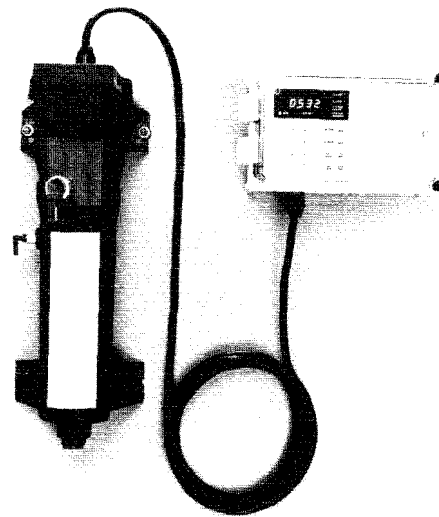


Model 1720C
LOW RANGE
PROCESS TURBIDIMETER
Instruction Manual



CERTIFICATION

Hach Company certifies this instrument was tested thoroughly, inspected and found to meet its published specifications when it was shipped from the factory.

The 1720C has been tested and is certified as indicated to the following instrumentation standards:

UL 1262 (Product Safety): Listed by DS&G/ETL (Listing #H0492805390)

CSA C22.2 No. 142 (Product Safety): Listed by DS&G/ETL (Certification #H0492805390)

EN61010-1/IEC 1010-1 per 73/23/EEC Low Voltage (Product Safety): Supporting test records by DS&G/ETL certified compliance by Hach Company

FCC Part 15, Sub-part B Class A Limits: Supporting test records by DS&G/ETL, certified compliance by Hach Company

Canadian Radio Interference Regulation, Chapter 1374, Class A

EN 55011/CISPR 11 "A" Limits (EMI) per 89/336/EEC EMC: Supporting test records by DS&G/ETL, certified compliance by Hach Company

EN 50082-1 (Immunity) per 89/336/EEC EMC: Tested by DS&G and certified by Hach Company. Standards include:

IEC 801-2 (ESD)

IEC 801-3 (RF & EM Field)

IEC 801-4 (Fast Transient)

Edison Testing Laboratories (ETL) and Dash Straus & Goodhue, Inc. (DS&G) are Nationally Recognized Testing Laboratories (NRTLs) recognized by the Occupational Safety and Health Administration (OSHA) as acceptable Test Laboratories for approval of industrial and scientific instrumentation to UL Standards.

Under the terms of the US/Canadian "Free Trade Agreement", Article 6051989 approved U.S. and Canadian test agencies must be allowed to test one-another's national safety standards. ETL is accredited by the Standards Council of Canada (SCC) and listed in Section III of the National Standards System's Directory of Accredited Certification Organizations. Additionally, ETL is acknowledged and recognized as an acceptable test certification agency for Canadian Safety Standards by all provincial governments of Canada

RADIO FREQUENCY INTERFERENCE

"This digital apparatus does not exceed the Class A limits for radio noise emissions from digital apparatus set out in the Radio Interference Regulations of the Canadian Department of Communications."

"Le présent appareil numérique n'émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de la classe A prescrites dans le Règlement sur le brouillage radioélectrique édicté par le ministère des Communications du Canada."

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Warning: Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. **These limits are** designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

RADIO FREQUENCY INTERFERENCE (continued)

Shielded cables must be used with this unit to ensure compliance with the Class A FCC limits. Because this instrument operates on and generates radio frequency energy, interference to radio and television reception may occur. If such interference does occur, the operator should take the necessary steps to correct the interference.

The following techniques of reducing interference problems are applied easily.

1. Disconnect power from the Analyzer to verify that it is the source of the interference.
2. If the Analyzer is plugged into the same outlet as the device with which it is interfering, try another outlet.
3. Move the Analyzer away from the device receiving the interference.
4. Reposition the receiving antenna for the device receiving the interference.
5. Try combinations of the above.

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SAFETY PRECAUTIONS

Please read this entire manual before attempting to unpack, set up, or operate this instrument. Pay particular attention to all warnings, cautions and notes. Failure to do so could result in serious injury to the operator or damage to the equipment.

Use of Hazard Information

If multiple hazards exist, the signal word corresponding to the greatest hazard shall be used.

DANGER

Indicates an imminently hazardous situation which, if not avoided will result in death or serious injury

WARNING

indicates a potentially hazardous situation that could result in death or serious injury

CAUTION

Indicates a potentially hazardous situation that may result in minor or moderate injury

NOTE

Information that requires special emphasis

SHALL

This word understood to be mandatory

SHOULD

This word understood to be advisory

Precautionary Labels


Please pay particular attention to labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed.




This symbol, if noted on the instrument, references the Instruction Manual for operational and or safety information.

 Section 1.1 Instrument Description

 Section 5.7 Electrical Connections

 Section 5.7.1 Power

 Section 5.7.2 Alarms

SPECIFICATIONS

(Specifications subject to change without notice)

Range: 0-100 nephelometric turbidity units (NTU)

Accuracy*: $\pm 2\%$ from 0-30 NTU; $\pm 5\%$ of reading from 30-100 NTU

Resolution: 0.001 NTU or 0.0001 NTU below 0.1 NTU. Selectable

Repeatability: Better than $\pm 1.0\%$ or ± 0.002 NTU

Response Time: For a full scale step change, initial response in 2 1/2 minutes, 90% response in 5 minutes at 750 mL/min flow rate. Varies with flow rate

Sample Flow Required: 250-750 mL/minute (3.5 to 11.5 gph)

Sample Temperature Range: 0 to 50 °C

Operating Temperature Range: 0 to 50 °C

Recorder Output: Selectable for 0-10 mV, 0-100 mV, 0-1 V or 4-20 mA. Output span programmable over any portion of the 0-100 NTU range

Alarms: Two turbidity set-point alarms, instrument warning and system shutdown alarms are each equipped with an SPDT relay with unpowered contacts rated for 5A resistive load at 230 Vac

Power Requirements: 115/230 Vac, 50/60 Hz, switch selectable; 0.5/0.3A

Sample Inlet Fitting: 1/8" NPT female, 1/4" hose barb provided

Drain Fitting: 3/4" NPT female, 3/4" hose barb provided

Control Unit Case: NEMA-4X fiberglass instrument enclosure with clear polycarbonate cover. Suitable for indoor installation.

Dimensions: W x H x D

Control Unit 34.3 22.8 19.0 cm (13.5 X 9 X 7.5")

Turbidimeter Body: 21.6 60.9 20.3 cm (8.5 X 24 X 8")

Mounting: Wall mount (optional floor stands available)

Shipping Weight: 11.3 kg 25 lbs)

*The 1720C Turbidimeter may be sensitive to electromagnetic fields of 3 volts per meter, see Supplemental Compliance Information in this instrument manual.



OPERATION

WARNING

Handling chemical samples, standards, and reagents can be dangerous. Review the necessary Material Safety Data Sheets and become familiar with all safety procedures before handling any chemicals.

ADVERTENCIA

La manipulacion de muestras quimicas, patrones y reactivos puede ser peligrosa. Antes de manipular cualquier productor quimico, conviene leer las Fichas Tecnicas de Seguridad y familiarizarse con los procedimientos de sugeridad.

ADVERTENCIA

A manipulacao de amostras, padroes e reagentes quimicos pode serperigosa. Reveja as necessarias Fichas Tecnicas de Seguranca do Material e familiarizese corn os procedimentos de seguranca antes de manipular quaisquer substancias quimicas.

ATTENTION

La manipulation des echantillons chimiques, etalons et reactifs peut etre dangereuse. Lire les fiches de donnees de securite des produits necessaires et se familiariser avec toutes les procedures de securite avant de manipuler tout produit chimique.

WARNHINWEIS

Da das Arbeiten mit chemikalischen Proben, Standard.s, Reagenzien und Abfallen mit Gcfahren verbunden ist, empfiehlt die Hach Company dem Benutzer dieser Produkte dringend, sich vor der Arbeit mit sicheren Verfahrensweisen und dem richtigen Ggebrauch der Chemikalien oder Biogefahrgut zu machen und alle entsprechenden Materialsicherheitsdateenblätter aufmerksam zu lesen.

SECTION 1 GENERAL INFORMATION

1.1 Instrument Description

Hach's Model 1720C Turbidimeter is a continuous reading nephelometric turbidimeter designed for low-range turbidity monitoring. It features an automatic-ranging digital display and is capable of measuring turbidities from 0.001 to 100.0 NTU. As with all Hach turbidimeters, calibration is based on formazin, the primary turbidity reference standard adopted by the APHA Standard Methods for the Examination of Water and Wastewater and the U.S. Environmental Protection Agency (EPA). The instrument consists of a control unit, head assembly and turbidimeter body (see Figure 1).

WARNING

The 1720C Turbidimeter is not designed for use with samples that are flammable or explosive in nature. If any sample solution other than water is used in this product, test the sample/product compatibility to assure user safety and proper product performance.

ADVERTÊNCIA

O Turbidímetro 1720C não é concebido para uso com amostras que sejam inflamáveis ou explosivas. Se qualquer solução que não seja de água se usar neste produto, dever-se-á ensaiar a compatibilidade da amostra/produto para garantir segurança ao usuário e desempenho correto do produto.

ADVERTENCIA

El Turbidímetro 1720C no está diseñado para usarse con muestras de naturaleza inflamable o explosiva. Si se empleara en este producto alguna solución de muestra que no fuera a base de agua, ponga a prueba la compatibilidad de la muestra/producto, para cerciorarse de la seguridad y del correcto funcionamiento del producto.

ATTENTION

Le turbidimètre 1720C n'est pas prévu pour utilisation avec des échantillons de nature inflammable ou explosive*. Pour toute solution d'échantillon autre que de l'eau utilisée avec cet appareil, tester la compatibilité échantillon/appareil pour assurer la sécurité de l'utilisateur et le fonctionnement correct de l'appareil.

WARNHINWEIS

Das Trübungsmeßgerät 1720C darf nicht in Verbindung mit Proben benutzt werden, die entflammbar oder explosiv sind. Wenn irgendeine andere Lösung als Wasser in diesem Gerät analysiert werden soll, muß die Proben/Gerät-Kompatibilität getestet werden, um die Sicherheit des Benutzers und korrektes Arbeiten des Gerätes zu gewährleisten.

1.1.1 Control Unit and Head Assembly

All the electronics are contained in the control unit and head assembly. The control unit enclosure houses the keyboard microprocessor board and power supply components. Optical components (i.e., the lamp and photocell plus a preamplifier board) are contained in the head assembly. The 20-foot cable linking the control unit and head assembly is installed at the factory.

Operating controls and indicators, except for the power switch, are on the keyboard. Twelve numeric keys and nine function keys are used to program the instrument for recorder output minimums and maximums and for turbidity level alarm set points as well as to perform a number of diagnostic self-tests and programming operations.

Sample turbidity is displayed continually by the four-digit LED display during normal operations. Because of the automatic-ranging feature with automatic decimal point positioning, no range selection is needed. Indicators for turbidity level alarm conditions and certain critical system malfunctions or impending malfunctions also are provided on the keyboard.

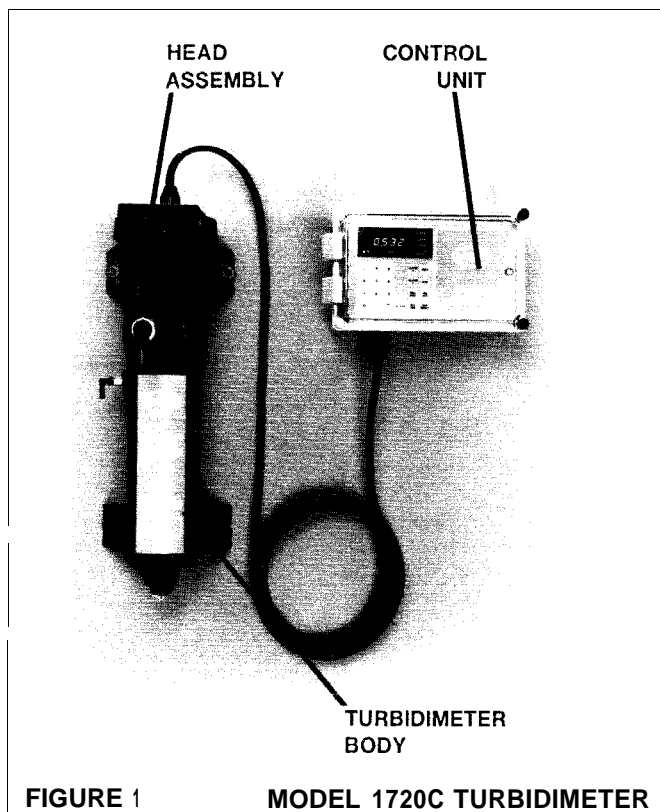


FIGURE 1

MODEL 1720C TURBIDIMETER

Recorder outputs of 0- 10 mV, 0- 100 mV, 0-1 V or 4-20 mA are available to drive a chart recorder.

Recorder span minimum and maximum values in NTUs can be programmed by the operator at the turbidimeter keyboard.

Programmable alarm circuits provide relay closures, both normally open and normally closed, for two selectable turbidity level set points. Set points can be programmed by the operator anywhere within the over-ail range. Separate system warning and system alarm features provide automatic self-testing, diagnostics that can detect a number of possible malfunctions and initiate alarm relay closures indicating a need of operator attention.

An optional serial input/output interface: allowing the 1720C Turbidimeter to supply data to an external printer or computer and receive command inputs from a computer, is available.

The control unit case is designed to meet NEMA-type 4X industrial enclosure requirements. It is constructed of corrosion-proof materials. Keyboard indicators are fully visible through the clear plastic front cover. External mounting blocks provide wall-mounting capability without affecting the environmental integrity of the case. An optional floor stand is available, Electrical access holes are sized for 1/2-inch conduit.

1.1.2 Turbidimeter Body

The turbidimeter body is the unit through which the monitored sample flows and is measured for turbidity. The optical head assembly is placed in the top of the body with the photocell submerged in the sample. An internal bubble trap channels the sample through a series of baffles; entrained bubbles escape and are vented from the turbidimeter body. The bubble trap can be removed for cleaning. The body is designed for wall-mounting but may be installed on an optional floor stand.

The sample inlet port is fitted with a 1/46" to 1/8" NPT adapter fitting. A hose barb adapter fitting also is supplied. The drain fitting is a 3/4" NPT to 3/4" ID tubing hose barb elbow.

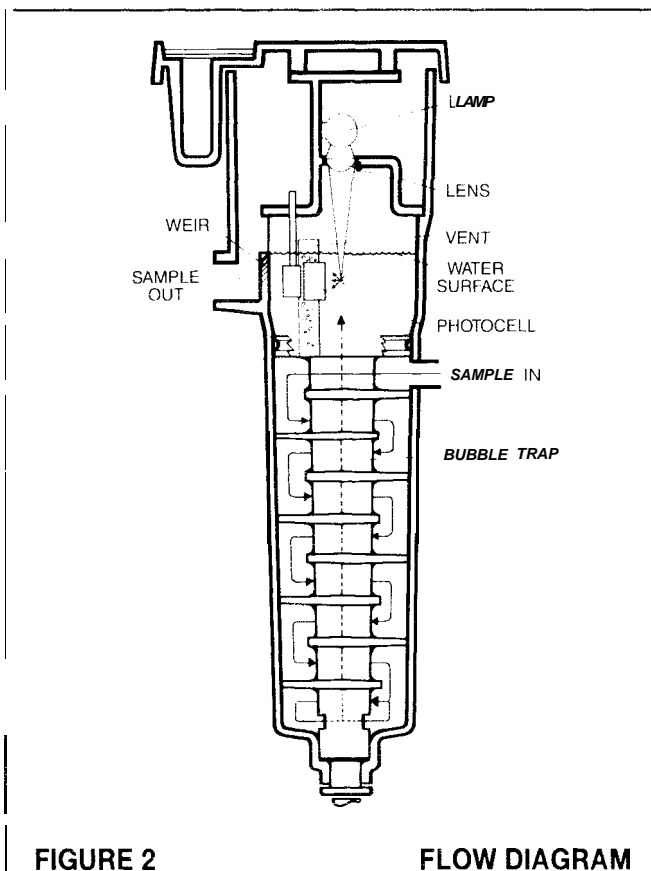
1.2 Principle of Operation

Turbidity is measured in the 1720C Turbidimeter by directing a strong beam of light from the optical head

assembly down into The sample in the turbidimeter body. Light scattered at 90° by suspended particles in the sample is detected by the submerged photocell. Figure 2 presents a diagram of the instrument optics and sample flow path.

The amount of light scattered is proportional to the turbidity of the sample. If the turbidity of the sample is negligible, little light will be scattered to the photocell and the turbidity reading will be low. High turbidity, on the other hand, will cause a high level of light scattering and result in a high reading. Because of the high sensitivity of this instrument, turbidities as low as 0.001 NUT can be measured accurately.

Sample enters the turbidimeter body and flows through a baffle network that forces a downward flow of the sample. The downward flow (relatively slow) allows bubbles to rise and either cling to surfaces of the baffle or rise to the surface and vent to atmosphere. At the bottom of the baffling, sample enters the center column of the bubble trap and rises up into the measuring chamber and spills over the weir to the drain port



SECTION 2 START UP

2.1 Introduction

This section provides instructions for initially placing the turbidimeter in operation or restarting the instrument after an extended shutdown.

2.2 Starting Sample Flow

Start sample flow through the instrument by opening the sample supply valve. Allow the turbidimeter to run long enough for the tubing and body to become

completely wetted and the reading on the digital display to stabilize. One to two hours may be required initially.

2.3 Description of Keyboard

Figure 3 illustrates the control unit keyboard and Table 1 describes the function of each key and indicator.

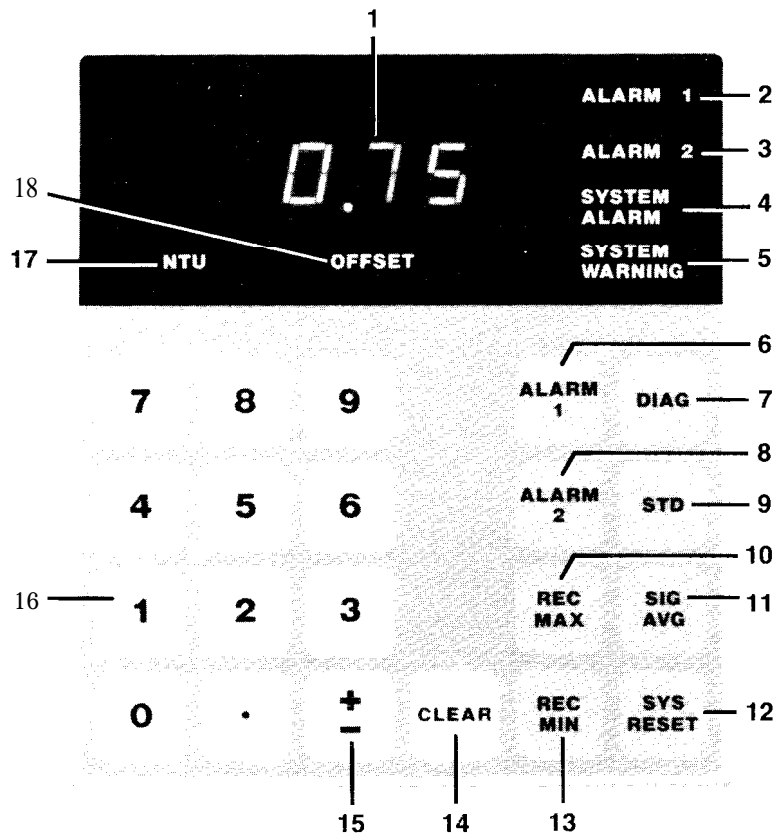


FIGURE 3

KEYBOARD

Table 1 Keyboard Description

Item No.	Key/indicator	Description
1	Display	Four-digit display shows turbidity level in nephelometric turbidity units during normal operation. In an overrange condition, the display flashes 100.0 intermittently. Decimal point is positioned automatically. Also displays programming and diagnostic entries. Software configuration code appears momentarily when instrument is first turned on and following system reset.
2	ALARM 1 LED	Indicates turbidity level ALARM 1 set point has been exceeded
3	ALARM 2 LED	Indicates turbidity level ALARM 2 set point has been exceeded
4	SYSTEM ALARM LED	Indicates a malfunction which has halted operation. Requires operator intervention for correction and restart
5	SYSTEM WARNING LED	Indicates turbidimeter has detected a possible malfunction requiring investigation. Instrument continues to operate.
6	ALARM 1 Key	Used to enter and recall ALARM 1 turbidity level set point
7	DIAG Key	Used to perform programming and self-test operations. Refer to section 2.4 and 7.2.
8	ALARM 2 Key	Used to enter and recall ALARM 2 turbidity level set point
9	STD Key	Used to enter the value of a known standard or sample being supplied to the turbidimeter for calibration
10	REC MAX Key	Used to enter and recall full-scale value of the recorder output in NTUs
11	SIG AVG Key	Used to enter and recall the time duration (seconds) the measurements are averaged; 6, 30, 60 and 90 seconds. Average measurement is updated every three seconds.
12	SYS RESET	Clears alarms and warnings and initiates self tests; then restarts for turbidity measurement
13	REC MIN Key	Used to enter and recall minimum value of recorder output in NTUs
14	CLEAR Key	Used to clear numerical entry error and/or return display to turbidity reading after some other display
15	± Key	Changes sign (positive or negative) of numerical value being entered
16	Numeric Keys	Used to enter numeric portion of commands
17	NTU LED	Lights when display is reading turbidity. Flashes when alarms are locked out
18	OFFSET LED	Lights when pure water turbidity offset or some nonstandard offset has been entered for subtraction from turbidity measurement

2.4 Instrument Programming

Programmable functions are set to default values established at the factory when power is first applied to the instrument. Once programmed to operate according to your needs, a battery back-up circuit will protect the program in the event of a power failure.

