CONFAB INSTRUMENTATION

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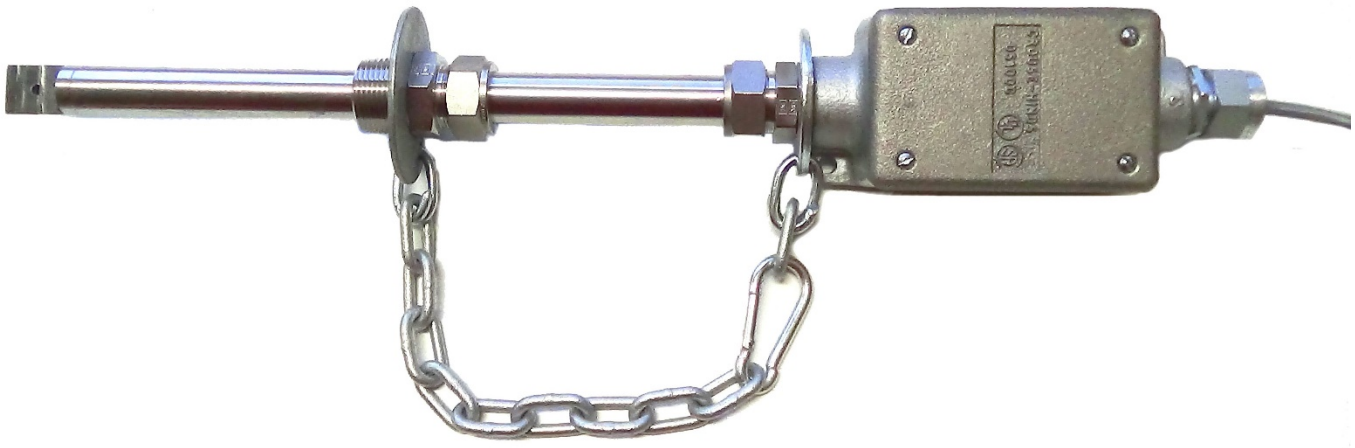
MODEL 851
Turbidity Sensor
Installation & Instruction Manual



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1. PRINCIPLE OF OPERATION

The Model 851 Turbidity Sensor is a rugged DC-powered insertion-type probe with four user-selectable ranges. A prefocused incandescent lamp directs an intense beam of light through the process fluid. The particulate in the fluid scatters the light in proportion to its concentration. The scattered light is detected by a silicon detector that generates a current signal proportional to the particulate concentration. The signal is converted, amplified and scaled to provide a linear 4-20mA isolated output signal for connection to control/monitoring systems.

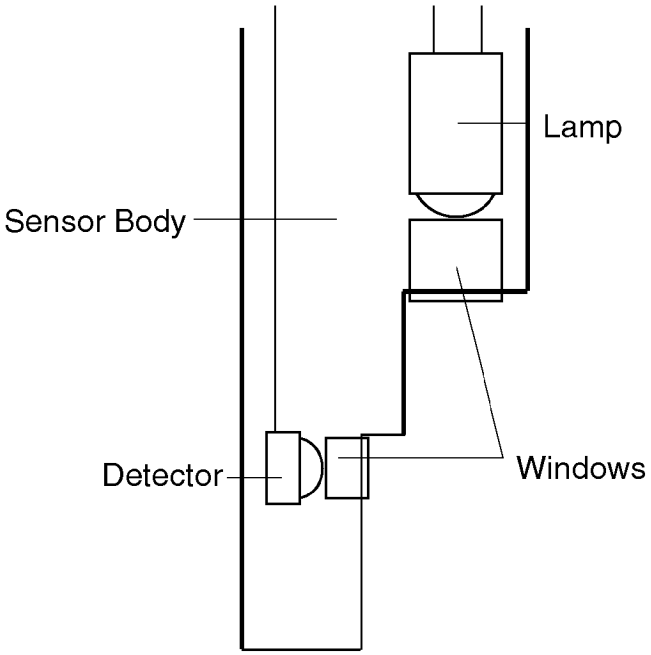
The instrument is "peaked" to operate in the near infrared (NIR) radiant energy spectrum to eliminate errors due to visible colors in the particulate and the process liquid.

The silicon detector is positioned at a right angle to the light beam so that true nephelometric readings are obtained. The detector's wide viewing angle provides a measurement that is least affected by particle shape variations. Key components of the sensing head are shown in Figure A below.

The sensor's unique design reduces the effects of stray light and moderate window obscuration, and its short optical path provides a linear response over a wide dynamic range of turbidity.

