

MODEL 3000

OPERATING INSTRUCTIONS

Software Version 3.2b

SWOFFER INSTRUMENTS, INC
1048 INDUSTRY DRIVE
SEATTLE, WA USA
FAX (206) 575-1329
(206) 575-0160

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MODEL 3000

CURRENT VELOCITY AND STREAM DISCHARGE INDICATOR

The *Model 3000* is used with rotating sensor current meters for calculating, storing, and processing stream velocity and discharge data to enable on-site evaluation. The *Model 3000* can operate in units of either feet or meters. There are four basic modes of operation:

CALIBRATE MODE

This mode is used to input directly or to field calculate the pitch of a “prop”. Field calibration is accomplished by towing the prop through a water course of known length while the *Model 3000* counts the number of pulses produced. The prop pitch is then automatically calculated;

$$(1) \quad \text{pitch} = \text{number of pulses} / \text{course length (10 feet \& 10 meters)}$$

dimensions are pulses per foot OR pulses per meter

COUNT (COUNT REVOLUTIONS) MODE

This mode counts prop revolutions for a user definable time period. The number of pulses per revolution of a prop will vary for different props and rotor assemblies. After the timing period and pulses per revolution are set the number of revolutions during the time period can be calculated; This mode is primarily used with the USGS Price Type AA and Pygmy meters using the original "catwhisker contactor" sensors or the Swoffer optic retrofit (Model 2200) sensors.

$$(2) \quad \text{revolutions} = \text{pulses during period} / \text{pulses per revolution}$$

VELOCITY MODE

This mode calculates the velocity of water flowing past the sensor using the formula;

$$(3) \quad \begin{aligned} \text{velocity} &= (n/p) / t \\ t &= \text{measurement period in seconds} \\ p &= \text{prop pitch in pulses per 10 feet OR pulses per 10 meters} \\ n &= \text{number of pulses counted during period } t \end{aligned}$$

dimensions are feet per second OR meters per second.

DISCHARGE MODE

This mode calculates total stream discharge using individual partial area and velocity measurements taken across the stream bed.

$$(4) \quad Q = \sum av$$

Q is total discharge in ft³ per second OR m³ per second

a is an individual partial cross section area

v is the corresponding mean velocity of the flow normal to the partial area

The cross section is defined by depths at locations 1, 2, 3, . . . n. At each location the velocities are measured to obtain the mean of the vertical distribution of velocity. The partial discharge is now computed for any partial section at location x as:

$$(5) \quad q_x = v_x \left[\frac{(b_x - b_{(x-1)})}{2} + \frac{(b_{(x+1)} - b_x)}{2} \right] d_x$$

$$= v_x \left[\frac{b_{(x+1)} - b_{(x-1)}}{2} \right] d_x$$

$x = 1, 2, 3, \dots, n$, observation points

q_x = discharge through partial section x

v_x = mean velocity at location x

b_x = distance from initial point to location x .

$b_{(x-1)}$ = distance from initial point to preceding location

$b_{(x+1)}$ = distance from initial point to next location

d_x = depth of water at location x

The v_x 's in the above formula are usually measured using one of two methods:

1. Velocity measurement taken at depth $(0.6)d_x$.
2. The average of two velocity measurements taken at depths of $(0.2)d_x$ and $(0.8)d_x$.

NOTE: Other methods are also valid and in fact are called for in special types of measurement situations. The ones stated here are merely shown as guides to help use the *Model 3000* in natural streams.

This procedure for discharge measurement is used by the US Geological Survey and is described in detail in Chapter A8, *Discharge Measurements at Gaging Stations*, a publication of the US Geological Survey. The procedure is also covered in *Hydrology and Hydraulics Systems*, Ram S. Gupta, Prentice Hall, and *Hydraulic Engineering*, Roberson/Cassidy/Chaudhry, Houghton Mifflin. *Open-Channel Flow*, M. Hanif Chaudhry, Prentice Hall, ISBN 0-13-637141-8 is also an excellent reference work for applications in many different types of channels.

KEYPAD OPERATION

The operator controls the *Model 3000* through a 20 button keypad. The keypad is configured as 4 rows by 5 columns:



THE PRIMARY FUNCTIONS AND THE SHIFT FUNCTIONS

The primary functions are printed in the lower half of the key, and the shift functions are printed in the upper half.

Select a primary function by pressing only that key.

Select a shift function by first momentarily pressing the SHIFT key, then the desired key. *Do not hold the SHIFT key down while pressing a shifted function key.*

POWER ON AND OFF

The PWR key turns the *Model 3000* on and off. ON is instant after pressing the PWR key. OFF requires that the key be held depressed for four seconds. The *Model 3000* display counts down from three seconds to OFF while the key is depressed.

The *Model 3000* also has an "auto off" feature. After no keypad activity for 20 minutes, the instrument shuts down. To restart press the PWR key. No saved data is lost at auto shutdown.

The ENTER key

The ENTER key is used to tell the *Model 3000* that a number has been entered and generally to progress to the next display screen.

The ESC (Escape) key.

One of the most important keys on the pad since it allows you to "back out" of almost anywhere and any function. Generally, to enter into a new Function you must begin from the initial screen. Press the ESC key the number of times necessary to reach the initial screen, as displayed:

M3000 (feet) Command

For the display to show meters press the "0" (numeral zero key) at the initial screen (see UNITS OF MEASURE):

M3000 (meters) Command

DISPLAY OPERATION

The *Model 3000* communicates to the user by the Liquid Crystal Display (LCD). The display is arranged as 2 rows by 16 characters per row:

Model 3000 LCD 2 rows X 16 char

ENTERING NUMBERS

When the *Model 3000* requires numerical input the display will show the number field to be entered with a cursor under the rightmost digit position:

000.00

As the number keys are pressed the last number pressed will appear in the rightmost position and the other digits will be shifted (scrolled) left. For example, if the digit "8" were pressed the display would look like this:

000.08

and after following with the digit "3":

000.83

then after pressing the digit "5":

008.35

Pressing any of the number keys will cause the digits to appear on the LCD entering at the rightmost position and shifting the other digits to the left. The left most digit is "thrown away" each time a number key is pressed. This means that if a mistake is made just enter the number you want until it appears correctly in the LCD.

Press the ENTER key after you are satisfied with the number you see displayed.

