CT-100 Active Rough Vacuum Gauge

INSTRUCTION MANUAL

Manual No. 699908070
Revision D
February 2007
CT-100 Active Rough Vacuum Gauge

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Apiezon® L grease is a registered trademark of M&I Materials Ltd.
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All claims under warranty must be made promptly after occurrence of circumstances giving rise thereto, and must be received within the applicable warranty period by Seller or its authorized representative. Such claims should include the Product serial number, the date of shipment, and a full description of the circumstances giving rise to the claim. Before any Products are returned for repair and/or adjustment, written authorization from Seller or its authorized representative for the return and instructions as to how and where these Products should be returned must be obtained. Any Product returned to Seller for examination shall be prepaid via the means of transportation indicated as acceptable by Seller. Seller reserves the right to reject any warranty claim not promptly reported and any warranty claim on any item that has been altered or has been returned by non-acceptable means of transportation. When any Product is returned for examination and inspection, or for any other reason, Customer shall be responsible for all damage resulting from improper packing or handling, and for loss in transit, notwithstanding any defect or non-conformity in the Product. In all cases, Seller has the sole responsibility for determining the cause and nature of failure, and Seller’s determination with regard thereto shall be final.

If it is found that Seller’s Product has been returned without cause and is still serviceable, Customer will be notified and the Product returned at Customer’s expense; in addition, a charge for testing and examination may be made on Products so returned.

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Preface

EMC Warnings

EN 55022 Class A Warning

This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

FCC

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesirable operation.

NOTE

The equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generated, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is also likely to cause harmful radio communications interference in which case the user will be required to correct the interference at his own expense.

Installation Requirements

To maintain compliance with both the FCC Part 15 rules and the European Union’s EMI directives, the user must use a shielded cable constructed of a braided shield and metal or metalized plastic backshells directly connected to the cable shield at the 15 pos D-Sub connector of the Eyesys Mini-BA. The shield must be connected to ground at the user’s equipment. Failure to install the equipment in this way may result in the unit no longer meeting the requirements for radiated emissions and susceptibility.
Hazard and Safety Information

This manual uses the following standard safety protocols:

**WARNING**

The warning messages are for attracting the attention of the operator to a particular procedure or practice which, if not followed correctly, could lead to serious injury.

**CAUTION**

The caution messages are displayed before procedures, which if not followed, could cause damage to the equipment.

**NOTE**

The notes contain important information.

Operators and service personnel must be aware of all hazards associated with this equipment. They must know how to recognize hazardous and potentially hazardous conditions, and know how to avoid them. The consequences of unskilled, improper, or careless operation of the equipment can be serious. This product must only be operated and maintained by trained personnel. Every operator or service person must read and thoroughly understand operation/maintenance manuals and any additional information provided by Varian. All warning and cautions should be read carefully and strictly observed. Consult local, state, and national agencies regarding specific requirements and regulations. Address any safety, operation, and/or maintenance questions to your nearest Varian office.
Equipment, General

**WARNING**

1. Equipment tightness is guaranteed for normal operating conditions when the equipment leaves the factory. It is the user’s responsibility to maintain the level of tightness particularly when pumping dangerous products.

2. This product is not intrinsically safe and can initiate and sustain a fire if used with combustible gas mixtures containing hydrogen, gasoline, ethanol or similar compounds.

**CAUTION**

The performance and operating safety of this equipment can only be guaranteed if it is operated according to normal conditions of use.

**WARNING**

Disconnect power from the CT-100 before performing any maintenance procedure that requires physically disconnecting or opening any part of the system.

Vacuum Equipment and Cleanliness

Cleanliness is vital when servicing any vacuum equipment. The substances used for cleaning can lead to hazardous conditions or have adverse effects on the equipment.

**WARNING**

Explosion and Fire from Acetone and Alcohol: This device may be cleaned with acetone and alcohol. When combined with air, oxygen, and other oxides, alcohol and most other solvents are very flammable and explosive. Never permit any trace of these cleaners to remain in or on the gauge. Always remove all traces of alcohol and acetone and other cleaners with clean, dry, oil-free compressed air.

**CAUTION**

Do not use silicone oil or silicone grease.

Use powder-free butyl or polycarbonate gloves to prevent skin oils from getting on vacuum surfaces.

Do not clean any aluminum parts with Alconox®. Alconox is not compatible with aluminum and will cause damage.

**NOTE**

Normally, it is unnecessary to use vacuum grease. However, if it must be used, avoid silicone types, and use it sparingly. Apiezon® L grease is recommended (Technologies Part Number 695400004).
Varian Services

Please see our catalog, or contact us to learn of the services that are available to assist in your vacuum measurement and leak detection efforts.

Contacting Varian

In the United States, you can contact Varian Customer Service at 1-800-8VARIAN.

Internet users:

- Send email to Customer Service & Technical Support at vpl.customer.support@varianinc.com
- Visit our web site at www.varianinc.com/vacuum
- Order on line at www.evarian.com

See the back cover of this manual for a listing of our sales and service offices.
Declaration of Conformity
Konformitätserklärung
Déclaration de Conformité
Declaración de Conformidad
Verklaring de Overeenstemming
Declarazione di Conformità

We declare under our sole responsibility that the product,
Erklären, in alleniniger Verantwortung, daß dieses Produkt,
déclarons sous notre seule responsabilité que le produit,
declaramos, bajo nuestra sola responsabilidad, que el producto,
verklaren onder onze verantwoordelijkheid, dat het product,
dichiariamo sotto nostra unica responsabilità, che il prodotto,

declare under our sole responsibility that the product,

CT-100 Active Rough Vacuum Gauge

to which this declaration relates is in conformity with the following standard(s) or other normative documents.
auf das sich diese Erklärung bezieht, mit der/den flogenden Norm(en) oder Richtlinie(n) übereinstimmt.
auquel se réfère cette déclaration est conforme à la (auz) norme(s) ou au(x) document(s) normatif(s).
al que se refiere esta declaración es conforme a la(s) norma(s) u otro(s) documento(s) normativo(s).
waamaar deze verklaring verwijst, aan de volende norm(en) of richtlijn(en) beantwoordt.
a cui se riferisce questa dichiarazione è conforme alla/e sequente/l norma/o documento/l normativo/i.

