIZER AND SAMPLER DRIVE, FUNCTIONAL THEORY (See Figure 2-4)

The UTC-210 Open Channel Flow Totalizer and Recorder accepts an 8 bit digital input which represents flow, with the 3 digit switch set to standardize the flow (gallons per minute, etc.) this standardized flow information drives a counter which reads total flow (not flow rate). A sampler output (option) enables taking samples based on total flow per unit time; an optional event marker on a recorder may be driven by this sampler output to indicate when each sample is taken.

U1 generates a pulse train of 3413.33 Hz (with a maximum input of 255 bits the totalizer will count 99.9 counts in one minute when the BCD switch S1 is set at 999).

The counter (U4) runs continuously and drives the digital comparator in U2 and U3.

U5 accepts the output from the comparator. This output is only high when the count in U4 is less than the input signal it is compared to. For example: if the input is zero, the count in U4 will always be higher than the input signal, and U5 pin 10 remains low; if the input is one half (127 bits) U5 will provide pulses one half of the time, and be turned off one half of the time; and if the input is high (255 bits) U5 will gate the count from U1 through continuously. The number of pulses emanating from U5 pin 10 is directly proportional to the input signal.

U6, 7 and 8 form a rate proportional multiplier, whose multiplication rate is set by S1. For example, put 999 pulses into the multiplier (from U5 pin 10). If S1 is 999, the result is 999 pulses out (U8 pin 6); if S1 is 666, the result is 666 pulses out, etc.

U9 divides the output of the rate multiplier by 2^{11} and U5 pin 1, 2 and 3 is a one shot which, through Q1 drives the counter.

S3 selects outputs from U12 to divide the totalizer drive pulses by 1, 10, or 100, and S2 enables U10 to further divide the pulse train by 1, 2, 3...9, or (infinity) "0". This pulse output (U11 pin 3) drives the one shot in U11 to pulse the sampler relay K2.
FIGURE 2-4. TOTALIZER AND SAMPLER DRIVE, BLOCK DIAGRAM
SECTION III
INSTALLATION AND OPERATION

3.1 INSTALLATION

All instruments of the UT"X"-2100A system are housed in watertight, and dust-tight NEMA 4 enclosures, although vertical mounting is preferable all units can be mounted and will function in any position. However, any unit equipped with the optional heater strip must be mounted vertically. To determine if the unit has a heater strip, open the front panel. A placard at the back left side reading HEATER STRIP will be visible if the heater is installed (see Figure 3-9).

3.1.1 Mounting Considerations (see Figures 3-1 and 3-2)

3.1.1.1 Accessibility

Leave sufficient space for the door to fully open and for the wires to exit through the holes in the bottom of the unit.

3.1.1.2 Direct Sunlight

The unit should be mounted so that direct sunlight is avoided. The unit is sealed and heat may build up to extremes.

3.1.1.3

The unit should be mounted to avoid caustic vapors and liquids which may damage the paint, clamps and window.

3.1.1.4 Connections (see Figure 3-3)

Input and output connections are made through the three holes in the bottom of the enclosure.

CAUTION: Connections for power and for output signals must be routed through sealed compression bushings to maintain environmental integrity of the NEMA 4 enclosure. The unused holes must be sealed to prevent damage to the internal circuitry.

NOTE: Do not overlook the entry of gasses through the conduit. Many gasses typical to field applications can rapidly destroy the instrument.
FIGURE 3-1. UTL/UTF-2102A DIMENSIONS (WITHOUT RECORDER)
FIGURE 3-2. UTL/UTF/UTC-2102A DIMENSIONS (WITH RECORDER)
CAUTION
HIGH VOLTAGE
NO USER SERVICEABLE PARTS
BEHIND THIS PANEL—REFER
SERVICE TO QUALIFIED
PERSONNEL ONLY

