

Vacuum

Series 937A

DIGITAL COMBINATION VACUUM GAUGE SYSTEM

Technology
WWW.MKSINST.COM



Series 937A

Features and Benefits

- Provides simultaneous readout for a combination of up to five vacuum gauges
- Wide measurement range of 10^{-11} to 10^{-4} Torr
- Computer Interface: RS232, RS485 and Profibus DPV1
- Field upgradeable, modular design
- Repeatable measurements and five independent relay set points for improved process control
- Gas-type sensitivity allows sensors to be used for rough leak detection
- Rapid response to pump down
- Leak test function with bar graph display and audio alarm
- Cold cathode and standard Pirani sensors may be mounted in any position, increasing flexibility during installation
- Series 937A is fully CE compliant with EMC directive 89/336/EEC and Low Voltage directive 72/23/EEC
- Models available that indicate pressure in Torr, millibar, Pascal, or microns

Description

The Series 937A combination vacuum gauge system is part of the HPS® family of vacuum gauges. It will operate as many as five sensors simultaneously, and every controller is configured to the user's specifications regarding sensors, line voltage and frequency, units of measure and communication choice.

The Series 937A combines the technologies of the cold cathode, standard Pirani, convection Pirani, thermocouple, capacitance manometer and absolute Piezo sensors to measure from ultra-high vacuum to above atmospheric pressure.

The Controller

The 937A controller is designed for versatility, reliability and economy. The large, easy to read, liquid crystal display provides readout for up to five sensor tubes simultaneously. The switches are color coded for ease of use and space is available for the user to add identification to the sensor read outs.

The controller may contain a cold cathode board and can be configured with two more gauge boards to accommodate up to four additional gauges. The controller may also be configured with two additional cold cathode boards allowing the simultaneous operation of three high vacuum gauges.

There are dual or single gauge boards for the standard Pirani, convection Pirani, thermocouple and capacitance manometer sensors. The differences between the 937A and the previously offered 937 include more control of the cold cathode high voltage, more flexibility on the use of control gauges, a new protection set point feature, and an expanded RS-232/485 command set.

Set Points

Up to five independently adjustable set points are standard. This allows for the automation of process related functions. The set point values are nonvolatile and remain unchanged after power down or power failure. They are easily viewed with the function select switch and adjusted with color coordinated push buttons. The 937A also includes an adjustable control that turns the cold cathode tube's high voltage off at high pressures, prolonging the sensor's life.

Leak Test

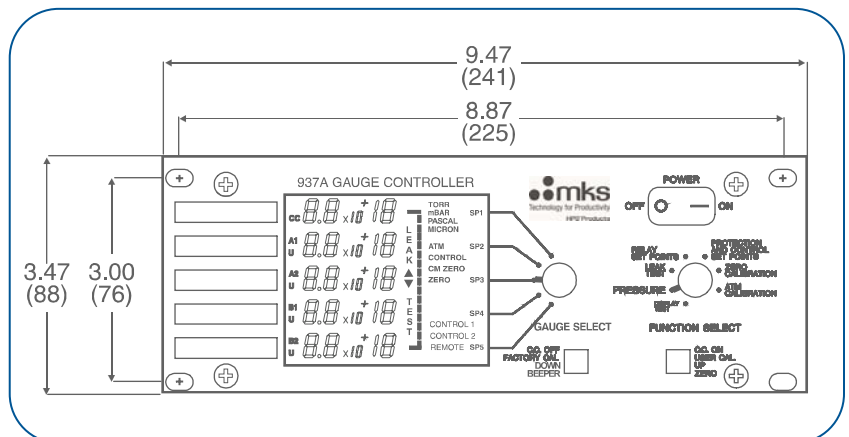
The leak detector includes a bar graph and variable beeper to assist in locating leaks within a system. The function operates with the cold cathode, Pirani, thermocouple and convection tubes. By taking advantage of differences in tracer gas sensitivity, this provides an excellent tool for helping locate system leaks.

Output Signals

The controller provides analog output signals accessible at a rear panel connector. Three types of analog signals are available. The unprocessed analog signals have fast response times. The logarithmic output voltages are scaled so that 0.6 Volts equals one decade of pressure. Combination output is a log output of the cold cathode gauge and a Pirani or other medium pressure gauge, for continuous output from 10^{-11} to 1,000 Torr.

