

WALCHEM

IWAKI America Inc.

Fluorescent Sensors

**Turner Designs
Little Dipper™ 2 Fluorometer
Instruction Manual**

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Information

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1.0 Introduction

Turner Designs' Little Dipper™ 2 is an accurate, single-channel fluorometer designed to measure the concentration of your fluorophore of interest. The Little Dipper™ 2 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™ 2 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™ 2'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 of source water. Turner Designs' Little Dipper™ 2 has a low maintenance design that will provide trouble-free performance.

Two sensors are available through Walchem. You can choose the PTSA sensor for a variety of applications including cooling towers. You can choose the Fluorescein sensor for a variety of applications including boilers. Both 1" PVC tees or ¾" GFPP tees are available.

2.0 Installation

2.1 Installation

Turner Designs' Little Dipper™ 2 is rated for light industrial environments. Do not install the Little Dipper™ 2:

- 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™ 2 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

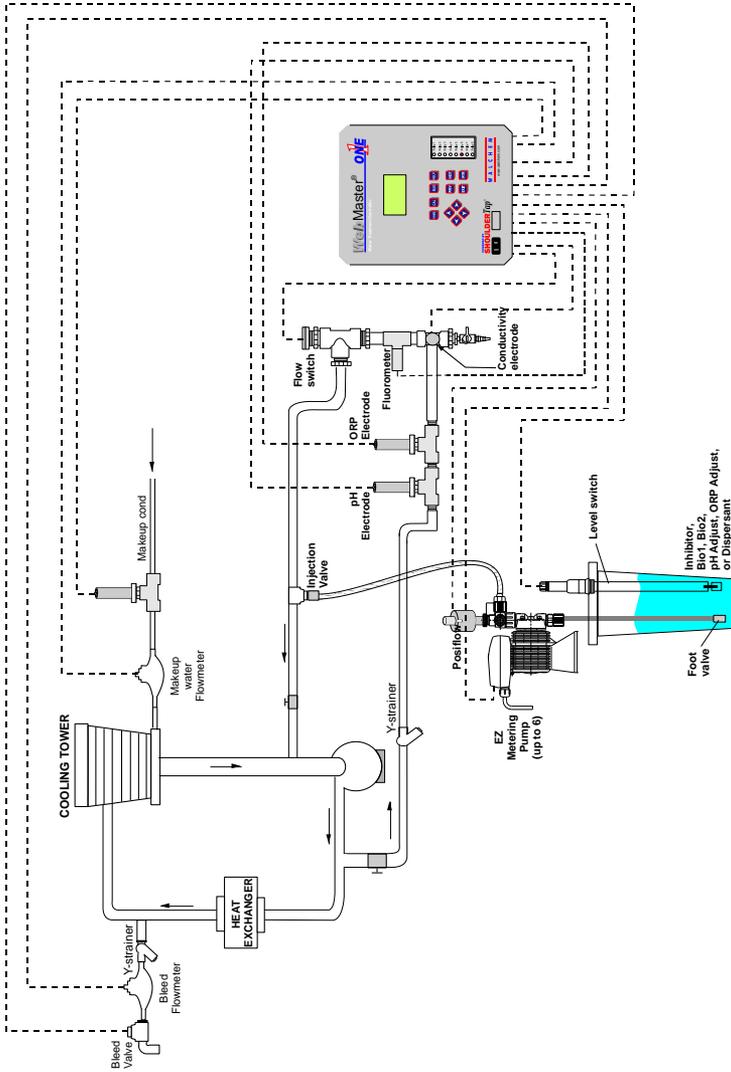
2.2 Tee Installation

We recommend the following installation procedure for installing the Little Dipper 2 onto the mounting tee provided for flow through applications.

Note: Only use the mounting tee provided when connecting the Little Dipper 2 inline!

