E P I M A X C
P I M A X C O
I M A X C O N
M A X C O N T
A X C O N T R
X C O N T R O
C O N T R O L

EpiMax Ltd
Bwthyn Cadwen
Pen-y-cae Mawr
Usk, Gwent
Wales, UK
NP15 1NA
Tel: +44 1291 671002 Fax: +44 1291 671003 sales@epimax.com

PVC*i* & PVC*i*Duo

Process Vacuum Controller

ion gauge

User Handbook
(Firmware version 3.03 and above)

Features:

- **1 UHV ion gauge (PVC*i*) or 2 UHV ion gauges (PVC*i*Duo) in a 1U instrument**
- **7 emission levels (+ auto) and ramp/soak degas control**
- **Pressure measurement and over pressure protection during degas**
- **7 trips and 2 digital inputs**
- **Rapid response to pressure transients (*Rippa*)**
- **Options: Pirani and thermocouple modules**
- **Multiple ramp/soak bake-out control with integrated pressure/process interlocking**
- **Auto-degas after bake-out**
- **Auto pump-down and pressure-interlocked timer functions (PVC*i*)**
- **User-scalable/configurable analogue output**
- **Unit naming for ease of identification**
- **MODBUS interface with RS232 and RS485**

SAFETY NOTES ... **4**
QUICK SETUP AND START ... **5**
1. OVERVIEW ... **7**
1.1 GENERAL DESCRIPTION ... 7
1.1.1 Product Summary ... 7
1.1.2 The differences between PVCi and PVCiDuo ... 7
1.2 FEATURES SUMMARY ... 7
1.3 SPECIFICATION ... 8
1.4 FUNCTION DESCRIPTION ... 11
1.4.1 Ion Gauge Control ... 11
1.4.2 Backing Pressure Modules and Auto Pump-down ... 12
1.4.3 Thermocouple Modules and System Bake-out ... 12
1.4.4 Trip Relays and Digital Outputs ... 13
1.4.5 Digital Inputs ... 13
1.4.6 Analogue Output ... 14
1.4.7 Timer (PVCi only) ... 14
1.4.8 Miscellaneous Parameters ... 14
1.5 ACCESSORIES LIST ... 15
1.6 W, THORIA-COATED AND YTTRIA-COATED IR FILAMENTS 15
1.7 PVCIDUO EMISSION CONTROL ... 15
1.8 THERMAL MANAGEMENT SYSTEM ... 15
2. INSTALLATION AND SETTING UP ... **16**
2.1 PHYSICAL ... 16
2.2 REAR PANEL ... 16
2.2.1 Rear Panel PVCi ... 16
2.2.2 Rear Panel PVCiDuo ... 16
2.3 LINE VOLTAGE SETTING AND FUSING ... 16
2.4 LOCATION ... 17
2.5 PROTECTION AND INTERFERENCE ... 17
2.6 IONISATION GAUGES. ... 17
2.6.1 Connecting up Ion Gauges ... 17
2.6.2 QM Power Connector ... 17
2.6.3 Collector BNC connector. ... 18
2.6.4 Ion Gauge Fuses - PVCi ... 18
2.6.5 Ion Gauge Fuses - PVCiDuo ... 18
2.7 ANALOGUE OUTPUT ... 18
2.8 SLOTS "A" AND "B" ... 19
2.8.1 Slots and Modules ... 19
2.8.2 Installing a Module into a Slot ... 19
2.8.3 Removing a Module ... 19
2.8.4 Module Auto-Identification ... 20
2.9 PROCESS CONTROL "TRIP" OUTPUTS AND DIGITAL INPUTS 20
2.9.1 Digital functions ... 20
2.9.2 Wiring of the Digital I/O ... 20
2.9.3 Relay Applications ... 21
2.9.4 Open-collector Applications ... 22
2.9.5 Digital Input Applications ... 23
2.9.6 High Power Trips/Digital Extension Unit – PVCRL7DIN ... 23
2.10 SERIAL INTERFACE ... 23
2.10.1 Serial Communications Daisy-Chaining ... 23
2.10.2 Configuration of the PVC's Serial Connectors ... 23
2.10.3 RJ45 8/8 Connectors ... 23
2.10.4 Connection from host to the first PVC ... 23
2.10.5 Standard 9-pin PC RS232 to PVCi Interface Cable (PVCi-9D232) ... 24
2.10.6 Flexible Communications Cable (PVCi-UTD) ... 24
2.10.7 Daisy-chain Cable (PVCi-RJ45-x) ... 24
2.11 EARTHING AND INITIAL POWER UP ... 24
3. MANUAL OPERATION ... **25**
3.1 FRONT PANEL CONTROLS AND DISPLAYS ... 25
3.2 MANUAL CONTROL AND BUTTON OPERATION ... 25
3.3 THE PVC DISPLAY ... 25
3.4 PVCI INSTRUMENT PAGES ... 26
3.4.1 The PVCi Instrument Page ... 26
3.4.2 The PVCi Ion Gauge Status Summary during Pump-Down 27
3.5 PVCIDUO INSTRUMENT PAGES ... 27
3.5.1 The PVCiDuo Instrument Pages ... 27
3.5.2 PVCiDuo All Gauges Instrument Page ... 27
3.5.3 PVCiDuo Gauge 1 and 2 Instrument Pages ... 28
3.6 PVC PROCESS PAGES ... 28
3.6.1 Slot Process Page ... 28
3.6.2 Bake-out Process Page ... 28
3.6.3 Timer Summary Display – PVCi ONLY ... 28
3.7 DEFAULT MENUS FOR INSTRUMENT AND PROCESS PAGES 29
3.7.1 Default Menus for PVCi ... 29
3.7.2 Default Menus for PVCiDuo ... 29
3.8 MENU STRUCTURE – PARAMETER EDITING ... 29
3.8.1 Parameters ... 29
3.8.2 Menu Groups ... 29
3.8.3 Editing Parameters ... 29
3.8.4 Returning through the Menus using the CANCEL button 30
3.9 POWER OFF DATA RETENTION ... 30
4. ION GAUGE OPERATION ... **31**
4.1 ION GAUGE – STATUS ... 31
4.2 ION GAUGE PARAMETERS ... 31
4.2.1 Emission Current Range ... 31
4.2.2 Auto emission Current ... 31
4.2.3 Degas Powers and the Degas Programme ... 32
4.2.4 Degas Start-up Over-Pressure Protection ... 32
4.2.5 Sensitivity ... 32
4.2.6 Electrometer Calibration Factor ... 32
4.2.7 Filter ... 32
4.2.8 Digital Input Mode: Protection/Remote (Versions 1.08 and later) ... 32
4.2.9 Filament number ... 33
4.2.10 Filament Type (PVCi only) ... 33
4.2.11 Display Resolution ... 33
4.2.12 Ion Gauge Run Time ... 33
4.2.13 Emission Emergency Off ... 33
4.3 ION GAUGE MEASUREMENT STABILITY AND STABILISATION TIME ... 33
4.4 PARAMETER RESET ... 33
5. BACKING GAUGE MODULES AND THEIR OPERATION ... **34**
5.1 BACKING GAUGE MODULES ... 34
5.2 TYPE "V" MODULE: VG SCIENTA PIR5 PIRANI GAUGE HEADS 34
5.2.1 Type "V" Module Connector ... 34
5.2.2 VG Scienta Pirani Gauge Connector Converter ... 34
5.2.3 "V" Module Parameter ... 34
5.2.4 "V" Module Calibration ... 34
5.3 TYPE "T" MODULE: EPIMAX EMP8 & EMP16, AND THYRACONT VSP521/522 PIRANI GAUGE HEADS ... 35
5.3.1 Type "T" Module Connector ... 35
5.3.2 "T" Module Parameter ... 35
5.3.3 "T" Module Calibration ... 35
5.4 TYPE "U" MODULE: USER-DEFINED 'UNIVERSAL' MONITORING ... 35
5.4.1 Type "U" Module Description ... 35
5.4.2 Type "U" Module Connector ... 35
5.4.3 Type "U" Module PCB Jumpers ... 35
5.4.4 Type "U" Module Parameters ... 36
6. THERMOCOUPLE AMPLIFIER OPERATION ... **37**
6.1 THERMOCOUPLE AMPLIFIER BOARDS ... 37
6.2 THERMOCOUPLE AMPLIFIER BOARD CONNECTOR ... 37
6.3 THERMOCOUPLE ASSEMBLY ... 37
6.4 "K" MODULES PARAMETERS ... 37
7. DIGITAL "TRIP" OUTPUTS ... **38**
7.2 TRIP PARAMETERS ... 38
7.2.1 State ... 38
7.2.2 Allocation ... 38
7.2.3 Ion Gauge Degas ... 38
7.2.4 Direction ... 38
7.2.5 Level ... 38
7.2.6 Hysteresis ... 38

8. DIGITAL INPUTS 39
8.1 DIGITAL INPUT TYPE 39
8.2 DIGITAL INPUT PARAMETERS 39
8.2.1 State 39
9. PUMP DOWN (PVC*I* ONLY) 40
9.1 PUMP DOWN OPERATION 40
9.2 PUMP DOWN PARAMETERS 40
9.2.1 Start/Stop 40
9.2.2 Digital Input Protection 40
9.2.3 Ion Gauge Start Pressure 40
9.2.4 Ion Gauge Start Delay 40
9.2.5 Ion Gauge Start Attempts 40
10. BAKE OUT 41
10.1 THE BAKE OUT PROCESS 41
10.2 DEFINING A BAKE-OUT TEMPERATURE PROFILE 41
10.3 BAKE OUT PARAMETERS 41
10.3.1 Start/Stop 41
10.3.2 Step Temperatures – Steps 1 to 6 41
10.3.3 /Step Times – Steps 1 to 6 41
10.3.4 Pressure Limit 42
10.3.5 Pressure Action 42
10.3.6 Ion gauge 2 Pressure Limit (PVCiDuo only) 42
10.3.7 Ion gauge 2 Pressure Action (PVCiDuo only) 42
10.3.8 Digital Input Protect 42
10.3.9 Digital Input Action 42
10.3.10 Temperature Control Hysteresis 42
10.3.11 Auto-Degas Ion Gauge (1) at end of Bake-out 42
10.3.12 Auto-Degas Ion Gauge 2 at end of Bake-out (PVCiDuo only) 42
11. ANALOGUE OUTPUT 43
11.1 ANALOGUE OUTPUT 43
11.2 ANALOGUE OUTPUT PARAMETERS 43
11.2.1 D/A Allocation 43
11.2.2 Minimum value 43
11.2.3 Maximum Pressure value 43
11.2.4 Minimum D/A Parameter Value 43
11.2.5 Maximum D/A Parameter Value 43
11.2.6 D/A Function 43
12. TIMER MENU (PVC*I* ONLY) 44
12.1 TIMER FUNCTION 44
12.2 TIMER PARAMETERS 44
12.2.1 Skip To 44
12.2.2 Off Duration 44
12.2.3 On Duration 44
12.2.4 Pressure Limit 44
12.2.5 Digital Input Protection 44
13. SETUP OPTIONS 45
13.1 SETUP PARAMETERS 45
13.1.1 Instrument Name 45
13.1.2 Pressure units 45
13.1.3 Display Brightness 45
13.1.4 Communications Address 45
13.1.5 Communications Protocol 45
13.1.6 Communications Baud Rate 45
13.1.7 Parity 45
13.1.8 Version 45
13.1.9 Heatsink Temperature 45
14. TROUBLESHOOTING 46
14.1 OPERATION 46
14.2 ION GAUGE 46
14.3 DIGITAL OUTPUT TRIPS 46
14.4 DIGITAL INPUTS 46
14.5 BACKING PRESSURE MODULES (“V”, “T” & “U”) 47
14.6 THERMOCOUPLE MODULE 47
14.7 BAKE-OUT OPERATION 47
14.8 ANALOGUE OUTPUT 47
14.9 TIMER 47
15. IONISATION GAUGE OPERATION AND MEASUREMENT 48
16. SHORT-CUTS 49
17. MENU STRUCTURE 50

SAFETY NOTES

1. Voltages up to **750V** are present within the PVC controller. During degas, voltages up to **750V** are present on the cable and in the ion gauge. Voltages up to **350V** are present during normal operation. To prevent such voltages appearing between the chamber and PVC, ensure that both are connected to a single high-quality earthing (ground) point on the vacuum system.
2. Before removing the top cover of the instrument, allow at least 5 minutes for the high voltage capacitors do discharge fully. **Unless technically qualified to do so, do NOT operate PVC with the cover removed.**
3. Always turn off power to the controller before connecting any cable to the controller or the ion gauge or performing any maintenance to either.
4. It is the user's responsibility to ensure that the signals used with the trip outputs are employed safely. In safety critical installations, an independent means of over-riding/inhibiting the trip signals should be provided to facilitate manual control.
5. Operation with an erroneous setting of the mains line voltage selector will damage the PVC and may cause injury to personnel.
6. Careful design, commissioning and operation are essential to avoid damage to any part of the equipment configuration, or injury to personnel. In particular, consideration must be taken of the conditions and consequences of any part of the configuration failing, providing independent failsafe mechanisms for protection, and ensuring that sensible safe limits are placed on controlled devices.

All conductors exposed to high voltage MUST be mechanically shielded to prevent contact with personnel.
Insulation MUST be rated at >1000V continuous.
Where shielding involves metal, these parts MUST be connected to a high integrity earth.

In some situations, particularly at high pressures, dangerous high voltages can be coupled to any isolated metal parts of the vacuum system through the gas. This particularly relates to vacuum systems which use glass, ceramic, plastic or rubber components. All exposed and isolated metal parts should therefore be reliably grounded to a common system earth point via 4mm^2 or thicker copper wire/braid, the integrity of which should be checked regularly.

QUICK SETUP AND START

1 Unpack the instrument. Check contents against packing note. Inspect for damage.

2 Ensure ion gauge is functional and in an operational environment (e.g. vacuum < $1x10^{-3}$mBar).

3 Check that the power switch is OFF and the voltage selector is set to 115V or 230V to match your mains (line) voltage. If the voltage requires changing, change mains fuses – see section 2.3 for appropriate ratings.

4 Connect the PVC to the ion gauge head(s) using a suitable gauge lead – see section 2.6 for wiring information. **Both** the 6-pin QikMate power lead and the collector BNC lead for each gauge must be connected.

5 Connect a power lead to PVC and turn the instrument on. Ensure that display indicates ion gauge **OFF**. If **!I'LOCK!** message indicated, the gauge lead interlock has not been made. Note: the fan will come on for a few seconds after power up and will then turn off (until required to regulate internal temperature).

6 **Steps 6 to 15 should be followed to ensure that the PVC is set up appropriately for your gauge type. If using a PVC*i*Duo, repeat for the second gauge head**.

7 Press the MENU button repeatedly until display reads: **Ion Gauge Menu (**PVC*i*Duo: **1: Ion Gauge Menu** for gauge 1, **2: Ion Gauge Menu** for gauge 2). Press OK to display first menu item. Continue to press MENU button until you reach **MinEmission**. By default this is set to 0.1mA; if a different value is required use the UP and DOWN buttons to select value. Press OK to enter the value.

8 Press the MENU button to display **MaxEmission**. By default this is set to 10mA; if a lower value is required, use the UP and DOWN buttons to select value and press OK to enter the value.

9 Press the MENU button and ensure that **DI1Mod** reads **None**. Repeat for **DI2Mod**.

10 Press the MENU button to set which filament to use (1 or 2).

11 Press the MENU button to the filament type (Tungsten – W, or Iridium – Ir) – PVC*i* only.

12 Press the MENU button to set the Sensitivity factor value for the connected ion gauge.

13 Press the MENU button to set the Filter; this should be set at 2.0 secs and should not need adjusting, except in exceptionally noisy environments.

14 Press the MENU button to set the ion gauge pressure resolution (1 or 2 decimal places.)

15 Press the CANCEL button twice to return to the main display: **OFF**.

16 **Steps 17 to 19 set the pressure units**.

17 Press <u>and hold</u> the MENU button (or repeatedly press the MENU button) until the words **Setup Menu** appear. Press OK.

18 Press the MENU button until "PresUnits" appears. Use the UP / DOWN buttons to select your preferred units. Press OK.

19 Press the CANCEL button twice to return to the main display: **OFF**.

20 **To start the ion gauge**. Press the MENU button and use the UP and DOWN keys to select the desired emission current, or Auto emission. Press OK. To start second ion gauge of a PVC*i*Duo, press MENU twice to access emission selection. A message appears as the emission current is established, after which the pressure should be indicated. If the PVC is unable to start the gauge, the detected fault condition is displayed.

21 **To turn off the ion gauge**. *Either*: follow step 20 selecting the **OFF** option. *Or*: Press and hold the CANCEL and OK buttons simultaneously for >1.5 seconds. For the PVC*i*Duo, the latter turns BOTH gauges off.

MENU UP DOWN OK CANCEL

Please note: As part of the thermal management, the fan does NOT operate continually – see section 1.8

Dual filament, UHV ion gauge and bakeable lead available from EpiMax.
Filament options: EMW1 for tungsten, EMT1 for thoria-coated iridium and EMY1 for yttria-coated iridium.

Warranty

EpiMax Ltd warrants that the equipment described herein shall be free of defects in materials and workmanship for the period of 12 months from date of installation or 15 months from date of shipment (whichever is the shorter). EpiMax will, at its option, either repair or replace any part which is defective in materials or workmanship without charge to the purchaser. The foregoing shall constitute the exclusive and sole remedy of the purchaser for any breach of EpiMax of this warranty.

Where, equipment is sold on, alone or as part of a larger installation (for example, by an OEM), the end user should notify the original purchaser of any warranty issues and return the instrument *via* the original purchaser.

The purchaser, before returning any equipment covered by this warranty, which is asserted to be defective by the purchaser, shall make written arrangements with respect to the responsibility for shipping the equipment and handling any other incidental expenses with EpiMax. For equipment that is sold on, EpiMax's responsibilities and correspondence is with the original purchaser only; any issues arising from return of the equipment to the original purchaser should be covered by the original purchaser.

The user will also return with the instrument a completed copy of the "Fault Report and Declaration of Contamination" form (see documentation CD). It is at EpiMax's discretion whether equipment is repaired without this documentation.

This warranty covers normal usage of the equipment in accordance with specifications recommended by EpiMax for the proper use of the equipment. It does not cover damage caused by mis-use of the equipment, attachment to faulty or wrongly wired devices (such as wrongly wired ion gauge leads), or use in hostile or unsuitable environments (such as exposure to rain).

It is the purchaser's responsibility to check that any equipment returned is actually faulty, and that non-operation is not due to misunderstanding of usage of the equipment, protection faults (such as blown fuse) or faulty external equipment (such as cabling etc.). Please refer to the section "Troubleshooting" for initial diagnosis of faults. A charge will be made where equipment has been returned for such non-warranty repairs.

EpiMax shall not be liable under any circumstances for consequential or incidental damage in connection with, or arising out of the sale, performance, or use of the equipment covered by this warranty. For critical and hazardous installations, it is the user's responsibility to ensure that an independent failsafe mechanism is employed.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES BY EPIMAX LTD, EXPRESSED OR IMPLIED, INCLUDING THE IMPLIED WARRANTY OF MERCHANTABILITY, THE IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE, AND ANY WARRANTY AGAINST INFRINGEMENT OF ANY PATENT.

1. OVERVIEW.

1.1 General Description

1.1.1 Product Summary

The **PVC*i*** and **PVC*i*Duo** instruments are HV/UHV ion gauge and vacuum system controllers. This handbook refers to these instruments jointly as **PVC**s. Both are housed in 1U high 19” rack-mounting enclosures.

The PVC*i* operates one (1) ion gauge head, and the PVC*i*Duo two (2) ion gauge heads simultaneously.

PVCs have 2 “module” slots providing optional functionality such as backing gauge and thermocouple (bake-out) support. PVC’s have 7 digital “trips”, 2 digital interlock inputs and user-definable analogue output (emission current and sensitivity corrected). The PVC*i* also has timer and auto pump-down functions.