Digital Signals

Along with analog outputs, the 937A can input and output digital data for direct computer communication. A slot is available in the controller for an optional board that supports either RS232, RS485, or Profibus DPV1 communications. The 937A can communicate with a host computer with either of these ports. Remote control of set points and high voltage disable are some of the features available with communications options.



Cold Cathode Sensors

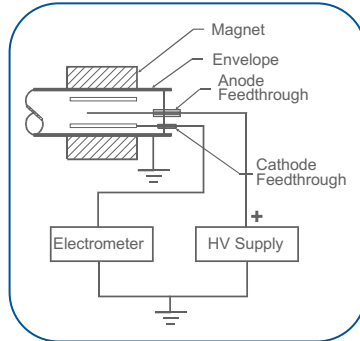
In a cold cathode gauge, ionization is the result of a high voltage discharge of electrons. Sensitivity is enhanced by a magnetic field. Cold cathode gauges are rugged sensors without filaments to break or burnout.

There are two HPS cold cathode gauges: the Series 421 and the I-Mag®. The HPS inverted magnetron design includes an isolated collector, making the tube less susceptible to contamination and allowing a wide pressure measurement range.

The 421 Sensor should be selected when you want to bake the sensor to 250°C with the magnet in place. The sensor connectors need to be removed.

The I-Mag Cold Cathode Sensor was created to provide a lower cost alternative to the 421 where high operating temperature is not important. The sensor is more compact, less expensive and easier to maintain. If bakeout is required, the magnets and sensor connectors can be removed and the sensor can be baked to 400°C.

In addition we provide a variety of customized gauges to suit specific customer needs. This includes special sensors for many semiconductor processes as well as high energy physics facilities. We have special versions of the 421 that will operate at 250°C or others that can be used in high radiation environments.



Pirani Sensors

In Pirani-type sensors, vacuum measurement is based on thermal conductivity of the gas. The tube contains a fine wire that is maintained at a constant temperature. Heat transferred from the wire relates to the amount of gas present and is used to indicate pressure. There are two types of Pirani tubes that can be run on the HPS 937A Combination Gauge System.

Standard Pirani

The Standard Pirani sensor will read continuously from 5×10^{-4} Torr to 100 Torr. Pressure readings above 100 Torr read as 200 Torr, 400 Torr, and Atmosphere. The sensor has a greater signal output at the high vacuum end of its range, providing an added half decade of reading, down to 5×10^{-4} Torr.

The HPS® Pirani platinum filament ensures compatibility with a wide array of process gases. Only UHV compatible materials are exposed to vacuum. The 345 Pirani sensor is shielded for use where CE marking is a requirement and has a standard 9-pin D-sub connector.

Convection Enhanced Pirani

The convection Pirani style sensor design enhances heat transfer through convection at higher pressures. This sensor will read continuously with full resolution from 1×10^{-3} Torr to 1,000 Torr. The shielded version of the 317 sensor is for use where CE marking is needed. A 250°C bakeable version is available upon request.

Thermocouple

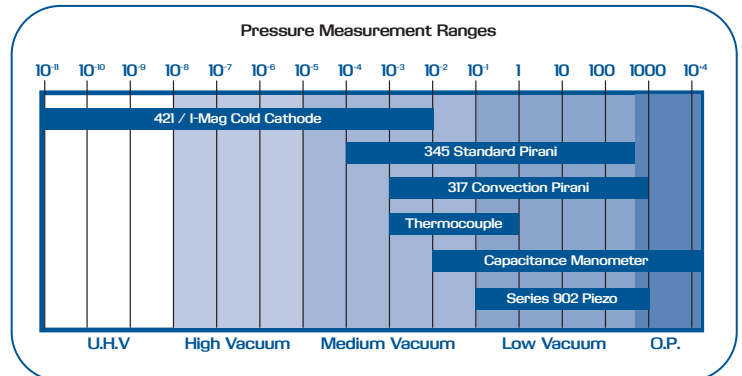
Thermocouple gauges, like Piranis, measure vacuum through thermal conductivity. A thermocouple is used to measure temperature of a heated wire. The temperature of the wire is directly related to the gas pressure. Thermocouple sensors measure pressure from 10^{-3} Torr to 1 Torr, are low cost, but are limited in range and accuracy.