IMPORTANT NOTE: Changing numbers or values is not possible without a visible cursor. Be careful however, when you do see the cursor in any screen that you do not accidentally change figures you may only wish to view, not modify. If the cursor is visible, you can edit the data...whether you want to or not. Pressing the ESC key when the cursor is visible will make it disappear and prevent editing.

POWER ON MESSAGE

When the *Model 3000* is first powered on it will display:

M3000 (feet)
Command

UNITS OF MEASURE

The Model 3000 works in both feet and meters units of measure. The *Model 3000* does not show the units on the LCD except at the initial screen. Units may be toggled from feet to meters by simply using the 0 key (zero) while the Indicator is in the initial screen. Each press of the 0 key will change units from feet to meters to feet, etc. No data will be lost in the stored registers and all data in the Model 3000 will be recalculated instantly based on the new units selected. Units may be changed any time by returning to the initial screen and toggling the 0 key.

MEMORY CAPACITY

The *Model 3000* is capable of holding one hundred stream cross-sections (referred to as **Transects** or **Sections**) with a total of 1000 Stations. Any combination of station numbers can be used in the Sections as long as the total number does not exceed 1000 Stations. (Example: two Sections of 500 Stations, five Sections of 200 Stations or one Section of 1000 Stations, etc.) Each **Station** stored in memory consists of, **the Station Number** (width from initial point 0), **Depth**, **Velocity**, **Angle** and **Time & Date**.

Any of the Sections may be erased completely and separately at any time without affecting the other Sections *and* any Station in any Section may be erased or modified at any time.

When memory has reached the 1000 Station capacity, the Model 3000 will display "MEMORY FULL". No further storage is possible until a Section or Sections are deliberately erased using the procedure described in the Data Erase portion of the instructions.

SELECTING A SENSOR (PROP key)

Before any measurements can be made a "prop" must be selected. The default is Prop no. 1, the 2 inch propeller which has been standard with all previous Model 2100 instruments and is now standard with the *Model 3000*.

The *Model 3000* Indicator uses *calibration numbers* or the "pitch" of the prop (or other type sensor) connected to it to determine velocities. The *Model 3000* indicator stores the pitches for five different props plus the USGS AA meter, Pygmy meter and a spare location for any other "contact-closure" type sensor. The props are identified as 1, 2, 3, 4, and 5, AA 1/1, Pygmy and "Contact closure". There are two additional positions for input of the equation supplied with AA and Pygmy Price Type vertical axis meters with their rating charts. These two positions follow the contact closure position and are called "Equation/Contact" and "Equation/Optic". Scrolling through the PROP menu is accomplished by pressing the PROP key repeatedly. When the last Prop position is reached the menu returns to the first one again. ("Scrolling" of Prop selections goes only in one direction). Selecting a Prop is done by pressing ENTER when the desired Prop is displayed. Press the ESC key to return to the initial screen. The Model 3000 will always power up with this prop selection until changed again.

The *Model 3000* comes with default calibrations for the three standard propeller / sensor combinations normally used with the instrument. 1, 2 and 3 are the 2", 3" and 1³/₈" propellers. 4, 5, and Equation/Optic are pre-calibrated for AA and Pygmy meters using the Swoffer Model 2200 optical retrofit sensor. Positions **AA 1/1**, **Pygmy**, **Contact closure** and **Equation/Contact** automatically convert the *Model 3000* from optical input to contact closure input (non optical sensors) and require connecting the sensor wires to different positions in the battery compartment. (Several options for alternate cabling hookups are available with the *Model 3000* . Please see any supplemental sheets for the most recent variations. *Your version may differ in some ways.*)

To select a prop press the PROP key, the display will look like this (with units = Feet selected):¹

Prop 1 Pitch : 186.00

If prop number 1 is not the desired prop press PROP again, the display will look like this:

Prop. 2 Pitch : 130.00

Repeated pressing of the PROP key will cause the *Model 3000* to display the pitches for prop numbers 3, 4, and 5. Pressing PROP again will scroll the display to show the pitch for a USGS AA meter using the original catwhisker contactor (one pulse per revolution) on the 1/1 connection. Pressing PROP again will display the calibration number for a USGS Pygmy meter using the cat whisker contactor and pressing once again will display "Contact closure", "Equation/Contact", and "Equation/Optic". The Props scroll around to No. 1 again with the next press of the PROP key. When the desired prop number is displayed you may press the ENTER key to select it. The display will read:

Prop p SELECTED

The *Model 3000* will always use this Prop selection even after shut down and re-start until changed again. Remember that the AA 1/1, Pygmy, Contact Closure and Equation /contact positions also change the *Model 3000* from an optical input (electronic signal processing) to a contact closure type of system **only**. Different electrical connections in the battery compartment are required for operation in these three positions.

Calibration numbers (Pitch) displayed for the different props represent the number of sensor pulses produced when a sensor/propeller combination (AA and Pygmy meter included) is dragged through a distance of ten units (feet or meters) of quiet water. The *Model 3000* uses these figures along with an internal timer to compute velocity. Default calibration numbers have been derived by Swoffer (and others) to be the *norm* for each sensor/propeller combination represented, however, these can be changed to match any new or newly derived calibrations determined by the user's field trials.

IMPORTANT: If very accurate and consistent velocity data is to be derived from the Model 3000 then the following calibration procedures must be put to use regularly .

CALIBRATE MODE

a: Automatic Entry of Prop Pitch by *Model 3000* Calculation:

To determine the pitch of a propeller by actual field calibration trials use the Calibrate mode. Calibration is then accomplished by towing the propeller through a course of known length of quiet water while the *Model 3000* counts the number of sensor pulses produced. The prop pitch is then calculated:

$$\text{Pitch} = \frac{\text{number of pulses}}{\text{course length}} \quad \text{pulses in 10 feet (or meters)}$$

To calibrate a propeller, first select the propeller number to be used (press PROP until the desired Prop No. is displayed then press ENTER to select it. Press ESC twice to return to the main screen. Next enter the Calibrate mode by pressing *shift* CALIBRATE. Display will read:

0 = Calculate 1 = Manual Entry

To do an actual field calibration, press 0.

To determine a reliable calibration number for your *Model 3000* [something you must do if you are working with slow flows (below about 1.5 FPS) and for measurements taken in very shallow streams] perform the following:

SUGGESTED METHOD OF COURSE LAYOUT AND PROCEDURE FOR FIELD CALIBRATIONS

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 swimming pool or dock into a quiet lake serves well.