NOTES:
1. UNUSED TERMINALS MAY BE LEFT OPEN
2. IF THE 0-1 mA OUTPUT IS USED FOR EXTERNAL METER, THE
   METER SUPPLIED WITH THE UNIT MUST BE REMOVED
3. BATTERY CONNECTIONS MUST BE PLUS TO PLUS AND MINUS
   TO MINUS
4. SOME OPTIONS WILL REQUIRE TWO OR THREE WIRES TO
   CONNECT AT ONE TERMINAL
5. WIRE COLOR SHOULD BE MARKED NEXT TO ITS TERMINAL

Figure 3-3. Power and Output Connections

REAR OF FRONT PANEL
3.1.2 Transducer Installation

Mount the Transducer as close as possible to the liquid level, but no closer than 21 inches (53 cm) from the max level. Where Transducer mounting is restricted to measurements less than 21 inches, refer to Figure 3-4, View "B", for alternate mounting configurations.

Air Temperature compensation is provided by a sensing element in the Transducer, so the Transducer should be at ambient air temperature. Exposure to direct sunlight should be avoided. Heat from the sun will cause the Transducer to give false air temperature information. Direct sunlight would also reduce the life expectancy of the transducer. Where possible, windy, gusty locations should be avoided.

Obstructions should be kept clear of the path between the Transducer and the level being measured; i.e., grating, plumbing. A nearby wall can interfere it if it’s too close; a 7" beam should only reach the flow target.

3.1.2.1 Installation Procedures (see Figure 3-5)

a. Pull the transducer coaxial cable through the threaded hole in the adjusting plate of the bracket.

b. Screw the transducer into the threaded adjusted plate. Hand tighten firmly. Too much torque can permanently damage the transducer.

c. Locate the bracket flange against the mounting surface. Use a level to align the transducer in the horizontal and vertical axis.

NOTE: Bracket must be installed so that the face of the transducer is over the center of the channel.

The transducer should be mounted between the arrows on flumes, or further upstream. On 6" or 4" Palmer Bowlsus flumes, better accuracy can be assured by placing the transducer at least a full channel diameter upstream from the bottom of the step (the step is the hump in the bottom of a Palmer Bowlsus flume). For weir applications, the transducer must be upstream of the crest of the weir by a factor of at least 4 times the distance between the zero flow height and the 100% flow height.

d. Secure the bracket to the mounting surface with 4 bolts. (Type of bolts depends on mounting surface; i.e., wood, metal, concrete, etc.)

e. Route the coaxial cable back along the bracket and tie the cable down with the clamp at the center of the bracket.

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FIGURE 3-4. TRANSDECER INSTALLATION
3.2 CALIBRATION

3.2.1 Terminology (See Figure 3-6)

**Dead Zone**
Distance in front of the Transducer where no meaningful measurements can be taken (the powerful pulse causes the Transducer to ring out for a short while, so the receiver is blanked to exclude the ringing from valid echos).

**Range:** 25.0 in. to 21.8 ft. (63.5 cm to 6.65 m)
Maximum distance at which a measurement can be taken. It is adjustable, and is used to set the zero point, or zero level, zero flow.

**Span:** 4.0 in. to 20 ft. (10.2 cm to 6.1 m)
Distance in which all useful measurements are taken. It is adjustable, and is used when setting max (full channel).

**Zero**
Lower limit on the meter and outputs, and when the range is set accurately, will indicate zero or minimum level or flow.

**Max**
Upper limit on the meter and outputs, and when the span is set accurately, will indicate maximum height or flow (round pipes excepted).

3.2.2 Pre-Calibration

NOTE: Although the UT"X" system has been calibrated at the factory prior to shipping, zero and span settings must be adjusted to conform to the level of the channel to be measured.

```
--- FACTORYSETTING ---

LEVEL

FIELD SETTING (CORRECT)
```

Before calibrating the range and span it is necessary to determine what the distances will be in your application, from the face of the transducer to the zero level or flow, and to the 100% level or flow. In some applications this is straight forward, i.e. level in a tank, or flow through a half-round pipe. If a flume or weir is being used, it may be necessary to refer to the flow table or formula for that device.

