

***FRG-700  
Inverted  
Magnetron Pirani  
Gauge***

*SHORT OPERATING  
INSTRUCTIONS*

# FRG-700 Inverted Magnetron Pirani Gauge



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Vacuum Technologies

### Warranty

Products manufactured by Seller are warranted against defects in materials and workmanship for twelve (12) months from date of shipment thereof to Customer, and Seller's liability under valid warranty claims is limited, at the option of Seller, to repair, to replace, or refund of an equitable portion of the purchase price of the Product. Items expendable in normal use are not covered by this warranty. All warranty replacement or repair of parts shall be limited to equipment malfunctions which, in the sole opinion of Seller, are due or traceable to defects in original materials or workmanship. All obligations of Seller under this warranty shall cease in the event of abuse, accident, alteration, misuse, or neglect of the equipment. In-warranty repaired or replaced parts are warranted only for the remaining unexpired portion of the original warranty period applicable to the repaired or replaced parts. After expiration of the applicable warranty period, Customer shall be charged at the then current prices for parts, labor, and transportation.

Reasonable care must be used to avoid hazards. Seller expressly disclaims responsibility for loss or damage caused by use of its Products other than in accordance with proper operating procedures.

Except as stated herein, Seller makes no warranty, express or implied (either in fact or by operation of law), statutory or otherwise; and, except as stated herein, Seller shall have no liability under any warranty, express or implied (either in fact or by operation of law), statutory or otherwise. Statements made by any person, including representatives of Seller, which are inconsistent or in conflict with the terms of this warranty shall not be binding upon Seller unless reduced to writing and approved by an officer of Seller.

## Warranty Replacement and Adjustment


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.

3/1/00

## Product Identification

In all communications with VARIAN, please specify the information given on the product nameplate. For convenient reference copy that information into the space provided below.

VARIAN Lexington MA 02421 USA	
Model: .....	
PN: .....	
SN: .....	
..... V ..... W	



## Validity

This document applies to products with the following part numbers:

FRG700KF25	(DN 25 ISO-KF)
FRG700CF35	(DN 40 CF-F)

The part number (PN) can be taken from the product nameplate. If not indicated otherwise in the legends, the illustrations in this document correspond to the gauge with vacuum connection DN 25 ISO-KF. They apply to the gauge with other vacuum connection by analogy.

We reserve the right to make technical changes without prior notice.

All dimensions in mm.

### Intended Use

The Inverted Magnetron Pirani Gauge FRG-700 has been designed for vacuum measurement in the pressure range of  $5 \times 10^{-9}$  ... 1000 mbar.

The Inverted Magnetron Pirani Gauge must not be used for measuring flammable or combustible gases which react in air.



The gauge can be operated in connection with a VARIAN FRG Control Unit, a VARIAN Turbo AG Rack Controller, or with another controller.

### Functional Principle

The gauge consists of two separate measurement systems (Pirani and cold cathode system) the signals of which are combined in such a way that one measurement signal is output. The Pirani measurement circuit is always on.

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For cross-references within this document, the symbol (→  XY) is used, for cross-references to further documents, listed under literature, the symbol (→  [Z]).

## 1 Safety

### 1.1 Symbols Used



**DANGER**

Information on preventing any kind of physical injury.



**WARNING**

Information on preventing extensive equipment and environmental damage.



**Caution**

Information on correct handling or use. Disregard can lead to malfunctions or minor equipment damage.



Notice

### 1.2 Personnel Qualifications






**Skilled personnel**

All work described in this document may only be carried out by persons who have suitable technical training and the necessary experience or who have been instructed by the end-user of the product.






### 1.3 General Safety Instructions

- Adhere to the applicable regulations and take the necessary precautions for the process media used.  
Consider possible reactions with the product materials.  
Consider possible reactions (e.g. explosion) of the process media due to the heat generated by the product.
- Adhere to the applicable regulations and take the necessary precautions for all work you are going to do and consider the safety instructions in this document.
- Before beginning to work, find out whether any vacuum components are contaminated. Adhere to the relevant regulations and take the necessary precautions when handling contaminated parts.

 <b>DANGER</b>	
	<b>DANGER: magnetic fields</b> Strong magnetic fields can disturb electronic devices like heart pacemakers or impair their function.
	Maintain a safety distance of $\geq 10$ cm between the magnet and the heart pacemaker or prevent the influence of strong magnetic fields by antimagnetic shielding.



Communicate the safety instructions to all other users.