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. Using the *wand* or wading rod rather than the sensor as a guide, press and release **COUNT** at the instant the wand enters the course. The *Model 3000* indicator will count the number of sensor pulses generated as you walk through the length of the course. At the instant the wand leaves the course press and release **COUNT** again. Several passes through the course in both directions will develop a reliable average calibration figure for the rotor-propeller assembly being tested.

IN PRACTICE

Following the in-water placement of the sensor and the walking procedure just described:

Pressing the 0 key will prompt the *Model 3000* display to ask you for the course length. Enter the length of course to be used by pressing digits followed by ENTER. Any course length will do since the Model 3000 adjusts the number to equal counts in 10 feet/10 meters, but the longer the distance the better. Display will read:

```
Course length?  
0.00
```

Press ENTER again and the display will read:

```
Count = _  
Pass number = 1
```

Begin walking the sensor several feet before course start mark and at the instant the sensor wand enters the actual course press the COUNT button. Display will begin counting up sensor pulses generated through the length of the course. At the instant the wand reaches the course end, press COUNT again. Counting will stop and the *Model 3000* will automatically calculate a pitch, converting the pulses into a figure in 10 feet (or 10 meters). Display will read:

```
Pitch = ppp.pp  
ENTER or REJECT
```

This pitch is entered in the memory if accepted and it is expressed as the number of sensor output pulses generated in ten feet or meters. It is strongly advised to take four to six passes through the course in both directions to determine a reliable average count for the pitch. The model 3000 keeps track of the number of "passes" back and forth and you may accept or reject any pass as necessary by aborting mid-way (press ESC anytime during the pass) or *shift* REJECT at the end of a pass. Press ENTER after a successful pass to save the count. Press COUNT again to begin another pass and COUNT to stop counting at the end of the next pass. ENTER to accept.

IMPORTANT NOTE: Pressing ENTER a second time after accepting any count will total and average the counts up to that point and will assign the average as the calibration number for that prop pitch. Once done, you have three choices: accept the figure, enter a different figure manually, or start the passes over again for a new set of data.

b: Manual entry of Prop Pitch:

If the pitch of a propeller is known and it is desired to enter it, the manual Calibration mode is used:

First, select the sensor (Prop No.) to be used by scrolling through the menu then pressing ENTER. ESC to the main screen and enter the calibrate mode by pressing *shift* CALIB. Display will read:

0 = Calculate 1 = Manual Entry

Press 1. Display will read:

Prop # N Pitch = PPP.PP

Enter the digits necessary to display the known pitch (pulses per unit of measure). Then press ENTER to put this pitch in the memory.

Manual Calibration mode may be used when changing optic rotor assemblies. New designs may have more (or fewer) pulses per revolution, for instance the AA meter can have an upgraded optics rotor which has four pulses instead of the original 2 pulses per revolution, effectively doubling the calibration number.

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 a Prop or rotor and the number that the indicator displays for the rotor.

Example: If the ideal number is 186 and the displayed number is 184 then the velocity error due to calibration error will be about 1%.

EQUATION / CONTACT and EQUATION / OPTIC ... CALIBRATION INPUT

In the Equation mode, the *Model 3000* uses the slope - equation normally provided with some propeller and all vertical axis meters ($y = mx + b$). In the Equation / Contact mode the *Model 3000* converts from optic (electronic) to contact closure input signal only (catwhisker, reed switch, etc.). In the Equation / Optic mode the *Model 3000* converts back to optical (electronic signal) input only. In both cases the operator must first tell the *Model 3000* what the variables in the equation are.

1. Select by using the PROP key the Equation version desired. We will use the standard catwhisker input style for these instructions. Press PROP until "Equation / Contact" is displayed then press ENTER.
2. Press ESC until the initial screen is reached.
3. Press (shift) Calibrate.
4. The display will show:

m part of equation 02.180

5. Enter the first number on the Rating Chart (for an AA meter it will probably be about 2.180, Pygmy meter=0.977).
6. Press ENTER again and the display will show:

b part of equation 00.020

7. Enter the b part of the equation, usually about 0.020 for a standard AA meter (Pygmy = 0.028).
8. Press ENTER again and the screen will read;

pulses per rev 01

9. This will be the number of sensor pulses generated in one meter revolution. With an AA or Pygmy meter, cat whisker contactor, the figure should be 1. (AA meters also have a position for 1 pulse in five revolutions but it is not necessary to use this position. Optical sensors by Swoffer (2200-3000) provide at least two and some are available with four or six pulses per revolution. Gurley Precision makes an optical sensor that produces one pulse per revolution.
It is very important that this information be entered correctly. Count and verify the number of pulses in a meter revolution before proceeding. Using fiber-optic sensors count the number of “eyes” you see in the rotor. There will always be an even number ; two, four, six, eight, etc.
10. When all three data are entered press ESC three times (or until the initial screen appears). You are now ready to take velocity measurements in the normal manner using either the menu selected by the Velocity key or the Discharge key.

COUNT REVOLUTIONS MODE

This mode is used with the US Geological Survey's Price Type AA and Pygmy current meters. The manufacturers of these meters provide rating tables that are a listing of rotor revolutions and time periods to turn those revolutions. Opposite these parameters are tabulated the corresponding velocities.

Before initiating this mode select the "PROP" (sensor) you will be using. The *Model 3000* default for this setting is an AA or Pygmy meter using the Swoffer optical retrofit sensor producing 2-pulses per revolution. If you are using that combination no further selections are necessary. In this mode the *Model 3000* computes revolutions based on 2 pulses per rev with an opto-electronic input signal.

If you will be using an AA or Pygmy meter with the original catwhisker contacts you must first do three things:

1. Scroll the PROPs key until one of the contact closure inputs is selected ("AA 1/1", "Pygmy", or "Contact Closure"). Without this selection no signal will be processed by the *Model 3000* .
2. Change the pulses per rev from 2 to 1 at the first COUNT screen. Otherwise revolutions shown will be ½ (or fewer) than actually turned.
3. Connect the meter to the contact closure posts "GND" and "DSR" in the battery compartment.

To determine the number of rotor revolutions for a selected time period the *Model 3000* must have two user inputs: (1) Length of timing period in seconds; (2) Number of pulses per revolution for the rotor.