1.1.2 The differences between PVC*i* and PVC*i*Duo

Full specifications for the PVCs are given in sections 1.2 and 1.3. The PVC*i* and PVC*i*Duo differ in the following ways:

- Both support Thoria- and Yttria- coated Ir filaments but only the PVC*i* supports Tungsten filaments.
- Both support operating emission currents of 0.1, 0.2, 0.5, 1, 2, 5, 10 and auto-emission, with user definable minimum and maximum currents. However, the <u>total</u> maximum emission available to the PVC*i*Duo (i.e. ion gauge 1 emission + ion gauge 2 emission) is 12mA. Please refer to section 1.7 for further discussion. However, there is no restriction on simultaneous degas power.
- The PVC*i*Duo has additional trip, interlock etc options available associated with the second ion gauge head.
- The following functions are only available on the PVC*i*: timer, auto pump-down/ion gauge auto-start

1.2 Features Summary

General	➢ 1U high 19” rack-mounting ➢ One (PVC*i*) or two (PVC*i*Duo) HV/UHV Bayard-Alpert gauge ➢ Two “options” slots for Pirani and/or thermocouple amplifier boards (for bake-out control) ➢ Seven process outputs (“trips”) ➢ Two digital process inputs for interlocking/protection ➢ Pump-down feature allows evacuation of system and automatic start of ion gauge (PVC*i* only) ➢ 6 step system bake-out controller with pressure and digital input process protection ➢ Timed events, such as TSP control and pump-recycling; pressure and system interlock protected (PVC*i* only) ➢ User-definable (span, range, conversion function) analogue output corrected for sensitivity and emission ➢ Units: Torr, mBar or Pascal ➢ Clear 20 character dot-matrix VFD display ➢ Simple manual operation ➢ Full control/monitoring/data logging over serial comms
Ion Gauge	➢ Suitable for all standard HV and UHV gauge heads ➢ Display resolution: 1 or 2 decimal place mantissa (0 decimal places during degas) ➢ Single or dual, W (PVC*i* only), thoriated Ir or Yttria-coated Ir filament assemblies ➢ $1x10^{-13}$ – $1x10^{-2}$ mBar pressure range (gauge dependent) ➢ Emission: 0.1, 0.2, 0.5, 1, 2, 5 or 10mA. *Auto*: pressure-dependent auto-ranging emission with hysteresis ➢ Sensitivity range 1.0 – 99.9 $mBar^{-1}$ ➢ Over pressure, over/under current, gauge fault and interlock protection ➢ *Rippa* algorithm – rapid response to pressure transients ➢ Degas Power: PVC*i*: 1, 2, 3, 6, 12, 20 & 30W. PVC*i*Duo: 1, 2, 3, 6, 15 & 30W. ➢ Pressure measurement during degas ➢ Degas Protection option for disabling degas at pressures above $1x10^{-5}$mB ➢ 2 step degas sequence. Step 1 ramp from 1W to selected power. Step 2 hold at selected power. 1-999 minutes per step ➢ “Quick Degas”: 1 minute at selected Degas power ➢ Ion gauge cumulative run time
Modules	➢ 2 module “slots”. Any combination of the following modules: ➢ Type **‘U’** (Universal). Voltage input reads pressure from external device (e.g. Mini-convectron, Instrutech “Stinger”, Thyracont VSP62, MKS baratrons etc.). User selectable input gain (0-10V, 0-3V, 0-1V), pressure range and matching voltage input range ➢ Type **‘V’**. Supports VG Pirani gauge head. User calibration: minimum pressure setting ➢ Type **‘T’**. Supports EpiMax EMP8 and EMP16, VG and Thyracont VSP521/522 Pirani gauge heads. User calibration: minimum pressures setting ➢ Type **‘K’**. Type K thermocouple monitoring with cold-junction compensation. Temperature range 0-600°C. ➢ **‘U’**, **‘V’** or **‘E’** module in slot A allows for auto-pump down (PVCi only) ➢ **‘K’** module in slot B allows bake-out control

Process Trips	➢ 7: 4x change-over relays (1A @ 24Vdc, 0.5A @ 125Vac) + 3x NPN open collector (0.1A @ 20V) ➢ Change-over relays provide NO or NC wiring options ➢ Individually assigned: ion gauge, ion gauge 2 (PVC*i*Duo), either slot, bake-out, pump-down (PVC*i* only) or timer (PVC*i* only) ➢ Individually set to operate at > or < trip level. Optionally during degas ➢ User configure for normal on/off, over-ride and inhibit states ➢ Hysteresis 1.0x (no hysteresis) to 99.9x in 0.1 increments
Digital Inputs	➢ 2 opto-isolated digital inputs. 3 to 32Vdc; 2.2kΩ series resistance with reverse polarity protection ➢ User-assignable to: ion gauge, ion gauge 2 (PVC*i*Duo), either slot, bake-out, pump-down (PVC*i* only) or timer (PVC*i* only) ➢ User configure for normal input, over-ride and inhibit states
Analogue Output	➢ Assignable to: ion gauge, ion gauge 2 (PVC*i*Duo), slot 1 or 2, ion gauge + Pirani (air to UHV) ➢ User-definable pressure and output voltage range ➢ User-definable to be linear or logarithmic relationship ➢ Sensitivity and emission current corrected
Display	➢ Bright 20 character alpha-numeric ➢ Blue/green vacuum fluorescent display (VFD) ➢ 4 user-selectable brightness levels ➢ Overlay filter enhances contrast
Operation	➢ Operation through 5 front panel touch buttons ➢ Simple menu structure provides easy access to all parameters
Communi-cations	➢ All parameters set/monitored over serial communications bus ➢ Fast multi-parameter MODBUS protocol. Floating point resolution data transfer ➢ Multi-drop RS232 and RS485 interface as standard ➢ Up to 8 PVCs per RS232 bus and 16 PVCs per RS485 bus ➢ 2 communications connectors for simple daisy-chaining using industry standard RJ 45 cables
Applications	➢ General UHV and HV system monitoring and management. ➢ Surface science and deposition equipment. ➢ Analogue output suitable for flux rate calibration in MBE ➢ Easy integration with automated systems.
Options	➢ Plug-in Pirani boards provide support for EpiMax, Thyracont and VG Pirani gauge heads ➢ Plug-in thermocouple amplifier board
Accessories	➢ Ion gauge heads. Standard and bake-able gauge cables in various lengths ➢ Pirani gauge heads and cables ➢ DIN-rail based Trip relay expansion ➢ Solder-free connection to trips and interlocks ➢ Communications cables to standard PC ports.

1.3 Specification

GENERAL

Dimensions	19" full-width rack Height: 1U. Depth: 257mm, excluding connectors. Weight: 6.8kg (PVC*i*) 7.3kg (PVC*i*Duo)
Mains Power	230Vac or 115Vac +10-15% (selected via the IEC connector). Rear panel filter/IEC connector and switch
Power	200VA max. 40VA typical
Mains Fusing	FS1/FS2 Live and neutral fuses 5x20mm. 230Vac – T2.0A, 115Vac – T3.16A
Supply Fusing	F1 Grid/degas supply: T250mA 5x20mm F2 Filament supply: **PVCi** - F6.3A 5x20mm; **PVCiDuo** – F4.0A 5x20mA F3 PVCiDuo Gauge 2 Filament supply: **PVCiDuo** – F4.0A 5x20mA
Environmental	Integral fan-assisted convection cooling Electrometer in screened, temperature controlled enclosure Operating temperature: 0°C to +35°C ambient. Storage temperature: -10°C to +70°C. Relative humidity: 5 to 80RH, non-condensing. Installation: Non-explosive atmosphere. Electrically conductive pollution must be excluded from enclosure.
Data Retention	Non-volatile memory power off protection of all settings
Lock-out	Communications-based lock-out allows all values to be inspected but not changed.
Main Display	20 character green/blue VFD alpha-numeric display with 4 brightness levels
CE Conformance	Conforms with relevant EU directives

ION GAUGE

Type	HV and UHV Bayard-Alpert gauges. Pressure range 10^{-13} to 10^{-2} mBar.
Gauge Connectors	6-pin "Qikmate" for filament/grid supplies. Insulated BNC for collector
Sensitivity	Range: 1.0 to 99.9 $mBar^{-1}$ in 0.1 increments

Display	Units: Torr, mBar or Pascal. Resolution: 1 or 2 decimal place mantissa. 1 digit exponent for –2 to –9; 2 digit exponent for <= -10. Display update rate: ~5/sec. Display Range: $1x10^{-13}$ to $1x10^{+6}$ (depending on instruments)
Grid	*Pressure measurement*: +185V. *Degas*: Nominal +650V
Filament	(PVC*i* only) Tungsten: 14V. Current limit: 5.5A (±0.3A) (Both:) Thoria-coated or Yttria-coated Iridium: 7V. Current limit: 3.2A (±0.2A) – see section 1.5 Filament number 1 or 2 selection *Pressure measurement*: +40V with respect to earth. *Degas*: at earth
Collector	Potential: 0V with respect to earth
Emission Current	Soft-start emission control Fixed values of 0.1, 0.2, 0.5, 1, 2, 5 or 10mA Auto-ranging selects best emission current for pressure. 1 decade hysteresis
Degas	Soft-start control Note: Power levels quoted are for electron heating and **do not include additional resistive heating by the filament**. Power: (PVC*i*) 1, 2, 3, 6, 12, 20 and 30 Watts (nominal) Power: (PVC*i*Duo, each gauge head) 1, 2, 3, 6, 15 and 30 Watts (nominal) *2 Step degas*: Step 1 ramps from 1 W to requested power level. User defined time of 0 to 999 minutes Step 2 holds at requested power for user-defined time of 1 to 999 minutes. "*Quick Degas*" degasses the gauge for 1 minute at the selected Degas Power *Protection*: If ON, degas cannot be started if gauge is off or pressure > $1x10^{-5}$ mBar Pressure measurement during degas corrects for emission current and gauge operating conditions Over-pressure protection during degas
Digital	A/D: 12 bit resolution. 4x/8x over-sampled Sample rate during normal pressure measurement: 10 times/sec. Sample rate during degas: 2/sec. Digital low pass filter: 0.0 (OFF) to 9.9 seconds at 0.1 increments. Default = 1.0 seconds.
Protection	Thermal trip at 75°C Connector Interlock: Interlock pins must be connected before supplies are enabled Filament over-current trip: 3A for Ir and 6A for W filament. Over/Under emission trip Over pressure trip (mBar): >$1x10^{-2}$ for Ir @ 0.1mA, >$1x10^{-4}$ for W @ 10mA, else >$1x10^{-3}$ Over pressure trip during Degas (mBar): >$1x10^{-3}$ for Ir and >$1x10^{-4}$ for W
Electrometer	Log Temperature Stability: <1% over ambient temperature range 20-40°C Drift: <1pA. Stabilization Time: Typically 45 mins
Lower Electrometer Limit	At gauge sensitivity setting of 10 $mBar^{-1}$, the minimum pressure measurements (subject to X-ray limits of gauge head): 0.1mA = $1x10^{-10}$, 0.2mA = $5x10^{-11}$, 0.5mA = $2x10^{-11}$, 1mA = $1x10^{-11}$, 2mA = $5x10^{-12}$, 5mA = $2x10^{-12}$, 10mA = $1x10^{-12}$ mBar Minimum pressure indicated as "MinLimit"
Run Time	The cumulative time that the gauge head has run. User time reset.

OPTIONAL MODULE TYPES

Options Slots	2 option slots support backing gauge and thermocouple (bake-out) modules.
Universal Module	Type '**U**': Powers and monitors pressure/voltage linearized devices, e.g. Thyracont VSP621, Instrutech Stinger, GP Mini-Convectron, MKS 121 & 627 baratrons etc. ➢ User (hardware) selection of voltage input range 0-10V, 0-3V or 0-1V ➢ Software selection of minimum and maximum voltage and corresponding pressure values. Linear or log V vs Pressure ➢ Supplies ±14.7V (nominal) at up to 120mA (current limited). Devices requiring higher currents require external power supply
Pirani Modules	Type '**T**': Constant temperature architecture. Supports Thyrcont VSP521 and VSP522, and EpiMax EMP16 and EMP8 Pirani gauge heads. Constant temperature architecture. Temperature compensated. Lifetime calibration. Type '**V**': Supports VG Scienta Pirani gauge heads. Constant current, half-bridge. Calibration at gauge head. Both modules: software calibration of low pressure value *Range: $1x10^{-3}$ to atmosphere.*
Thermocouple module	Type '**K**': Supports type K thermocouple measurement with cold junction compensation. Range 0 to 600°C *Units: °C. Resolution: 1°C . Sample rate and display update rate: ~2/sec.* *Accuracy: 100 to 500°C ±2°C.*
Connector	Type '**U**': 6-pin Mini-DIN. Type '**T**': 3 pin Mini-DIN. Type '**V**': 6-pin Mini-DIN. Type '**K**': 4-pin Mini-DIN.

PROCESS TRIPS

Number	Seven trips: 4 change-over relays; 3 NPN open-collector outputs
Relay types	Single pole, change-over. Common, normally open and closed contacts at connector 1A@24V dc, 0.5A @ 125Vac. Max. switched power 30W, 62.5VA. Minimum switching = 1mA @ 5V

Open-Collector Types	NPN Darlington outputs Absolute maximum rating: 250mA @ 20Vdc
Connector	Male 25pin D-type (shared with digital inputs)
Assignment	Assignment options: None, ion gauge(s) pressure, Slot A, Slot B, Pump Down, Bake-out, Timer etc. Can be (optionally) operated in response to degas pressure
Direction	Trips can be set to operate at > or < trip level
Trip levels & Operation	Range: $1x10^{-13}$ to $1x10^{+6}$ [absolute value] Normal (on/off action), Override or Inhibit action
Hysteresis	User-defined at 1.0x (no hysteresis) to 99.9x in steps of 0.1x

DIGITAL INPUTS

Number	Two
Input type	Opto-isolated. 3 to 32Vdc input (drawing ~1mA @ 3V and ~14mA @ 32V). Reverse voltage protected.
Connector	Male 25pin D-type (shared with Process Trips)
Assignment	Ion gauge(s), slots, Pump Down, Bake Out and Timer etc.
Operation	Normal (on/off action), Override or Inhibit action
Protection/ Remote Control	User-assignable protection (interlock) of ion gauge, pump-down, bake-out, timer operation User-assignable "remote" control over ion gauge emission and degas

ANALOGUE OUTPUT

Type	Resolution: 12-bit D/A. Updated 5 times per second. Minimum to maximum range -0.2 to 10.4Vdc.
Compensation	For ion gauge scaling: mirrors pressure displayed on front panel - **compensated for ion gauge sensitivity and emission current**. Indicates output during degas.
Assignment	Assignment options: fixed to minimum or maximum output, ion gauge, ion gauge 2 (PVC*i*Duo only), Slot "A", Slot "B", ion gauge + Slot "A", Extern (computer value), square wave
Pressure range	User-defined minimum and maximum pressure assignment to minimum and maximum output voltage
Output Assignment	User assignment of minimum and maximum D/A output values (0 to 4095). Note, "minimum" value can exceed "maximum" value to allow low output to correspond to high pressure end (inverted output)
Function	Logarithmic or linear scaling of output voltage with pressure
Connector	Standard 3.5mm socket

PUMP-DOWN (PVCi only)

Operation	Requires Pirani module in Slot "A"
Trip	Assigned trips activate when pump-down is started and remain on until ion gauge turns on, or fails
Digital Input	Digital input(s) assigned to Pump-down will inhibit attempts to turn ion gauge on
Ion Gauge Start-up	User-defined Pirani pressure below which attempts made to turn gauge on Number of attempts to start the ion gauge can be set between 1 and 9 Delay of between 0 and 999 seconds after reaching turn-on pressure before first and between attempts

BAKE-OUT

Operation	Requires type K thermocouple amplifier board in Slot "B"
Temperature Range:	Operating range: 20°C to 600°C. Accuracy (including cold junction correction): ±2° from 100°C to 500°C
Resolution	Display resolution 1°C. Internal measurement/processing resolution <0.2°C
Programme	Up to 6 programme steps. For each step, define: Temperature reached at the end of the step (0 to 600°C) Duration 0.0 to 99.9 hours; Total duration: 599.4 hours (>24 days)
Hysteresis	User-defined from 0 (off) to 99°C in 1°C increments to avoid cycling
Trips	Trip(s) assigned to Bake-out provide on/off temperature control
Digital Input	Digital input(s) assigned to Bake-out can be set to: Turn trips off only; Turn trips off and suspend temperature ramp/count-down; Terminate bake-out
Pressure Level	User-defined pressure level ($1x10^{-13}$ to $1x10^{+6}$) above which one of the following actions can be set: Turn trips off only; Turn trips off and suspend temperature ramp/count-down; Terminate bake-out

TIMER (PVCi only)

Function	On/Off cyling timer with up to 1 day on and 1 day off time.
Timing	On and off times: 0 to 1440.0 mins in 0.1min increments
Trips	Any number of Trips can be assigned to the Timer
Ion Gauge	Ion gauge off inhibits timer on trips. User set pressure limit inhibits timer on trips
Digital Inputs	Timer on can be inhibited by either or both digital inputs.
Skip	User can skip to start of on or off period.

COMMUNICATIONS

Interface	RS232 and RS485 interfaces provided as standard
Connectors	2x RJ45 sockets provide for simple daisy-chaining using industry-standard cables
Settings	8 bits, no/even/odd parity, 1 start bit, 1 stop bit. Baud rates: 4800, 9600, 19200, 38400
Protocol	MODBUS. Multi-parameter data Write and Read within each message
Operation	All aspects of gauge operation can be controlled over serial communications Full monitoring of all parameters for data logging. Designed for "zero-conflict" with manual operation

1.4 Function Description

This section discusses the functionality and features of the PVCs, and indicates their interrelationships.

1.4.1 Ion Gauge Control

Emission

Ion gauge emission settings are OFF, 0.1, 0.2, 0.5, 1, 2, 5 and 10mA, and "auto". The user can define the **Minimum** and **Maximum Emission** settings to provide safe operation of the gauge.

In auto emission mode, the PVCs select an appropriate emission current for the measured pressure. The pressure range $1x10^{-5}$ to $1x10^{-11}$ mBar is divided between the minimum to maximum emission settings, incrementing or decrementing the emission current as each transition is crossed. Hysteresis of a decade in measured pressure is applied between increasing and decreasing emission current to eliminate cycling between emission currents. If the pressure rises above $1x10^{-5}$ mBar, the PVCs immediately revert to the minimum emission current setting.

Emission "soft-start" ensures gentle heating/cooling of the filament to avoid pressure bursts. The gauge may take 20 to 40 seconds to reach emission during which time correct filament operation is checked. Up to 60 seconds are allowed for soft start power up before failure is reported.

PVCs support single and double filament heads, Thoria- or Yttria-coated Ir. However, only the PVC*i* support W filaments.

Degas

Degas is only available if the ion gauge is already on. In addition, if **Degas Protection** is set on, the pressure must be below $1x10^{-5}$mBar to permit degas; if set off, degas can be started at any pressure. The available degas powers are 1, 2, 3, 6, 12, 20 and 30 watts for the PVC*i*, and 1 ,2, 3, 6, 15 and 30W for the PVC*i*Duo. Degas is executed by ramping the power from 1W to the desired value (**Degas Power**) in the set **Degas Ramp Time**, and then holding the power for the **Degas Time**. At the end of degas, the ion gauge is automatically restarted at its previous emission setting.

Pressure measurement operates during degas (at reduced resolution due to non-ideal operating conditions for the gauge heads). The user can select whether to **protect** the ion gauge against over-pressure during degas, and the vacuum system to standard interlock conditions.

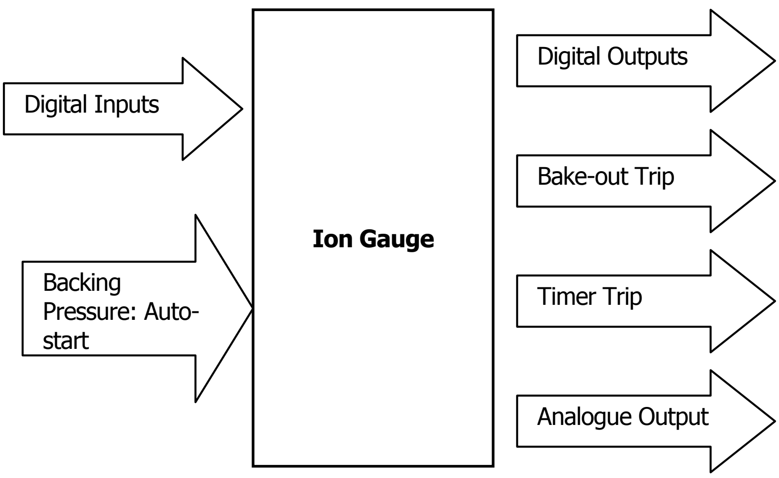
Quick Degas

Quick Degas degasses the ion gauge at the **Degas Power** value for 1 minute, at the end of which, the ion gauge is automatically restarted.

Measurement

The electrometer converts the collector ion current to a logarithmically scaled voltage. In addition to a fixed electronic filter, the user can set a software **Filter**. The default time constant is 2.0 second. *Rippa* (*Rapid Increment Pressure Protection Algorithm* - see section 4.2.7) provides protection of the gauge head and vacuum system to sudden changes in pressure, even with long filter time constants.

The electrometer circuitry is housed in a metal enclosure to minimize noise pick-up. In addition, the enclosure is kept at a constant temperature to minimize thermal drift of the sensitive electrometer amplifier.



Relationships

Ion gauge operation interacts with the following:

- Digital Inputs. The digital inputs can be set to trip the gauge (interlock mode) when failed, or can be used to turn the ion gauge on/off, either in response to the digital input status, or to a pulse.
- A backing pressure module in Slot A can be set to auto-start the ion gauge in auto-emission when the pressure drops below a preset value. The number of attempts can be set. (PVC*i* only)

- Digital outputs. The ion gauge can influence the state of any number of the 7 digital outputs. The output can be made to be on or off when the pressure is above or below user-defined pressure values. The hysteresis parameter precludes contact chatter.
- Bake-out trip. A thermocouple module in Slot B allows PVC to perform a multi-step bake-out of a vacuum system. The bake-out can be suspended or terminated if the ion gauge pressure exceeds a user-defined value.
- Timer Trip. Timer switching into the ON state can be inhibited by ion gauge pressure exceeding a user defined value. (PVC*i* only)
- Analogue output. The ion gauge pressure can be output as a logarithmically or linearly scaled voltage, corrected for sensitivity and emission current. The pressure and voltage range can be user defined.

1.4.2 Backing Pressure Modules and Auto Pump-down

Backing Pressure Modules

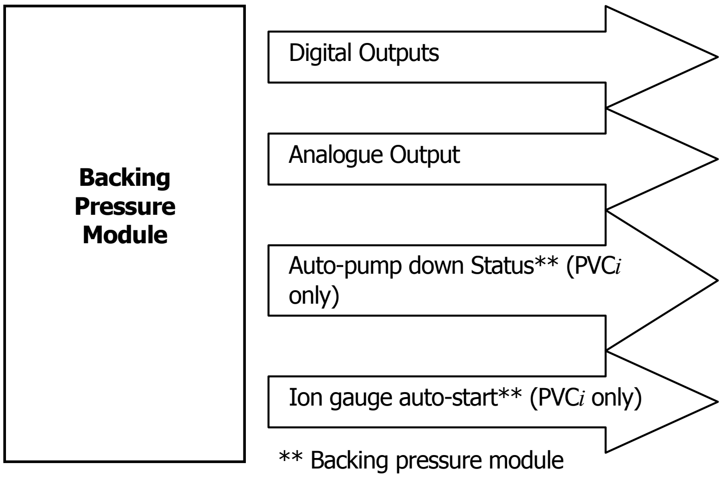
Backing pressure modules (types **U**, **V** or **T**) can be inserted in either or both Slot A and Slot B.