## 2 Technical Data

Measuring range (air, N <sub>2</sub> )	5×10 <sup>-9</sup> ... 1000 mbar
Accuracy	≈±30% (in the range 1×10 <sup>-8</sup> ... 100 mbar)
Repeatability	≈±5% (in the range 1×10 <sup>-8</sup> ... 100 mbar)
<hr/>	
Output signal (measuring signal)	
Voltage range	0 ... +10.5 V
Measurement range	1.82 ... 8.6 V
Voltage vs. pressure	logarithmic , 0.6 V/decade
Error signal	<0.5 V no supply >9.5 V Pirani sensor defective (filament rupture)
<hr/>	
Output impedance	2×10 Ω
Minimum loaded impedance	10 kΩ, short-circuit proof
Response time	(pressure dependent)
p > 10 <sup>-6</sup> mbar	<10 ms
p = 10 <sup>-8</sup> mbar	≈1000 ms
<hr/>	
Identification gauge	85 kΩ, referenced to supply common
<hr/>	
Status	pin 6
p > 10 <sup>-2</sup> mbar Pirani-only mode	 Low = 0 V
p < 10 <sup>-2</sup> mbar Cold cathode not ignited Pirani-only mode	 Low = 0 V
p < 10 <sup>-2</sup> mbar Cold cathode ignited Combined Pirani / cold cathode mode	 High = 15 ... 30 VDC
LED	High voltage on (LED on)

## FRG-700 Inverted Magnetron Pirani Gauge

### Supply

	 <b>DANGER</b>
	The gauge may only be connected to power supplies, instruments or control devices that conform to the requirements of a grounded protective extra-low voltage (SELV-E according to EN 61010). The connection to the gauge has to be fused <sup>1)</sup> .

Voltage at the gauge	15 ... 30 VDC (ripple $\leq 1 V_{pp}$ )
Power consumption	$\leq 2$ W
Fuse <sup>1)</sup>	$\leq 1$ AT
Voltage at the supply unit with maximum cable length	16 ... 30 VDC (ripple $\leq 1 V_{pp}$ ) <sup>2)</sup>
Adjustment	
Potentiometer <HV>	adjustment under $10^{-4}$ mbar
Potentiometer <ATM>	adjustment at atmospheric pressure
Electrical connection	FCC68 socket, 8 poles
Sensor cable	8 poles, shielded
Line length	$\leq 50$ m      ( $8 \times 0.14$ mm <sup>2</sup> )
Operating voltage	$\leq 3.3$ kV
Operating current	$\leq 500$ $\mu$ A
Grounding concept	→ "Electrical Connection"
Vacuum connection –measuring common	connected via 10 k $\Omega$ (max. voltage differential with respect to safety $\pm 50$ V accuracy $\pm 10$ V)
Supply common – signal common	conducted separately

<sup>1)</sup> VARIAN controllers fulfill this requirement.

<sup>2)</sup> The minimum voltage of the power supply unit must be increased proportionally to the length of the sensor cable

## FRG-700 Inverted Magnetron Pirani Gauge

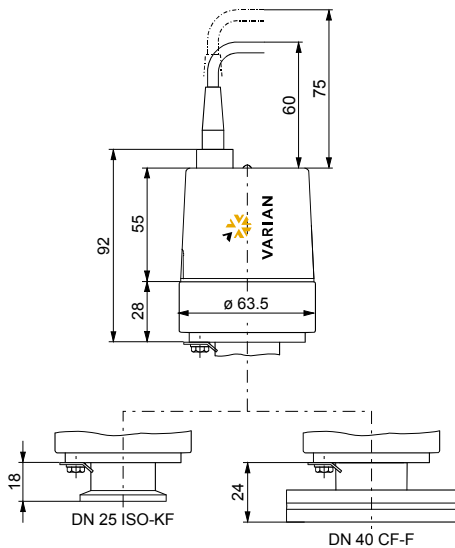
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Materials on the vacuum side	
Vacuum connection	stainless steel
Measurement chamber	stainless steel
Feedthrough isolation	ceramic
Internal seal	FPM 75
Anode	Mo
Ignition aid	stainless steel
Pirani measurement tube	Ni, Au
Pirani filament	W
Internal volume	≈20 cm <sup>3</sup>
Pressure	≤10 bar (absolute), limited to inert gases
<hr/>	
Temperatures	
Operation	+5 ... +55 °C
Bakeout	150 °C (without electronics and magnetic shielding)
Pirani filament	120 °C
Storage	-40 ... +65 °C
Relative humidity	≤80% at temperatures ≤+31°C decreasing to 50% at +40°C
Mounting orientation	any
Use	indoors only, altitude up to 2000 m
Type of protection	IP 40
<hr/>	

## FRG-700 Inverted Magnetron Pirani Gauge

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### Dimensions [mm]