For weirs and Parshall flumes, a maximum flow height can be selected from the appropriate flow table to suit the current needs of the application. Overall system accuracy improves with higher % flow, and fuller flumes at 100% height. A system that normally reads 3% to 9% (so that winter storms won't go over 100%) will not be as reliable as a system that normally reads 30% to 90%.
FIGURE 3-6. GRAPHIC EXPLANATION OF TERMINOLOGY (SHEET 1 OF 2)
FIGURE 3-6. GRAPHIC EXPLANATION OF TERMINOLOGY (SHEET 2 OF 2)
For Palmer Boulus flumes there is no choice of maximum flow heights. The highest listing in the flow table is the maximum flow height to use in calibration for that size flume. Note that the zero flow distance in a Palmer Boulus is not the distance to the bottom of the flume, but rather the distance to the standing water upstream of the step when the flow stops. The maximum flow height refers to the height above the zero flow height.

Echo Light:  
OFF - Good echo, in range, in span  
FLASHING - Good echo, out of range or span  
ON - Inadequate echo, lost echo

NOTE: False indications if:  
  a. power off or low  
  b. unit improperly grounded (meter over 100%, or bouncing)  
  c. transducer or cable bad or not connected

3.2.3 Level or Flow Calibration In The Shop (See Figure 3-7)

The transducer must be at air temperature. Allow at least one hour for stabilization to any sudden temperature shift.

a. Switch the power on (A.C. or BAT.); allow the instrument to stabilize - at least a few minutes.

b. Open the calibration door under the meter and place toggle switches S1 and S4 in the down position.

c. With a small screwdriver turn the SPAN and RANGE pots CCW to stops. Turn the SPAN pot CW 1/2 turn.

d. Hang the transducer by its cable, centered over a target at the maximum distance, to simulate zero level or zero flow. It may be necessary to bend the cable where it enters the neck of the transducer, to aim straight down. For accurate settings, the target should be water; in a cake pan or bucket. For initial testing, the target can be any smooth, flat, hard surface such as linoleum, concrete, metal or plastic. A 1/10" error in the distance set-up would result in a 3% level error for an application with a 3" span. For horizontal testing, be aware that any floor, wall, table surface, etc., should be at least 4 inches from the center of the sound path, and that this distance should increase proportionally as the target distance exceeds 21".

e. Turn the RANGE (zero) pot CW until the echo light goes out as the meter comes up off of zero, then turn slowly CCW until the meter reads zero percent. The exact zero point is where the echo light starts flashing regularly. To insure that the range pot is not turned too far CCW, the adjustment could be set to where the echo light occasionally goes out (this would cause a small false totalization in UTCs - counts would eventually accumulate during zero flow - you would show maybe 1/2% flow or less when there wasn’t any).
FIGURE 3-7. CALIBRATION CONTROLS AND SWITCHES
NOTE: When zero is being set at long ranges, variations in air movement can cause changes in readings. In this instance it is easier to set zero by first turning the span pot clockwise a few turns.

NOTE: At long ranges it may be necessary to increase the gain setting. If the gain is changed, repeat the range setting.

GAIN (Aiming the transducer)

NOTE: The gain is factory set and should require no adjustment under normal conditions. A mark on the gain pot indicates its normal position. Do not use the gain pot as a substitute for aligning the transducer.

With the power on, lift the meter switch S4 up; the meter now indicates the strength of the echo. With the target at maximum distance for your application, carefully aim the transducer for a maximum echo strength indication. Use the two adjusting knobs on top of the transducer mounting bracket, where applicable, for the precise adjustment of the transducer right angle to the flow. Acoustic superiority may be achieved at a slightly crooked angle.

If over 100%, reduce gain CCW, aim for maximum meter indication, and secure transducer.

If under 10%, increase gain CW; avoid full CW setting.

It is normal for the strength to waver by about 10% of a given reading. If it periodically bounces above and below this amount, either the target is moving (ripples, waves, or turbulent air between the transducer and surface), or the unit is improperly grounded.