Low Voltage Directive
EN61010-1 1993 Safety requirements for electrical equipment for measurement, control, and laboratory use, incorporating Amendments Nos. 1 and 2.

EMC Emissions and Immunity
EN 61326 1997 Measurement, control and laboratory equipment, EMC requirements – Industrial use.

EMC Emissions
FCC 47 CFR part 15 Class A emissions requirements (USA).
EN 55011 1998 Group 1 Class A ISM emissions requirements (EU).

Frederick C. Campbell
Operations Manager
Varian, Inc.
Lexington, MA, 02421-3133 USA

October 2002
Introduction

The CT-100 Active Rough Vacuum Gauge provides pressure measurements over a range of 1x10^-4 Torr (1.33x10^-4 mbar) to atmosphere. The 0.2 second response time of the CT-100 and its excellent accuracy and precision allows its use in place of Pirani gauges.

The CT-100 provides a stable analog voltage output as an indication of the test pressure; the unit can be calibrated in a selection of vacuum ranges. Two potentiometer-variable setpoints provide electrical alarms at selected pressures within the calibrated range of the device. Alarm indications are via the open collector grounding of two output transistors and by the illumination of two LEDs.

An internal power supply provides stable operating voltages from a wide range of external DC power sources.

The gauge is contained in a plastic housing mounted by a 1/8” NPT vacuum fitting. Electrical connections are on a single 9-pin D-subminiature connector.

The output pressure signal is a convenient 1.000 VDC to 9 VDC at 100 Ω internal impedance that can be used with strip chart recorders or other analog voltage data acquisition systems.

Specifications

Measurement, electrical and mechanical specifications for the CT-100 are given in Table 1.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pressure ranges</strong></td>
<td></td>
</tr>
<tr>
<td>Calibration at vacuum</td>
<td>1x10^-4 to 100 Torr, sensitive to ATM</td>
</tr>
<tr>
<td></td>
<td>1.33x10^-4 to 133 mbar, sensitive to ATM</td>
</tr>
<tr>
<td>Calibration at atmospheric pressure</td>
<td>20x10^-2 Torr to ATM</td>
</tr>
<tr>
<td></td>
<td>2.6x10^-2 to 1000 mbar</td>
</tr>
<tr>
<td>Measurement response time</td>
<td>0.2 seconds</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>UL recognized: From 0 °C to 40 °C; maximum relative humidity 80% for temperatures up to 31 °C decreasing linearly to 50% relative humidity at 40 °C</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-15 °C to 85 °C</td>
</tr>
<tr>
<td>Mounting orientation</td>
<td>Vacuum port pointing down for best results above 1 Torr (1.33 mbar)</td>
</tr>
<tr>
<td>Weight with NPT fitting</td>
<td>560 grams (0.25 lb)</td>
</tr>
</tbody>
</table>
The CT-100 is compatible with a wide range of Varian pumps as listed in Table 7 on page 24.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface</td>
<td></td>
</tr>
<tr>
<td>Setpoints</td>
<td>Two user defined pressure setpoints for process steps, alarms, high vacuum gauge trigger, or other pressure-induced events</td>
</tr>
<tr>
<td>Setpoint alarm output</td>
<td>Dual, non isolated, open collector outputs 0.3 VDC @ 100 mA (ON)</td>
</tr>
<tr>
<td>Setpoint voltage level</td>
<td>0 VDC to 12 VDC referred to analog output 100 kΩ output impedance</td>
</tr>
<tr>
<td>Adjustments</td>
<td></td>
</tr>
<tr>
<td>Analog voltage output</td>
<td>Proportional to pressure</td>
</tr>
<tr>
<td></td>
<td>Non-linear, 1 VDC to 9 VDC, nominal 100 Ω output impedance</td>
</tr>
<tr>
<td>Power supply</td>
<td>UL recognition for 24 VDC ±10% @ 500 mA max</td>
</tr>
<tr>
<td></td>
<td>(18 VDC to 30 VDC @ 125 mA, typical operating)</td>
</tr>
<tr>
<td>Fault</td>
<td>&lt;0.5 VDC or &gt;9 VDC</td>
</tr>
<tr>
<td>Displays</td>
<td></td>
</tr>
<tr>
<td>Setpoint indicators</td>
<td>Two LEDs indicating that the measured pressure is lower than the respective setpoint</td>
</tr>
<tr>
<td>Vacuum Indicator</td>
<td>Green LED indicates &lt;100 mTorr (0.133 mbar) vacuum is achieved</td>
</tr>
<tr>
<td>Construction</td>
<td></td>
</tr>
<tr>
<td>Materials exposed to vacuum</td>
<td>Nickel plated mild steel, nickel alloy</td>
</tr>
<tr>
<td>Casing</td>
<td>Flame retardant ABS (Acrylonitrile-butadiene-styrene)</td>
</tr>
<tr>
<td>Sensor element</td>
<td>Platinel</td>
</tr>
<tr>
<td></td>
<td>Sensor internal volume 5.4 ml</td>
</tr>
<tr>
<td>Connections</td>
<td></td>
</tr>
<tr>
<td>Electrical</td>
<td>9-pin D-subminiature</td>
</tr>
<tr>
<td>Vacuum</td>
<td>1/8&quot; NPT vacuum fitting</td>
</tr>
<tr>
<td>Installation</td>
<td></td>
</tr>
<tr>
<td>Indoor use</td>
<td>Installation Category II</td>
</tr>
<tr>
<td>Pollution category</td>
<td>Category 2</td>
</tr>
<tr>
<td>Altitude</td>
<td>2000 m</td>
</tr>
</tbody>
</table>

Table 1 Specifications (Continued)
Setup and Calibration

Factory Calibration

The CT-100 is calibrated at the factory at high vacuum of 10^{-5} Torr (1.33\times10^{-5} mbar). You will achieve the highest measurement accuracy by recalibrating the gauge after installation of the vacuum system using the procedure in “Calibrating the Gauge” on page 9.