Capacitance Manometers

Capacitance manometers supported by the 937A controller include the MKS Baratrons 722, 622 and 626. Capacitance manometers measure pressure directly by measuring the deflection of a thin Inconel® diaphragm. Baratrons are widely known for their accuracy and reliability and are available in full scale ranges from 10,000 Torr to 1 Torr with three decades of reading when connected to the 937A.

Absolute Piezo Transducer

The HPS® Series 902 Piezo transducer combines the pressure measurement technology of a Piezo sensor with an integrated electronic control circuit. The 902 Piezo is an absolute direct reading sensor, allowing the measurement to be gas independent. The sensor includes a unique temperature compensation, allowing for high accuracy over a wide measurement range (10^{-1} to 1,000 Torr). The Series 902 Piezo is used in conjunction with the Capacitance manometer card.



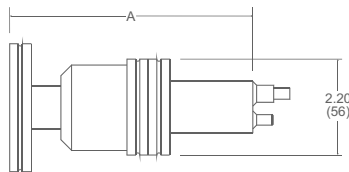
Dimensions & Specifications

Series 937A Controller Specifications

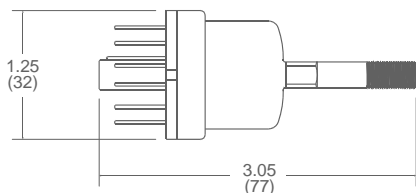
Measurement Range	1.0 X 10 ⁻¹¹ to 1.0 X 10 ⁻⁴ Torr 1.0 X 10 ⁻¹¹ to 1.3 X 10 ⁻⁴ mbar 1.0 X 10 ⁻⁹ to 1.3 X 10 ⁻⁶ Pascal 1.0 X 10 ⁻⁸ to 1.0 X 10 ⁻⁷ microns
Operating Temperature	5° to 40° C (41° to 104°F)
Storage Temperature	-10° to 55°C (14° to 131°F)
Relative Humidity	80% max for temperatures less than 31°C, decreasing linearly to 50% maximum at 40°C
Altitude	2000 m maximum
Power Requirement and Consumption	100, 120, 220 or 240 Vac, 50 or 60 Hz, 35 watts
Set Point Relays	Five pressure dependent set points; SPDT relays, contact rating 2 amps @ 30 Vac, IEC 950 safety rating: 2A @50 Vac
Output	Buffered analog outputs for each gauge; Logarithmic outputs for each gauge (0.6V/decade output); Combination output, combining cold cathode and auxiliary gauge (0.6V/decade output)
Front Panel Controls	Power on/off, seven position rotary switch to select operating functions, two push buttons to adjust the operating functions and five position rotary switch for tube selection
Display	Liquid crystal; 5 pressure displays with 2 digit mantissas and 1 digit exponents; 0.36" digit height, ±60° viewing angle; Updated 20 times per second; Display indicators for unit of measure, calibration functions, user calibration, set points, gauge position indicators
Leak Test	Relative logarithmic bar graph display and variable rate audio signal
Insulation Coordination	Overvoltage Category II, Pollution Degree 2
CE Certification w/appropriate sensors	89/336/EEC EMC Directive 73/23/EEC Low Voltage Directive
Controller Weight	8 lbs (3.6 kg)

421 Cold Cathode in./(mm)

Size	A
NW 25 KF	6.72(171)
NW 40 KF	6.32(161)
2 3/4" CF (non-rotatable)	6.27(159)
1" Tube	6.22(158)
8 VCR®-F *	7.59(193)

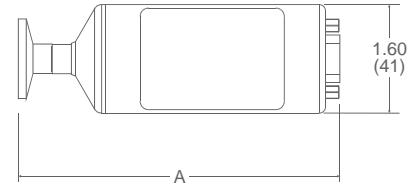


Thermocouple in./(mm)



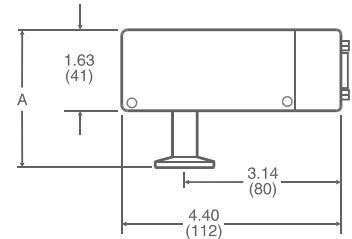
345 Standard Pirani in./(mm)

