

## **SWOFFER INSTRUMENTS, INC.**

### *MODEL 2100 SERIES CURRENT VELOCITY METERS*

#### *Instructions for Operation and Maintenance of 2100 Indicator\**

### **INDICATOR FEATURES and OVERVIEW**

The *Model 2100* Current Velocity Meter provides stream current measurements from 0.1 to 25 feet per second by reading directly in feet or meters per second. Velocity is shown on a liquid crystal display readout and units of measure are selected by a toggle switch located inside the battery compartment at the back of the indicator.

The display has three averaging periods as selected by the rotary switch. These averaging periods range from a minimum time of about 5 seconds to a maximum time of about 90 seconds in the feet per second mode. The liquid crystal display holds the average velocity for the most recent update period until the end of the next period when a new average velocity will appear in the display and hold.

The *Model 2100* Indicator is powered by a single 9-volt battery, which also supplies power to the photo-diode and the photo-transistor in the sensor. A 2-inch (50 mm) propeller drives a rotor containing two fiber-optics bundles. The rotation of these fiber-optics bundles gates infrared light from the photo-diode to the phototransistor creating a pulse rate that is proportional to the propeller RPM. The pulses are counted and stored then compared to a quartz crystal oscillator and processed to display velocity.

The *Model 2100* Indicator can be calibrated in the field and corrections can be made for optimum accuracy at the velocities most often encountered. Velocities below about 1.5 feet per second require some minor calibration adjustments, which will be discussed later in the CALIBRATION section. PLEASE READ IT CAREFULLY.

The battery compartment at the back of the indicator can be opened by use of the four thumbscrews at the corners of the case back. Space in the compartment is provided for both the operating battery and a spare plus there are cutouts in the foam lining for those accessories required for the particular Model being used.

The *Model 2100* Indicator is water sealed at the case front and at the bottom in the battery compartment. The battery compartment itself is not watertight however, and can fill with water if the indicator is immersed. The indicator will float even with the battery compartment filled because the foam lining is closed-cell and will not absorb moisture except on its surface.

The electrical connector between the sensor and the indicator is water-resistant only when mated. The connector is keyed (mate the two sides carefully) and locks with a twist of the fluted collar.

A neck strap is furnished with the *Model 2100* and it clips to the loop located at the bottom end of the battery compartment cover on the back of the indicator. Make sure that all four battery compartment screws are snug before suspending the meter from the battery back. Thumb tight is all that is necessary.

\* Separate instructions are provided for operating the specific type of sensor and wand shipped with the 2100 Indicator

## QUICK OPERATING INSTRUCTIONS FOR THE MODEL 2100

All *Model 2100* instruments regardless of the complete Model Number operate in the following manner:

1. Remove the sensor protection cap (if used) and install the propeller rotor using the Rotor Installation Wrench (1/16" Allen wrench). This set screw in the side of the sensor body need only be snug to the shaft, do not over-tighten it ! Damage to the sensor can result. The set screw is a 6-32 x 3/16" stainless steel socket head set screw with a nylon patch to prevent back out.
2. Connect the Sensor Wand to the *Model 2100* Indicator by using the twist lock electrical connector. The connector is keyed so align it carefully, press the two halves together and twist the collar.
3. Rotate the Indicator selector switch to the **CALIBRATE** position. The display should read about **186\*** (feet per second mode) or **610\*** (meters per second mode, 2" (50 mm) propellers only.) \*Important Note: see page 4, *Calibration of the Model 2100 Indicator*. Change to whichever unit of measure is wanted by use of the FEET/METERS toggle switch located inside the battery compartment.
4. Rotate the selector switch to the **COUNT** position. Spin the propeller and confirm that the indicator reads increasing counts (sensor output pulses) as the propeller spins. There should be four counts per revolution. (The spin test is described later in the calibration instructions).
5. Rotate the selector switch to the minimum update time. (First position from the left hand **OFF** position).
6. Place the sensor in the stream with the propeller facing into the flow.
7. Press and release the **RESET** button to zero the display.
8. The next figure, which appears on the display, will be the stream velocity. That velocity will remain on the display until the next update period ends. The figure in the display will always be the velocity of the last averaging period. (The indicator **does not** provide a "moving average" nor instantaneous "real time" velocity.