Return the meter switch to the down position.
Verify or fine-adjust the range setting.

f. Move the transducer or target to set up the minimum distance; to simulate 100% level or flow. As you decrease the distance, the panel meter should rise smoothly and peg-out above 100% (it won’t get that far if the span pot has already been turned CW too far).

NOTE: For round pipe applications, where a round pipe FROM is installed, simulate a full pipe. This will yield a reading of 93% on the panel meter when calibrated - over range will peg-out to the right from 93%, not from 100%. 
NOTE: If the instrument does not behave at this point, it was probably seeing something closer than your 0% target when the range was set. It might help to reduce the gain, then repeat the range setting. Continued trouble could mean there is something acoustically odd about the application, or the transducer is ringing excessively (check to see that it was not over-tightened in its mounting).

NOTE: For maximum accuracy, use a water target. It is especially important to use the same type of material as was used for the range setting (variations in envelope result from variations in acoustic reflections, resulting in errors of .3 inch or multiples of .3 inch).

g. Turn the SPAN (max) pot CW until the echo light stops flashing, as the meter drops below 100%; then CCW until the meter reads 100% (93% with a round pipe FROM). The echo light may flash occasionally, as the meter jumps above 100%.

h. For maximum accuracy, repeat the longer distance set up for range adjustment, and fine-adjust if necessary. If this setting is changed, repeat the span set up and adjustment.

i. Calibration is complete at this point if the transducer can be field mounted to the identical distances. For maximum accuracy, follow step j.

j. If known flow or level can be determined, accuracy can be checked and fine-adjusted. Ideally, if the flow can be turned off, then one careful setting of the range pot for 0% will ensure maximum accuracy. If the flow cannot be turned off, a known level or flow can be used to set a matching panel meter reading with the range pot - DON'T TOUCH THE SPAN POT!

A dip stick measurement can be used to determine level; and the level divided by maximum level yields % level. For flow, a flow able or formula is needed to convert height to flow; then divide by maximum flow to get % flow.

3.2.4 Level or Flow Calibration in the Field

The outline for calibration in the shop can be followed for calibration in the field, with the following differences:

Watch out for sudden temperature change to the transducer; i.e. removing it from a truck in which the heater or air conditioner has been on. If the transducer is already mounted, gaining access could impose a sudden temperature shift. The solution may be to make access quickly several times, if for example you only need to take some measurements - a piece of heavy cardboard could be used temporarily in place of a manhole cover, between measurements. If it is necessary to cause a temperature shift, then it is necessary to allow at least an hour for the transducer to stabilize before calibration.
If it is possible to stop the flow, then this condition should be used to set the range.

After setting the range to zero, if it is possible to control the flow to the 100% height, then this condition could be used to set the span, if the level or flow surface is flat - having ripples of less than 1/8". A known high flow could be used to set the span for a matching panel meter reading - the closer to 100%, the better.

If the flow cannot be stopped for the range setting, it may be possible to calibrate using low and high known flows. The low flow is used to set the range, then the high flow is used to set the span - but this procedure must be repeated until the range no longer requires adjustment.

It may be possible to lower a target below the transducer to simulate flow levels. The target should have a water surface if accuracy is critical - heavy foil can be fashioned into a shallow container. This target should be the full width of narrow flumes. The water need only be deep enough to cover the whole target. Shims can be measured for placement under the target to produce known flow heights.

In some installations it may be easier to move the transducer to an area beside the flow, over a water target, and raise and lower one or the other precisely for range and span settings. After replacing the transducer, verify a known flow, or fine-adjust the range to match a known flow.

3.2.5 Calibration To A Different Transducer

If the transducer is swapped, it is probably necessary to at least fine-adjust the range, if accuracy is critical. Transducers differ from one another effectively by as much as 1 1/2", particularly when comparing older and newer units.