All programmable functions are set and checked via the keyboard. Most of the basic operational functions are programmed with specific dedicated keys. Other are controlled by codes entered with the DIAG (diagnostic) key. To check the setting of any dedicated key function simply press the key and the setting will be shown in the display. To change the setting, the new setting is entered into the display by using the numeric keypad before pressing the function key. If the keyboard is in the lockout mode, see *section 2.4.11*, or if an invalid entry is attempted, a triple "beep" will be sounded -- indicating the entry was not accepted.

When making keyboard entries, the display will show the entries for approximately 10 seconds after the last key stroke. The display will then revert automatically to a turbidity display. Pressing the CLEAR key after keyboard entries will return the display to turbidity immediately.

The following steps describe how to program the turbidimeter to meet your needs:

2.4.1 Line Power Frequency Setting

The turbidimeter is factory-set for a line voltage frequency of 60 Hz. If the instrument is to be operated on 50-Hz power, the proper frequency must be entered. Display the current line voltage frequency setting by pressing 19 DIAG. To change the setting, press 20 DIAG. Check to make sure the setting has been changed correctly by pressing 19 DIAG.

2.4.2 Turbidity Level Set Point Alarm Settings

Turbidity level ALARMS 1 and 2 are two completely independent, fully programmable alarm systems that provide an alarm indication when the programmed turbidity limits are exceeded. Either one or both can be set to actuate at any point within the 0- 100 NTU range. Either also can be set to actuate when turbidity goes above the set point (high alarm) or when turbidity goes below the set point (low alarm).

To set the alarm as a high alarm (actuates when turbidity goes above set point), enter the desired set point into the display, using the numeric keypad and press ALARM 1 or ALARM 2 as appropriate. To set the alarm as a low alarm (actuates when turbidity goes below set point), enter the

desired set point into the display as a negative number and press the appropriate key.

For example, to set ALARM 1 as a low alarm at 10 NTU and ALARM 2 as a high alarm at 30 NTU, enter by pressing -10, ALARM 1, 30 ALARM 2. Press the alarm keys again to verify the correct settings.

2.4.3 Alarm Hysteresis Setting

The alarm hysteresis default value is 5% of the turbidity level alarm set point. This means that if the alarm was set for 0.8 NTU, the alarm condition would occur at 0.8 NTU and remain on until the turbidity dropped back 5% below the alarm point or to 0.76 NTU.

This feature is to prevent alarms from cycling on and off if the turbidity level remained near the alarm set point. Other hysteresis options are 2.5% and 10%. To select the desired hysteresis, enter 12 DIAG for 2.5%, 13 DIAG for 5% or 14 DIAG for 10% hysteresis. The alarm hysteresis value can be recalled by pressing 15 DIAG.

2.4.4 Alarm Lockout Setting

Alarm actuation can be disabled temporarily to prevent inadvertent alarms during calibration and maintenance. To lock out the alarm function for 30 minutes, press 9 DIAG. Alarm actuation will be disabled for 30 minutes, after which the alarm circuits will reactivate automatically. Alarms can be reactivated at any time by pressing the SYS RESET (system reset) key. The NTU LED flashes while alarms are locked out.

2.4.5 Recorder Output Span Settings

The recorder output of the turbidimeter can be set to cover any portion of the 0- 100 NTU range. This feature allows the operator to bracket the normal turbidity level with the recorder output for the desired level of resolution on the recorder. If the turbidity in the sample normally is 0.5 to 0.7 NTU, the recorder output span can be set for 0 to 1 NTU.

Initially, an output span the operator knows will cover the range of turbidity in the sample should be selected. With experience, the operator will be able to determine the best span for the particular application by monitoring turbidity levels over time.

Once the proper output span range is determined, use the numeric keypad and press the REC MIN (recorder minimum) key to enter the low end of the range into the display. To enter the top end of the range into the display use the numeric keypad and press the REC MAX (recorder

maximum)key. For example to enter an output span of 0-1 NTU, press 0 REC MIN and 1 REC MAX. Press the REC MIN and REC MAX keys again to verify the correct settings.

2.4.6 Recorder Output Calibration

The 1720C Turbidimeter is capable of self-calibrating the voltage or current limits to ensure a 0-100 mV output is truly 0-100 mV or a 4-20 mA output is exactly 4-20 mA. This programmed capability eliminates the need for a volt meter or milliammeter for output calibration. Calibrating the recorder output involves a two part procedure. First, a coarse adjustment to set the voltage (follow step 1 below) or current limit (follow step 2 below, is completed. Second, a fine tuning (step 3 below) is performed.

1. If a voltage output has been selected, voltage limits are calibrated automatically by entering 4 DIAG. Microprocessor programming routines will measure and calibrate the output limits. This procedure will set the output to approximately +/- 1%. Fine tune the recorder output by following the procedure in step 3.
2. If the 4-20 mA output is used, it is self-calibrating by selecting the 4-20 mA CAL output with the recorder output selector switch (see Figure 8).
 - a. Set the 4-20 mA CAL switch to on (closed). Because only one switch should be on at any one time, all other switches should be off (open) while the 4-20 mA CAL switch is on during self-calibration. There will be no recorder output while the 4-20 mA CAL switch is selected.
 - b. Using the keyboard, enter 3 DIAG.
 - c. Using the recorder output selector switches, turn the 4-20 mA CAL switch off and then turn the 4-20 mA on. This procedure will set the output to approximately +/- 1%. Fine tune the recorder output by following the procedure in step 3.
3. To fine tune the calibration, press 0 DIAG and observe The recorder reading. The recorder should indicate the low end of the chart exactly. If the recorder zero reading is not correct, proceed as follows:
 - a. If the recorder zero reads too high, press 8 DIAG. The recorder reading will move downscale. When the recorder indicates zero, press any key.
 - b. If the recorder zero reads too low, press 7 DIAG. The recorder reading will move up-scale. When the recorder indicates zero press any key.

Press 1 DIAG and observe the recorder reading. The recorder should indicate the high end of the chart exactly. If the recorder reading is not correct, proceed as follows:

- a. If the recorder full scale reads too high, press 6 DIAG. The recorder reading will move downscale. When the recorder reads full scale, press any key.
- b. If the recorder full scale reads too low, press 5 DIAG. The recorder reading will move upscale. When the recorder reads full scale, press any key.

2.4.7 Turbidity Measurement Averaging

With the 1720C Turbidimeter comes the capability of averaging measurements taken over a selectable period of time to provide a more stable output. By selecting 6, 30, 60 or 90 signal average, the instrument will compute and display the average measurement from measurements taken over the last 6, 30, 60 or 90 seconds, respectively. For example, if you wish to average measurements taken over a 60-second period, enter 60 SIG AVG (signal average). The signal average setting can be recalled by pressing SIG AVG. The default setting is 90 seconds. Signal average of 6 seconds is used for calibration. After 30 minutes, the signal average will return to the last signal average value entered other than 6.

2.4.8 Bubble Rejection Mode

Occasionally, larger air bubbles, primarily caused by the dissolution of dissolved gasses from the sample in the turbidimeter body, will pass in front of the detector and cause brief increases or spikes in the turbidity reading. These spikes can make a recorder chart difficult to read, and false alarms can be triggered when high turbidity set point alarms are used.

Selecting the bubble reject mode will eliminate any momentary spikes in the reading and yield a smooth, stable output. This mode is switched on and off by entering 30 DIAG. Determine whether the bubble reject mode is on or off by entering 29 DIAG. If the bubble reject is off, the display will show 0; if it is on, the display will show 1. To change this status, enter 30 DIAG and verify the change by entering 29 DIAG. Normal operation with bubble rejection on is recommended.

2.4.9 Pure Water Turbidity Offset

Pure, particle-free water has a finite, measurable turbidity due to light scattering from the water molecules. The exact value of pure water turbidity as measured by any turbidimeter varies from one turbidimeter design to the next, depending on several design characteristics. The

turbidity of pure water on the 1720C has been established at 0.015 NTU.

The 1720C has the capability to offset this fixed value so that particle-free water will read 0.000 NTU, and the instrument display will read particulate turbidity only. This mode is selected by entering 25 DIAG. The 0.015 NTU value of pure water will then be subtracted from all measurements and the offset indicator on the control unit display will be lit. The normal display mode is restored by entering 26 DIAG.

It also is possible to establish other offsets by defining the current sample as zero. In certain applications where relative change from a "normal" process baseline is more important than an absolute NTU value, the instrument display can be offset to zero at any point by entering 27 DIAG. The display will then show change in NTU from that point: the offset indicator will be lit and a system warning will be set to indicate a "nonstandard" offset. The exact value of the offset can be recalled by entering 28 DIAG. The normal display mode is restored and the offset is cancelled by entering 26 DIAG.

2.4.10 Low Turbidity Display Resolution

Two options are provided for display resolution when monitoring sample water below 0.1 NTU in turbidity: 0.001 NTU and 0.0001 NTU. The default resolution is

0.001. Resolution is changed by entering 55 DIAG and the current status is verified by entering 54 DIAG. The display will show 0 for 0.001 NTU resolution or 1 for 0.0001 NTU resolution. The latter setting would be used only for very high purity water.

2.4.11 Keyboard Lockout

To prevent unauthorized or inadvertent changes to turbidimeter programming or operation, a keyboard lockout program is available. On initial start-up, the keyboard is unlocked to permit programming and start-up operations. Once programmed, the keyboard can be functionally locked. It will continue to allow display of programmed settings by pressing various keys, but no changes to settings will be accepted.

The keyboard can be locked or unlocked by entering the appropriate code listed in Table 2 followed by pressing the DIAG key.

Table Keyboard Lockout

Diagnostic Code	Description
6234	Locks keyboard permanently
6345	Unlocks keyboard permanently
6123	Unlocks keyboard for five minutes

SECTION 3 INSTRUMENT OPERATION

3.1 Instrument Observation

Once the turbidimeter is on line and normal operations are defined operator requirements are limited to periodic calibration and standardization checks and maintaining peripheral equipment such as a recorder or printer. Also, any system warnings should be investigated promptly to avoid a more serious malfunction. The operator should monitor the control unit indicators frequently to be aware of any abnormalities.

3.1.1 NTU Indicator

During normal operation the NTU LED will be lit -- indicating the digital display represents turbidity. A flashing light will occur if the alarms are locked out.

3.1.2 Offset Indicator

The offset indicator will be lit any time a display offset mode has been selected. Normally this would indicate the pure water turbidity offset mode has been selected (refer to section 2.4.9). If this is the case the display will show particulate turbidity only and the 0.015NTU turbidity of pure water has been subtracted automatically. The value of the offset can be recalled for confirmation by entering 28 DIAG.

3.1.3 Digital Display

The digital readout will indicate the turbidity level of the sample in nephelometric turbidity units during normal operation. Only when the keyboard is used to enter or recall some other function will the turbidity reading be interrupted. When that is done, the NTU indicator will go out. If sample turbidity is above 100 NTU, the display will show 100.0 flashing on and off.

3.1.4 Alarms 1 and 2 Indicators

These LEDs come on when the programmed alarm set points have been exceeded. If turbidity is within the set point limits, they will be off. An alarm condition may or may not require action by the operator, depending on how the alarm circuits are used. Alarm indicators will go off automatically if turbidity returns to within the set point limits.

3.1.5 System Warning Indicator

A system warning light indicates a minor malfunction may have occurred and should be investigated. The display continues to indicate sample turbidity. By entering 10 DIAG, an error code indicating the cause of the malfunction will be displayed. Refer to the Error Code Table in section 7 for error code descriptions.

3.1.6 System Alarm Indicator

This indicator lights when a malfunction has prevented instrument operation. The operator must investigate the cause of the malfunction and take corrective action to restore operation. An error code indicating the cause of the alarm will be displayed by entering 11 DIAG. Refer to the Error Code Table in section 7 for error code descriptions.

3.2 Calibration

The Model 1720C Turbidimeter is factory-calibrated before shipment. Recalibration is required after any significant maintenance or repair and at least once every four months of normal operation. A standardization check as described in section 3.3 should be performed on a monthly basis and may indicate the need for recalibration. There are two calibration methods: the calibration kit method and the comparison method. Use of the calibration kit method is strongly recommended for greatest calibration accuracy (refer to sections 6.4.1 Calibration Kit Method and 6.4.2 Comparison Method in the Installation/Maintenance section of the manual).

3.3 Standardization Checks

Monthly Standardization checks should be performed by analyzing a grab sample with a properly calibrated laboratory turbidimeter as described in section 6.4.2 Comparison Method of the Installation/Maintenance section of this manual.

3.4 Maintenance Requirements

Some maintenance activities should be performed at established intervals to ensure good long-term reliability (refer to section 6.1 Scheduled Maintenance in the Installation/Maintenance section of manual).

SECTION 4 SERIAL INTERFACE OPERATION (optional)

4.1 Description

A serial interface kit, Cat. No. 44278-00, is available as a user-installed option for the 1720C Turbidimeter. The board serves as a direct connection from the instrument to a printer or a computer to provide a permanent record of sample turbidity levels and the occurrence of any alarm conditions. Connection with a computer allows the computer to compile and store sample turbidity data and to control turbidimeter programming and operation from a remote location. (Installation of the serial interface board is covered in section 5.9 Serial Interface Installation in the Installation/Maintenance section of this manual.

The interface board was designed primarily to permit direct connection of the turbidimeter data output to an external printer. Interface with an external computer requires computer programming to permit communication with and control of the turbidimeter. Due to the variety of computer equipment and programming formats in use, this manual is written for an operator knowledgeable about digital interface protocols and programming requirements. The interface board can be set for two serial interface configurations: standard RS-232C format or a current loop format.

4.2 Data Communications Format

Data communications format selections of baud rate, parity, stop bit and word length other than those established as default settings may be required for compatibility with peripheral equipment. The selections are made by entering the appropriate diagnostic codes in accordance with Table 3. Default values are indicated with an asterisk.

4.3 Output to Printer

4.3.1 Data Output Interval

If a printer is to be used, the data output or print interval can be set for several choices. Print intervals can be set for print every one minute, 15, 30 or 60 minutes. Diagnostic codes pertaining to printer operation are listed in Table 4. A default setting is indicated by an asterisk.

Table 3. Data Format

Diagnostic Code	Description
31	Set 300 baud
32	Set 600 baud
33	Set 1200 baud*
34	Set 2400 baud
35	Set 4800 baud
36	Set 9600 baud
37	Recall baud rate status
38	Set parity odd
39	Set parity even
40	Parity disabled*
41	Recall parity status
42	Set one stop bit
43	Set two stop bits*
44	Recall Stop bit status
45	Set word length = 7
46	Set word length = 8*
47	Recall word length

*default values

Table 4. Printer Setup

Diagnostic Code	Description
49	Set print interval for 1 minute*
50	Set print interval for 15 minutes
51	Set print interval for 30 minutes
52	Set print interval for 60 minutes
53	Recall print interval

*default setting

4.3.2 Print Format

The data print format is set for a 20-column print width. On power-up, system reset, or on command, a data header is output to be printed. A sample header is shown in Figure 4. The data header contains

information about the turbidimeter programming
Entering 48 DIAG will initiate a print setup listing.

4.4 Computer Interface Input Commands

Instrument operation and programming can be controlled by a remote computer transmitting specific messages to the turbidimeter through the interface. Commands, sent as ASCII character strings, generate a response from the turbidimeter to acknowledge receipt of the command. The response to the remote command can be recognized by the steering character preceding the message. No handshaking lines are provided by the 1720C Turbidimeter. Thus it may be necessary to program a delay into the computer's transmitting software. At baud rate of 1200 or slower, no delay is needed; data can be transmitted continuously. For baud rate of 2400 or greater, 10 milliseconds should be programmed into the computer's transmitting software for each ASCII character. Command codes and functions and the Turbidimeter response messages are given in Table 5.

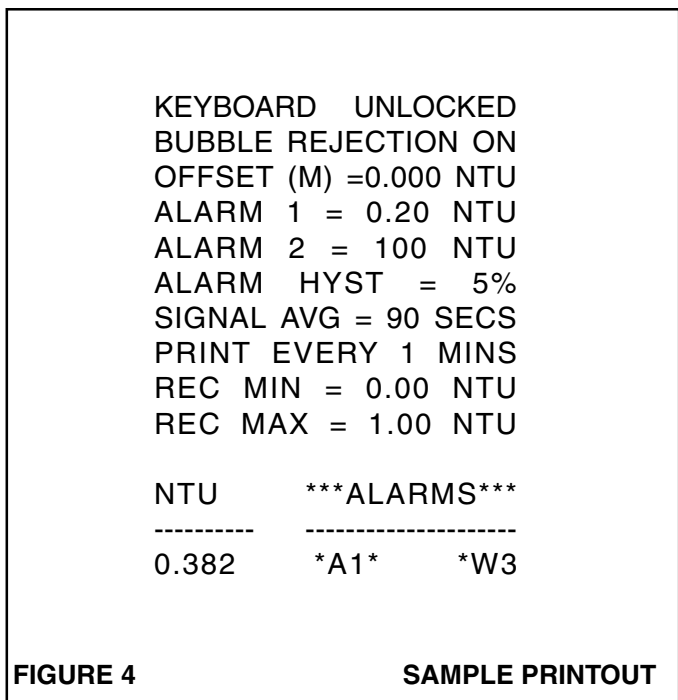


FIGURE 4

SAMPLE PRINTOUT

Table 5. Command Codes

Code	Function	Response
AL1	Recall or set alarm 1 value (-100 to 100). To set, enter AL1=value.	Value (on recall); OK (on set)
AL2	Recall or set alarm 2 value (-100 to 100). To set, enter AL2 = value.	Value (on recall); OK (on set)
RMX	Recall or set recorder maximum value (-100 to 100). To set, enter RMX = value.	Value (on recall); OK (on set)
RMN	Recall or set recorder minimum value (- 100 to 100). To set, enter RMN = value.	Value (on recall); OK (on set)
RST	Initiate system reset, clears all alarms	Prints setup
OMX	Outputs recorder maximum value. Drives recorder to maximum reading	OK
OMN	Outputs recorder minimum value. Drives recorder to minimum reading	OK
OHF	Outputs recorder mid-scale value. Drives recorder to mid-scale reading	OK
ASV	Auto setup of voltage recorder output	OK
ALO	Initiates alarm lockout	OK
RWN	Recalls system warning causes	Warning cause printed followed by OK. OK if no warning occurred
RAM	Recalls system alarm causes	System alarm cause printed followed by OK. OK if no alarm occurred.
HYS	Recall or set ALARM 1 and 2 hysteresis (2.5, 5 or 10% of alarm point) To set, enter HYS = 2.5, 5 or 10.	Selected % (on recall); OK (on set)
CST	Initiates cold start. (Returns programmed settings to default values)	Prints setup
LFS	Recalls or selects line frequency status (50 or 60 Hz). To set, enter LFS = 50 or 60.	50 or 60 011 recall); OK (on set)
SCD	Sets gain at 1.0 (default value)	OK
LST	Initiates printout of turbidimeter setup	Prints setup
PIV	Recalls or sets print interval (1, 15, 30 or 60 minutes). To set, enter PIV= value.	Selected time (on recall); OK (on set)
PAT	Recalls or sets "print on alarm" transition. To set enter PAT = value (0 = disabled, 1= enabled)	Prints 0 or 1 (on recall); OK (on set)
KLO	Initiates keyboard lockout	OK
NLO	Unlocks keyboard	OK
PSK	Initiates printout of turbidimeter internal measurements for troubleshooting	OK then prints values
REL	Initiates alarm relay open-close test	OK
SAV	Recalls or sets signal average duration (6, 30, 60 or 90 seconds). To set, enter SAV = value.	Prints seconds (on recall); OK (on set)
BRJ	Enables and disables bubble rejection function. To set, enter BRJ = 0 (disabled) or 1 (enabled)	Prints 0 or 1 (on recall); OK (on set)
RTB	Recalls last turbidity reading	Prints value
OFF	Recalls or sets NTU offset value (other offset value). To set, enter OFF =0,0. 15 (pure water turbidity offset) or 1 (NTU display)	Prints value
PVS	Initiates printout of voltage stack	Prints instrument voltages



INSTALLATION/MAINTENANCE

WARNING

Some of the tasks in this section of the manual have safety issues associated with them. Because the potential for injury to individuals and equipment exists when these safety issues are not addressed, Hach Company strongly recommends that qualified personnel conduct the installation, and that all installation personnel review the associated instructions carefully.