Figure A

Key Components of Sensor Head



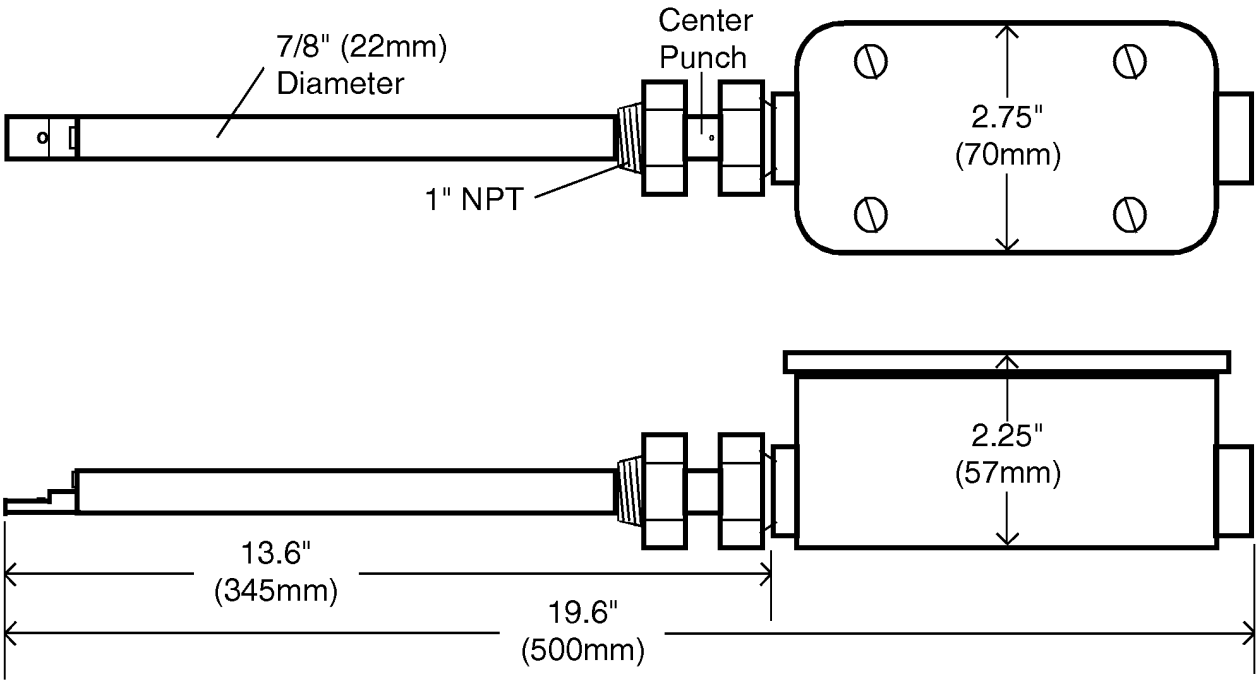
2. INSTALLATION

A. Dimensions

Figure B below shows the dimensions of the insertion-type sensor.

Figure B

Insertion-Type Sensor Dimensions

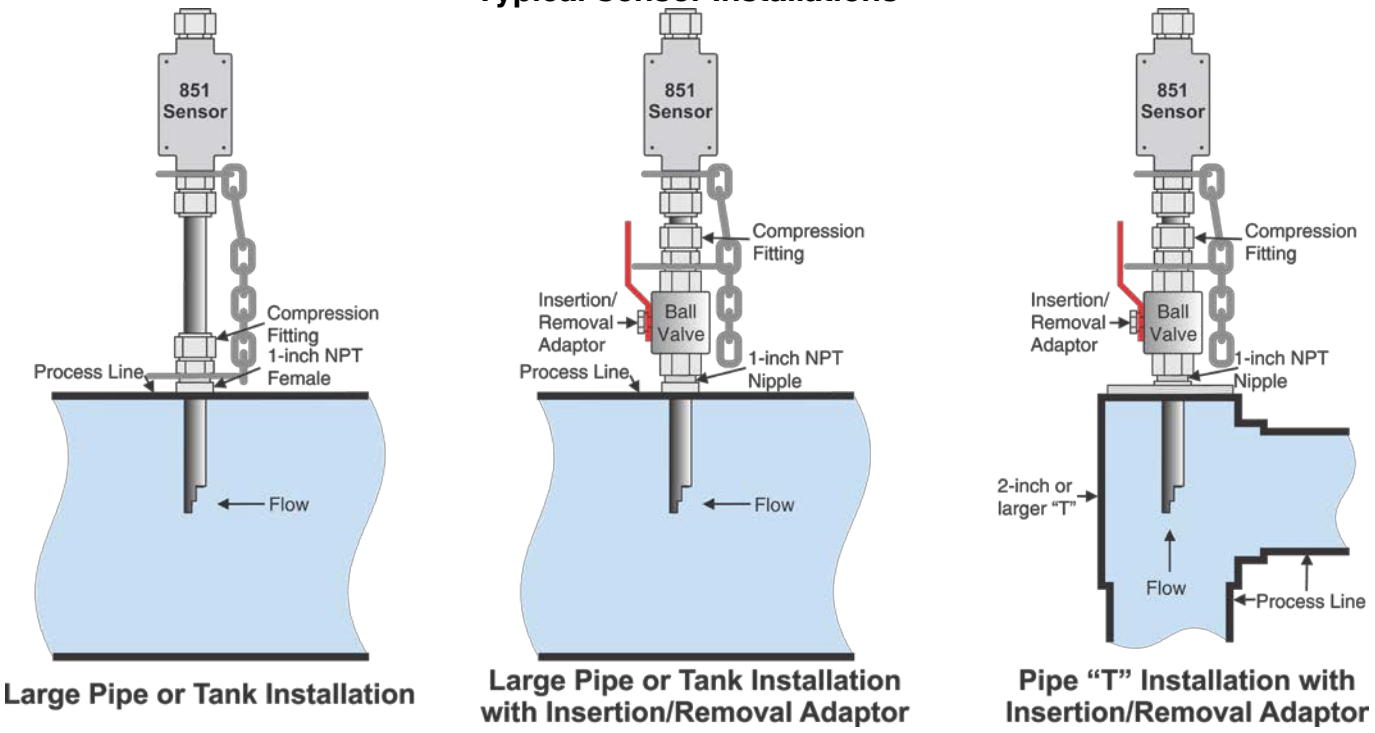


B. Installation

Line Size: There are no restrictions on the maximum pipe diameter into which the sensor can be installed. However, if a 2-inch or smaller line is to be monitored, install a 2-inch or larger "T" to prevent the sensor from blocking the line. Figure C below shows some typical insertion-type sensor installations.

Figure C

Typical Sensor Installations



Transparent Lines: If the sensor is to be used in a transparent (e.g., glass, PVC, acrylic, etc.) process or sample line, the pipe must be wrapped with tape to prevent ambient light from entering the pipe and affecting the readings. Wrap the pipe for a distance of at least five pipe diameters from the sensor. **Black PVC electrical tape will not block light sufficiently.** Use an aluminum tape or wrap any tape over a metallic foil.

Temperature: The sensor should not be exposed to a process temperature that is below -10^{0}C or greater than 110^{0}C.

Pressure: The sensor should not be used where the process pressure is greater than 150 psig (10 BAR). **A safety chain is provided and MUST be used (see Section C on page 4).**

Entrained Gas: Gas bubbles in suspension can cause errors, so care should be taken to locate the sensor upstream of anything that could create a pressure drop (e.g., orifice plates, valves, pumps, etc.) and cause dissolved gases to come out of solution.

Mounting (without optional insertion/removal adaptor ball valve assembly): While any position on the periphery of the process pipe may be used to install the sensor, a position above the horizontal plane is recommended, particularly if the sensor is to be removed frequently. The sensor may either be installed through a "T" or a weldment that has been installed on the process pipe. The "T" or weldment must provide a 1" NPT female thread. After mounting the "T" or weldment, thread the male compression fitting supplied with the instrument into the "T" or weldment. Be sure that the large washer with one end of the safety chain fastened to it is captured between the compression fitting and the process pipe.

