Vac Ion Pump Operation

The vacuum pumping mechanism inside ion pumps operate by capturing gas atoms and molecules. They provide a clean, simple, low maintenance alternative for producing and maintaining high and ultra-high. Since ion pumps have a finite gas storage capturing capacity, at some point in time the pump must be reconditioned or replaced. This this is often after many years of solid operation.

Operating Principle

Inside the sputter ion vacuum pump a high voltage discharge with potential usually in the 3,000 to 7,000 VDC range is maintained inside a permanently applied magnetic field, ranging from 800 to 2,000 G, to produce a trapped electron cloud. Molecular gas ions are produced when high energy electrons collide with gas molecules. These molecular gas ions are accelerated towards and collide with the cathode sputtering target. The force of this collision is sufficient to cause atoms to be ejected from the cathode and "sputtered" onto the adjacent walls of the pump. Freshly sputtered titanium (Ta) is extremely reactive and will chemically react with active gases. On impact the accelerated ions often become buried within the cathode. The resulting compounds accumulate on the surfaces of the pump elements and pump walls. Active gases are those such as oxygen (O_2), nitrogen (N_2), carbon monoxide (CO), carbon dioxide (CO_2), and water (H_2O), as opposed to the noble gases like helium (He), neon (Ne), argon (Ar), krypton (Kr), and xenon (Xe), which are non-reactive. The latter are pumped by "ion burial" which is the plastering over of inert gas atoms by the sputtered getter atoms.

Vac Ion Pump Selection

There are four traditional types of ion pump designs: Diode, Noble Diode, Starcell and Titanium Sublimation. Each are designed in a way to improve pumping efficiency for a targeted specific type of gases.

Diode

The diode ion pump is the simplest type of ion pump being essentially a penning cell, with both sides of the cathode being made of titanium (Ti). The diode ion pump has the highest pumping speed among all configurations for active gases such as oxygen (O_2), nitrogen (N_2), carbon dioxide (CO_2), carbon monoxide (CO), and similar reactive getterable gases. The simple design and construction means it can be used in close proximity of other high energy electronic devices. They do not however, have good efficiency for noble gases such as argon (Ar), helium (He), or methane (CH_4). The titanium cathode has a high solubility for hydrogen (H_2) so even though it does not react like other gases with the sputtered cathode material it easily gets embedded in it and covered by the next sputtered film. Diode type ion pumps are popular in UHV applications and are often used in sensitive electron microscopes where there are no concerns of noble gases. Diode ion pumps require positive (+) polarity voltage from the ion pump power supply.

Vac Ion Pump Selection(cont.)

Nobel Diode

The noble diode ion pump has a similar design to the diode ion pump except that one of the cathode plates is replaced by the heavier metal Tantalum (Ta). This change allows better pumping of noble gases like argon (Ar) and helium (He) with lower re-emission. Noble Diode ion pumps are used in any application where the pumping of noble gases is important to the process. Noble gases are pumped by being buried by sputtered material. The high nuclear mass of tantalum increases the back-scattering probability and consequently the pumping speed for noble gases. It's an excellent pump when the aim is to generate UHV and stay at that pressure with occasionally cyclic exposure to noble gases like Argon. They are popular in particle accelerator and synchrotron rings where only the ion pump is used to generate UHV pressures. Noble Diode ion pumps require positive (+) polarity voltage from the ion pump power supply.

Starcell

The Starcell is the latest variation of the Triode configuration, which was originally designed for optimal pumping of all gases across the spectra. Its unique star like design gives it a good pumping speed for active gases, hydrogen (H_2), and noble gases. Being highly stable, having a good pumping speed, and performance at relatively higher pressures makes it a popular choice with scientists and engineers who need an overall non-gas type dependent ion pump. Starcell technology is used for pumping applications in most existing accelerators and synchrotron sources, beam lines, transfer lines, and similar devices delivering maximum speed for all the gas species. Starcell ion pumps require negative (-) polarity voltage from the ion pump power supply.