ADVERTENCIA

Algunas de las tareas comprendidas en esta sección del manual pueden ocasionar daños a las personas y al material si no observan las medidas de seguridad. Hach Company recomienda encarecidamente que el material sea instalado por un personal cualificado y que el personal encargado de la instalación lea atentamente estas instrucciones.

ADVERTÊNCIA

A execução de algumas tarefas previstas nesta seção do manual pode causar ferimentos as pessoas ou estragos no equipamento se não forem observadas precauções de segurança. A Hach Company recomenda vivamente que o equipamento seja instalado por pessoal qualificado e que todas as pessoas afetadas à sua instalação leiam atentamente estas instruções.

ATTENTION

Certaines tâches dans ce chapitre du mode d'emploi peuvent causer des blessures aux personnes et endommager le matériel si les consignes de sécurité ne sont pas suivies. Hach Company recommande vivement que l'installation soit faite par du personnel qualifié et que toutes les personnes effectuant l'installation lisent attentivement ces instructions.

WA R N U N G

Einige der in diesem Abschnitt der Betriebsanleitung beschriebenen Arbeiten können bei Nichtbeachtung der Sicherheitsvorschriften zu Verletzungen von Personen oder Schäden am Gerät führen. Es wird dringend empfohlen, die Installation ausschließlich von qualifiziertem Personal durchführen zu lassen; mit der Installation beauftragte Personen sollten diese Anweisungen aufmerksam lesen.

SECTION 5 INSTALLATION

The nature of tasks described in this section of the manual requires individuals to be technically knowledgeable of the associated dangers. Burns, shock, eye damage, fire and chemical exposure may occur if this work is not done by qualified personnel. Hach Company assumes individuals performing these tasks are qualified and aware of proper safety procedures. Always review appropriate Material Safety DATA Sheets (MSDS) before working with chemicals.

CAUTION

This instrument should be installed by qualified technical personnel to ensure adherence to all applicable electrical and plumbing codes.

ADVERTENCIA

Este instrumento debe ser instalado por personal técnico capacitado para asegurar el cumplimiento con todos los códigos eléctricos y de plomería aplicables.

AVISO

Este instrumento deve ser instalado por pessoal técnico qualificado para assegurar o cumprimento de todas as normas elétricas e de canalização aplicáveis.

ATTENTION

Cet appareil doit être installé par du personnel technique qualifié, afin d'assurer le respect de toutes les normes applicables d'électricité et de plomberie.

WARNHINWEIS

Um zu gewährleisten, daß alle elektrischen und sanitärinstallationstechnischen VDE-Vorschriften und gegebenenfalls die Zusatzvorschriften der zuständigen Elektrizitäts- und Wasserwerke erfüllt werden, darf dieses Gerät nur von geschultem Fachpersonal installiert werden.

5.1 Unpacking the Instrument

Remove the instrument from the shipping carton and verify that no visible damage has occurred during shipment. Be sure the following items were included in the carton.

Control Unit and Head Assembly
Turbidimeter Body
Instruction Manual
Accessory Kit Items
(listed in Section 9)

5.2 Environmental Requirements

The instrument enclosure is designed for general -duty, indoor installation. Ambient temperatures may range from 0 to 50 C (32 to 122 F) but best performance will result if it does not change rapidly. Do not mount the instrument in direct sunlight.

5.3 Selecting the Turbidimeter Location

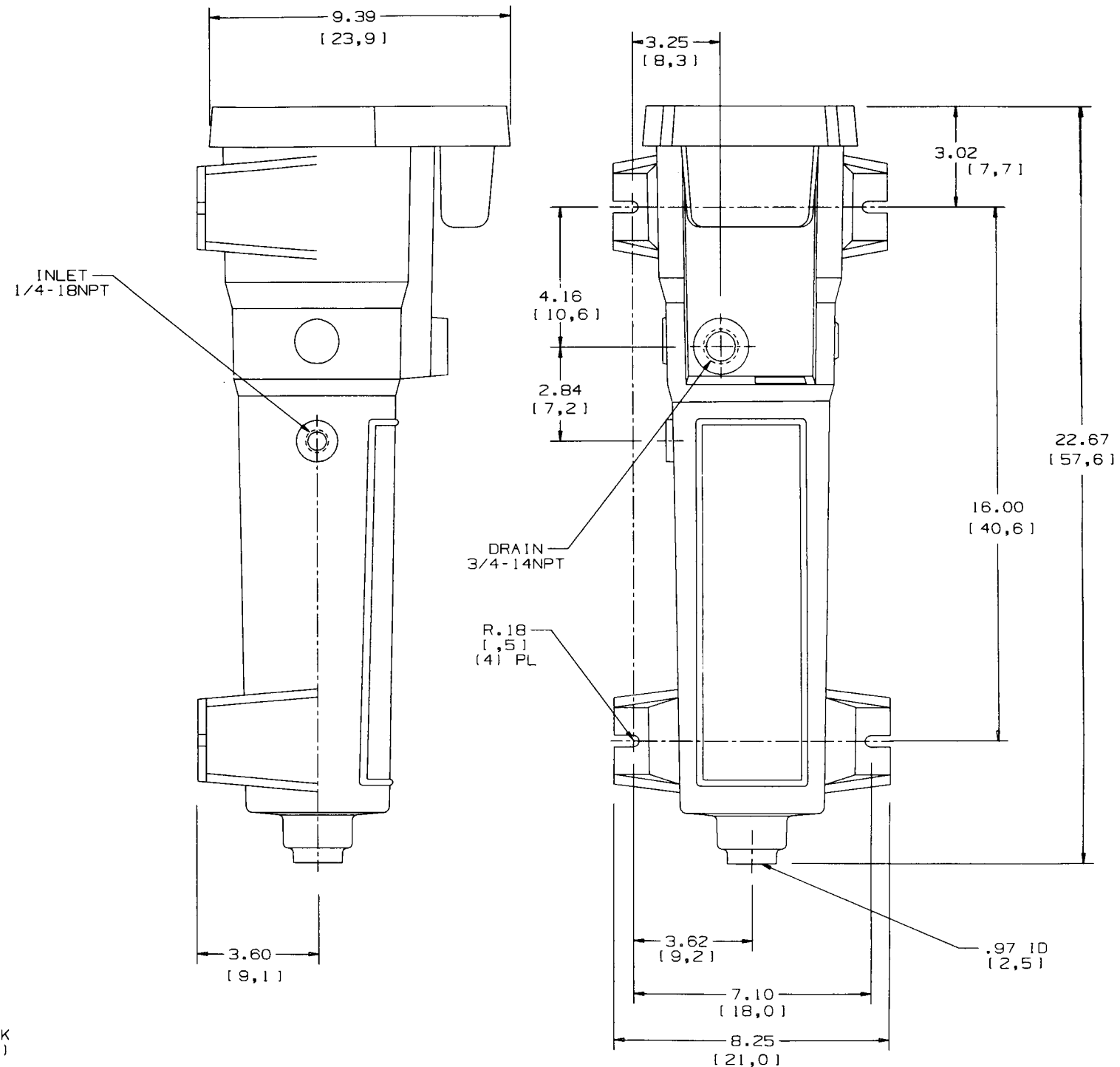
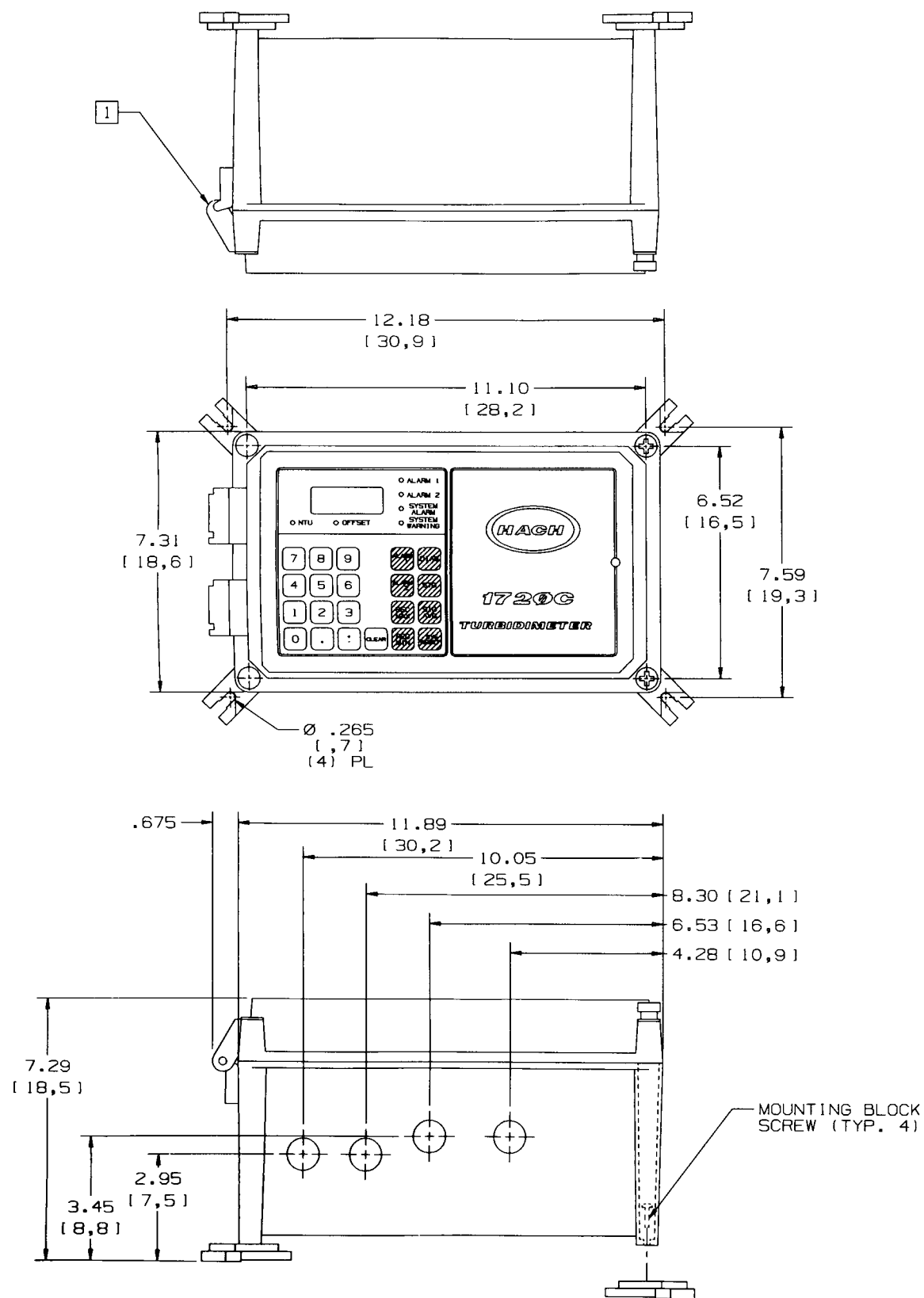
Turbidimeters should always be located as close to the sampling point as possible. The shorter the distance travelled by the sample to the turbidimeter, the faster the turbidimeter can respond and indicate changes in sample turbidity. The control unit enclosure is designed to protect the electronics from typical conditions in water treatment and industrial facilities.

5.4 Mounting the Instrument

Dimensions and other installation information are shown in Figure 5. Both the control unit and the turbidimeter body are designed for wall-mounting. They must be mounted within 20 feet of each other because of the length of the interconnecting cable. Clearance for removal of the head assembly and bubble trap from the top of the turbidimeter body should be at least 46 cm (approximately 18 inches). Floor stands are available for both units if floor or bench-mounting is preferred.

NOTES:

1 ALLOW MIN OF 3.00" CLEARANCE FOR DOOR & HINGE MOVEMENT.



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Sheet 1 of 2	G

FIGURE 5

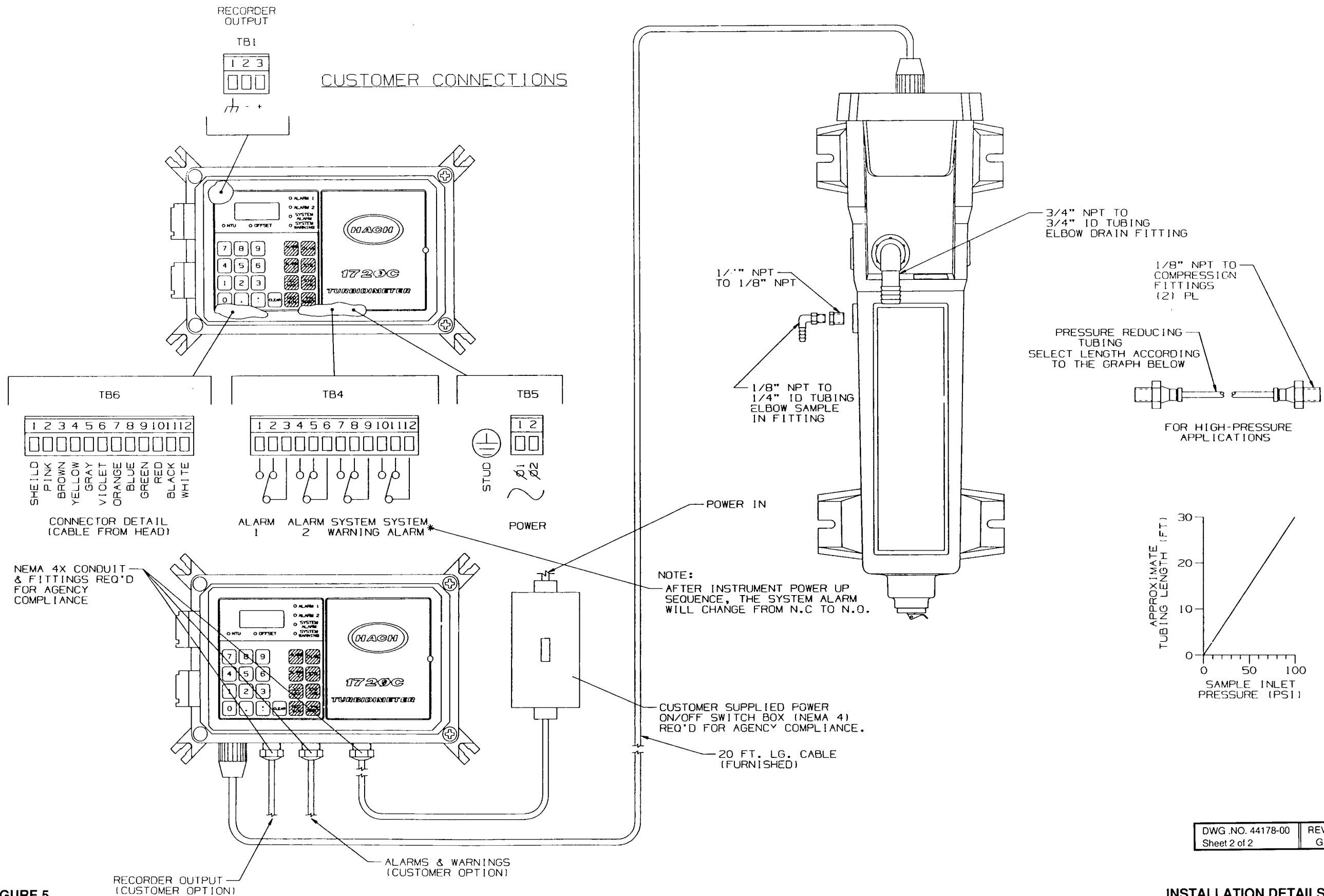


FIGURE 5

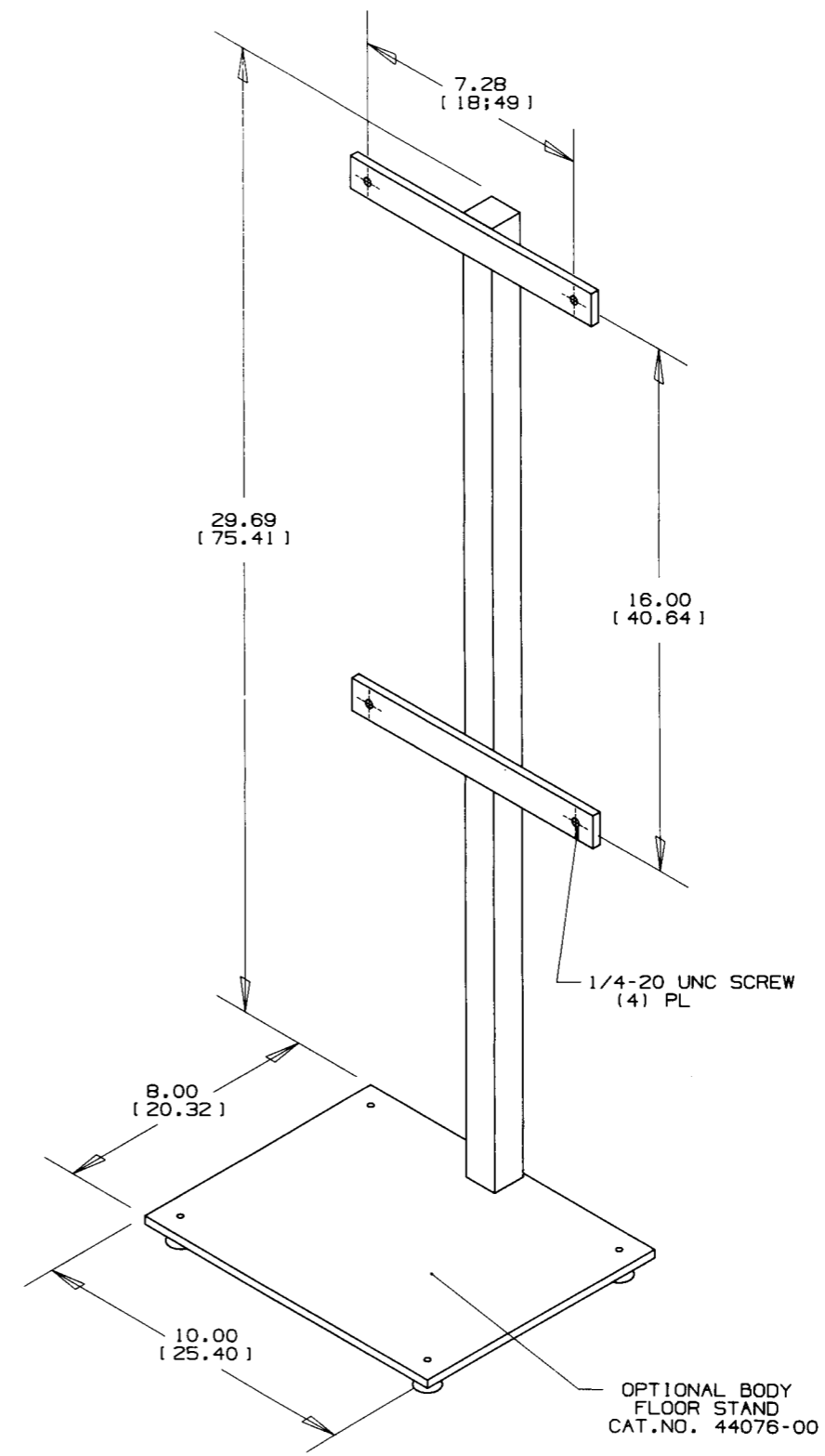
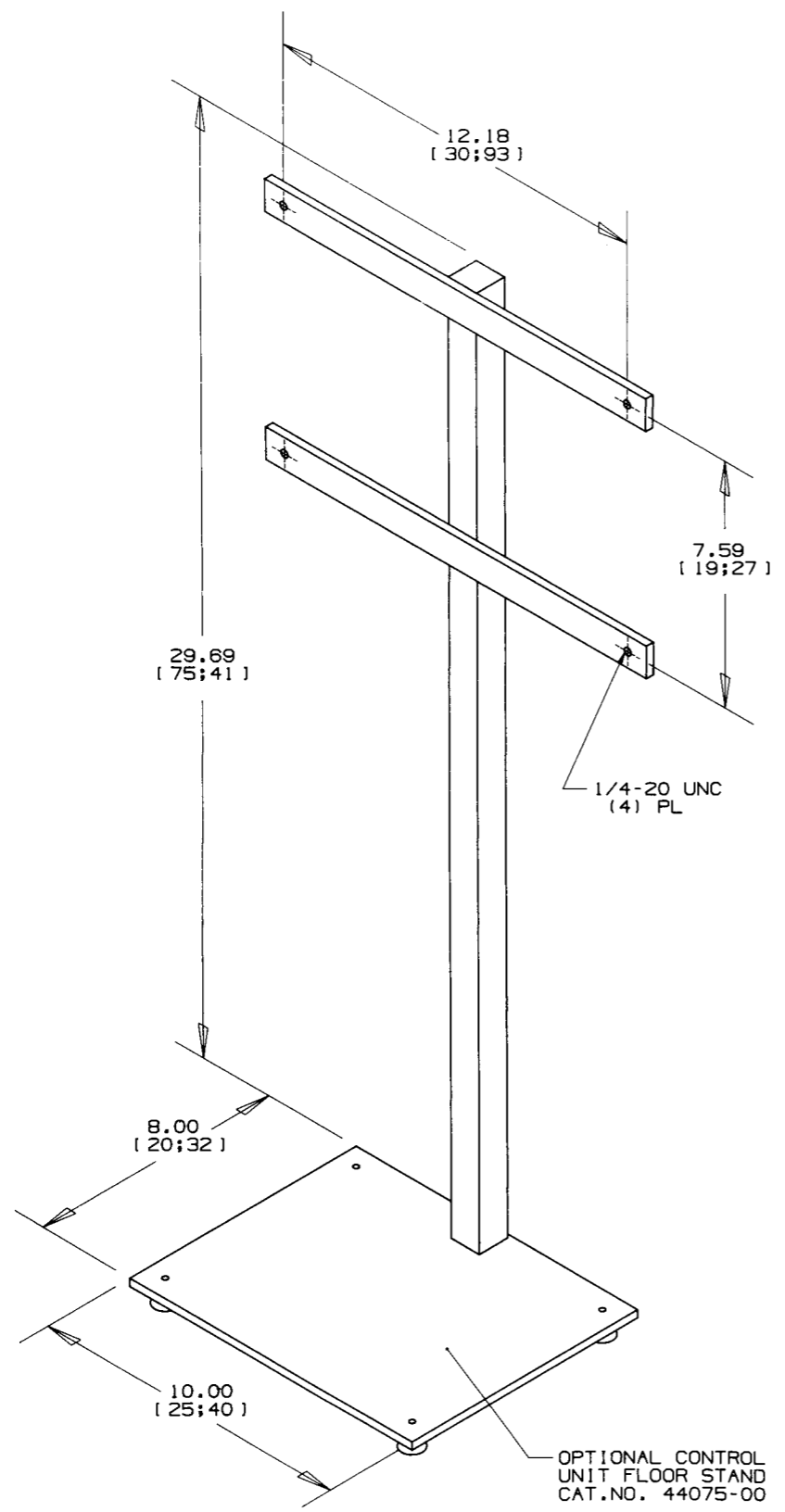