Mounting (with optional insertion/removal adaptor ball valve assembly): While any position on the periphery of the process pipe may be used to install the sensor, a position above the horizontal plane is recommended, particularly if the sensor is to be removed frequently. The sensor may either be installed through a "T" or a weldment that has been installed on the process pipe. The "T" or weldment must provide a 1" NPT male thread. After mounting the "T" or weldment, thread the supplied ball valve assembly into the "T" or weldment.

C. Insertion

CAUTION: IT IS HIGHLY RECOMMENDED THAT THE PROCESS LINE BE DEPRESSURIZED AND DRAINED BEFORE INSERTING OR REINSERTING THE SENSOR. DO NOT ATTEMPT TO INSERT THE SENSOR WHEN THE PROCESS FLUID IS HIGHLY ACIDIC OR CORROSIVE, OR AT ELEVATED TEMPERATURES OR PRESSURES.

An insertion depth between 1" and 4" is suggested. If the process pipe is empty or filled with a clean fluid, position the sensor at a depth where a minimum reading is obtained on the meter. This is to assure that any internally-reflected light from the process piping can be zeroed out. To further reduce internally reflected light, rotate the sensor so that the small center punch located below the junction box is facing upstream. In other words, if the process pipe is horizontal and the sensor is inserted into the top of the pipe, the center punch should be facing in line with the flow towards the upstream side. This permits a "scrubbing" action on the windows, and helps eliminate any buildup on the sensor while keeping reflected light at a minimum. Figure C on page 3 shows how to position the sensor. Follow the appropriate instructions below to complete the insertion of the sensor.

Insertion (without optional insertion/removal adaptor ball valve assembly): When the sensor has been positioned satisfactorily, firmly tighten the compression fitting so that the sensor cannot be pulled out or rotate. **The large washer that holds one end of the safety chain must be captured between the compression fitting and the process pipe.**

AFTER PROPERLY INSTALLING THE SENSOR AND BEFORE THE LINE IS PRESSURIZED, TAKE ALL THE SLACK OUT OF THE SAFETY CHAIN BY MOVING THE "CLIP" TYPE LINK UNTIL THE SAFETY CHAIN IS TAUT.

Insertion (with optional insertion/removal adaptor ball valve assembly): With the ball valve in the "closed" position and the compression fitting slightly loosened, insert the sensor into the compression fitting until it stops against the closed portion of the ball. Reconnect the safety chain and remove all slack using the "clip" connector on the chain. **The large washers on the safety chain must be "captured" between the compression fittings -- one on the valve and the**

other on the sensor. Tighten the compression fitting to a "snug" position, then insert the sensor further while containing most of the liquid. While standing to the side of the sensor, **SLOWLY** open the ball valve to permit the liquid to reach the outer compression fitting. When the valve is completely open, insert the sensor to its proper position and retighten the compression fitting until it stops leaking.

AFTER PROPERLY INSTALLING THE SENSOR AND BEFORE THE LINE IS PRESSURIZED, TAKE ALL THE SLACK OUT OF THE SAFETY CHAIN BY MOVING THE "CLIP" TYPE LINK UNTIL THE SAFETY CHAIN IS TAUT.

Junction Box: Route the power and output cable through the cable seal as described on page 6. Tighten the seal to ensure a moisture-tight seal. Make the wire connections as shown in Figure D on page 7 and reinstall the cover and gasket to assure a weather-tight seal. It is important that the inside of the junction box be kept dry at all times. If the junction box is positioned so that it is difficult to make the wire connections, the box may be rotated by loosening the compression fitting immediately under the box.

NOTE: DO NOT ROTATE THE BOX MORE THAN 180 DEGREES IN EITHER DIRECTION OR THE INTERNAL WIRING MAY BE DAMAGED. BE SURE TO RETIGHTEN THE COMPRESSION FITTING.

This completes the installation of the sensor.

D. Removal

CAUTION: DO NOT ATTEMPT TO REMOVE THE SENSOR WHEN THE LINE IS FILLED OR UNDER PRESSURE IF THE PROCESS FLUID IS ACIDIC, CORROSIVE, OR AT ELEVATED PRESSURES OR TEMPERATURES. NEVER STAND IN FRONT OF THE SENSOR WHILE ATTEMPTING TO REMOVE IT FROM A PIPE THAT IS UNDER PRESSURE.

To remove the sensor from the process line, please follow the appropriate steps below.

Removal (without optional insertion/removal adaptor ball valve assembly): The process line will have to be depressurized and probably drained. The sensor may then be safely removed by disconnecting the safety chain and loosening the compression fitting.

Removal (with optional insertion/removal adaptor ball valve assembly): If it is not possible or practical to de-pressurize the line, **extreme care** must be taken to ensure that the sensor is not "blown out" by the process pressure when the compression fitting is loosened. Please follow these steps:

1. Loosen the safety chain one or two links by moving the "clip" towards the process pipe.
2. Loosen the compression fitting sufficiently to permit pulling the sensor out to the new limit of the safety chain.
3. Retighten the compression fitting and repeat steps 1 through 3 until the sensor is clear of the ball valve.
4. Close the valve and withdraw the sensor completely.

3. WIRING

A. General

1. All wires should be routed away from potential RF (radio frequency) sources and large inductive loads.

2. All wiring connections at the sensor must go through the cable seal, and the seal must be tightened sufficiently to keep moisture out. Be sure that the cover on the sensor is tightly screwed down to avoid leakage into the sensor.

3. Assure that the interconnecting cable to the sensor is correctly installed (see Figure D on page 7) and all terminals are tightened. Strip about 3 to 4 inches of the cable cover back to expose the 5 wires. Make sure the cable seal on the sensor seals against the unstripped cable. The cable seal will not seal around the 5 exposed wires. **Use only the cable supplied with the instrument or equivalent.** Standard cable length is 25 feet. Optional lengths up to 1000 feet are available.

4. Before connecting the power, be sure that the supplied voltage matches the voltage indicated on the service label. Figure D on page 7 shows how the power wires should be connected.