### Weight

FRG700KF25

≈700 g

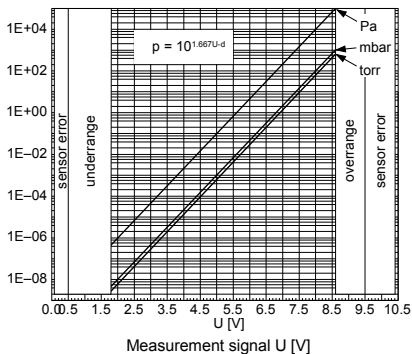
FRG700CF35

≈980 g

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## Measuring Signal vs. Pressure

Pressure p

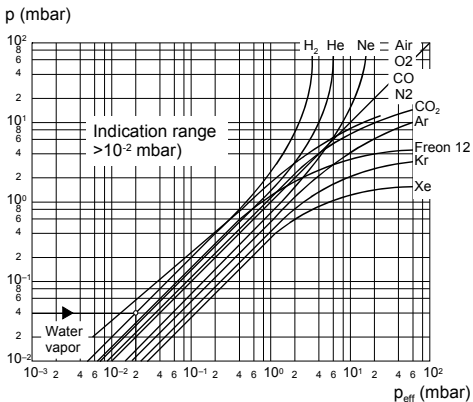


$$p = 10^{1.667 \times U - d} \quad \Leftrightarrow \quad U = c + 0.6 \log_{10} p$$

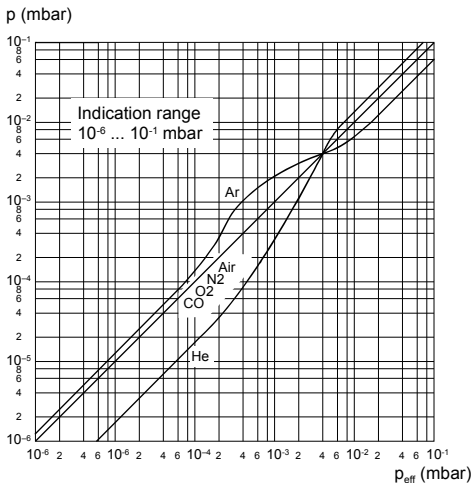
	mbar	Pa	Torr
d	11.33	9.33	11.46
c	6.8	5.6	6.875

valid in the range  $5 \times 10^{-9}$  mbar  $< p < 1000$  mbar  
 $3.8 \times 10^{-9}$  Torr  $< p < 750$  Torr  
 $5 \times 10^{-7}$  Pa  $< p < 1 \times 10^5$  Pa

## Gas Type Dependence



## FRG-700 Inverted Magnetron Pirani Gauge



In the range below 10<sup>-5</sup> mbar, the pressure indication is linear. For gases other than air, the pressure can be determined by means of a simple conversion formula:

$$p_{\text{eff}} = K \times \text{pressure reading}$$

Where	Gas type	K (mean values)
	Air (O <sub>2</sub> , CO, N <sub>2</sub> )	1.0
	Xe	0.4
	Kr	0.5
	Ar	0.8
	H <sub>2</sub>	2.4
	Ne	4.1
	He	5.9



## 3 Installation

### 3.1 Vacuum Connection

 **DANGER**



**DANGER:** overpressure in the vacuum system  
>1 bar

Injury caused by released parts and harm caused by escaping process gases can result if clamps are opened while the vacuum system is pressurized.

Do not open any clamps while the vacuum system is pressurized. Use the type clamps which are suited to overpressure.

 **DANGER**



**DANGER:** overpressure in the vacuum system  
>2.5 bar

KF flange connections with elastomer seals (e.g. O-rings) cannot withstand such pressures. Process media can thus leak and possibly damage your health.

Use O-rings provided with an outer centering ring.



### DANGER



**DANGER:** protective ground

Products that are not correctly connected to ground can be extremely hazardous in the event of a fault.

Electrically connect the gauge to the grounded vacuum chamber. This connection must conform to the requirements of a protective connection according to EN 61010:

- CF flanges fulfill this requirement.
- For gauges with a KF flange, use a conductive metallic clamping ring.



### Caution



**Caution:** vacuum component

Dirt and damages impair the function of the vacuum component.

When handling vacuum components, take appropriate measures to ensure cleanliness and prevent damages.



### Caution



**Caution:** dirt sensitive area

Touching the product or parts thereof with bare hands increases the desorption rate.

Always wear clean, lint-free gloves and use clean tools when working in this area.



### WARNING



WARNING: electric arcing

Helium may cause electric arcing with detrimental effects on the electronics of the product.