FIGURE 5

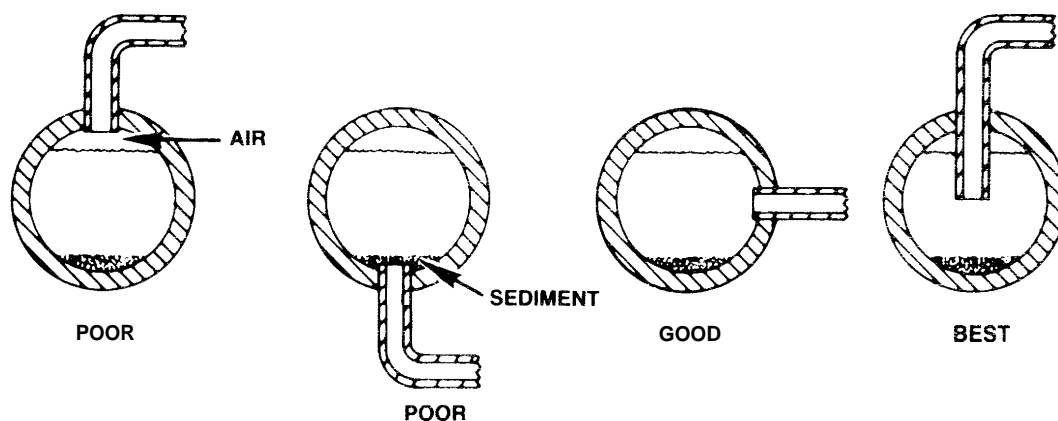


FIGURE 6

SAMPLING TECHNIQUES

5.4.1 Mounting the Control Unit

Mounting blocks are secured to the four rear corners of the instrument case. A mounting kit consisting of the four blocks and four screws is included in the accessory kit. Mounting blocks should be positioned as shown in *Figure 5* and secured with the four screws provided. Remove the front cover and insert one of the screws into each of the four holes in the corners of the case. A long-shafted screwdriver is required to turn the screws into the threaded holes of the mounting blocks. Screws or bolts to mount the instrument to a wall are not furnished. If the optional floor stand or panel mount kit are purchased, the necessary bolts and nuts are included.

Thumb grips are provided with the accessories that snap into the two enclosure screws in the control unit cover. Once installed a screwdriver is not needed to secure the cover closed.

5.4.2 Mounting the Turbidimeter Body

Slotted mounting brackets are integral parts of the turbidimeter body. Rubber washers used to absorb vibration and compensate for wall irregularities are included in the Accessory Kit. Hardware to mount the body is not supplied with the instrument. Allow adequate space above the body to install and remove the head assembly and bubble trap. Leave room below the body to flush the system through the bottom plug if cleaning should be necessary. If the optional floor stand is purchased, $\frac{1}{4}$ "-20 bolts and nuts are included in the kit.

5.5 Installing a Sample Line

Sample lines to the turbidimeter body should be run with small diameter tubing to minimize the lag time

for a sample to flow from the sampling point to the instrument. One-fourth inch O.D. rigid or semi-rigid tubing is recommended. Route the tubing as directly as possible between the sampling point and the turbidimeter. Long sample lines result in significant lag time between actual process line conditions and what the instrument measures. Sample line taps should be installed into larger process pipes to minimize the chances of ingesting sediment from the pipe-line bottom or air bubbles from the top. A tap projecting into the center of the pipe is ideal. *Figure 6* shows both good and poor methods of installing a sample tap.

5.6 Hydraulic Connections

Sample inlet and drain connections are made on the turbidimeter body as shown in *Figure 5 Installation Details, sheet 2*. The sample inlet fitting installed in the body is a $\frac{1}{4}$ " to $\frac{1}{8}$ " NPT female adapter. Two additional fittings supplied with the instrument are a $\frac{1}{8}$ " NPT-to-hose barb elbow fitting for use with $\frac{1}{4}$ " ID flexible plastic tubing and a $\frac{1}{8}$ " NPT-to-tubing compression fitting for $\frac{1}{8}$ " OD rigid plastic tubing.

The hose barb adapter can be used with relatively low sample inlet pressures suitable for flexible plastic tubing. A sample shutoff-flow control valve should be used to control the sample flow rate between 250 and 750 mL per minute (3.5 to 11.5 gph).

In higher pressure installations where flexible tubing is not suitable, the compression fitting and semi-rigid plastic tubing supplied should be used (refer to the chart in *Figure 5* as a guide in determining the length of tubing required to provide the proper flow rate to the turbidimeter for the available sample line pressure).

Connect a length of tubing (slightly longer than indicated by the chart) to the sample supply line. Before connecting it to the turbidimeter, open the sample supply valve fully and measure the flow at the turbidimeter end of the tube. If the measured flow is between 250 and 750 mL per minute, connect the tube to the turbidimeter. If the flow rate is too slow, shorten the tubing length little by little until the proper flow rate is achieved.

NOTE

When setting the flow rate, take care to avoid sweeping air “micro-bubbles” through the internal bubble trap. Observe the sample flow inside the turbidimeter body. If small air bubbles can be seen flowing up through the center, the flow rate should be reduced.

5.7 Electrical Connections

WARNING

All electrical connections should be made by a qualified technician to assure compliance to all applicable electrical codes. To meet UL, CSA and other applicable instrument safety standards, an external power disconnect switch must be installed. This power disconnect switch should be located near the instrument. Wiring for the recorder and serial interface connections must be routed separately from the alarm connections and AC power line for safe operation. Separate 1/2 - inch conduit openings are provided for this purpose. Shielded cables may be required if cables are not routed in grounded metal conduit to ensure emission's compliance (see the *Radio frequency Interference* section on page iii).

ADVERTENCIA

Todas las conexiones eléctricas deben ser realizadas por un técnico capacitado para asegurar el cumplimiento con todos los códigos eléctricos. Para cumplir con las normas UL, CSA y otras normas de seguridad aplicables a los instrumentos, debe instalarse un interruptor de desconexión de la alimentación externa. El mismo debe estar ubicado cerca del instrumento. El cableado para la grabadora y las conexiones de interfaz en serie deben encaminarse de manera separada de las conexiones de la alarma y la línea de alimentación de CA para un funcionamiento seguro. Se proporcionan

aberturas separadas de conductos de 1/2 pulgada para este propósito. Podrían requerirse cables protegidos si los mismos no están encaminados en conductos metálicos conectados a tierra, para asegurar el cumplimiento con la emisión (consulte la sección de *Interferencia por frecuencia de radio* en la página iii).

AVISO

Todas as conexões elétricas devem ser realizadas por técnico qualificado para garantir o cumprimento de todas as normas elétricas aplicáveis. Para cumprir as especificações UL, CSA e outras medidas de segurança padrão aplicáveis ao instrumento, deve ser instalado um interruptor externo para desligar a energia. Este interruptor desligador da energia deverá ser colocado pet-to do instrumento. As instalações elétricas das conexões do registro e as entrefásicas em série deverão estar separadas das conexões do alarme e da linha de CA, para que sua operação seja segura. Eletrodutos de passagem de 1/2 polegada são fornecidos em separado para este propósito. Caso os cabos não forem traçados por eletrodutos metálicos com ligação à terra, para garantir a conformidade com as normas de irradiação, poderá ser necessário o uso de cabos blindados (veja a seção *Interferência da Frequência de Rádio* na página iii).

ATTENTION

Tous les branchements électriques doivent être effectués par un technicien qualifié, afin d'assurer le respect de toutes les normes électriques applicables. Pour répondre aux normes UL, CSA et à d'autres normes applicables concernant la sécurité de l'appareil, il est nécessaire d'installer un interrupteur externe permettant de couper l'alimentation électrique. Cet interrupteur doit être situé près de l'appareil. Le câblage pour l'enregistreur et les branchements de l'interface série doivent être tirés séparément des branchements de l'alarme et du fil d'alimentation électrique, afin d'assurer un fonctionnement sans risque. Des orifices de conduits de 1/2 pouce séparés sont fournis à cet effet. Des câbles blindés peuvent être nécessaires si les câbles ne sont pas tirés dans un conduit métallique relié à la terre, afin de respecter les normes sur les émissions électro-magnétiques (voir la

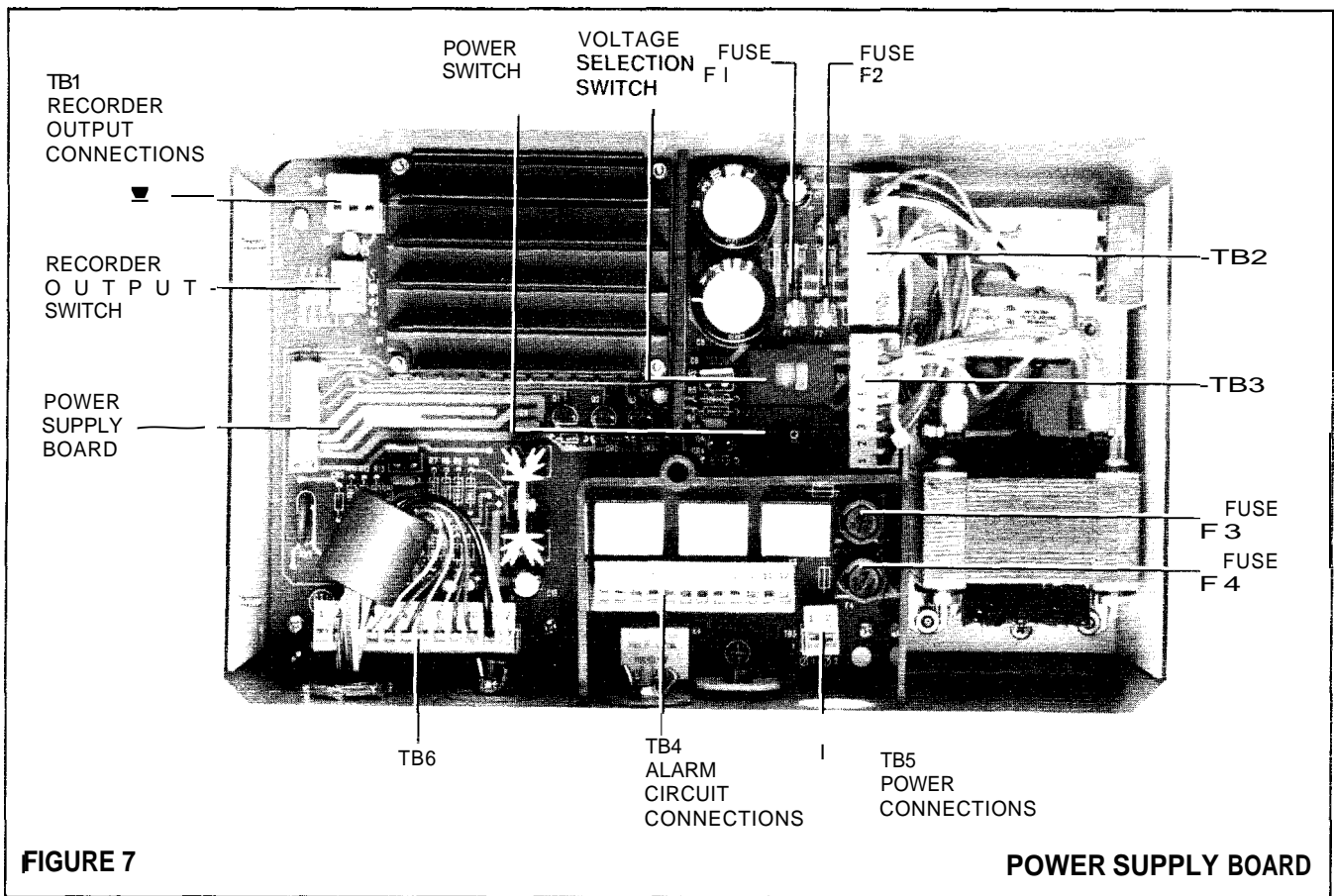


FIGURE 7

POWER SUPPLY BOARD

section *Interférences avec les fréquences radio à la page iii*)_

WARNHINWEIS

Um zu gewährleisten, daß alle elektrischen Anschlüsse den VDE-Vorschriften und gegebenenfalls den Zusatzvorschriften der zuständigen Elektrizitätswerke sowie anderen zutreffenden Sicherheitsnormen entsprechen, dürfen diese Anschlüsse nur von geschultem Fachpersonal hergestellt werden. Um allen zutreffenden Sicherheitsbestimmungen für das Gerät zu entsprechen, muß ein externer Netztrennschalter installiert werden. Dieser Netztrennschalter sollte sich in unmittelbarer Nähe des Gerätes befinden. Die Verdrahtung für den Anschluß an die Registriergerät-Schnittstellen sowie an die seriellen Schnittstellen ist aus Betriebssicherheitsgründen getrennt von den Warnanschlüssen und der WS-Netzleitung zu führen. Zu diesem Zweck sind separate Rohröffnungen mit einem Durchmesser von 0,5 Zoll vorgesehen. Um zu gewährleisten, daß die Emmissionsbestimmungen erfüllt werden, sind eventuell Abschirmkabel

erforderlich, insofern die Kabel nicht in geerdeten Metallrohren geführt werden (cf. das Kapitel über *Hochfrequenz-Störungen auf Seite iii*).

5.7.1 ⚠ Power

Power connections at the control unit terminal block TB5 located at the bottom right corner of the power supply board are accessible when the molded plastic cover over the power supply is removed. Line voltage phases 1 and 2 are wired directly to TB5. TB5 is depluggable to simplify wiring. The ground connection is made to the adjacent #8 ground stud using an appropriate closed loop connector or method. All line voltage connections must be made with 18 AWG wire or greater and with wire insulation rated for 300V RMS/600V PK; however, a water-tight strain relief is provided in the accessory kit for use with a power cord. The power cord is not supplied and must be selected to meet applicable electrical codes for the installed site.

Extra wire left inside the instrument as a service loop must be contained within the wire barrier.

CAUTION

The voltage selector switch must be set properly for the line voltage to be used. Improper setting can result in serious damage to the instrument when power is applied.

PRECAUCION

El interruptor selector de voltaje debe ajustarse correctamente para el voltaje de línea que será usado. Un valor incorrecto puede dar como resultado daños serios al instrumento al aplicarse la alimentación eléctrica.

PRECAUÇÃO

O interruptor de seletor de voltagem deve ser conectado de maneira apropriada na linha de voltagem a ser usada. Uma ligação errada pode causar sérios danos ao instrumento quando o mesmo for ligado à fonte de energia.

PRUDENCE

Le selecteur de tension doit être réglé correctement pour la tension d'alimentation qui sera utilisée. Un réglage incorrect peut provoquer de sérieux dégâts de l'appareil lors de la mise en route.

VORSICHT

Der Spannungsumschalter muß entsprechend der zu verwendenden Netzspannung eingestellt werden. Eine unsachgemäße Einstellung kann bei Stromzufuhr eine schwere Beschädigung des Gerätes nach sich ziehen.

This instrument is factory set and fused for 115Vac, 60 Hz operation. If the instrument is to be converted for 230Vac, 50 Hz operation, the voltage selector switch must be set to the 230 Volt position and fuses F3 and F4 replaced with 1/2-amp fuses. To gain access to the voltage selector switch and the AC line fuse, a cover barrier internal to the instrument must be removed (see Figure 7). The 1/2-amp fuses supplied in the accessories kit are IEC type fuses intended for use in 230Vac European power systems. They are not acceptable for 230Vac US and Canadian systems. To convert the instrument to 50 Hz power, refer to section 2.4.1 for programming instructions. There must be power to the instrument prior to programming for 50 Hz operation.

WARNING

Instrument power must be disconnected prior to the removal or installation of the instrument input power fuses. This is accomplished by way of a remote power switch or circuit breaker system. The instrument power switch DOES NOT remove input power from the fuses. (Note: If instrument alarms are operated on AC line power, the power circuit should be remotely opened or disconnected from the alarm relays as well.)

ADVERTENCIA

La alimentación eléctrica al instrumento debe desconectarse antes de retirar o instalar los fusibles de la línea de entrada del instrumento. Esto se logra mediante un interruptor remoto de la alimentación o un sistema de cortacircuitos. El interruptor de la alimentación al instrumento NO QUITA la alimentación de entrada a los fusibles. (Nota: En caso de que las alarmas del instrumento funcionen a partir de la línea de alimentación de CA, el circuito de alimentación también deberá abrirse o desconectarse remotamente de los relés de la alarma.)

AVISO

A energia do instrumento deve ser desligada prévio a remoção ou instalação dos fusíveis da energia de entrada do mesmo. Isto efetua-se por meio de um interruptor de energia indireto ou sistema de quebra de circuito. O interruptor de energia do instrumento NÃO elimina a energia de entrada dos fusíveis. (Nota: Si os alarmes do instrumento funcionam numa linha de CA, o circuito de força deve ser desligado remotamente ou desconectados relés do alarme também.)

ATTENTION

L'alimentation électrique de l'appareil doit être interrompue avant le retrait ou la mise en place des fusibles d'alimentation électrique de l'appareil. Cela peut être effectué au moyen d'un interrupteur ou d'un disjoncteur. L'interrupteur de mise en marche de l'appareil NE COUPE PAS l'alimentation électrique des fusibles. (N.B.: Si les alarmes de l'appareil fonctionnent à partir d'une alimentation électrique à courant alternatif, le circuit électrique doit également être ouvert ou débranché au niveau des relais d'alarmes.)

WARNHINWEIS

Vor dem Herausnehmen oder Installieren der Eingangsleistungssicherungen des Geräts muß das Gerät vom Netzstrom getrennt werden. Diese Trennung wird über einen Fernnetzschalter oder ein Stromunterbrechungssystem vorgenommen. Durch den Netzschalter des Gerätes wird der die Sicherungen speisende Netzstrom **NICHT** unterbrochen. (Hinweis: Werden die Warnvorrichtungen des Gerätes mit WS-Leitungsstrom betrieben, sollte der Starkstromkreis ebenfalls ferngesteuert geöffnet oder von den Warnrelais abgeschaltet werden.)

5.7.2 Alarms

Alarm circuit connections are made at the control unit power supply board depluggable terminal block TB4 as shown in *Figure 5, Sheet 2 and Figure 7* and on the back of the keyboard panel. The control unit keyboard panel must be open and the molded plastic cover over the power supply circuit board must be removed. Terminals are unpowered and rated for 5 A resistive load at 230 Vac.

Both normally open and normally closed relay contacts are provided for each of the four alarm circuits.

A wiring access hole, sized for 1/2-inch conduit, is located in the bottom of the control unit case.

WARNING

If high-voltage power is applied to the alarm relays, provisions must be made for disconnecting external power to the analyzer during servicing.

ADVERTENCIA

En caso de aplicarse una alimentación de alta tensión a los relés de la alarma, deben tomarse las precauciones necesarias para desconectar la potencia externa a los relés del analizador al realizar el servicio.

AVISO

Caso os relés do alarme forem conectados à energia de alta voltagem, deverá ser tomada a precaução de desligar a energia externa dos relés do analisador durante os consertos.

ATTENTION

Si du courant à haute tension doit être appliqué aux relais d'alarmes, il est nécessaire de prévoir un moyen de débrancher l'alimentation électrique externe des relais de l'analyseur au cours de la maintenance.