\*For specific instructions for your *Model 2100* see the documentation for the wand assembly that came with your current meter.



## CARE AND MAINTENANCE OF THE MODEL 2100 INDICATOR

Should the indicator fall into the stream, open the battery compartment as soon as possible and dry the battery terminals and the cable connections. Since the foam lining is closed-cell, water will not absorb into more than just its surface. Allow the compartment to air dry or use a hair dryer if available before replacing cover. If you can see evidence of water inside the Indicator (inside window or on the LCD) immediately disconnect the battery and make all attempts to dry the indicator. You must remove the calibration adjustment screws and drain as much water as possible then place the indicator in an extremely dry location and under very warm temperature (not to exceed 150° F) for several days. Contact Swoffer for further details about a water incursion. No permanent damage should result, however the operation of the Model 2100 Indicator may be temporarily compromised with water on the circuit board.

Always make sure that the calibration adjustment cover screws located at the bottom end of the indicator are tightly fitted. These provide **DIRECT ACCESS TO THE CIRCUIT BOARD** and if loose, will allow water to enter the indicator.

Clean the indicator only with a solution designed for plastics. The indicator lens is made of acrylic and can be easily scratched if an abrasive cloth is used. The indicator case is ABS and there are many chemicals that act as solvents for ABS, severely affecting its appearance if they make contact. Use caution when cleaning.

Periodically check the condition of the pins and sockets in the connector. Keep the contacting surfaces clean and bright and make sure the pins are not bent and that the sockets still fit the pins snugly. Although the connection cable is rugged, avoid sharp bending and re-bending and **DO NOT SUSPEND THE WAND OR INDICATOR BY THE CABLE**.

Extreme temperatures will effect the *Model 2100* Instrument. At below freezing temperatures the liquid crystal display becomes sluggish making response time slow. Some "ghosting" of unused digit segments may also be noticed. This condition is only temporary and the instrument will operate normally after temperatures rise to normal operating levels.

The battery is also affected by low temperatures and may not have enough power to bring the calibration numbers up to the correct level for accurate measurement. Check calibration number frequently when working in low temperatures. For best results keep the indicator close to the body inside your coat during operation in the cold. Keep extra batteries in your coat and exchange them often.

High temperatures and direct sunlight will also effect the operation of the *Model 2100*. **DO NOT LEAVE THE INDICATOR IN A CLOSED VEHICLE EXPOSED TO THE SUN**. Cover the indicator and avoid prolonged exposure of the liquid crystal display to ultra-violet rays. Ultra-violet will eventually degrade the display requiring its replacement.

High temperatures may also cause the indicator electronics to give erroneous readings due to pulse-count-timing errors.

*In short, keep the Model 2100 Indicator within the recommended operating temperatures for optimum results.*

<b>NORMAL OPERATING TEMPERATURE</b>	<b>77°F (25°C)</b>	
<b>MIN. TEMP (FOR RELIABLE OPERATION)</b>	<b>-14°F (-25.56°C)</b>	
<b>MAX. TEMP.</b>	<b>180°F (82°C) @ LESS THAN 15%</b>	<b>RELATIVE HUMIDITY</b>
	<b>120°F (49°C) @ LESS THAN 95%</b>	<b>RELATIVE HUMIDITY</b>

## BATTERY CONDITION AND ITS EFFECTS ON THE MODEL 2100

The battery, which powers the Model 2100, is a single alkaline type 9-volt transistor cell. This battery powers both the indicator electronics and the sensor photo-diode/transistor circuitry. **The indicator alone draws very little current, however the sensor circuit (if allowed to remain on constantly) can drain a fully charged battery in a short time.** Depending on your use of the *Model 2100*, a fresh battery can last as long as several months or as short as a few days. To conserve battery life be sure to return the selector switch to one of the "OFF" positions after each measurement has been taken and always have a fresh spare battery on hand.

