Model 8355/8357

VELOCICALC®

and Model 8360

VELOCICALC® Plus

Air Velocity Meters

Operation and Service Manual

February 1995
P/N 1980131 Rev B

TSI Incorporated

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Service Policy

Knowing that inoperative or defective instruments are as detrimental to TSI as they are to our customers, our service policy is designed to give prompt attention to any problems. If any malfunction is discovered, please contact your nearest sales office or representative, or call TSI's Customer Service department at (800) 777-8356 (USA) and (001 612) 490-2807 :(International).

CONTENTS

Chapters

Available Application Notes

- Constant Temperature Thermal Anemometry Theory .....#TI-105
- Traversing a Duct to Determine Average Air Velocity or Volume .....#TI-106
- Applications Using the 8360 to Measure Pressure .....#TI-107
- VELOCICALC Serial Interface Connections .....#TI-108

To obtain any of the listed Application Notes contact TSI at
U.S. (800) 926-8378/(612) 490-2760 Fax: (612) 490-2874
International (001 612) 490-2807 Fax: (001 612) 490-2874

Chapter 1

Unpacking and Parts Identification

Carefully unpack the instrument and accessories from the shipping container. Check the individual parts against the list of components in Table 1. If any are missing or damaged, notify TSI or your local distributor immediately.

Table 1. List of components

Qty	Item Description	Part/model
1	Model 8355 VELOCICALC or	8355
	Model 8357 VELOCICALC(Articulating Probe) or	8357
	Model 8360 VELOCICALC Plus	8360
1	Carrying Case	800277
4	AA Alkaline batteries	1208013
1	AC Adapter 115V (Optional)	2613033
1	Operation and Service Manual	1980131
	VELOCICALC PLUS Model 8360 only	
5ft	Vinyl pressure tubing	3001744
2	Pressure tube adapters	1081278
2	3/16" hose adapter assembly	1081395
2	1/4" hose adapter assembly	1081396

Parts Identification

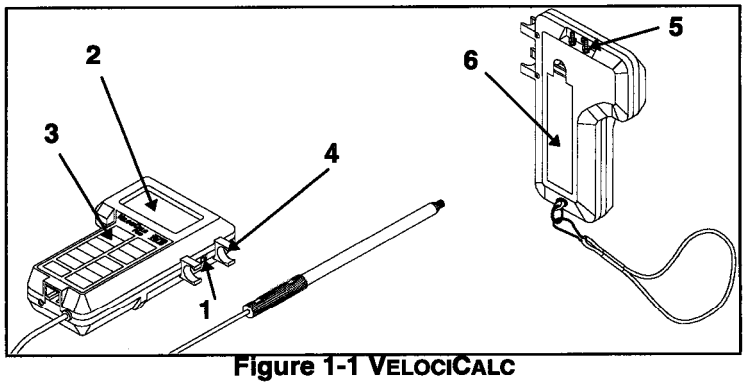


Figure 1-1 VELOCICALC

1. On/Off Switch
2. Display
3. Function Keys
4. Probe Mounting Clips
5. Pressure Measurement Ports
6. Battery Access Cover

Chapter 2

Setting-Up

Supplying Power to the VELOCICALC

The VELOCICALC can be powered in one of two ways: four size AA batteries or the optional AC Adapter.

Installing the Batteries

Insert four AA batteries as indicated by the diagram located on the inside of the battery compartment. TSI ships the unit with alkaline batteries. The VELOCICALC is designed to operate with either alkaline or NiCd rechargeable batteries. Carbon-zinc batteries are not recommended because of the danger of battery acid leakage.

Table 2-1 Typical Battery Life at 20 deg C

Air Velocity (ft/min)	(m/s)	Alkaline (hrs)	NiCd (hrs)
100	0.5	7.0	5.0
1000	5.0	4.4	3.5
9000	45.0	2.4	2.4

Using the AC Adapter

When using the AC adapter, the batteries (if installed) will be bypassed. The AC adapter is not a battery charger.

Selecting the Display Units

The VELOCICALC is capable of displaying the measured values in several different measurement units. The choices of measurement units are shown in Table 2-2.