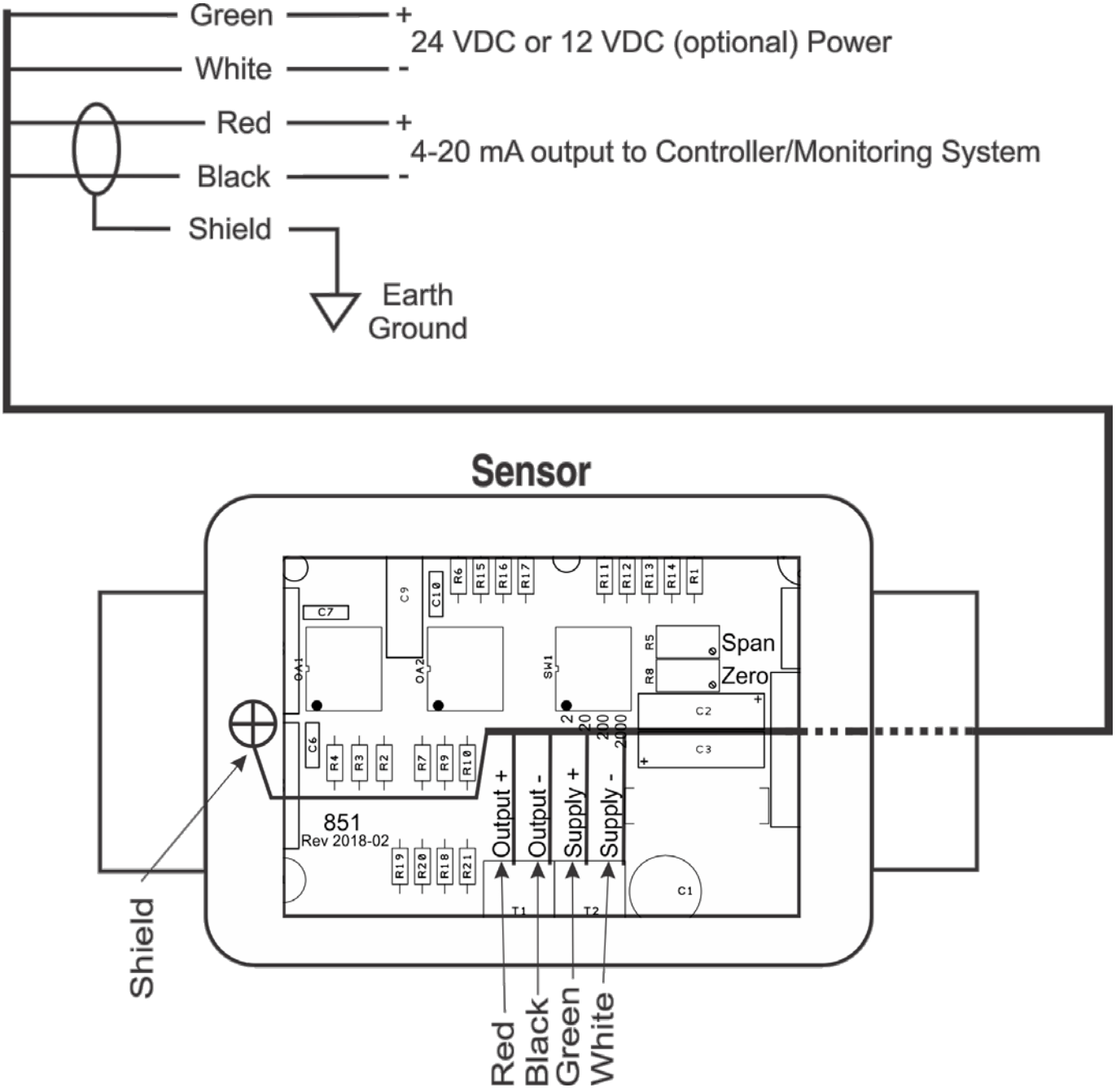
5. Wire the sensor output with the shielded twisted pair (red and black wires) as shown in Figure D on page 7. Ground the shield as shown in Figure D on page 7**.**

NOTE: RFI (Radio Frequency Interference) and large inductive loads such as motors, solenoid valves and large switches can affect the operation of the instrument. Therefore, both the sensor should be properly grounded to eliminate the effects of RFI. If the instrument is mounted in the vicinity of any large inductive loads, all interconnecting cable should be installed in conduit that does not contain power cables.

B. Wiring Diagram

Figure D

Wiring Diagram



12 VDC Power Connections (Optional)

For units equipped with optional 12-volt DC-powered operation, make all connections as above. Be sure the unit will operate on 12 VDC before making the connections. The service label will indicate the power supply voltage options.

4. CALIBRATION

A. General

The Model 851 has been factory calibrated using precise turbidity standards. Calibration standard solution is available directly from GFS Chemicals using the links below or by calling 877-534-0795 (U.S. and Canada) or 740-881-5501 (International). We recommend that you purchase a minimum volume of 500ml.

0 NTU Standard
http://www.gfschemicals.com/statics/productdetails/AMCO_CLEAR_TURBIDITY_STANDARD_8000.html
(500ml use SKU 85004, 1L use SKU 85005, 1gal use SKU 85006)

10 NTU Standard
http://www.gfschemicals.com/statics/productdetails/AMCO_CLEAR_TURBIDITY_STANDARD_8014.html
(500ml use SKU 85065, 1L use SKU 85063, 1gal use SKU 85067)

100 NTU Standard
http://www.gfschemicals.com/statics/productdetails/AMCO_CLEAR_TURBIDITY_STANDARD_8021.html
(500ml use SKU 85095, 1L use SKU 85092, 1gal use SKU 85097)

1000 NTU Standard
http://www.gfschemicals.com/statics/productdetails/AMCO_CLEAR_TURBIDITY_STANDARD_8030.html
(500ml use SKU 85125, 1L use SKU 85122, 1gal use SKU 85126)

Inside the sensor box there are four calibrated range switches. The four calibrated ranges are: 0-2 NTU, 0-20 NTU, 0-200 NTU and 0-2000 NTU. Since there may be differences in the amount of reflected light depending on the pipe line size into which the sensor is installed, it is necessary when starting up the instrument to perform a zero calibration check to ensure maximum accuracy in your turbidity readings.

NOTE: With proper installation, the maximum error due to reflected light should be no more than 5 NTU. If the range in which you are operating is sufficiently high so that a 5 NTU possible error is inconsequential, you may wish to ignore the zero calibration check.