3.2.6 Calibration with A Cal-100

A Cal-100 can be used in place of a transducer and movable target. The cal-box is first set to simulate the distance from the transducer to zero flow, and the range is set. Then the cal-box is set for the distance from transducer to 100% flow, and the span is set. The general accuracy of this procedure is improved if you use measurements to 1/2" above the face of the mounted transducer. Final adjustment of the range, using the transducer over a known flow, is necessary for maximum accuracy.

3.2.7 Totalizer (UTC)

Setting the totalizer is simply a matter of adjusting the three MAXIMUM FLOW INPUT switches, with a small screwdriver, to your 100% flow rate, in units PER MINUTE. The unit can be gallons, tens of gallons, cubic feet, liters, etc.; whatever units you want the totalizer counts to represent - but the rate must be figured by the minute, at 100% flow. This can be determined from a flow table or formula for your application.
In many cases the flow rate has more than three digits. This will require the use of a multiplier to interpret the totalizer counts. The flow rate entered into the maximum flow input is the three left-most significant figures - the more right-side figures you have to drop off, the more zeros you have to add to the right of your totalizer reading.

Since the totalizer counter is not resettable, it is necessary to take a reading at the beginning of the totalizing period. This number is subtracted from the next reading to obtain the number of counts accumulated during that period.

In most applications each count represents ten gallons; so the panel labeling has been geared to that. This will be the case for you if the 100% flow rate is some number of hundreds of gallons per minute; i.e. between 100 and 999. Where 100 has been entered into the maximum flow input, and there is a 100% flow rate at 100 gallons per minute, the counter will accumulate 10 counts; each count representing 10 gallons - to read gallons you use a basic multiplier of 10. Where 500 has been entered, representing 500 GPM, the count will be 50 per minute at 100% flow, etc. The fastest possible counting rate is almost 100 counts per minute (999 per 10 min). Lower flows and lower maximum flow input setting simply slow down the counting rate proportionally.

In the case where you have less than 100 units of flow per minute at 100% flow, the counter can indicate units directly. For example if the 100% flow rate is 51.9 gallons per minute, and you enter 519 into the maximum flow input, then each count of the totalizer will be one gallon, because you will get 51.9 counts per minute at 100% flow.

If enough time passes between counter readings, the counter may "turn over" back to 0s, and continue to where the results could be ambiguous; particularly if the counter turns over more than once. The solution to this problem is to slow down the counter by a factor suitable to your schedule, and multiply your readings by the same factor. For a factor of ten, enter a leading zero into the maximum flow input; i.e. where you would have put 165, you put 017 - now each count represents ten times as much flow. Similarly, the maximum flow input could be reduced by a factor of two, to 083, and readings would be doubled to yield total flow.

3.2.8 Damping Circuit

If turbulent level or flow conditions cause the meter and/or recorder to bounce, place the dampening switch (S1) up. This will introduce a 2-3 minute time constant and reduce the bouncing. In other words, the instrument will average out its readings, and respond very slowly.

NOTE: Do not calibrate the unit with S1 in DAMPEN.

NOTE: When S1 is first raised, the meter usually goes to zero for about a half minute, and then slowly rises to the flow reading.
UTX-2100A ULTRASONIC SYSTEM

EXAMPLE

CONTACT CLOSURE
ALARM SET POINT
CONTACT CLOSURE
ALARM SET POINT

CAUTION: 5 AMP MAX.
28VDC OR 110VAC RESISTIVE

manning

CAUTION
HIGH VOLTAGE
NO USER SERVICEABLE PARTS
BEHIND THIS PANEL—REFER
SERVICE TO QUALIFIED
PERSONNEL ONLY

OUTPUTS

1-5 VOLTS
4-20mA
100Ω MAX
100Ω MAX

POWER

12V BATTERY
10 TO 16 GAUGE WIRE

FIGURE 3-8. ALARM CONNECTIONS

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FIGURE 3-9. ALARM CIRCUIT (ALARMS 4, 5, AND 6)
Specifications

Setability: With the UTL-2102A the alarms trip on level, with the UTF-2102A the alarms trip on flow. The alarm trip points are settable to within 1% of meter or output reading. They may be set to trip on over range (surcharge). A light emitting diode (LED) turns on whenever the alarm trip point has been exceeded.