Size	A
NW 16 KF	4.83(123)
NW 25 KF	4.34(110)
1 1/3" CF	5.87(149)
2 3/4" CF	5.87(149)
8 VCR®-F *	5.83(148)
1/8" NPT-M	5.65(144)
15 & 18 mm	5.78(147)



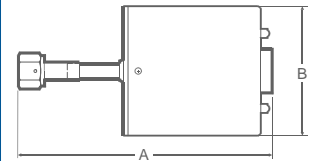
317 Convection Pirani in./(mm)

Size	A
NW 16 KF	2.76(70)
NW 25 KF	2.76(70)
1 1/3" CF	3.06(78)
2 3/4" CF	2.73(69)
8 VCR®-F *	2.83(72)
4 VCR®-F *	2.51(64)
1/8" NPT-M	2.93(74)
15 & 18 mm	3.19(81)



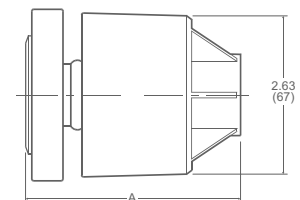
Baratron® in./(mm)

Dimension A	622	626
NW 16 KF	5.18/(132)	4.70/(119)
1 1/3" CF	5.05/(128)	4.57/(116)
1/2" tube	4.93/(125)	4.75/(121)
8 VCR®-F * (low range)	6.05/(154)	5.57/(142)
8 VCR®-F * (high range)	6.14/(156)	5.66/(144)
8 VCO®-F *	6.05/(154)	5.57/(142)
Dimension A	722	
Weld Stub	3.94/(100)	
Dimension B	722	622/626
	1.50/(38)	2.56/(65)



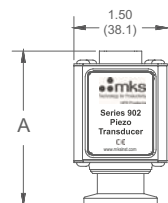
I-Mag® Cold Cathode in./(mm)

Size	A
NW 25 KF	3.41(87)
NW 40 KF	3.41(87)
2 3/4" CF (rotatable)	3.47(88)
1" Tube	3.26 (83)



Series 902 in./(mm)

Size	Dimension A
NW 16 KF	2.26/(57)
4 (1/4") VCR®-F *	2.59/(66)
8 (1/2") VCR®-F *	2.93/(74)



