

# TURNER DESIGNS

Reliable Instruments for an Unreliable World



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P/N 998-2800

**TURNER DESIGNS**

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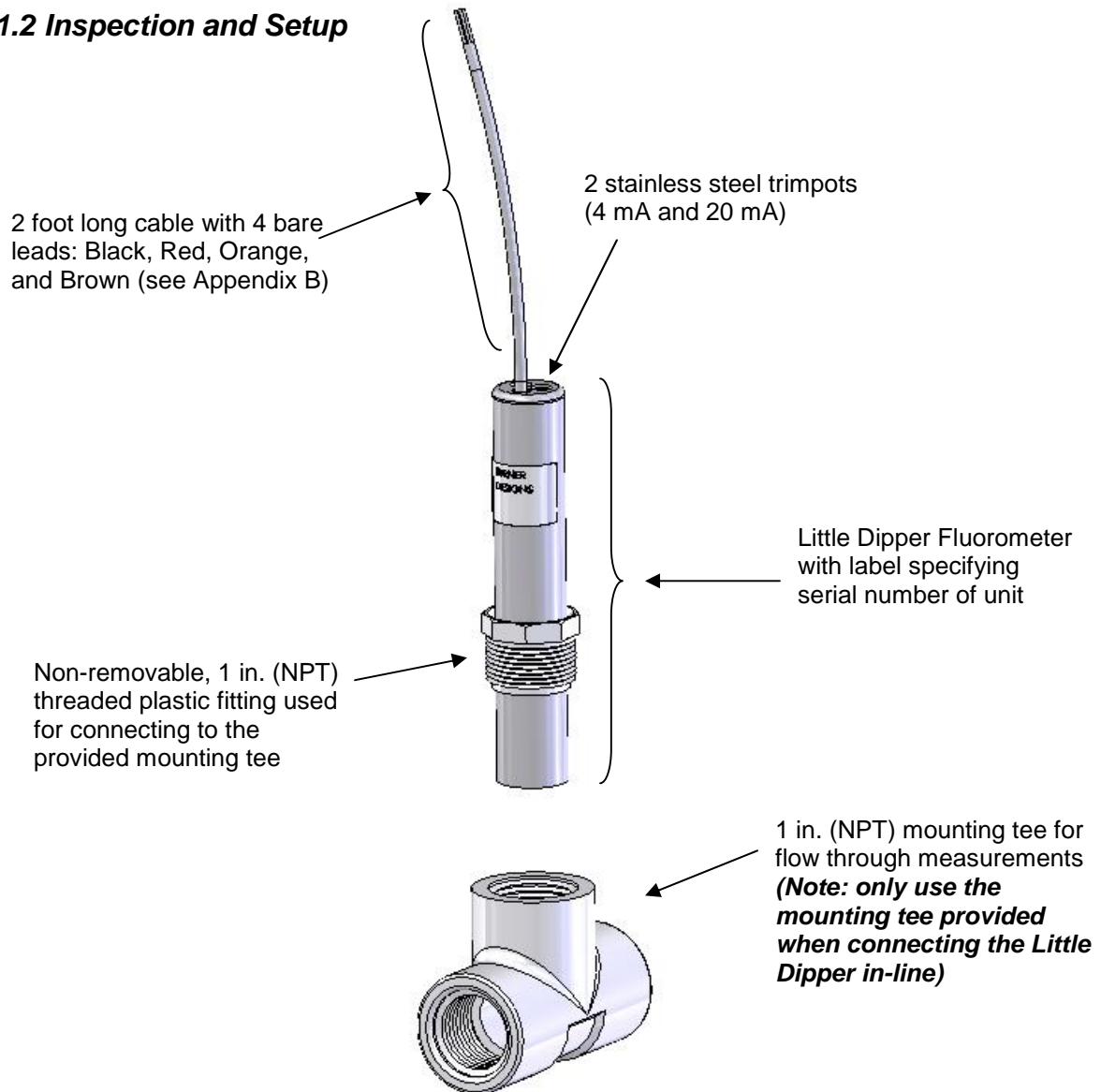
**Equipment Specified as Electrical and Electronic Waste**

# 1.0 Introduction

## 1.1 Description

Turner Designs' Little Dipper is an accurate, single-channel fluorometer designed to measure the concentration of your fluorophore of interest. The Little Dipper provides 4 - 20 mA output signal proportional to the concentration of the fluorophore in the sample or source water. In a representative application, the Little Dipper can be used with a data collection system to monitor and control the level of treatment chemicals in industrial applications. The sample water's fluorescence intensity is measured by passing the sample water, containing the fluorophore of interest, past the Little Dipper's optical window. An excitation light source illuminates the solution and excites the fluorophore in the solution which fluoresces at a different wavelength. The intensity of the emitted light is proportional to the concentration of the fluorophore in the sample or source water. Turner Designs' Little Dipper has a low maintenance design that will provide trouble-free performance.