Hysteresis: The alarms have a 2% to 3% hysteresis to suppress multiple (ON/OFF/ON/OFF etc.) trips caused by ripples or turbulence.

Contact Rating: Isolated form C contacts are provided for each alarm. They are rated a 5 amp resistive load, and are not fused. Maximum voltages are D.C. 28 volts, A.C. 220 volts.

Installation: Alarm connections are made by opening the front panel. All terminals are placarded (see Figure 3-8).

3.3.1.1 Alarm Setup

NOTE: The unit must be calibrated (see Paragraph 3.2) prior to setting alarms.

a. Access: To set up alarms 1, 2, and 3 (R12, R13, R14), open the small door on the front panel below the meter. Access to alarms 4, 5, and 6 (R10, R11, R12) is on the rear of the panel (see Figure 1-2).

b. Setup: Switches S1 and S4 down. Turn the appropriate alarm control fully clockwise.

c. Moveable Target Setup

1. Set a "target" at the desired alarm trip point (Trip point can be measured or the meter can be used). Check the echo LED to verify a good echo.

2. Slowly turn the appropriate alarm pot counterclockwise until the LED next to the pot just comes on.
   NOTE: Stop turning the pot the instant the LED lights. If the adjustment is overshot, turn the pot clockwise and again CCW until the LED just comes on.

d. Fixed Target

1. Note meter reading.
2. Turn Range control until desired alarm trip point is indicated on the meter.
3. Slowly turn the appropriate alarm pot counterclockwise until the LED just comes on.
4. Turn Range control to meter reading noted in Step 1.

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3.3.2 Heater Strip (See Figure 3-10)

The heater strip provides calibrated operation of the electronic circuitry when temperatures outside the enclosure are below 0°F. When on, the heater uses approximately 250 watts. A thermostat mounted on the side of the heater strip controls heater on/off operation. Heater connections are shown in Figure 3-10.

3.3.3 Sampler Drive

Two switches on the front panel permit setting the rate of samples taken from 1 for each count of the totalizer to 1 sample per 900 counts. These settings do not affect the totalizer - only the sample output rate.

3.3.3.1 Sampler Output (see Figure 3-10)

Two screw terminals connect to a relay rated at 5 amps, 24 volts maximum. A 5 amp fast flow fuse protects the relay. Contact closure is approximately 200-100 ms but will be longer if an event marker (option) is included in the recorder.

3.3.3.2 Sampling Conditions

In range, in span: flow rate dependent
Out of range/span:
   Over range (surcharge): samples at maximum rate (as if 100% flow)
   Under range: No sample
Lost echo: Continues to sample at rate of last valid reading.
Accuracy: The sampler will track the flow output ±0.5 percent.

3.3.3.3 Sample Rate Setting

To set the sampler output (volume of flow per sample taken), set the screwdriver adjustable sample rate switch to read from 1 to 9. Set the adjacent 3-position switch to X10, X100, or X1000 to indicate the desired volume of flow that will pass between samples.

With a setting of "1" and "X10" a sample will be taken each time the totalizer counts. With a setting of "2", it is every other time; a setting of "3" is every third time, etc. With the toggle raised to "X100", the rate is slowed by a factor of 10 - a setting of "5" and "X100" would be one sample per 50 counts. "X1000" slows the rate another factor of 10 - "9" and "X1000" is one sample per 900 counts. In most applications, a count represents 10 gallons, so a setting of "9" and "X1000" give one sample per 9000 gallons of flow.

When the sample rate is set, turn the unit OFF for five seconds and then ON (BAT. or A.C. as applicable). This loads the sampler numbers into the logic.

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FIGURE 3-10. TERMINAL CONNECTION LOCATIONS FOR HEATER STRIP AND SAMPLER
SECTION IV
MAINTENANCE AND TROUBLESHOOTING

4.1 MAINTENANCE

The TN/Manning UT"X"-2100A system for ultrasonic measurement of level, flow rate, and total flow has undergone stringent quality assurance inspection and tests and is designed to give long, trouble free operation. No scheduled maintenance is required other than replacement of the chart paper every 30 days. It is recommended that calibration of instruments be checked every six months.