WARNHINWEIS

Soll den Warnrelais Hochspannungsstrom zugeführt werden, ist dafür zu sorgen, daß während der Wartung die externe Stromversorgung zu den Analysator-Relais unterbrochen ist.

57.3 Recorder Output

Recorder output connections are made at power supply board depluggable terminal block TB 1 as shown in *Figure 5, Sheet 2 and 7* and on the circuit board cover label on the back of the keyboard panel. The keyboard panel must be opened and the molded plastic cover over the power supply circuit board must be removed. A wiring access hole, sized for 1/2-inch conduit is located in the bottom of the control unit case.

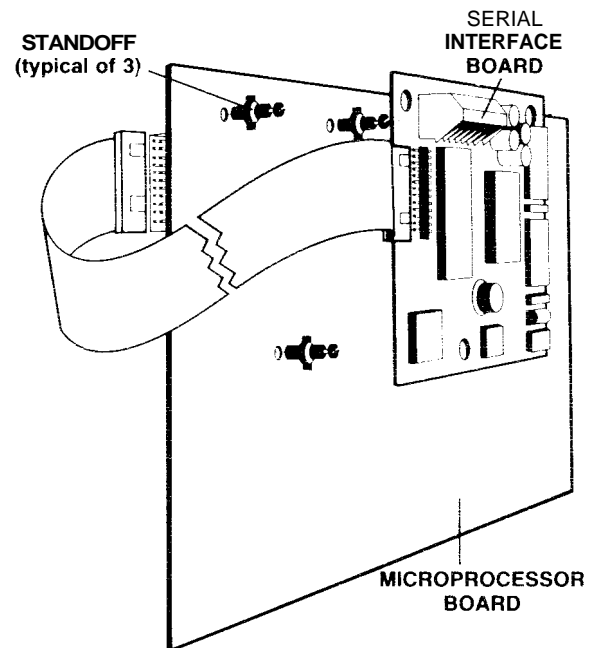


FIGURE 8

SERIAL INTERFACE BOARD INSTALLATION

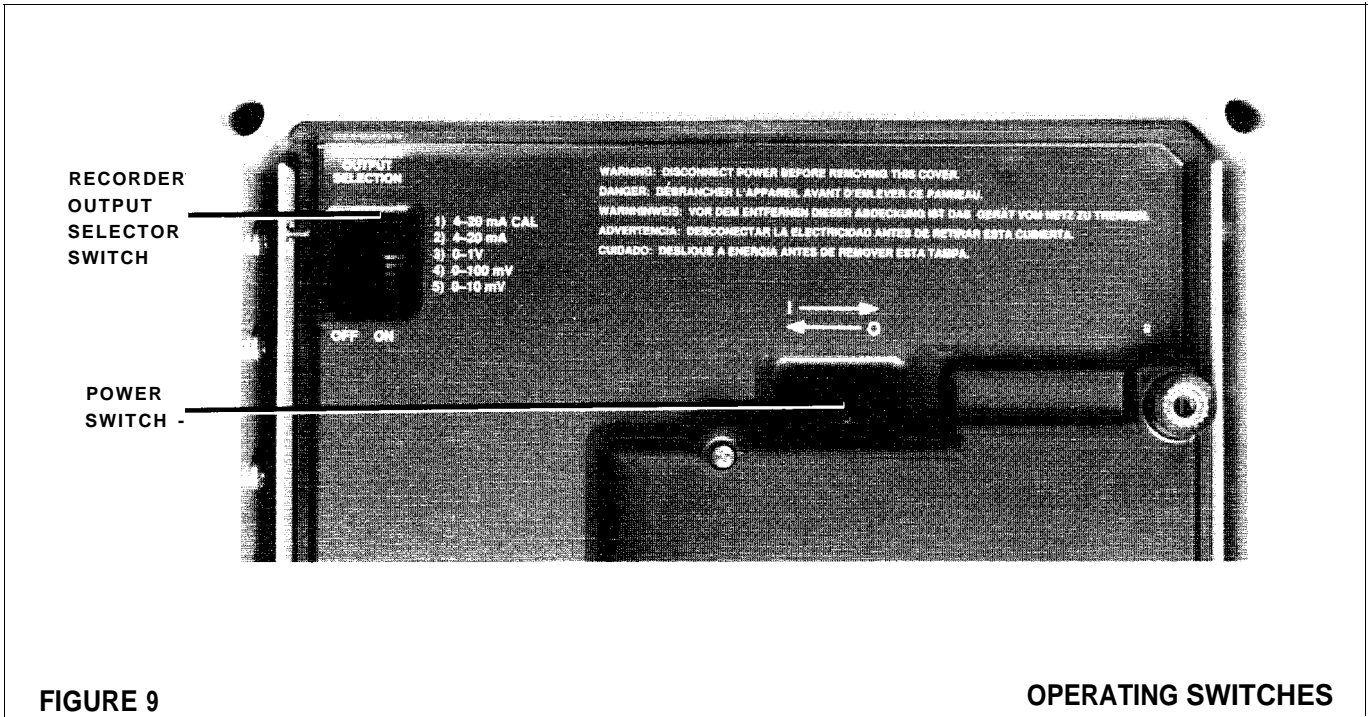
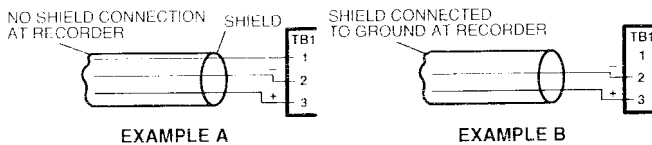


FIGURE 9

OPERATING SWITCHES

The recommended recorder hookup uses shielded, twisted-pair cable. The shield should be connected to earth ground (pin 1 of TB 1) at the instrument end and left open at the recorder end. The negative side of the recorder output should be connected to pin 2 of TB 1 (see Example A.) To operate with this hookup, the following conditions are required at the recorder end. The input to the recorder must be isolated from chassis (earth) ground of the recorder. If the recorder has more than one input, they must be differential inputs. If this is not the case, then use the connection in Example B.



A choice of outputs, 0-10 mV, 0-100 mV, 0-1 V or 4-20 mA, can be selected by a DIP switch setting. The switch is located on the power supply board and is accessible with the cover in place. The instrument is shipped from the factory with the switch set for 4-20 mA. One of the recorder output switch options other than 4-20 mA CAL must be selected. The switch is

located on the power supply board and is accessible with the cover in place. Set the individual microswitch for the desired output in the ON (closed) position and the remaining switches in the OFF or OPEN position (see Figure 9). The switches used are the third through the seventh of the eight microswitches on the DIP switch assembly.

Recommended output impedances are listed below:

Output Impedance	Recommended Load
0-10 mV	500 ohms or greater
0-100 mV	5,000 ohms or greater
0-1 V	50,000 ohms or greater
4-20 mA	3.6 to 500 ohms

5.7.4 Serial Interface Connections

An optional serial interface kit, Cat. No. 44278-00, is available to permit the turbidimeter to drive an external printer or to allow interface with a computer. Refer to section 5.9 for installation instructions and section 4.4 for computer command codes.

5.8 Head Assembly Installation

After the control unit and turbidimeter body have been mounted and connected on-line, place the head assembly on the top of the turbidimeter body.

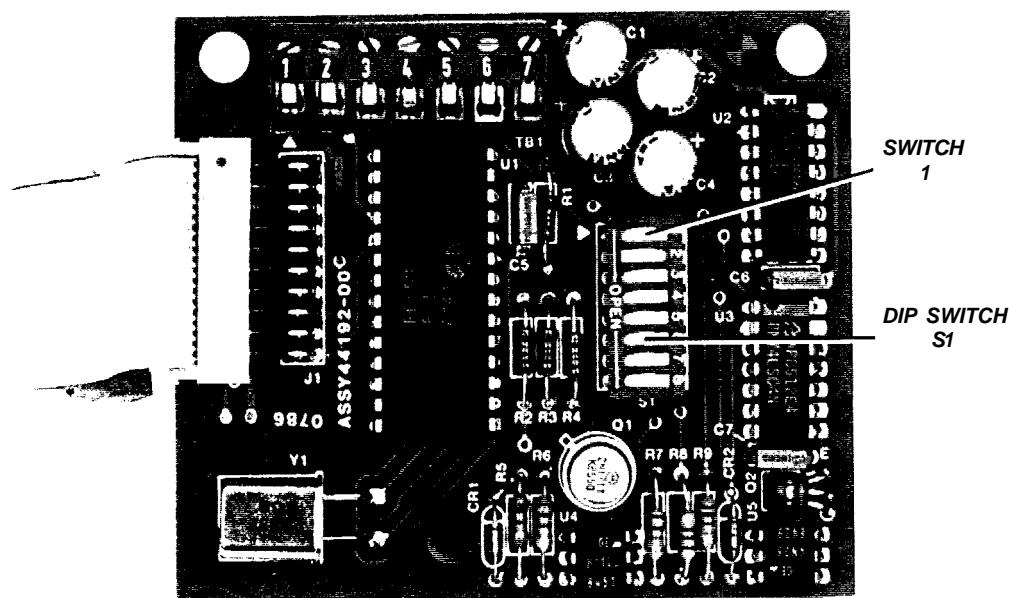


FIGURE 10

SERIAL INTERFACE BOARD

5.9 Serial Interface Installation

The serial interface board must be mounted on the microprocessor circuit board on the back of the keyboard panel. Refer to *Figure 8* and install the board as follows:

NOTE

The serial interface and microprocessor boards are subject to damage by static electricity. Use all available precautionary measures when installing this board.

1. Open the keyboard panel and remove the cover from the microprocessor board.
2. Install the three standoffs supplied with the serial interface board into the holes provided in the microprocessor board (see *Figure 8*). Press the standoffs firmly into place until the collar is against the board surface. Then press down on the screwhead on the top of the standoffs. This will flare the bottom of the standoff to lock it in place.
3. Connect the ribbon cable supplied with the serial interface board to the connector on the under side (component side) of the microprocessor board. Place the cable connector so that the leads are exiting the connector on the side away from the board.

4. Connect the other end of the ribbon cable to the serial interface board connector as shown in *Figure 8*. Note the leads exit the cable connector on the side away from the board.

5. Mount the serial interface board on the standoffs installed in Step 2. When all three standoffs are through the holes in the interface board, press firmly on the board near each hole until the board snaps into position on the standoffs.

6. Lock the board in position by turning the screw in the top of each standoff 1/4 of a turn.

7. Replace the cover over the microprocessor circuit board.

5.9.1 RS-232C Interface Configuration

The RS-232C interface configuration is suitable in cases where the distance between the turbidimeter and an external device is relatively short (50 feet or less). Longer distances make the interface connection vulnerable to electrical interference and data transmission errors. Use of the current loop configuration is recommended for distances longer than 50 feet. To select the RS-232C format, microswitch No. 2 of DIP switch S1 on the interface board must be set to the closed position and microswitch No. 1 must be open (see *Figure 10*).

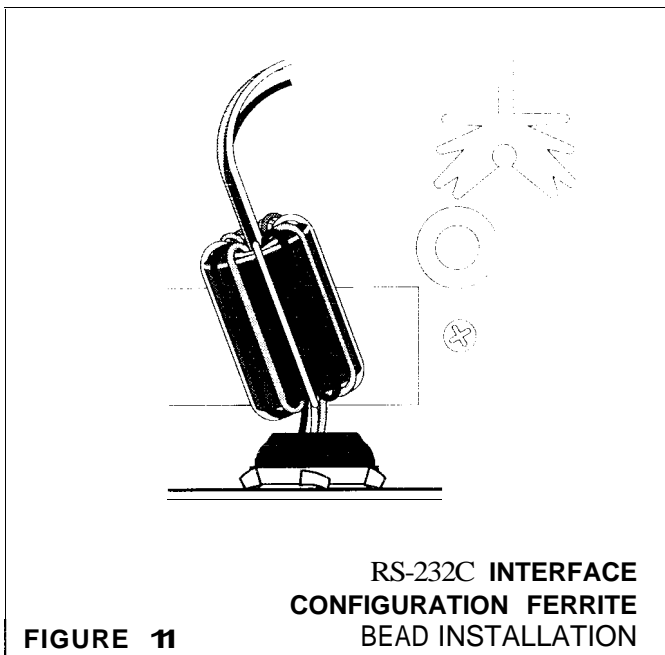
Connections are made at the 7-pin terminal block on top of the interface board. Connections can be made from this terminal block to a standard RS-232C 25 pin D connector (see the information below). In order to comply with European immunity standards, a Ferrite Bead (P/N 46786-00) must be installed on the connector wiring. This bead is included in the optional Serial Interface Kit (P/N 44278-00). Thread each of the three wires (ground, data out, and data in) through the center opening of the bead. Loop each wire back around the bead and through the center opening four times (see *Figure 11 RS-232C Interface Configuration Ferrite Bead Installation*). The bead should be positioned as closely as possible above the 1/2-inch conduit opening that is located beneath TB6.

A 1/2-inch conduit opening located beneath TB6 at the bottom of the enclosure is provided for serial connections. A water-tight strain relief is provided in the accessory kit for applications where a conduit is not used.

5.9.2 Current Loop Configuration

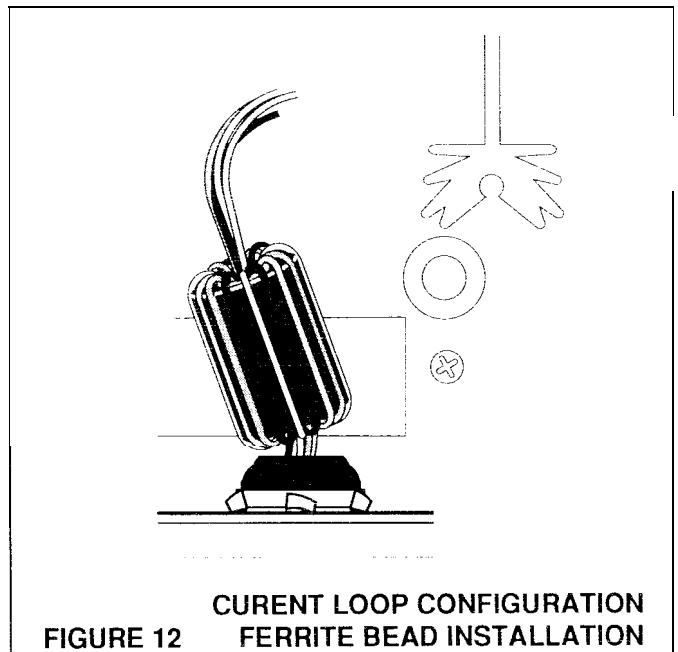
A current loop interface configuration is used to transmit data over longer distances with a two-shielded pair cable. The current loop interface mode is selected by placing switch No. 1 of S1 in the closed position and switch No. 2 in the open position (see *Figure 10*).

Connection in the current loop configuration is made using pins 4 through 7 of the terminal block, there is no standard format for connector pinuse in a current loop configuration; the user must wire connectors and cables as required for the individual installation. in order to comply with European immunity standards. a Ferrite Bead Shield (P/N 46786-00) must be installed on the connector wiring. This bead is included in the optional Serial Interface Kit (P/N 44278-00). Thread each of the four wires [current loop in (-), current loop in (+), current loop out (-), current loop out (+)] through the center opening of the bead. Loop each wire back around the bead and through the center opening four times (see *Figure 12 Current Loop Configuration Ferrite Bead Installation*). The bead should be positioned as closely as possible above the 1/2-inch conduit opening that is located beneath TB6.



Descriptions and functions of the terminal block pins follow:

Term. No.	D.conn. Pin No.	Description	Function
1	1	Ground	Digital common
2	2	Transmitted data out	Data from turbidimeter to computer or printer
3	7	Received data in	Data from computer turbidimeter



Term No.	Description	Function
4	Current loop in (-)	Data input loop, negative
5	Current loop in(+)	Data input loop, positive
6	Current loop out(-)	Data output loop, negative
7	Current loop out (+)	Data output loop, positive

In the recommended connection configuration shown in Figure 13, the current source for both the input and output loops is provided by the external computer or printer interface. This configuration provides an optical isolation between the analyzer and the current loop. In the second connection configuration shown in Figure 13, the analyzer is set up to provide both of the current sources. This configuration does not provide the isolation that may be required at the computer or printer interface.

DIP switch S 1 on the board must be set according to the particular operational application. Table 6 explains the function of each of the individual microswitch closures.

A 1/2-inch conduit opening located beneath TB6 at the bottom of the enclosure is provided for serial connections. A water-tight strain relief is provided in the accessory kit for applications where a conduit is not used.

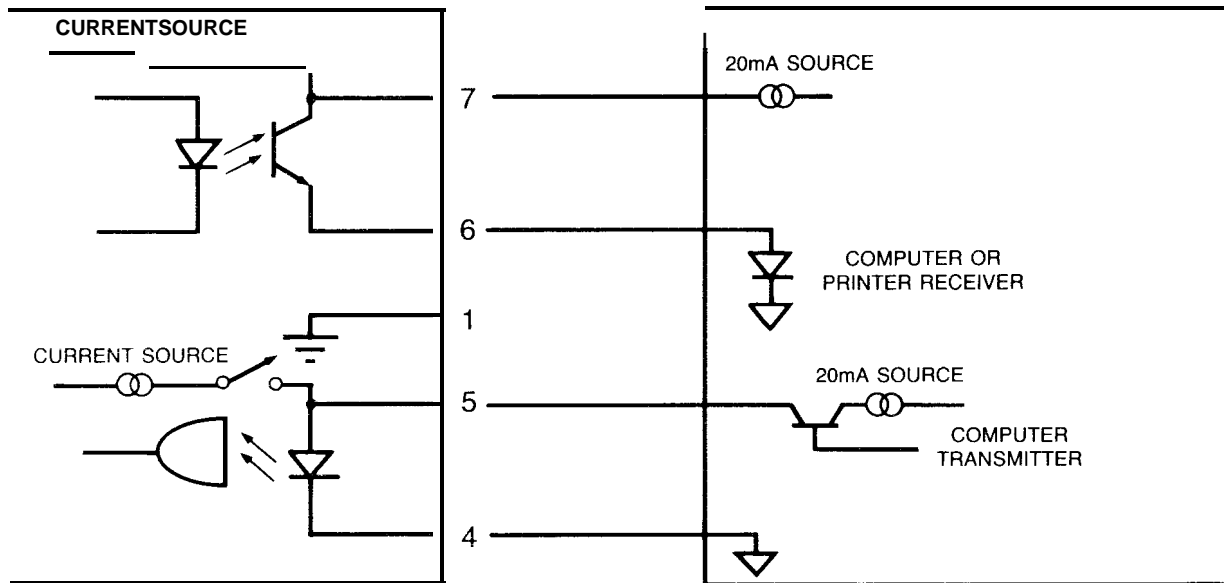
Table 6. DIP Switch S1 Descriptions

Switch	Function
S1-3	Selects turbidimeter as the output current source in current loop mode
S1-4	Increase current output if S1-3 output is not enough
S1-5	Selects computer as the input current source in current loop mode
S1-6	Increases current input if S1-5 input is not enough

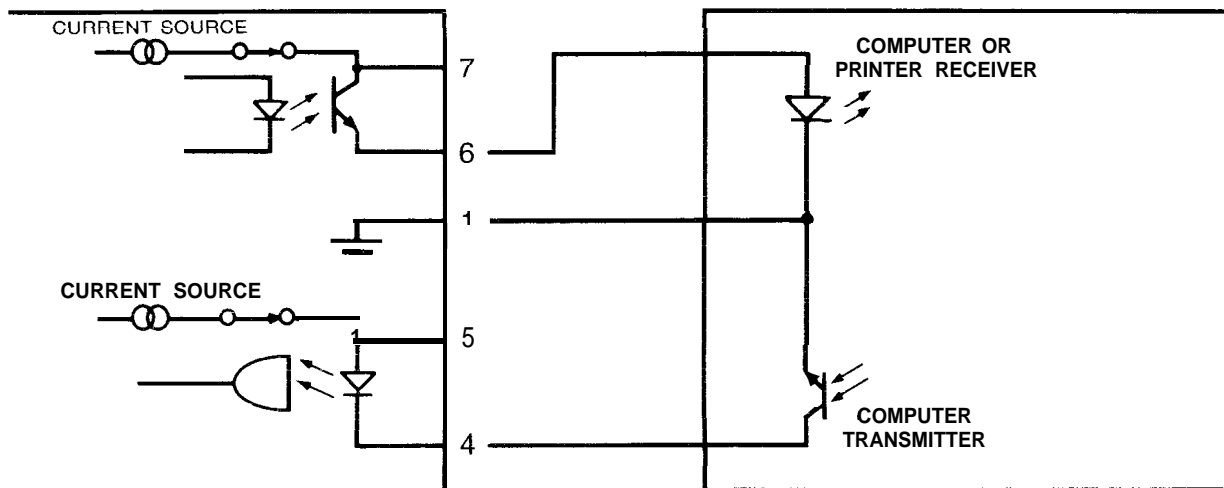
5.9.3 Instrument Power On

Turn on the instrument power (I setting of the I/O switch, see Figure 9) and start sample flow through the instrument by opening the sample supply valve. An externally installed operator accessible power switch is required for agency compliance.