## 1.2 Inspection and Setup



## 2.0 Installation and Operation

### 2.1 Installation

Turner Designs' Little Dipper is rated for light industrial environments.

Do not install the Little Dipper:

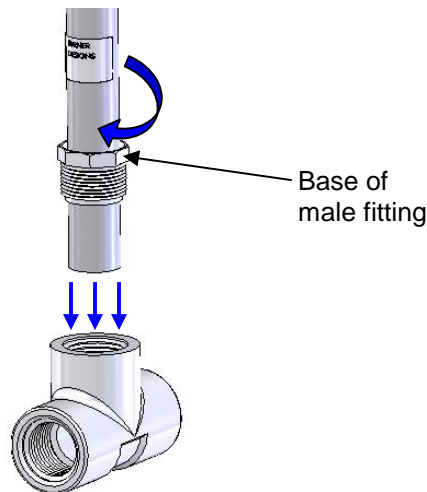
- In direct sunlight or near heat sources (operating temperature 0-50°C)
- On vibrating walls or surfaces that affect the flow
- Near devices that produce a strong electromagnetic field, such as large generators

It is recommended that the Little Dipper be installed in such a way that the flow is directed upward to expel any trapped air bubbles as air trapped on the optical window will influence signal and cause erratic readings (see section 4.0).

### 2.2 Tee Installation

We recommend the following installation procedure for installing the Little Dipper onto the mounting tee provided for flow through applications:

- 1) Wrap Teflon tape around the threaded male fitting which is bonded to the fluorometer's housing. **Note: Turner Designs applies Teflon tape prior to shipping. For re-applications, do not wrap Teflon tape more than 3 – 4 full turns.**
- 2) Turning clockwise, fully hand-tighten the Little Dipper to the mounting tee provided.



- 3) After the Little Dipper is fully hand tightened, use a wrench to make one more full clockwise turn.
- 4) Connect the mounting tee in line with your flow and start flowing water.
- 5) Inspect for leaks.

- 6) If a leak occurs, continue tightening  $\frac{1}{4}$  inch at a time until the leaking stops. **Note: the base of the male fitting should not be flush with the mounting tee; the male fitting's threads should be visible after securing the connection using a wrench.**

## 2.3 Operation

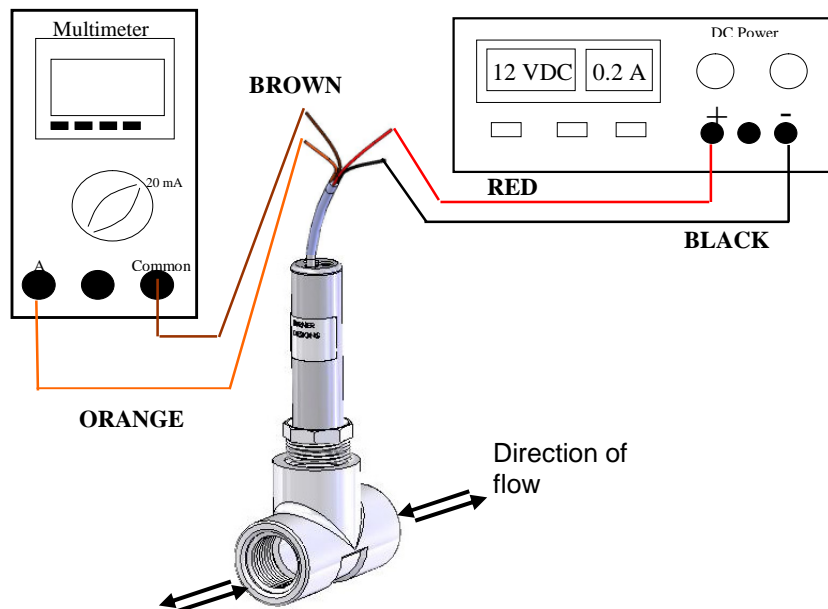
Turner Designs' Little Dipper uses a Light Emitting Diode (LED) at a specific wavelength to excite the fluorophore of interest in samples or source water. Upon excitation, the fluorophore emits a different wavelength of light (fluorescence) that will be detected by the fluorometer's photodiode.

