

# INSTRUCTION MANUAL

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## **DIGIVAC Model 45 and 100 Series**

Digital Vacuum Gauges

### **Digivac Models**

Model 45 / v

Model 100 Tc

Model 100 LED

Model 100 Tc/Hast/Batt

Model 100 Tc/F

Model 100 / 760

### **Ranges**

1 to 1999 microns

1.to 199.9 microns

1 to 19.99 Torr

1 to 760 Torr and 1 to 199.9 Torr

0 to 29.9 Inches of Mercury

0 to 1 Bar or 0 to 1013 Millibar



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## 1.0 DESCRIPTION AND PRINCIPLE OF OPERATION

DIGIVAC™ 100 series gauges are compact, digital vacuum sensing instruments. They use either thermocouple or strain gauge transducers to sense vacuum.

If in doubt about what gauge you have, consult the Digivac packing list that came with your instrument for positive identification.

Major models and variations are as follows:

- **Model 45 / v** Plastic slant front case with D-cell battery.
- **Model 100 Tc** Plastic Case with Liquid crystal display (LCD) with AC wall adapter.
- **Model 100 LED** Extruded Aluminum Case, Red LED display and internal power supply.
- **Model 100 Tc/Hast** Similar to Model 100 Tc except uses Hastings DV6 or DV4 sensors
- **Model 100 Tc/Hast/Batt** Similar to 100 TC above; powered by 9 volt battery.
- **Model 100 Tc/Fred** Uses Frederics 2A gauge tube; very popular for Neon Sign processing.
- **Model 100 Tc/Fred/Batt** As above except runs on C-cell batteries
- **Model 100/760** Pressure transducer Model; 0 to 760 Torr (independent of gas).
- **Model 100/29.9** Pressure transducer Model; 0 to 29.9 Inches of Mercury (independent of gas).

Consult the Digivac website [www.digivac.com](http://www.digivac.com) for information about other Digivac gauges.

Units with a /V suffix use the **Varian 531** and compatible tubes. As tabulated above, some units use an absolute pressure transducer which reads from 0 to 760 torr or a differential transducer that reads 0 to 29.9 inches of mercury. Other models are available for gauge tubes from other manufacturers.

Other Digivac vacuum gauges (the 200 series and 801w ) use thermocouple tubes and sense from atmosphere to 1 millitorr while auto ranging and providing improved accuracy. These instruments are discussed in the Digivac 200 series instruction manual.

All Digivac products (except 0 to 760 Torr and 0 to 29.9 inches of mercury) operate by measuring the temperature rise of an electrically heated thermocouple exposed to a vacuum. As vacuum increases, absolute pressure decreases, fewer and fewer molecules of gas are available to cool the thermocouple, and its temperature rises.

Digivac gauges with transducers use precision strain gauge pressure sensors. The circuitry in the Digivac puts a precisely controlled excitation current on the transducer. Op amp circuitry then amplifies the low level electrical output from the transducer to a signal large enough to be displayed on by the Digivac.

A precision reference inside the Digivac, in conjunction with an integrated circuit amplifier, controls the electrical excitation of the filament. In gauges that use Hastings tubes, a precision, temperature compensated AC square wave oscillator is included in the electronics.

A CMOS A to D converter then digitizes the signal and drives the LCD (or LED) display. The Instrument then reads either 0 to 1999 microns, 0.0 to 199.9 microns, or 0.00 to 19.99 Torr, depending on the model.

## **2.0 CONSTRUCTION**

The Digivac consists of the indicating and controlling instrument, the gauge tube, the gauge tube cable, and an AC adapter (on applicable models).

The instrument is housed in a rugged free-standing plastic or extruded aluminum enclosure. It is normally simply placed on a suitable surface, but can be flush mounted in a panel if desired. (Digivac 100P/200P series instruments are designed to mount in a panel.)

The gauge tube is a nickel-plated assembly which houses the various thermocouple sensing, heating and compensating elements and terminates in an octal connector. On most models, the connector wiring terminates at the instrument with a D-subminiature connector. If longer leads are necessary, an extension can be made simply by adding appropriate male and female connectors, and wiring pin to pin. Extension cables are also available from Digivac. Regulating circuitry in the Digivac provides constant current for gauge tube excitation, and thus compensates for resistance in the probe leads. Leads up to 100 feet in length will not affect the accuracy of the instrument. Hastings-compatible units use a constant voltage excitation, and are affected by cable length.

Adjustments for zero, span, and gauge tube excitation are accessible from inside the instrument. Most instruments also have a hole in the top of the case for the zero adjust. Internal adjustments are provided for setting of the heater excitation. Refer to Calibration instructions.