Before performing any tightness tests put the product out of operation and remove the electronics unit.




The gauge may be mounted in any orientation. To keep condensates and particles from getting into the measuring chamber preferably choose a horizontal to upright position and possibly use a seal with a centering ring and filter.



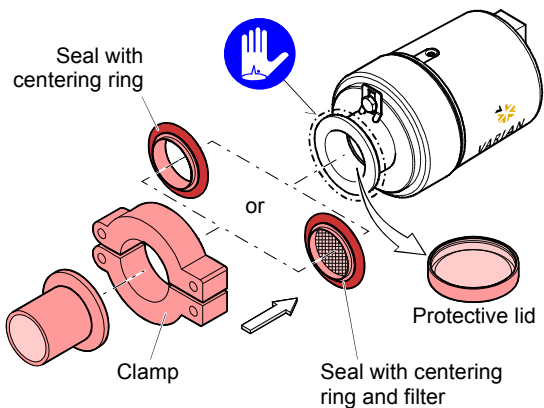
If adjustment should be possible after the gauge has been installed, be sure to install it so that potentiometers <HV> and <ATM> can be accessed with a screwdriver (→ "Adjusting the Gauge").



When making a CF flange connection, it can be advantageous to temporarily remove the electronics and the magnet unit (→  Instruction Manual tqna48e1).

## FRG-700 Inverted Magnetron Pirani Gauge

Remove the protective lid and connect the product to the vacuum system.



Keep the protective lid.

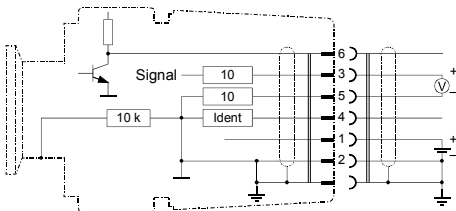
### 3.2 Electrical Connection



Make sure the vacuum connection is properly made (→ "Vacuum Connection").

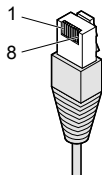
**1**

If no sensor cable is available, make one according to the following diagram.



#### Electrical connection

Pin 1	Supply (15 ... 30 VDC)
Pin 2	Supply common
Pin 3	Signal output (measuring signal)
Pin 4	Identification
Pin 5	Signal common
Pin 6	Status
Pin 7, 8	n.c.



8 poles FCC-68

**2**

Connect the gauge to the controller using the sensor cable.

## 4 Operation

When the supply voltage is applied, the measuring signal is available between pins 3 and 5. Over the whole measurement range, the measuring signal is output as a logarithm of the pressure (measuring signal vs. pressure → "Technical Data").

Allow for a stabilizing time of ≈10 minutes. Once the gauge has been switched on, permanently leave it on irrespective of the pressure.

- The Pirani measurement circuit is always on.
- The cold cathode measurement circuit is controlled by the Pirani circuit and is activated only at pressures  $<1 \times 10^{-2}$  mbar.

### 4.1 Gas Type Dependence

The measurement value depends on the type of gas being measured. The value displayed is accurate for dry air, O<sub>2</sub>, CO and N<sub>2</sub>. It can be mathematically converted for other gases (→ "Technical Data").

If the gauge is operated in connection with an VARIAN vacuum gauge controller, a calibration factor can be entered for correction of the reading.

### 4.2 Ignition Delay

When cold cathode measurement systems are activated upon switching the gauge on, an ignition delay occurs, which is typically:

$10^{-5}$ mbar	≈ 1 second
$10^{-7}$ mbar	≈ 20 seconds
$5 \times 10^{-9}$ mbar	≈ 2 minutes

As long as the cold cathode measurement circuit has not yet ignited, the measurement value of the Pirani is output as measuring signal ("Pirani underrange" is displayed for pressures  $<5 \times 10^{-4}$  mbar).

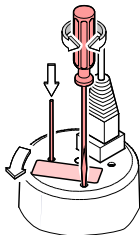
### 4.3 Adjusting the Gauge

The gauge is factory-calibrated. If used under different climatic conditions, through extreme temperatures, aging or contamination, and after exchanging the sensor, the characteristic curve can be offset and readjustment may become necessary.

The cold cathode measurement circuit, which is dominant for low pressures ( $<1 \times 10^{-3}$  mbar), is factory-calibrated. By way of contrast, the Pirani measurement circuit can be adjusted. Any adjustment has a negligible effect on the pressure range between approx.  $10^{-2}$  mbar and  $10^2$  mbar.

- 1 If you are using a seal with centering ring and filter, check that they are clean or replace them if necessary (→ "Deinstallation").
- 2 Activate the gauge.
- 3 Evacuate it to  $p \ll 10^{-4}$  mbar and wait at least 10 minutes.
- 4 Turn the nameplate counter-clockwise until the mechanical stop is reached.