Sensor Specifications

	Cold Cathode	Standard Pirani	Convection Pirani	Thermocouple	Baratron®	Absolute Piezo
Models	Series 421 I-Mag®	Series 345 (shielded)	Series 317 (shielded)	DV-6M equivalent	722, 622 and 626	Series 902
Sensor Construction (materials exposed to vacuum)	Series 421: Stainless steel, silver-copper brazing alloy, alumina ceramics, aluminum AL 6061, Elgiloy®, OFHC® copper I-Mag®: Stainless steel, 6061 aluminum, Inconel®, glass and alumina ceramic	304 stainless steel, platinum alloy, alumina ceramic, silver brazing alloy, nickel 200, glass	304 stainless steel, nickel 200, glass, platinum	Nickel plated steel, noble metal alloy, glass	Inconel®	304, 316 stainless steel
Measurement Range	1.0x10 ⁻¹¹ to 1.0x10 ⁻² Torr 1.3x10 ⁻¹¹ to 1.3x10 ⁻² mbar 1.3x10 ⁻⁹ to 1.3 Pascal 1.0x10 ⁻⁸ to 10 micron	5.0x10 ⁻¹ Torr to ATM 7.0x10 ⁻¹ mbar to ATM 7.0x10 ⁻² Pascal to ATM 5.0x10 ⁻¹ micron to ATM	1.0x10 ⁻³ to 1.0x10 ⁻³ Torr 1.3x10 ⁻³ to 1.3x10 ⁻³ mbar 1.3x10 ⁻¹ to 1.3x10 ⁻⁵ Pascal 1.0x10 ⁻⁶ micron	1.0x10 ⁻³ to 1.0 Torr 1.3x10 ⁻³ to 1.3 mbar 1.3x10 ⁻¹ to 1.3x10 ⁻² Pascal 1.0 to 1.0x10 ⁻³ micron	Three decades of measurement below full scale	1.0x10 ⁻¹ to 1.0x10 ⁻³ Torr 1.3x10 ⁻¹ to 1.3x10 ⁻³ mbar 130 to 1.3x10 ⁻⁵ Pascal
Resolution	1% of indicated decade, except 10% below 10 ⁻¹⁰ Torr and above 10 ⁻³ Torr	% of indicated decade, except 10% below 10 ⁻³ Torr and above 100 Torr - see text	1% of indicated decade	1% of indicated decade	1% of indicated decade	1% of indicated decade
Set Point Response	50 milliseconds	15 to 150 milliseconds	15 to 150 milliseconds	150 milliseconds	50 milliseconds	50 milliseconds
Set Point Range	2.0x10 ⁻¹⁰ to 9.5x10 ⁻³ Torr 2.7x10 ⁻¹⁰ to 1.2x10 ⁻² mbar 2.7x10 ⁻⁸ to 1.2 Pascal 2.0x10 ⁻⁷ to 9.5 micron	2.0x10 ⁻³ to 9.5x10 ⁻¹ Torr 2.7x10 ⁻³ to 1.2x10 ⁻² mbar 2.7x10 ⁻¹ to 1.2x10 ⁻⁴ Pascal 2.0 to 9.5x10 ⁻⁴ micron	2.0x10 ⁻³ to 9.5x10 ⁻² Torr 2.7x10 ⁻³ to 1.2x10 ⁻³ mbar 2.7x10 ⁻¹ to 1.2x10 ⁻⁵ Pascal 2.0 to 9.5x10 ⁻⁴ micron	2.0x10 ⁻³ to 9.5x10 ⁻¹ Torr 2.7x10 ⁻³ to 1.2 mbar 2.7x10 ⁻¹ to 1.2x10 ⁻² Pascal 2.0 to 9.5x10 ⁻⁴ micron	2% to 95% of the full measurement range of the head	1.0 to 1.0x10 ⁻³ Torr 1.3 to 1.3x10 ⁻³ mbar 1.3x10 ⁻² to 1.3x10 ⁻⁶ Pascal
Reproducibility	5% of indicated pressure	5% of indicated pressure	5% of indicated pressure	5% of indicated pressure	0.1% of indicated pressure	0.1% of indicated pressure
Cables & Connectors	Maximum length is 300 ft Series 421: Cables connected via bayonet and threaded type coaxial connectors I-Mag®: Tube Side: molded connector with a positive locking bolt Controller Side: bayonet connector and threaded coaxial connector	Maximum length is 500 ft Series 345: 9-pin D-sub to 9-pin D-sub connectors, multiconductor shielded cable	Maximum length is 500 ft 9 pin D-sub connectors, multiconductor shielded cable	Maximum length is 25 feet 9 pin D-sub with polarized key to octal connector; multiconductor shielded cable	Maximum length is 50 feet 9 pin D-sub with polarized key to 15 pin D-sub or terminal strip connector	Maximum length is 500 ft. 9-pin D-sub to 9-pin D-sub
Operating Temperature	0° to 70°C (32° to 158°F) A high operating temperature version of the Series 421 is available. Call for information.	0° to 50°C (32° to 122°F)	0° to 50°C (32° to 122°F)	0° to 40°C (32° to 104°F)	0° to 50°C (32° to 122°F)	0° to 50°C (32° to 122°F)
Bakeout Temperature	Series 421: 250°C (482°F) connectors off, 100° C (212°F) connectors on, cables off I-Mag®: to 400°C (752°F) with CF flanges, with magnet and cable removed	50° C (122°F)	150° C (302°F) non-operating, without cable or electronics 100°C (212°F) shielded version *Special order version available to 250° C.	60°C (140°F)	N/A	85°C (185°F), non-operating
Weight	Series 421: 2.8 lbs. (1.3 Kg) w/ CF I-Mag®: 2.0 lbs (0.8 Kg) w/ CF	0.5 lb (0.2 kg)	0.5 lb (0.2 kg)	0.11 lb (.04 kg)	Type 722: 0.5 lb (0.2 kg) Type 622: 1.0 lb (0.4 kg)	3.4 oz (97 g)
Volume	Series 421: 1.8 in. ³ (30 cm ³) max I-Mag®: 0.9 in. ³ (15 cm ³) max	0.5 in. ³ (8.0 cm ³) maximum	2.0 in. ³ (33 cm ³) maximum	0.5 in. ³ (8.2 cm ³)	Type 722: 0.3in. ³ (4.9 cm ³) Type 622 & 626: 0.39 in. ³ (6.3 cm ³)	0.21 in. ³ (3.4 cm ³)