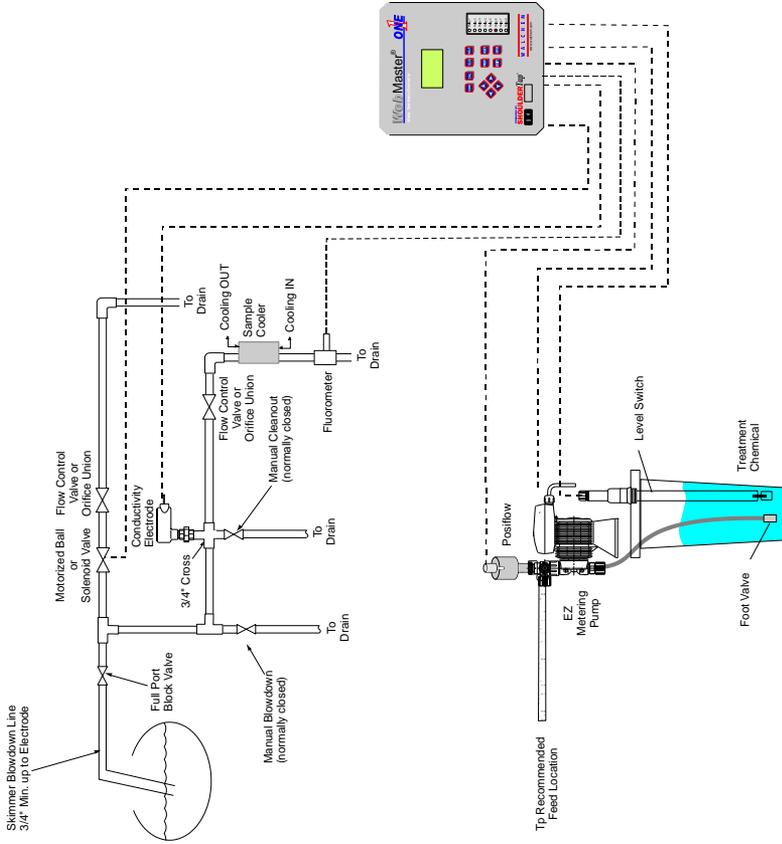
1. Assure that the o-ring is in place in the mounting tee
2. Insert the Little Dipper 2 into the mounting tee, aligning the tab on the sensor with the notch in the tee.
3. Install the mounting nut and hand tighten. DO NOT USE A TOOL TO TIGHTEN.
4. Connect the mounting tee in line with your flow and start flowing water.
5. Inspect for leaks.

Typical Installation – Cooling Tower



Note: Sensors should be selected by the installer based on system requirements.

Typical Installation – Boiler Continuous Sampling Only



Note: Sensors should be selected by the installer based on system requirements.

2.3 **Wiring**

Connect the 5 foot (1.5 m) cable to the top of the Little Dipper™ 2. The connector is keyed so it can only be inserted one way. Hand-tighten the locking nut to ensure a watertight seal.

Sensor to WebMaster

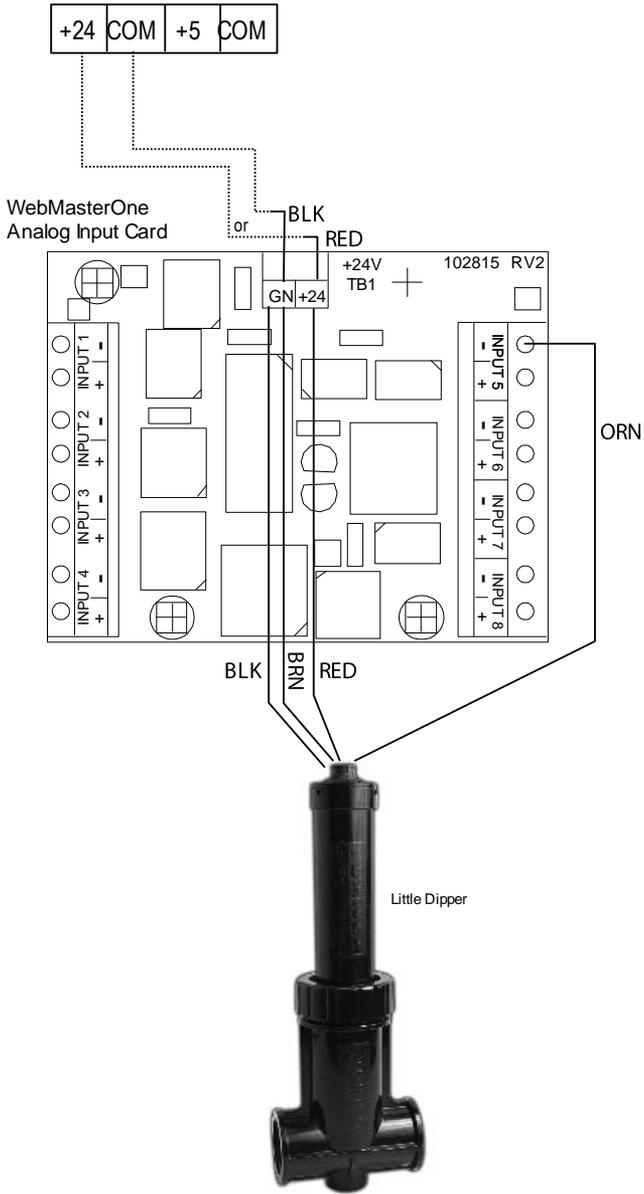
The wiring to the optional analog input card in the controller is as follows:

Shield Drain:	Earth Ground Stud
ORN:	IN-
BRN:	GND
RED:	24 VDC
BLK:	GND

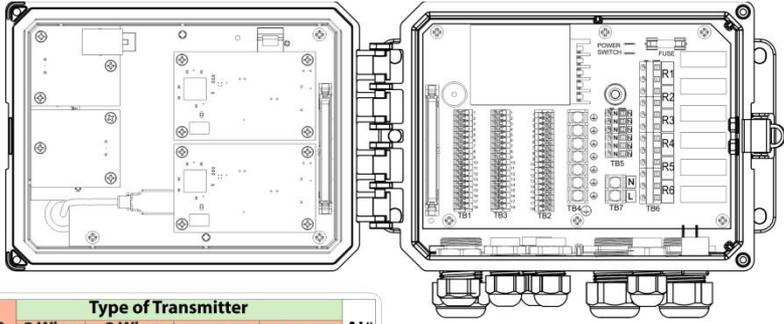
Sensor to W600

The wiring to the optional dual analog input card in the controller is as follows:

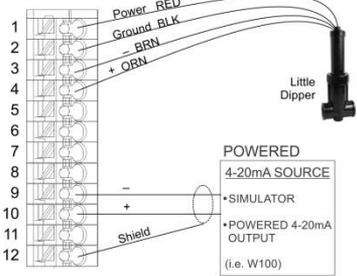
Shield Drain:	TB pin 6 (for AI 1) Or TB pin 12 (for AI 2)
ORN:	TB pin 4 (for AI 1) Or TB pin 10 (for AI 2)
BRN:	TB pin 3 (for AI 1) Or TB pin 9 (for AI 2)
RED:	TB pin 1 (for AI 1) Or TB pin 7 (for AI 2)
BLK:	TB pin 2 (for AI 1) Or TB pin 8 (for AI 2)



Little Dipper™ 2 to WebMaster



TB Pin#	Type of Transmitter				AI#
	2 Wire Loop	2 Wire Powered	3 Wire	4 Wire	
1	+24V		+24V	+24V	1
2				24V(-)	
3		XMTR-		XMTR-	
4	XMTR-	XMTR+	XMTR+	XMTR+	
5			COM(-)		
6	SHIELD	SHIELD	SHIELD	SHIELD	
7	+24V		+24V	+24V	
8				24V(-)	
9		XMTR-		XMTR-	
10	XMTR-	XMTR+	XMTR+	XMTR+	
11			COM(-)		
12	SHIELD	SHIELD	SHIELD	SHIELD	



POWERED
4-20mA SOURCE
•SIMULATOR
•POWERED 4-20mA
OUTPUT
(i.e. W100)

TB1 or 2

Little Dipper™ 2 to W600

3.0 Operation

Turner Designs' Little Dipper™ 2 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™ 2, allow 5 seconds for the LED to stabilize. After 5 seconds measurements can be taken continuously as current output (4 – 20 mA).

Programming the WebMaster

Refer to the detailed WebMaster instruction manual if necessary for information on how to connect to the controller via computer and program set points.

1. Go to the Analog Inputs 4-20 mA Inputs menu and assign the input where the Little Dipper™ 2 is connected as a Generic type input.
2. Go to the Analog Inputs Generic menu and Enable Fluorometer Mode for the input where the Little Dipper is connected and click Submit.
3. Leave the 4 mA = and 20 mA = menus where they are. The 4 mA = should be set to 0 ppm. The 20 mA = setting will be automatically filled in after each 1 Point Calibration.

Programming the W600

Refer to the detailed W600 instruction manual if necessary for information on how to connect to the controller via computer and program set points.

1. Go to the Analog Input settings menu and assign the input where the Little Dipper™ 2 is connected as a Generic AI type input.
2. Change the Units to ppm.
3. The 4 mA Value menu should be set to 0 ppm. The 20 mA Value setting will be automatically filled in after each 1 Point Calibration.

Calibration

The frequency of calibration is a function of many factors. These factors include:

1. The accuracy required by the application.
2. The value of the off-specification product versus the cost of calibration.
3. The coating or abrasive nature of the application.
4. The stability of the sensor and controller as a system.