CAUTION: ALWAYS KEEP THE INSTRUMENT SEALED AIR TIGHT, INCLUDING WIRING ENTRY POINTS INSIDE CONDUIT.

OIL OR OTHER LUBRICANT SHOULD NEVER BE APPLIED TO THE INSTRUMENT(S). FAILURE TO OBSERVE THIS CAUTION CAN RESULT IN A MALFUNCTIONING SYSTEM.

4.2 TROUBLESHOOTING (see Table 4-1)

Troubleshooting instructions are based on analyses that follow a logical sequence of events leading to a malfunction. When a trouble event occurs, look for the obvious possibilities first. When a trouble event occurs, look for the obvious possibilities first. Is the power supply connected? Circuit breaker open? Is a switch in the wrong position? Fuse blown? Are connections loose or wires broken? review the malfunction, review normal operation and check one possibility at a time starting with the easiest to verify.
Remedial steps marked with an asterisk (*) indicate the following: If the instrument is under contact TN/Manning for assistance. If out of warranty, refer remedy to a QUALIFIED technician or contact TN/Manning.

**POWER**

A. System does not function when power switch turned on (AC operation)

1. Fuse F1 blown
   a. Replace Fuse F1

2. AC power not connected
   a. Connected proper AC power to unit

3. Power switch not in AC position
   a. Set power switch to AC position

4. Defective PC board
   a. *Contact factory for assistance

B. System does not function when power switch turned on (DC operation)

1. Polarity reversed causing fuse F2 to blow
   a. Reconnect wiring to obtain correct polarity
   b. Replace Fuse F2

2. Low battery
   a. Charge battery or replace with fully charged battery

3. Power switch not in DC position
   a. Set power switch to DC position

4. DC power not applied to correct terminals
   a. Connect DC wires to proper terminals

5. Wrong size DC wires
   a. Check placarding on rear of unit and install correct size wires

6. Defective PC board
   a. *Contact factory

**ECHOES/METER**

A. Weak or lost echo

1. Transducer incorrectly aligned with target
   a. Align transducer (see Paragraph 3.3)
2. Extreme roughness or foam on surface of target
   a. Relocate transducer to target with smooth surface
   b. Install baffles to eliminate turbulence or foam

3. Transducer not connected to unit or open/short in transducer cable
   a. Connect transducer cable to unit
   b. Close open circuit(s)
   c. Open short in cable

4. Low Battery
   a. Charge battery or replace with fully charged battery

B. Echo LED flashing and meter indication over 100 percent
   1. Unit under range
      a. Calibrate zero pot (see Paragraph 3.2)

C. Echo LED flashing and meter indication 100 percent
   1. Over range, over span, or both
      a. Calibrate span and meter range pot (see Paragraph 3.2)

D. Echo LED ON (not flashing)
   1. Transducer not correctly aimed for maximum echo return
   2. Transducer not connected to unit
      a. Connect transducer to unit
ECHOES/METER (Cont'd)

E. Meter bouncing

1. Target moving (ripples, waves, or severe air turbulence between transducer and surface)
   a. Place dampen switch (S1) up
   b. Install baffles to quiet surface and reduce air turbulence

(Level/Flow)

A. Discrepancy between level to flow data (UTF/UTC)

1. Incorrect Flow Curve for type of channel
   a. Select correct flow curve

2. Incorrect channel shape
   a. Change channel shape to match selected Flow Curve.

OUTPUTS

A. ALARMS (4-20 mA/1-5V)
   1 - 3
   4 - 6 (option)
   LED's do not light when preset level or flow exceeded (outputs in-