Table 2-2. Choices of Measurement Units

Velocity	Temperature/ Dew Point	Flow Rate	Pressure
ft/min	°F	ft^3/min	in H_2O
m/s	°C	m^3/hr	mm Hg
		l/s	kPa

If you wish to change the display units on your VELOCICALC, see Appendix B, DIP Switch Settings.

Using The Telescoping Probe

The telescoping probe, mounted on the side of the VELOCICALC, contains the velocity, temperature, and humidity sensors (humidity sensor, Model 8360 only). The probe is shipped pointing downward in the stowed position. You can use the probe either mounted on the VELOCICALC or held in your hand.

If the probe is to be used mounted to the VELOCICALC, remove the probe from its stowed position, turn it 180° and reinstall (pointing upward) in the probe mounting brackets.

Extending The Probe

To extend the probe, hold the handle in one hand while pulling on the knurled tip with the other hand. Do not hold the cable while extending the probe, this prevents the probe from moving.

Retracting The Probe

To retract the probe, hold the handle in one hand while pushing on the probe tip with the other hand. If you feel the probe antenna binding, pull gently on the probe cable until the smallest antenna section is retracted. Then collapse the rest of the antenna by pressing the tip.

When using the probe, make sure the sensor window is fully exposed and the red orientation dot is facing upstream.

Chapter 3

Operation

Overview

The model 8355/8357 VELOCICALC and the model 8360 VELOCICALC Plus measure air velocity and temperature and calculate volumetric flow rates. In addition the 8360 VELOCICALC Plus measures relative humidity, and differential pressure, and calculates dew point from the temperature and relative humidity readings. Both the VELOCICALC and VELOCICALC Plus can store individual readings and compute the average of these readings.

Keypad Functions

When pressing the keys on the front panel, the VELOCICALC will beep to confirm the function. If you press a key and the VELOCICALC does not beep, then the VELOCICALC does not allow that function during the selected mode. The beep function can be disabled by changing of the internal DIP switch (see Appendix B).

ON/OFF Switch

Slide the switch upward to the ON position. The power switch is marked in the international symbols 'I' for *on* and 'O' for *off*. When the instrument is first turned on it goes through a preprogrammed power-up sequence that includes an internal self-check. First, all displayable items will appear for a few seconds, if a problem is detected, the display will light 'CAL' to indicate that it should be returned for servicing and calibration. When the VELOCICALC completes it's internal self-check, it will display the approximate percentage of battery life remaining. This feature is accurate for alkaline batteries only.

Measuring Velocity

Press the VELOCITY key to display velocity measurements (the VELOCICALC will automatically start in velocity mode). The velocity will be displayed in ft/min or m/s depending on the setting of DIP switch #1 (see appendix B). Place the end of the probe in the location where you want to make the measurement. Make sure the sensor window is fully opened and the red orientation dot is facing up stream.

Measuring Temperature

Press the TEMP key to display air temperature readings. The VELOCICALC will display temperature readings in either degrees Celsius (°C) or degrees Fahrenheit (°F), depending on the DIP switch settings (refer to Appendix B). Allow about 30 seconds for the temperature reading to stabilize after switching to temperature mode. This is necessary because the velocity

sensor is heated during the velocity mode, and some heat is conducted down to the temperature sensor.

Measuring Pressure (Model 8360 Only)

Press the PRESSURE key to measure differential pressure. First, tubes must be connected to the pressure ports on the top back of the unit. Use the blue (+) tube for connecting to the more positive pressure. Use the clear (-) tube for connecting to the more negative pressure. When the pressure is connected the same way the tubes are marked, the meter will display a positive number.

Zeroing Pressure

If the zero reading of pressure has drifted, the pressure function can be easily re-zeroed. To reset the zero, make sure that the pressure ports are exposed to the exact same pressure. The easiest way to do this is to remove the pressure hoses and leave both ports exposed to ambient pressure.

Press and hold the PRESSURE key down for at least three seconds. The VELOCICALC will give a double beep and the display will show "0 in. H_2O"(or whatever units have been selected). When the pressure key is release the display will be re-zeroed.

Measuring Humidity (Model 8360 Only)

Press the HUMIDITY key to display humidity readings. The readings will be in units of percent relative humidity (%rh). The reading may need time to stabilize if the ambient conditions have recently changed.