Pump-down (PVC*i* only)

A backing pressure module in Slot A can also be used for system pump-down and auto-start of the ion gauge.

Pump-down can only be started if the ion gauge is switched off, i.e. it is assumed that the vacuum system is at air. When a pump-down sequence is started, the pressure monitored by the module in Slot A is checked to see if it is <u>below</u> the value in **Pump-Down Start Pressure**. If this condition pertains for longer than **Pump-Down Delay**, PVC*i* will attempt to start the ion gauge. If ion gauge start-up fails, PVC*i* will repeat this **Pump Down Attempts** times, with a time delay between each attempt of the duration of **Pump-Down Delay**.

Pump-Down DI Protect dictates whether a digital input influences the pump-down. If a digital input that is allocated fails, the pump-down sequence is suspended until the DI recovers



** Backing pressure module in Slot A

Relationships

The backing pressure modules interact with the following:

- Digital outputs. The state of any number of the 7 digital outputs. The output can be made to be on or off when the pressure is above or below defined pressure values. The hysteresis parameter precludes contact chatter.
- Analogue output. The pressure can be output as a voltage, scaled logarithmically or linearly. Pressure and voltage range can be user defined.
- Auto-pump down (PVC*i* only). The pump-down sequence is monitored using a module in Slot A and controls external devices via the trips.
- Ion gauge auto-start (PVC*i* only). When the pressure monitored by Slot A is attained, 1 or more attempts can be made to start the ion gauge. A user-defined interval can be set between attempts.

1.4.3 Thermocouple Modules and System Bake-out

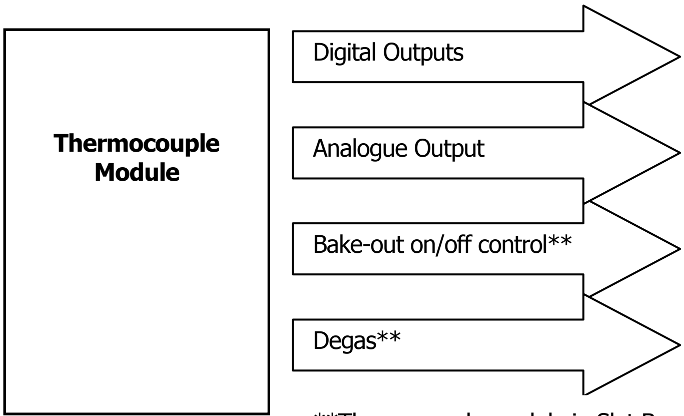
Thermocouple Module

Thermocouple module type **K** measures the thermal emf from a type K thermocouple applying cold-junction compensation. Measurement range is from 20°C to 600°C.

Bake-out

A thermocouple module in Slot B can be used for system bake-out. The bake-out algorithm compares the measured temperature to a setpoint value (see below). One or more on/off control outputs can be selected by assigning trips to "Bake-out" using **Trip Allocation**.

Bake-out comprises a sequence of up to 6 steps; the duration (0 to 99.9hours) and end temperature (0 to 600°C) of each step is defined in the **Bake-Out Time** and **Bake-Out Temperature** parameters. A step with a bake-out time of zero causes an instantaneous change in temperature, or if at the end of the sequence, is skipped (thus a 2 step bake-out can be set by setting the time for steps 3 to 6 to be zero). During the first step, the temperature is ramped from the current measured value to temperature of the first step over its duration.



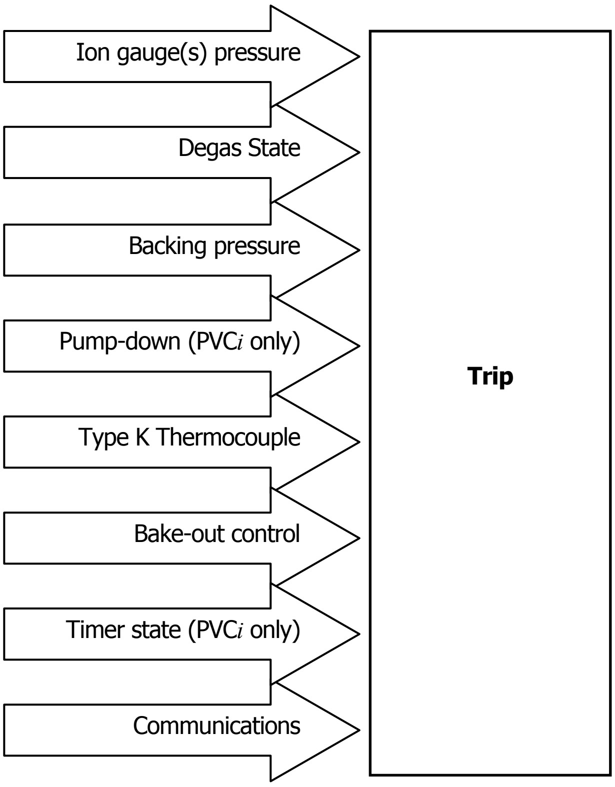
**Thermocouple module in Slot B only

PVCs allow interlocking of ion gauge pressure(s) to bake-out. In the case of the PVC*i*Duo, neither, either or both ion gauges can be used for this function. **Bake-Out Pressure Limit** sets an internal interlock to the ion gauge pressure(s); the action to be taken is dictated by **Bake-Out Pressure Action**. This can be "normal" (the output is set to off until the pressure recovers though the bake-out time continues to decrease), "suspend" (the outputs is set to off but the bake-out time is suspended until the pressure recovers thereby ensuring full bake-out duration below the pressure limit), "abort" (the bake-out instantly terminates), or "ignore" (the ion gauge is ignored).

Bake-Out DI Protect dictates how a digital input influences the bake-out. If an allocated digital input fails, **Bake-Out DI Action** specifies what action to take. This can be "normal" (the output is set to off until the digital input recovers though the bake-out time continues to decrease), "suspend" (the outputs is set to off but the bake-out time is suspended until the digital input recovers), or "abort" (the bake-out instantly terminates).

To avoid output "chatter" when the temperature is close the Setpoint, **Bake-Out Hysteresis** sets a switching "window". The output is on when the temperature drops below the setpoint, but does not turn off until the temperature is at or above (setpoint + the hysteresis value).

At the end of a bake-out sequence, the **Auto-Degas** parameter(s) optionally executes a degas of the gauge head(s).



Relationships

The Thermocouple modules interact with the following:

- Digital outputs. The temperature can influence the state of any number of the 7 digital outputs. The output can be made to be on or off when the temperature is above or below defined pressure values.
- Analogue output. The temperature is output as a voltage, scaled logarithmically or linearly. Temperature and voltage range are user defined.
- Bake-out on/off control. The temperature monitored by Slot B can be compared with a bake-out sequence temperature to provide on/off temperature control via one or more digital outputs. A user-defined hysteresis can be applied to stop contact chatter near the Setpoint.
- Degas. At the end of a bake-out sequence, the ion gauge(s) can be set to degas automatically.

1.4.4 Trip Relays and Digital Outputs

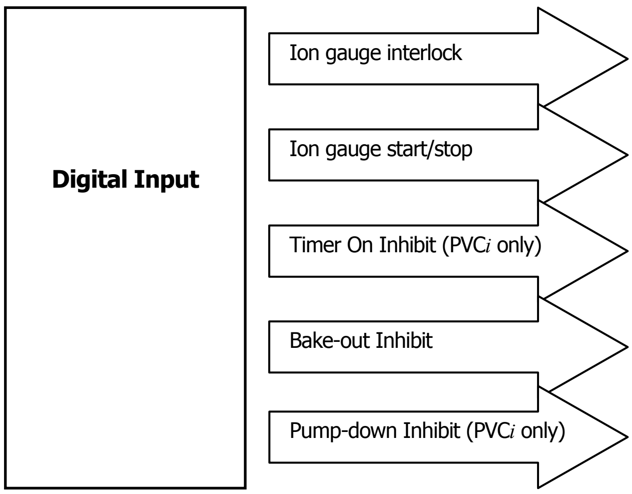
Output Types

PVC has 7 trip outputs. Trips 1 to 4 are change-over relays and trips 5 to 7 are NPN open-collector outputs. Trips can be allocated to PVC functions, inhibited (off) or overridden (on).

Relationships

Each trip can interact with the following:

- Ion gauge(s) pressure. On or off, above or below the setpoint, including during degas
- Degas State. On whilst the ion gauge is degassing.
- Backing pressure. On or off, above or below the setpoint.
- Pump-down status (PVC*i* only). A Pirani module in Slot A used for Pump-down can control and external device(s) via allocated trips.
- Thermocouple temperature. On or off, above or below temperature setpoint.
- Bake-out temperature. A thermocouple module in Slot B being used for bake-out provides control of the heater(s) via allocated trips.
- Timer State (PVC*i* only). On when the timer on state is active.
- Communications. Can be set on or off over communications bus.



1.4.5 Digital Inputs

Input Type

The 2 digital inputs are electrically isolated from ground and from each other. A dc voltage of between 3 and 32V is required to energise the inputs. They can be set either to depend on the input voltage, inhibited (permanently off) or overridden (permanently on).

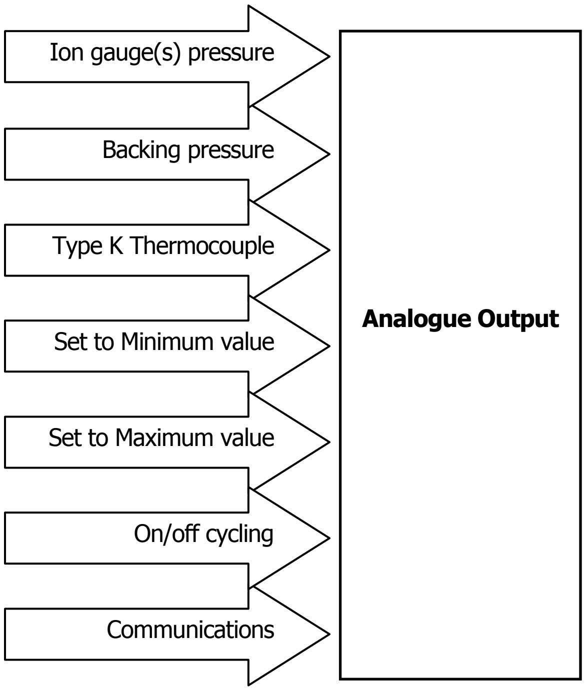
Relationships

Each digital input can interact with the following components:

- Ion gauge interlock. The ion gauge will fail to start or turn off as long as the digital input is failed.
- Ion gauge start/stop. 2 modes: (i) The gauge will start when the digital input is ok and will turn off when failed. (ii) The gauge will toggle on/off in response to a short ok pulse from the digital input.

- Timer On Inhibit (PVC*i* only). The timer on state will be inhibited when the digital input is fails.
- Bake-out. Outputs are inhibited, or the bake-out is inhibited/terminated when the digital input fails.
- Pump-down Inhibit (PVC*i* only). The pump-down is inhibited or terminated when the digital input fails

1.4.6 Analogue Output



Analogue Output

The PVC's analogue output provides for accurate and application specific data logging (e.g. for MBE flux monitoring). **The analogue output is based on the displayed value, i.e. in the case of the ion gauge(s), corrected for pressure units, emission current and sensitivity factor**. The output can scale logarithmically or linearly, as determined by **D/A Function**.

If the analogue output is assigned to an ion gauge, it also indicates pressure *during* degas. Whilst degas is starting and before emission restarts after degas, the last reading is "latched" into the analogue output to avoid sudden change to indicate OFF condition (maximum voltage output).

The analogue output is assigned via **D/A Allocation** to the ion gauge reading, slot A value, slot B value or ion gauge + slot A value (e.g. to give automatic output on backing and ion gauge pressure depending on pressure range), or can be set to predefined values set by communications.

D/A Pressure Minimum and **D/A Pressure Maximum** set the range of interest of the allocated device (limits: $1x10^{-13}$ to $1x10^{+6}$).

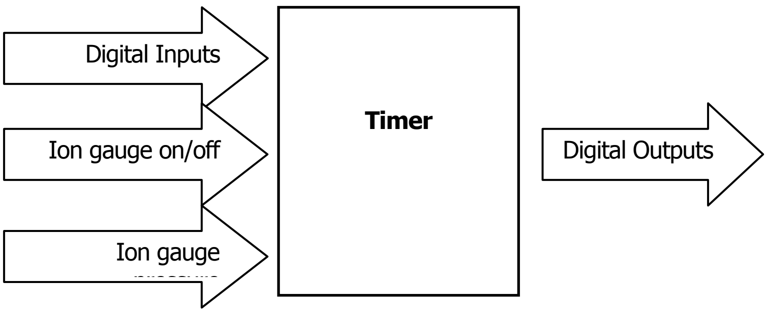
D/A Output Minimum and **D/A Output Maximum** set the output voltage range. Since the output has 12 bit resolution, the range for these parameters is from 0 to 4095. Note that the minimum can exceed the maximum to allow for "inverted" operation. Whilst either of these parameters is being displayed, the analogue output registers the value so that the value can be read on a meter and set appropriately. The range is ~ -0.2V to ~ +10.4V to allow offsets in the monitoring equipment to be compensated for.

Relationships

The analogue output can interact with the following:

- Ion gauge/backing gauge. The analogue output can be set to scale linearly or logarithmically with the ion gauge pressure, backing pressure in either Slot A or Slot B, or a combination of ion gauge(s) + backing.
- Alternatively, the analogue output can be scaled with temperature from a type '**K**' module, set to the min or max value, made to cycle between min and max or set to a value specified over communications bus.

1.4.7 Timer (PVC*i* only)



Timer

The timer can be used to trigger external events at regular intervals, e.g. switching on a supply (e.g. TSP) for 1 minute every 6 hours. Note that the timer cannot enter the "on" state if the ion gauge is switched off.

The timer off and on periods are set by **Timer Off Time** and **Timer On Time**. These can each be set in the range 0.0 to 1440.0 minutes (=1 day) with a resolution of 0.1minute.

Timer Pressure Limit sets the maximum ion gauge pressure value below which the timer can enter the "on" state.

Timer DI Protect sets whether digital input(s) influence timer operation. A failed digital input inhibits the timer entering the "on" state.

Timer Skip to allows the user to jump to the start of the next "on" or "off" time; this effectively provides a user "reset" function.

Relationships

The timer can interact with the following components:

- Digital inputs can be used to inhibit the timer from entering the "on" state.
- The timer on state cannot be entered unless the ion gauge is on.
- The ion gauge pressure exceeding a user-defined value can inhibit the timer entering the "on" state.

1.4.8 Miscellaneous Parameters

In addition to the above, functionality, the following miscellaneous parameters are available:

- **Name** allows the 4 character name of the controller to be changed

- **Pressure Units** selects between mBar, Torr or Pascal
- Screen **Brightness** can be set at 25% (dimmest), 50%, 75% or 100% (brightest)
- The PVC offers control over the RS232/422 bus using a MODBUS protocol. Each PVC on a bus must be given a unique address (1-99), set into **Address**. The **Baud Rate** and **Parity** on all the controllers on the bus must be set to the same value as the control PC or device.
- **Version** is a read only parameter indicating the internal software version
- **Heatsink Temperature** is a read only parameter indicating the temperature of the internal heatsink (for diagnostics only)

1.5 Accessories List

An accessories pack is provided with each PVC; the parts included differ between the PVC*i* and PVC*i*Duo:

Description	PVC*i*	PVC*i*Duo
Fuse, T250mA 5x20mm. Anti-surge	1	1
Fuse, F6.3A 5x20mm. Fast action.	1	0
Fuse, F4.0A 5x20mm. Fast action.	0	2
Fuse, T2.0A 5x20mm. Anti-surge	2	2
Fuse, T3.16A 5x20mm. Anti-surge	2	2
QM Cable plug with hood, 6-way	1	2
QM Contact pins	6	12
Cable tie	1	2
BNC plug	1	2
25-Way 'D' socket	1	1
25-Way 'D' Hood	1	1
3.5mm Jack plug	1	1

1.6 W, Thoria-coated and Yttria-coated Ir Filaments

PVC*i* operates both Tungsten ("W" setting) filaments (maximum power 14V @ 5.5A) or coated Iridium ("Ir" setting) filaments (maximum power 7V @ 3.2A). PVC*i*Duo does not have the Tungsten filament power setting; this does not necessarily preclude operation of W filaments but may limit the emission current that can be obtained.

It is important that you set the Filament Type Parameter to match the type of filament you are using.

The advantages of Ir filaments are operation at higher pressures, longer life (since Ir does not suffer from embrittlement at operating temperatures), lower operating temperature and lower filament degassing under operating conditions.

Iridium filaments are coated to lower the work function; this aids emission, to lower the filament temperature. There are 2 types of coating:

- **Thoria**. This provides the best emission characteristics. **However, Thoria is toxic and slightly radioactive**.
- **Yttria**. Yttria-coating is a safe alternative to Thoria-coating. Yttria is not as effective at lowering the work function of the filament as Thoria, thus Yttria-coated filaments require ~15% MORE power than Thoria-coated filaments for the same emission.

PVC*i* and PVC*i*Duo will run Thoria or Yttria-coated Ir filaments on the "Ir" Filament Type setting.

1.7 PVCiDuo Emission Control

As mentioned in section 1.1.2, the total emission current (ion gauge 1 + ion gauge 2) for the PVC*i*Duo is 12mA. The gauges can be operated at any combination of emission currents up to and including 5mA each. In most situations, an emission current of 5mA permits pressure measurement down to the X-ray limit of the gauge head (typically low/mid 10^{-11} mBar range); lack of the 10mA emission setting therefore does not impose a lower limit to measurement in most UHV systems. As a result, the factory default setting for the **Maximum Emission** setting for both gauges is 5mA.

If the 10mA setting is required for one of the gauges (for example, in a processing chamber capable of extremely low pressures and using appropriate gauging), the **Maximum Emission** current available to the other gauge head (in load-lock or buffer/preparation chamber) will automatically be reset to 2mA. Note that the Maximum Emission parameter of the PVC*i*Duo cannot be changed during ion gauge operation.

1.8 Thermal Management System

The PVCs employs a thermal management system that keeps the temperature of the internal electronics at a near-constant temperature, thereby improving the stability of emission control and collector measurement. **Please note that the fan therefore switches on and off as required by the internal sensors within the PVCs**. If the fan is not turning, this is NOT an indication of failure – fan failure is reported by the instrument as a "Fan Fail" message on the front panel.

2. INSTALLATION AND SETTING UP

2.1 Physical

Prior to installation, please check the instrument carefully for transit damage. In the event that problems are encountered, or the instrument does not respond as indicated below, please contact your PVC dealer, referencing the serial number on the rear.

If you have ordered the Accessories pack to aid your installation, the use of the included parts is described below.

2.2 Rear Panel

2.2.1 Rear Panel PVC*i*

The rear panel of the PVC*i* instrument is shown below:

From the left, the main features are:

1. Serial communications connectors. 2x RJ45 simplifies daisy-chaining.
2. Ion gauge collector connector. BNC.
3. Analogue output connector. 3.5mm jack socket.
4. Slot A and B connectors. Mini-DIN types.
5. Trip and digital input connector. Male D25.
6. Fan vent.
7. Filament fuse. F6.3A
8. Grid fuse. T250mA.
9. Ion Gauge Power connector. 6 pin QM multipole.
10. Combined mains inlet, double fuse holder, mains on/off switch and 115/230V selector. **Note: for serial numbers below 300, the mains selector, on/off switch and mains inlet/fuse drawer were separate.**

2.2.2 Rear Panel PVC*i*Duo

The rear panel of the PVC*i*Duo instrument is shown below:

From the left, the main features are:

1. Serial communications connectors. 1x RJ45 simplifies daisy-chaining.
2. Ion gauge collector 2 connector. BNC.
3. Analogue output connector. 3.5mm jack socket.
4. Ion gauge collector 1 connector. BNC.
5. Trip and digital input connector. Male D25.
6. Slot A and B connectors. Mini-DIN types.
7. Gauge 2 Filament Fuse. F4.0A
8. Gauge 2 power connector. 6 pin QM multipole.
9. Fan vent.
10. Gauge 1 Filament Fuse. F4.3A
11. Grid fuse. T250mA.
12. Gauge 1 power connector. 6 pin QM multipole.
13. Combined mains inlet, double fuse holder, mains on/off switch and 115/230V selector.

2.3 Line Voltage Setting and Fusing

To select line voltage and/or replace fuses:

1. Disconnect the mains plug.
2. Using a small flat-bladed screw driver, lift up the hinged panel cover.
3. Using a small flat-bladed screw driver, *gently* ease the voltage selector/fuse holder and remove.

4. There are 2 fuses – both the Live and Neutral lines are fused – one on each side of the holder. The fuses can be either 5x20mm or ¼ x 1 ¼" types; the former fit into the rear section of the fuse slots, the latter the whole fuse slot. PVCi is supplied with 5x20mm fuses. **T2.0A fuses are required for 230V operation** and **T3.16A fuses are required for 115V operation**. **Please ensure correct fuse rating before continuing**.
5. Insert the voltage selector/fuse holder back so that the required voltage shows through the window of the hinged panel cover

2.4 Location

PVCs are designed to be mounted in a standard 1U high "19-inch" rack. Please note:

- **Because of the weight, PVCs MUST be supported by runners/support brackets**, as appropriate to your rack design. **The weight of the instrument MUST NOT be supported by the screws that secure the front panel to the rack** – mechanical damage caused by this form of mounting will void the EpiMax warranty.
- The instrument should be secured using appropriate screws through the front panel mounting holes. Note that these screws are intended to retain the instrument in the rack ***but will NOT support its weight***.
- The instrument is force-air cooled through grills on one side and a vent at the rear. Mount to avoid obstruction to the vents. PVC uses intelligent temperature management to ensure a stable thermal environment for the electrometer, as well as to provide thermal protection.
- **Do not stack PVCs more than 3 deep**. A 1U space should be left between groups of 3 for ventilation; this can be covered with a standard 1U blanking plate.
- **Do not mount the controller adjacent to heat generating equipment.**

2.5 Protection and interference

PVCs are designed to withstand most ion gauge fault conditions. However, care should be taken to avoid frequent fault conditions.

