

Model 8704

DP-CALC®

Micromanometer

***Operation and Service
Manual***

*September 1998
P/N 1980261 Rev C*

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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 (1) 651-490-2711 :(International).

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Available Application Notes

- Traversing a Duct to Determine Average Air Velocity or Volume#TI-106
- Using DP-CALC for Pressure Measurements.....#TI-113

To obtain any of the listed Application Notes contact TSI at
 U.S. (800) 777-8356/(651) 490-2711 Fax: (651) 490-2874
 International (1) 651-490-2711 Fax: (1) 651-490-2874

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 8704 DP-CALC	8704
1	Carrying Case	1319114
4	AA Alkaline batteries	1208013
1	AC Adapter (optional) 115V, NEMA-5 230 V, European, CEE 7/16 230 V, Great Britain 240 V, Australian	2613033 2613078 800169 2613105
1	Operation and Service Manual	1980261
8 ft	Rubber tubing	801039
1	Static pressure tip	3002017
1	Pitot tube (optional)	3002018
1	Computer Interface Cable	800563
1	DP-CALC Data Downloading Software	801038

Parts Identification

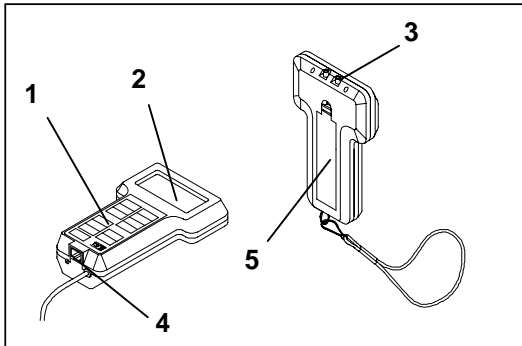


Figure 1-1 DP-CALC

- 1. Keypad
- 2. Display
- 3. Pressure Measurement Ports
- 4. RS-232 Printer Port
- 5. Battery Access Cover

Chapter 2

Setting-Up

Supplying Power to the DP-CALC

The DP-CALC 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 DP-CALC 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. Typical battery life at 20°C is 40 hours for alkaline batteries or 15 hours for NiCd batteries.

Using the Optional AC Adapter

The optional AC adapter allows you to power the DP-CALC from a wall outlet. 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 DP-CALC is capable of displaying the measured values in several different measurement units. The choices of measurement units are shown in Table 2.

Table 2. Choices of Measurement Units

Pressure	Velocity	Flow Rate
in. H ₂ O	ft/min	ft ³ /min
mm Hg	m/s	m ³ /hr
Pa		l/s

If you wish to change the display units on your DP-CALC, refer to Appendix B, DIP Switch Settings.

Setting the Real-Time Clock

The DP-CALC has an internal real-time clock that keeps track of the time of day (the format is HH.MM where HH is the hour in 24-hour format and the MM is minutes) and the date. It is very important for the DP-CALC to have the time and date correctly set, otherwise date and time stamping of recorded data will not be correct.

To set the time and date, press and hold the **SAMPLE** key during the power-up sequence immediately after the time of day is displayed. The DP-CALC will beep once to indicate when the **SAMPLE** key should be pressed. Release key when the DP-CALC beeps again. You will have an opportunity to view and/or change the hours, minutes, year, month, and day of month in sequence. Use the up and down arrow keys (↑↓) to change a setting. Use the **SAMPLE** key to store each setting and advance to the new one.

Connecting the Optional Model 8925 Portable Printer

To connect the Model 8925 printer to the DP-CALC, locate the Printer Interface cable (supplied with the optional printer) and connect the 9-pin end labeled “**PRINTER**” to the printer and the other end to the data port of the DP-CALC. Always turn the DP-CALC on **BEFORE** the printer. If the printer prints question marks (?????), asterisks (*****), or random characters, reset it by turning it off and then on again. If necessary, refer to the *Model 8925 Portable Printer Operation and Service Manual*.

Connecting to a Computer

Use the Computer Interface Cable provided with the DP-CALC to connect the instrument to a computer for downloading stored data. A 9-pin to 25-pin adapter may be required if your computer has a 25-pin serial port.

Chapter 3

Operation

Overview

The Model 8704 DP-CALC measures differential pressure, calculates velocity, and calculates volumetric flow rate. It has data storage capability and can store individual readings and calculate statistics.

Keypad Functions

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

ON/OFF Key

Use the ON/OFF key to turn the DP-CALC on and 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 'SErr' for one second and then 'CAL' to indicate that it should be returned for servicing and calibration. When the internal self-check is completed, the current time set on the internal real-time clock will be displayed. After displaying the time, the approximate percentage of battery life remaining will be displayed. This feature is accurate for alkaline batteries only. When the battery voltage becomes very low, 'LO' appears on the display, and the unit may automatically turn off.