Setup Procedures

There are four procedures involved in applying the CT-100 to a vacuum system. This ease of use coupled with the simplicity of fault repair makes the CT-100 very desirable in situations where many gauges are employed and in harsh environments that can lead to stress on the gauge and subsequent expectation of short life.

The setup procedures are:

1. Mount the gauge with its NPT fitting facing downward. A range of fitting adaptors is available from Varian as listed in Table 2 on page 5.

   **CAUTION**  
   Do not tighten the fitting by twisting the plastic case as this will result in damage to the gauge. Use the wrench specified in “Tools and Equipment” on page 4 below.

2. Plug the single electrical cable into the D-connector and appropriately connect the free-end wires according to information in Table 3 on page 6.

3. Perform a one-point calibration of the non-linear sensor as described in “Calibrating the Gauge” on page 9.

   Calibration must be done at vacuum below 1\times10^{-4} Torr (1.33\times10^{-4} mbar) or at atmosphere, depending on the expected range of the gauge use. Calibration at intermediate pressures may also be performed with the use of a calibrated pressure reference.

   **NOTE**  
   Record the pressure at which you performed the calibration.

4. Adjust the two setpoint potentiometers to the desired trigger levels as described in “Setting the Alarms” on page 13. If you do not want either alarm to go off, turn the potentiometers fully clockwise to maximum vacuum, a level that may not be expected for this system.
Tools and Equipment

Have the following items available for setup and calibration.

- 7/16" wrench for the 1/8" NPT fitting
- Digital voltmeter
- 24 VDC power supply, 125 mA capacity
- Vacuum pump able to reach $1 \times 10^{-5}$ Torr, $(1.33 \times 10^{-3}$ mbar) with its necessary fittings
- Plumber’s sealing tape or other suitable thread sealant

Vacuum System Configuration

The engineering drawing of the gauge shown in Figure 1 points out the locations of user items on the CT-100. All adjustment locations are readily accessible when the unit is mounted vacuum port downward in the vacuum system.

![Figure 1 Dimensions, inches (mm), and Important Items](image-url)
Important items shown in the figure are:

1. Potentiometers — Setpoints 1 and 2
2. Setpoint alarm LEDs
   These LEDs are OFF until the vacuum reaches the setpoint level. Thereafter, they remain
   RED as long as the pressure stays below the setpoint.
3. VACuum OK indicator
   This LED is OFF at atmospheric pressure and turns GREEN when the vacuum is below
   100 milliTorr (0.133 mbar).
4. 9-pin D-subminiature connector for interface cable to the electrical system.
5. Allen screw access for fixing the sensor orientation after replacement.
6. 1/8" NPT vacuum fitting

Vacuum Connections

Vacuum fitting may be purchased from Varian to mate your system with the 1/8" NPT fitting
integral to the CT-100. The available stainless steel and aluminum fittings are listed in
Table 2. Be sure the appropriate fitting for the vacuum system to be measured is installed on
your CT-100.

<table>
<thead>
<tr>
<th>Fitting Size</th>
<th>Varian Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>304 Stainless Steel</td>
<td></td>
</tr>
<tr>
<td>KF16</td>
<td>KAFP160125S</td>
</tr>
<tr>
<td>KF25</td>
<td>KAFP250125S</td>
</tr>
<tr>
<td>Aluminum</td>
<td></td>
</tr>
<tr>
<td>KF16</td>
<td>KAFP160125A</td>
</tr>
<tr>
<td>KF25</td>
<td>KAFP250125A</td>
</tr>
</tbody>
</table>

|NOTE| Mount the gauge with the vacuum port facing downward for optimum measurement accuracy.|

Vacuum Sealing

The CT-100 must be securely connected to the vacuum system to be tested. Seal all
threaded joints using plumber’s tape or an appropriate sealant. Tighten the thread securely.
Electrical Connections

All signals and voltages are handled through a 9-pin D-subminiature connector mounted on the side of the CT-100 as shown in Figure 1 on page 4.

The electrical pinouts for this connector are given in Table 3. The connector pin layout is shown in Figure 2.

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Relay #2 N.O.</td>
</tr>
<tr>
<td>2.</td>
<td>Relay #1 N.O.</td>
</tr>
<tr>
<td>3.</td>
<td>Power Input (+24 VDC)</td>
</tr>
<tr>
<td>4.</td>
<td>Power Ground</td>
</tr>
<tr>
<td>5.</td>
<td>Analog Output</td>
</tr>
<tr>
<td>6.</td>
<td>Relay Common</td>
</tr>
<tr>
<td>7.</td>
<td>Setpoint #2 Output</td>
</tr>
<tr>
<td>8.</td>
<td>Signal Ground</td>
</tr>
<tr>
<td>9.</td>
<td>Setpoint #1 Output</td>
</tr>
<tr>
<td>Shell</td>
<td>Chassis Ground in the gauge. Connect to the Power Supply at the Power Supply</td>
</tr>
</tbody>
</table>

Figure 2 9-Pin D-subminiature Connector
Connecting to the Gauge

The CT-100 generates five signal levels that are externally measured or sensed. These signals, with their pin location on the D-subminiature connector, are given in Table 3.

The voltage on pin 5 represents the pressure in the test object. The equivalent circuit for this output is shown in Figure 3.

![Figure 3 Pressure Output Equivalent Circuit](image)

The voltages on pins 7 and 9 represent the setpoint alarm pressures. These voltages are taken from the wipers of the screwdriver-adjust potentiometers respectively labelled Setpoint 2 and Setpoint 1 in Figure 1 on page 4. The circuit for these outputs is shown in Figure 4. The sensing circuit loaded on this output should have an impedance of at least 10 \(\text{Meg} \Omega\).