After power (8 - 30 VDC) is applied to the Little Dipper allow 5 seconds for the LED to stabilize. After 5 seconds measurements can be taken continuously as current output (4 - 20 mA).

## 3.0 Calibration and Calculations

### 3.1 Calibration

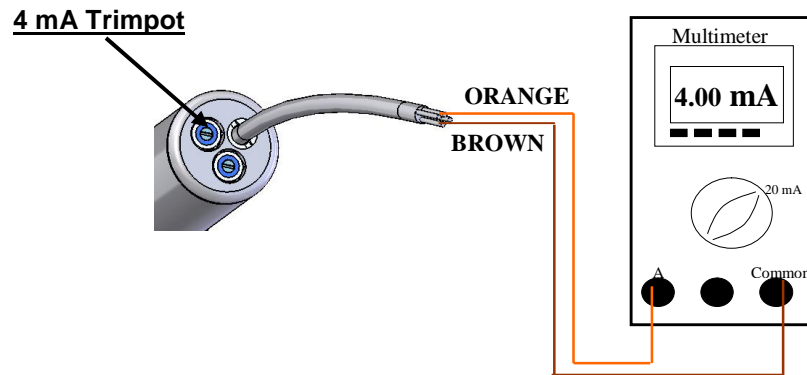
- 1) Connect the Little Dipper to the mounting tee provided (see section 2.2).
- 2) Connect the Little Dipper to the power supply and digital multimeter as shown below. **(Note: The power ground (Black Wire) and the 4-20 mA return (Brown Wire) are not common. These wires should not be connected to the same point).**



- 3) Obtain a bucket with a known volume of the source water you will be measuring **(Note: this water should represent the signal you intend to set as zero).**
- 4) Fully submerge the mounting tee into the bucket with water and allow water to fill the mounting tee.

**(IMPORTANT NOTE: MAKE SURE TO REMOVE ALL BUBBLES FROM THE MOUNTING TEE BY TILTING THE LITTLE DIPPER AND GENTLY SHAKING WHILE FULLY SUBMERGED IN THE WATER AS AIR BUBBLES TRAPPED NEAR OR ON THE OPTICAL HEAD WILL INFLUENCE RESULTS)**

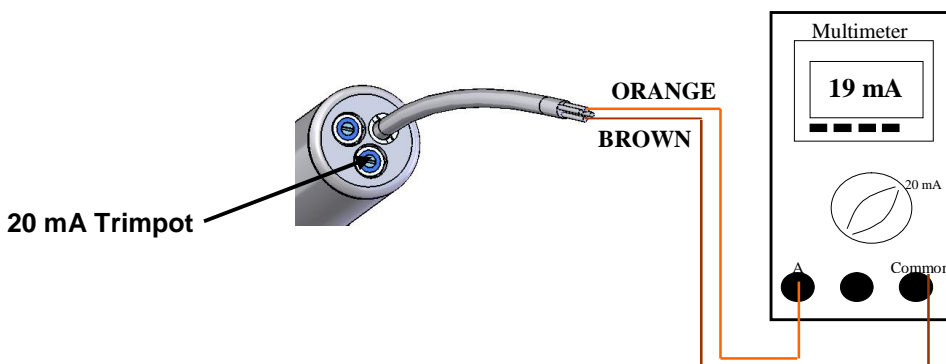
- 5) Once bubbles have been removed, allow the multimeter signal to stabilize, and then use a flathead screwdriver to rotate the marked 4 mA trimpot so that the multimeter reads a minimum of 4 mA. *(Note: allow the multimeter reading to stabilize before adjusting the trimpot between readings)*



- 6) Make sure to log the reading (see table 1 for example).
- 7) Remove the Little Dipper from the bucket.
- 8) In the same bucket which contains a known volume of your source water, make a solution using your fluorophore of interest that represents the maximum concentration you intend to measure
- 9) Submerge the Little Dipper with mounting tee into the solution and allow the solution to fill the mounting tee.

**(IMPORTANT NOTE: MAKE SURE TO REMOVE ALL BUBBLES FROM THE MOUNTING TEE BY TILTING THE LITTLE DIPPER AND GENTLY SHAKING WHILE FULLY SUBMERGED IN THE SOLUTION AS AIR BUBBLES TRAPPED NEAR OR ON THE OPTICAL HEAD WILL INFLUENCE RESULTS)**

- 10) Once bubbles have been removed, allow the multimeter signal to stabilize, and then use a screwdriver to rotate the marked 20 mA trimpot so that the multimeter reads 19mA. *(Note: allow the multimeter reading to stabilize before adjusting the trimpot between readings)*



- 11) Make sure to log the reading (see table 1 for example).
- 12) You can now install the Little Dipper in line with the system you intend to monitor following installation instructions provided (see section 2.1).