Equipment where high energy discharges occur (e.g. high-voltage arcing) may require that the gauge head is shielded by baffling or using an earthed fine mesh screen. Locating the gauge head near electron or ion sources may compromise pressure measurement.

Use of high frequency spark coils for leak testing should be avoided.

2.6 Ionisation Gauges.

2.6.1 Connecting up Ion Gauges

PVC*i* operates one and PVC*i*Duo operations two Bayard-Alpert type or similar ionisation gauge, see section 15 for theory of operation. Thoria- or Yttria-coated iridium filaments are recommended, since they offer prolonged life at higher pressures, however, tungsten filaments can also be used with the PVC*i* – see section 1.6. Please ensure that you set the type of filament (W or Ir-based) into the **Filament Type** parameter of the PVC*i*.

Please refer to the gauge instructions regarding mounting to the vacuum system (for example, recommendations relating to orientation to avoid filament droop). Ensure that the electrons the gauge generates do not interfere with other equipment in the vacuum system, and that electrons, ions or X-rays generated by such equipment does not interfere with gauge operation. Screening can be accomplished by positioning the ion gauge behind a solid or earthed mesh metal baffle, although care should then be taken to ensure good conductance to the rest of the vacuum system.

The ion gauge requires two connectors. The 6 pin QM connector labelled "Gauge" provides the power to the gauge. **Potentially lethal voltages are present on the cable when the ion gauge is operating; do not attempt any work on the cable whilst the PVC is powered up.** The collector signal requires a standard BNC connector. **High voltages can appear at the BNC connector if connected to a faulty or damaged ion gauge; it is ALWAYS advisable to turn off the PVC before handling the ion gauge lead.**

2.6.2 QM Power Connector

EpiMAX can supply cables for a number of standard gauge types. However, if you are using an existing ion gauge cable, a plug, shell and pins are provided within the Accessories Pack to adapt the existing cable. **A qualified electrician should perform the modification. Ensure appropriate voltage and current rating for and compliance with local safety and interference standards. EpiMAX does not accept any responsibility for operation with modified cables.**

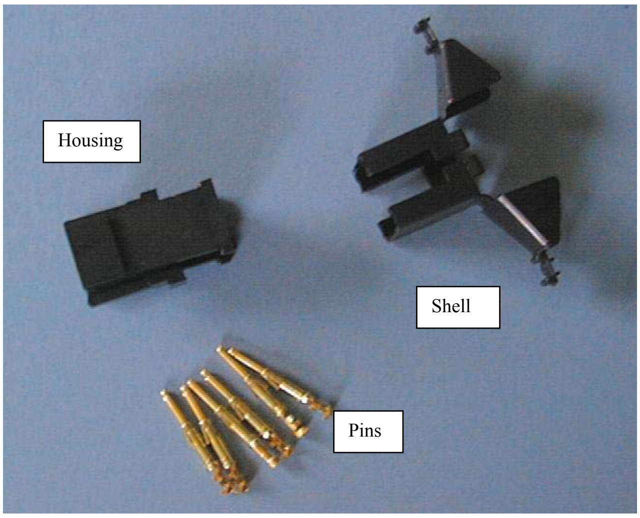
The pin allocation for the QM connector are shown right.

Pin	Function
1	Interlock$^{\text{Note 1}}$
2	Grid
3	Interlock$^{\text{Note 1}}$
4	Filament common
5	Filament 1$^{\text{Note 2}}$
6	Filament 2$^{\text{Note 2}}$

Note 1: The interlock pins MUST be connected together before the PVC will enable power to the gauge. Ideally, these should be linked *in-vacuo* at the gauge head.

Note 2: For single filament ion gauges, use filament common (pin 4) and either Filament 1 or 2 (pin 5 or 6). Ensure that the selected filament number is set in the **Filament Number** parameter.

The ion gauge filament conductors should be capable of carrying continuous currents of 6A or higher (at 250°C if bakeable cable is used) – this corresponds to a Copper cross-section of at least 1mm^2. The grid current is small (max. 250mA protected by the fuse) so finer wire can be used. ***However, the insulation on all wires must be rated for at least 1000V and should be physically protected against mechanical damage***. The cable should be kept as short as possible to minimise the voltage drop to the filament. Bakeable cables are available from EpiMAX.



The figures right shows the parts needed, and over, a completed connector.

Please ensure that you know the function of each wire of your ion gauge cable before commencing since once the pins are inserted into the housing they are difficult to remove without special tooling.

1. Strip each of the wires to the ion gauge by ~15mm.
2. Insert the bare wire into the pin, so that the insulation meets the crimp end of the pin; if it does not meet, remove and trim.
3. Carefully crimp the pin and ensure that the wire cannot be pulled out.
4. Insert the pins into the housing from the rear, taking great care to ensure correct numbering, as indicated on the plug housing. Ensure that each pin cannot be pulled out.
5. If your existing ion gauge does not provide for the interlock wires (i.e. to ensure that the cable is also attached at the ion gauge), connect a pin to each end of a 5cm long length of wire and insert into pins 1 and 3.
6. When all pins have been inserted, clip fit the shell onto the plug housing.
7. Secure the shell with the cable tie from the Accessories Pack as shown below. This acts to relieve strain on the individual conductors and restricts accidental probe entry.

2.6.3 Collector BNC connector.

In addition to the power supply leads to the ion gauge, the collector lead needs to be connected. As this carries the tiny pressure-related ion current, the lead MUST be a high quality screened cable. It connects to the rear panel BNC connector labelled "COLLECTOR"; a matching BNC plug is available in the accessories pack. The central wire should be connected to the internal pin, and the screen to the shell of the BNC. Please see the instruction sheet supplied with the BNC connector. **To avoid "earth loops" in the sensitive signal return path, the screened cable should only be earthed at the instrument end**. At the ion gauge end, the screen should be sleeved so it cannot come in contact with any other part. If modifying an existing cable using the screen as a safety earth to the ion gauge connector shell, disconnect from the shell and run a separate 4mm^2 earth wire from the shell to the system earth point.

To reduce interference, this cable should be kept as short as possible and routed away from other cables carrying high power or high frequency signals. Where there is significant noise in the measure pressure, the low pass filter time constant may need to be increased (see section 4.2.5). Typical filter values for low noise environments are 0.2 to 1 seconds, and for noisy environments 2 to 4 seconds – the factory setting is 2.0 second; *Rippa* – see section 4.2.7 – ensures that longer values do not reduce the ability of the PVC to respond to sudden pressure error conditions.

2.6.4 Ion Gauge Fuses - PVC*i*

The following fuses are associated with PVC*i* ion gauge operation and clearly labelled on the rear panel:

- **Emission Current Grid Fuse: 250mA(T) anti-surge type.** Protects the gauge and grid supply from short circuits to the grid.
- **Filament Current: 6.3A(F) fast-action type.** Protects the filament and its supply from over-current conditions, e.g. short-circuited filaments.

2.6.5 Ion Gauge Fuses - PVC*i*Duo

The following fuses are associated with PVC*i*Duo ion gauge operation; they are clearly labelled on the rear panel:

- **Emission Current Grid Fuse: 250mA(T) anti-surge type.** Protects the gauge and grid supply from short circuits to the grid. This fuse protects BOTH gauge heads.
- **Filament Current Gauge 1: 4A(F) fast-action type.** Protects gauge 1 filament and its supply from over-current conditions, e.g. short-circuits.
- **Filament Current Gauge 2: 4A(F) fast-action type.** Protects gauge 2 filament and its supply from over-current conditions, e.g. short-circuits.

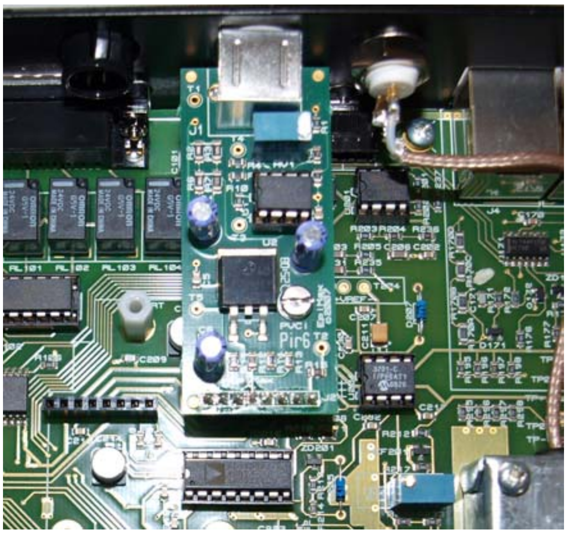
2.7 Analogue Output

Although the PVCs provide fast communications for gauge pressure and status monitoring over the serial interface, there are occasions where a simple pressure-scaled analogue output can be useful. **For full details about the implementation of the analogue output of the PVCs, please see section 11**.

The analogue output is provided via a standard 3.5mm "jack" socket. The inner connector is the output, and the outer connection is to 0V (earth). The limiting output voltage range is -0.2 to +10.2V, but this can be tailored to any voltage span using the

Minimum and **Maximum D/A** parameters; alternatively a resistor network can be used to scale the output – please section 11 for further details.

2.8 *Slots "A" and "B"*



2.8.1 Slots and Modules

In addition to the ion gauge, PVCs support one or two secondary functions depending on which "modules" are in the two option **slots**. Modules can be added as required by the user; installation of modules is described in section 2.8.2.

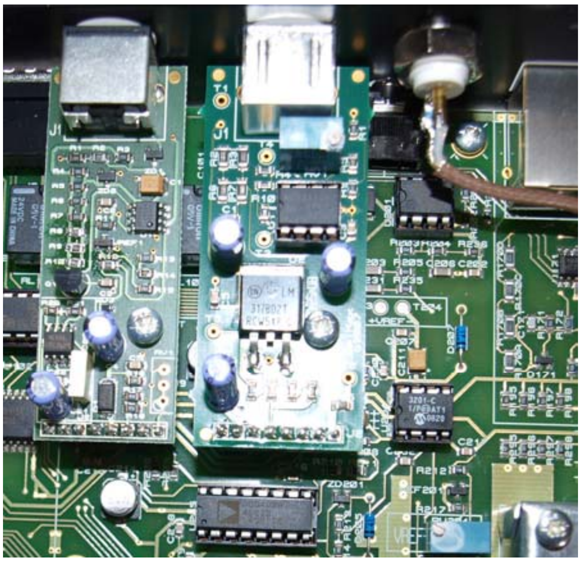
The modules connect to the devices they monitor via Mini-DIN sockets. Please refer to sections 1.3, 5 and 6 for details of modules available.

2.8.2 Installing a Module into a Slot

Installing or removing a module is relatively straightforward. However before commencing:

- **<u>Turn off the PVC. Disconnect all power and ion gauge leads. Before removing top cover, allow 5 minutes for the high voltage capacitors to fully discharge</u>.**
- **PVC contains both high voltage parts AND static-sensitive components. DO NOT TOUCH ANY ELECTRONIC COMPONENTS.**
- **Handle the modules by the edge – do NOT touch the components, the PCB tracks or the connector pins. If available, use an earthed wrist strap during installation; alternatively, touch the side of the instrument frequently to ensure you are at the same potential as the electronics.**

- Remove and retain the 6 screws on the sides of the PVC. Carefully lift the cover off.
- Place the PVC with the rear of the instrument facing you and locate the 2x 8pin slot sockets by identification on the rear panel.
- The picture (above) shows a PVC with a Type **'V'** Pirani module in Slot A; Slot B being free. The Slots are labelled on the rear panel of the instrument. Note the 8 pin socket that connects the module Slot of the mother board, and the free PTFE pillar which secure the module.
- Gently push the plug outwards from the inside to remove the blanking plug from the Slot position that the module will be installed into.
- Each module has an 8 way connector below the board which must match up with the 8 way socket on the mother board. This is shown in the photograph above. The modules are secured in place using one 6mm long M3 bolts and washers (supplied with the module).
- Insert the 8 way connector into the socket from above. **Ensure that the plug and sockets align so that all 8 pins are inserted into their corresponding holes**. **The M3 securing hole should line up correctly with the threaded tops of the PTFE support pillar**.
- Secure the module by using the M3 bolt and locking washers. **DO NOT OVER-TIGHTEN THE BOLTS; DOING SO WILL STRIP THE THREAD WITHIN THE PTFE SUPPORT PILLARS**.
- The picture shows the view after installation of a Pirani Type **'T'** module.
- Finally, replace the cover ensuring the correct orientation. Secure with the 6 screws removed in the first step.



2.8.3 Removing a Module

Removing a module follows the same basic procedure as indicated for installation – please refer to section 2.8.2 for important safety information and for description of locations and parts.

To remove the module, remove the M3 securing bolt completely, then, holding the mini-DIN connector and the far edge of the module, lift to disconnect the pins from the mother board socket. Store in a static-protective bag, or wrap in Aluminium foil. Replace the hole plug.

2.8.4 Module Auto-Identification

As part of its power up sequence, PVC interrogates the slots to determine to identify any modules present. It then reconfigures itself to accommodate the installed modules. After module insertion or removal, you may need to reconfigure some of the parameters (for example, trips and digital inputs) to achieve the desired module functionality.

2.9 Process Control "Trip" Outputs and Digital Inputs

2.9.1 Digital functions

Function	Pin	Pin	Function
		1	Relay 1 Normally Open
Relay 1 Common	14		
		2	Relay 1 Normally Closed
Relay 2 Normally Open	15		
		3	Relay 2 Common
Relay 2 Normally Closed	16		
		4	Relay 3 Normally Open
Relay 3 Common	17		
		5	Relay 3 Normally Closed
Relay 4 Normally Open	18		
		6	Relay 4 Common
Relay 4 Normally Closed	19		
		7	Outputs 5 to 7 0V (Earth)
Outputs 5 to 7 0V (Earth)	20		
		8	Open Collector Trip 5
Open Collector Trip 6	21		
		9	Open Collector Trip 7
[Not connected]	22		
		10	Outputs 5 to 7 0V (Earth)
Outputs 5 to 7 0V (Earth)	23		
		11	[Not connected]
Digital 1 input +ve	24		
		12	Digital input 1 –ve
Digital 2 input +ve	25		
		13	Digital input 2 –ve

PVCs provide 7 process "trips" as standard (four change-over relays and 3 open-collector NPN transistor outputs). These can be used for pressure-dependent interlocking, pump-down control, bake-out on/off control and timer output. The trips are individually assignable to the required function, thus more than one trip can be associated with each function. The trips can be overriden (set "on"), inhibited (set "off") or operated as dictated by the assigned function.

PVCs also provides 2 opto-isolated digital inputs. Various PVC functions can be set to depend on the state of one or both digital inputs, for example, tripping the ion gauge, suspending bake-out etc.

For safety when handling the trip connector, do NOT connect voltages in excess of 40Vdc/ac to relay trips, and in excess of 20Vdc to open-collector trips.

DO NOT CONNECT MAINS/LINE VOLTAGES TO THE CONNECTOR; IF MAINS/LINE VOLTAGES ARE TO BE SWITCHED, USE AN INTERMEDIATE RELAY (see sections 2.9.3, 2.9.4 and 2.9.6).

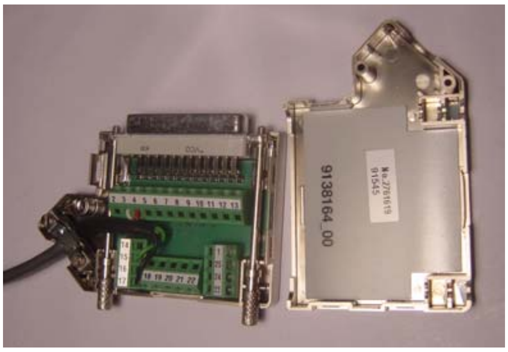
It is the user's responsibility to ensure that the switched signals are wired safely, and the trip levels are appropriate to the application and to the safety of personnel and equipment. Although PVC provides inhibit/over-ride functionality, in hazardous or safety-critical applications, an additional fail-safe should be provided.

The trips and digital inputs are accessed via a male D25 connector (female required on connecting cable) with pin assignments as shown left.

2.9.2 Wiring of the Digital I/O

When connecting up the relays, open-collector outputs and digital inputs, please ensure their voltage/current ratings/requirements – there are discussed in detail in the remained of section 2. Relay ratings are specifically selected to match use of DB25-type connector.

To permit soldering-free wiring, a DB25 to screw terminal converter is available (part code PVCiS25 – see figure):



- **With the PVCS25, do NOT use voltages that exceed 40V dc or 40V ac for the relays trips (trips 1 to 4)**
- **Do NOT use voltages that exceed 20Vdc or <u>ac</u> voltages at any level with the open-collector trips (Trips 5-7)**
- **Ensure that appropriate diode or snubber protection is used with inductive loads – see section 2.9.3 of the handbook.**
- **Do NOT exceed 32Vdc or use ac voltages with the digital inputs**
- **The PVCiS25 is specified for operation with voltages not exceeding 40V dc/ac**
- **To switch mains/line voltages, use an suitably specified intermediate relay**

- **Ensure that the switched signals are wired safely and that the trip levels are appropriate to the application. Although PVC provides inhibit/over-ride functionality, in hazardous or safety-critical applications, additional fail-safes MUST be provided.**

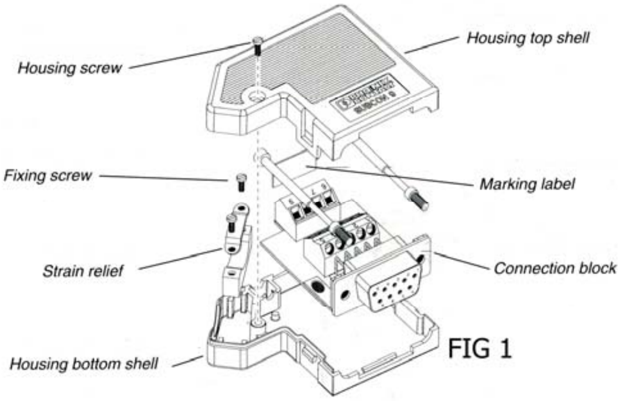


FIG 1

Fig 1: Cable entry from left or right (see Fig 2) by rotating connection block in the housing

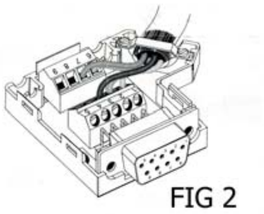


FIG 2

Fig 2: If shielded (screened) wire is used, trap the strands under the strain relief clamp

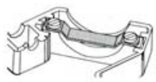


FIG 3

Fig 3: To clamp small cable cross-sections, install the clamp upside down

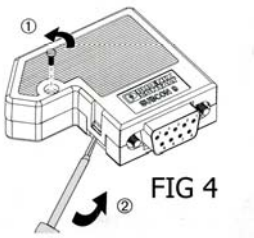


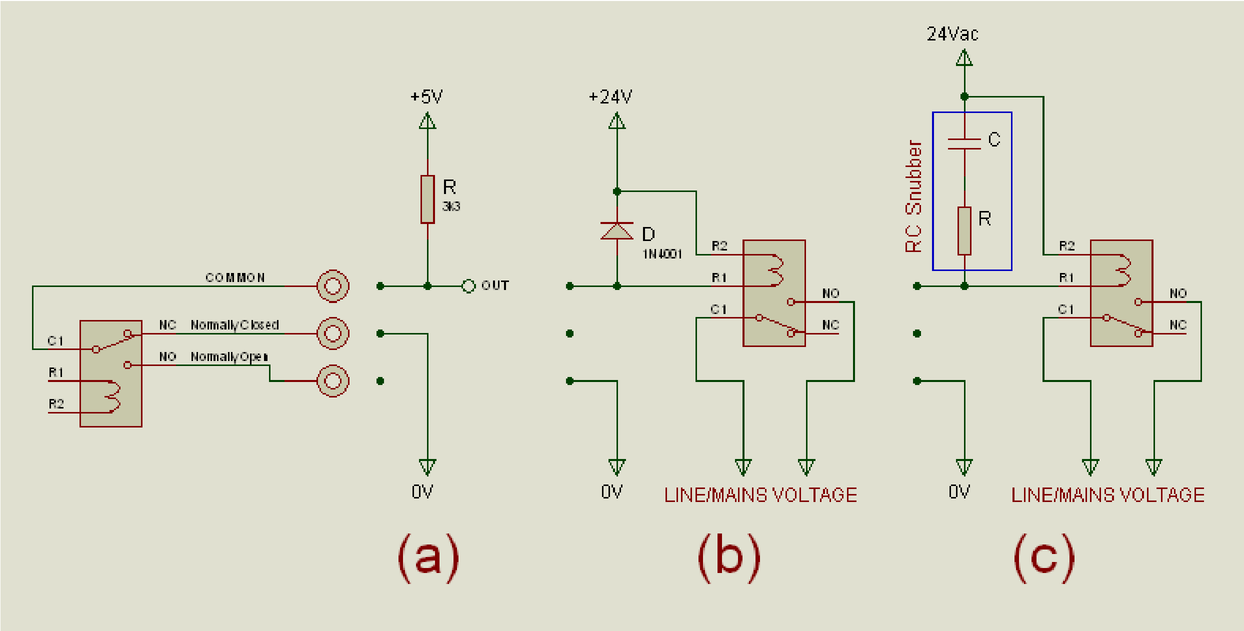
FIG 4

Fig 4: To open the housing:
1. Remove the housing screw
2. Unlatch the housing top shell using a screw driver

2.9.3 Relay Applications

Trips 1 to 4 are provided with single pole, change-over relays, contacts rated at 1A@24V dc, 0.5A @ 125Vac. (max. switched power 30W, 62.5VA). The minimum switching capacity is 1mA @ 5Vdc. **Note that to ensure long life operation for the relay contacts when driving inductive or capacitive loads, standard methods of spike suppression (see below) MUST be used.**

The following diagram shows several typical applications:



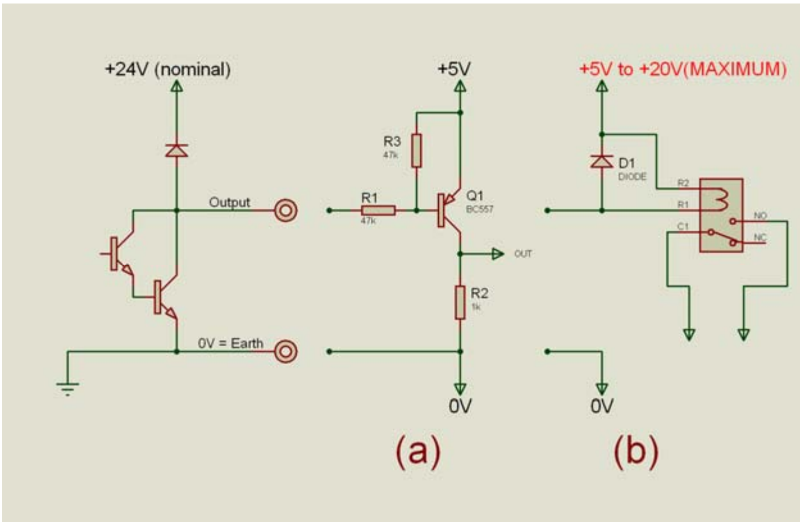
(a) Uses the normally closed contact to output 0V when the trip is off and +5V when the trip is on, e.g. for interfacing to TTL circuitry with galvanic isolation. Since the minimum reliable switching current for the relay is 1mA, the <u>maximum</u> value of pull-up resistor at 5V is 5kΩ.