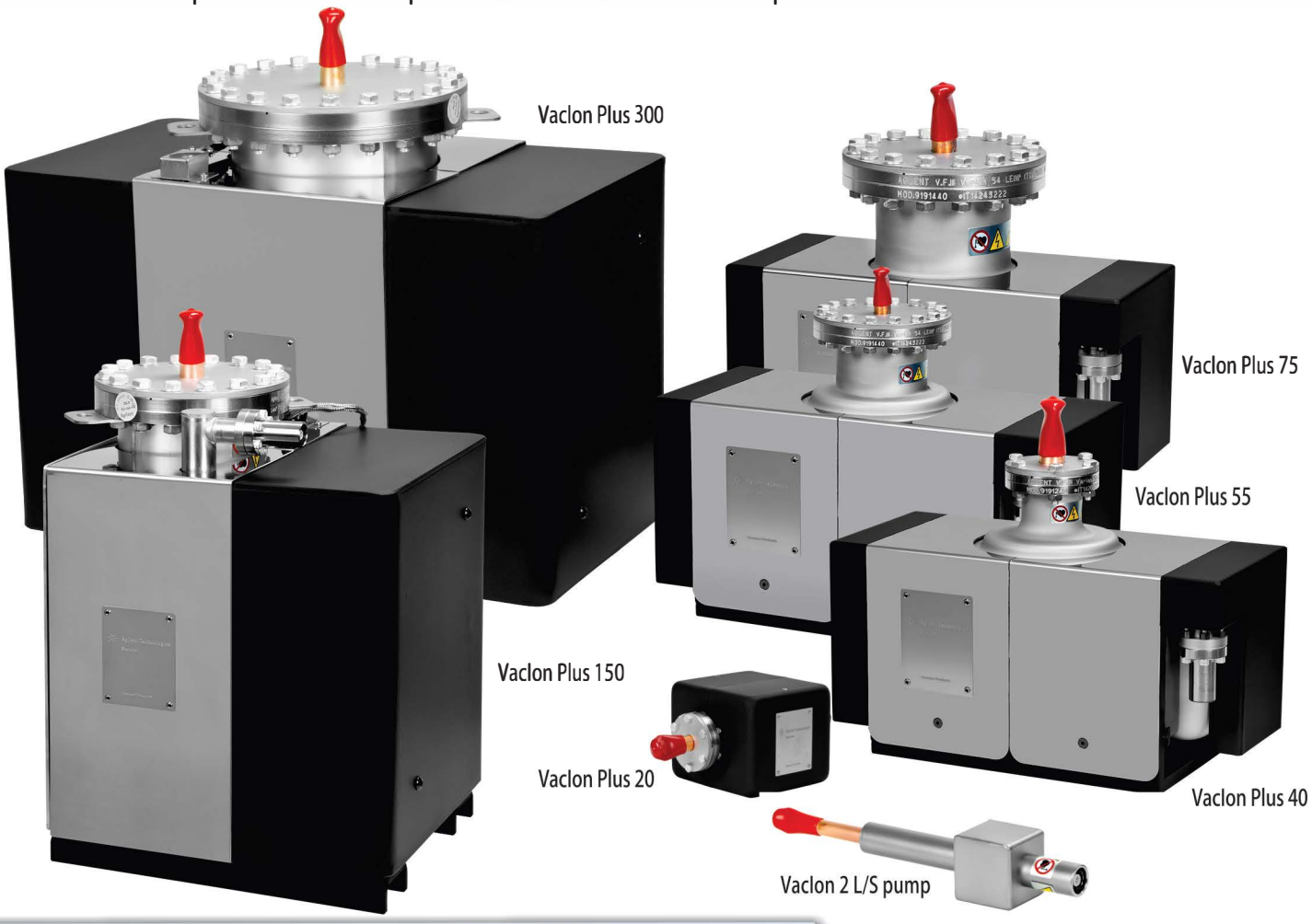
Combination and Titanium Sublimation Pump

Ion pumps used along with TSPs (Titanium Sublimation Pumps) make a great combination high-vacuum pumping system. The titanium sublimation creates extra high pumping speed of the getterable gases, e.g., carbon monoxide (CO), carbon dioxide (CO_2), hydrogen (H_2), nitrogen (N_2), and oxygen (O_2) while the ion pumping mechanisms handle the non-getterable gases such as argon (Ar) and methane (CH_4). They are commonly used in scientific research, academic lab, namely in research areas like particle physics, material characterization, space studies, electron microscopes, and various other areas of fundamental scientific research.