In the case of the Model 45, zero and span adjustments are provided at the top of the instrument.

## **3.0 UNPACKING AND INSPECTION**

After the DIGIVAC is received, it should be carefully unpacked and inspected for damage during shipment and for completeness. The package should contain, at a minimum, the instrument, the thermocouple gage tube, the tube connecting cable, and an instruction manual. In the event of a loss during shipment, a claim should immediately be made to the common carrier or the postal service, as applicable. The Digivac warranty pertains only to the instrument, and does not cover losses in shipping.

## **4.0 INSTALLATION**

### **Instrument**

The instrument should be located in a clean, dry environment for best results. Its AC adapter or line cord should be plugged into a suitable AC outlet, and plugged into the power jack at the rear of the instrument. The electrical connections to the apparatus that is to be controlled should be made where applicable. The leads are normally identified by wire tags or markings.

### **Gauge Tube**

Thermocouple gauge tubes must be installed in a stem-down orientation. Transducer tubes are not sensitive to orientation.

If the gauge is used in a Neon sign processing facility, the following is recommended to protect the gauge from damage from bombarding:

The gauge tube should be isolated from the system with a stopcock. The stopcock should be closed when bombarding.

There should be at least 2 feet of tubing between the electrode and the Digivac. For best results, the tubing should be metal.

In extreme cases, the gauge can be absolutely protected by installing a normally open solenoid valve between the gauge tube and the system. The solenoid valve coil should be in parallel with the bombarding transformer. In this way, the solenoid will be closed and the gauge tube will be positively protected whenever bombarding is done.

If a gauge is damaged by bombarding, it can generally be brought back to operating condition by replacing the Op amp which controls the gauge tube current. *Consult Digivac.*

Gauges which are damaged by bombarding will normally be repaired by Digivac free of charge.

The tube should be installed, threaded end down, in a clean dry vacuum system. While threading the gauge tube in, the cable should be disconnected. In this way, twisting of the cable and the octal socket on the tube is avoided.

Care should be exercised to install the tubes in a dry part of the system. Since the instrument works on the principle of temperature rise, the probes will not work if they become filled with a liquid such as vacuum or diffusion pump oil.

*See section 6.0 for gauge tube cleaning instructions.*

Some Digivac gauges, particularly gauges which read gauge (as opposed to absolute) pressure, have an internal sensor. These gauges have either an O-Ring fitting or a hose barb. Make the appropriate connection to your system.

## **5.0 OPERATION**

After installation, the DIGIVAC is ready for immediate operation.

The unit will normally provide accurate readings immediately; however, occasionally a gauge tube will have absorbed material during storage, and may require as much as 24 hours of operation before accurate readings are attained.

It is recommended that the DIGIVAC be energized continuously during vacuum system operation. In this way, the hot filament will not allow contaminants to condense.

In cases where the system has contaminants, as is often the case with metalizing and coating equipment, it is often effective to isolate the gauge tube with a solenoid or manual valve during periods when contamination is most active.

## **6.0 SERVICING**

### **Gauge Tube Cleaning**

In many cases, a gauge tube may become fouled with oil or other foreign matter. It is often possible to restore the functionality of contaminated probes with cleaning. If the contaminant is known, the tube should be filled with a fluid that is known to be a solvent to that contaminant. As an example, ether is often effective in removing residues of some oils. Commercial carburetor cleaners are very powerful solvents and are highly effective against some contaminants.

After cleaning with solvents, the gauge tube should be completely dried or flushed with a volatile solvent to assure that it is dry prior to re-installing it. If this is not done, contamination of the system may result.

## **6.1 FACTORY REPAIR AND CALIBRATION**

The DIGIVAC is designed to provide years of trouble-free service, and the liberal internal use of plug-in components make it easily repairable.

No field servicing of the unit is recommended, other than replacement of the gauge tube, but factory servicing and calibration are available at a nominal cost and turn-around times of 24 hours are typical.

Unless an instrument has been grossly damaged, it can normally be repaired and restored to original specifications for a cost of less than 25% of the purchase price of a replacement instrument.

## **6.2 FIELD CALIBRATION**

Although it is preferable that all calibration be performed at Digivac, field calibration can be accomplished.

Before re-calibrating the instrument, it should be ascertained that the instrument is in fact incorrect. In many cases, the problem will be with a tube that is fouled, or a system that is operating improperly. It is recommended that a spare tube be kept on hand and stored in a clean, dry place. Then, in cases of suspect readings, the tube should be changed before proceeding further.