RECOMMENDED CURRENT LOOP CONFIGURATION



CURRENT LOOP CONFIGURATION WITH TURBIDIMETER PROVIDING CURRENT SOURCES*



*NOTE: In this configuration, the turbidimeter is not isolated from the current loop.

FIGURE 13

RECOMMENDED CURRENT LOOP HOOKUP

SECTION 6 MAINTENANCE

CAUTION

Maintenance should be performed by qualified technical personnel to ensure adherence to all applicable electrical and plumbing codes.

PRECAUCION

El mantenimiento debe ser realizado por personal técnico capacitado a fin de cumplir con todos los códigos eléctricos y de plomería aplicables.

PRECAUÇÃO

A manutenção deve ser efetuada por pessoal técnico qualificado a fim de se ajustar a todas as normas elétricas e de canalização aplicáveis.

PRUDENCE

Toute maintenance doit être effectuée par du personnel technique qualifié, afin d'assurer le respect de toutes les normes applicables d'électricité et de plomberie.

VORSICHT

Um zu gewährleisten, daß alle elektrischen und sanitarinstallations-technischen Anschlüsse den VDE-Vorschriften und gegebenenfalls den Zusatzvorschriften der zuständigen Elektrizitäts- und Wasserwerke entsprechen, dürfen Wartungsarbeiten nur von geschultem Fachpersonal vorgenommen werden.

6.1 Scheduled Maintenance

Scheduled periodic maintenance requirements of the 1720C are fairly minimal. Standardization checks and calibration are the primary requirements. Several other activities should be performed on a regular basis but scheduling may depend on the installation and sample.

6.1.1 Standardization and Calibration

Standardization checks should be performed on a monthly basis as described in section 3.3 Standardization Checks. Calibration should be performed at least every four months by one of the methods described in section 6.4 Calibration.

NOTE

Due to the ease with which the comparison method calibration can be performed (see section 6.4.2 Comparison Method), better accuracy can be maintained by performing a comparison calibration at monthly intervals instead of the standardization check. Periodic calibration on a formazin primary standard is recommended for best accuracy (refer to section 6.3 Preparing Formazin Standards).

6.1.2 Cleaning Photocell Window

Occasional cleaning of the photocell window will be required. Frequency will depend on the nature and concentration of dissolved and suspended solids in the sample. Inspect the photocell window during standardization checks and calibration to determine cleaning needs.

Any growth or film on the photocell window should be cleaned off before standardization or calibration. A mild detergent on a damp, soft cloth will clean off sediment and dirt. Mineral scale build-up may require cleaning by a mild acid applied with a cotton swab followed by a detergent wash.

6.1.3 Cleaning the Turbidimeter Body

Sediment may collect in the turbidimeter body after extended service. The turbidimeter body can be drained and cleaned on a semi-annual schedule or as determined by visual inspection to remove accumulated sediment. The bubble trap is removable for this purpose. A special tool is available as an optional accessory for easy removal. Clean the turbidimeter body as follows:

1. Turn off sample flow to the turbidimeter body.
2. Remove the head assembly from the body.
3. Drain the body by removing the plug from the bottom of the body.
4. Use the removal tool as shown in *Figure 14*. With the handle of the tool toward the front of the turbidimeter body, hook the bottom of the bubble trap and pry down on the handle until the bubble trap is loose. Unhook the tool and lift the bubble trap from the body.

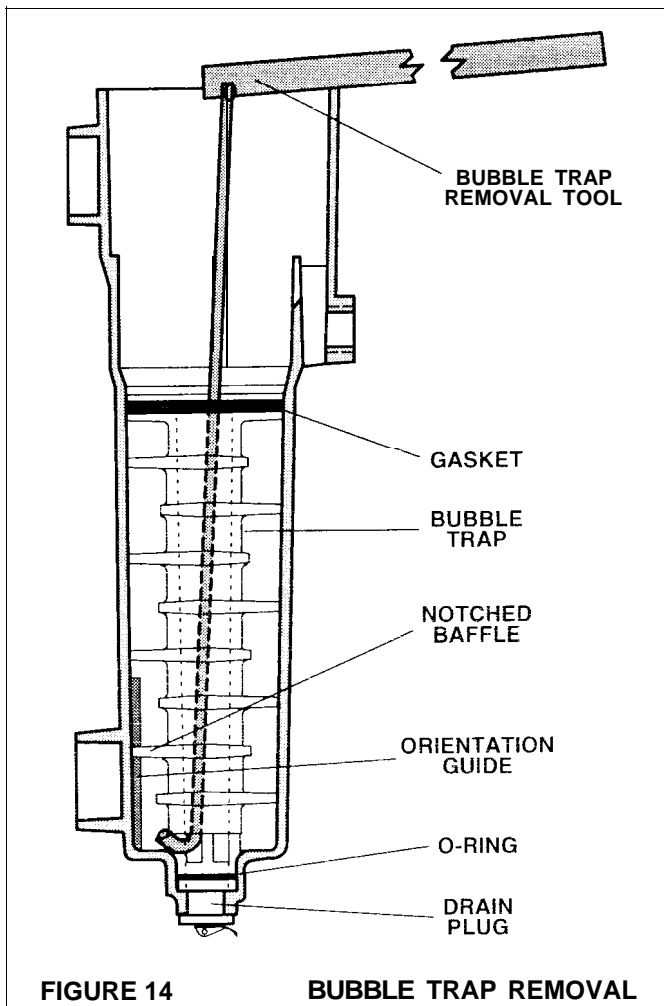


FIGURE 14 BUBBLE TRAP REMOVAL

5. Replace the drain plug and pour some diluted chlorine solution (25 mL of household bleach in 3.78 liters of water) into the body. Use a brush to clean the inside surfaces of the body. Remove the drain plug again and thoroughly flush the turbidimeter body. Clean and replace the plug.

6. Remove the foam gasket and O-ring seal from the bubble trap. Clean the bubble trap using a brush and the diluted chlorine solution.

7. Install a new gasket and O-ring seal on the bubble trap and replace the unit in the turbidimeter body. Note the notch in the second lowest bubble trap baffle must align with the orientation guide provided on the side of the body. Be sure the unit is firmly seated in place.

8. Replace the head assembly in the top of the body.

9. Restore sample flow to the instrument.

10. Calibrate the instrument as described in *section 3.2 Calibration*.

6.2 Unscheduled Maintenance

6.2.1 Fuse Replacement

WARNING

Disconnect power to the instrument before removing any cover. Electrical shock can cause serious injury. All electrical service should be performed by a qualified technician. All replacement components must meet or exceed original equipment specifications to maintain applicable safety standards and certifications and ensure proper instrument performance.

ADVERTENCIA

Siempre desconecte la **alimentación eléctrica** al instrumento antes de desmontar cualquier cubierta. El **choque eléctrico** puede causar **lesiones graves**. **Todo el servicio eléctrico** debe ser realizado por un **técnico capacitado**. Todos **los componentes** de reemplazo deben cumplir o exceder las especificaciones originales del **equipo para mantener las normas** y certificaciones de seguridad aplicables y asegurar un **desempeño adecuado del instrumento**.

AVISO

Sempre desligue a energia do instrumento antes de abrir qualquer **tampa**. Um **choque elétrico** pode causar **sérios ferimentos**. Todos os **serviços elétricos** devem ser realizados por **técnico qualificado**. Todas as **peças de reposição** devem cumprir com as **especificações** originais do equipamento ou **superá-las para manter as medidas de segurança padrão aplicáveis e certificados de qualidade**, a fim de garantir o desempenho **próprio do instrumento**.

ATTENTION

Toujours **débrancher l'alimentation électrique** de l'**appareil** avant d'enlever un quelconque des **capots**. Un **choc électrique** peut provoquer de graves **lésions**. Toute maintenance **électrique** doit être **réalisée** par un **technicien qualifié**. Tous les composants de remplacement doivent avoir des **spécifications égales ou supérieures** à celles du **matériel d'origine**, afin de rester conforme

aux normes de securite et aux certificats applicables, et pour assurer un fonctionnement correct de l'appareil

WARNHINWEIS

Vor dem Entfernen einer jeden Abdeckung oder Haube ist die Stromzufuhr zu dem Gerat zu unterbrechen. Ein elektischer Schlag kann zu schweren Korperverletzungen fuhren. Alle elektrischen Wartungs- und Instandhaltungsarbeiten sind von einem qualifizierten Techniker vorzunehmen. Alle Ersatzeinbauteile müssen den Original-Gerate-Spezifikationen entsprechen oder diese sogar tibertreffen, urn zu gewährleisten, daß die Anforderungen der entsprechenden Sicherheitsnormen und Zulassungen erfüllt werden und das Gerat ordnungsgemaf3 funktioniert.

F1 is mounted in a clip on the power supply board in the control unit (see *Figure 7*). The cover must be removed to gain access to the fuse. Use a 1-ampere fuse for 115-volt operation and a ½-ampere fuse for 230 volts (UL/CSA approved fuse for North America and IEC for Europe).

6.2.2 Lamp Replacement

Lamp DS1 is located on the head assembly (see *Figure 15*). With the power off, remove the lamp texts from the terminal block by inserting a small screwdriver into the opening above the wire to be removed and pressing hard to release the cage lamp while pulling the wire. Remove the white wires from terminals 2 and 3.

6.2.3 Photocell Replacement

Replace the photocell assembly as follows:

1. Set the power switch to off (0 setting of the 1/0 switch).
2. Remove the head assembly from the turbidimeter body and place the unit on a work surface.
3. Remove the cover plate over the preamplifier board compartment by removing the six screws and prying the cover off with a small screwdriver. Pull out the preamp board (see *Figure 15*). (RTV caulking compound applied where the **Wiring enters the compartment will pull apart easily.**)
4. Loosen the screws securing the photocell leads in terminal barrier J2 and pull the wires free.

5. Remove the nut and washers from the stem assembly. Remove the photocell assembly from the head assembly.

6. Install the replacement photocell assembly as shown in *Figure 15*. Pass the photocell cable and photocell stem up through the photocell assembly cradle and install the washers and nut.

7. Pass the photocell cable through the slot in the cap ml connect the leads to terminal block J2 on the preamplifier board. Connect the white lead to the terminal nearest the center of the board and the white/black lead to the terminal nearest the edge of the board.

8. Replace the preamp board in the cap compartment. Two grooves in the bottom of the compartment hold the board in place. Lay the photocell cable in the groove provided for it in the cap and arrange the other interconnecting wires as flat as possible where they pass over the compartment partition. Apply enough new caulking material to reseal the area where the wiring passes under the cover plate. Use a non-corrosive caulking that does not contain acid, such as Dow Corning 3 145 or 739 RTV adhesive/sealant. This minimizes moisture entering the preamp board compartment.

9. Install the cover plate.

10. Wipe the photocell window clean and place the head assembly on the turbidimeter body.

11. Calibrate the instrument as described in section 6.4 Calibration.

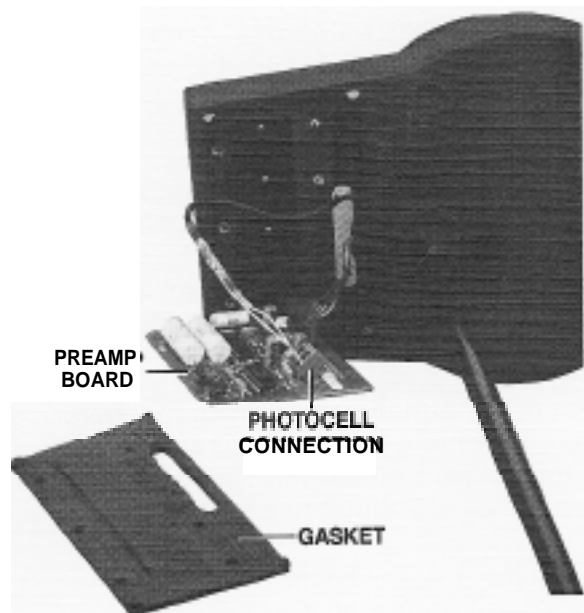
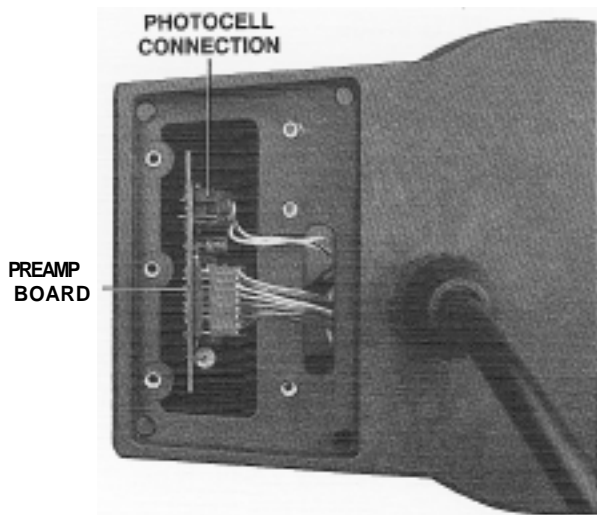
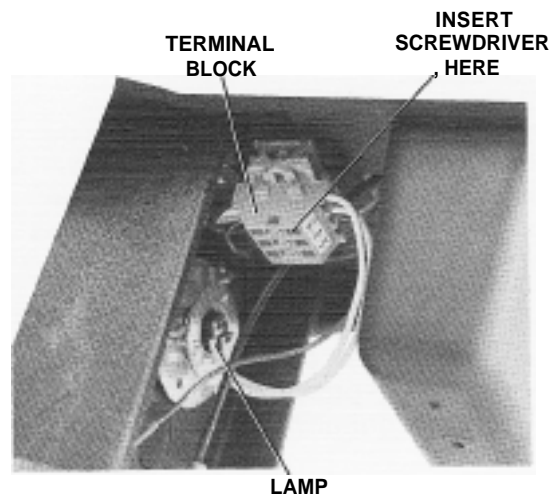
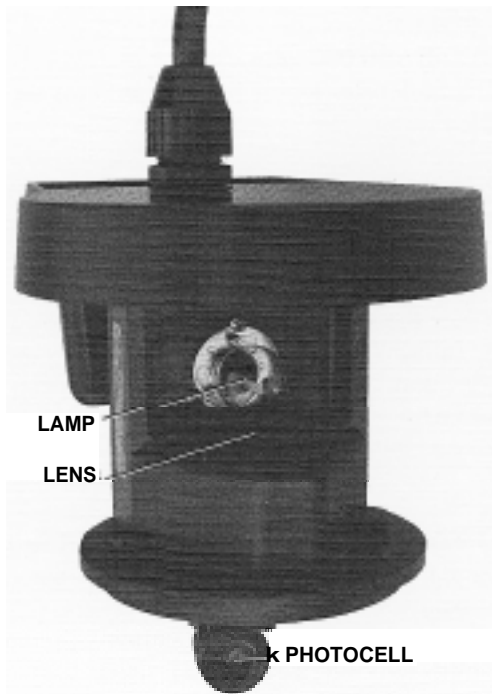
6.3 Preparing Formazin Standards

WARNING

To familiarize yourself with handling precautions, dangers and emergency procedures, always review the Material Safety Data Sheets prior to handling containers, reservoirs, and delivery systems that contain chemical reagents and standards. Protective eye wear always is recommended when contact with chemicals is possible.

ADVERTENCIA

Para familiarizarse con las precauciones de manipulacion los peligros y los procedimientos de emergencia, siempre estudie las Hojas de Datos de Seguridad de



FIGURE

HEAD ASSEMBLY

los *Materiales antes de manipular recipientes, depósitos y sistemas de entrega que contengan reactivos y patrones químicos. Siempre se recomienda el uso de protectores oculares cuando sea posible el contacto con productos químicos.*

AVISO

Para familiarizar-se *corn as precauções de manipulação, riscos e procedimentos de emergência, examine sempre o Folheto de Dados de Segurança antes de manipular os recipientes, tanques e sistemas de distribuição que contenham reagentes químicos e outros elementos padronizados. Se recomenda sempre o uso de protetores para olhos, quando possa acontecer contato corn os produtos químicos.*

ATTENTION

Pour se familiariser avec les précautions à prendre lors de la manipulation, les dangers et les procédures d'urgence, toujours lire les Fiches de Données de Sécurité de manipuler les recipients, les réservoirs et les systèmes de distribution contenant les réactifs chimiques et les solutions étalons. Il est toujours recommandé de porter des lunettes de protection lorsqu'un contact avec les produits chimiques est possible.

WARNHINWEIS

Es wird dringend empfohlen, die Sicherheitsdatenblätter vor der Handhabung von Behältern, Tanks und Zufuhrsystemen, die chemische Reagenzien und Standardsubstanzen enthalten, aufmerksam durchzulesen, damit Sie sich mit den beim Umgang mit diesen Chemikalien notwendigen Vorsichtsmaßnahmen, Risiken und Notfallschutzmaßnahmen vertraut machen, Es wird empfohlen, in allen Situationen, in denen mit einem Kontakt mit Chemikalien zu rechnen ist, eine Schutzbrille zu tragen.

Formazin is the recognized primary standard for turbidity. Formazin standards can be prepared at any turbidity value up to 4000-NTU for instrument calibration or to verify instrument accuracy and linearity. A 4000-NTU formazin stock solution can be purchased in a 500-mL bottle, Cat. No. 2461-49, or can be prepared on site as follows (refer to the formazin MSDS for appropriate safety equipment and precautions).

6.3.1 Making Formazin Stock Solution

1. Dissolve 5.000 grams of reagent grade hydrazine sulfite ($N_2H_4 \cdot H_2SO_4$) in about 400 mL of distilled water.
2. Dissolve 50.000 grams of pure hexamethylenetetramine in about 400 mL of distilled water.
3. Pour the two solutions into a 1-liter volumetric flask and dilute to the mark with distilled water. Mix well.
4. Allow the solution to stand for 48 hours at 20 to 22 °C (68 to 72 °F). During this time, the suspension will develop. The stock suspension then can be diluted with distilled or demineralized water to achieve a solution of the desired NTU value.

6.3.2 Preparing Dilute Formazin Standards

Dilution rates for several standard suspensions are listed below. Clean glassware and precise measurements are critical in accurately preparing standards. Dilution water purity also is extremely important. For best results, filter dilution water through a 0.1-micron membrane filter before use. Thoroughly mix the stock suspension before removing a portion for dilution.

Turbidity Standard Dilutions

NTU Value	mL Stock per liter
100	25.0
50	12.5
20	5.0
10	2.5
5	1.25
1	0.25

Notes

1. Making standards below 1 NTU is not recommended. The level of precision and cleanliness required makes repeatable and accurate preparation of low turbidity standards very difficult. Discrepancies in the intended value of the standard and the instrument reading are just as likely to be a variation in the standard as a reading error in the instrument and, therefore, not reliable for checking instrument accuracy.

2. Dilution water turbidity may be significant in the preparation of a 1 -NTU standard. Measure dilution water turbidity on a sensitive, calibrated laboratory turbidimeter and add the dilution water turbidity to the nominal value of the standard prepared.

3. Instead of diluting a formazin stock solution, StablCAL™ stabilized formazin suspensions may be used. Order StablCAL Calibration Kit for the 1720C Turbidimeter, Cat.No. 26596-00.

6.4 Calibration

The Model 1720C Turbidimeter is factory-calibrated before shipment. Recalibration is required after any significant maintenance or repair and at least once every four months of normal operation. A standardization check as described in section 3.3 should be performed on a monthly basis and may indicate the need for recalibration. There are two calibration methods: the calibration kit method and the comparison method. Use of the calibration kit method is strongly recommended for greatest calibration accuracy.

6.4.1 Calibration Kit Method

An optional calibration kit, Cat No. 44156-00, is available for convenient calibration of the 1720C Turbidimeter on a formazin primary standard. This kit contains a TenSette Pipet dispenser, a 4000-NTU formazin primary standard and a calibration cylinder in which to mix formazin primary standard. The calibration cylinder, Cat No. 44153-00, is available separately. After the formazin standard is mixed in the cylinder, the instrument head assembly is inserted into the cylinder, immersing the photocell in the standard solution. The instrument is then set to the value of the standard.

This calibration method is performed as follows:

1. Accurately measure 1 liter of low turbidity water and pour it into the clean, dry calibration cylinder. Any source of clean, clear water can be used. The turbidity of this water will be measured and taken into account in the following steps.
2. Remove the head assembly from the turbidimeter body and clean the lamp, lens and photocell window. Place the head assembly in the calibration cylinder.
3. Gently swirl the cylinder a few times to free any bubbles adhering to the photocell window. Press SYS RESET and 6 SIG AVG and allow the water to stand until the turbidity reading stabilizes. Press 0.0 STD. This step stores the light scatter level in the dilution

water so that the dilution water turbidity is compensated for in the formazin standard,

4. Attach a clean, dry pipet tip to the end of the TenSette Pipet. Set the dispenser knob to the 5-mL position.
5. Gently invert the formazin bottle several times to mix the solution. Depress the pipet plunger and immerse the end of the tip one half inch into the formazin. Slowly release the plunger to draw formazin into the tip.
6. Set the pipet knob to the 6-mL position. Lift the head assembly out of the calibration cylinder and smoothly depress the pipet plunger to dispense the formazin into the calibration cylinder. This will produce a 20-NTU turbidity standard.
7. Gently stir the formazin solution in the cylinder and replace the head assembly. Allow to stand until the reading stabilizes. Press 20.0 STD. The display will show the value of the 20-NTU standard plus the turbidity of the dilution water.
8. Replace the instrument head assembly in the turbidimeter body. The instrument is now calibrated.