In order to see if the humidity reading has stabilized it is a good idea to extend the probe and gently wave it back and forth (or place it in a location where there is a sufficient quantity of moving air), while checking the display for an upward or downward trend in the readings. When no particular trend is apparent, the reading has stabilized.

Situations that may require time to stabilize the sensor would be when moving the instrument from a cold vehicle or storage place into a heated building. Also, if the end of the probe has been warmed by being handled, it will need to cool to ambient temperature. Another example would be when moving from a location with low humidity to high humidity, or vice versa.

Dew Point Function (Model 8360 Only)

Press the DEW POINT key to display the dew point temperature. The dew point is calculated using the temperature and relative humidity measurements. Because dew point is not measured directly, accuracy of this calculation depends on both ambient temperature and relative humidity. The

dew point reading will be most accurate when the relative humidity is 50% and above (and dew point temperature is closer to the actual temperature). It will be less accurate when the relative humidity is less than 50% (and dew point temperature is farther away from the actual temperature).

Flow Rate Function

The VELOCICALC's flow rate function can calculate the flow rate through a known area. The VELOCICALC measures the velocity and then calculates the volumetric flow rate, in ft^3/min, m^3/hr or l/s, depending on the DIP switch setting (refer to Appendix B). The flow rate can be calculated for a round, square or rectangular duct. The operator must first indicates the shape and size of the duct or other area through which they want to measure flow rate.

Entering Shape and Size

Press the FLOWRATE key to put the VELOCICALC in flow rate mode. The VELOCICALC will prompt the user to enter the shape and size, if this has not been done since the instrument was turned on. The VELOCICALC will ask you to enter the shape by alternately flashing the circle and rectangle on the display. If shape and size have been entered, the VELOCICALC will go directly to displaying flow rate.

Press the SHAPE key to select the shape of the area, rectangular (square) or circular, you wish to measure. Each time the SHAPE key is pressed the shape will change back and forth between the circle and rectangle. When the shape you want to use appears on the display press the ENTER key. This will enter the shape and the VELOCICALC will then ask you for the size.

Use the LARGER and SMALLER keys to select the size of the flow rate area. For a circular flow shape the VELOCICALC will ask for one size, the diameter of the circular area. Select the size and press ENTER to accept it. For a rectangular area the VELOCICALC will ask for two dimensions. First the horizontal dimension, when selected press the ENTER key, second the vertical dimension, select and press ENTER.

If you wish to change the shape or size, press the SHAPE key to select the desired shape. Proceed as above to enter the shape and dimensions.

Time Constant Function

Momentarily press and release the TIME CONSTANT key to view the current time-constant. To change the time-constant, press and hold the key down. The available time-constant choices (1, 5, 10, 15 and 20 seconds) will sequence on the display. When the desired value is displayed

immediately release the key. The VELOCICALC will always reset the time constant to 1 second when turned off.

The time-constant is actually an averaging period. The VELOCICALC display is always updated every second, however, the reading displayed is the average reading over the last time-constant period. For example, if the current time-constant is set to 10-seconds, the display will show readings averaged over the previous 10 seconds, updated every second. This is also called a 10-second "moving average."

Using the Clear, Store and Average Functions

The VELOCICALC has the ability to compute the average of a number of individual stored readings. The way this works is that every time the STORE key is pressed, the currently displayed reading is added to a store buffer. When the AVERAGE key is pressed, the readings in the store buffer are divided by the number of stored readings to get the average. The CLEAR key is used to clear out the store buffer in order to start taking a new average.

Store Function

Press and hold the STORE key to store the currently displayed measurement. The display will display "STORE" and a number indicating the number of stored data points that are in memory for about two seconds, and then the recorded value will be displayed until the STORE key is released.

The individual stored values can not be recalled. Only the average of the stored values can be recalled. There are five different store buffers: one for both velocity and flow rate, one for temperature, one for humidity, one for pressure and one for dew point. You can switch between measuring modes and store data without affecting data stored in the buffer for another measuring mode. You can later return to any mode and add additional values to the already stored values.

The Flow rate function (measures and stores velocity readings, calculates flow rate) and Velocity function use the same storage buffer. Measurements made in one mode are added to those made in the other mode.