Ordering Information

Series 937A Controller

Base Controller		Line Voltage	Line Frequency	Units of Measure	Base Gauge Slot		Gauge Choice Slot "A"	Gauge Choice Slot "B"	Communication Port		
Part Code	Price	Part Code	Part Code	Part Code	Part Code	Price	Part Code	Part Code	Price Each	Part Code	Price
937A		100V 100 Vac	50 50 Hz	TR Torr	CC Cold Cathode		CC Cold Cathode	CC Cold Cathode		232 RS232	
		120V 120 Vac	60 60 Hz	MB mbar	NA Blank		PR Dual Standard Pirani	PR Dual Standard Pirani		485 RS485	
		220V 220 Vac		PA Pascal			CT Dual Convection Pirani	CT Dual Convection Pirani		PF Profibus	
		240V 240 Vac		MC micron			TC Dual Thermocouple	TC Dual Thermocouple		NA Blank	
							CM Dual Baratron®/Piezo	CM Dual Baratron®/Piezo			
							P1 Single Standard Pirani	P1 Single Standard Pirani			
							C1 Single Convection Pirani	C1 Single Convection Pirani			
							T1 Single Thermocouple	T1 Single Thermocouple			
							M1 Single Baratron®/Piezo	M1 Single Baratron®/Piezo			
							NA Blank	NA Blank			

The basic Series 937A includes the controller, a power cable, accessory connector kit, and instruction manual. Space is provided for up to three gauge modules and one communication module.

To obtain the total controller price, add the prices of the base 937A controller and each of the options. Sample part number: 937A-120V60TR-CCCCPR232.

Plug-In Controller Boards

Part Number	Type	Price
100009428	Cold Cathode	
100005961	Dual Standard Pirani	
100007943	Dual Convection Pirani	
100006034	Dual Thermocouple	
100007321	Dual Capacitance Manometer/Piezo	
100007033	Single Standard Pirani	
100007035	Single Convection Pirani	
100007034	Single Thermocouple	
100006037	Single Capacitance Manometer/Piezo	
100009183	RS232/RS485	
100012702	Profibus Card	

Use these part numbers when purchasing boards separately for retrofit.

Accessories

Part Number	Description	Price
103150001	USA power cable	
100005651	Half rack mounting kit	
100009273	937A Instruction Manual	
100006734	Rebuild kit for 421 cold cathode tube	
100002353	Rebuild kit for I-Mag cold cathode	
100005279	Spanner wrench for 421 tube rebuild	
100007700	Full rack mounting kit	



Ordering Information

421 Cold Cathode Sensor Tube

Part Number	Connection	Price
104210004	NW 25 KF	
104210001	NW 40 KF	
104210002	2 3/4" CF	
104210003	1" Tube	
104210005	8 VCR®-F *	

I-Mag® Cold Cathode Sensor Tube

Part Number	Connection	Price
104230004	NW 25 KF	
104230001	NW 40 KF	
104230002	2 3/4" CF	
104230003	1" Tube	

345 Standard Pirani Sensor Tube

Part Number	Connection	Price
103450010	NW 16 KF	
103450011	1/8" NPT-M 1/2" tube	
103450012	8 VCR®-F *	
103450013	1 1/3" CF	
103450014	2 3/4" CF	
103450015	NW 25 KF	
103450016	15 mm. tube	
103450018	18 mm. tube	

317 Shielded Convection Pirani Sensor

Part Number	Connection	Price
103170010SH	NW 16 KF	
103170011SH	1/8" NPT-M 1/2" tube	
103170012SH	8 VCR®-F *	
103170013SH	1 1/3" CF	
103170014SH	2 3/4" CF	
103170016SH	15 mm. tube	
103170018SH	18 mm. tube	
103170027SH	NW 25 KF	
103170029SH	4 VCR®-F *	