AGILENT Varian

VacIon Plus Ion Pumps

VacIon Plus is a complete family of ion pumps, controllers, options and accessories, designed to provide solutions to every application. Parameters such as operating pressure, the gas mixture to be pumped, the starting pressure, etc. can vary so dramatically that Agilent Varian decided to develop dedicated ion pump solutions (including controllers and all other accessories) for different applications. The VacIon Plus family includes 4 different models, the Diode, Noble Diode, Starcell and Titanium Sublimation Pumps. This allows Agilent Varian to provide the best technology for each field of application. The ultimate pressure on these pumps is down to ultra high vacuum (UHV) of 10^{-11} Torr. The family is complemented by the MiniVac and 4UHV pump controllers that provide different power levels and interface capabilities.



* Catalog Pricing Subject to Change

AGILENT Varian
VacIon Plus Ion Pumps

VacIon Plus 300 SPECIFICATIONS

	StarCell	Noble Diode	Diode
Nominal pumping speed for Nitrogen (l/s)	240	260	300
Operating life at 1x10-6 mbar (hours)	80,000	50,000	50,000
Maximum starting pressure (mbar)	≤ 5x 10^{-2}	≤1x 10^{-3}	≤1x 10^{-3}
Weight, kg (lbs.)	69 (149)		
Max. baking temperature (°C)	350		
CONTROLLLER	4UHV Ion Pump or Mini Vac		
Agilent Varian Part Number	9191641	9191621	9191611
Ideal Vacuum Part Number	P105757	P105774	P105773
Price:*	$9,408.00	$9,408.00	$8,880.00

Intake CFF 8.00 in.
ULTIMATE PRESSURE: 10^{-11} Torr

VacIon Plus 150 SPECIFICATIONS

	StarCell	Noble Diode	Diode
Nominal pumping speed for Nitrogen (l/s)	125	135	150
Operating life at 1x10-6 mbar (hours)	80,000	50,000	50,000
Maximum starting pressure (mbar)	≤ 5x 10^{-2}	≤1x 10^{-3}	≤1x 10^{-3}
Weight, kg (lbs.)	43 (94)		
Max. baking temperature (°C)	350		
CONTROLLER	4UHV Ion Pump or Mini Vac		
Agilent Varian Part Number	9191541	9191521	9191511
Ideal Vacuum Part Number	P105775	P105759	P105776
Price:*	$6,940.00	$6,940.00	$6,676.00

Intake CFF 6.00 in.
ULTIMATE PRESSURE: 10^{-11} Torr

VacIon Plus 75 SPECIFICATIONS

	StarCell	Noble Diode	Diode
Nominal pumping speed for Nitrogen (l/s)	65	68	75
Operating life at 1x10-6 mbar (hours)	80,000	50,000	50,000
Maximum starting pressure (mbar)	≤ 5x 10^{-2}	≤1x 10^{-3}	≤1x 10^{-3}
Weight, kg (lbs.)	19 (42)		
Max. baking temperature (°C)	350		
CONTROLLER	4UHV Ion Pump or Mini Vac		
Agilent Varian Part Number	9191440	9191420	9191410
Ideal Vacuum Part Number	P105778	P105777	P105758
Price:*	$3,860.00	$3,660.00	$3,726.00