![Figure 4 Setpoint Level Equivalent Circuit](image)
The voltage on pins 1 and 2 are the switched collectors indicative of a tripped setpoint alarm. The equivalent circuit for these outputs is shown in Figure 5. The collector is clamped to ground when the setpoint level is reached. This circuit can sink up to 100 mA from a supply of up to 30 VDC.

**CAUTION**

Since the usual driven element is a relay coil, a snubber diode is required for protection from inductive flyback as is shown below and in Figure 12 on page 17.

![Setpoint Output Driver Equivalent Circuit](image)

**Figure 5  Setpoint Output Driver Equivalent Circuit**

The CT-100 appears as shown in Figure 6 when mounted in a vacuum system.

**NOTE**

Mount the gauge with the vacuum port facing downward for optimum measurement accuracy.

![Installed CT-100](image)
Calibrating the Gauge

Perform a recalibration every few months or more often as needed (see Table 6 on page 18) based on the temperature and the process chemistry in which the gauge is used. Your Varian Customer Support Center can provide advice on establishing a routine calibration schedule for your applications. See the rear cover of this manual for a list of Center locations.

The CT-100 pressure vs. voltage calibration curves for air and argon are given in Figure 7. The data on which to base a calibration are given in Table 4 on page 10. The calibration procedure for any gas with a reference gauge is based on establishing a datum at either:

- The ultimate vacuum for the CT-100 at 1x10^{-5} Torr (1.33x10^{-5} mbar) where the gauge output voltage is set to 1.000 VDC for any gas, or
- At atmospheric pressure of 760 Torr (1000 mbar) where the gauge voltage is set to:
  - 8.255 VDC in air/N₂, or
  - 6.783 VDC in argon.

![Figure 7 Air/N₂ and Argon Calibration Curves](image-url)
To calibrate the CT-100:

1. Connect the gauge to the vacuum system to be measured.
   If you want to establish the datum at atmospheric pressure, the system does not have to be pumped down.
2. Connect the cable to a power supply.
3. Connect a voltmeter to gauge ground pin # 4 and to gauge output pin # 5 on the cable from the D-connector.

### Table 4  Air/N₂ and Argon Calibration Data

<table>
<thead>
<tr>
<th>Pressure (Torr)</th>
<th>Pressure (mbar)</th>
<th>Pressure (Pa)</th>
<th>$V_{out}$ (Air/N₂)</th>
<th>$V_{out}$ (Argon)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00E-04</td>
<td>1.33E-04</td>
<td>1.33E-02</td>
<td>1.002</td>
<td>1.002</td>
</tr>
<tr>
<td>2.00E-04</td>
<td>2.66E-04</td>
<td>2.66E-02</td>
<td>1.004</td>
<td>1.003</td>
</tr>
<tr>
<td>5.00E-04</td>
<td>6.65E-04</td>
<td>6.65E-02</td>
<td>1.007</td>
<td>1.005</td>
</tr>
<tr>
<td>1.00E-03</td>
<td>1.33E-03</td>
<td>1.33E-01</td>
<td>1.013</td>
<td>1.008</td>
</tr>
<tr>
<td>2.00E-03</td>
<td>2.66E-03</td>
<td>2.66E-01</td>
<td>1.025</td>
<td>1.015</td>
</tr>
<tr>
<td>5.00E-03</td>
<td>6.65E-03</td>
<td>6.65E-01</td>
<td>1.055</td>
<td>1.036</td>
</tr>
<tr>
<td>1.00E-02</td>
<td>1.33E-02</td>
<td>1.33E+00</td>
<td>1.111</td>
<td>1.069</td>
</tr>
<tr>
<td>2.00E-02</td>
<td>2.66E-02</td>
<td>2.66E+00</td>
<td>1.216</td>
<td>1.136</td>
</tr>
<tr>
<td>5.00E-02</td>
<td>6.65E-02</td>
<td>6.65E+00</td>
<td>1.501</td>
<td>1.330</td>
</tr>
<tr>
<td>1.00E-01</td>
<td>1.33E-01</td>
<td>1.33E+01</td>
<td>1.940</td>
<td>1.562</td>
</tr>
<tr>
<td>2.00E-01</td>
<td>2.66E-01</td>
<td>2.66E+01</td>
<td>2.540</td>
<td>2.085</td>
</tr>
<tr>
<td>5.00E-01</td>
<td>6.65E-01</td>
<td>6.65E+01</td>
<td>3.678</td>
<td>2.977</td>
</tr>
<tr>
<td>1.00E+00</td>
<td>1.33E+00</td>
<td>1.33E+02</td>
<td>4.737</td>
<td>3.787</td>
</tr>
<tr>
<td>2.00E+00</td>
<td>2.66E+00</td>
<td>2.66E+02</td>
<td>5.703</td>
<td>4.312</td>
</tr>
<tr>
<td>5.00E+00</td>
<td>6.65E+00</td>
<td>6.65E+02</td>
<td>6.547</td>
<td>5.288</td>
</tr>
<tr>
<td>1.00E+01</td>
<td>1.33E+01</td>
<td>1.33E+03</td>
<td>6.999</td>
<td>5.598</td>
</tr>
<tr>
<td>2.00E+01</td>
<td>2.66E+01</td>
<td>2.66E+03</td>
<td>7.241</td>
<td>5.892</td>
</tr>
<tr>
<td>5.00E+01</td>
<td>6.65E+01</td>
<td>6.65E+03</td>
<td>7.405</td>
<td>6.017</td>
</tr>
<tr>
<td>1.00E+02</td>
<td>1.33E+02</td>
<td>1.33E+04</td>
<td>7.463</td>
<td>6.065</td>
</tr>
<tr>
<td>2.00E+02</td>
<td>2.66E+02</td>
<td>2.66E+04</td>
<td>7.548</td>
<td>6.097</td>
</tr>
<tr>
<td>5.00E+02</td>
<td>6.65E+02</td>
<td>6.65E+04</td>
<td>7.762</td>
<td>6.347</td>
</tr>
<tr>
<td>7.60E+02</td>
<td>1.01E+03</td>
<td>1.01E+05</td>
<td>8.255</td>
<td>6.783</td>
</tr>
</tbody>
</table>
4. Plug the cable into the gauge and turn the power supply ON.