(b) Illustrates switching line/mains voltage levels and/or high currents using an intermediate relay with a 24Vdc coil. Note that the relay coil resistance must be greater than 30Ω to limit switched current to 1A. As shown, a reverse-biased diode is required to suppress back-emf during relay switching; the diode must a reverse voltage rating well in excess of the dc supply voltage and should be current rated at > 2x current flow through the coil. For example, a 1N4001 diode (rated at 1A) is suitable for supplies up to 40V and relay coil resistances >120Ω.

(c) Illustrates the method for switching line/mains voltage levels and/or high currents using an intermediate relay with a 24Vac coil. Note that the relay coil resistance must be greater than 30Ω to limit switched current to 1A. As shown, an RC snubber network is required to suppress back-emf during relay switching. Typical values for R and C are 100Ω and 100nF; these can be obtained in an integrated package with R and C built in. Alternatively, appropriately specified Varistors can be used, rated at voltage values of 2x the ac rms supply voltage.

2.9.4 Open-collector Applications

Trips 5, 6 and 7 are provided as open-collector Darlington type outputs capable of switching 250mA. **DO NOT EXCEED 20Vdc at the open collector outputs.** The equivalent circuit of the Open-collector outputs is shown on the left of the diagram; applying voltages in excess of 20Vdc could exceed the internal 24V (nominal) supply and cause damage to the internal PVC electronics.



Two typical applications are shown:

(a) Switching of TTL level devices. Since the output comprises a Darlington pair (to provide the high current sink capability), a voltage of ~1V or more can be present between the output and the 0V line. This may exceed the low logic level threshold for some logic families (e.g. 74HC series). The circuit shown provides a suitable buffer, and in addition inverts the output (i.e. there will be 0V output when the trip is off and +5V when the trip is on). R2 can be any value above 560Ω.

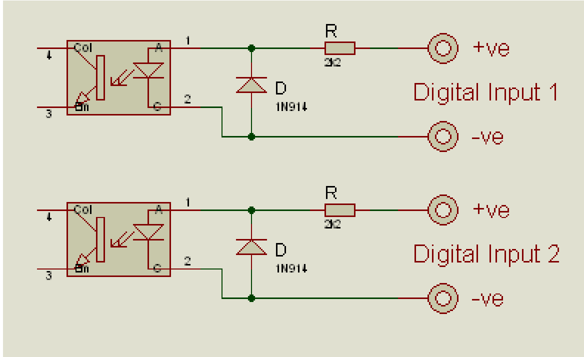
(b) Illustrates switching line/mains voltage levels and/or high currents using an intermediate relay. Note that the relay coil resistance must be such as to ensure that the current sink into the open collector is <250mA (e.g. >50Ω at 12V) . A reverse-biased diode is required to suppress back-emf during relay switching; the diode must a reverse voltage rating well in excess of the dc supply voltage and should be current rated at > 2x current flow through the coil.

Notes:

- **The 0V (common) line for trips 5, 6 and 7 is internally wired to earth potential**. Ensure that any power supply used is either floating (i.e. not earth referenced) or is earthed at its negative terminal.
- **The open-collector output CANNOT be used with ac supplies**.
- **Ensure correct polarity connection**

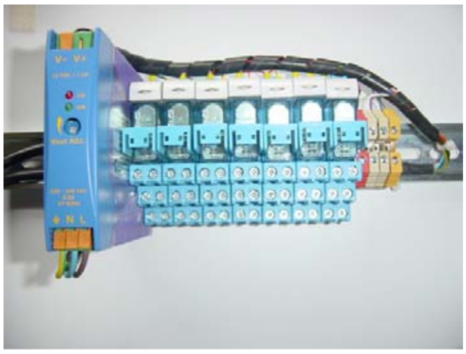
2.9.5 Digital Input Applications

The equivalent circuit for the 2 digital inputs is shown right:



- Both inputs are isolated from each other and from ground. They can therefore be connected to any voltage source in the range 3V to 32V, floating or grounded. Higher voltages can be used by putting a resistor in series with the +ve input pin; the current should be limited to ~10mA.
- The input polarity MUST be observed. However, the reverse biased diode (D) protects the opto-isolator in the event of reverse connection.
- AC supplies should NOT be used.

2.9.6 High Power Trips/Digital Extension Unit – PVCRL7DIN



The maximum voltages handled by PVC trips are limited to comply with safety directives. Sections 2.9.3 & 4 described how to increase the voltage and current capabilities. Alternatively, the EpiMax PVCRL7DIN (shown right) provides seven 16A change over relays (at up to 380Vac) operated by a PVC. Typical applications include switching of bake-out heaters (single or three phase), power supply/control switching and valve interlocking.

The unit connects to the PVC DB25 connector via a 2m long cable (included) and incorporates screw terminals for connecting to the digital inputs. The relays are powered from an "universal" power supply shown left of the relays (96-256Vac).

2.10 Serial Interface

2.10.1 Serial Communications Daisy-Chaining

The communications protocol used by the PVC allows several PVCs to be connected to the same computer/PLC serial port. The PVC*i* has 2 parallel-wired RJ45 serial connectors; the host PC is connected to one, and the other used to "daisy-chain" to the next controller etc. Due to lack of rear panel space, the PVC*i*Duo has only 1 RJ45 serial connector, daisy chaining therefore requires a "hub" (a box that has several RJ45 wired in parallel).

PVCs provide RS232 and RS485 (3 wire) interfaces. The RS485 interface allows up to 16 PVCs can be connected to an RS485 bus. Although RS232 was originally designed to allow a PC to communicate with only 1 device, **PVCs implement a "dormant" state for the transmit line when data is not being transmitted allowing up to 8 PVCs to be connected to a single RS232 port**.

2.10.2 Configuration of the PVC's Serial Connectors

PVCs provide RS232 and RS485 communications as standard wired via shielded RJ45 8-pin connectors as shown right.

Note that the RS485 0V return signal at pins 4, 5 and 6 is connected to internal 0V (earth) via a 100Ω resistor to reduce the likelihood of earth loops when using the RS485 interface.

Pin	Function
1	RS232 0V (Earth)
2	RS232 receive
3	RS232 transmit
4	RS485 0V return
5	RS485 0V return
6	RS485 0V return
7	RS485 transmit A
8	RS485 transmit B
Shield	Earth

2.10.3 RJ45 8/8 Connectors

The connectors used by the PVCs are standard "telephone" types known as **shielded RJ45 8/8**. These have 8 "pins" and a shield contact that couples with screen of the cable. The advantages of this type of connector are:

- Plug and play wiring
- Industry standard type specifically designed for data networking/communications.
- Inexpensive, ready-made moulded cable assemblies are available from a large number of electrical/telecommunications suppliers; alternatively EpiMax can supply your needs.

Cable assemblies are available as UTP (unscreened/unshielded) and FTP (screened/shielded). **We strongly recommend use of the screened/shielded FPT variety, since they provide significant benefits in terms of noise exclusion. They are generally referred to as "SHIELDED, Cat5e COMPLIANT, RJ45 PATCH LEADS".**

2.10.4 Connection from host to the first PVC

There are a number of serial connectors used by host PCs, PLCs etc. For example, the "standard" PC RS232 serial port is either a 9 pin and 25 pin DB type. In the case of the RS485 port, most manufacturers use their own proprietary connection scheme.

For this reason, although daisy-chaining of PVCs can be accomplished using standard and cheap cable assemblies, the cable connecting the first PVC in a chain to the host serial port requires consideration. However, EpiMax offers several ready-made solutions (e.g. to standard PC ports and EpiMax ControlFrame and EpiFrame Universal Interface Instruments), as well as a kit that makes manufacturer for a non-standard cable configuration easy. These are discussed in subsequent sections.

2.10.5 Standard 9-pin PC RS232 to PVC*i* Interface Cable (PVCi-9D232)

The 3m long PVCi-9D232 cable connects a standard PC RS232 interface connector to the first of up to 8 daisy-chained PVC*i*'s or to a RJ45 hub which is then connected to PVC*i*Duos using a daisy-chain cable. Longer cables can be supplied on request.

The interface is 3 wire (transmit, receive and 0V). Handshaking connections within the PC connector are terminated accordingly.

A converter from 9 pin to 25 pin connector can used for PC having the older style D25 connector.

2.10.6 Flexible Communications Cable (PVCi-UTD)

This 3m cable allows a PVC RJ45 connector to be wired into virtually any RS232 or RS485 port. One end of the cable is free (no connector) and needs to be soldered to a connector corresponding to the type used by the serial port.

The cable supplied is 8-core, screened, comprising 4 pairs of twisted wires. **In wiring using the cable, the screened should be stripped back and insulated to preclude its contact to any other wire.** The screen is wired at the RJ45 connector end to internal 0V.

To Connect To RS232 Port connect the following wires:

All unused wires should be clipped back and insulated to ensure that their conductors do not touch any metal parts.

In addition, to disable hand-shaking:

- Connect RTS and CTS pins together. (9-pin PC port: Link 7 & 8; 25-pin PC port: Link 4 & 5)
- Connect DSR, DCD and DTR together. (9-pin PC port: Link 1, 4 & 6; 25-pin PC port: Link 6, 8 & 20)

Host RS232 pin	Wire colour	PVC pin & function
0V or "Ground Return"	Orange/White	Pin 1 – 0V
Transmit	Orange	Pin 2 – Receive
Receive	Green/White	Pin 3 – Transmit

To Connect To RS485 (3-wire) Port connect the following wires:

All unused wires should be clipped back and insulated to ensure that their conductors do not touch any metal parts.

Host RS232 pin	Wire colour	PVC pin & function
0V or "Ground Return"	Orange/White	Pin 6 – 0V
B	Brown	Pin 8
A	Brown/White	Pin 7

2.10.7 Daisy-chain Cable (PVCi-RJ45-x)

Provision of 2 communications connectors allows simple daisy-chaining of PVCs to a serial port; up to 8 PVCs can be connected to an RS232 port and 16 to an RS485 port. The PVCi-RJ45 cables are standard network cables and allow PVCs to be daisy-chained together. The cable can be supplied in lengths of 1, 2 or 3 metres.

Note that all the PVCs on the bus will automatically operate on which ever comms interface (RS232 or RS485) is wired at the PC.

NOTE: When daisy-chaining PVCs, it is recommended that the total length of cable (i.e. from the host interface port to the last PVC in the chain) does NOT exceed 15m.

2.11 Earthing and Initial Power Up

WARNING: High and potentially lethal voltages are present at the ion gauge. Furthermore electrical discharges may occur through the gas resulting in high voltages in some parts of the vacuum system. Care should be taken when handling ion gauge cables.

PVCs HAVE A GROUNDED SCREW TERMINAL ON THE REAR PANEL. THIS SHOULD BE CONNECTED USING A HEAVY DUTY GROUND WIRE (>=4mm^2 or 12awg) TO THE VACUUM SYSTEM EARTH DISTRIBUTION POINT.

1. Ensure that the earth terminal at the rear of the PVC is securely wired to an appropriate earth point on the vacuum system.
2. Ensure the mains line voltage is correctly set and appropriate fusing is present - see section 2.3.
3. Ensure that the ON/OFF switch is set to OFF. Note that the ON/OFF switch is located on the rear panel, since the PVC is intended for continuous operation. If frequent off periods are required, PVC should be powered from a suitable switched power source.
4. Attach gauge and relays connectors as appropriate.
5. Connect the line cord to the appropriate mains socket and to an appropriate supply.
6. Turn the gauge ON/OFF switch to ON. The PVC logo will appear for approximately 5 seconds whilst the instrument powers up and retrieves data settings, after which the ion gauge status will be displayed.

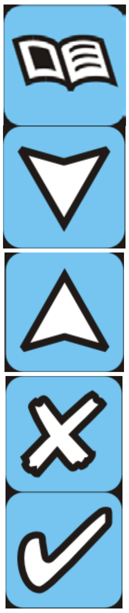
3.1 Front Panel Controls and Displays

The PVC front panel is shown below:

From the left, the front panels comprise:
1. **20 character VFD Display**. Provides alpha-numeric status information.
2. **5 Push Buttons**. For manual control of PVC.

3.2 Manual Control and Button Operation

The PVCs can be controlled from the front panel, or over its communications bus. Front panel control is via the 5 touch panel buttons:



MENU BUTTON
Provides access to the menu structure

DOWN BUTTON
Decreases the value of numerical data

UP BUTTON
1. Increases the value of numerical data
2. With Menu button, scrolls upwards through the Parameter Menu

CANCEL BUTTON
Cancels entered data, returning to previous value.
Exits from Parameter Menu

OK BUTTON
Enters newly entered data.

The buttons are "membrane" types, comprising a domed area with a tactile response when pressed. They are designed to be used with fingers. DAMAGE CAUSED BY USING SHARP OBJECTS ON THE BUTTONS IS NOT COVERED BY WARRANTY.

To access a menu, repeatedly press (or hold down) the MENU button until it appears. Press the OK button to enter the menu. Press the MENU button (or hold down) to scroll through the menu items; the current value for each is indicated by the '**=**' symbol at the right side of the screen. Pressing the UP or DOWN buttons scrolls through the available options or changes the values. For numerical values, holding the UP or DOWN buttons will cause the rate at which the number increments/decrements to increase after ~4 seconds. When a parameter value has been changed, the '**=**' symbol changes to '**?**'; to enter the new value, press OK, to revert to the old value, press CANCEL. To move back up a level, press CANCEL; repeat as required to return to the default screen.

PVC*i*: From the default screen (ion gauge pressure), pressing UP displays information for slots A and B (e.g. Pirani pressure and thermocouple module temperature). Pressing UP again indicates status of the bake-out programme and UP again, the Timer function status.

PVC*i*Duo: From the default screen (pressure of both gauges), pressing the UP button causes the pressure display for ion gauge 1 only to appear (as well as unit name) and again shows ion gauge 2 only. Further presses of the UP button causes the information for slots A and B to be displayed, and then the bake-out status screen.

3.3 The PVC Display

The PVC displays comprise a 20off 5x7 pixel matrix, thus up to 20 alpha-numeric and graphical characters can be displayed. The brightness of the display can be set to match ambient light conditions, the default 50% setting is sufficient for most lighting situations.

Information on the PVCs is displayed in "pages" – complete sets of information relating to the instrument or some aspects of its behaviour. There are 3 page catagories:

- **Instrument Pages**. This is the default power-up page and provides key information about the current status of the instrument.
  The **PVC*i*** has 1 instrument page which shows the current status of the ion gauge or the pump-down status (pressure, emission, slot A and B bargraphs, bake-out status, Digital I/O status). See section 3.4 for discussion of the PVC*i* Instrument Page.
  The **PVC*i*Duo** has 3 instrument pages: (i) a summary of the pressure status of both ion gauges, (ii) the full status of ion gauge 1 and (iii) the full status of ion gauge 2. In addition, all 3 instrument pages of the PVC*i*Duo also show slot A and B bargraphs, bake-out status, Digital I/O status. See section 3.5 for discussion of PVC*i*Duo Instrument pages.
- **Process Pages**. These display a summary of various process features, for example, bake-out status, slot A and B, pump-down status, timer status. See section 3.5.
- **Menu Pages**. Menus provide access to parameters or parameter groups for editing. **Menus are accessed and scrolled between using the MENU button**. See section 3.6.

Once an Instrument Page is selected by the user, it remains visible continually. However, if process or menu pages are selected and no action is taken by the user for ~5 minutes, the PVC's revert to the last instrument page that was displayed.

3.4 PVCi Instrument Pages

3.4.1 The PVC*i* Instrument Page

The information displayed on the instrument page of the PVC*i* depends on whether the instrument is in Pump-Down or not. For information on Pump-Down presentation, please see section 3.4.2.

The Ion Gauge Status summary provides the following information:
Character 1: Slot A and B summary. The second and fourth vertical row of pixels show the state of Slots A and B respectively; note the "A B" legend below the character. If no pixel in the column is lit, no board resides in the corresponding Slot. A single pixel at the bottom indicates lowest value, and a complete vertical column the highest state. The table summarizes the conditions for some modules:

Number of Pixels	Type **'T'** & **'V'** modules (mBar*)	Type **'K'** Thermocouple module (°C)
7	Atmosphere (>100)	>600
6	>10	>500
5	>1	>400
4	>1x10^{-1}	>300
3	>1x10^{-2}	>200
2	>2x10^{-3}	>100
1	>=1x10^{-3}	<=100
0	No board in slot	No board in slot

* Apply appropriate correction factor for other pressure units

Character 2: Normally blank. However, during bake-out, this character flashes "°C".
Characters 3-6: Instrument Name. Shows the 4 character user-defined instrument name. See section 13.2.1.
Characters 7-17: Ion gauge pressure and status. The pressure is displayed in exponential format (e.g. 1.23E-9), using 1 or 2 decimal place mantissa (as set in the Ion Gauge menu – see section 4.2.8). The value is followed by the instruments (mB, T or Pa). Finally, a trend arrow indicates whether the pressure is increasing, decreasing or staying unchanged.
Character 18: Emission current. The emission current is displayed as ".1", ".2", ".5", "1.", "2.", "5." or "10". If blank, the ion gauge is OFF. If the top row of pixels above the emission current is illuminated (see below), PVC*i* is set to auto-range the emission – the indicated value is that currently selected by PVC*i*.

Character 19: Digital Inputs. The two top rows indicate the status of digital inputs 1 and 2:

State	Indication
Inhibit	□■■■■
OFF	□□■■■
ON	■■■□□
Over-ride	■■■■□

Where □ = Pixel illuminated and ■ = Pixel off

Character 20: Trips. Each row corresponds to the status of a trip, with the top row = Trip 1 and the bottom row = Trip 7, as indicated on the legend on the instrument. The indication is as for character 19 Digital Inputs above.

To illustrate the digital input/output indication:

Both digital inputs are off.
Trips 1, 6 and 7 are ON, Trips 2 and 5 are OFF, Trip 3 is inhibited and Trip 4 is over-ridden.

3.4.2 The PVC*i* Ion Gauge Status Summary during Pump-Down

A backing pressure board is present in Slot A can be used to control system pump down of the and start-up of the ion gauge – see section 8. As indicated above, if the instrument is performing a system pump down, the Ion Gauge Status Summary differs from that discussed in section 3.4.1 in the information presented in characters 3 to 17.

Characters 3-6: The instrument name is replaced with "PD:" to indicate that a pump down is in progress.
Characters 7-17: The ion gauge pressure is replaced with the Pirani pressure. If this pressure is below the ion gauge start up value, "ig" is appended. Once the Start-up Delay time has elapsed, the display indicates the attempt number to start the gauge and the start-up emission current. If a digital input is allocated to pump down, failure of the digital input(s) will be indicated by the message "DI Fail".

3.5 PVC*i*Duo Instrument Pages

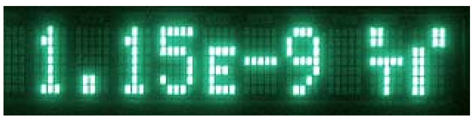
3.5.1 The PVC*i*Duo Instrument Pages

The PVC*i*Duo has 3 instrument pages. They are scrolled to using either the **UP** or **DOWN** buttons; further operation of these buttons takes the user to the Process Pages.

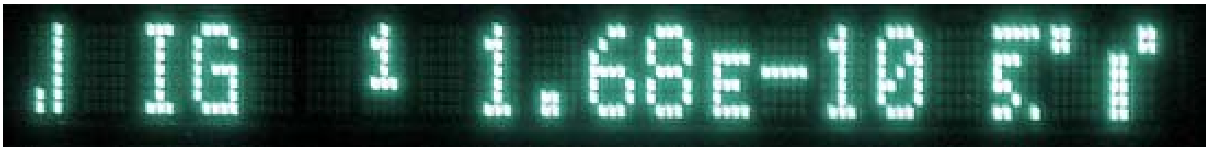
3.5.2 PVC*i*Duo All Gauges Instrument Page

This page provides information regarding the pressure status of both ion gauges, as well as summary information relating to the 2 slots, bake-out and digital trips. It does not show the instrument name or the emission status for the two gauges.