Intake CFF 6.00 in.
ULTIMATE PRESSURE: 10^{-11} Torr

* Catalog Pricing
Subject to Change

AGILENT Varian

VacIon Plus Ion Pumps

VacIon Plus 55 SPECIFICATIONS

Intake CFF 4.50 in.
ULTIMATE PRESSURE: 10^{-11} Torr

	StarCell	Noble Diode	Diode
Nominal pumping speed for Nitrogen (l/s)	50	53	55
Operating life at 1x10-6 mbar (hours)	80,000	50,000	50,000
Maximum starting pressure (mbar)	≤ 5x 10^{-2}	≤1x 10^{-3}	≤1x 10^{-3}
Weight, kg (lbs.)	18 (39)		
Max. baking temperature (°C)	350		
CONTROLLER	4UHV Ion Pump or Mini Vac		
Agilent Varian Part Number	9191340	9191320	9191310
Ideal Vacuum Part Number	P105779	P105781	P105780
Price:*	$3,488.00	$3,488.00	$3,105.00

VacIon Plus 40 SPECIFICATIONS

Intake CFF 2.75 in.
ULTIMATE PRESSURE: 10^{-11} Torr

	StarCell	Noble Diode	Diode
Nominal pumping speed for Nitrogen (l/s)	34	36	40
Operating life at 1x10-6 mbar (hours)	80,000	50,000	50,000
Maximum starting pressure (mbar)	≤ 5x 10^{-2}	≤1x 10^{-3}	≤1x 10^{-3}
Weight, kg (lbs.)	17 (37)		
Max. baking temperature (°C)	350		
CONTROLLER	4UHV Ion Pump or Mini Vac		
Agilent Varian Part Number	9191240	9191220	9191210
Ideal Vacuum Part Number	P105784	P105783	P105782
Price:*	$2,732.00	$3,488.00	$2,601.00

VacIon Plus 20 SPECIFICATIONS

Intake CFF 2.75 in.
ULTIMATE PRESSURE: 10^{-11} Torr

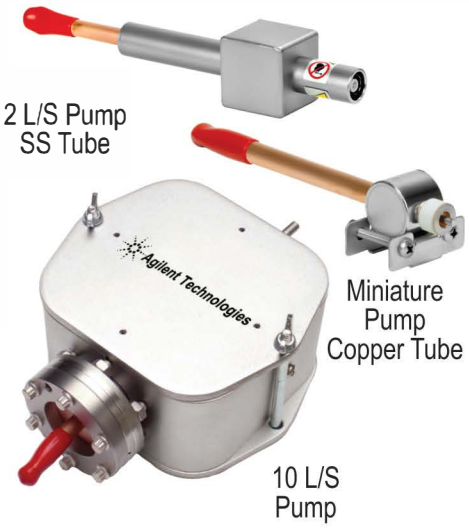
	StarCell	Noble Diode	Diode
Nominal pumping speed for Nitrogen (l/s)	20	22	27
Operating life at 1x10-6 mbar (hours)	80,000	50,000	50,000
Maximum starting pressure (mbar)	≤ 5x 10^{-2}	≤1x 10^{-3}	≤1x 10^{-3}
Weight, kg (lbs.) with ferrite magnet	7 (15)		
Max. baking temperature (°C)	350		
CONTROLLER	4UHV Ion Pump or Mini Vac		
Agilent Varian Part Number	9191145	9191125	9191115
Ideal Vacuum Part Number	P105785	P105786	P105756
Price:*	$1,778.00	$1,733.00	$1,733.00

* Catalog Pricing Subject to Change

AGILENT Varian

Miniature & Small Vaclon Ion Pumps

Agilent Varian offers a wide variety of small size ion pumps designed especially for electron device and detector applications. The Miniature Vaclon pump is a diode configuration and provides approximately 0.4 l/s of nitrogen pumping speed. The 2 l/s model is a modified diode configuration to enhance starting at low pressure. The 10 l/s pump is a noble gas optimized diode configuration with high efficiency for residual gases such as hydrogen. The pumping speed for noble gases is about 20% of the nominal speed. Pumps that are processed are baked to 400 °C and pinched off under vacuum, which allows the vacuum integrity to be verified by the user just before use. Non-processed pumps are tested for no vacuum leaks and minimum leakage current.