Press the COUNT key to enter count revolutions mode and the LCD will look like this:

Pulses / Rev. ? 00

Using the number keys enter the number of pulses produced for each prop (meter) revolution then press the ENTER key. The LCD will then look like this:

```
Time period ?  
000 seconds
```

Using the number keys enter the time period for counting revolutions, then press the ENTER key. The LCD will then look like this:

```
Pulses =  
ENTER to start
```

When the meter is correctly positioned and you are ready to start counting revolutions press the ENTER key and the LCD will look like this:

```
Pulses = rrrr  
Time = ttt
```

As pulses of the rotor are counted they will be displayed on the top line. The bottom line will display seconds remaining in the timing period.

If you wish to stop the counting, press ESC any time during the count. You may then start over.

When ttt = 000 the total accumulated pulses will be divided by the pulses per revolution and the display will look like this; showing the number of revolutions counted and the elapsed time in seconds:

```
r.rr revs.  
in ttt seconds
```

COUNT MODE TO DETERMINE OPTICAL ROTOR CONDITION (ROTOR MAINTENANCE)

You may also use the COUNT MODE of the *Model 3000* to determine the condition of the bearings of a propeller rotor assembly. The standard rotor assembly "off the shelf", equipped with the 2" propeller, should be able to "spin up" counts from a zero reset to about 350 to 400 pulses.

Enter the Count Mode by pressing the COUNT key. Enter the number of sensor pulses per revolution. With propeller sensors it will be four (the default in this mode is 2 so be sure to change it). Set the Time Period to a high figure (about 100 seconds).

Place the sensor in a position so that the propeller is pointing straight up in the air. Blow down as hard as you can on the propeller and at the instant you stop blowing press and release the ENTER key. Let the rotor coast to a halt. The final count should be about 350 or more to equal a rotor assembly that will perform to the limits of its design. This method requires some practice to perfect but the results are a good indicator of the response characteristics of a particular rotor assembly. (More detailed rotor testing and care instructions are included with the sensor wand portion of the instructions.)

If you are not getting the counts suggested then check the method again and if valid, disassemble the rotor assembly and clean it thoroughly. You may need to replace worn parts and give the spin test another try.

SELECT AN AVERAGING TIME

For the *Model 3000* to calculate velocity, the desired measurement period in seconds must be entered. This is done by pressing the SHIFT key followed by the AVG. TIME key, this will cause the LCD to look like this:

Avg. period? 020 seconds

20 seconds is the default timing period. If this number does not need to be changed press ENTER. If you wish to change the timing period use the number keys to enter a new figure, then press ENTER. The *Model 3000* retains whatever value is entered. The LCD will then look like this:

Averaging period sss seconds

Where sss can be either the original number displayed or the new value. Any number from 1 to 999 seconds is valid and will remain as the default until changed again.

VELOCITY MODE

Used for determining point velocities in open channels. Values cannot be stored in this mode. If storage of data for later upload is required, use the DISCH mode.

Before using the velocity mode select a prop using the PROP key and enter a new averaging period if desired. Default Prop is #1, 2" dia. propeller and averaging period is 20 seconds but whatever you select will become the default.

Pressing the VELOCITY key will put the *Model 3000* in velocity mode, and the LCD will look like this:

Avg. time:	xx_
Avg. vel:	0.00

When the prop is in position in the stream press the ENTER key. The *Model 3000* will display:

Press Enter to start

Press Enter again and the display will instantly turn to:

Time = (your averaging time)
Pulses =

with the pulses counting up as the sensor rotates. The *Model 3000* counts up sensor pulses as it counts down the seconds remaining for the measurement. If the ESC key is pressed before $tt = 0$ then the measurement will be aborted and the LCD will go back to the last measured velocity:

Avg. time:	tt_
Avg. vel:	0.00

If allowed to proceed to the end of the timing period the display goes to:

Velocity: vv.vv Enter or Reject

If ENTER is pressed now the velocity will be averaged into the last one and the LCD will return to:

Avg. time tt_sec Enter to start

and a new measurement can be started by pressing ENTER again. If you want to average this velocity measurement with other measurements pressing ENTER will command the *Model 3000* to average a velocity with subsequent velocity measurements.

When the measurement completes and $tt = 0$ then the LCD will look like this:

velocity = vv.vv ENTER or REJECT

If you do NOT want to average this measurement, press the *shift* REJECT key. The LCD will then look like this:

Avg. time: tt Avg. vel: vv.vv

Where vv.vv is the accumulated average velocity. The *Model 3000* is then ready to make another velocity measurement.

There is no limit to the number of measurements that can be taken and averaged, with the options of aborting, rejecting, or using each measurement.

To exit the velocity mode press ESC. You may then start another series of averaged velocities by pressing VELOCITY and beginning the process again.

NOTE: Any time you exit the velocity mode any accumulated average velocity is lost and will be reset to zero. You may only record and store velocities in the Discharge Mode.

DISCHARGE MODE

Discharge mode allows the operator to make velocity and depth measurements at Stations and record this information in the *Model 3000's* memory. The *Model 3000* can then calculate total stream discharge using formulas (4) - (5), (page 3) . The data stored in memory can also be transferred to a computer (page 18) for more detailed analysis.

DEFINITIONS

SECTION

A stream cross-section (Transect) made up of a series of at least two Stations.

- STATION - The distance from an initial point at the edge of a stream to positions (Stations) on a "tag line" stretched across the stream. Decimal units are in feet or meters between 000.00 and 999.99. This number is input by the operator, and is used by the *Model 3000* to calculate total discharge.
- STATION DEPTH - The measured water depth at a STATION, a decimal number between 00.00 and 999.99. This number is input by the keypad, and is used by the *Model 3000* to calculate total discharge.
- STATION VELOCITY - This quantity is measured by the *Model 3000* at each station. Since multiple velocity measurements can be averaged to arrive at this number the 6/10 depth or the 2/10 - 8/10 depth method can be used. Additionally, if the flow at a station is not at 90° to the cross-section the actual angle can be entered and the *Model 3000* will apply a cosine correction to the velocity. Used by the *Model 3000* to calculate total discharge.