5. Allow the gauge to warm up for 1/2-hour.
   - To calibrate at atmosphere, go to step 6.
   - To calibrate at vacuum, go to step 7.

6. Adjust the CAL screwdriver potentiometer as shown in Figure 8 until the voltmeter reads 8.255 VDC.
   
   If calibrating in an argon atmosphere, adjust the output to 6.783 VDC.
   
   The gauge is now calibrated with maximum accuracy obtained near atmospheric levels.

To calibrate the gauge for optimum accuracy at high vacuum levels:

7. Connect the gauge to a pump and precision gauge able to achieve and measure 1x10\(^{-5}\) Torr (1.33x10\(^{-5}\) mbar) or lower.

8. Adjust the CAL screwdriver potentiometer as shown in Figure 8 until the voltmeter reads 1.000 volts.

   Note in Table 4 that the output voltage rises by 2 millivolts at the lowest accurately measurable level for the CT-100, 1x 10\(^{-4}\) Torr (1.33x10\(^{-4}\) mbar).

   The gauge is now calibrated for measurements from 10\(^{-4}\) to 100 Torr (1.33x10\(^{-4}\) to 133 mbar).
Calibration at Intermediate Pressures

The CT-100 can be calibrated at intermediate pressures to attain the best accuracy near that level, or to compensate for use at high altitude.

To calibrate the gauge at intermediate pressures:

1. Determine the pressure at which you want to calibrate the gauge.
   
   If the gauge is being operated at high altitude, determine the local air pressure.

2. Refer to the chart in Figure 7 on page 9 or to Table 4 on page 10 and determine the output voltage corresponding to that pressure.
   
   A linear interpolation between points in the table will provide sufficient accuracy. For example, at a calibration pressure of 20 milliTorr (0.266 mbar), the output voltage should be adjusted to 1.216 VDC as shown in Table 4.

3. Use a calibrated reference gauge to verify that the pressure in the system is at the desired value.

4. Adjust the **CAL** potentiometer until the output voltage reads the value just determined.
Setting the Alarms

The two setpoints are screwdriver adjusted as shown in Figure 9.

![Figure 9 Screwdriver Adjustment of the Setpoints](image)

The output voltage of 1 VDC to 9 VDC covers the measurement range from vacuum to atmospheric. The setpoints can be extended beyond this range to the limits of 0 to 12 volts for alarm settings beyond the accurate range of the gauge.

*Examples:*

- If the setpoint is greater than the reading for ATM, the output and the LED will always be active whenever power is applied to the gauge.
- If the setpoint is lower than the VAC reading, the setpoint can indicate a sensor failure.

When a setpoint is activated, the corresponding open collector, on pin 1 for setpoint 2 and on pin 2 for setpoint 1, becomes active and can sink current to the common ground. This connection may be used to drive a relay coil (see Figure 12 on page 17) or other indicator that shows the trigger setpoint has been reached.

*There are two ways to adjust the setpoints:*

- Use a voltmeter to measure the voltage equivalent of the pressure at which the alarm is to be set. This provides the most accurate way to establish a setpoint.
- Rotate the potentiometer screw by referring to the line markings on the front panel. These marking provide approximate pressure settings throughout the range of measurable vacuum.
**Voltmeter adjustment of a setpoint:**

1. Connect power to a CT-100 gauge that has been calibrated. The voltage to be measured is from 0 up to 12 VDC. If necessary, set the voltmeter scale to measure this range.

2. Attach the voltmeter ground to pin 8 on the D-connector cable.

3. Attach the voltmeter probe to pin 9 to measure setpoint #1 and to pin 7 for setpoint #2 as determined from Table 3 on page 6. At this point you are reading the voltage on the wiper of the selected potentiometer.

4. Refer to the Table 4 on page 10 or to Figure 7 on page 9 for the gas you wish to measure.

   This data is given in Torr, mbar, and Pascals on the pressure X-axis.

5. Locate the pressure for the setpoint on the X-axis of the chart and read off the voltage from the Y-axis, or find a specific pressure in the table and its associated voltage. Use a linear interpolation between the nearest data points for intermediate values.

6. Adjust the screwdriver potentiometer for the appropriate setpoint until the voltmeter reads the value indicated on the curve or the table.

   You can calibrate to three decimal places, ±1 millivolt.

**NOTE**

*If you are measuring a different gas, the setpoints must be readjusted.*
Setpoint Adjustment from Panel Markings:

Each setpoint can be brought to an approximate pressure level by rotating the screwdriver adjustment according to the markings on the side panel surrounding the potentiometer. These markings are placed approximately at each decade of vacuum (refer to Figure 10 and Table 5).

![Potentiometer Pressure Markings on the Side Panel](image)

**Table 5  Marking Pressures**

<table>
<thead>
<tr>
<th>Marking Clockwise</th>
<th>Torr</th>
<th>mbar</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATM</td>
<td>760</td>
<td>1000</td>
</tr>
<tr>
<td>1</td>
<td>100</td>
<td>133</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>13.3</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>1.33</td>
</tr>
<tr>
<td>4</td>
<td>100 mT</td>
<td>1.33x10^{-1}</td>
</tr>
<tr>
<td>5</td>
<td>10 mT</td>
<td>1.33x10^{-2}</td>
</tr>
<tr>
<td>VAC</td>
<td>1 mT</td>
<td>1.33x10^{-3}</td>
</tr>
</tbody>
</table>
Cleaning

Exterior

The exterior of the CT-100 may be kept clean using a cloth slightly dampened with water.

Interior

Remove all power from the CT-100 before opening the cover to clean its internal parts. To remove the cover, follow the procedure given in “Changing the Vacuum Sensor” on page 21. The only internal part that may require cleaning is the vacuum port and the sensor mounted inside the port. Use alcohol or acetone for cleaning.