Series 902 Piezo Transducer

Part Number	Connection	Price
902-1112	902 Transducer, NW 16 KF, RS485	
902-1212	902 Transducer, 4 VCR®-F*, RS485	
902-1312	902 Transducer, 8 VCR®-F*, RS485	
902-1113	902 Transducer, NW 16 KF, RS232	
902-1213	902 Transducer, 4 VCR®-F*, RS232	
902-1313	902 Transducer, 8 VCR®-F*, RS232	
902-1105	902 Transducer, NW 16 KF, 0-10V	
902-1205	902 Transducer, 4 VCR®-F*, 0-10V	
902-1305	902 Transducer, 8 VCR®-F*, 0-10V	
902001	902 LED Local Display (Torr)	
902002	902 LCD Local Display (Torr)	

Thermocouple Sensor Tube

Part Number	Connection	Price
100006763	1/8" NPT-M	

Baratron® 722A

Part Number:	Description	Price
722AXXXYYWGZ	722A Absolute Baratron®	
Ordering Code (XXX)	Ranges (Torr)	Price
11T	10	
12T	100	
13T	1,000	
14T	10,000	
Ordering Code (YY)	Fittings	Price
BA	1/2" tube	
CD	4 VCR®-F	
HA	1 1/3" CF Mini	
GA	NW 16 KF	
CE	8 (1/2") VCR®-F	
DA	8 (1/2") VCO®-F	
Ordering Code (W)	Input/Output	Price
2	+13 to +32 VDC input, 0-10 VDC output	
Ordering Code (G)	Accuracy	Price
F	Standard: 0.5% of reading	
Ordering Code (Z)	Connector	Price
A	9-pin Type D	

Baratron® 622A & 626A

Part Number	Description	Price
622AXXXYZ	622A with terminal power strip	
626AXXXYZ	626A with male type D connector	
Ordering Code (XXX)	Ranges (Torr)	Price
01T	1	
11T	10	
12T	100	
13T	1,000	
Ordering Code (Y)	Fittings	Price
A	1/2" tube	
B	8 (1/2") VCR®-F	
C	1 1/3" CF mini	
D	NW 16 KF	
E	8 (1/2") VCO®-F	
Ordering Code (Z)	Accuracy	Price
E	± 0.25%	
D‡	± 0.15%	

‡ Not available with 1 Torr range.

* VCR® or VCO®-compatible parts may be used



Ordering Information

Series 421 Cables

Part Number	Length	Price
100006171	10 ft (3.0 m)	
100006172	25 ft (7.6 m)	
100006173	50 ft (15.2 m)	
100006174	100 ft (30.5 m)	
100006175	Custom (max length 300 ft.)	

I-Mag® Cables

Part Number	Length	Price
100002505	2 ft (0.6 m)	
100007873	10 ft (3.0 m)	
100007874	25 ft (7.6 m)	
100002395	50 ft (15.2 m)	
100008759	Custom (max length 300 ft.)	

Series 317 and 345 Cables

Part Number	Length	Price
103170006SH	10 ft (3.0 m)	
103170007SH	25 ft (7.6 m)	
103170008SH	50 ft (15.2 m)	
103170009SH	Custom (max length 500 ft.)	

Series 902 Cables

Part Number	Length	Price
100011869	10 ft (3.0 m)	
100011870	25 ft (7.6 m)	
100011871	50 ft (15.2 m)	
100011872	Custom (max length 50 ft.)	

Thermocouple Cables

Part Number	Length	Price
100007448	10 ft (3.0 m)	
100007449	20 ft (6.1 m)	
100007450	Custom (max length 25 ft.)	

622 Baratron® Cables

Part Number	Length	Price
100007550	10 ft (3.0 m)	
100007551	25 ft (7.6 m)	
100007552	50 ft (15.2 m)	

626 Baratron® Cables

Part Number	Length	Price
100007555	10 ft (3.0 m)	
100007556	25 ft (7.6 m)	
100007557	50 ft (15.2 m)	

722 Baratron® Cables

Part Number	Length	Price
100010000	10 ft (3.0 m)	
100010001	25 ft (7.6 m)	
100010002	50 ft (15.2 m)	



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