NOTE

Because the response of the instrument is completely linear from zero to 20 NTU, accuracy, even at very low turbidity levels, is assured by setting the instrument calibration at 20 NTU. Attempting to calibrate with a lower value standard can, in fact decrease the accuracy due to the difficulty in achieving the precision required to prepare an accurate low turbidity standard.

Calibration at lower turbidities can be checked by preparing the formazin solution in the cylinder as described in section 6.3 *Preparing Formazin Standards*.

Alternately, Hach's StablCAL Calibration Kit for the 1720C Turbidimeter. Cat.No. 26596-00, provides a stabilized, 20-NTU formazin standard for convenient calibration.

6.4.2 Comparison Method

Calibration by comparison should be used only when a formazin calibration kit is not available. The method should not be used when sample turbidity is less than 2 NTU. This method transfers the calibration of a laboratory instrument to the on-line instrument and the practice is approved by the U.S.

Environmental Protection Agency and Standard Methods.

Before performing this method, make sure the laboratory turbidimeter to be used is calibrated properly with primary turbidity standards according to the **manufacturer's** directions. Sample cells for the laboratory instrument must be free from dirt, fingerprints and scratches. For greater convenience, the laboratory instrument should be moved to a location close to the on-line unit(s) to be calibrated. Take a grab sample from the on-line instrument's drain or sample inlet line and immediately measure its turbidity in the laboratory instrument. If the on-line instrument reading is off by more than 2%, enter the laboratory measurement value into the 1720C Turbidimeter, using the numeric keypad and pressing the STD key. Be sure to enter a decimal point; otherwise the calibration will not be accepted.

StabICAL and TenSette are Hach Company trademarks.

SECTION 7 TROUBLESHOOTING

7.1 Introduction

The 1720C Turbidimeter incorporates a number of self-diagnostic functions to monitor key performance parameters and a number of keyboard-actuated diagnostic functions. Continuous diagnostic functions are used to detect certain types of system failures, actuate a system warning or alarm (upon detection) and display an error code indicating the nature of the failure.

Keyboard-actuated diagnostics are used to test instrument functions, check autodiagnostic error messages and set a number of program functions. The keyboard must be unlocked to enter diagnostic codes (refer to section 2.4.11).

7.2 Keyboard Diagnostic Codes

Keyboard diagnostic functions are performed by entering the desired code into the display, using the numeric key pad and then pressing the DIAG key. The following table provides a reference to all available keyboard diagnostic codes and their function:

NOTE

Avoid inadvertent execution of the wrong diagnostic function. Always make certain the correct code is shown in the display before pressing the DIAG key.

Table 7. Keyboard Diagnostic Codes

RECORDER CALIBRATION

Diagnostic Code	Diagnostic Function
0	Check recorder output, recorder operation and connection. Outputs a zero indication to recorder
1	Check recorder output, recorder operation and connection. Outputs a full scale indication to recorder
2	Check recorder output, recorder operation and connection. Outputs a half-scale indication to recorder
3	Automatically calibrates current recorder output. 4-20 mA CAL recorder output must be selected on power supply circuit board switch for 3 diagnostic to function.
4	Automatically calibrates voltage recorder output for the selected output range
5	Moves recorder full-scale output in a positive direction to calibrate recorder. Press any key when reading is correct.
6	Moves recorder full-scale output in a negative direction to calibrate recorder. Press any key when reading is correct.
7	Moves recorder minimum output in a positive direction to calibrate recorder. Press any key when reading is correct.
8	Moves recorder minimum output in a negative direction to calibrate recorder. Press any key when reading is correct.

ALARM

Diagnostic Code	Diagnostic Function
9	Initiates lockout duration of alarm circuits for 30 minutes
10	Recalls appropriate system warning code. Refer to section 7.3 for descriptions of warning codes.

Table 7. Keyboard Diagnostic Codes (continued)

Diagnostic Code	Diagnostic Function
11	Recalls the appropriate system alarm code. Refer to paragraph 7.3 for the alarm code descriptions.
12	Sets alarm hysteresis at 2.5%. Alarm condition holds until turbidity level drops to 2.5% below set point.
13	Sets alarm hysteresis at 5%. Alarm condition holds until turbidity level drops to 5% below set point. This is the default value.
14	Sets alarm hysteresis at 10%. Alarm condition holds until turbidity level drops to 10% below set point.
15	Recalls alarm hysteresis setting (2.5, 5, 10%)
16	Recalls print on alarm change status and prints alarm data
17	Toggles print on alarm change status. Alarm disabled (0)/enabled (1). Disabled is the default condition.

INSTRUMENT SETUP

Diagnostic Code	Diagnostic Function
18	Places analyzer in the cold start condition, setting all programmed parameters to their default values. Does an auto voltage recorder setup
19	Recalls status of frequency setting, 50 or 60 Hz
20	Toggles frequency between 50 and 60 Hz. Used to match analyzer to frequency of available facility power. 60 Hz is the default value.
21	Removes any correction values entered for gain. Default calibration values are restored.
22	Removes any correction values entered for offset. Default value of 0 is restored.
23	Recalls amplifier offset with a gain of one (low gain)*.
24	Recalls amplifier offset with a gain of 32 (high gain)*.
25	Selects pure water turbidity offset. Subtracts 0.015 measurement and lights OFFSET LED
26	Selects "no offset" condition. OFFSET LED is off. This is the default condition.
27	Offsets present measurement to 0.0 NTU. OFFSET LED is on. Warning 15 indicates a nonstandard offset has been entered.
28	Recalls NTU offset.
29	Recalls bubble reject status; 1+ yes, 0 = no. One is the default status.
30	Toggles bubble reject status between 1 (yes) and 0 (no)
54	Recalls selected resolution; 1 = 0.0001, 0 = 0.001. Zero is the default value.
55	Toggles resolution between 1 (0.0001) and 0 (0.001)

*Turbidimeter head must be in place on turbidimeter body or calibration cylinder during system reset

SERIAL I/O SETUP

Diagnostic Code	DiagnosticFunction
31	Sets baud rate for serial interface setup to 300
32	Sets baud rate for serial interface setup to 600
33	Sets baud rate for serial interface setup to 1200. This is the default setting.
34	Sets baud rate for serial interface setup to 2400
35	Sets baud rate for serial interface setup to 4800
36	Sets baud rate for serial interface setup to 9600
37	Recalls baud rate selected.
38	Selects odd parity for serial interface setup
39	Selects even parity for serial interface setup
40	Disables parity, This is the default condition.
41	Recalls parity status; even = 2, odd = 1, disabled = 0
42	Selects stop bits of one for serial interface setup
43	Selects stop bits of two for serial interface setup. This is the default selection.
44	Recalls stop-bit status (1 or 2).
45	Sets word length to 7 bits for serial interface setup
46	Sets word length to 8 bits for serial interface setup. This is the default selection.
47	Recalls word length selected.

PRINTER SETUP

Diagnostic Code	DiagnosticFunction
48	Prints instrument setup
49	Selects 1 -minute print interval for printer setup. This is the default selection.
50	Selects 15-minute print interval for printer setup
51	Selects 30-minute print interval for printer setup
52	Selects 60-minute print interval for printer setup
53	Recalls print interval (1, 15, 30 or 60)

KEYBOARD LOCK

Diagnostic Code	DiagnosticFunction
6123	Unlocks keyboard for 5 minutes. Automatically returns to locked status if programmed
6234	Locks keyboard, preventing keyboard use except for monitoring
6345	Unlocks keyboard. This is the default selection.

7.3 Error Message Codes

Error codes for system warnings and system alarms are displayed when 10 DIAG and 11 DIAG,

respectively, are entered. Error codes are indicated with an E followed by a numerical code. Refer to the following table for code interpretation.

Table 8. Error Codes

SYSTEM ALARMS

Error Code	Cause of Malfunction
E00	RAM error - memory failure
E01	ROM error - memory failure
E02	A/D malfunction

SYSTEM WARNINGS

Error Code	Cause of Malfunction
E10	Software restart
E11	Display error - indicates error in calculating display value (divide by 0, overflow, log of negative number, etc.). This is self-correcting.
E12	Cold start - indicates cold start has occurred since last system reset.
E13	Power Failure - indicates power was lost since last system reset.
E14	Marginal gain - indicates gain correction made during calibration was excessive. Calibration should be rechecked.
E15	Modified NTU offset (DIAG 2)
E16	Marginal offset - indicates high offset measurement was made during system reset. Light leak is primary cause.
E17	Voltage out of limits - indicates a power supply problem,
E18	Low signal. Possible causes: 1. lamp out; 2. offsets changed. May need system reset

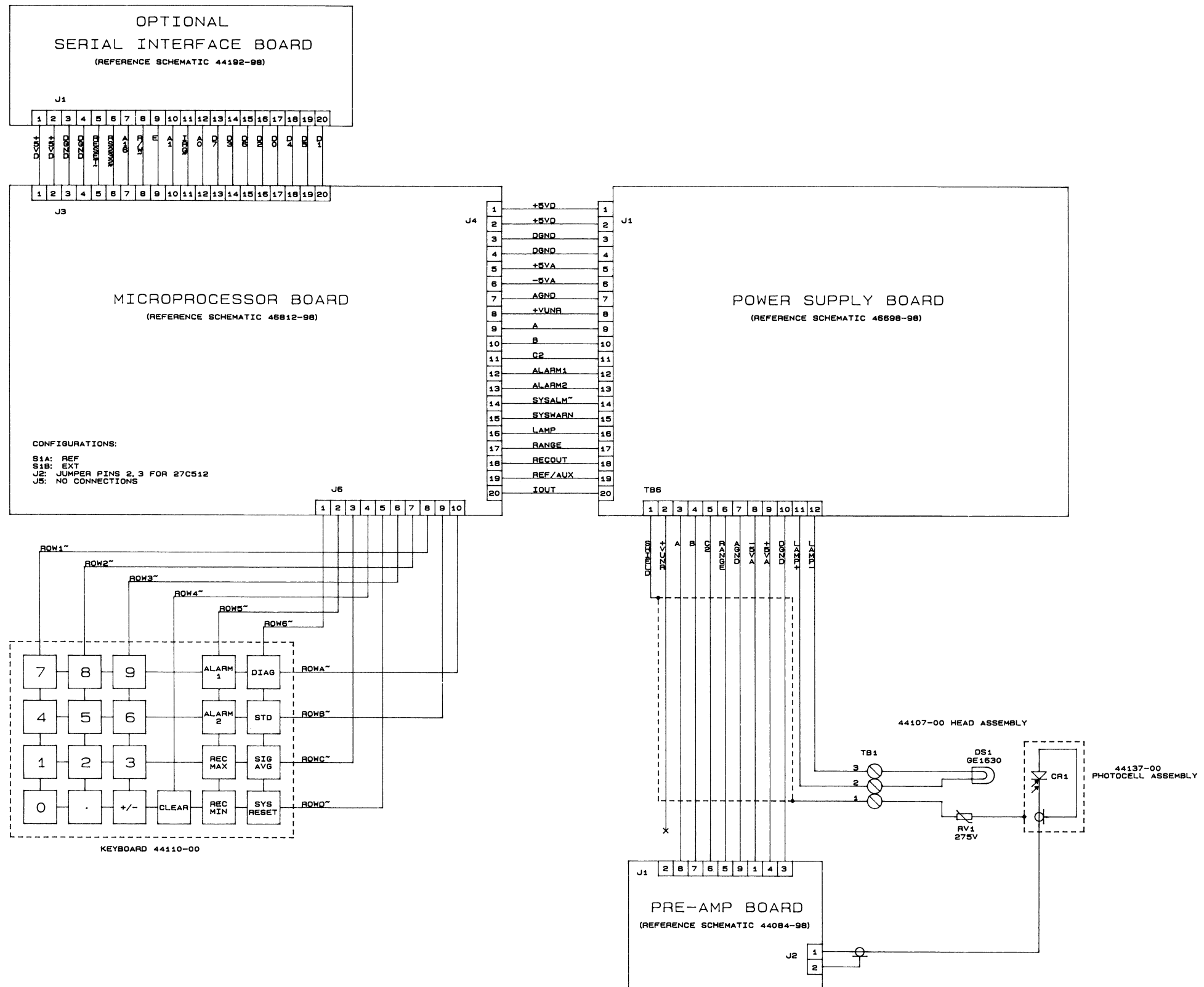
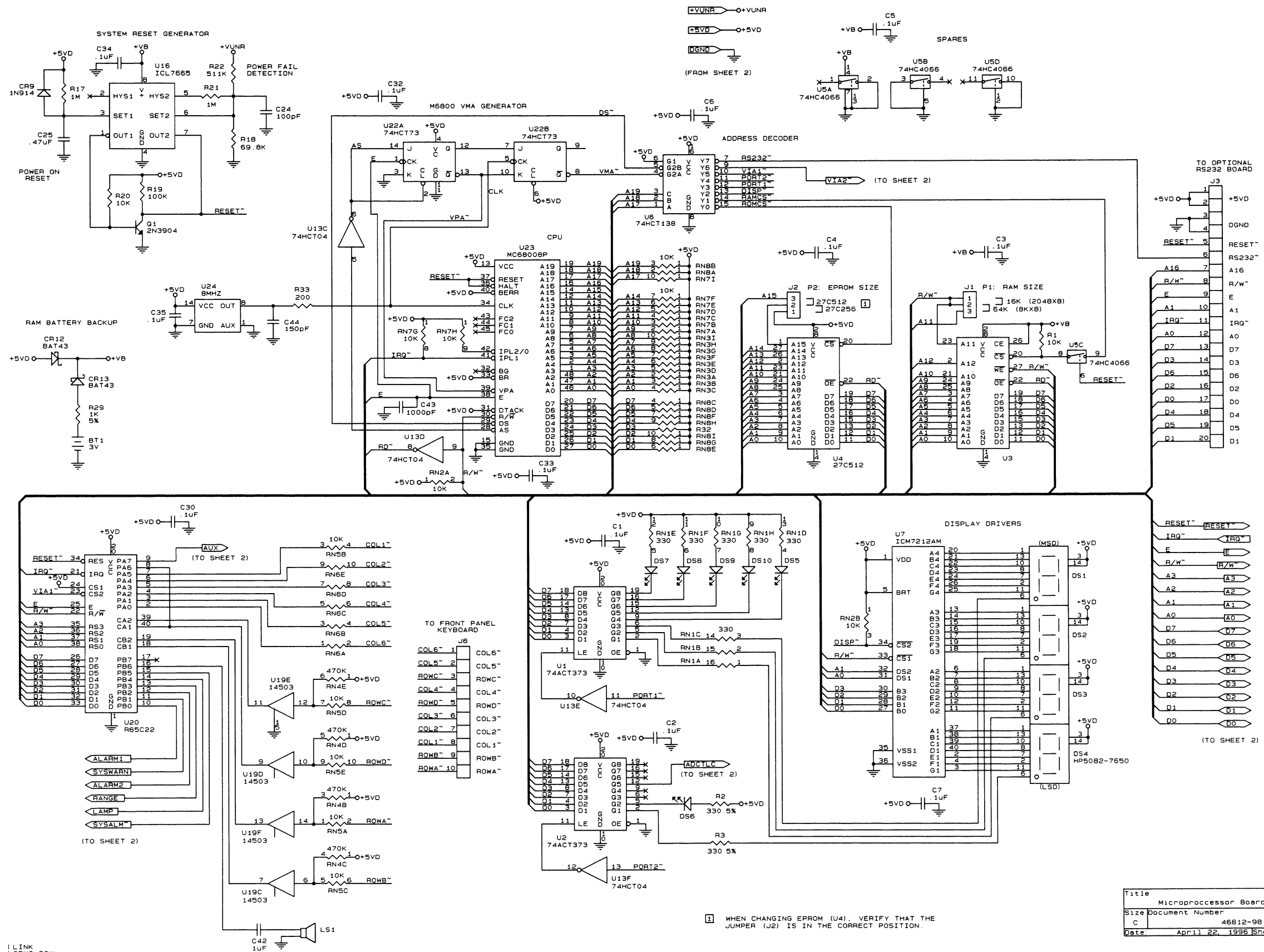


FIGURE 16



1 WHEN CHANGING EPROM (U4), VERIFY THAT THE JUMPER (J2) IS IN THE CORRECT POSITION.

Title	Microprocessor Board Schematic	REV	D
Size	Document Number	46812-98	
C			
Date:	April 22, 1996	Sheet	1 of 2

FIGURE 16

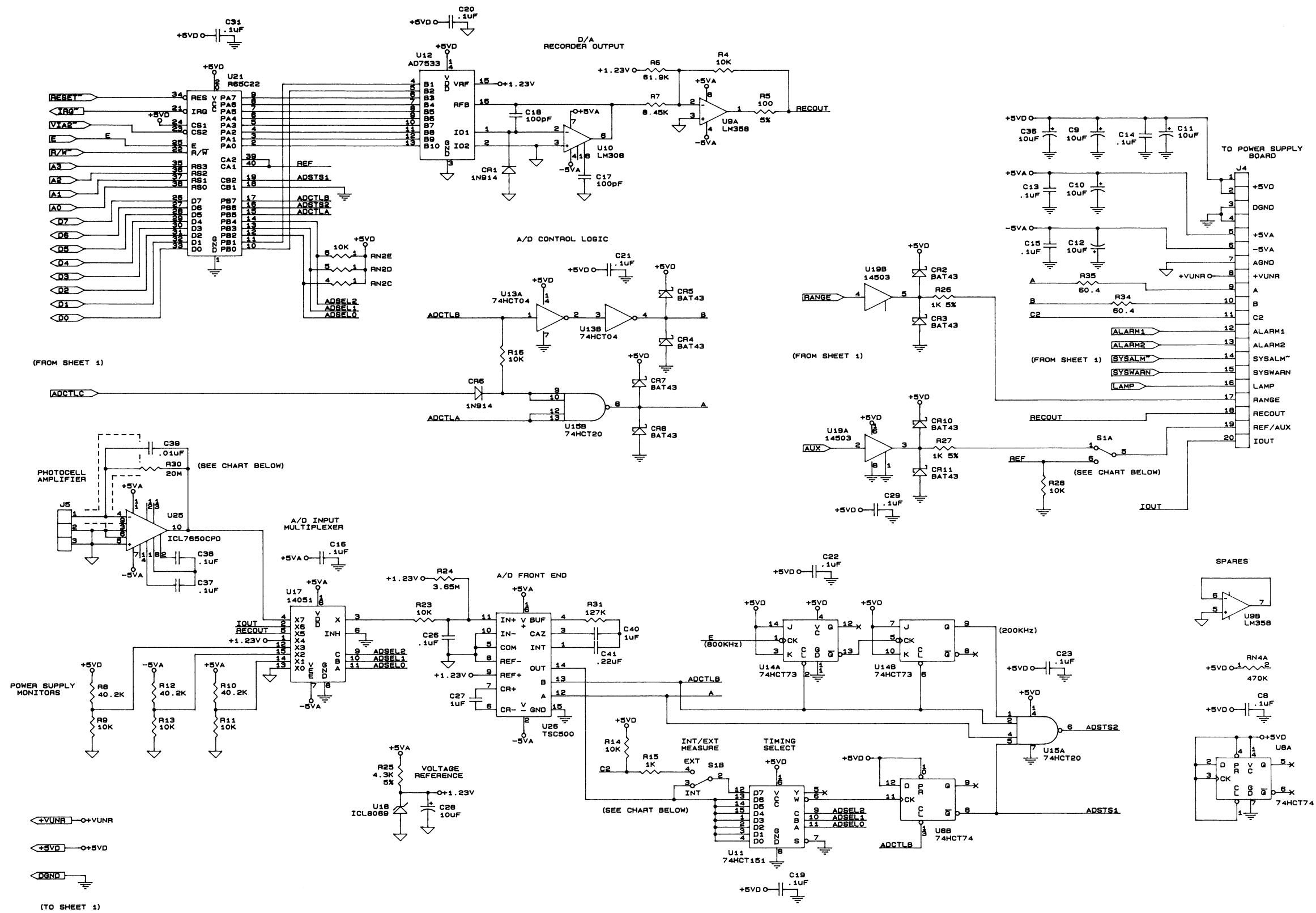
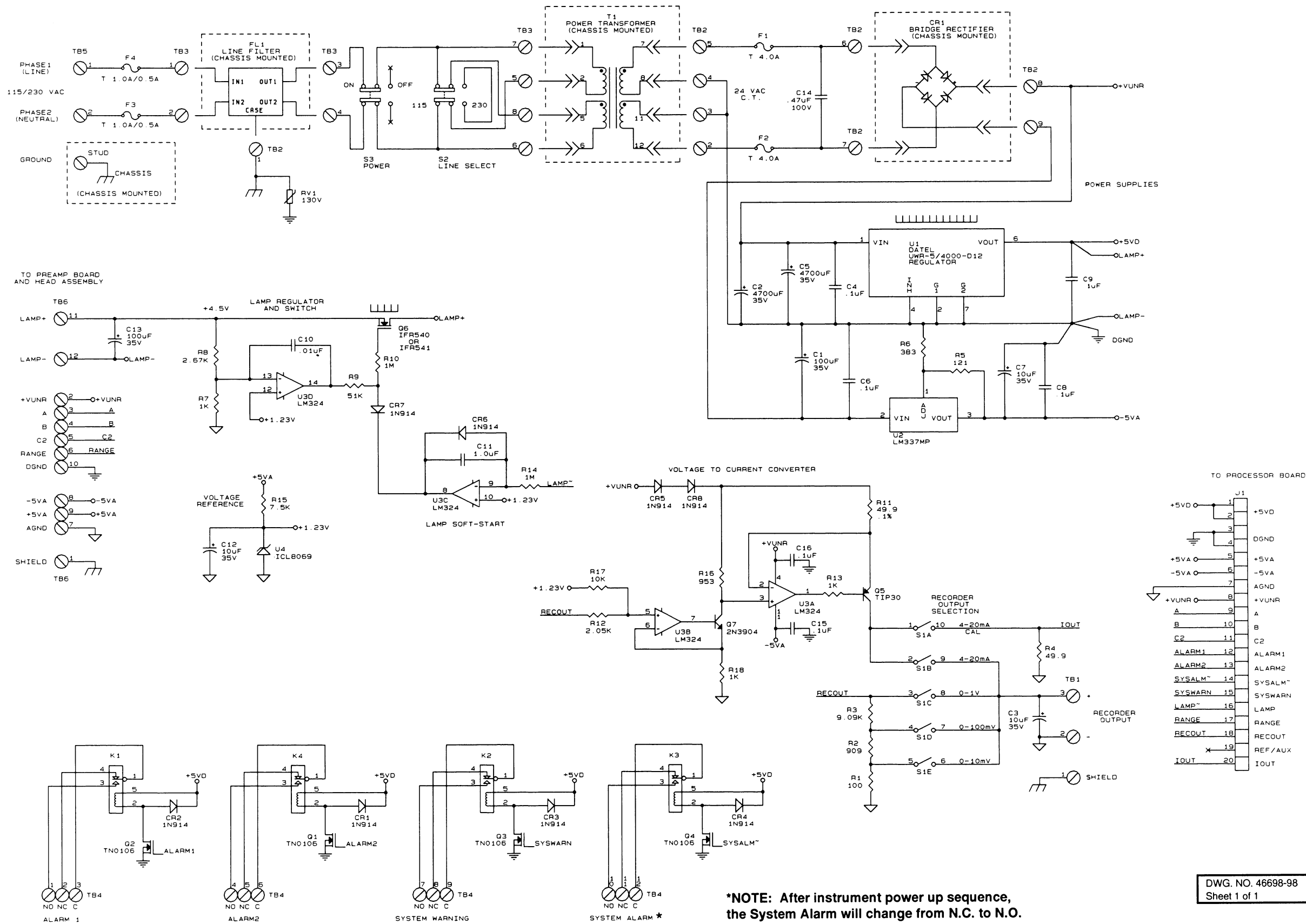