The zero calibration check is to be done after the sensor has been installed in your pipeline. If an accurate laboratory nephelometer is available and a representative sample of the process fluid can be taken, then please **follow PROCEDURE A**. If a laboratory nephelometer is not available, please **follow PROCEDURE B**.

NOTE: The calibration procedures do NOT require any adjustment of the SPAN trimmer.

Procedure A

1. Set the range switches for the range you wish to measure. Only one switch should be in the “on” position and it should be the switch that corresponds to the desired turbidity range. The “on” position is in the direction of the arrow on the switch.
2. Take a representative sample of your process fluid and simultaneously note the output from the Model 851 sensor.
3. Calculate the turbidity that corresponds to the measured output.

   Turbidity *= [**Range** (NTU)/(**16** mA)] x [**measured output** (mA)-**4** (mA)]*

4. Determine the NTU value of the sample with a lab nephelometer.
5. Subtract the nephelometer reading from the calculated turbidity value to obtain the "difference".
6. Calculate the change in current needed to offset turbidity difference.

   Output Difference *(mA) = [**16** (mA) / **Range** (NTU)] x **Turbidity Difference** (NTU)*

7. Note the present output from the sensor, adjust the “Zero” trimmer (in the sensor box) to correct the sensor output by the calculated amount from Step 6. If the "difference" is negative, meaning the output current is too low, turn the “Zero” trimmer clockwise to increase the output. If the "difference" is positive, meaning the output is higher than the reading obtained by the nephelometer, adjust the “Zero” trimmer counterclockwise to decrease the sensor output.
8. After adjustment, be sure to replace the box cover and tighten all the screws so that fluid does not enter the sensor.

EXAMPLE 1:

1. Range switch set at 200 NTU
2. Output when sample was taken..... **5.60** mA
3. Calculated turbidity for 5.6 mA……. **20.0** NTU
4. Lab nephelometer reading..... **18.0** NTU
5. Difference..... **+2.0** NTU
6. Calculate current for 2.0 NTU difference…….. **0.16** mA
7. Present output is…… **5.40** mA

   Turn the Zero trimmer counterclockwise until the output current changes to 5.24 mA (5.40-0.16=5.24). Note that the "difference" is positive (that is, the meter reads too high), so turn the Zero trimmer counterclockwise to reduce the reading by 0.16 mA.

EXAMPLE 2:

1. Range switch set at 20 NTU
2. Output when sample was taken..... **12.0** mA
3. Calculated turbidity for 12.0 mA……. **10.0** NTU
4. Lab nephelometer reading..... **12.0** NTU
5. Difference..... **-2.0** NTU
6. Calculate current for -2.0 NTU difference…….. **-1.60** mA
7. Present output is…… **11.0** mA
Turn the Zero trimmer clockwise until the output current changes to 12.60 mA (11.00-(-1.60) = 12.60). Note that the "difference" is negative (that is, the meter reads too low), so turn the Zero trimmer clockwise to increase the reading by 1.60 mA.

Procedure B

1. Since a laboratory nephelometer is unavailable, Procedure A cannot be used. However it is assumed that the turbidity of plant or domestic water is known or can be obtained. (NOTE: This is usually about 0.5 NTU)
2. Run plant or domestic water through your process piping and adjust the Zero trimmer until meter reads 0.5 NTU, or the known value of your water supply.

B. Laboratory

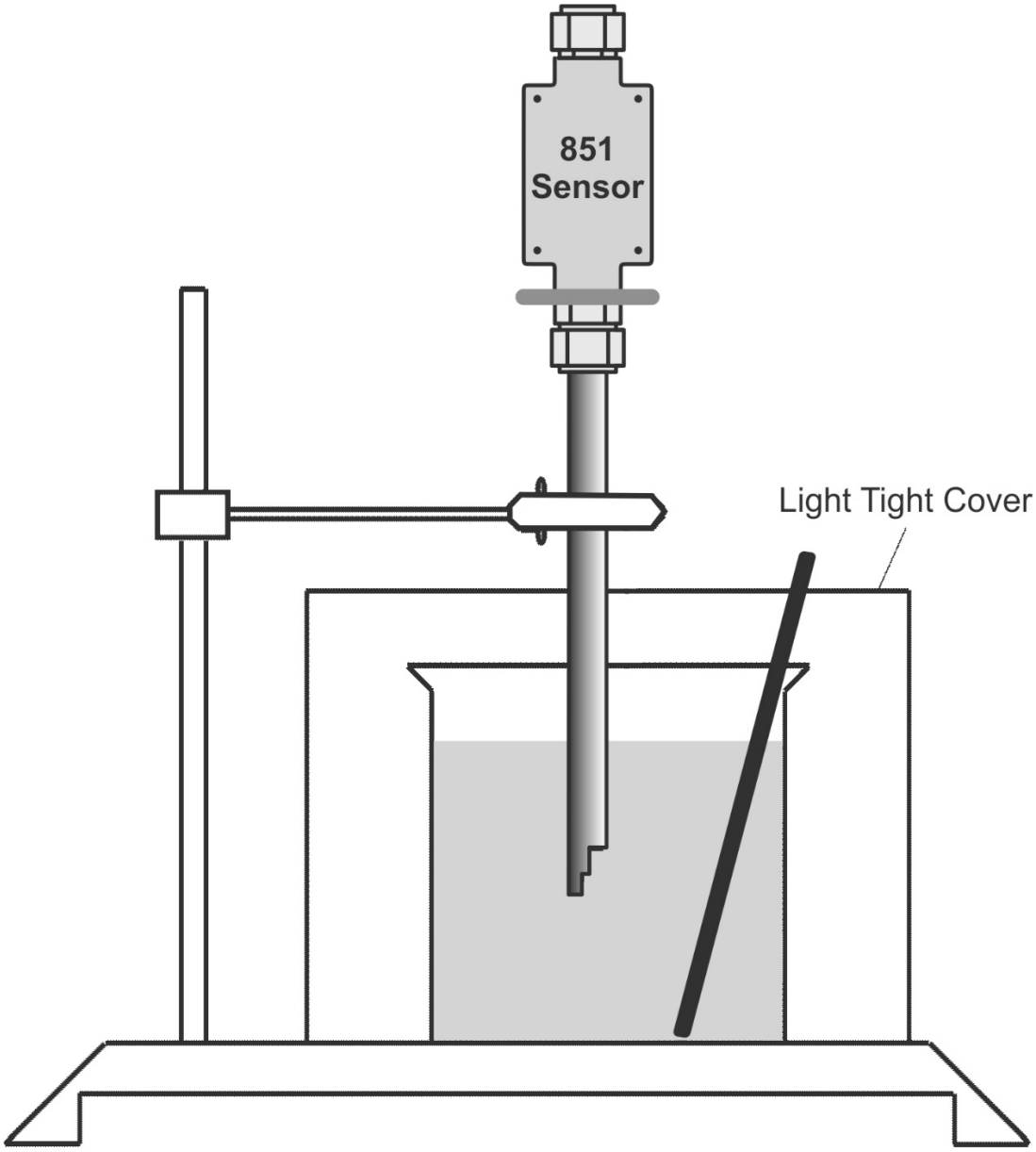
This method is normally used on new instruments prior to their installation or on instruments that have been completely removed from the process. Laboratory calibration will require the apparatus shown in Figure E on page 11. The instrument must be wired according to the wiring instructions. During calibration, care must be taken to eliminate all natural light from the sample and sensor tip. Care should also be taken to place the sensor in the middle of the sample chamber to avoid internally reflected light.