Average Function

Press the AVERAGE key to display the average of the stored values of the current operating mode. The message "AVG" will appear first along with a number (between 1 and 255) indicating how many stored values are in the memory buffer. The average value is then displayed for one second. To keep displaying the average value, press and hold

the AVERAGE key. You can store additional values after the AVERAGE key has been pressed. The next time the AVERAGE key is pressed, the additional values are averaged with those already accumulated.

Clear Function

Press the CLEAR key to erase the stored value in the buffer of the currently active function. Pushing the CLEAR key in one function will not affect the values stored in other buffers. But remember velocity and flow rate use the same buffer. Example; pushing CLEAR while measuring velocity will not affect the values stored for temperature.

Printer Port

While pushing the STORE, AVERAGE or CLEAR key the data is automatically transmitted to the printer port. If you have the optional printer connected the readings will be printed.

Chapter 4

Maintenance

Probe Tip

Periodically inspect the probe tip to ensure that it is clean. Dust and oil deposits on the velocity sensor decrease the accuracy of the VELOCICALC.

Caution:	The VELOCICALC must be switched off for cleaning. Do not use high-pressure air, strong solvents, or brushes to clean the sensor tip; damage to the sensors could result.

To remove dust, blow it off with a gentle stream of air or rinse it off with a gentle stream of water. To remove a combination of dust and oil, rinse the probe tip in isopropyl alcohol and then blow it off with a gentle stream of air. ***Be careful not to get the humidity sensor wet!*** (The humidity sensor is located at the base of the probe window, just inside the antenna tube.) Also, for the 8357, be careful not to allow water to enter the articulating probe joint.

Caution:	Never use heat to dry the probe. Permanent damage to the sensor could result.

Recalibration

To maintain a high degree of accuracy in your measurements, TSI recommends that you return your instrument for annual recalibration. For a nominal fee, we will recalibrate the unit and return it to you with a certificate of calibration and US National Institute of Standards Technology (NIST) tractability. This 'annual checkup' assures you of consistently accurate readings; it is especially important in applications where strict calibration records must be maintained.

Cases

If the instrument case or storage case needs cleaning, wipe it off with a soft cloth and isopropyl alcohol or a mild detergent. Never submerse the VELOCICALC.

Storage

When storing the VELOCICALC for more than a month, it is recommended to remove the batteries. This prevents damage due to battery leakage.

Chapter 5

Troubleshooting

Table 5 lists the symptoms, possible causes, and recommended solutions for common problems encountered with the VELOCICALC. If your symptom is not listed, or if none of the solutions solves your problem, please contact TSI.

Table 5. Troubleshooting the VELOCICALC

Symptom	Possible Causes	Corrective Action
No display	Unit not switched on	Switch on the unit.
	Low or dead batteries	Replace the batteries or plug in the AC adapter.
	Dirty battery contacts	Clean the battery contacts.
BAT is blinking	Batteries are low	Replace or recharge batteries.
Display reads "LO BAT"	Low battery charge	Replace or recharge batteries.
	Wrong AC adapter	Replace with the correct AC adapter.
	Low AC line voltage	Correct the AC line voltage or use batteries.
	Dirty battery contacts	Clean the battery contacts.
Temperature initially reads high	Temperature sensor is still warm from velocity mode	Allow about 30 seconds before reading temperature.
Display reads "ERR"	You are trying to enter more than 255 readings	Read or record the average; clear the storage register and proceed.
Display reads "CAL"	The VELOCICALC has detected an internal fault	Return to factory for service.
Velocity reading fluctuates badly	The flow is fluctuating	Reposition the probe in a less turbulent section of the flow or use a longer time constant.

Symptom	Possible Causes	Corrective Action
Display says "OVER"	The velocity, temperature or pressure is too high	Use an alternate measurement method.

Warning! Remove the probe from excess temperature immediately: excessive heat can damage the sensor. The pressure sensor is protected from damage for up to 10 psi. (75 kPa or 560 mmHg) At higher pressures it can burst!

Notice: There is sometimes confusion between dewpoint temperature and wet-bulb temperature when comparing VELOCICALC humidity readings to sling psychrometer readings. (Dewpoint temperature and wet bulb temperature are not the same thing.) On the psychometric chart used with a sling psychrometer, dewpoint temperature is a flat horizontal line, wet bulb temperature is a straight line angling downwards from the left, dry bulb temperature is a straight vertical line and relative humidity is a curved line angling upwards from the left.