Small Ion Pumps SPECIFICATIONS

	Miniature Pump	2 L/S Pump	10 L/S Pump
Nominal pumping speed for Nitrogen (l/s)	0.4	2	10
Operating life at 1x10-6 mbar (hours)	NA	8,000	40,000
Maximum starting pressure (mbar)	≤ 1x 10-4		
Weight, kg (lbs.)	0.5(1)	0.9 (2)	3.6 (8)
Max. baking temperature (°C)	400*/(150)**	400*/(150)**	350

Magnets for small pumps must be ordered separately. *without magnet **with magnet

OPTIONS & ACCESSORIES

Miniature Pump	Agilent Varian P/N	Ideal Vacuum P/N	Price:*
With 3/8 in. OD 180° stainless steel tube	9130038	P106089	$490.00
With 3/8 in. OD 90° stainless steel tube	9130041	P106090	$492.00
With 3/8 in. OD 180° copper tube, vacuum processed	9130049	P105760	$529.00
With 3/8 in. OD 90° copper tube, vacuum processed	9130050	P106088	$553.00
Magnet for Miniature pump	9130042	P106094	$278.95
HV cable, (8 ft.) long for Mini Vaclon pumps	9240122	P105771	$629.16
2 L/S Pump			
With 3/4 in. OD 180° stainless steel tube	9190521	P106092	$613.00
With 3/4 in. OD 180° copper tube, vacuum processed	9190522	P105788	$848.00
With 3/4 in. OD 180° stainless steel, vacuum processed	9190523	P105789	$712.00
With 3/4 in. OD 90° stainless steel vacuum processed	9190524	P106091	$777.00
With 1 1/3 in. CFF 180° vacuum processed	9190520	P106093	$689.00
Magnet for 2 L/S pump	9190038	P105790	$406.00
HV bakeable cable, radiation resistaant, (13 ft.) with inerlock for 2 L/S pump	9290706	P105770	$726.92
10 L/S Pump			
10 L/S Vaclon pump, vacuum processed, with 2 3/4 in. CFF	9195005	P106095	$1,272.00
Magnet for 10 L/S pump	9110030	P105791	$775.28
HV cable, (10 ft.) for 10 L/S pump	9240741	P105772	$690.71

* Catalog Pricing Subject to Change

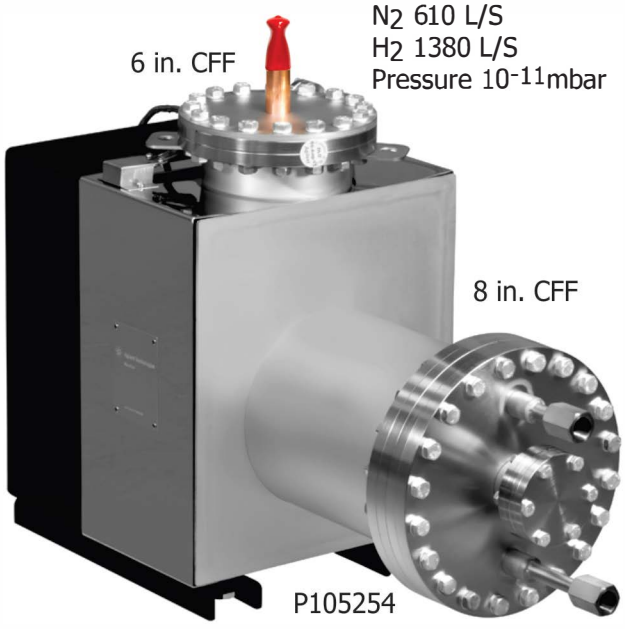
AGILENT Varian VacIon Plus Combination Titanium Sublimation Pumps (TSP)

Ion-Sublimation combination pumps have been a popular choice for many years for creating ultra high vacuum environments. The titanium sublimation creates extra high getterable gas pumping speed while the ion pumping mechanisms handle the non-getterable gases.