Pressure Key

Press the PRESSURE key to display differential pressure measurements (the DP-CALC will automatically start in pressure mode). The pressure will be displayed in in. H₂O, mm Hg, or Pa depending on the setting of DIP switches #3 and #4 (refer to Appendix B).

To measure pressure, tubing must first be connected to the pressure ports on the top back of the unit. Connect the other ends of the tubing to the measurement device or pressure source, with the more positive pressure connected to the port marked '+' and the more negative pressure connected to the port marked '-'. When the pressure source is connected the same way the pressure ports 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 both pressure ports are exposed to ambient pressure.

Press and hold the **PRESSURE** key down for at least three seconds. The DP-CALC will beep and the display will show “0 in. H₂O” (or whatever units have been selected). When the **PRESSURE** key is released the pressure will be re-zeroed.

Velocity Key

Press the **VELOCITY** key to display velocity. The velocity will be displayed in ft/min or m/s depending on the setting of DIP switch #1 (refer to Appendix B).

Flow Rate Key

Press the **FLOWRATE** key to display volumetric flow rate. The DP-CALC can calculate the flow rate using a known area or calculate the flow rate using a manufacturer-supplied flow factor. If the shape, size, or flow factor have not previously been entered, the DP-CALC display will be blank. The DP-CALC displays the volumetric flow rate in ft³/min, m³/hr or l/s, depending on the setting of DIP switches #1 and #2 (refer to Appendix B).

Flow Rate (Calculated Using Pressure and Duct Area)

This flow rate option is available when DIP switch #8 is OFF (refer to Appendix B). The flow rate is calculated by multiplying the velocity by the flow rate area. The flow rate can be calculated for a round, square or rectangular duct. You must first indicate the shape and size of the duct or other area through which you want to measure flow rate.

Entering Shape, Size, And K Factor

Press the **FLOWRATE** key to enter the shape, size, and K factor (if desired) of the flow rate area. Use the up and down arrow keys (↑↓) to toggle between circle and rectangle symbols. Press the **FLOWRATE** key to accept the shape and move to selection of the size.

For a circular flow shape, the DP-CALC will ask for the diameter of the circular area. Use the up and down arrows keys (↑↓) to select the diameter of the circular area. Press the **FLOWRATE** key to accept the size.

For a rectangular flow shape, the DP-CALC will ask for two dimensions. Use the up and down arrow keys (↑↓) to select the horizontal dimension, then press the **FLOWRATE** key. Use the up

and down arrow keys (↑↓) to select the vertical dimension, then press the FLOWRATE key.

To choose the K factor of the flow rate area, use the up and down arrow keys (↑↓), then press the FLOWRATE key to accept the K factor and begin measuring flowrate.

Flow Rate (Calculated Using Pressure and Flow Factor)

This flow rate option is available when DIP switch #8 is ON (refer to Appendix B). The flow rate is calculated by multiplying the square-root of the pressure reading by a manufacturer-supplied flow factor. This flow rate calculation method is applicable for diffusers that contain pressure taps designed for this purpose.

NOTE: When using this option, make sure that the DP-CALC pressure measurement units and the flow rate measurement units are set using the DIP switches to correspond to those provided by the diffuser manufacturer (refer to Appendix B). If they are set incorrectly, the calculated flow rate will be incorrect.

Entering Flow Factor

Press the FLOWRATE key to enter the flow factor. Use the up and down arrow keys (↑↓) to scroll through the circle, rectangle, and K_f symbols. Press the FLOWRATE key to accept the flow factor (K_f) choice and move to the selection of the flow factor value. Use the up and down arrow keys (↑↓) to choose the flow factor, then press the FLOWRATE key to begin measuring flowrate.

Actual/Standard Key

When a density correction factor, K_d , is entered, pressing the ACTUAL/STANDARD key toggles between actual and standard velocity or flow rate readings. The density correction factor is the ratio of the air density at actual conditions to the air density at standard conditions ($K_d = \text{density}_{ACT} / \text{density}_{STD}$). To enter the density correction factor, press and hold the ACTUAL/STANDARD key. Release key when the K_d symbol appears on the display. Use the up and down arrow keys (↑↓) to select K_d , then press the ACTUAL/STANDARD key to enter the value.

When standard velocity or flowrate is being measured, the 'STANDARD' symbol will be shown on the display. When actual velocity or flowrate is being measured, no symbol will be shown on the display.