FIGURE 16



***NOTE:** After instrument power up sequence, the System Alarm will change from N.C. to N.O.

DWG. NO. 46698-98	REV.
Sheet 1 of 1	D

FIGURE 16

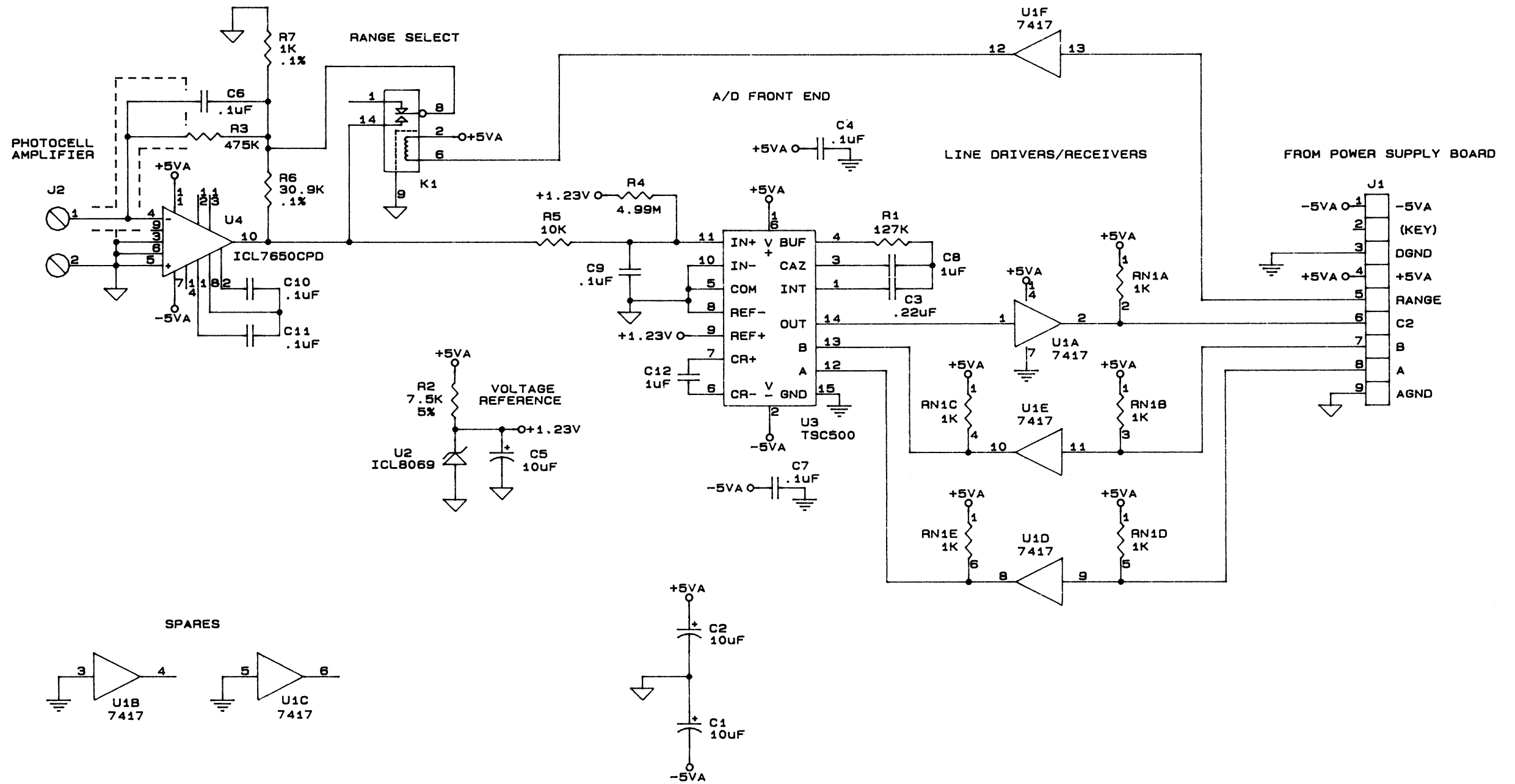


FIGURE 16

SECTION 9 REPLACEMENT PARTS

Ref	Description	Cat. No.
	Accessory Kit	
	Bushing, strain relief (3)	43794-00
	Fitting, compression, for high-pressure installations (2)	47307-00
	Fuse, ½ Amp, for 230V operation (IEC).....	44592-00
	Locknut, strain relief(3).....	10596-12
	O-Ring, sealing (3)	10338-14
	Rubber Washers (4).....	44173-00
	Thumb Grips (2)	45321-00
	Tubing, pressure reducing	45524-00
	Wall Mounting Kit.	44247-00
	Battery, lithium	441 86-00
	Card, Quick Reference	44000-44
	Circuit Board Assembly,I/O serial interface (part of optional Serial Interface Kit)	44192-00
	Circuit Board Assembly, microprocessor w/ROMs	468 12-00
	Circuit Board Assembly, power supply.....	46698-00
	Circuit Board Assembly, preamplifier	44084-00
CR1	Diode Bridge..	13774-00
FL1	Filter, EMI line	44269-00
F3, F4	Fuse, 1amp, for 115V operation (UL/CSA)	44590-00
	Gasket, bubble trap.....	44136-00
	Keyboard..	441 10-00
DS1	Lamp Assembly	19554-00
	Lens.....	44114-00
	Lens Retainer Ring	44115-00
	Manual..	44000-18
	O-ring, bubble trap	45480-00
	Photocell Assembly	44137-00
T1	Transformer, power	44 127-00
Fl, F2	Fuse, 4 amp, 250V for secondary (UL/CSA)	44591-00

SECTION 10 OPTIONAL ACCESSORIES

Bubble Trap Removal Tool	45497-00
Calibration Cylinder	44153-00
Calibration Kit	44156-00
StabICAL™ Calibration Kit for the 1720C Turbidimeter	26596-00
Floor Stand, control unit	44075-00
Floor Stand, turbidimeter body	44076-00
Formazin Stock Solution, 4000 NTU, 473mL	2461-49
Formazin Supplies for preparing primary standard solution (refer to <i>section 6.3.1</i>)	
Hexamethylenetetramine, 100g	1878-26
Hydrazine Sulfate, 100g	742-26
Recorder, Honeywell 4200 GP	45967-00
Remote Indicator, Newport current loop.....	45965-00
Serial I/O Interface Kit	44278-00
Wall Mounting Kit	44247-00
Power Cord, UL, CSA approved for 115 V operation	44964-00

SECTION 11 REPAIR SERVICE

Authorization must be obtained from Hach Company before sending any items for repair. Please contact the Hach Factory Service Center serving your location.

In the United States:

Hach Company
100 Dayton Ave.
P.O. Box 907
Ames, Iowa 50010
800-227-4224 (U.S.A. only)
FAX: (515)232-1276

In Latin America, the Caribbean, the Far East, the Indian Subcontinent, Africa (excluding Mediterranean Africa) or the Pacific Basin:

Hach Company, World Headquarters
P.O. Box 389
Loveland, Colorado 80539 U.S.A.
Telephone: (970) 669-3050
Telex: 160840
FAX: (970) 669-2932

In Canada:

Hach Sales & Service Canada Ltd.
1313 Border Street, Unit 34
Winnipeg, Manitoba
R3H 0X4
800-665-7635 (Canada only)
(204) 632-5598
FAX: (204) 694-5134

In Europe, the Middle East, or Mediterranean Africa:

Hach Europe S.A./N.V.
Chaussée de Namur, 1
B-5150 Floriffoux (Namur) Belgium
Telephone: (32)(81)44.71.71
FAX: (32)(81)44.13.00

SECTION 12 WARRANTY

Seller warrants equipment of its manufacture against defective materials or workmanship for a period of two years from date of shipment. Warranty can be extended to two years from start-up date if minimum one-day paid service is performed by a Hach representative. Service must be purchased prior to initial start-up.

Seller warrants all chemicals to be of the highest quality, to be free of material defects on the date of shipment, and to be exactly as specified on the container label or in our literature for a period of one year from date of shipment.

The liability of Seller under this warranty is limited, at Seller's option, solely to (1) repair, (2) replacement with equivalent Hach equipment, or (3) an appropriate credit adjustment not to exceed the original states price of equipment returned to the Seller, provided that:

- a. Buyer promptly notifies Seller in writing on discovery of the defects, stating, where applicable, the product type and serial numbers and fully describing the circumstances giving rise to the claim. Seller must receive such notification within the applicable warranty period in order for this warranty to apply.
- b. On receipt of written instructions from Seller, Buyer returns the equipment as instructed with transportation charges prepaid by Buyer; and
- c. Seller's examination of such equipment discloses to its satisfaction that the defects have not resulted from

any negligence, misuse, improper installation, accident, or unauthorized repair or alteration by the Buyer. Seller's determination of the cause and nature of the failure of the equipment shall be final.

This warranty does not include limited life electrical components which deteriorate with age such as batteries, lamps, photocells, electrodes, etc. In the case of equipment and accessories not manufactured by Seller, but furnished with equipment of Seller's manufacture, Seller's liability is limited to whatever warranty is extended by the manufacturers thereof and transferable to the Buyer.

This warranty is applicable to the original Buyer only and shall be in lieu of and exclude all other warranties, expressed or implied, including, but not limited to, any implied warranty of merchantability or fitness. The foregoing shall constitute the sole and exclusive remedy of Buyer and the sole and exclusive liability of Seller, whether Buyer's claims shall be for breach of warranty or negligence. Seller neither assumes nor authorizes any person to assume for it any other obligation or liability in connection with the sale of the equipment. In no event shall Seller be liable for special, incidental or consequential damages.

If Seller finds that Buyer has returned the equipment without cause, Seller shall notify Buyer and return the equipment at Buyer's expense; in addition, Seller may, at its sole discretion, impose a charge for testing and examination of any equipment so returned.

SUPPLEMENTAL COMPLIANCE INFORMATION

The 1720C Turbidimeter shows slight accuracy shifts when exposed to radio frequency interference of 3 volts per meter. What this means to you: if the displayed data are not stable (within the accuracy and repeatability specifications), and other interferences are not suspected as the cause, inspect the area for portable phones, paging service tower/antennas, or any other transmitting communications device. For example, if the user of the instrument detects a measurement deviation while using a hand-held radio communication device to relay information to a base station the interference is clearly caused by the hand-held radio communication device. To resolve the interference problem? move the hand-held radio communication device at least 3 to 4 meters from the instrument to provide isolation.

As shown in the following table, the instrument reading may deviate slightly at frequencies from 82 to 236 MHz. Maximum deviation is from -0.6 NTU to +1.0 NTU.

Any electronic instrument is sensitive to radio waves if the power is great enough. However, typical transmitting power is limited by regulatory controls and field strengths greater than 3 volts per meter are seldom experienced.

Frequency (MHz)	Nominal Value (NTU)	Display Value With Instrument In a 3V/m E-Field (NTU)
82.0 to 89.0	0.667	0.404 to 0.549
90.0 to 92.0	0.667	0.212 to 0.326
93.0 to 94.0	0.667	0.052 to 0.062
96.0 to 98.0	0.667	0.166 to 0.198
100.0	0.667	0.227
104.0	0.667	0.018
106.0	0.667	0.211
108.0 to 112.0	0.667	0.402 to 0.532
114.0 to 116.0	0.667	0.607 to 0.650
131.0 to 137.0	0.667	0.504 to 0.627
139.0 to 157.0	0.667	0.699 to 0.788
159.0 to 163.0	0.667	0.950 to 1.192
165.0 to 167.0	0.667	1.322 to 1.392
169.0 to 179.0	0.667	1.402 to 1.611
181.0 to 183.0	0.667	1.312 to 1.392
185.0 to 193.0	0.667	0.924 to 1.179
195.0 to 208.0	0.667	0.801 to 0.886
210.0 to 220.0	0.667	0.730 to 0.770
223.0 to 236.0	0.667	0.692 to 0.705



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FAX: (32) (81) 44. 13. 00

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In the U.S.A. Call 800-227-4224 toll-free for more information.
Outside the U.S.A. Contact the Hach office or distributor serving

KEYBOARD FUNCTIONS

LED INDICATORS	DESCRIPTION
Display	Four-digit display shows turbidity level in NTUs during normal operation. In over-range condition, the display flashes 100.0 intermittently. Decimal point positioned automatically* Also displays programming and diagnostic entries. Software configuration code appears momentarily when instrument is first turned on and following system reset
NTU	Lights when display is reading turbidity. Flashes when alarms are locked out.
OFFSET	Lights when pure water turbidity offset or some nonstandard offset is entered for subtraction from measurement
ALARM 1	Indicates turbidity level ALARM 1 set point has been exceeded
ALARM 2	Indicates turbidity level ALARM 2 set point has been exceeded
SYSTEM ALARM	Indicates a malfunction that has halted operation. Requires operator intervention for correction and restart.
SYSTEM WARNING	Indicates turbidimeter has detected a possible malfunction requiring investigation. Instrument continues to operate.
DESCRIPTION KEYS	DESCRIPTION
ALARM 1	Enters and recalls ALARM 1 turbidity level set point
DIAG	Performs programming and self-test operations.
ALARM 2	Enters and recalls ALARM 2 turbidity level set point
STD	Enters the value of a known standard or sample being supplied to the turbidimeter for calibration
REC MAX	Enters and recalls full-scale value of the recorder output in NTUs
SIG AVG	Enters and recalls the time duration (seconds) the measurements are averaged; 6, 30, 60 and 90 seconds. Average measurement is updated every three seconds.
SYS RESET	Clears alarms and warnings and initiates self tests; then restarts for turbidity measurement
REC MIN	Enters and recalls minimum value of recorder output in NTUs
CLEAR	Clears numerical entry error and/or return display to turbidity reading after some other display
±	Changes sign (positive or negative) of numerical value being entered
Numeric Keys	Enters numeric portion of commands

KEYBOARD DIAGNOSTIC CODES

CODE	FUNCTION
RECORDER CALIBRATION	
0	Check recorder output, recorder operation and connection. Outputs a zero indication to recorder
1	Check recorder output, recorder operation and connection. Outputs a full scale indication to recorder
2	Check recorder output, recorder operation and connection. Outputs a half-scale indication to recorder
3	Auto matically calibrates current recorder output. Must select 4-20 mA CAL recorder output switch on power supply board.
4	Autotomatically calibrates voltage recorder output for the selected output range
5	Moves recorder full-scale output in a positive direction to calibrate recorder Press any key when reading is correct
6	Moves recorder full-scale output in a negative direction to calibrate recorder. Press any key when reading is correct
7	Moves recorder minimum output in a positive direction to calibrate recorder. Press any key when reading is correct.
8	Moves recorder minimum output in a negative direction to calibrate recorder. Press any key when reading is correct.
ALARM SETUP	
9	Initiates lockout duration of alarm circuits for 30 minutes
10	Recalls appropriate system warning code.
11	Recalls the appropriate system alarm code.
12	Sets alarm hysteresis at 2.5%. Alarm condition holds until turbidity level drops to 2.5% below set point.
13	Sets alarm hysteresis at 5%. Alarm condition holds until turbidity level drops to 5% below set point. This is the default value.
14	Sets alarm hysteresis at 10%. Alarm condition holds until turbidity level drops to 10% below set point.
15	Recalls alarm hysteresis setting (2.5, 5, 10%)
16	Recalls print on alarm change status. Alarm disabled = 0; alarm enabled = 1. Disabled is the default condition.
17	Toggles print on alarm change status. Alarm disabled = 0; alarm enabled = 1. Disabled is the default condition.
INSTRUMENT SETUP	
18	Places analyzer in cold start condition, setting all programmed parameters to their default values. Does an auto voltage recorder setup.
19	Recalls status of frequency setting, 50 or 60 Hz.
20	Toggles frequency between 50 and 60 Hz. Matches analyzer to frequency of available facility power. Default value is 60 Hz.
21	Removes any correction values entered for gain. Default calibration values are restored.

1720C Low Range Turbidimeter Quick Reference Guide

KEYBOARD DIAGNOSTIC CODES, continued

INSTRUMENT SETUP, <i>continued</i>	
CODE	FUNCTION
22	Removes any correction values entered for offset. Default value of 0 is restored.
23	Recalls amplifier offset with a gain of one (low gain)*
24	Recalls amplifier offset with a gain of 32 (high gain)*
25	Selects pure water turbidity offset. Subtracts 0.015 measurement and lights OFFSET LED
26	Selects "no offset" condition. OFFSET LED is off. This is the default condition.
27	Offsets present measurement to 0.0 NTU. OFFSET LED is on. Warning 15 indicates a nonstandard offset has been entered.
28	Recalls NTU offset.
29	Recalls bubble reject status; 1 = yes, 0 = no. One is the default status.
30	Toggles bubble reject status between 1 (yes) and 0 (no)
54	Recalls selected resolution; 1 = 0.0001, 0 = 0.001. Zero is the default value.
55	Toggles resolution between 1(0.0001) and 0 (0.001)
KEYBOARD LOCK	
6123	Unlocks keyboard for 5 minutes. Automatically returns to locked status if programmed
6234	Locks keyboard, preventing keyboard use except for monitoring
6345	Unlocks keyboard. This is the default selection

Turbidimeter head must be in place on turbidimeter body or calibration cylinder during system reset

ERROR CODES

CODE	CAUSE OF MALFUNCTION
SYSTEM ALARMS	
E00	RAM error—memory failure
E01	ROM error—memory failure
E02	A/D malfunction
SYSTEM WARNINGS	
E10	Software restart
E11	Indicates error in calculating display value (divide by 0, overflow, log of negative number, etc.) This is self-correcting.
E12	Cold start—indicated cold start has occurred since last system reset.
E13	Power Failure—indicates power was lost since last system reset.
E14	Marginal gain—indicates gain correction made during calibration was excessive. Calibration should be rechecked.
E15	Modified NTU offset (DIAG 27)
E16	Marginal offset—indicates high offset measurement was made during system reset. Light leak is primary cause.
E17	Voltage out of limits—indicates a power supply problem.
E18	Low signal. Possible causes: 1. lamp out; 2. offsets changed. May need system reset.

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