Characters 1, 2 and 20: Please refer to section 3.4.1 for information regarding their function.
Characters 3-9: Ion Gauge 1 Status/Pressure. This shows the status (e.g. OFF or Interlock status) or current pressure of ion gauge 1. The pressure displayed at the resolution selected (1 or 2 decimal places); however, for clarity of presentation, a resolution of 1 decimal places is always used at pressures below 1.0e-9 (see above).
Characters 11-17: Ion Gauge 2 Status/Pressure. As characters 3-9 but for gauge 2.
Character 19: Digital Inputs and Pressure Units. The two top rows indicate the status of digital inputs 1 and 2, as discussed in section 3.4.1. In addition, the lower 4 rows show the pressure units in use. For example, the 'T' in the example right indicates that the units are Torr. 'P' indicates Pascal and blank space (see picture above) indicates mBar



3.5.3 PVC*i*Duo Gauge 1 and 2 Instrument Pages



The PVC*i*Duo Ion Gauge 1 Status summary provides the following information:

Characters 1-6: Please see section 3.4.1
Character 7: Ion gauge Number. Shows a superscripted "1" for gauge 1 instrument page (see above) or "2" for gauge 2 instrument page
Characters 9-16: Ion gauge pressure and status. The pressure is displayed in exponential format (e.g. 1.23E-9), using 1 or 2 decimal place mantissa (as set in the Ion Gauge menu – see section 4.2.8).
Character 18: Emission current. See section 3.4.1.
Character 19: Digital Inputs and Pressure Units. See section 3.5.2.
Character 20: Trips. See section 3.4.1

3.6 PVC Process Pages

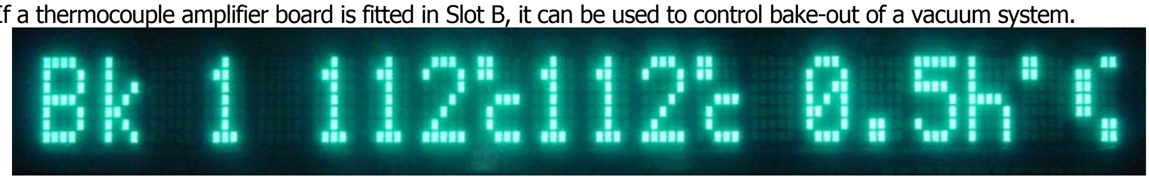
3.6.1 Slot Process Page

The Slot Process Page provides numeric presentation of data for the two options Slots.

Characters 1-9: Slot A. "A:" followed by measured value for device in Slot A. For backing pressure boards, the pressure units are as for the ion gauge. For thermocouple amplifier boards, the instruments of °C are indicated on the display.
Characters 10-18: Slot B. "B:" followed by measured value for device in Slot B.
Characters 19 and **20**: See section 3.4.1.
If one of the slots is empty, its data area is represented as "-----".

3.6.2 Bake-out Process Page

If a thermocouple amplifier board is fitted in Slot B, it can be used to control bake-out of a vacuum system.

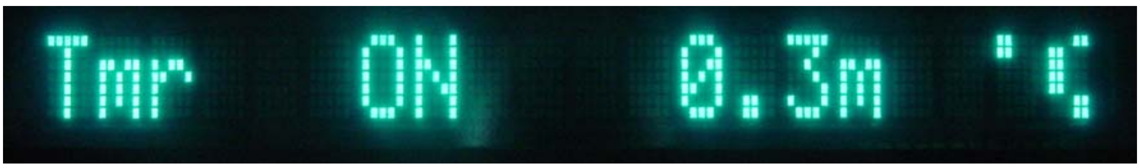


Characters 1-2: Indicator. "Bk" bake-out indicator
Characters 4-9: During bake-out, the step index (1 to 6) followed by the Setpoint temperature. When not in bake-out, "PrTrip" if ion gauge is off, "DIFail" if digital input inhibited or "OFF".
Characters 10-12: Measured Temperature.
Character 13: Instruments. Always °C.
Characters 54-18: Remaining Time. The remaining time for the complete bake-out sequence is indicated. For times > 9.9 hours, no decimal places, otherwise 1 decimal place. The remaining time display will alternate with one of the following messages if the condition arises:

- "**DI**" if protected by a digital input that has failed with the "normal" digital input protection option set.
- "**DISp**" if protected by a digital input that has failed with the "suspend" digital input protection option set.
- "**Pr**" if the ion gauge pressure exceeds the bake-out pressure limit with the "normal" over-pressure protection option set.
- "**PrSp**" if the ion gauge pressure exceeds the bake-out pressure limit with the "suspend" over-pressure protection option set.

Characters 19 and **20**: See section 3.4.1.
If Slot B does not have a thermocouple board fitted, the display indicates "Bk ----- ".

3.6.3 Timer Summary Display – PVC*i* ONLY



The Timer Summary Display provides information about the current state of the timer:
Characters 1-3: "Tmr"

Characters 5-10: Status. "ON"/"OFF" for normal operation. If operation is inhibited by the ion gauge being off or pressure above the Pressure Limit, or by the Digital inputs the display reads "**PrTrip**" or "**DIFail**" respectively.
Characters 12-16: Remaining Time. The remaining time in the ON or OFF period. For times > 99mins, no decimal places, otherwise 1 decimal place.
Characters 19 and **20**: See section 3.4.1.

3.7 Default Menus for Instrument and Process Pages

Pressing the **MENU** button from within any of the Instrument or Process Pages, provides direct access to the menu item most closely associated with that page.

3.7.1 Default Menus for PVC*i*

- **Instrument Page**. Selection of the required emission current – see section 3.8.
- **Slot Process Page**. Neither the Pirani nor the Thermocouple boards have any editable parameters; PVC*i* therefore provides access to the ion gauge emission menu.
- **Bake-Out Process Page**. Start/Stop Bake-out option.
- **Timer Process Page**. Skip to start of On/Off time.

3.7.2 Default Menus for PVC*i*Duo

- **Instrument Page**. Selection of the required emission current for ion gauge 1. Pressing **MENU** again provides access to the required emission current for ion gauge 2. See section 3.8
- **Ion gauge 1 Page**. Selection of the required emission current for ion gauge 1 – see section 3.8
- **Ion gauge 2 Page**. Selection of the required emission current for ion gauge 2 – see section 3.8
- **Slot Process Page**. Neither the Pirani nor the Thermocouple boards have any editable parameters; PVC*i*Duo therefore provides access to the ion gauge 1 emission menu.
- **Bake-Out Process Page**. Start/Stop Bake-out option.

3.8 Menu Structure – Parameter Editing

3.8.1 Parameters

All parameters values are accessed/edited using the 5 front panel buttons. The parameters are organised in a Menu-like structure, where parameters associated with a given display or function are grouped together. The complete parameter list and scrolling order is summarised at the rear of this document, and on the separate sheet provided with the controller.
Note that many of the parameters are non-volatile, i.e. they saved when PVC is switched off – see section 3.9.

3.8.2 Menu Groups

Starting at the Instrument Page, pressing the **MENU** button, or holding the **MENU** button down scrolls through the menu groups as follows:

PVC*i*	**PVC*i*Duo**
➔ Ion Gauge Emission Selection	➔ Ion Gauge 1 Emission Selection
	➔ Ion Gauge 2 Emission Selection
➔ Ion Gauge Menu	➔ Ion Gauge 1 Menu
	➔ Ion Gauge 2 Menu
➔ Slot A Menu[A]	➔ Slot A Menu[A]
➔ Slot B Menu[A]	➔ Slot B Menu[A]
➔ Trip 1 Menu ➔ … ➔ Trip 7 Menu	➔ Trip 1 Menu ➔ … ➔ Trip 7 Menu
➔ Digital Input 1 Menu ➔ Digital Input 2 Menu	➔ Digital Input 1 Menu ➔ Digital Input 2 Menu
➔ Pump Down Menu[B]	
➔ Bake-out Menu[C]	➔ Bake-out Menu[C]
➔ D/A Output Menu	➔ D/A Output Menu
➔ Timer Menu	
➔ Setup Menu	➔ Setup Menu
➔ return to Emission and then restart cycle	➔ return to Emission and then restart cycle

[A] If Slot is occupied
[B] Only available if Backing Pressure module is resident in Slot A and ion gauge is off
[C] Only available if a thermocouple amplifier module is resident in Slot B

Press the **OK** button to enter a menu. On reaching "Setup", the menu returns to "Emission" and starts to cycle through again.

3.8.3 Editing Parameters

Sections 4 onwards provide specific information about the parameters. This section describes the process of editing parameters values.

On entering a parameter, PVC displays the current value of the parameter. This could be a numerical value (such as a sensitivity of 19.0 $mBar^{-1}$), an option value (such as Iridium filament) or a parameter state (such as Trip 1 in override). The current value is indicated by the equals sign "=" in the last character of the display. Values are scrolled up or down using the **UP** or **DOWN** buttons. **Note: the rate at which numerical values change increases the longer the UP or DOWN buttons are held**, thereby speeding changes to parameters with a large dynamic/numerical range (e.g. pressure level values, D/A output). On releasing the buttons, the rate at which the value changes reverts to the initial slow speed.

The current value of a parameter is indicated with '=' in the last display character. A modified value is indicated with '?'.

Once the required value is selected, the value must be "entered" by pressing the OK button; '**?**' then changes to '**=**'. Pressing the **CANCEL** button, returns the value to its current state, i.e. the value displayed when the parameter was entered.

3.8.4 Returning through the Menus using the CANCEL button

Pressing the **CANCEL** button at any time allows you to step back to a higher level. For example, when editing a parameter value, pressing **CANCEL** will return the currently set value (see section 3.8.3), then return to the Menu Group, then return to the last Instrument Page displayed.

3.9 Power Off Data Retention

Many of the parameters are non-volatile, that is, they are retained in EEPROM when the instrument is switched off. During the power up sequence, the parameters are read back into the µprocessor, and their format is verified to ensure that the values are valid.

In the event that the µprocessor detects an error in the format of the EEPROM data, a memory error message is displayed (**Mem Error**) at the end of the power up sequence, and all parameter settings are reset to their default conditions; these are then saved to EEPROM before normal operation commences.

Note that when a parameter is changed, either manually from the front panel or using comms, storage of the new value in EEPROM is scheduled to the next internal "save cycle". As a result, the value may not reach the EEPROM for up to 5 minutes after a change occurs. It is advisable to leave at least 5 minutes after making a change to non-volatile parameters before turning the PVC off.

4. ION GAUGE OPERATION

4.1 Ion Gauge – Status

The Instrument Page reports the operating status of the ion gauge. If the ion gauge is on, this will be the measured pressure value, or, if the ion current is below the electrometer detection limit (e.g. the collector disconnected), the display reads "**<MinLimit**". If the ion gauge is not on, one of the following will be indicated:

Display	Condition
OFF	The ion gauge is off and no error conditions apply
A/D ER!	Fault detected with A/D converter. Ion gauge will be switched off.
!HiV ER!	Fault detected with high voltage (grid) power supply. Ion gauge will be switched off. (Check grid fuse – see trouble shooting).
OvrTemp UndTemp	Internal over or under temperature condition. Ion gauge will be switched off.
I'Lock!	Ion Gauge Interlock FAIL. [Usually indicates that the ion gauge lead is not connected.]
FilTrip	The ion gauge tripped out due to a Filament problem (e.g. open or short circuit filament)
EmTrip	The ion gauge tripped out because emission fell outside acceptance range
EmFail	The ion gauge tripped out because the emission current could not be established, or failed.
OvrPress	An over pressure condition caused the ion gauge to trip. >$1x10^{-2}$ for Ir @ 0.1mA, >$1x10^{-4}$ for W @ 10mA, else >$1x10^{-3}$ mBar
DIError	Digital input assigned to the ion gauge failed, causing the ion gauge to trip out
→ *xx*mA	Emission current is changing to *xx* mA
→ OFF	The ion gauge is being powered down
ToDgs	Starting degas
DgsEnd	Degas has ended; preparing to restart ion gauge at last emission current
PD: A:[Numerical value][A]	In pump down
PD: A:[Numerical value]ig[A]	In pump down, attained ion gauge start pressure and in delay time
PD: *x* → 0.1mA[A]	In pump down, *x* = attempt number to start the ion gauge, followed by the emission current used.

[A] Not applicable to the PVC*i*Duo.

4.2 Ion Gauge Parameters

4.2.1 Emission Current Range

Parameter: Emission Current [Not stored]; Minimum Emission [Stored]; Maximum Emission [Stored]

PVCs have 7 **emission currents** of 0.1, 0.2, 0.5, 1, 2, 5, 10mA and *Auto*. On power up, emission is OFF. The **maximum and minimum emission currents** set the operating conditions for the gauge head in use manually and when in "Auto" emission.

Note that whilst the ion gauge is powering up or into the Degas state, the only permitted emission selection is "OFF". This avoids de-stabilising the feedback loop whilst emission is being established.

The "soft-start" feature of the emission control ensures gentle operation of the filament and avoids pressure bursts due to initial ion gauge degassing. The gauge may take up to 40 seconds to reach emission current during which time correct operation of the filament is checked continually. PVC allows up to 60 seconds for the gauge to power up before failing the power-up sequence.

PVC*i*Duo only: Total available emission (ion gauge 1 + ion gauge 2) is 12mA (see section 1.7). The PVC*i*Duo will limit the values available for setting the Maximum Emission settings to gauges 1 and 2 to ensure compliance. Note: The Maximum and Minimum Emission settings cannot be changed when the ion gauge is on.

4.2.2 Auto emission Current

Parameter: Emission Current; (see also Minimum Emission; Maximum Emission)

Emission currents can be manually set; alternatively, the *Auto* setting allows the PVC to choose the emission current best suited to the current pressure range. Changes are made by one emission current increment per step, except at the high pressure limit where pressure in excess of $1x10^{-5}$mBar will immediately set the emission to the minimum emission value.

Auto-emission divides the logarithmic pressure span of 10^{-5} to 10^{-10}mBar amongst the permitted emission values (minimum to maximum emission parameters) and changes emission at the calculated pressure transitions. A one decade difference between changing down and changing up precludes pressure-induced emission cycling.

The auto-emission facility is particularly useful in protecting an ion gauge where a vacuum system pressure is cycled regularly (for example, for gas feed) or heater/thermal evaporator induced pressure bursts.

4.2.3 Degas Powers and the Degas Programme

Parameters: Degas Power [Stored]; Degas Ramp Time [Stored]; Degas Time [Stored]

PVC*i*Duo only: Both gauges can be degassed simultaneously or separately, and use independent power and time settings.

Selecting the Degas option in the Emission parameter list will start a degas programme. **The degas option is only available if the ion gauge is switched on and, if the degas Protect parameter is enabled, the pressure is below $1x10^{-5}$mBar**. PVC*i* has 7 (1, 2, 3, 6, 12, 20 and 30W nominal), and the PVC*i*Duo 6 power settings (1, 2, 3, 6, 15 and 30W nominal). **Note: these power levels only account for heat associated with the emission current and do not include the power dissipated by the filament**. The user can set any of these using the Degas Power parameter. However, 2 parameters, Degas Ramp Time and Degas Time define how degas is executed; both these can be set to a maximum of 999 minutes. At the end of the degas programme, PVC turns emission off, waits ~ 5 secs to allow the system pressure to recover and then restarts the ion gauge at the emission current it was using prior to the degas (or at 0.1mA if the emission was set to Auto-emission).

There are 2 degas programmes, "full" and "quick".

FULL DEGAS SEQUENCE: PVC starts the ion gauge at a degas power of 1W and ramps it to the Degas Power in degas level increments over the Degas Ramp Time to the Degas Power level. Gradually ramping the degas power avoids pressure surges.

If the Degas Ramp Time is set to 0, the degas power is immediately set to the user-selected value.

At the end of the Degas Ramp Time, PVC holds the power at the user-selected value for the duration of the Degas Time.

QUICK DEGAS: Quick degas simply runs the degas sequencer at the selected Degas Power for 1 minute.*

4.2.4 Degas Start-up Over-Pressure Protection

Parameter: DgsProtect [Stored]

Selects whether the ion gauge can be started at pressures above $1x10^{-5}$mB. The default is ON (protection on), however, the user may turn protection off, for example, to permit degassing of a dirty ion gauge.

4.2.5 Sensitivity

Parameter: Sensitivity [Stored]

The "sensitivity" factor reflects the efficiency to the ion current collection. Values typically vary between 5 and 30 $mBar^{-1}$. This parameter can be set between 1.0 and 99.9 $mBar^{-1}$, with 0.1 increments. The default factory value is 19.0 $mBar^{-1}$.

Please note, regardless of the set pressure units, this value needs to be entered in its $mBar^{-1}$ value. For example, a sensitivity of 20 $Torr^{-1}$ will need to be entered as 20 x 0.76 (Torr to mBar conversion) = 15.2 $mBar^{-1}$.

4.2.6 Electrometer Calibration Factor

Parameter: Calib [Stored]

This parameter corrects for non-linearity of the electrometer at very low ion currents (below 10pA). It has no effect at higher ion currents. **This parameter is factory set and not user adjustable.**

4.2.7 Filter

Parameter: Filter [Stored]

The PVC electrometer reading uses a digital low-pass filter to reduce the effects of noise on the measurement stability. The time constant can be set between 0.0 (OFF – no filter) and 9.9 seconds in 0.1 second increments; the default is 2.0s.

Although stability of measurement increases with increasing filter time, the consequence of using long time constants is insensitivity of the gauge protection mechanisms to sudden pressure bursts. PVC's ***Rippa*** (Rapid Increment Pressure Protection Algorithm) protects the ion gauge head and system by automatically suspending filter operation in the event of sudden changes in pressure, thereby allowing trip and protection algorithms to operate quickly.

4.2.8 Digital Input Mode: Protection/Remote (Versions 1.08 and later)

Parameter: DI1Mod [Stored], DI2Mod [Stored]

These 2 parameters provide digital input protection and/or control over ion gauge operation:

- **None**. No effect
- **I'Lock**. The digital input acts as an interlock, tripping the gauge if the digital input fails.
- **Em On**. When digital input is OK, the emission is turned ON in **auto-emission mode**. [The emission range can be restricted using the Min and Max Emission parameters.] Emission remains on until either the gauge trips due to a fault, or until the digital input fails. To protect the gauge against continuous on/off cycling if the digital input remains OK after the gauge has tripped, the digital input must be failed for >1 second and then set to OK to restart the gauge.
- **Em Tog**. The ion gauge is toggled between the on and off states in response to driving the digital input to OK for a period of >1 second, and then returning to fail. Emission is turned ON in auto-emission mode. [The emission range can be restricted using the Min and Max Emission parameters.] If the gauge trips, the next toggle will turn the gauge back on.
- **Dgs On**. When digital input is OK, emission is already on and the pressure is $<1x10^{-5}$mBar, starts a degas sequence. At the end of the degas sequence, the gauge reverts to pressure reading under the emission conditions prior to degas. If the digital input fails during the degas sequence, degas is terminated. If the digital input remains OK after the degas sequence has finished, the digital input is ignored; to start a new sequence, the digital input must be failed for >1 second and then set back to OK.

- **DgsTog**. The degas sequence is started/stopped in response to the digital input pulse longer than 1 second.

Note: Em On and **Dgs On** modes conflict with operation of the ion gauge from the front panel since if the ion gauge/degas is started manually and the digital input is in the failed condition, the operation will fail. The **Em Tog** and **DgsTog** toggle modes allow co-operative remote control with manual operation.

4.2.9 Filament number

Parameter: Filament # [Stored]

Many UHV ion gauges provide filament redundancy, i.e. there are 2 filaments on the gauge head. This parameter switches between the 2 filaments. **This parameter cannot be changed whilst the ion gauge is switched on.**

4.2.10 Filament Type (PVC*i* only)

Parameter: Filament Type [Stored]

PVC*i* supports Tungsten (W) and Thoriated/Yttria-coated Iridium (Ir) filaments; please refer to section 1.5.

The power for W and Ir filaments differs significantly. To allow correct operation of gauge and controller, prolong filament life and provide appropriate operating protection, set PVC*i* filament type parameter appropriately. Failure to do could result in damage to the gauge head, the PVC*i* or both.

For the W setting, PVC*i* provides up to 14V, and the internal current limit is set to 6.0A. The values for Ir (which is the default) are 7V and 3.0A. **This parameter cannot be changed whilst the ion gauge is switched on.**

4.2.11 Display Resolution

Parameter: DecimalPlaces [Stored]

The ion gauge pressure is displayed with a mantissa resolution of 1 (1.2E-8) or 2 (1.24e-8) decimal places.

Note: this parameter only applies to normal measurement mode; during degas, pressure is displayed with no decimal place resolution (1E-8).

PVC*i*Duo only: This menu option appears in both gauge 1 and gauge 2 menus. It is a global parameter value that applies to both gauges, regardless where set.

4.2.12 Ion Gauge Run Time

Parameter: IGRunTime [Stored]

The length of time that the ion gauge is operating can be used to assess filament lifetime or system vacuum time in hours. Pressing the Up or Down button provides the "Reset to zero" option.

4.2.13 Emission Emergency Off

When displaying the Instrument Page, pressing the CANCEL and ENTER buttons simultaneously and holding for 1.5 seconds or longer with turn the PVC*i* ion gauge off, and in the case of the PVC*i*Duo, both ion gauges. Note: if the ion gauge(s) is/are degassing when this combination is pressed, degas is terminated and the ion gauge is turned back on at its previous level. To turn off the gauge, press the CANCEL and ENTER buttons together again.