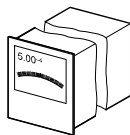
**5**



While depressing the tactile switch with a cylindrical pin ( $\varnothing \approx 3$  mm), adjust the <HV> potentiometer by means of a 1.5 mm screwdriver ...

... to 4.20 V

or ... to  $5 \times 10^{-4}$  mbar

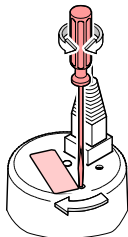


**6** Vent the gauge with air or nitrogen to atmospheric pressure, and wait at least 10 minutes.

**7** Turn the nameplate clockwise until the mechanical stop is reached.



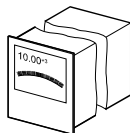
**8**



Using the 1.5 mm screwdriver, adjust the <ATM> potentiometer ...

... to 8.60 V

or ... to  $1 \times 10^3$  mbar



**9** Turn the nameplate back to its original position (it catches).

## 5 Deinstallation



### DANGER



DANGER: contaminated parts

Contaminated parts can be detrimental to health and environment.

Before beginning to work, find out whether any parts are contaminated. Adhere to the relevant regulations and take the necessary precautions when handling contaminated parts.



### Caution



Caution: vacuum component

Dirt and damages impair the function of the vacuum component.

When handling vacuum components, take appropriate measures to ensure cleanliness and prevent damages.



### Caution



Caution: dirt sensitive area


Touching the product or parts thereof with bare hands increases the desorption rate.

Always wear clean, lint-free gloves and use clean tools when working in this area.

- 1 Vent the vacuum system.

- 2** Put the gauge out of operation and unplug the sensor cable.
- 3** Remove the gauge from the vacuum system and place the protective lid.



When deinstalling a CF flange connection, it can be advantageous to temporarily remove the electronics and the magnet unit (→  Instruction Manual tqna48e1).

## 6 Maintenance, Troubleshooting

→  Instruction Manual tqna48e1



If operated at high pressures or under dirty conditions, the gauge must be regularly cleaned.

Gauge failures due to contamination, as well as expendable parts (filament), are not covered by the warranty.

## 7 Returning the Product



### WARNING

WARNING: forwarding contaminated products  
Contaminated products (e.g. radioactive, toxic, caustic or microbiological hazard) can be detrimental to health and environment.

Products returned to VARIAN should preferably be free of harmful substances. Adhere to the forwarding regulations of all involved countries and forwarding companies and enclose a duly completed declaration of contamination.

Products that are not clearly declared as "free of harmful substances" are decontaminated at the expense of the customer. Products not accompanied by a duly completed declaration of contamination are returned to the sender at his own expense.

## 8 Disposal



### DANGER

DANGER: contaminated parts  
Contaminated parts can be detrimental to health and environment.

Before beginning to work, find out whether any parts are contaminated. Adhere to the relevant regulations and take the necessary precautions when handling contaminated parts.



### WARNING



WARNING: substances detrimental to the environment

Products or parts thereof (mechanical and electric components, operating fluids etc.) can be detrimental to the environment.


Dispose of such substances in accordance with the relevant local regulations.

### Separating the components

After disassembling the product, separate its components according to the following criteria:

- Contaminated components  
Contaminated components (radioactive, toxic, caustic or biological hazard etc.) must be decontaminated in accordance with the relevant national regulations, separated according to their materials, and disposed of.
- Other components  
Such components must be separated according to their materials and recycled.

## 9 Literature

-  [1] [www.varianinc.com](http://www.varianinc.com)  
Instruction Manual  
Inverted Magnetron Pirani Gauge FRG-700  
tqna38e1  
Varian Vacuum Technologies, MA 02421, USA

## EC Declaration of Conformity



We, VARIAN, hereby declare that the equipment mentioned below complies with the provisions of the Directive relating to electrical equipment designed for use within certain voltage limits 2006/95/EC and the Directive relating to electromagnetic compatibility 2004/108/EC.

# FRG-700 Inverted Magnetron Pirani Gauge

### Part numbers

FRG700KF25  
FRG700CF35

### Standards

Harmonized and international/national standards and specifications:

- EN 61000-6-2 (EMC: generic immunity standard)
- EN 61000-6-3 (EMC: generic emission standard)
- EN 61010-1 (Safety requirements for electrical equipment for measurement, control and laboratory use)

### Signatures

Varian Vacuum Technologies, USA

9 December 2008

*Frederick C. Campbell*

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Operations Manager

**Notes**

*Original: English*



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