SPECIAL KEYS USED IN THE DISCHARGE MODE

There are five keys which are used **only** in the discharge calculation mode, they are:

- DISCH - Commands the *Model 3000* to operate in the discharge mode. Can be addressed only from the initial screen.
- STATION - Tells the *Model 3000* to ask the operator for a station number (a measured width from an initial point at the stream edge). Possible Sections numbers are 1 to 100.
- DEPTH - Used to make a depth entry.
- ANGLE (A shifted key) Used to modify a velocity which is not at 90° to the stream cross section. Applies a cosine function to the velocity at the measurement point.
- CALC - Tells the *Model 3000* to calculate and display the total stream discharge for a section using all station data in the memory. *You must have at least two stations entered before the Model 3000 will compute a discharge.*

When in the Discharge mode the VELOCITY key is used to tell the *Model 3000* to enter the velocity calculation mode and to save the measurement for the station.

When in the Discharge mode the *shift* UP arrow and *shift* DOWN arrow are used to scroll through the stored Station data. (When not in the Disch mode the arrow keys are only used to adjust the display contrast).

Scrolling through the stations returns to the first station after the last one is reached. To rapidly scroll Stations press the *shift* key then hold a direction arrow. If you release pressure on the arrow key you may then press **shift up** or **down** for each consecutive Station.

ENTERING THE DISCHARGE MODE

To enter the Discharge mode, press the DISCH key. LCD will display:

Section Number: 1 1 .. 100

The *Model 3000* shows the last Section number used and allows you to pick 1 through 100 for the next Section. Enter the Section number desired. LCD will read:

Section : S Stations : 0-1000

NOTE: If the section contains any stored data (Stations greater than 0) the Stations can be displayed using the *shift UP* (arrow) and *shift DOWN* (arrow) keys.

If all new data are to be obtained for this section, all previously stored station data should first be erased.

INDIVIDUAL SECTION ERASE PROCEDURE

Input the section number you wish to erase

Press *shift REJECT*.

Display will read:

ERASE SECTION ? REJECT = YES

Press *shift REJECT* again to accomplish erasure. LCD will now read:

Section : S Stations : 0

ALL SECTIONS ERASE PROCEDURE

Erases all Sections entirely but does not erase or reset any calibration data or other modified "defaults".

1. From the main screen press the DISCH MODE key.
2. Select section 101 and press ENTER.

Erase ALL sectns REJECT = yes

3. Press (shift) REJECT will erase all sections, ESC will cancel the erase procedure.

DISCHARGE MODE DATA ENTRY

To proceed with measurements in the Discharge mode press ENTER. The LCD will read:

Sta : 0.00	VEL:
DP : 0.00	0.00

Press the STATION key and a cursor will appear under the least significant digit. Enter the station number (the measured width from a zero point) and press ENTER. Cursor will disappear and LCD will read: (Where sss = your entered number for width)

STN : SSS	VEL:
DP : 000.00	000.00

When station depth is determined press DEPTH key and the cursor appears under the least significant digit. Key in the depth and press ENTER. The display will read the station number and the depth: (where ddd.dd = your entered value for stream depth).

STN : SSS	VEL:
DP : ddd.dd	000.00

*Notes: 1. Either depth or station may be entered first but Velocity mode cannot be entered **until** a Station number is entered. Depth may be zero, but a Station **must** have a value.
2. The Model 3000 will not allow two Station numbers of the same value. If you try to enter the same number as a Station which already exists, the Model 3000 will simply return a value of zero.*

Press VELOCITY. LCD will read:

Avg. time : 20
Avg. Vel: 0.00

(where Avg. time is the Model 3000 default averaging period.)

Press ENTER and display will read:

Press ENTER to start

When propeller is in position in the stream press ENTER to start velocity measurement. Time will begin counting down and sensor pulses will begin counting up. (If it is desired to stop any measurement *before* countdown is complete, press ESC and start over again by pressing ENTER). LCD will be reading:

Time = tt.t
Pulses = ppp.pp

The ending screen shows the average velocity over the timing period:

Velocity: vv.vv
Enter or Reject

Entering saves the velocity, then the display shows:

Avg. time: 20
Avg. vel: vv.vv

Pressing ENTER again allows you to take another velocity reading, averaging it with the last one(s). You may repeat the procedure as many times as you wish to develop a multiple sample average, pressing ENTER after each timing period ends.

Pressing *shift* REJECT *after* any timing period ends will void that period and the *Model 3000* will not use it in the average.

Pressing ESC anytime *during* the averaging period will stop the counts and you may start that velocity over again from the last display screen:

Avg. time: 20
Avg. vel: vv.vv

IMPORTANT NOTE: Pressing ESC *after* a velocity has been completed will terminate velocity averaging for that Station. The *Model 3000* then displays all station values as have been input (depth & width) and as calculated (velocity):

STN: ww.ww	VEL:
DP: dd.dd	vv.vv

Pressing ENTER will save the station with the message:

Station saved

The next screen will be the SECTION number along with its number of STATIONS.

Section: 1 (2,3,4,5)
Stations: ss

To start another Station press ENTER and a new blank Station will appear for you to repeat the above procedures:

STN: 0.00	VEL:
DP: 0.00	0.00

Be sure to enter an "ending station" with a width (Station Number) but with a velocity and/or a depth of zero. See Discharge Calculation in the next section.

FLOW DIRECTION CORRECTION

In some discharge measurements parts of a Station's flow direction will be at an angle other than 90° to the stream cross-section. When this is encountered, the angle can be entered (0-90°) *before* the velocity measurement is taken and the **Model 3000** will then compute and display the velocity component normal to the Transect.

NOTE: *Angle measurement is only available when the Model 3000 is in the velocity reading portion of the DISCHARGE Mode. Angle cannot be used when in the VELOCITY only mode.*

If no angle is entered the *Model 3000* always assumes the angle is 0°.

To enter a velocity angle press VELOCITY, then press *shift* ANGLE. The cursor appears under the least significant digit. Display will read:

Cosine angle = 00

Press keys to enter the angle in degrees, then press ENTER. The cursor will disappear and the angle will have been logged as part of that Station.

Press ESC and the display will change to Velocity Mode and will read:

Avg. time: tt
Avg. vel: 00.00

The *Model 3000* will now compute the velocity in the normal manner except that the displayed velocity will be the measured value multiplied by the cosine of the entered angle. As many measurements as desired (at the same angle) can be averaged using the same procedures listed above.

When finished averaging press ESC to display Station data.