4.3 Ion Gauge Measurement Stability and Stabilisation Time

Ion gauge pressure measurements depend on such factors as gas composition and gauge placement, as well as controller-related issues such as accuracy and stability of emission current and, more critically, electrometer performance. The PVC instrument uses an advanced electrometer that converts the log of the ion current to a voltage that can be measured using PVC's A/D converter. The design provides high stability, long term reproducibility and minimizes the effects of ambient temperature on measurement.

In common with most instrumentation electronics PVC requires 30-60mins to reach thermal equilibrium after power up.

If you are intending to make intermittent pressure readings (for example, flux monitoring), leave the PVC controller switched on even when the emission is off; keeping the electronics powered up will ensure that once established, thermal equilibrium is maintained.

4.4 Parameter Reset

WARNING: Reset should be used with caution: it will replace user-defined parameter values with a "default" set.

It may be necessary to "reset" the PVC ion gauge, digital output and digital input parameters to a set of "default" values. This can be effected **by pressing and holding the UP and ENTER buttons whilst powering up the instrument**.

The most important default parameters are:

Ion Gauge (s): Filament 1, Ir filament (PVC*i*), Sensitivity = 19 $mBar^{-1}$
Trip 1: State = Trip, Alloc = Ion Gauge, IGDegas = OFF, Dir = <, Level = $1.0x10^{-7}$mBar, Hyst = 1.1
Trip 2: State = Trip, Alloc = Ion Gauge, IGDegas = OFF, Dir = <, Level = $1.0x10^{-8}$mBar, Hyst = 1.1
Trips 3 – 7: State = Trip, Alloc = None , IGDegas = OFF, Dir = <, Level = $1.0x10^{-11}$mBar, Hyst = 1.1
DI1 and 2: State = Trip.

5. BACKING GAUGE MODULES AND THEIR OPERATION

5.1 Backing Gauge Modules

In addition to the ion gauge, PVCs provide secondary functions of either backing gauges or thermocouple monitoring/bake-out (see section 6) in the 2 options slots. A backing gauge module in Slot A can be used for Pump Down (PVC*i* only) – see section 10. There are 3 types of backing pressure modules:

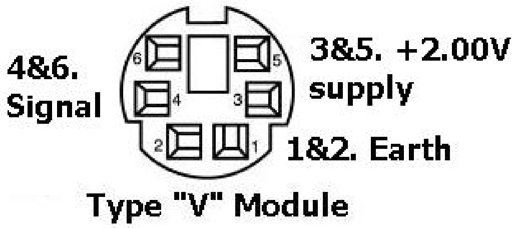
The type **"V"** supports the VG Scienta PIR5 Pirani gauge head, and the type **"T"** module supports the Thyracont VSP521/522 and the EpiMax EMP8 and EMP16 Pirani gauge heads. A Pirani gauge operates on the basis of the effects of pressure on the thermal losses from an *in vacuo* filament. Its usable pressure range is about 1 down to 10^{-3}mBar.

The type **"U"** provides user-defined generic support and, in some cases, power for a range of linearized pressure measurement devices, for example, the Granville-Philips mini-convectron, Instrutech Stinger, MKS 121 and 627 baratrons, Thyracont 622 gauges, or analogue outputs from other gauge controllers. This flexibility of this module lends itself to a range of applications.

5.2 Type "V" Module: VG Scienta PIR5 Pirani Gauge Heads

5.2.1 Type "V" Module Connector

The connector for the Pirani gauge is a **6 pin Mini-DIN** type. **The 3 connections are wired to pairs of pins**. Looking at the rear of the PVC, the pin assignments are:



5.2.2 VG Scienta Pirani Gauge Connector Converter

The "standard" connector for older Pirani gauges is a 5 pin DIN connector. A conversion cable can be made up by connecting the +2.00V supply lead to pins 3 and 5 of the standard Pirani connector, the 0V supply to pins 1 and 4, and one of the signal pins to pin 2 of the Pirani gauge head.

A 2m long conversion cable (part number PVCPir5) is available from EpiMax.

5.2.3 "V" Module Parameter

The "V" module has one parameter in its menu related to low pressure calibration:

Parameter: PirCalib [Stored]

Sets the low pressure ($1x10^{-3}$mB) calibration point for the PIR5 Pirani gauge being used. For further information on calibration procedure, see section 5.2.4.

Range: 1 to 500 au. Default value (no calibration correction): 50

The Pirani low offset value is applied in the following way:

Indicated pressure = (Measured pressure x PirCalib) ÷ 50

5.2.4 "V" Module Calibration

The VG PIR5 Pirani head is factory calibrated using two potentiometers housed in the top of the head body, one to set the bridge to balance at atmosphere, and one to set the current imbalance resistor to allow correct reading of $1x10^{-3}$mBar at this pressure or below. Due to the wide tolerance variation between gauge heads, the PVCs provide a means for calibrating the measurement electronics for the specific gauge head using the Slot menu displayed when a **"V"** module is detected:

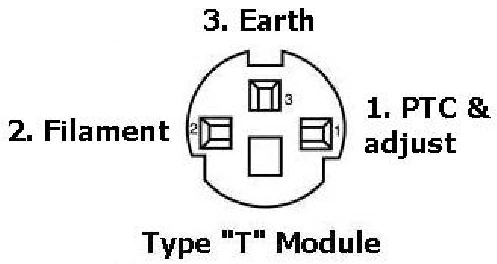
1. Ensure that the Pirani gauge and ion gauge controller are operating under stable conditions by running for at least 1 hour before calibration.
2. With the gauge head at atmosphere, ensure that the PVC reads "Atmos" for the slot.
3. Evacuate the backing line to a pressure of $1x10^{-3}$mBar or less, for example using a sorption pump, or exposing the backing line to a high vacuum pump. Note that a pressure below $1x10^{-3}$ is preferred since this is the pressure limit of the gauge head.
4. Read the Pirani pressure as indicated for its Slot.
5. Scroll to the Slot menu, press enter to access the PirCalib parameter (see section 5.2.3). This parameter can be adjusted from its default (no correction) value of 50.
6. If the pressure reads $1x10^{-3}$ or below, adjust this parameter until the pressure reads **above** $1x10^{-3}$. This step may require several read/adjust iterations.
7. Now adjust the parameter in small increments until the closest reading to $1x10^{-3}$mBar is obtained. This step may require several read/adjust iterations.
8. Allow at least 5 minutes after the final adjustment is made before turning off the ion gauge controller to ensure storage of the calibration value in EEPROM (see section 3.9)

Rather than using $1x10^{-3}$mB as the calibration point, a higher known (e.g. independently measured) pressure value can be used. However, the validity of the calibration decreases with increasing pressure and pressures in excess of $1x10^{-2}$mBar are not recommended.

5.3 Type "T" Module: EpiMax EMP8 & EMP16, and Thyracont VSP521/522 Pirani Gauge Heads

5.3.1 Type "T" Module Connector

The connector for the Pirani gauge is a **3 pin Mini-DIN** type. Looking at the rear of the PVC, the pin assignments are shown right. EpiMax Pirani gauge heads are shipped with appropriate cables; standard length is 3m though different lengths available on request. Appropriate cables are available from EpiMax for the Thyracont VSP521/522 gauge heads.



5.3.2 "T" Module Parameter

The "T" module has one parameter which operates as described for the "V" module in section 5.2.3.

5.3.3 "T" Module Calibration

The "T" module can be calibrated in the same fashion as described in section 5.2.4.

5.4 Type "U" Module: User-defined 'Universal' monitoring

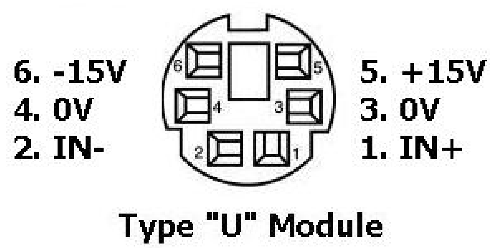
5.4.1 Type "U" Module Description

The type "U" module provides support for a wide range of measurement devices that contain "head amplifiers" that linearize the raw sensor data to provide a pressure *vs* voltage or current relationship read out. Examples include: Granville-Philips mini-Convectron, Instrutech "Stinger", Thyracont VSP622, MKS 121 and 627 baratrons, and many more. The common feature of these devices is that they provide a linearized analogue output signal that scales with the pressure; for example, the Instrutech "Stinger" log-linear output option provides a voltage output of 1V/decade, with 1V corresponding to $1x10^{-4}$.

For devices which output a current, a sample resistor can be used to convert the current to a voltage. For example, a 500Ω resistor between IN- and IN+ of the Univeral module will convert a 4-20mA current loop output to a 2-10V signal.

The "U" module has two functions:

- Provide user-defined monitoring of the signal output. To this end, the user has hardware and software options.
  - The hardware can be ***set for an input range of 0-10V, 0-3V and 0-1V inputs using a jumper***, as clearly labelled on the module PCB (see section 5.4.3).
  - In addition, the PVC software allows the user to specify the type of relationship between the voltage input and pressure (log or lin), the voltage input span and the corresponding pressure range (see section 5.3.3). This allows virtually device of this type to be monitored by the "U" module. The signal input to pins 1 and 2 is differential to avoid earth loops, but please note that **the maximum permissible input into either pin is ±12V with reference to earth**.
- Provide power to the device. The "U" module provides a nominal ±14.7V power supply derived from the internal supplies. Both supply rails are current limited to 120mA and reverse bias protected. T current is sufficient to drive a wide range of devices (for example, the mini-Convectron, Instrutech Stinger, Thracont VPS622, MKS 121); if current requirements exceed ±120mA (e.g. the MKS 627 which requires in excess of 200mA) or a specific close tolerance voltage is required, an external power supply can be used. **If an external power supply is used, pins 5 and 6 MUST be left unconnected and the 0V line of the external power supply MUST be connected to either pin 3 or pin 4.**



5.4.2 Type "U" Module Connector

The connector for the type "U" module is a **6 pin Mini-DIN** type. Since this is the same as used for the VGS PIR5, care should be exercised to avoid confusion.

Looking at the rear of the PVC, the pin assignments are as shown right:

5.4.3 Type "U" Module PCB Jumpers

The full scale range (fsr) of the "U" module can be selected using the jumpers on the module PCB located in the centre of the board, adjacent to the securing screw. There are 4 pins and a single jumper; the pair of pins that require shorting using the jumper are clearly labelled with the legends "0-10V", "0-3V" and "0-1V".

Note that these fsr settings are local to the PCB and not accessed within the PVC. Thus if using either the 0-3V or 0-1V settings, the values entered into the InputMin and InputMax parameters (as dictated by the device being monitored) must be multiplied by 3.333x and 10x respectively. The modules are calibrated for standard 0-10V operation. A slight tolerance error may be present when using other settings; however, this can be corrected for by applying a correction to the parameters to compensate.

5.4.4 Type "U" Module Parameters

The type "U" module is configured for different devices through the following parameters:

Parameter: Function [Stored]

Specifies the type of relationship between pressure and voltage input. Either lin (linear) or log (V is proportional to log(pressure)).

Range: 1 to 199. Default value (no calibration correction): 100

Parameter: PressMin [Stored]

Specifies the pressure value that InputMin parameter indicates.

Range: $1x10^{-13}$ to $1x10^{+6}$ pressure units.

Parameter: PressMax [Stored]

Specifies the pressure value that InputMax parameter indicates.

Range: $1x10^{-13}$ to $1x10^{+6}$ pressure units.

Parameter: InputMin [Stored]

Specifies the minimum voltage input which corresponds to the PressMin parameter.

Range: 0.000 to 9.999V. ***Please note that if the module jumpers are set to 3V or 1V full scale, the voltage entered into this parameter should be multiplied by 3.333x or 10x respectively – see section 5.4.3.***

Parameter: InputMax [Stored]

Specifies the minimum voltage input which corresponds to the PressMin parameter.

Range: 0.000 to 9.999V. ***Please note that if the module jumpers are set to 3V or 1V full scale, the voltage entered into this parameter should be multiplied by 3.333x or 10x respectively – see section 5.4.3.***

NOTE: The voltage and corresponding pressures are available for most devices. Small differences between indicated values between the device and PVCi may (caused, for example, by voltage offsets or calibration drift) can be corrected for by adjusting pressure or input values to compensate. However, corrections cannot be made for curvature of the linearizations or log conversion algorithms used by the devices.

6. THERMOCOUPLE AMPLIFIER OPERATION

6.1 Thermocouple Amplifier Boards

In addition to the ion gauge and optional backing gauges, PVC is designed to operate one or two Thermocouple amplifiers in slots A and/or B. **A thermocouple amplifier board in Slot B can be used for System Bake-out – see section 11.**

The thermocouple amplifier provides for input from a type K thermocouple. The cold junction temperature is monitored by a sensor in contact with the "block" formed by the thermocouple plug and the module socket.

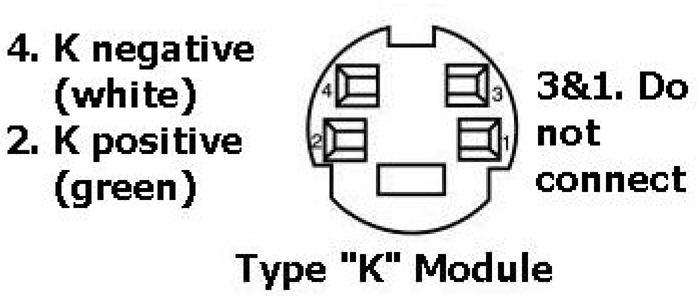
Note: The thermocouple amplifier is designed for use over the bake-out temperature range of 40°C to 600°C; it has an accuracy (including cold junction) of ±2°C over the range 100°C to 500°C.

For thermocouples below ~35°C (where the thermocouple temperature may be below the cold junction temperature) the indicated temperatures may read high (up to 35°C). This is caused by the inability of the PVC's A/D converter to process negative thermocouple emf that arises under these conditions. As soon as the thermocouple temperature exceeds the cold junction temperature (usually above ~35°C), accurate measurements ensue.

6.2 Thermocouple Amplifier Board Connector

The connector for the type K thermocouple is a **4 pin Mini-DIN** type, of which only 2 pins are used. Looking at the rear of the PVC, the pin assignments are (pin 4 = type K negative [white], pin 2 = type K positive [green]):

Note: for cold junction compensation, type K thermocouple leads or type K compensating leads should be soldered/spot welded directly into the matching cable connector. The board has a temperature sensor mounted in close thermal contact with the Mini-DIN socket, as discussed above.



6.3 Thermocouple Assembly

The EMTCK3 and EMTCK6 are 3m and 6m long type K thermocouple assemblies for use with the type **"K"** module. They comprise a type K thermocouple housed in an M6 ring suitable for direct mounting to the system using a bold (e.g. flange bold), with a 2m of bakeable steel sheaved cable. The remaining length is made from type K compensating cable.

For more information, please refer to your PVCi supplier.

6.4 "K" modules Parameters

There are no parameters associated with the "K" module. As a result, no menu appears in the PVCi.

7. DIGITAL "TRIP" OUTPUTS

Trip Types

PVC has 7 digital "trip" outputs: trips 1 to 4 are change-over relays and trips 5 to 7 are open-collector outputs. Please refer to section 2.9 for details of switching capability and connection.

7.2 Trip Parameters

Each of the seven trips has its own menu of parameters:

7.2.1 State

Parameter: Tr State [Stored]

- **Normal**. The trip switches on or off depending on its assignment and trip level.
- **Override**. Set the trip to on permanently.
- **Inhibit**. Set the trip to off permanently.

7.2.2 Allocation

Parameter: Tr Alloc [Stored]

- **None**. The trip is not allocated.
- **Ion Gauge** (PVC*i*) / **Ion Gauge 2** (PVC*i*Duo). Ion gauge (2) pressure is compared with the Level parameter and trip on/off state is determined on basis of Direction parameter.
- **Slot A**. The measured value returned by Slot A is compared with the Level parameter and trip on/off state is determined on basis of Direction parameter. If the slot is empty, the trip remains off.
- **Slot B**. The measured value returned by Slot B is compared with the Level parameter and trip on/off state is determined on basis of Direction parameter. *Note: If Slot B is a thermocouple board and bake-out control is required, select **Bake-out** below*. If the slot is empty, the trip remains off.
- **PumpDown** (PVC*i* only). The trip is on when the pump down is started and turns off only when either the ion gauge is on, or the ion gauge has failed to start after the specified number of attempts.
- **Permanently ON** (PVC*i*Duo only). The trip remains as long as the instrument is powered up.
- **Bake-out**. The trip is on when the thermocouple board measured temperature is less than the current temperature in the bake-out sequence, and off when the measured temperature is less than required temperature minus the bake-out hysteresis value, or when the bake-out limit pressure or any assigned digital inputs fail.
- **Timer** (PVC*i* only). The trip is on when the timer is within its ON period. The trip remains off if the ion gauge is off, the Timer pressure limit is exceeded or any digital input allocated to the Timer has failed.
- **Ion Gauge 2** (PVC*i*Duo only). Ion gauge 2 pressure is compared with the Level parameter and trip on/off state is determined on basis of Direction parameter.
- **Degas**. The digital output is on whilst the ion gauge is being degassed.

7.2.3 Ion Gauge Degas

Parameter: Tr IGDegas [Stored]

This parameter only applies to trips allocated to the ion gauge.

- **OFF**. (Default value). The trip "fails" when ion gauge degas starts, and does not respond to degas pressure measurements
- **Prot**. (Protected). The trip responds to degas pressure measurements. In addition, on starting degas and when the ion gauge is restarted after degas, the trip state is latched at its last value.

7.2.4 Direction

Parameter: Tr Dir [Stored] [This parameter only applies when Tr Alloc = Ion Gauge, Ion Gauge 2, Slot A or B]

- **>** On if measured parameter (e.g. ion gauge pressure) exceeds Trip level.
- **<** On if measured parameter (e.g. ion gauge pressure) is less than Trip level.

7.2.5 Level

Parameter: Tr at < or Tr at > [Stored] [This parameter only applies when Tr Alloc = Ion Gauge, Slot A or B]

Sets the level at which the trip operates. Range is 10^{-13} to 10^{+6} instruments. Note that for pressure assignment of trips, the parameter is set in as a pure number; the absolute value of the trip level therefore depends on the current pressure instruments.

7.2.6 Hysteresis

Parameter : Trip Hyst [Stored] [This parameter only applies to trips with Tr Alloc = Ion Gauge, Slot A or B]

This parameter is common to all 7 trips and is **not** set individually for each. It defines a band between which the trip will turn on and turn off, and is intended to avoid "cycling" due to noise or operation.

The range is 1.0x (no hysteresis) to 99.9x (where the off occurs at 99.9 times the trip level). For example, for a trip level of 10^{-6}mBar and a Trip hysteresis of 2.0, the trip will set on at 10^{-6}mBar but not set off until the pressure exceeds $2x10^{-6}$mBar.

8. DIGITAL INPUTS

8.1 Digital Input Type

PVCs have 2 digital inputs that can be used to provide interlocking from external equipment. These inputs can be applied to various aspects of PVC operation, for example, to trip ion gauge, inhibit/suspend/abort bake-out etc.

Note that the effects of the inputs can be multiplicative. For example, if you set the ion gauge to turn off in the event of DI1 failure, then other functions that rely on the ion gauge being on (for example, timer or bake-out) will also fail with DI1.

The two digital inputs comprise an opto-isolator LED (protected by a reverse biased diode) in series with 2.2kΩ. A dc voltage in the range 3 to 32Vdc will activate – do not exceed 32V input. To preclude switching of the digital inputs caused by spurious signals or noise, the readings from 4 consecutive samples (~0.4 seconds) must all have the same state before action is taken.

Please refer to section 2.10 for further specifications and connection details.

8.2 Digital Input Parameters

8.2.1 State

Parameter: DI State [Stored]

- **Normal**. Its state is set by the applied input voltage (on or off).
- **Override**. The digital input is set to on permanently.
- **Inhibit**. The digital input is set to off permanently, i.e. will not affect any assigned function.

9. PUMP DOWN (PVC*i* ONLY)

9.1 Pump Down Operation

PVC*i* provides the facility to pump-down a vacuum system from atmosphere and automatically start the ion gauge. For this feature to be available, a backing pressure measurement board (types "U", "V" or "T") MUST be present in Slot A.

On starting the pump down, the Slot A pressure is monitored. Once it is less than the value set in the Ion Gauge Start Pressure Parameter, PVC*i* waits for the duration of the Ion Gauge Delay Parameter and then attempts to start the ion gauge. If the gauge does not start, PVC*i* waits for a further Delay Parameter value before attempting to stat the ion gauge again. The pump down terminates either when the ion gauge is turned on successfully, or if PVC*i* has tried and failed to start the ion gauge the number of times determined by the Ion Gauge Attempts Parameter.

Notes:

- The option to start Pump-Down is only available if the ion gauge is off; if the ion gauge is on, PVC*i* assumes that the system is already pumped down.
- You can assign Trips to the Pump Down. In this case the trip turns on when the pump down starts and turns off when the pump down is completed. For trip control which is independent of pump down (for example, for operating a pump based on a ballast pressure), trips should be assigned directly to Slot A.

9.2 Pump Down Parameters

9.2.1 Start/Stop

Parameter: PumpDown

- **Start**. [Only available if the ion gauge is off]
- **Stop**. [Only available during a pump down]
- **-----**. [Indicates that ion gauge is already on; a pump down cannot be executed]

9.2.2 Digital Input Protection

Parameter: PDDIProt [Stored]

Selects whether and which digital inputs will operate on the pump-down:

- **None**.
- **DI1**. Digital input 1 only.
- **DI2**. Digital input 2 only.
- **DI1&2**. Both digital inputs.

9.2.3 Ion Gauge Start Pressure

Parameter: PDStartP [Stored]

Slot A pressure at which it is safe to attempt to start the ion gauge.