To check calibration of the span, it is best to use a sample of around 100 NTU. You will also need a sample of 0 NTU liquid (distilled water). Using the apparatus shown in Figure E on page 11, proceed as follows:

1. Set the range switch to “on” for the 200 position. Make sure the other switches are off.
2. Place the 0 NTU sample in the sample chamber.
3. Immerse the sensor in the 0 NTU sample, eliminating all the ambient light from the sample chamber. Make sure the sensor is totally immersed in the sample. Never calibrate in direct sunlight.
4. Adjust the Zero trimmer in the sensor so that the output measures 4.00 mA.
5. Remove the 0 NTU sample from the sample chamber, and place the 100 NTU sample in the chamber. Again totally immerse the sensor in the sample, eliminating all the ambient light.
6. Adjust the Span trimmer in the sensor so that the output measures 20.00 mA.
7. The span is now calibrated. The range switches can now be set for the desired range.
8. When the instrument is reinstalled in the process line, calibrate the zero using Procedure A or Procedure B above to account for reflected light in the pipe.

Figure E

Laboratory Apparatus



C. Calibration in Units Other Than NTU

The Model 851 has been factory calibrated for NTU (Nephelometric Turbidity Units) readings. If a reading is desired in PPM (parts per million) rather than NTU, samples of known concentration (PPM) and of distilled water (0 ppm) must be prepared (see below). Then a span and zero calibration must be completed following Procedure A or Procedure B described on pages 9 and 10.

NOTE: A 100PPM mixture may be prepared as follows:

a. Mix 1 gram of the solids from your process with one liter of distilled water.

b. After mixing well, put 100 ml (100 cc) of the mixture into a one-liter graduate and add distilled water until the one-liter level is reached.

5. TROUBLESHOOTING

Problem	Possible Causes	Check/Remedy
No output (0.00 mA)	No power to sensor	Check voltage at supply terminals in sensor.
	Blown fuse	Check fuse and replace if needed. Use a 500 mA (1/2 Amp) 2AG (5mm x 15mm) fuse. If fuse continues to blow, check for water in sensor.
	Reversed supply polarity	Be sure the power supply has the correct polarity.
	Sensor failure	If sensor has proper voltage at supply terminals, fuse has been replaced and still has no output, the sensor should be evaluated at our facility.
Output will not zero to 4.00 mA.	Too much scattered light (high turbidity) in sample.	Remove sensor and place in clean water with a cover to shield ambient light.
	Too much ambient light or too much reflected light	Try repositioning the sensor to reduce reflection inside the pipe. PVC plastic pipes must be wrapped with metallic tape or foil to block ambient light from passing through to the sensor.
	Poor sensor connections or incorrect wiring	Check connections and wiring.
	Sensor leads not insulated from body of sensor or conduit	Check sensor wires.
	Wet connection in converter or sensor housings	Look for water or condensate on connections. Dry if needed.
	Failed sensor	Cover light source at tip of sensor and place sensor tip in dark box. If output still will not zero, then the sensor has possibly failed.
Unstable reading	Air bubbles or very large particles in process line	Take sample and check for bubbles or large particles. If present relocate sensor.
	RFI pickup	Earth ground instrument properly.
	Heavy Inductive loads	Mount instrument away from power cables. Put cables in conduit.
Reading does not agree with lab results	Improper calibration	Recalibrate instrument.
	Lab procedure error	Check procedure.
	Lab instrument error	Check instrument.
Readings drift with time	Converter not warmed up	Warm up converter for 5 minutes.
	Sensor/converter connections wet	Look for water or condensate on connections. Dry connections with hair dryer. Make sure cable gland and box cover are sealing properly.
	Deposit buildup on sensor	Remove sensor and clean.
Negative readings or output is below 4.00 mA	Sensor out of calibration	Check calibration
	Wet or damp connections	Dry connections with hair dryer. Make sure cable gland and box cover are sealing properly.
	Faulty sensor bulb	Check to see if sensor lamp is on. If lamp is off, the sensor should be evaluated at our facility.