One way to determine battery strength is to check the Calibration Number held by the indicator. Rotate the selector switch to the calibrate position. If the displayed calibration number is much less than when you set it then the battery should be replaced. **NOTE:** This test is only valid with the sensor connected to the indicator and the rotor positioned so that the optics trigger an "on" condition. Only then is maximum battery drawdown achieved.

*In no case should you use a battery with less than 5 volts remaining.* Below the threshold of about 5 volts the battery will operate the indicator electronics **but not the sensor circuit too.** The sensor will not be able to transmit a signal to the indicator or will transmit only an occasional signal, which will give erroneous readings. This is also relative to the manufacturing date of the Model 2100 sensor. Sensors produced later than mid 1992 require much less power for operation than earlier units and can be used at lower voltages.

Mid-stream sensor "wink out" can usually be avoided by occasionally checking the sensor output and replacing the battery if necessary. Spin the propeller while the indicator is in the COUNT mode. If the display counts up the sensor pulses as the rotor spins then the battery can be considered acceptable. There are four counts per revolution. (One revolution of the propeller must produce 4 counts on the LCD).

*Errors in measurements due to battery voltage drop (and subsequent CALIBRATION NUMBER drop) will be in direct percentage proportion to the difference between the "ideal" calibration number and the displayed calibration number.*

## CALIBRATION OF THE MODEL 2100 CURRENT METER

The *Model 2100* Current Meter is designed to be easily calibrated by the user. This calibration must be done with each Rotor you use. *The calibration numbers recommended by SWOFFER INSTRUMENTS, INC. are not necessarily correct for all measuring situations, therefore for optimum accuracy the user must calibrate the rotors before use and at or near to the velocities expected to be encountered.*

**If very accurate velocity measurements are required then you must calibrate your *Model 2100* system and check the calibrations often.** The instructions below should be followed very carefully for reliable measurements using the *Model 2100*.

**IMPORTANT NOTE:** "Calibrating a sensor" is actually calibrating a particular propeller rotor for use with the *Model 2100* Indicator. If you use more than one propeller-rotor assembly you must check the calibration for *each* rotor assembly and adjust the Indicator Calibration Numbers accordingly as you switch from one propeller assembly to another. A calibrated rotor assembly will produce the same velocity results on any Model 2100 sensor as long as the calibrated Indicator and rotor assembly are paired

Calibration numbers correctly matching a rotor assembly to a 2100 indicator are especially important at the lower velocities (1.5 FPS and lower) and can vary greatly depending on many factors; bearing surface condition in the rotor, make-up of the water being measured (amount of suspended particulates), any damage to the propeller, rotor, shaft, thrust-bearing nut, etc. Calibrate your rotors !

**What a calibration number is:**

The Model 2100 rotors produce four pulses per revolution. Each of the four fiberoptic “eyes” in the rotor triggers an electrical pulse from the sensor. These pulses are called “Counts” and are read by the Model 2100 Indicator. The Indicator uses these counts, measuring the number of them against an internal timer to determine velocity. The two calibration numbers therefore represent the number of counts a specific rotor produces as it travels through 10 feet and 10 meters of still water. When the sensor is *stationary* and water is moving past the propeller, a specific number of counts produced in a specific amount of time determines velocity when you know how many counts are produced per foot or meter (pitch). Calibration numbers then, can also be referred to as Pitch.

Although rotor/propeller combinations are “similar” they are not necessarily “identical” and therefore each may have a slightly different Calibration Number. Always remember that the Calibration Numbers shown on the Indicator’s display represent the Calibration Numbers for a single rotor assembly only. Double check any and all rotor assemblies used for a measuring job and make sure that each is within your accepted tolerance for calibration variation ( i.e. "error"). Only go out into the field with specific knowledge of each rotor assembly’s calibration number. It is essential that the calibration number shown on the 2100 Indicator display matches the calibration number of the rotor that is attached to the sensor before relying on any readings.