Data collected upon completing these calibration steps can be put into a table similar to the table below.

Table 1: Example of data collected from calibration steps 1-10

<b>Solution Measured</b>	<b>Concentration</b>	<b>Multimeter current output</b>
Blank Solution	$C_b$ (0 ppb)	$R_b$ (4 mA)
Sample Solution	$C_s$ (30 ppb)	$R_s$ (19 mA)

### 3.2 Calculating Calibration Coefficients

With the data collected you can find the coefficients required for calculating concentrations using the equation:

$$y = mx + c \quad \text{(Equation 1)}$$

Where:

y is the sample concentration,  
 m is the slope of your equation,  
 x is the sensor output in mA,  
 c is a constant equal to y when x = 0.

1. Finding the slope of your equation using example data from Table 1:

$$m = [(C_s - C_b) / (R_s - R_b)] \quad \text{(Equation 2)}$$

$$m = [(30 - 0) / (19 - 4)] = 30/15 = 2$$

2. Finding the c constant using example data from Table 1:

$$0 = [(m * R_b) - C] \quad \text{(Equation 3)}$$

$$0 = [(m * 4) - C]$$

$$c = -8$$

3. Substitute m and c from Equation 1 with end values from Equations 2 and 3:

$$y = 2x - 8 \quad \text{(Equation 4)}$$

You can now calculate y (ppb) concentrations simply by substituting sensor output (mA) values for x in equation 4.

## 4.0 Recommended Measurement Practices

### 4.1 Minimizing Variations in Signal

Turner Designs' Little Dipper has a flat surfaced optical window that might trap air bubbles when positioned vertically. For this reason we recommend:

- 1) Installing the Little Dipper horizontally so that the mounting tee is in a vertical position.
- 2) That the flow direction is upward through the mounting tee.

This will ensure than any trapped air bubbles will be released and will not interfere with sample measurement.

### 4.2 Temperature Considerations

Fluorescence is temperature dependant. The fluorescence signal from most fluorophores will decrease as sample temperature increases. However, fluorescence values can be corrected for temperature effects if the temperature correction coefficient of the fluorophore being measured is known. Table 2 lists known temperature correction coefficients. These coefficients can be used with recorded temperatures in the following equation to correct temperature effects on fluorescence values:

$$F_r = F_s * e^{[n (T_s - T_r)]}$$

Where:

$F_r$  is the calculated fluorescence at the reference temperature,  $T_r$

$T_r$  is the reference temperature

$T_s$  is the sample temperature at time of reading  $F_s$

$F_s$  is the sample's fluorescence at the time the temperature of the sample is measured,  $T_s$ .

$e$  is the base of natural log

$n$  is a temperature coefficient for whatever dye is used (see table 2)

For greatest accuracy, determine, if possible, the temperature correction coefficient of the dye or fluorophore being used, record the sample temperature, and correct the sensor output for changes in temperature. Additional information on how to apply these corrections is included in the Turner Designs Application Note: [A Practical Guide to Flow Measurements](http://www.turnerdesigns.com/t2/doc/appnotes/998_5000.html),

[http://www.turnerdesigns.com/t2/doc/appnotes/998\\_5000.html](http://www.turnerdesigns.com/t2/doc/appnotes/998_5000.html)

Table 2: Temperature correction coefficients for specific dyes.

Dye	Correction (/°C)
Rhodamine WT	-0.026
Rhodamine B	-0.027
Pontacyl Brilliant Pink B	-0.029
PTSA	-0.126
Fluorescein	-0.0036

## 5.0 Maintenance

The Little Dipper fluorometer is designed for light industrial monitoring applications that require continuous measurements. It provides maximum performance and solid state reliability with minimal maintenance.

A maintenance check should be made once per month to ensure the optical window is free from any chemical or biological fouling. Frequency of maintenance checks are dependant on the fouling rate of the system being monitored. Systems that have a higher fouling rate might require more frequent maintenance checks.

### 5.1 Visual Inspection and Cleaning

To visually check if the optical window has been fouled:

- 1) Remove the Little Dipper from the mounting tee.
- 2) If there is any noticeable fouling, use a soft bristle brush and soapy water to clean the optical window.
- 3) If the fouled window is unable to be cleaned with soapy water and the soft bristle brush, make a 10% HCL solution and use that solution, in place of the soapy water, with the soft bristle brush to clean the window. **(Note: Hydrochloric acid is a hazardous material and should be handled only by qualified personnel)**
- 4) Once the optical window has been cleaned, re-install the mounting tee back onto the Little Dipper **(Note: see section 2.2 on how to properly install the mounting tee)**

### 5.2 Maintenance Check Using Standard Solutions

You may also check if the unit is responding correctly simply by running standard solutions past the optical window.