If adjustments are to be made, proceed as follows:

- Operate the vacuum system at the lowest attainable pressure, and allow the system and the gauge tube to stabilize for several minutes. Factory zero setting is done at a pressure of .1 millitorr (.1 micron) or less.
- Adjust the zero setting potentiometer. This adjustment is accessible from a small hole in the top of 100 tc series gauges. It is accessible by removing the front panel of LED series gauges.
- Check the operation of the gauge at other pressures. Normally, adjustment of the zero will not be interactive with the readings of the instrument at higher pressures.
- If necessary, adjust the span with the span potentiometer. This potentiometer is located on the vertical voltmeter board of the Model 100 tc and on the main board of the Model 45. In the case of the Model 45, the span potentiometer access hole is on the right side of the instrument.

## **6.3 FIELD CALIBRATION OF TRANSDUCER (760) GAUGES**

These gauges utilize a strain gauge absolute pressure transducer that is incorporated into its gauge tube. (On some gauges, the transducer is internal to the gauge.)

**Overall Gain Potentiometer (in cable)**

The transducers have varying gain factors. An adjustment for this is provided in the gauge tube cable. If a transducer tube is changed, it may be necessary to adjust this.

- Determine the local ambient pressure  
*(If at or near sea level, this is the "Altimeter Setting" number at any local airport. It decreases 1 inch of mercury per 1000 feet of altitude.)*
- Remove the hood from the gauge tube cable at the instrument end.
- Adjust the potentiometer as required. This is a span adjustment only.

**Instrument Calibration**

The Model 100Led760/sw has three potentiometers. They are marked "Z", "S" and ".S"

- Adjust the "Z" for zero pressure. The gauge tube should be exposed to a pressure less than 0.1 torr to make this adjustment.
- Adjust the "S" potentiometer for span at atmosphere.
- After "S" is adjusted, expose the sensor to a pressure of aprox. 150 torr as seen on the high scale, then switch to the low scale and adjust ".S"
- Adjust the potentiometer as required. This is a span adjustment only.

**7.0 NOTES ON CALIBRATION**

The DIGIVAC is calibrated in nitrogen, which has thermal properties virtually identical to air. Other gasses will affect the readings by an amount proportional to the thermal conductivity of the gases. In most cases, the gases present in a vacuum system will be air, nitrogen, or oxygen, and no appreciable errors will occur.

Certain other gases, however, have thermal conductivity significantly greater than air and will cause the instrument to read higher than the actual amount of pressure. Examples of such gasses are water vapor, fluorocarbon refrigerants, and acetone. Conversely, other gasses have thermal conductivity significantly lower than air and will cause the instrument to read lower than actual pressure. Examples of such gasses include helium, oxygen and to a lesser extent, CO2.

When interpreting readings using gasses other than air, it should be kept in mind that the DIGIVAC reads microns, which are a measure of absolute pressure, which is the opposite of vacuum. Thus, a lower numerical reading actually is a higher level of vacuum. For more information, refer to section 8.0. When in doubt, consult Digivac.

**Expected accuracy:**

The table below shows the expected uncertainty of gauges with a **Varian 531** gauge tube.

To achieve this accuracy, the tube must be calibrated to the gauge, with the zero and span adjusted.

Actual	Tolerance +/-
1	2
10	3
25	8
50	15
100	25

200	35
500	40
750	50
1000	70

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The table below shows the expected uncertainty of gauges with a **Thermionics Tg 500** gauge tube.

To achieve this accuracy, the tube must be calibrated to the gauge, with the zero and span adjusted.

Actual	Tolerance +/-
1	2
10	2
25	5
50	10
100	15
200	25
500	40
750	50
1000	70

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\*Above 1000 millitorr, all thermocouple gauge tubes have a very low incremental output. The Digivac readings are, however, guaranteed to be monotonic (There are no reversals; increasing pressure always results in an increasing reading) and continuous (There are now "dead" spots, readings will always increase)

*Digivac 200* series gauges read all the way to atmosphere.

#### **Expected Accuracy of Transducer gauges**

Digivac gauges with transducers have an accuracy of better than +/- 1/2% of full scale.

## **8.0 UNDERSTANDING MICRONS**

The DIGIVAC and most similar instruments are calibrated in microns or "millitorr." It is appropriate to discuss what microns are and how to relate microns to other measures of pressure and vacuum.

Microns are not really a measure of vacuum at all, but rather of absolute pressure.

It will be recalled that the pressure of the atmosphere is 14.696 or approximately 14.7 pounds per square inch at sea level. This pressure is due to the weight of all of the air in the earth's atmosphere above any particular square inch.