**THE SPIN TEST :** The Rotor Assembly (**2100-A21**) should spin very freely when held in the vertical position (propeller pointing up) and simply blow lightly on the propeller. If it does not, clean the bore of the Rotor and the surface of the Rotor Shaft thoroughly.

One method to determine an acceptable level of low-velocity performance by a particular Rotor Assembly is to perform a "Spin Test":

Install the Rotor on the sensor, connect the sensor to the Indicator, and place the Indicator in the **COUNT** mode. With the propeller pointing straight up blow very hard straight down on the propeller. *At the instant you stop blowing* hit the **RESET** key on the indicator and allow the rotor to coast to a stop. A rotor, that will perform to the low velocity limits of its design, produces counts on the indicator of at least 400.

**CHECKING AND CHANGING CALIBRATION OF THE MODEL 2100**

Before applying corrections to the *Model 2100* rotate the selector switch to the **CALIBRATE** position. A figure will appear in the display and will be either the FEET calibration number or the METERS calibration number depending on the position of the FEET/METERS switch (located in the battery compartment). For many measuring applications using the 2" (50 mm) propeller the calibration numbers will be *about*:

<b>FEET</b>	<b>=</b>	<b>186</b>
<b>METERS</b>	<b>=</b>	<b>610</b>

If the displayed figures are much lower than these figures the first thing to check is the battery. A weak battery can allow the indicator calibration numbers to "drift" downward slightly and will cause errors in measurements. Be sure to connect the sensor to the indicator when confirming battery strength. Always keep a *full charge* 9-volt battery in the compartment as a spare. The next thing to check is your calibration for the rotor. It may be that the calibration number is lower than the above values because the rotor to be used has a lower cal. Number. When using the 3" (70 mm) propeller the Cal nos. are 130 for feet and 426 for meters). Be sure before relying on any readings.

*NOTE: It is important to note that errors in measurements due to Calibration Number variation will be in direct percentage proportion to the difference between the ideal (correct) Calibration Number for any rotor assembly and the number that the indicator displays.*

*Example: If the ideal number is 186 for a particular rotor assembly and the Indicator-displayed number is 184 then the velocity error due to calibration error will be about 1%.*

To determine a reliable calibration number for your *Model 2100* perform the following: This is something you **must** do if you are working with slow flows (below about 1.5 FPS) and for measurements taken in very shallow streams. NOTE: This procedure as described is performed for readings in feet per second with a conversion to meters after.

Mark a straight course of 10 to 20 feet in length in a body of calm, current-free water along which the sensor can be towed by walking the course (a shorter length course can be satisfactory as well; just multiply your counts from the short course so that the results equal equivalent counts for 10 feet and 10 meters). A swimming pool or dock into a quiet lake serves well. Rotate the selector switch to the **COUNT** position. If the display does not show all zeros press and release **RESET**. (The decimal point does not show in the count mode.)

Place the sensor in the water a few feet before the beginning of the course, 6 to 12 inches below the surface. Begin walking the sensor through the course at a rate close to that which you will be measuring. (If shallow flows are to be encountered try to duplicate those conditions when making calibration checks.) Using the wand rather than the propeller as a guide, press and release the **RESET** button at the instant the wand enters the course. The indicator will begin counting the number of sensor pulses as you walk. At the instant the wand leaves the course press and release the **START/STOP** button. The display now shows (and will hold) the number of pulses generated through the course length. Several passes through the course in both directions are recommended to develop a reliable average figure. Press and release **RESET** each time a run is completed to re-zero the display.

Determine the average number of pulses generated through the course. If your course length is not 10 feet, compute the number of pulses that the sensor would generate if the course were exactly 10 feet. This will be the **CALIBRATION NUMBER** that the *Model 2100* Indicator should hold for accurate measurements with that rotor assembly in feet per second:

$$\text{FEET CAL. No.} = \frac{10 \times \text{AVERAGE No. OF PULSES}}{\text{COURSE LENGTH (IN FEET)}}$$

This number can then be multiplied by 3.281 (the number of feet in one meter) to determine a calibration number for meters. NOTE: If calibrating directly for meters and the course length is in meters disregard this multiplier.