- 1) Make a standard solution (solution of known concentration of the fluorophore being measured) that is less than the maximum concentration set for the Little Dipper
- 2) Flow this solution past the optical window
- 3) If the readings vary by more than 5% of the known value of the solution's concentration, see section 5.1 for visual inspection and cleaning

Maintenance checks are important and will ensure the Little Dipper is continuing to provide maximum performance and measurement reliability.

# Warranty

## **Terms**

Turner Designs warrants the Little Dipper and accessories to be free from defects in materials and workmanship under normal use and service for a period of 12 months from the date of shipment from Turner Designs with the following restrictions:

- Turner Designs is not responsible for replacing parts damaged by accident or neglect. Your instrument must be installed according to instructions in the User's Manual. Damage from corrosion is not covered. Damage caused by customer modification of the instrument is not covered.
- This warranty covers only Turner Designs products and is not extended to equipment used with our products. We are not responsible for accidental or consequential damages, except in those states where this limitation is not allowed. This warranty gives you specific legal rights and you may have other rights which vary from state to state.
- Damage incurred in shipping is not covered.

## **Warranty Service**

To obtain service during the warranty period, the owner shall take the following steps:

1. Write, email or call the Turner Designs Technical Support department and describe as precisely as possible the nature of the problem.

**Phone:** 1 (877) 316-8049

**Email:** [support@turnerdesigns.com](mailto:support@turnerdesigns.com)

2. Carry out any adjustments or tests as suggested by the Technical Support Department.

3. If proper performance is not obtained you will be issued a Return Materials Authorization number (RMA) to reference. Package the unit, write the RMA number on the outside of the shipping carton, and ship the instrument, prepaid, to Turner Designs. If the failure is covered under the warranty terms, the instrument will be repaired and returned free of charge, for all customers in the contiguous continental United States.

For customers outside of the contiguous continental United States who purchased equipment from one of our authorized distributors, contact the distributor. If you purchased directly, contact us. We will repair the instrument at no charge. Customer pays for shipping duties and documentation to Turner Designs. Turner Designs pays for return shipment (custom duties, taxes and fees are the responsibility of the customer).

## **Out of Warranty Service**

Follow steps for Warranty Service as listed above. If our Technical Support department can assist you by phone or correspondence, we will be glad to, at no charge. Repair service will be billed on a fixed price basis, plus any applicable duties and/or taxes. Shipment to Turner Designs should be prepaid. Your bill will include return shipment freight charges.

### **Address for Shipment:**

Turner Designs, Inc.  
845 W. Maude Ave.  
Sunnyvale, CA 94085



**Equipment Specified as Electrical and Electronic Waste**

## Appendix A

### *Fluorometer Specifications*

<b>Parameter</b>	<b>Specification</b>
Linearity (over dynamic range)	0.99 r <sup>2</sup>
Power Draw	0.96 W @ 12 VDC (1.2 W max.)
Input Voltage	8 – 30 VDC
Signal Output	4 – 20 mA
Light Source	Light Emitting Diode
Detector	Photodiode
Warm up time	5 seconds
Dimensions	Length: 5.92 in. (15.04 cm) Diameter (housing): 1.05 in. (2.67 cm) Diameter (Max.): 1.54 in. (3.91 cm)
Weight	3.35 oz. (95 g)
Material	PVC – Type I, machined plastic

### *Mounting Tee Specifications*

<b>Parameter</b>	<b>Specification</b>
Material	PVC – Type I, molded plastic
Threading	1 inch (NPT)
Length	3.44 in. (8.74 cm)
Dynamic Pressure Rating	100 PSI
Fitting	Schedule 80

## Appendix B

### *Wiring Guide*

<b>Wire Color</b>	<b>Function</b>	<b>Connection</b>
<b>Red</b>	Supply Voltage 8 – 30 VDC	PSU – Positive Connection
<b>Black</b>	Supply Ground 0 VDC	PSU – Ground Connection
<b>Orange</b>	Signal out to data logger, “A”, 4 – 20 mA DC	Multimeter “A” Connection
<b>Green/Brown</b>	Signal out to data logger, “Common”, 4 – 20 mA DC	Multimeter “Common” Connection