This combination pump is a VacIon Plus 150, they also come in 300 and 500 models. They all have an extra side or bottom-mounted 8" ConFlat port. The combination pump includes the cylindrical cryo panel and TSP source mounted to the extra port. Getterable gases enter the end of the cylindrical cryo panel and are pumped by being combined with the freshly-deposited titanium there. Liquid nitrogen cooling the cryopanel increases the efficiency of the gettering process and adds greatly to the water pumping speed.

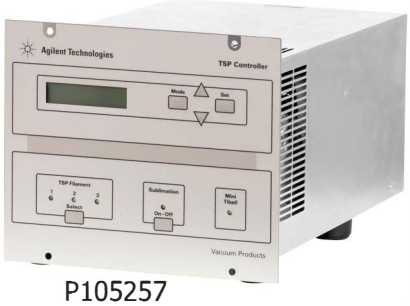
The Agilent Varian VacIon Plus series combination pumps allow addition of a cryopanel from the bottom of the pump or from the side. This can be a significant advantage in situations where height restrictions are present. Customized pump configurations are also available.

TSP VacIon Plus 150 Starcell
N_2 610 L/S
H_2 1380 L/S
Pressure 10^{-11}mbar



P105254

TSP Controller
1/2 Standard rack
Auto or manual operation
Remote control via RS232
Operates TSP filament



P105257

OPTIONS & ACCESSORIES

TSP VacIon Plus 150 Ion-Sublimation Combination Pump	Agilent Varian P/N	Ideal Vacuum P/N	Price:*
150 Diode, with side mounted cryopanel, with TSP cart. with installed heater 120VAC	9192510		
150 Diode, with side mounted cryopanel, with TSP cart. with installed heater 220VAC	9192511		
150 Nobel Diode, with side mounted cryopanel, with TSP cart. with installed heater 120VAC	9192520		
150 Nobel Diode, with side mounted cryopanel, with TSP cart. with installed heater 220VAC	9192521		
150 Starcell, with side mounted cryopanel, with TSP cart. with installed heater 120 VAC	9192540	P105254	$10,733.00
150 Starcell, with side mounted cryopanel, with TSP cart. with installed heater 220VAC	9192541		
TSP filament cartridge on 2.75 in. CFF	9160050	P105793	$1,235.00
Replacement filaments, 12 each	9160051		
Titanium Sublimation Pump Control unit RS232 120VAC	9290032	P105257	$2,240.00
Titanium Sublimation Pump Control unit RS232 220VAC	9290033		
Sublimation Cryopanel on 8 in. CFF	9190180		
Signal cable for TSP Cartridge to controller (12ft.)	9240730	P105258	$827.74
Signal cable for Mini Ti-Ball to controller (12ft.)	9240752		

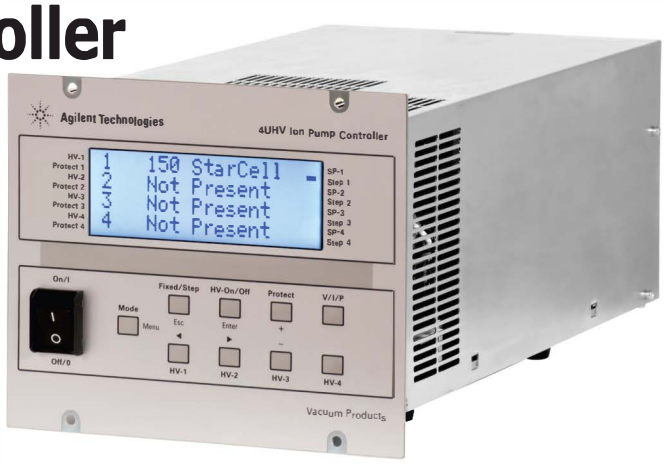
* Catalog Pricing Subject to Change

AGILENT Varian

4UHV Ion Pump Controller

The new state-of-the-art Agilent Varian 4UHV Ion Pump Controller operates up to four ion pumps simultaneously and independently. The 4UHV starts and controls ion pumps of any type (Diode, Noble Diode, StarCell) and size (from 20 to 500 l/s). A large four-line LCD display allows simultaneous reading of individual pump voltage, current and pressure. The variable voltage feature ensures optimum pumping speed and pressure reading throughout the operating pressure range. Built-in set points, remote operation and RS232/485 computer interface are standard (Profibus and Ethernet optional).