6. TECHNICAL SUPPORT

If technical support is required, please contact us at the phone number on the front cover, and be prepared to provide the following information:

_____**Model Number** (851)

_____**Serial Number** (stamped on back of sensor box)

_____**Date Purchased**

_____**Output** (Current/Voltage)

_____**Power** (12VDC/24VDC)

_____**Process Temperature**

_____**Process Pressure**

_____**Process Turbidity Range** (0-2NTU/0-20NTU/etc.)

_____**Process Solid** (Sand/Pulp/Yeast/etc.)

_____**Process Liquid** (Water/Oil/Alcohol/etc.)

_____**Process Solid Concentration**

_____**Process Piping Material** (ABS/Stainless/etc.)

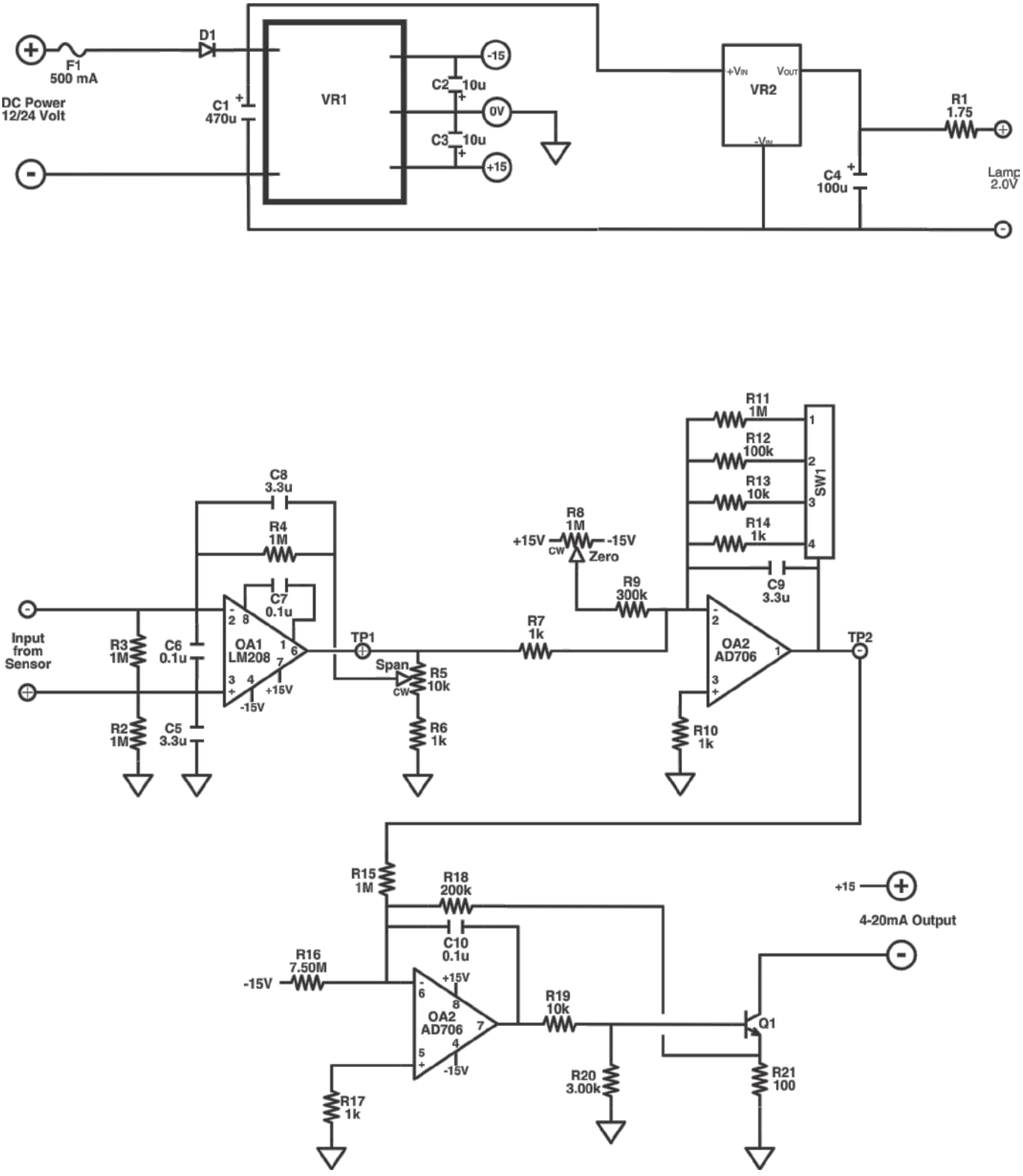
_____**Process Piping Size**

_____**Anything else you feel is important**

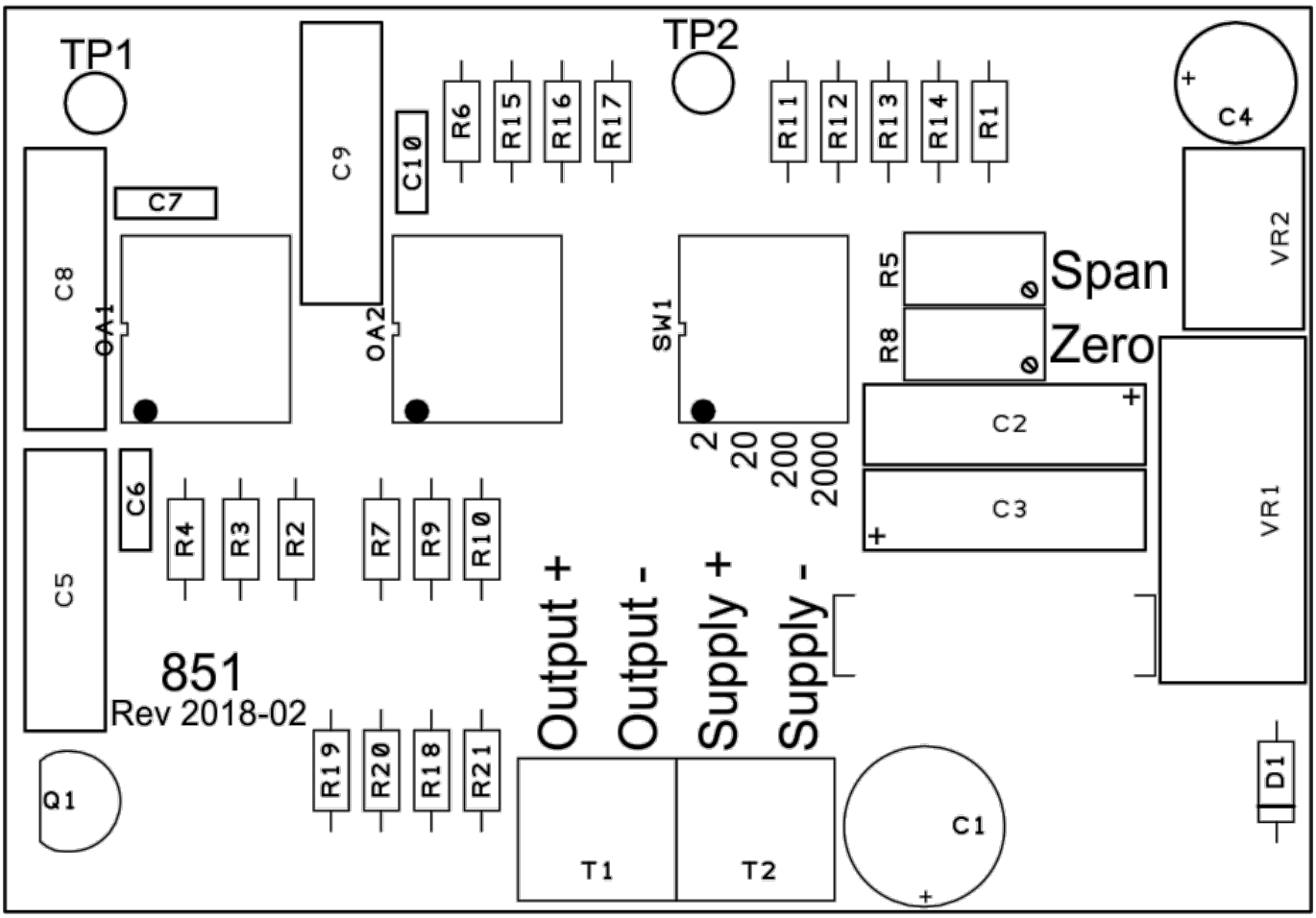
7. TECHNICAL DIAGRAMS

A. Model 851 Turbidity Sensor

Model 851 Circuit Diagram

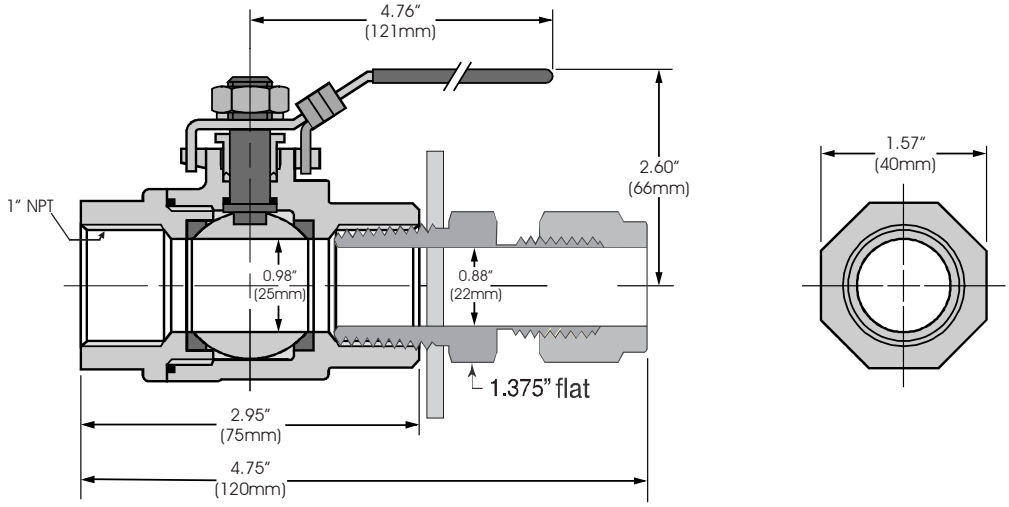


Model 851 Circuit Board Component Layout

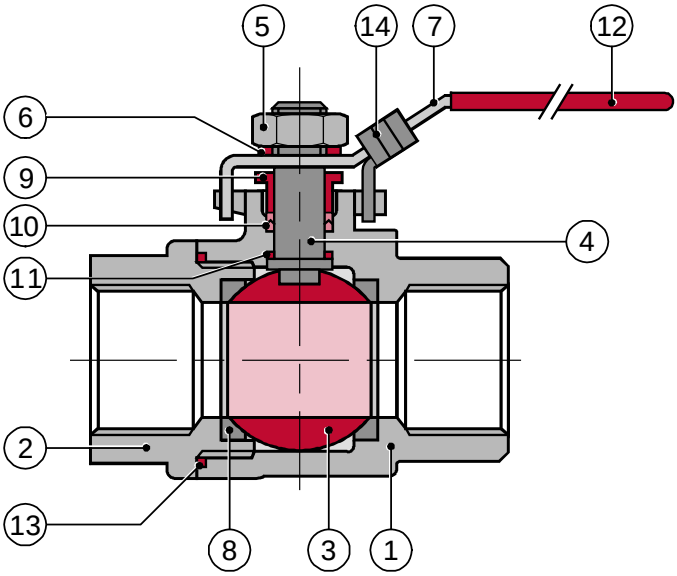


B. Optional Insertion/Removal Adaptor Ball Valve Assembly Dimensions and Materials

Dimensions:



Materials:



No.	Part	Material	Qty.
1	Body	ASTM A351 Gr. CF8M	1
2	End Cap	ASTM A351 Gr. CF8M	1
3	Ball	AISI 316	1
4	Stem	AISI 316	1
5	Stem Nut	AISI 304	1
6	Stem Washer	AISI 304	1
7	Handle	AISI 304	1
8	Seat	PTFE	2
9	Gland Nut	AISI 304	1
10	Stem Packing	PTFE	1
11	Thrust Washer	PTFE	1
12	Handle Sleeve	Vinyl	1
13	Joint Gasket	PTFE	1
14	Locking Device	AISI 304	1

8. WARRANTY

Confab Instrumentation's products are warranted to be free from defects in material and workmanship for a period of one (1) year from the date of shipment. The final determination as to whether the product has failed due to defects in materials or workmanship rests solely with Confab Instrumentation. Products that have been proven to be defective in workmanship or materials will be repaired or replaced at Confab Instrumentation's facility at no charge to the buyer. Defective instruments must be returned to Confab Instrumentation freight prepaid. **THERE ARE NO IMPLIED WARRANTIES OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE GIVEN IN CONNECTION WITH THE SALE OF ANY CONFAB INSTRUMENTATION PRODUCT(S).** In no event shall Confab Instrumentation be liable for consequential, incidental or special damages. The buyer's sole and exclusive remedy and the limit of Confab Instrumentation's liability for any loss whatsoever, shall not exceed the purchase price paid by the purchaser for the product or equipment to which a claim is made.