WARNING

Explosion and Fire from Acetone and Alcohol: This device may be cleaned with acetone and alcohol. When combined with air, oxygen, and other oxides, alcohol and most other solvents are very flammable and explosive. Never permit any trace of these cleaners to remain in or on the gauge. Always remove all traces of alcohol and acetone and other cleaners with clean, dry, oil-free compressed air.
Gauge Applications

The CT-100 setpoint trigger can be used to enable or disable the sensor filament in an associated Eyesys precision vacuum gauge. The connections to achieve this are shown in Figure 11.

**Figure 11** Setpoint Output to the Eyesys Mini-BA

**CAUTION** When using the CT-100 setpoint trigger output to drive an external relay, a diode must be placed across the coil to avoid the flyback voltage from damaging the output collector. This circuit is shown in Figure 12.

**Figure 12** Setpoint Output Driving a Relay Coil
Troubleshooting

Qualified Service

The only user-serviceable procedure in the CT-100 is the replacement of the vacuum sensor as discussed in “Changing the Vacuum Sensor” on page 21. All other service or repair must be done only by Varian qualified service staff. Refer to “Contacting Varian” on page xiv.

Table 6 contains a list of failure symptoms for the CT-100, the possible causes for the failure, and the corrective actions that you can take.

**NOTE**
The vacuum sensor is the only replaceable part in the CT-100. No other replacements or repairs are authorized for customer action. If you replace any part other than the sensor, you will void the warranty and negate the certification to industrial standards.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible Causes</th>
<th>Corrective Action</th>
<th>See...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green LED does not light at HI vacuum</td>
<td>Power not applied</td>
<td>Apply power correctly.</td>
<td>Table 3 on page 6</td>
</tr>
<tr>
<td></td>
<td>Power polarity reversed</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sensor failure</td>
<td>Replace sensor.</td>
<td>Section “Changing the Vacuum Sensor” on page 21</td>
</tr>
<tr>
<td>Setpoint LEDs do not light</td>
<td>Power not applied</td>
<td>Apply power correctly.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Power polarity reversed</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sensor failure</td>
<td>Replace sensor.</td>
<td>Section “Changing the Vacuum Sensor” on page 21</td>
</tr>
<tr>
<td></td>
<td>Setpoint level set too high</td>
<td>Readjust setpoint level.</td>
<td>“Setting the Alarms” on page 13</td>
</tr>
<tr>
<td>Analog output near 0 volts at any pressure</td>
<td>Power not applied</td>
<td>Apply power.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Power polarity reversed</td>
<td>Apply power correctly.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sensor failure</td>
<td>Replace the sensor.</td>
<td>Section “Changing the Vacuum Sensor” on page 21</td>
</tr>
<tr>
<td></td>
<td><strong>CAL</strong> adjustment incorrect</td>
<td>Recalibrate.</td>
<td>“Calibrating the Gauge” on page 9</td>
</tr>
<tr>
<td></td>
<td>Printed circuit board failure</td>
<td>Call the Customer Support Center.</td>
<td></td>
</tr>
</tbody>
</table>
Table 6  Troubleshooting (Continued)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible Causes</th>
<th>Corrective Action</th>
<th>See...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog output above 9 volts at any pressure</td>
<td>Supply voltage greater than 30 VDC</td>
<td>Reduce the supply voltage.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sensor contaminated</td>
<td>Clean the sensor.</td>
<td>“Cleaning” on page 16</td>
</tr>
<tr>
<td></td>
<td>Sensor failure</td>
<td>Replace the sensor.</td>
<td>Section “Changing the Vacuum Sensor” on page 21</td>
</tr>
<tr>
<td>Draws excessive power. Supply current &gt; 125 mA</td>
<td>Printed circuit board failure</td>
<td>Call the Customer Support Center.</td>
<td></td>
</tr>
<tr>
<td>Does not track calibration curve</td>
<td>CAL adjustment incorrect</td>
<td>Recalibrate.</td>
<td>“Calibrating the Gauge” on page 9</td>
</tr>
<tr>
<td></td>
<td>Gas other than air or argon</td>
<td>Calibrate with the actual gas used.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Contaminated sensor</td>
<td>Clean or replace the sensor.</td>
<td>Section “Changing the Vacuum Sensor” on page 21</td>
</tr>
<tr>
<td></td>
<td>Leak at pipe thread fitting</td>
<td>Reattach the CT-100 with new thread sealant using the proper torque.</td>
<td>“Vacuum Sealing” on page 5</td>
</tr>
<tr>
<td>Analog output unstable</td>
<td>Power supply voltage too high</td>
<td>Lower the voltage to under 30 VDC.</td>
<td>Section “Changing the Vacuum Sensor” on page 21</td>
</tr>
<tr>
<td></td>
<td>Sensor failure</td>
<td>Replace the sensor.</td>
<td>Section “Changing the Vacuum Sensor” on page 21</td>
</tr>
<tr>
<td></td>
<td>Cable shield and power return tied together at gauge</td>
<td>Tie the cable shield and power return together at the power supply, only.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Use of unshielded cable</td>
<td>Use a shielded cable grounded at the power supply.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RFI or EMI are above the limits of EN61326</td>
<td>Reduce the RFI and EMI to below levels of EN61326 or add additional shielding.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pressure in chamber fluctuates</td>
<td>No action required. Gauge responds to pressure changes of 0.2 seconds.</td>
<td></td>
</tr>
</tbody>
</table>
### Table 6  Troubleshooting (Continued)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible Causes</th>
<th>Corrective Action</th>
<th>See...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unable to calibrate</td>
<td>Incorrect pressure level</td>
<td>Replace the sensor.</td>
<td>Section “Changing the Vacuum Sensor” on page 21</td>
</tr>
<tr>
<td>Sensor failure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Printed circuit board failure</td>
<td></td>
<td>Call the Customer Support Center.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Setpoint potentiometer markings not accurate</td>
<td>Markings are approximate</td>
<td>Use setpoint level outputs to obtain an accurate setting.</td>
<td>“Setting the Alarms” on page 13</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Setpoint outputs stay at 0 volts</td>
<td>No pull-up resistor</td>
<td>Connect a pull-up resistor.</td>
<td>Figure 5 on page 8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Printed circuit board failure</td>
<td>Call the Customer Support Center.</td>
<td></td>
</tr>
</tbody>
</table>
Changing the Vacuum Sensor

The thermal pressure vacuum sensor is mounted inside the plastic housing and is accessible for changing by opening the housing. Perform this work at an ESD controlled workstation.