B. Recorder Event Marker does not mark time of sample taking

1. Sample rate too fast
   a. Set sample rate correctly (see Paragraph 3.3.3)

OPTIONAL EQUIPMENT

A. Recorder malfunctioning operative)

   a. Refer to Recorder manual

B. Recorder Event Marker

   1. Sample rate too fast
      a. Set sample rate correctly (see Paragraph 3.3.3)
### OPTIONAL EQUIPMENT (Cont’d)

<table>
<thead>
<tr>
<th>Category</th>
<th>Issue</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>C. Counter not operating or is counting incorrectly</td>
<td>1. Incorrect max flow input setting</td>
<td>a. See Paragraph 3.2.5</td>
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<tr>
<td></td>
<td>2. Digit wheel(s) sticking</td>
<td>a. *Replace counter</td>
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<tr>
<td>D. Sampler does not take samples</td>
<td>1. Fuse F1 blown</td>
<td>a. Replace fuse F1 (1/4 amp)</td>
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<tr>
<td></td>
<td>2. Sampler not connected at terminals</td>
<td>a. Connect sampler to terminals (see Figure 3-10)</td>
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<tr>
<td></td>
<td>3. Sampler inoperative</td>
<td>a. Check by sorting leads to sampler</td>
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<tr>
<td>E. Sample taken at wrong flow increments</td>
<td>1. Sample switch incorrectly set</td>
<td>a. Set sample switch correctly (see Paragraph 3.3.3)</td>
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<tr>
<td>F. Heater strip does not operate below 32°F (0°C)</td>
<td>1. Fuse blown</td>
<td>a. Replace fuse</td>
</tr>
<tr>
<td></td>
<td>2. Wiring incorrect</td>
<td>a. See Figure 3-9</td>
</tr>
<tr>
<td>G. Heater strip gets too hot or too cold</td>
<td>1. Thermostat malfunctioning</td>
<td>a. *Replace defective thermostat</td>
</tr>
</tbody>
</table>
4.3 INSTRUCTIONS FOR RETURNING INSTRUMENTS FOR REPAIR

4.3.1 Call or write our service department before returning any instrument for repair. Simple difficulties can often be diagnosed over the phone.

4.3.2 Remove the main panel from the cabinet at the hinges - this provides the best protection for the boards, and allows conduits, etc., to remain intact with the cabinet.

Pack the instrument carefully, preferably in the original carton, and ship to your closest service dept., listed below. Be sure to enclose a note explaining the defect and a purchase order authorizing the repair plus your assigned R.M.A. # (Return Materials Authorization) from the factory.

ATTN: Service Department
TN Technologies, Inc.
manning products
2555 N IH35
Round Rock, Texas 78664
Phone: (512) 388-9100
FAX: (512) 388-9200
Telex: 77-6413

Permanent equipment:

For field service assistance on permanent equipment, contact the above service center.
SECTION V

ILLUSTRATED PARTS LIST

5.1 PURPOSE

The illustrated parts list is intended for use in provisioning, requisitioning, storing, and issuing replaceable parts and in the identification of new and reclaimed parts. It contains all parts information necessary for replacement of components.

5.2 HOW TO USE THE ILLUSTRATED PARTS LIST

a. Figure and item number are given in the left hand column to correlate the illustration to the listing.

b. Part number is shown in the second column.

c. Effectivity is shown in the fourth column and relates, where applicable, list parts to specific serial numbers of equipment.

d. Units per assembly, shown in the right hand column, shows the number of units required per assembly.
<table>
<thead>
<tr>
<th>FIG. &amp; ITEM NO.</th>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
<th>EFF. PER ASSY.</th>
<th>UNITS REF</th>
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FIGURE 5-2A. UT"X"-2100A LOGIC PRINTED CIRCUIT BOARD
03414-00 BOARD ASSEMBLY
FIGURE 5-2B. UT"X"-2100A LOGIC PRINTED CIRCUIT BOARD
05680-00 BOARD ASSEMBLY

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FIGURE 5-3. TOTALIZER PRINTED CIRCUIT BOARD
FIGURE 5-4. ALARM CARD PRINTED CIRCUIT BOARD