The 4UHV will select the right operating voltage to optimize the pumping speed of your ion pumps. By applying High Voltage in accordance with operating pressure, pumping speed performance is improved. It is important when ordering to be informed that the 4UHV ion pump controller can be purchased with up to four high voltage channels in different output power ratings with a maximum sum total power of 400 Watts. It is also important to know that the output polarity is NOT field adjustable on these 4UHV controllers, you must select an appropriate part number with desired output polarity, e.g., (Diode & Noble Diode) need positive voltages, while Triode style elements (old style Triode & StarCell) need negative voltages for operation. See options below.



SPECIFICATIONS

Input Voltage	100- 240 VAC
Input frequency	50/60hz
Display	4 rows with 20 characters
Available Configurations	1x120W, 1x200W, 2x80W, 2x200W, 4x80W + 1 x 200W
Minimum Configurations	One HV card with 120 W, 200 W or 2x80 W
Output voltage	3.5 and 7 kv
Output current	40mA for 80 W, 100mA for 200W
Modes of operation	Local / Serial / Remote
Front panel readings	Voltage, Pressure, Current, Status
Current measurement range	10 nA to 100 mA
Input signals	On/Off, Protect, Step Mode
Output signals	Analog out, NC Set-point, No Set-point
HV connector	Fischer Type 105
Output power maximum	400W
communications	RS232/485 standard, Profibus, Ethernet optional

OPTIONS

4UHV Controllers	Agilent P/N	Ideal Vac P/N	Price:*
1 x 120 Watt Negative Voltage Controller	9299100	P105255	$2,550.00
1 x 120 Watt Positive Voltage Controller	9299101	P105803	$2,550.00
1 x 200 Watt Negative Voltage Controller	9299010	P105804	$3,850.00
1 x 200 Watt Positive Voltage Controller	9299011	P105805	$3,850.00
2 x 80 Watt Negative Voltage Controller	9299200	P105806	$3,950.00
2 x 80 Watt Positive Voltage Controller	9299201	P105807	$3,950.00
2 x 200 Watt Negative Voltage Controller	9299020	P105768	$6,150.00
2 x 200 Watt Positive Voltage Controller	9299021	P105808	$6,150.00
1 x 200 Watt Positive Voltage &1 x200 Watt Negative Voltage	9299022	P105809	$6,765.00
4 x 80 Watt Negative Voltage Controller	9299400	P105810	$6,450.00
4 x 80 Watt Positive Voltage Controller	9299401	P105811	$6,450.00
2 x 80 Watt Positive Voltage 2 x 80 Watt Negative Voltage	9299402	P105812	$7,095.00
2 x 80 Watt Negative Voltage 1 x 200 Watt Negative Voltage	9299210	P105813	$5,750.00
2 x 80 Watt Positive Voltage 1 x 200 Watt Positive Voltage	9299211	P105814	$5,750.00
2 x 80 Watt Positive Voltage 1 x 200 Watt Negative Voltage	9299212	P105815	$6,325.00
2 x 80 Watt Negative Voltage 1 x 200 Watt Positive Voltage	9299213	P105816	$6,325.00

ACCESSORIES

For 4UHV Controllers	Agilent P/N	Ideal Vac P/N	Price:*
HV bakeable cable, radiation resistant, 13ft.	9290705	P105256	$726.92
HV bakeable cable, radiation resistant, 23ft.	9290707	P105794	$806.21
HV bakeable cable, radiation resistant, 33ft.	9290708	P105795	$903.12
HV bakeable cable, radiation resistant, 66ft.	9290709	P105796	$1,334.32
Rack adapter 19 in.	9290064	NA	$685.34
Mains AC cable NEMA plug, 10ft.	9699958	P103999	$88.03
Mains AC cable Europe plug, 10ft.	9699957	P104463	$88.03