Tools required:

- Phillips head screwdriver, small
- Allen (hex) wrench, 1/8".

To replace the sensor:

1. Disconnect the D-connector plug from the CT-100.
2. Remove the CT-100 from the vacuum system.
3. Remove three screws holding the cover to the gauge body and lift the cover off.
   The screw at the position shown in Figure 13 is longer than the other two screws and must be returned to the same place when reassembling the cover.

![Figure 13 Location of the Long Screw](image)

4. Locate the Allen (hex) screw at the top, outer end of the sensor body.
   Use a 1/8" hex wrench and remove the screw as shown in Figure 14.

![Figure 14 Location of Allen (hex) Screw](image)
5. Locate and unplug the red plastic connector that attaches the cable from the sensor to the circuit board, as shown in Figure 15.

![Figure 15 Red Connector and Sensor](image15.png)

6. Lift the sensor and its attached cable out of the gray plastic cradle.

7. Put the new sensor into the cradle. Be sure to locate the tube and wires as shown in Figure 16.

![Figure 16 Sensor in its Cradle](image16.png)
8. Rotate the sensor so the Allen screw anchor hole is at the top of the assembly and is visible through the hole in the cover as shown in Figure 17.

![CT-100 Active Rough Vacuum Gauge](image)

**Figure 17  Positioning the Sensor**

9. Insert and finger tighten the Allen screw.

10. Reattach the red connector. The connector is polarized to be inserted in only a specific orientation and with full alignment of plug and socket.

   **CAUTION**  
   Sensor failure may take place if the connector and plug are not aligned and if any pins are not firmly engaged.

11. Replace the gauge cover and fully tighten the Allen screw.

12. Locate the longer of the cover screws and insert it in the lower left position as shown in Figure 15 on page 22 with the vacuum port facing upward.

13. Replace the remaining two screws and replace the gauge in the vacuum system.

14. Calibrate the gauge using the procedure in “Calibrating the Gauge” on page 9.
## Compatible Vacuum Pumps

<table>
<thead>
<tr>
<th>Product</th>
<th>Vacuum Pumps</th>
<th>Vacuum Gauges</th>
</tr>
</thead>
<tbody>
<tr>
<td>SH-100 Dry Scroll</td>
<td>TriScroll Series - TS-300, 320, 600, 620</td>
<td>High Vacuum Gauge - Mini BA (Digital)</td>
</tr>
<tr>
<td>Rotary Vane</td>
<td>Turbo Molecular</td>
<td>High Vacuum Gauge - Mini IMG (Analog)</td>
</tr>
<tr>
<td>Ion</td>
<td>Diffusion</td>
<td></td>
</tr>
</tbody>
</table>

## Accessories and Replacement Parts

<table>
<thead>
<tr>
<th>Item</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface Cable with 9-pin, D-subminiature male connector</td>
<td>R0907xyz</td>
</tr>
<tr>
<td>xyz = length in feet</td>
<td></td>
</tr>
<tr>
<td>Power Supply/Breakout Box [24 VDC power and signal test points]</td>
<td>670077101</td>
</tr>
<tr>
<td>Vacuum Sensor 1/8&quot; NPT</td>
<td>L7426601</td>
</tr>
<tr>
<td>RJ45 Adapter for Edwards ATC and APG</td>
<td>L7439301</td>
</tr>
<tr>
<td>Mating DSUB Connector Kit</td>
<td>L7440301</td>
</tr>
<tr>
<td>Vacuum Fittings: 304 Stainless Steel</td>
<td></td>
</tr>
<tr>
<td>KF16</td>
<td>KAFP160125S</td>
</tr>
<tr>
<td>KF25</td>
<td>KAFP250125S</td>
</tr>
<tr>
<td>Vacuum Fittings: Aluminum</td>
<td></td>
</tr>
<tr>
<td>KF16</td>
<td>KAFP160125A</td>
</tr>
<tr>
<td>KF25</td>
<td>KAFP250125A</td>
</tr>
</tbody>
</table>
1. Return authorization numbers (RA#) will not be issued for any product until this Certificate is completed and returned to a Varian, Inc. Customer Service Representative.

2. Pack goods appropriately and drain all oil from rotary vane and diffusion pumps (for exchanges please use the packing material from the replacement unit), making sure shipment documentation and package label clearly shows assigned Return Authorization Number (RA#) VVT cannot accept any return without such reference.

3. Return product(s) to the nearest location:

North and South America
Varian, Inc.
121 Hartwell Ave.
Lexington, MA 02421
Fax: (781) 860-9252

Europe and Middle East
Varian S.p.A.
Via F.lli Varian, 54
10040 Leini (TO) – ITALY
Fax: (39) 011 997 9350

Asia and ROW
Varian Vacuum Technologies
Local Office

For a complete list of phone/fax numbers see www.varianinc.com/vacuum

4. If a product is received at Varian, Inc. in a contaminated condition, the customer is held responsible for all costs incurred to ensure the safe handling of the product, and is liable for any harm or injury to Varian, Inc. employees occurring as a result of exposure to toxic or hazardous materials present in the product.

---

CUSTOMER INFORMATION

Company name: ..............................................................

Contact person: Name: ............................................ Tel: ............................................

Fax: .............................................................. E-mail: ............................................