STN: ss.ss	VEL:
DP: dd.dd	vv.vv

Pressing ENTER ends the averaging and stores the station data with the message "Station saved".

Repeat the process for each of the desired stations across the stream.
You must re-enter any angle at each new Station.

DISCHARGE CALCULATION

At any time during a Transect the accumulated discharge can be displayed by pressing *shift* CALC keys. (You must have at least two Stations in a Section for calculation of discharge). Display will read:

Section #N
DISCHARGE = QQQQ

Additional stations can be added to a Transect at any time. See following note.

Important Note: For proper discharge calculations to be made there must be a beginning and an ending Station for any cross section. As you stretch your tag line across the stream you will almost never have the "zero point" at the stream edge. For this reason the discharge calculations in the *Model 3000* need a beginning and an ending point (the stream edges). At the edge of the stream from where you wish measurement to be calculated, input the distance (Station Number) but apply no velocity. Do the same for the other stream-edge Station. Now the *Model 3000* can accurately calculate the discharge between the two points.

STATION ERASURE

*Individual stations can be erased by scrolling to the Station to be erased then pressing **shift REJECT**. The Model 3000 asks:*

" Erase station ?"
REJECT = yes

Pressing *shift REJECT* a second time will erase all data for that station and it will be removed from the *SECTION* permanently.
Pressing *ESC* before the second *shift REJECT* will save (not erase) the Station.

STATION EDITING

You may adjust data at any Station by scrolling to the Station, pressing the key for the item to be modified (Station, Depth, Velocity, (shift) Angle, etc.). The cursor appears underneath the least significant digit and allows you to input new numbers. Pressing *ENTER* saves the new figure, pressing *ESC* backs out and produces no change.
Note that velocity cannot be keyed in directly but must be calculated again by using the Model 3000 with the sensor in the water.

Note:

Whenever velocity is displayed on the LCD it is the component normal to the cross-section, i.e., the measured velocity x cosine of any angle entered. If no angle has been entered the Model 3000 assumes the angle to be 0.0°. The actual measured velocities and any entered angles are retained in the memory and uploaded as such to the PC.

TRANSFER DATA TO COMPUTER

The station data in memory can be transferred to an IBM Compatible personal computer by connecting the Model 3000 to the RS232C serial communication port of the computer. Swoffer supplies a serial connection cable for this purpose.

1. Copy the two files from the floppy disk (the data transfer utility program M3K.EXE and the ASCII file, TRANSFER.TXT) to a new directory on your hard drive or another floppy disk.
2. Using the special adapter cable connect one end to the Model 3000 and the other end to the DB9 serial interface connector of the computer. You will also need to determine which COM port the connector is attached to: COM 1 or COM 2. (Only COM 1 or COM 2 will work with the transfer utility program software).
3. On your PC keyboard type the command M3K (M3K.EXE) followed by a space and a DOS-compatible name (xxxxxxx.xxx) for the file you wish to create which will hold the transferred data, followed by a space and the number 1 or 2 (whichever COM port you are using). Example: "M3K stream1.txt 1" (for COM 1).
[Note: The upload program will not allow you to overwrite a file with the same name. You must either choose a different filename or change the destination of the file. If you try the computer screen will respond with: "File: stream1.txt already exists, use a different file name"]
4. Prepare the Model 3000 Indicator for file transfer by pressing *shift Transfer* from the initial screen. The display responds with

Section: (1..102)
000

5. Key in the number of the section to transfer (1,2,3,4,5, etc.) and then press *ENTER*. The *Model 3000* responds with

Sending.....

- The next screen on the LCD will be the unique electronic serial number of the Model 3000 instrument plus the software version being used .

Ser 0000000001234 -02-123-99 ver 3.2b
--

- You can now press any key on your PC and may check your uploaded datafile using any text-compatible viewing or spreadsheet software. The file created is "comma delimited".
- To upload another Section you must press ESC on the Model 3000 (back out to the initial screen) then *shift* TRANSFER again. On the PC repeat the DOS command "M3K" along with a new file name and COM port and press Enter. Then on the Model 3000 key in the number of the transect to be uploaded and press the ENTER key on the Model 3000. Repeat this procedure for all sections you wish to upload. (see next step for all stations.)

Station data and the order transferred are: **station number, time and date, depth, measured velocity,** (not velocity x cosine of angle) **and angle**. If no angle was entered 0.0° will be transferred.

- To upload the entire Model 3000 (all cross sections) you can do it in two stages and into two files. For the first fifty Sections select station **101** (step 5 above). For the second fifty Sections select Station **102**. In both cases the data in the 50 Sections will be uploaded into a single file, separated only by the Section numbers. You must then Copy and/or Cut and paste them as needed into your spreadsheet. Only Sections containing data will be uploaded.

NOTE:

You may transfer the data from the *Model 3000* as many times and to as many file names as you desire, the data will not be changed or deleted until you deliberately erase it using the erase procedure. The software will not allow you to over-write a file with the same name. If you make a mistake and assign the wrong file name to a Section transferred to your computer, you must first use a Windows or DOS utility to erase or change the file name *or* you can transfer the data under another name or to another directory. This is designed to prevent over-writing previously transferred and saved data.

INDIVIDUAL SECTION ERASE PROCEDURE IS:

Press DISCH to enter discharge mode.

Choose a Section to be erased by pressing its number then ENTER.

Press (*shift*) REJECT Display will read:

Erase section ? REJECT = YES

Press (*shift*) **REJECT** to accomplish erasure or **ESC** to cancel. The LCD screen will read (if REJECT was pressed):

Section : S Stations: 0

Showing that Section now has 0 Stations.

“ALL SECTIONS” ERASE PROCEDURE

Erases all Stations in all Sections but does not erase or reset any calibration data or other "defaults".

Caution: All collected data will be erased permanently and completely with this procedure. Be sure you want to do this before proceeding.

1. From the main screen press the DISCH MODE key.
2. Select section 101 and press ENTER. Display reads;

Erase ALL sectns REJECT = yes

3. Press (shift) REJECT will erase all sections. Pressing ESC instead will cancel the erase procedure. The *Model 3000* can now be loaded with another 1000 stations worth of data.