NOTE: 4UHV Controllers do not come with Mains AC cable, must be purchased separately

* Catalog Pricing Subject to Change

AGILENT Varian
Mini Vac Ion Pump Controller

The MiniVac Ion Pump Controller is designed to economically operate any Vaclon Plus type and size ion pump: Diode, Noble Diode, and StarCell, from Miniature to 500 l/s pumps. The MiniVac is very compact and light, can be operated in local or remote mode, and is suitable for high radiation environments.

Medium pumps: (Vaclon Plus 20 to 75) can be operated at any pressure below 1 x 10-5 Torr (continuous operation).

Large pumps: (Vaclon Plus 150 to 500) can be operated at any pressure below 2 x 10-6 Torr (continuous operation). The MiniVac is designed to withstand continuous operation at short circuit conditions, without damaging the ion pump or itself. A 24 VDC battery-operable version is available for portable applications.

The requirement of negative or positive potential depends on the pumping element installed in the ion pump. Diode style elements (Diode & Noble Diode) need positive voltages, while Triode style elements (old style Triode & StarCell) need negative voltages for operation. The Mini Vac ion pump controllers can be field set to + or - to match your ion pump polarity requirement.

SPECIFICATIONS

Input	100- 130 VAC or 180-240 VAC or 24 VDC
Output	Voltage: 5000 VDC (open load)
	Current: 15mA (short circuit)
	Max. power: 21W (3kV at 7 mA)
Front panel	
	HV ON, HIGH LOAD, and POLARITY LEDs LED baragraph linear scale for current & voltage indication
	Recorder Output 0 to +10 VDC linear proportional to current (10 V = 10 mA)
Rear panel	
	3Nine pin "D" type connector with following available signals and commands Recorder outputs:
	• 0 to +5 VDC, linear proportional to HV (1 V = 1 kV)
	• 0 to +10 VDC, linear proportional to current (10 V = 10 mA)
	• 0 to +10 VDC, linear proportional to current (10 V= 1 mA)
	HV ON confirm signal:
	Contact rating – 1 A at 250 VAC; 0.2 A at 30 VDC
	Remote HV ON/OFF (interlock) command
	HV connector: Fischer type 105 or King type, 10 kV

OPTIONS & ACCESSORIES

Mini Vac Controller

For any Vaclon Plus ion pump	Agilent P/N	Ideal Vac P/N	Price:*
With Fischer HV connector, US plug, 120 VAC preset	9290191	P105800	$1,310.00
With Fischer HV connector, Euro plug, 220 VAC preset	9290290	P105801	$1,310.00
With Fischer HV connector, US plug, 24 VDC	9290196	P105802	$1,310.00
For 2 and 10 L/S pumps			
With King HV connector, US plug, 120 VAC preset	9290190	P105797	$1,310.00
With King HV connector, Euro plug, 220 VAC preset	9290291	P105798	$1,310.00
With King HV connector, US plug, 24 VDC	9290197	P105799	$1,310.00

Accessories

Rack adapter	9699191		$455.82
For any Vaclon Plus ion pump			
HV bakeable cable, radiation resistant, 13ft.	9290705	P105256	$726.92
HV bakeable cable, radiation resistant, 23ft.	9290707	P105794	$806.21
HV bakeable cable, radiation resistant, 33ft.	9290708	P105795	$903.12
HV bakeable cable, radiation resistant, 66ft.	9290709	P105796	$1,334.32
HV bakeable cable, radiation resistant, 13ft. (for 2 L/S pumps)	9290706	P105770	$726.92
HV bakeable cable, radiation resistant, 10ft. (for 10 & 8 L/S pumps)	9240741	P105772	$690.71

* Catalog Pricing Subject to Change