Appendix A

Specifications

Velocity Range (all models): 30 to 9,999 ft/min (0.15 to 50 m/s)

Range	30 to 500 ft/min	500 to 2000 ft/min	2000 to 6000 ft/min	6000 to 9999 ft/min	0.15 to 2.5 m/s	2.5 to 10 m/s	10 to 30 m/s	30 to 50 m/s
Accuracy***	2.5% rdg ±2 ft/min	2.5% rdg ±10 ft/min	2.5% rdg ±50 ft/min	2.5% rdg ±100 ft/min	2.5% rdg ±0.01 m/s	2.5% rdg ±0.05 m/s	2.5% rdg ±0.25 m/s	2.5% rdg ±0.5 m/s

	Model 8360 VelociCalc Plus	Models 8355/8357 VelociCalc
Temperature		
Measurement Range	14 to 140°F (-10 to 60°C)	0 to 200°F (-17.8 to 93.3°C)
Resolution	0.1°F (0.1°C)	Same
Accuracy	+0.5°F (0.3°C)+++	Same
Instrument Temp. Range		
Electronics		
Operation	40 to 113°F (5 to 45°C)	Same
Storage	-4 to 140°F (-20 to 60°C)	-22 to 194°F (-30 to 90°C)
Probe		
Operation	14 to 140°F (-10 to 60°C)	0 to 200°F (17.8 to 93.3°C)
Storage	-4 to 140°F (-20 to 60°C)	-22 to 194°F (-30 to 90°C)
Relative Humidity Range	0 to 95%	N/A
Accuracy	±3% rh++++	N/A
Dewpoint Range	5 to 120°F (-15 to 49°C)	N/A
Static/Differential Pressure		
Range****	-10.00 to +10.00 inches H_2O (-2.500 to +2.500 kPa or -20.00 to +20.00 mmHg)	N/A
Accuracy	±0.5% of rdg ±0.01 in H_2O (±0.002 kPa or ±0.02 mmHg) ±0.02%/°F (±0.03%/°C)	
Volumetric Flow Rate	.2 to 4,50,000 ft^3/min (0.0424 to 1,170,000 m^3/s or 0.1 to 325,000 l/s)	Same
Duct Sizes	1 to 100 inches in increments of 0.5 inch, 100 to 255 inches in increments of 1 inch (1 to 100 cm in increments of 0.5 cm, 100 to 255 cm in increments of 1 cm)	Same
Averaging Capability	Up to 255 values each of velocity, temperature, pressure, humidity	Up to 255 values each of velocity and temperature

	Model 8360 VELOCICALC Plus (Cont.)	Models 8355/8357 VELOCICALC (Cont.)
Response Time (63% of final value)		
To Velocity	200 milliseconds	Same
To Temperature	8 seconds	Same
Time Constant	Adjustable from 1 to 20 sec.	Same
Physical Dimensions		
External Dimensions	4.2 in x 7.2 in x 1.5 in (107 mm x 183 mm x 38 mm)	Same
Probe Length	29 in (735 mm)	37 in (940 mm)
Weight (with batteries)	1.2 lbs (0.54kg)	1.1 lbs (0.5 kg)
Display	4-digit LCD, 0.6 in (15 mm) digit height	Same
Serial Interface	Type: RS-232, BAUD Rate: 1200	Same
Power	Four AA-size NiCd rechargeable or Alkaline Batteries (included) or AC adapter	Same

***Temperature compensated over an air temperature range of 40 to 150°F (5 to 65°C)
+++Accuracy with instrument case at 77°F (25°C).
Add uncertainty of 0.05°F/°F (0.03°C/°C) for change in instrument temperature.
****Overpressure range = 300 inches H_2O (75 kPa, 560 mmHg)
++++Accuracy with probe at 77°F (25°C).
Add uncertainty of 0.1%rh/°F (0.2%rh/°C) for change in probe temperature. Includes 1% hysteresis.
Specifications within parentheses indicate metric equivalents.