The frequency of calibration is really determined by experience. At a new installation, calibration might initially be checked every day by comparing the controller reading to a handheld instrument or other manual analysis and logging the results. If the reading drifts off significantly in one direction you should consider calibrating. Resist the temptation to calibrate to correct for small errors that may be a result of normal variations in the test methods.

A calibration **MUST** be performed on initial installation, or after cleaning. A sensor installed in clean water can hold its calibration for several months.

Calibration using the WebMaster

Zero Calibration

1. Remove the sensor from the flow manifold and place it in a beaker of clean, fluorophore-free water taken from the same source as the water to be controlled. On system startup, if there is no fluorophore in the system water, the sensor may remain in the flow manifold. Make sure to remove all bubbles from the optical face by tilting the Little Dipper™ 2 and gently shaking while fully submerged.
2. Go to the Analog Inputs 4-20 mA Inputs menu of the controller. Refer to the controller instructions.
3. When the mA reading is stable, click on the button for Set 4 mA for the input where the Little Dipper™ 2 is connected. Click OK when prompted to perform the calibration.
4. The controller will return a calibration pass or fail message:

Calibration Result	Message Shown
The mA reading at the time was within 2 mA of 4 mA.	Calibration Success!
The mA reading at the time was not within 2 mA of 4 mA.	Range Error!

5. Return the sensor to the flow manifold if necessary and check for leaks.

One Point Process Calibration

1. Perform a handheld test or other manual analysis on the sample water.

2. Go to the Analog Inputs 4-20 mA Inputs menu of the controller. Refer to the controller instructions. Click on the 1 Pt Cal button for the input where the Little Dipper™ 2 is connected.
3. Enter the New Value in ppb obtained using the handheld. If this is the first calibration at startup, also enter the Dye/Product Ratio, and then click Continue.
4. The controller will return a calibration pass or fail message:

Calibration Result	Message Shown
The user entered value is within range.	Calibration Success!
The input current is below 5 mA.	Cal Fail. Input below 5 mA.
The input current is above 21 mA.	Cal Fail. Input above 21 mA.

One Point Calibration using Standard Solution

1. Remove the Little Dipper™ 2 from the flow manifold and insert it into a calibration tee filled with calibration standard solution.
2. Go to the Analog Inputs 4-20 mA Inputs menu of the controller. Refer to the controller instructions. Click on the 1 Pt Cal button for the input where the Little Dipper™ 2 is connected.
3. Enter the concentration of the calibration standard solution in ppb under New Value. If this is the first calibration at startup, also enter the Dye/Product Ratio, and then click Continue.
4. The controller will return a calibration pass or fail message:

Calibration Result	Message Shown
The user entered value is within $\pm 50\%$ of the uncalibrated value.	Calibration Success!
The input current is below 5 mA.	Cal Fail. Input below 5 mA.
The input current is above 21 mA.	Cal Fail. Input above 21 mA.

Calibration using the W600

Two Point Calibration using Standard Solution

1. Remove the sensor from the flow manifold and place it in a beaker of clean, fluorophore-free water taken from the same source as the water to be controlled. On system startup, if there is no fluorophore

in the system water, the sensor may remain in the flow manifold.
Make sure to remove all bubbles from the optical face by tilting the Little Dipper™ 2 and gently shaking while fully submerged.

2. Go to the Inputs menu of the controller, then to the input to which the sensor is connected. Touch the Calibration icon and select Two Point Analog Calibration. Refer to the controller instructions.
3. Confirm that control will be disabled and set the mA to 4.00. Confirm that the signal should be set to 4 mA.
4. The controller will return a calibration pass or fail message:
5. Place the sensor in the calibration tee containing fluorophore at the maximum value (100 ppb Fluorescein, 200 ppb PTSA).
6. Set the second input value to 20.00 mA and confirm that the signal should now be 20 mA.
7. The controller will return a pass or fail message:

Calibration Result	Message Shown
The calculated gain and offset were in range.	Cal Successful!
The gain is outside of 0.5 to 2.0, or the calculated offset is outside of -2 to 2 mA.	Calibration Failed

One Point Process Calibration

1. Perform a handheld test or other manual analysis on the sample water. Leave the sensor in the process with water flowing.
2. Go to the Inputs menu of the controller, then to the input to which the sensor is connected. Touch the Calibration icon and select One Point Analog Calibration. Refer to the controller instructions.
3. Confirm that control will be disabled and set the mA to the value calculated using the formula below. Confirm that the signal should be set to that mA value.