Time Constant Key

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 DP-CALC will always reset the time constant to 1 second when turned off.

The time-constant is actually an averaging period. The DP-CALC 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.”

Sample Key

Press the **SAMPLE** key to store the current measurement. The display will show the test ID number, the sample number of the test ID, and the word ‘SAMPLE’. One time-constant after the **SAMPLE** key is pressed, the measurement is stored. If the time-constant is longer than one second, a value will not be shown on the display until the end of the time-constant.

The DP-CALC can store samples in groups, called test IDs. Statistics are calculated for each test ID. When the DP-CALC memory is empty, the DP-CALC stores the first sample at test ID number 1, sample number 1, and the second sample at test ID number 1, sample number 2. When the DP-CALC memory already contains samples, the DP-CALC stores the sample as the next sample in the current test ID number.

Changing the Test ID Number

Press and hold the **SAMPLE** key for three seconds then release to display the current test ID number. Use the up arrow key (↑) to advance to the next test ID number. Press the **SAMPLE** key to accept the new test ID number and return to measuring mode.

The DP-CALC will automatically increment the test ID number under the following conditions:

- turning off the DP-CALC (only if there is previously stored data)
- storing a sample from a different measurement parameter than the last stored sample (for example, storing a flowrate reading after storing a pressure reading)
- storing a sample with a different density correction factor, K factor, flow factor, or duct size than the last stored sample
- storing a sample with a different actual/standard setting than the last sample

Incrementing the test ID number in these situations ensures that the statistics for each test ID are calculated for a group of samples that share the same measurement parameters.

You may not go back to a previous test ID and enter more samples. Once the test ID is incremented, the data stored in the previous test IDs cannot be changed in any way.

Recalling Data

Press and hold the **SAMPLE** key for three seconds then release to display the current test ID number. Use the down arrow key (↓) to display the desired test ID number. Press the **SAMPLE** key to accept the chosen test ID. Use the up and down arrow keys (↑↓) to display the desired sample number. Press the **SAMPLE** key to display the stored value of the chosen sample.

Press and hold the **SAMPLE** key for three seconds to return to measuring mode.

Statistics Key

Press the **STATISTICS** key to display the current test ID number. Use the up and down arrow keys (↑↓) to select the desired test ID number to review. The count (number of samples in the test ID), average, maximum, and minimum can be viewed by pressing the **STATISTICS** key repeatedly. The sixth time the **STATISTICS** key is pressed, the DP-CALC switches back to measuring mode. You must cycle through all the statistics for a test ID to return to measuring mode.

While the DP-CALC is displaying a particular statistic, use the up and down arrow keys (↑↓) to review the same statistic for other test IDs.

Clear Key

Press the **CLEAR** key to erase the last stored value. Press and hold the **CLEAR** key until the countdown reaches zero and beeps to erase all values stored in memory. The key must be released while '0' is shown on the display.

Print Key

Use the **PRINT** key to print information on the optional Model 8925 Portable Printer. The information printed will be different depending on what the DP-CALC is currently doing.

When the DP-CALC is displaying real-time readings, pressing the **PRINT** key causes the parameter currently being measured to be printed. The values printed reflect the current time-constant, therefore, they are the same as shown on the display.

When the DP-CALC is displaying any statistic, pressing the PRINT key will cause the current statistics to print. All statistics are printed as a set regardless of which one is currently displayed.

Press and hold the PRINT key until the countdown reaches zero and beeps to print all values stored in memory. The key must be released while '0' is on the display.

↑ and ↓ Keys

The two arrow keys are used to scroll through and select values as needed for DP-CALC functions.

Downloading Data to a Computer

DPDATA is a DOS-based program designed to download the data stored in the memory of the Model 8704 DP-CALC to a computer. This data includes the test ID, measurement, unit of measure, correction factors, actual/standard parameter, flow area, and time constant. This data is date and time stamped. In addition, the statistics for each test ID are provided. The file containing the downloaded data is sorted and comma delimited to allow it to be imported into a spreadsheet for further data manipulation.

To download data from the DP-CALC, connect the provided computer interface cable to the DP-CALC and to a serial port of a computer. Any serial port from COM 1 to COM 8 can be used. Change the current disk drive and directory to the one containing the DPDATA program. For example, if the DPDATA program is in the 'TESTDATA' directory on the 'C' drive, change to 'C:\TESTDATA'. Type 'dpdata' at the prompt to start the program. The program is self-directing; it provides all the necessary instructions for downloading data.

Chapter 4

Maintenance

The DP-CALC requires very little maintenance to keep it performing well.