Appendix B

DIP Switch Settings

To access the DIP switches, remove the batteries from the battery compartment. On the inside of the battery compartment, there is a window with eight DIP switches. The table below shows the functions for each switch.

Caution:	Make certain that power is turned off before changing DIP switch settings.

Switch	Function	OFF	ON
1	Velocity	ft/min & ft^3/min	m/s
2	Flow Rate*	l/s	m^3/hr
3	Pressure	in. H_2O	kPa and mmHg
4	Pressure**	kPa	mmHg
5	Temperature	Degrees Fahrenheit (°F)	Degrees Celsius (°C)
6		Reserved	Reserved
7		Reserved	Reserved
8	Beep	Beep Disabled	Beep Enabled

- The ON position is away from the batteries and OFF is towards the batteries.
- Always leave DIP switch #6 & #7 in the OFF position.

* To select Flow Rate to display FT^3/min DIP switch #2 must be in the OFF position.

** To select Pressure to display in. H_2O DIP switch #4 must be in the OFF position.

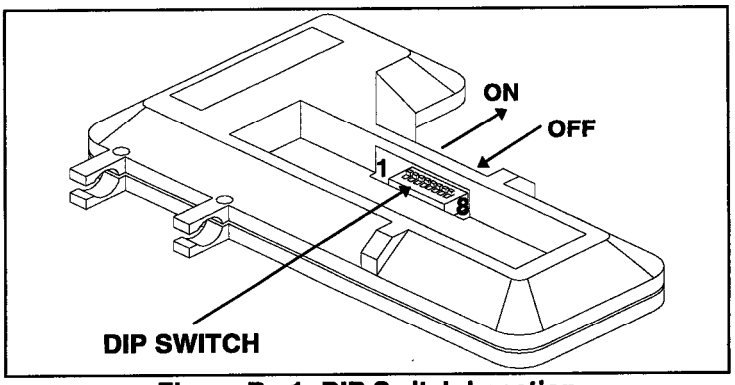


Figure B - 1: DIP Switch Location

Appendix C

Standard Velocity vs. Actual Velocity

Since thermal air velocity sensors are sensitive to changes in air density and air velocity, all thermal anemometers indicate velocities with reference to a set of standard conditions. For TSI instruments, standard conditions are defined as 70° F (21.1° C) and 14.7 psia (101.4 kPa). Other manufacturers may use different values.

Standard velocity is the velocity the air would be moving if the temperature and pressure were at standard conditions. It is usually the most useful measure of airflow because it defines the heat-carrying capacity of the air.

Actual velocity is the velocity at which a microscopic particle of dust would be traveling if it were in the air stream.

In some instances, actual air velocity rather than standard velocity may be of interest. To obtain the value for actual velocity, multiply your standard velocity by the following density correction factor:

$$Actual\ Velocity = (Standard\ Velocity)\left[\frac{460+T}{460+70}\right]\left[\frac{14.7}{P}\right]$$

Where

T = Ambient temperature in degrees Fahrenheit

P = Ambient pressure in psia

If you use metric units, the equation becomes:

$$Actual\ Velocity = (Standard\ Velocity)\left[\frac{273+T_m}{273+21.1}\right]\frac{101.4}{P_m}$$

Where

T_m = Ambient temperature in degrees Centigrade

P_m = Ambient pressure in kPa

Example No. 1:

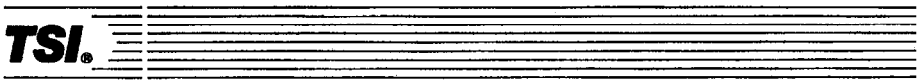
You want to measure the actual velocity in a duct. The air temperature in the duct is 55°F and the pressure is 14.24 psia. You take a measurement and the display reads 1200 feet per minute (ft/min).

$$ActualVelocity = 1200\left[\frac{460+55}{460+70}\right]\frac{14.7}{14.24} = 1203.7\,ft/min$$

Example No. 2:

You need to measure the actual velocity in a plenum. The air pressure is 99.4 kPa and the temperature is 27°C. The display reading is 2.3 meters per second (m/s).

$$ActualVelocity = 2.3\left[\frac{273+27}{273+21.1}\right]\frac{101.4}{99.4} = 2.39\,m/s$$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