GLOSSARY

AA & PYGMY METERS	US Geological Survey's Price Type AA and Pygmy meters. Vertical axis, rotating cup type current meters commonly used with earphones, a stopwatch and "standard rating tables". Rating tables provided with each meter convert the earphone clicks counted during specific time periods into velocity. The Model 3000 can sense the contact closure signals produced by the original "catwhisker" or the "magnetic head" used to make the earphones sound and can give direct velocity readings. The meters may also be updated with optics as with Swoffer Model 2200 sensor, available since 1980.
AUTO SHUTOFF	After twenty continuous minutes of no keypad activity the Model 3000 automatically shuts itself down. To restart press the PWR key. Data not saved by hitting the enter key will be lost. In no case will data loss be greater than the last station (if it was not saved) or the last velocity measurement taken.
AVERAGE VELOCITY	The velocity determined by the Model 3000 by sampling input pulses from a rotating sensor against the internal timing mechanism. The Model 3000 can be set to sample from 1 to 999 seconds. Each averaging period can also be averaged with as many successive sampling periods as desired to produce a moving average.
CALIBRATION NO.	Calibration numbers are also referred to as "Pitch". The Model 3000 uses calibrations based on the number of sensor output pulses produced if the sensor is moved through still water a distance of ten feet (or ten meters). Using the propeller-optic sensors the curve is very straight through the entire range of normal operation. That is, the 2 inch propeller has a calibration number of about 186 (pulses in 10 feet) meaning that within the range of speed capability of that propeller rotor assembly (0.1 to 20 feet per second), the sensor will produce the same number of output pulses in ten feet of travel at all speeds.
CONTACT CLOSURE	A method of making and breaking an electric circuit producing signals at an interval commensurate with rotation of a sensor. These signals are traditionally difficult to measure with electronic instruments because they are "dirty" (lots of electronic spikes which can be misread as sensor output pulses). The Model 3000 while in the AA 1/1 , PYGMY , Contact closure or Equation / Contact modes changes its input capabilities and senses these contacts making and breaking, <u>generally</u> without reading the "noise". Great care must be taken when adjusting AA and Pygmy meter "catwhiskers" to be sure that the contacts are <u>not</u> multiple-counting. To accurately determine velocities great care must be taken and periodic testing in the COUNT mode is highly recommended. The preferred sensor in this mode is a "reed switch" (magnetic sensor) which eliminates much of this problem.
DEFAULT VALUES	The Model 3000 is shipped with calibration numbers for the standard sensor assemblies supplied with and sold as accessories to the instrument. Other default values are also installed in the Model 3000 Indicator including a sample Transect in Section 100 of the Discharge Mode. All default values may be modified by the user at any time.

DELIMITED FILE	Text files created by the Model 3000 when uploaded to a PC have commas separating each value (section number, time, date, depth, width, velocity and angle). The files are thus called "comma separated values" and each data record has been "delimited" (separated) by a comma. This allows most spreadsheet software programs to separate discreet values, placing them into individual "cells" of the spreadsheet.
MEMORY RESET	Resets to zero all values which have been entered while in the Discharge mode including Section numbers, dates, velocities, angles and depths. Does not reset clock, or other defaults like calibration numbers and averaging times. (see System Reset). Invoke Memory Reset feature at the initial screen by entering the DISCH mode then keying in the number 101. Pressing (shift) REJECT + ENTER will erase all 1000 stations.
PROP KEY	A "PROP" is any sensor that can be used with the Model 3000. Commonly it is a propeller driven opto-electronic sensor, but any sensing device can be called a PROP and therefore have a "calibration number". The calibration numbers displayed with each press of the PROP key are the default values for standard sensors and propellers used with the Model 3000. All can be changed at any time - manually or by field calibration.
PULSES PER REV	Swoffer optical sensors produce pulses per revolution of a rotor based on the number of optical "eyes" seen on the fiber-optic rotor. The propeller sensors <i>usually</i> have four optic positions and the early AA and Pygmy sensors (Model 2200) optics have two optics. (Four and two pluses per revolution). Catwhisker contacts (AA and Pygmy meters) are one pulse per meter revolution. Always be sure of these figures before relying on velocity readings produced by the Model 3000 .
SHIFT KEY	Allows selection of the secondary function represented by the dual function on some keys. The upper portion of a dual-function key is the "shifted" function. Press then release the SHIFT key to access the shifted function. DO NOT HOLD DOWN THE SHIFT WHILE ACCESSING THE SHIFTED FUNCTION OF A KEY.
STATION	An individual point on a Tag Line (stream cross section) where the width from the shore, the depth, the velocity and an angle are stored for inclusion in the discharge equation.
SYSTEM RESET	Different from Memory Reset. The Model 3000 may be reset to the default configuration (all original calibration numbers, Section 100 has 10 pre-loaded stations, averaging time is 20 seconds, etc.) by the following: Turn meter off by pressing & holding PWR key for four seconds. Turn meter back on by pressing PWR key. Key in the value for "PI" (31415) and press ENTER. The Model 3000 will briefly display the message "Reset memory 1, Reset memory 2" and then all default values will have been restored. WARNING: <i>All stored data including custom calibrations along with Section and Station data will be erased and overwritten!</i>
SOFTWARE VERSION	You may determine the Model 3000's unique electronic serial number (different from the 4-digit production number shown in the battery compartment) and the software version it is programmed with by pressing the <i>shift</i> Transfer keys then the Escape key. The display will show the electronic serial no. and the version (which should be 3.2b or greater).
TRANSECT	A stream cross section or SECTION. Consists of two or more Stations (width, depth, velocity and angle) all used to measure the total discharge of the channel. A minimum of two Stations are required for the Model 3000 to determine Discharge.