This 14.696 psi is equivalent to the pressure produced by a mercury column of approximately 29.92 inches high or .76 meters (about 3/4 of a yard) or 760 millimeters of mercury. Atmospheric pressure varies greatly with altitude. It decreases approximately 1 inch of mercury per 1000 feet of altitude. It also varies widely with local weather conditions. (Variations of one half inch in a single day are common.)



The word vacuum means pressure lower than atmospheric or "suction," but, in describing negative pressure, the atmosphere is only a

satisfactory reference if we are dealing with values of vacuum down to about 27 inches of mercury. Below that, it is much more useful to talk in terms of absolute pressure, starting from absolute zero. The DIGIVAC and all similar instruments do just this.

One TORR, a commonly used unit, is an absolute pressure of one millimeter of mercury. A millitorr is equal to 1/1000 of a TORR. A MICRON is the same as a millitorr. The full scale reading of a DIGIVAC is 1999 microns and is equivalent to 1.999 TORR of approximately 2/760 of atmospheric pressure.

## **9.0 ACCESSORIES AND MODIFICATIONS**

The following are offered as accessory equipment or field-installed modifications.

### **Multi-tube Switching**

Multiple gauge tube switching can easily be accomplished with the DIGIVAC 100 Tc. This can be accomplished either with an external multi-probe harness, which plugs into the probe connection at the rear of the unit, or with internally installed multi-probe wiring. The filaments are connected in series, and continuously energized. Gauge tube switching is accomplished by switching the input amplifier between the sensing thermocouples. Because the filaments are constantly heated, the readings after switching probes are virtually instantaneous.

### **Padded shoulder strap Case with velcro closure**

For instruments that will be used in the field, particularly in cryogenic applications, a padded shoulder strap case is available. This case holds a Digivac 100tc battery powered gauge in the optimal reading position. The operator can open the Velcro cover, pull out the gauge tube cable, plug it into the tube on the equipment, and see the reading.

It was developed to assist in field service of cryogenic tank farms and vacuum jacketed piping.

### **230 VAC 50 and 60 HZ AC Power Adapter**

A special adapter can be ordered that will enable the DIGIVAC to operate from 230 VAC single phase 50 Hz power as is commonly used overseas. The Model 100LED has an internal transformer which can be connected for 230 vac operation.

### **Recorder Output**

The DIGIVAC has an internal analog signal of approximately 0 to 1.000 volt with a source impedance of approximately 75 ohms. This signal can be brought out to the rear of the unit and can be used for driving external recorders, data acquisition systems, etc. The signal is monotonic and reasonably linear in most of its useful range. Typical pressure/voltage curves are found at the end of this instruction book.

Other features, such as Linearized recorder outputs, 4 to 20 milliamp outputs, Rs 232 outputs and control setpoints are available on the microprocessor based 200 series Digivac gauges.

### **Compatibility with other Gauge Tubes**

On special order, Digivac Instruments can be provided to use with most other vacuum gauge tubes. AC and DC excitation are available. Gauges have been provided for Hastings, Varian, Thermionics, Veeco, VRC, and Frederics gauge tubes.

## **Wide Range Gauges**

Digivac 200 Series instruments, which are only slightly higher in cost than the 100 series, read the entire range of pressure from Atmosphere to below 1 Micron.

Consult Digivac or our representative for further information. The 200 series instruments are based on a microprocessor and are programmed in a high level language. Because of this design, sophisticated features such as Rs232 output, control setpoints and linearized analog outputs can be economically provided.

## **Process Computer / Controller / Printer Interface**

Digivac can offer a combination gauge and single board computer which can monitor a vacuum gauge tube, record readings, drive an external chart recorder, and control external apparatus such as valves, diffusion pumps, vaporizers, turbo pumps etc. It can be programmed to drive any printer in a manner to simulate a strip-chart recorder. The hard copy output from the recorder will be labeled in pressure units, and can also incorporate custom labels, such as the customer's name. Standard tractor-feed printer paper is used. The module consists of a single-board computer, which digitizes the signal and performs other housekeeping functions as necessary to drive the printer.

The module is programmed in BASIC and includes RS-232 connections which enable it to be connected to any computer for software modification. Actual software is stored in non-volatile memory. A real time clock-calendar is included.

Visual Basic interfaces are provided which draw graphical representations of a process on a PC screen, and log operating data to a hard drive.

*Consult Digivac or [www.digivac.com](http://www.digivac.com) for details.*

## **SPECIAL REQUIREMENTS**

It is the policy of the Digivac Company to customize instruments for specialized requirements whenever it is economically feasible to do so. We encourage inquiries about your special needs.

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For repair or recalibration, return gauges to:

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The Digivac Company manufactures a complete line of vacuum gauges and computers. Contact us or your distributor if you wish for further information.

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