Ship method: Shipping Collect #: ................................ P.O. #: ............................................

Europe only: VAT Reg Number: ...........

USA only: ☐ Taxable ☐ Non-taxable

Customer ship to: ............................................. Customer bill to: .............................................

---

PRODUCT IDENTIFICATION

<table>
<thead>
<tr>
<th>Product Description</th>
<th>Varian, Inc. Part Number</th>
<th>Varian, Inc. Serial Number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

TYPE OF RETURN (check appropriate box)

☐ Paid Exchange ☐ Paid Repair ☐ Warranty Exchange ☐ Warranty Repair ☐ Loaner Return

☐ Credit ☐ Shipping Error ☐ Evaluation Return ☐ Calibration ☐ Other

---

HEALTH and SAFETY CERTIFICATION

VARIAN, INC. CANNOT ACCEPT ANY BIOLOGICAL HAZARDS, RADIOACTIVE MATERIAL, ORGANIC METALS, OR MERCURY AT ITS FACILITY. CHECK ONE OF THE FOLLOWING:

☐ I confirm that the above product(s) has (have) NOT pumped or been exposed to any toxic or dangerous materials in a quantity harmful for human contact.

☐ I declare that the above product(s) has (have) pumped or been exposed to the following toxic or dangerous materials in a quantity harmful for human contact (Must be filled in):

Print Name: ............................................ Signature: ............................................ Date: ............................................

---

PLEASE FILL IN THE FAILURE REPORT SECTION ON THE NEXT PAGE

Do not write below this line

Notification (RA) #: .................................... Customer ID #: .................................... Equipment #: ....................................

August 2003 — Page 1 of 2
## Request for Return
### Health and Safety Certification

**FAILURE REPORT**
(Please describe in detail the nature of the malfunction to assist us in performing failure analysis):

### Turbo Pumps and Turbocontrollers

<table>
<thead>
<tr>
<th>Claimed Defect</th>
<th>Position</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>❑ Does not start</td>
<td>❑ Noise</td>
<td>❑ Vertical</td>
</tr>
<tr>
<td>❑ Does not spin freely</td>
<td>❑ Vibrations</td>
<td>❑ Horizontal</td>
</tr>
<tr>
<td>❑ Does not reach full speed</td>
<td>❑ Leak</td>
<td>❑ Upside-down</td>
</tr>
<tr>
<td>❑ Mechanical Contact</td>
<td>❑ Overtemperature</td>
<td>❑ Other</td>
</tr>
<tr>
<td>❑ Cooling defective</td>
<td>❑ Clogging</td>
<td></td>
</tr>
</tbody>
</table>

Describe Failure:

 Turbocontroller Error Message:

### Ion Pumps/Controllers

<table>
<thead>
<tr>
<th>Claimed Defect</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>❑ Bad feedthrough</td>
<td></td>
</tr>
<tr>
<td>❑ Vacuum leak</td>
<td></td>
</tr>
<tr>
<td>❑ Error code on display</td>
<td></td>
</tr>
</tbody>
</table>

Describe Failure:

Customer application:

### Valves/Components

<table>
<thead>
<tr>
<th>Claimed Defect</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>❑ Main seal leak</td>
<td></td>
</tr>
<tr>
<td>❑ Solenoid failure</td>
<td></td>
</tr>
<tr>
<td>❑ Damaged sealing area</td>
<td></td>
</tr>
</tbody>
</table>

Describe Failure:

Customer application:

### Leak Detectors

<table>
<thead>
<tr>
<th>Claimed Defect</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>❑ Cannot calibrate</td>
<td></td>
</tr>
<tr>
<td>❑ Vacuum system unstable</td>
<td></td>
</tr>
<tr>
<td>❑ Failed to start</td>
<td></td>
</tr>
</tbody>
</table>

Describe Failure:

Customer application:

### Instruments

<table>
<thead>
<tr>
<th>Claimed Defect</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>❑ Gauge tube not working</td>
<td></td>
</tr>
<tr>
<td>❑ Communication failure</td>
<td></td>
</tr>
<tr>
<td>❑ Error code on display</td>
<td></td>
</tr>
</tbody>
</table>

Describe Failure:

Customer application:

### All Other Varian, Inc.

<table>
<thead>
<tr>
<th>Claimed Defect</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>❑ Pump doesn’t start</td>
<td></td>
</tr>
<tr>
<td>❑ Doesn’t reach vacuum</td>
<td></td>
</tr>
<tr>
<td>❑ Pump seized</td>
<td></td>
</tr>
</tbody>
</table>

Describe Failure:

Customer application:

### Diffusion Pumps

<table>
<thead>
<tr>
<th>Claimed Defect</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>❑ Heater failure</td>
<td></td>
</tr>
<tr>
<td>❑ Vacuum leak</td>
<td></td>
</tr>
</tbody>
</table>

Describe Failure:

Customer application:
Sales and Service Offices

Canada
Central coordination through: Varian, Inc.
121 Hartwell Avenue
Lexington, MA 02421
USA
Tel: (781) 861 7200
Fax: (781) 860 5437
Toll Free: (800) 882 7426

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Xicheng District
Beijing 100031
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Fax: (86) 10 6608 1541

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7 avenue des Tropiques
Z.A. de Courtabeouf – B.P. 12
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Fax: (33) 1 69 28 23 08

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64289 Darmstadt
Germany
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Fax: (49) 6151 703 302

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7, Nangal Raya Business Centre
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Fax: (91) 11 5548445

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Fax (39) 011 997 9 350

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Fax: (82) 2 3452 2451

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Col Del Valle
C.P. 03100
Mexico, D.F.
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Fax: (52) 5 523 9472

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Italy
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Fax: (39) 011 997 9 316

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Fax: (886) 2 2698 9678

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Fax: (44) 1932 22 8769

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Italy
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Fax:(39) 011 997 9 350

Customer Support and Service:

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Worldwide Web Site, Catalog and On-line Orders:
www.varianinc.com

Representatives in most countries