MODEL 3000 CURRENT METER SPECIFICATIONS *

<i>VELOCITY RANGE</i>	<i>0.1 to 25 Feet Per Second 0.03 to 7.5 Meters Per Second (Using the Swoffer Model 2100 2" diameter propeller. Velocity limits are slightly different with other sensors attached.</i>
<i>DISPLAY</i>	<i>Two line by 16 characters Liquid Crystal Digital.</i>
<i>RESOLUTION</i>	<i>To hundredths, both feet and meters</i>
<i>ACCURACY</i>	<i>Can be held to within 1% with regular user-required calibration tests and adjustments</i>
<i>DISPLAY AVERAGING</i>	<i>Completely user adjustable. Remains the same as set until adjusted again.</i>
<i>OPERATING TEMPERATURE</i>	<i>LCD Min. -14° F (-25.56° C) Max. 180° F (82° C) @ 15% relative humidity Max. 120° F (49° C) @ 95% humidity Sensor Min. 0° F (17.8° C) Max. 300° F (149° C)</i>
<i>POWER REQUIRED</i>	<i>Four AA batteries. Alkaline or rechargeable ni-cads. Can also be operated with three AA's with a shorting bar installed in any single battery clip.</i>
<i>INDICATOR SIZE</i>	<i>4 by 6 by 2 inches (15.2 by 10.2 by 5.1 cm)</i>
<i>INDICATOR WEIGHT</i>	<i>25 oz (including 4 batteries).</i>
<i>INDICATOR MATERIAL</i>	<i>Vacuum-formed ABS with a clear acrylic viewing lens over the LCD.</i>
<i>INDICATOR KEYPAD</i>	<i>Back-printed polycarbonate in four colors plus black.</i>
<i>FASTENERS</i>	<i>Stainless Steel & Brass.</i>
<i>SENSOR WAND MATERIALS</i>	<i>Aluminum = 6061-T6, Stainless Steel = #303</i>
<i>SENSOR BODY AND ROTOR</i>	<i>Acetal-resin, carbon reinforced and machined from solid stock.</i>
<i>SENSOR PROPELLER</i>	<i>Glass-filled nylon. 2" diameter is supplied. Other sizes are available for special applications.</i>
<i>ELECTRICAL CONNECTION</i>	<i>Hyper-flexible PVC jacketed cable. Two-conductor sensor signal system. Circular plastic connector with twist-lock operation. Water resistant with gold plated contacts.</i>
<i>SENSOR CABLE LENGTH</i>	<i>Equal to wand at full extension plus five feet. Special lengths to 1000' are also available.</i>
<i>SENSOR TYPE</i>	<i>PHOTO-FIBER-OPTIC with all electronics permanently encapsulated in epoxy resin</i>
<i>CONTACT CLOSURE</i>	<i>Model 3000 can read contact closure signal inputs in any one of four modes; AA 1/1, Pygmy, Contact Closure and Equation / Contact accessed by pressing the PROP key. Extreme care must be used in the adjustment of catwhisker type signal input to prevent multiple counts and errors in measurement due to contact bounce.</i>

** SWOFFER INSTRUMENTS, INC. reserves the right to change design and operating specifications to further improve the instruments at any time and without notice.*

DEFAULT PROP PITCHES

These are the figures originally shipped with the Model 3000 and are also the ones which will be re-installed if the system is reset using the start up key sequence described under "System Reset" in the Glossary.

PROP	feet	meters
1	186	610.22
2	130	426.5
3	217	711.93
4 (AA meter, Optic)	9.19	30.18
5 (Pygmy Meter, Optic)	20.36	66.80
AA 1/1	2.29	7.54
Pygmy	5.09	16.69
Contact Closure	000	000
Equation/Contact	0.00	0.00
Equation/Optic	0.00	0.00

NOTE: All pitches can be changed any time either by direct calibration or by manually entering a pitch. If you only use one type of meter or propeller you may wish to adjust the first 5 positions to be the same pitch. i.e. 1,2,3,4,5 could all be 186 matching the 2" propeller rotor, standard with the Model 3000.

OTHER DEFAULT VALUES

1. Averaging time 20 seconds
2. PROP No. 1, (2" with a calibration of 186 in 10 ft)
3. UNITS feet
4. COUNT MODE 2 Pulses / Rev Time period ? = last saved value
5. Section 100 has 10 Stations preloaded. You may delete these any time if desired.
6. Time will be adjusted to Seattle, USA (Pacific Time) at time of shipment.

DISPLAY CONTRAST ADJUST

1. Press Shift CONTRAST
2. Pressing *shift up* arrow increases intensity of LCD display. *Shift down* decreases.
3. Press ENTER when an acceptable contrast is achieved.

CLOCK

To view the time and date press *shift* CLOCK. Pressing ESC takes you back to the initial screen.

To adjust the clock press *shift* CLOCK then press ENTER.

1. Each press of ENTER will advance to the next screen from Year, to Month, to Date, to Hour, to Minute.
2. At each stop you may enter the correct digits and advance or retreat using ENTER and ESC at each step.

3. When all inputs are acceptable, ESC step by step back to the main screen. The time and dates will then have been set.

CARE AND MAINTENANCE OF THE MODEL 3000 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. Allow the compartment to air dry or use a hair dryer if available before replacing cover.

If water is visible through the window inside the case, get the *Model 3000* to a warm, dry location as soon as possible. It may be necessary to breach the silicone sealer with a sharp knife along the periphery inside the battery compartment to allow for water to escape while heating the meter to about 150° F. The main circuit board is conformal coated so permanent damage should not occur. Contact Swoffer for further care instructions.

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 which act as solvents for ABS, severely effecting its appearance if they make contact.

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 SENSOR WAND OR INDICATOR BY THE CABLE**. Breaking strength of the standard cable (Belden 9397) is 10 lbs.

Extreme temperatures will effect the *Model 3000* 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 batteries are also affected by 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 close to your body and exchange them often.

High temperatures and direct sunlight will also effect the operation of the *Model 3000*. **DO NOT LEAVE THE INDICATOR IN A CLOSED VEHICLE IN 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 3000 Indicator within the recommended operating temperatures for optimum results.

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

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The default Pitch for each Prop (or more correctly; Rotor Assembly) represents sensor pulses produced in 10 feet / 10 meters for each rotor propeller combination. Prop No. 1 has a Pitch of about 186 (ft) or 610.22 (m), Prop No. 2 has a Pitch of about 130 (ft) or 426.5 (m), etc. For accurate readings with any of the Props (or other types of sensors represented by a Prop number) you should first calibrate the sensor rotor assemblies, developing your own calibration number for each Prop used. You may use either the calibration method as described or direct entry via the keypad.

NOTE: It is important to remember that the calibration number shown or derived is good only for the rotor with which it was derived. Others, even identical rotors, may have another calibration number. This is based on differences in wear, manufacturing tolerances, etc. The only practical way to ensure precise accuracy is to test and calibrate all sensor-rotor combinations. Calibrations for Swoffer propeller sensors are essentially "straight line" curves. That is, the sensors (ideally) produce the same number of pulses in ten feet / meters at all velocities within their designed range of operation. You must test rotors & sensors thoroughly for optimum accuracy and repeatability.