(Reading in ppb of handheld/range of sensor in ppb) x 16 mA) + 4
 Range of sensor is 200 ppb for PTSA, 100 ppb for Fluorescein

4. The controller will return a calibration pass or fail message:

Calibration Result	Message Shown
The user entered value is within range.	Calibration Success!
The calculated offset is outside of -2 to 2 mA.	Calibration Failed

One Point Calibration using Standard Solution

1. Remove the Little Dipper™ 2 from the flow manifold and insert it into a calibration tee filled with calibration standard solution.
2. Go to the Inputs menu of the controller, then to the input to which the sensor is connected. Touch the Calibration icon and select One Point Analog Calibration. Refer to the controller instructions.
3. Confirm that control will be disabled and set the mA to the value calculated using the formula below. Confirm that the signal should be set to that mA value.

$(\text{ppb of the standard solution}/\text{range of sensor in ppb}) \times 16 \text{ mA}) + 4$

4. The controller will return a calibration pass or fail message:

Calibration Result	Message Shown
The user entered value is within range.	Calibration Success!
The calculated offset is outside of -2 to 2 mA.	Calibration Failed

4.0 Recommended Practices

Minimizing Variations in Signal

Turner Designs' Little Dipper™ 2 has a flat surfaced optical window that might trap air bubbles when positioned vertically. For this reason we recommend:

- 1) Installing Little Dipper™ 2 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.

Temperature Considerations

Fluorescence is temperature dependent. 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:

$$Fr = Fs * e [n (Ts-Tr)]$$

Where:

Fr = the calculated fluorescence at the reference temperature, Tr

Tr = the reference temperature

Ts = the sample temperature at time of reading Fs

Fs = the sample's fluorescence at the time the temperature of the sample is measured, Ts.

e = the base of natural log

n = a temperature coefficient for whatever dye is used - see Table 2.

For greatest accuracy, determine 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.

Table 2: Temperature correction coefficients for specific dyes.

Dye	Coefficient
PTSA	-0.00126 / °C Exponential
Fluorescein	0.0036 / °C Exponential

5.0 Troubleshooting

Calibration Fail Message

Possible Causes	Corrective Actions
Optical window is dirty	Clean optical window as described in section 5.1
Calibration performed without a tee	Repeat the calibration with the sensor installed in a tee.
Problem with handheld instrument	Refer to the troubleshooting guide of the instrument used to measure the fluorophore.
Wiring incorrect	Check wiring against the wiring diagram. Ensure that each wire is stripped correctly and making contact with the terminal block.
Faulty analog input card	Replace analog input card.
Faulty Sensor	Replace sensor.

Reading is unstable

Possible Causes	Corrective Actions
Air bubbles in sample.	Find and repair any leaks in the sample manifold piping. Mount sensor tee vertically with flow going upwards.
Particles in sample.	Filter sample if necessary. Mount sensor tee vertically with flow going upwards.

6.0 Maintenance

The Little Dipper™ 2 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 dependent on the fouling rate of the system being monitored. Systems that have a higher fouling rate might require more frequent maintenance checks.

6.1 Visual Inspection and Cleaning

To visually check if the optical window has been fouled:

1. Remove the Little Dipper™ 2 from the mounting tee.
2. If there is any noticeable fouling, use a soft bristle brush and soapy water to clean the optical window. Be sure to rinse thoroughly.
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)***

7.0 Specifications

Fluorometer Specifications		
Parameter	Specification	
Linearity (over dynamic range)	0.99 r ²	
Power draw	0.99 W @ 12 VDC (1.0 W max)	
Input voltage	8 – 30 VDC	
Signal Output	4 – 20 mA	
Light Source	Light emitting diode	
Detector	Photodiode	
Warm-up time	5 seconds	
Length	8.63 inch (21.9 cm)	
Diameter (Housing)	1.3 inch (3.3 cm)	
Diameter (Maximum)	1.72 inch (4.4 cm)	
Weight	4.4 oz. (125 g)	
Material	PVC – Type I, molded	
Mounting Tee Specifications		
Parameter	Specification	
	1 inch	¾ inch
Materials	PVC – Type I, molded, FKM	GFRPP, FKM
Threading	1” NPTF	¾” NPTF
Length	3.3 inch (8.4 cm)	
Dynamic Pressure Rating	100 PSI (6.9 bar)	
Temperature Rating	122 °F (50 °C)	
Fitting	Schedule 80	

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