Next, rotate the selector switch to the **CALIBRATE** position. Put the **FEET/METERS** switch (in battery compartment) in the FEET position and the indicator will display the Calibration Number it presently holds for measuring in Feet Per Second. With a good battery it should be 180-186 [2" (50 mm) props only]. If your derived Calibration Number is different from the number displayed you must change the calibration number by using the **CAL ADJUST** screw(s) at the bottom end of the indicator. To access the **CAL ADJUST** screws first remove the cover screws (black plastic fillister-head screws).

USING ONLY A JEWELER'S SCREWDRIVER (to prevent damage to the adjustment screw) rotate the screw clockwise to increase the displayed number and counterclockwise to decrease the number. Do the same for the Meters calibration number. Each calibration adjustment screw is a 15-turn potentiometer with very fine resolution and plenty of latitude for normal adjustment given a full charge 9-volt battery.

**REPLACE THE ADJUSTMENT COVER SCREWS AFTER MAKING CALIBRATION CORRECTIONS. INDICATOR IS NOT WATER RESISTANT WITHOUT THESE COVER SCREWS IN PLACE !**

Note and store *with the Model 2100 Indicator* your new Calibration Number(s). Every time the instrument is used the calibration numbers and rotor assembly(s) that generated it must be confirmed (rotate switch to **CALIBRATE**) before relying on readings. Be sure to check the calibration number with the sensor connected to the indicator to achieve maximum battery current draw.

Remember that a calibration number is correct only for the rotor assembly that generated it. Each propeller & rotor used may have a different calibration number.

**IMPORTANT:** Errors in measurements due to Calibration Number variation will be in direct percentage proportion to the difference between the ideal (correct) Calibration Number and the number that the indicator displays.

**MODEL 2100 SERIES CURRENT METER-INDICATOR FUNCTION SWITCH**

**OFF & OFF** Redundant positions. Cuts all power from battery to the indicator and the sensor.

**VELOCITY** Three display averaging switch positions; from the minimum display update time to the medium to the maximum. The LCD displays and holds the stream velocity for the previous update time until the next averaging period is completed. Update times vary with the selection of FEET or METERS and also vary with the value of the calibration numbers held by the indicator. *Approximate* update times are as follows:

	FEET	METERS
<i>MIN</i>	10 SEC	1.5 SEC
<i>(Med)</i>	20 SEC	6.0 SEC
<i>MAX</i>	90 SEC	30.0 SEC

**START/STOP** Used mainly when calibrating. Begins and ends **COUNT** function. Display will hold data until **RESET** is pressed.

**RESET** Resets the display to zero. Will operate in any rotary switch position (except OFF). Used to begin timing functions at "time zero" (i.e. the first reading after the rotary switch has been shifted to a new position may not be accurate. Use of the **RESET** switch will eliminate "first averaging period" timing errors.

**CALIBRATE** LCD will show the figure that the indicator holds as the "Calibration Number". The **FEET-METERS** switch in the battery compartment is used to change the displayed number from feet to meters. See CALIBRATION INSTRUCTIONS.

**COUNT** Indicator counts and displays the number of sensor output pulses generated. Used when calibrating the *Model 2100* and checking sensor output.

**FEET/METERS** A toggle switch located inside the battery compartment changes the indicator readout between meters per second and feet per second.

**CALIBRATION ADJUST** Removing the plastic, fillister-head screws at the bottom end of the indicator provides access

to the Calibration Adjustment Screws. With the rotary switch in the **CALIBRATE** position the displayed figure can be altered by turning the adjustment screws. Clockwise rotation increases the calibration number. Use only a jeweler's screwdriver when making adjustments to prevent damage to the calibration adjustment screws. The plastic screws must be replaced after adjustments to preserve the water-resistance of the Indicator.

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