Recalibration

To maintain a high degree of accuracy in your measurements, we recommend that you return your DP-CALC to TSI for annual recalibration. For a reasonable fee, we will quickly recalibrate the unit and return it to you in “as new” working condition along with a Certificate of Calibration and NIST traceability. This “annual checkup” helps ensure that the DP-CALC is always in good working condition; 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 immerse the DP-CALC.

Storage

When storing the DP-CALC for more than a month, removing the batteries is recommended. This prevents damage due to battery leakage.

Chapter 5

Troubleshooting

Table 3 lists the symptoms, possible causes, and recommended solutions for common problems encountered with the DP-CALC. If your symptom is not listed, or if none of the solutions solves your problem, please contact TSI.

Table 3. Troubleshooting the DP-CALC

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.
Display reads "LO"	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.
Display reads "CAL"	The DP-CALC has detected an internal fault	Return to factory for service.
Display says "OVER"	The pressure or velocity is too high	Use an alternate measurement method.

Warning! The pressure sensor is protected from damage for up to 10 psi (75 kPa or 560 mm Hg). At higher pressures it can burst!
--

Appendix A

Specifications

Specifications are subject to change without notice.
Specifications in parentheses () indicate metric equivalents.

PRESSURE:

Range: -5 to +15 in. H₂O (-1245 to 3735 Pa, -9.3 to 28.0 mm Hg)
Accuracy: 1% of reading ± 0.005 in. H₂O (±1 Pa, ±0.01 mm Hg)

VELOCITY:

Range¹: 250 to 15,500 ft/min (1.27 to 78.74 m/s)
Accuracy²: 1.5% of reading at 2,000 ft/min (10.00 m/s)

FLOW RATE:

Displayed Range³: to 9,999,000 CFM (9,999,000 l/s, 9,999,000 m³/hr)
K factor Range: 0.01 to 2.00

INSTRUMENT TEMPERATURE RANGE:

Operating range: 32 to 158°F (0 to 70°C)
Storage range: -40 to 185°F (-40 to 85°C)

STORAGE CAPABILITY:

Range: Up to 500 values

TIME CONSTANT:

Values: 1, 5, 10, 15, or 20 seconds

POWER REQUIREMENTS:

Batteries: Four AA-size Alkaline or NiCd rechargeable
AC adapter: 7 VDC nominal, 300 mA
Approx. battery life: 40 hours (Alkaline), 15 hours (NiCd)

PHYSICAL:

External dimensions: 4.0 in x 6.6 in x 1.5 in (102 mm x 168 mm x 38 mm)
Weight (with batteries): 0.76 lb. (0.35 kg)
Display: 4-digit LCD, 0.6 in (15 mm) digit height

PRINTER INTERFACE:

Type: Serial
BAUD rate: 1200

- 3 Actual range is a function of maximum velocity, pressure, duct size, K factor, and density correction factor.
- 2 Accuracy is a function of converting pressure to velocity. Conversion accuracy improves when actual pressure values increase.
- 1 Pressure velocity measurements are not recommended below 1,000 ft/min (5.00 m/s) and are best suited to velocities over 2,000 ft/min (10.00 m/s).

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 ₂ O	Pa and mm Hg
4	Pressure**	Pa	mm Hg
5	Reserved	Reserved	Reserved
6	Calibration	Factory Calibration	User Calibration
7	Beep	Beep Disabled	Beep Enabled
8	Flow Rate	Flowrate from pressure and area	Flowrate from pressure and flow factor or area

* To select flow rate to display l/s or m³/hr, DIP switch #1 must be in the ON position.

** To select pressure to display Pa or mm Hg, DIP switch #3 must be in the ON position.

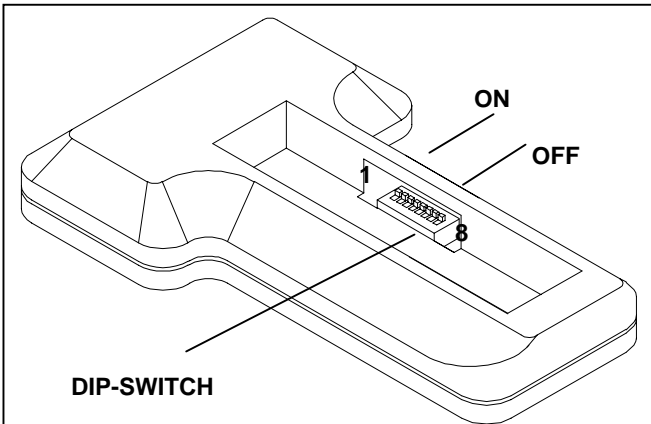


Figure B - 1: DIP Switch Location