Range: $1x10^{-13}$ to $1x10^{+6}$ pressure instruments

9.2.4 Ion Gauge Start Delay

Parameter: PDDelay [Stored]

The time PVC*i* waits after Slot A reaches the Pump Down Ion Gauge Start Pressure parameter before starting the ion gauge. Note that if during this time, Slot A pressure rise above the Ion Gauge Start Pressure parameter, the delay is cancelled.

This time is also applied by PVC*i* between attempts to start the ion gauge.

Range: 0 to 999 seconds

9.2.5 Ion Gauge Start Attempts

Parameter: PDAttempts [Stored]

The number of attempts PVC*i* will make to start the ion gauge. PVC*i* waits for the Pump Down Ion Gauge Start Delay time between attempts.

Range: 1 to 9

10. BAKE OUT

10.1 The Bake Out Process

The bake out function integrates control over system baking with pressure and external interlocking. Each of the 6 steps in a bake sequence can execute a temperature ramp or a soak period; "gentle" ramped thermal conditioning of the system avoids large pressure bursts. Automatic degas of ion gauge(s) can be set to occur at the end of the bake sequence, i.e. whilst the system is cooling.

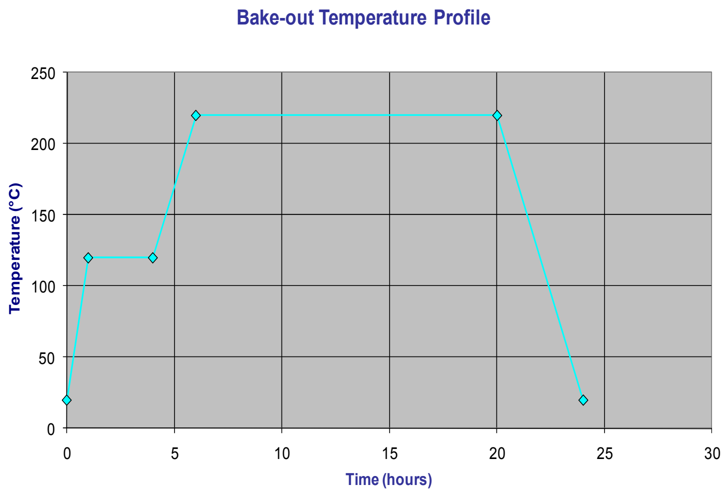
PVC provides on/off temperature control, comparing the required temperature with the measured value. Hysteresis can be set to avoid contact "chatter" (where the output switches rapidly on and off when the measured value is close to the Setpoint); a hysteresis value of 2°C is recommended. The output from the temperature control can be assigned one or more of the 7 Trips. **Note that the assignment must be made to "Bake-Out" and NOT to "Slot 2"** (see parameter Parameter Trip Allocation).

A user-defined ion gauge pressure trip value can be set. Response to the pressure trip value can be set to turn off the heating, turn of the heating and suspend bake-out count down (until the pressure recovers), or terminate the bake. In the case of the PVC*i*Duo, neither, either or both gauges can be set to provide pressure interlocking.

Digital input(s) assigned to the bake-out provide external interlock protection (e.g. from another gauge controller). On digital input failure, heating can be turned off ("DI") or suspended ("DISp"), or the bake terminated.

10.2 Defining a Bake-Out Temperature Profile

The bake-out temperature profile is made up of up to 6 steps. Each step can execute a gradual temperature ramp or hold a temperature for duration of up to 99.9 hours (total bake time is 559.4 hours in 0.1 hour increments). The first step ramps the temperature from the currently measured value to the temperature specified in parameter BOTemp1, subsequent steps BOTemp2 - 6 either ramp the temperature (if different from the previous step) or hold the temperature (if the same as the previous step). For example, the 24 hour long bake-out temperature profile illustrated was created by using the tabulated values shown right:



Note that unused steps at the end of the sequence (e.g. step 6 above) should be set to zero time. Step changes in temperature (e.g. setting the first step instantly to 120°C can be implemented by setting the duration for that step to 0.0 hours).

Step	BOTemp (°C)	BOTime (hours)
1	120	1.0
2	120	3.0
3	220	2.0
4	220	14.0
5	20	4.0
6	20	0.0

10.3 Bake Out Parameters

10.3.1 Start/Stop

Parameter: BakeOut

- **Start**. [Only available if the ion gauge is on and the bake out is off]
- **Stop**. [Only available if bake out is operating]
- **-----**. [Indicates that bake out facility is not available, e.g. because incompatible Slot B board, or ion gauge is off]

10.3.2 Step Temperatures – Steps 1 to 6

Parameters: BOTemp 1, BOTemp 2, BOTemp 3, BOTemp 4, BOTemp 5, BOTemp 6 [All Stored]

Control temperature at the end of the step. If the temperature differs from the value in the previous step (or the currently measured temperature in the case of the first step), the control temperature will be ramped over the duration of the step.

Range: 0 to 600°C in 1°C increments.

10.3.3 /Step Times – Steps 1 to 6

Parameters: BOTime 1, BOTime 2, BOTime 3, BOTime 4, BOTime 5, BOTime 6 [All Stored]

The duration of each step. If a step has a duration of 0, the control temperature is set instantly to the temperature of that step. Unused steps at the end of the sequence should be set to 0.0 hours.

Range: 0.0 to 99.9 hours in 0.1 hour increments

Note that when the bake-out time exceeds the total duration of the sequence, bake-out is terminated and any trips allocated are set to off, regardless of the temperature settings in subsequent steps.

10.3.4 Pressure Limit

Parameter: BOPrLimit (PVC*i*)/BOIG2Limit (PVC*i*Duo) [Stored]

The ion gauge (2) pressure at which the action defined in the Pressure Action parameter occurs.

Range: $1x10^{-13}$ to $1x10^{+6}$ pressure instruments

10.3.5 Pressure Action

Parameter: BOPrAct (PVC*i*)/BOIG2Act (PVC*i*Duo) [Stored]

The following actions can be executed if the ion gauge pressure exceeds the Pressure Limit parameter value:

- **Normal**. Allocated Trip(s) are set to off.
- **Suspend**. Allocated Trip(s) are set to off. Bake-out count down is suspended. Any control temperature ramp is suspended.
- **Abort**. The bake-out is terminated.

10.3.6 Ion gauge 2 Pressure Limit (PVC*i*Duo only)

Parameter: BOIG2Limit [Stored]

See 10.3.4.

10.3.7 Ion gauge 2 Pressure Action (PVC*i*Duo only)

Parameter: BOIG2Act [Stored]

See 10.3.5.

10.3.8 Digital Input Protect

Parameter: BODIProtect [Stored]

Selects whether and which digital inputs will operate on the bake-out:

- **None**.
- **DI1**. Digital input 1 only.
- **DI2**. Digital input 2 only.
- **DI1&2**. Both digital inputs.

10.3.9 Digital Input Action

Parameter: BODIAct [Stored]

The following actions can be executed if digital input(s) assigned to bake out are off:

- **Normal**. Allocated Trip(s) are set to off.
- **Suspend**. Allocated Trip(s) are set to off. Bake-out count down is suspended. Any control temperature ramp is suspended.
- **Abort**. The bake-out is terminated.

10.3.10 Temperature Control Hysteresis

Parameter: Temp Hyst [Stored]

To avoid on/off cycling when the measured value is close the setpoint value due to noise, this parameter sets a switching "window" for on/off processing. For example, at a control temperature of 200°C and with a hysteresis value of 1°C, when the measured temperature exceeds 200°C, the Trip(s) are turned off; the Trip(s) will not turn on again until the temperature falls below control setpoint temperature – hysteresis value (i.e. 199°C).

Range: 0 to 99°C in 1°C increments.

Recommended value: 2°C.

10.3.11 Auto-Degas Ion Gauge (1) at end of Bake-out

Parameter: BO Dgs (PVC*i*)/BO IG2 Dgs (PVC*i*Duo) [Stored]

Since it is considered beneficial to degas the ion gauge whilst the system is still hot after bake-out, when this Parameter set to "on", a degas sequence is started at the end of the Bake-out sequence, **provided the bake-out sequence terminated normally**. A degas sequence will <u>not</u> commence if the bake-out does not run its full course, for example, due to user termination, ion gauge trip etc.

Note: degas will not commence at pressures exceeding $1x10^{-5}$ mBar. However, with experience of the system pressure behaviour, it is straightforward to design a bake-out sequence that cools the system at the end sufficiently to ensure a pressure below $1x10^{-5}$ mBar.

Range: Off, On

10.3.12 Auto-Degas Ion Gauge 2 at end of Bake-out (PVC*i*Duo only)

Parameter: BO Dgs (PVC*i*)/BO IG2 Dgs (PVC*i*Duo) [Stored]

Operates on ion gauge 2 in same way as described in section 10.3.12

11. ANALOGUE OUTPUT

11.1 Analogue Output

The analogue output of the PVC differs from that of most other ion gauge controllers in that the output voltage and the parameter ranges can be arbitrarily set, as can the relationship between them. Either the pressure (usually) or temperature (from thermocouple module) can be output; in the case of pressure, the output is corrected for sensitivity and emission current.

Uniquely, PVC allows the user to set the relationship between monitored parameter and output:

- The pressure/temperature range required for output; for example, pressure range $1x10^{-10}$ to $1x10^{-08}$ mBar.
- The analogue output voltage range. The D/A output has a voltage range of ~ -0.2 (corresponding to a digital value of 0) to ~ +10.4V (corresponding to a digital value of 4095). The minimum and maximum D/A values can be set anywhere in this range. **Note: setting the D/A minimum to exceed maximum allows the analogue output to increase with decreasing pressure**. The extended voltage range provides the operator with the ability to correct for any offsets in the monitoring equipment electronics.
- The output voltage can be set to **scale logarithmically or linearly** with pressure/temperature. For example, consider setting a pressure range of interest between $1x10^{-11}$ and $1x10^{-6}$ mBar to correspond with an output of 0 and 10V. For the logarithmic setting, the output will vary by 2V/decade change: 0V = $1x10^{-11}$mBar, 2V = $1x10^{-10}$mBar etc. For linear setting, the output will be 10V at $1x10^{-6}$mBar, 1V at $1x10^{-7}$mBar, 0.1V at $1x10^{-8}$mBar etc.

11.2 Analogue Output Parameters

11.2.1 D/A Allocation

Parameter: D/A Alloc [Stored]

- **SetMin**: Output is permanently set to minimum D/A parameter value
- **IonG** (PVC*i* only): Output tracks the ion gauge pressure value, as indicated on the display
- **SlotA**: Output tracks the value associated with Slot A
- **SlotB**: Output tracks the value associated with Slot B
- **IG+StA**: If ion gauge is off, tracks the backing pressure gauge in Slot A, else tracks the ion gauge
- **Extern**: Output set to value sent over communications channel
- **Hz** (PVC*i* only): Output cycles between minimum and maximum D/A parameters values
- **IonG2** (PVC*i*Duo only): Output tracks the ion gauge 2 pressure value, as indicated on the display
- **SetMax**: Output is permanently set to maximum D/A parameter value

11.2.2 Minimum value

Parameter: D/A PrMin [Stored]

Sets the pressure that the minimum D/A parameter value corresponds to.

Range: $1x10^{-13}$ to maximum D/A parameter value.

11.2.3 Maximum Pressure value

Parameter: D/A PrMax [Stored]

Sets the pressure that the maximum D/A parameter value corresponds to.

Range: Minimum D/A parameter value to $1x10^{+6}$.

11.2.4 Minimum D/A Parameter Value

Parameter: D/A OutpMin [Stored]

Sets a D/A value that the minimum D/A Pressure value corresponds to.

Range: 0 to 4095 (12 bit count). Note: Minimum D/A parameter value can exceed the maximum D/A parameter value to.

Whilst this parameter is displayed, the analogue output generates the voltage that the currently set value corresponds to (Note: You must press the **OK** button to set the value before the output changes). This allows the user to set a specific voltage whilst measuring the output, for example, to remove any voltage offsets in the monitoring device.

11.2.5 Maximum D/A Parameter Value

Parameter: D/A OutpMax [Stored]

Sets a D/A value that the maximum D/A Pressure value corresponds to

See section 11.2.4 for range and usage.

11.2.6 D/A Function

Parameter: D/A Function [Stored]

Sets relationship between pressure and analogue output voltage.

Range: Linear or logarithmic.

12. TIMER MENU (PVC*i* ONLY)

12.1 Timer Function

The timer function allows the user to set a cycling on/off timer to control external devices, such as TSP or for pump regeneration. The on/off cycle times can each be set up to 1440mins (1 day), and any number of the Trips can be assigned using the Trip menu.

The timer is interlocked to the ion gauge on state, and a user-defined pressure limit for timer on condition can be set. In addition, digital input protection can be assigned.

12.2 Timer Parameters

12.2.1 Skip To…

Parameter: Tmr Skip To

- **OFF**. Skips to start of OFF period.
- **ON**. Skips to start of ON period.

12.2.2 Off Duration

Parameters: TmrOffT [Stored]

Range: 0.0 to 1440.0mins in 0.1min increments.

12.2.3 On Duration

Parameters: TmrOnT [Stored]

Range: 0.0 to 1440.0mins in 0.1min increments.

12.2.4 Pressure Limit

Parameter: TmrPrLimit [Stored]

The ion gauge pressure at which the timer on state is inhibited.

Range: $1x10^{-13}$ to $1x10^{+6}$ pressure instruments

12.2.5 Digital Input Protection

Parameter: TmrDIProt [Stored]

Selects whether and which digital inputs will inhibit the timer on state:

- **None**.
- **DI1**. Digital input 1 only.
- **DI2**. Digital input 2 only.
- **DI1&2**. Both digital inputs.

13. SETUP OPTIONS

13.1 Setup Parameters

13.1.1 Instrument Name

Parameter: Name [Stored]

Each PVC can be assigned a 4 character name to reflect its function and is displayed on some of the Instrument Pages, and as an identifier for serial communications. Each character can be any standard ASCII symbol in the range 20h to 7Ah inclusive:

<space> ! " # $ % & ` ( ) * + , - . /
0 1 2 3 4 5 6 7 8 9
: ; < = > ? @
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
[\ ] ^ _ `
a b c d e f g h I j k l m n o p q r s t u v w x y z

Note: Editing the Instrument Name differs from editing other numeric parameters. On entering the Instrument Name menu, pressing either the **UP** or **DOWN** buttons scrolls the **first** character in the name. When the required letter has been set, press **OK** button to change the next character. Continue for remaining characters.

13.1.2 Pressure units

Parameter: PresUnits [Stored]

mBar (default) **Torr** **Pascal**

13.1.3 Display Brightness

Parameter: Brightness [Stored]

25% (least bright) **50%** (default - recommended) **75%** **100%** (brightest)

Note: To avoid "burn in", use the lowest brightness setting compatible with the ambient lighting of the operating environment.

13.1.4 Communications Address

Parameter: Address [Stored]

Communications address required by communications protocol. Each PVC sharing a serial port MUST have a unique address.

Range: 1 to 99

13.1.5 Communications Protocol

Parameter: Protocol [Stored]

Communications protocol used by the serial ports.

MODBUS. For MODBUS implementation, please refer to the "PVC Communications Handbook".

13.1.6 Communications Baud Rate

Parameter: BaudRate [Stored]

4800 **9600** **19200** (recommended default) **38400**

13.1.7 Parity

Parameter: Parity [Stored]

None (recommended default) **Even** **Odd**

13.1.8 Version

Parameter: (Version)

Indicates the PVC software version. In form "v*xx*.*yy*" where *xx* is major version and *yy* is minor version. For example "v3.03".

13.1.9 Heatsink Temperature

Parameter: (HeatsinkT)

Since the PVC uses intermittent forced air cooling to maintain constant internal temperature, the heatsink temperature is monitored for correct operation in the range 0 to 75°C. Values below 0°C are interpreted as a fault condition – sensor failure. Values above 75°C are interpreted as fan failure or over temperature. In either case the ion gauge will be turned off and an appropriate message indicated on the display.

14. TROUBLESHOOTING

This section lists some commonly encountered problems along with possible solutions. If after reference to this section, the problem persists, contact your EpiMAX PVC dealer.

14.1 Operation

Symptom	Cause
- Instrument will not start: no display	1. Check Mains voltage selector is set correctly – see section 2.3. 2. Check mains fuses (both neutral and live are fused)
- Does not restart after brief power down	Under some circumstances, instrument may not restart (e.g. no display or operation) after brief power down or brown-out. **Solution**: Turn off for 10 seconds then back on.

14.2 Ion Gauge

Symptom	Cause
- I'Lock! message on front panel	1. Ion gauge power cable not connected 2. Interlock connection (pins 1 & 3) not connected together – section 2.6.2
- HiV Er! message on front panel	1. High voltage grid supply failed. Check the 250mA(T) emission fuse on the rear of the unit. Replace if blown
- OvrTemp or UndTemp message on front panel	1. Over or Under temperature. Check heatsink temperature in the Setup menu. If under temperature, usually caused by PVC fault. If over temperature, ensure fan operates.
- Ion gauge emission cannot be established or has failed: EmFail, FilTrip or EmTrip message - Ion gauge will not start	1. Filament blown. Change filaments. On dual filament head gauges, use other filament. Check filament integrity 2. Check 4A (PVCiDuo) or 6.3A (PVCi) filament fuse(s). Replace if blown 3. Wrong filament type selected; check the W or Ir setting corresponds to your gauge 4. Check status of digital inputs if assigned to interlock the gauge
- OvrPress message	1. Ensure that vacuum system is being pumped and is operating under correct vacuum conditions for the gauge 2. Check Sensitivity parameter is set to correct value
- Unstable pressure measurement (e.g. drifts around)	1. Ensure electrical integrity of the gauge collector lead and connector 2. Wrong filament type selected; check the W or Ir setting corresponds to your gauge
- Ion gauge repeatedly trips during degas	1. Dirty gauge head. Allow a long degas ramp time to permit thorough degas at reduced powers before higher power degas occurs 2. Check that there is good electrical isolation from the grid to the filaments and to ground at the gauge connector. Clean gauge thoroughly. 3. Set/reset degas over-protection parameter flag 4. Check status of digital inputs if assigned to interlock the gauge

14.3 Digital Output Trips

Symptom	Cause
- Does not operate as expected	1. Check the trip menu parameter allocations and values 2. Ensure that the direction, trip level and hysteresis parameters are correctly set
- Trip on and off pressures different - Trip cycles between on and off ("chattering")	1. Check and set the Hysteresis parameter appropriate to the process
- Trip does/does not operate as required during degas	1. Set/reset degas ion gauge protection parameter

14.4 Digital Inputs

Symptom	Cause
- Do not have desired effect on gauge or other processes	1. Check the digital input menu parameter allocations and values 2. Check the gauge or other process dependences (within their own menus) for correct parameter assignments

14.5 Backing Pressure Modules ("V", "T" & "U")

Symptom	Cause
- Connector type from VG Pirani does not match that on PVC	1. An adaptor cable is available to connector old-style VG Pirani heads to PVC 2. An adaptor can be made up using the information in section 5.2
- Device powered by type "U" module does not operate correctly.	1. If powered from "U" module, check the supplied voltage in case current limit exceeded
- Erroneous pressure indication	1. Check connecting cable 2. Recalibrate the gauge head or use the Parameters to calibrate

14.6 Thermocouple Module

Symptom	Cause
- Persistent sensor break indication	1. Check the thermocouple integrity and lead 2. Check connection – see section 6.2
- Wrong temperature indication	1. Ensure that type K thermocouple is used
- Temperature reads 30-35°C, with cold room temperature thermocouple	1. If the cold-junction sensor is warmer than the thermocouple tip, the indicated temperature will be the cold-junction value due to inability of the PVC A/D to measure negative thermocouple emf's. At temperatures above ~40°C, this effect disappears.

14.7 Bake-out operation

Symptom	Cause
- Cannot start bake-out	1. Ensure ion gauge is on, and that any digital input interlocks are made 2. Ensure pressure is below $1x10^{-5}$mB if protection is on.
- Bake-out timing is too short or too long	1. Check time and temperature parameters in the Bake-out menu 2. Set/reset the pressure and digital input action parameters
- On/off control cycles too quickly or chatters - Large temperature oscillation occurs	1. Set bake-out hysteresis parameter appropriately for the process (usually 1-2°C is sufficient)
- Ion gauge auto-degas at end of bake-out trips the ion gauge	1. Add a final bake-out step of an hour or more that ramps the system down to <half the bake-out temperature to allow system pressure and any temperature related electrical leakage to recover

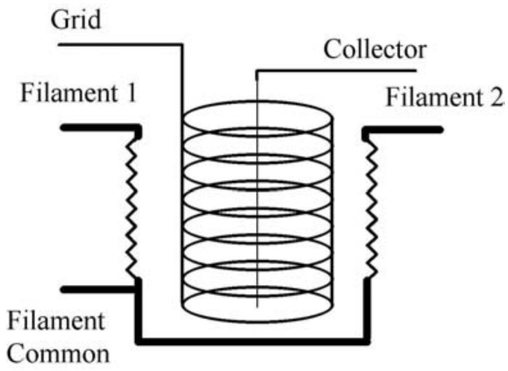
14.8 Analogue output

Symptom	Cause
- The output voltage does not correspond to the pressure - The output voltage range is too large/too small for the voltage monitor	1. Adjust the minimum and maximum digital output values to correspond to the minimum and maximum required output – see section 11.2

14.9 Timer

Symptom	Cause
- Does not operate as expected	1. Check Timer menu parameters 2. Ensure that dependencies on ion gauge/digital inputs etc are correct

15. IONISATION GAUGE OPERATION AND MEASUREMENT



A schematic of an ion gauge is shown left. Gauges have 1 or 2 filaments, but only one filament is used at a time. The filament is made of a low work function metal, typically Tungsten (W), thoriated Iridium (Ir-Th) or Yttria-coated Iridium (Ir-Y). Ir-based filaments operate at lower temperatures and consume about half the power of W, reducing degassing. **Thoriated Ir should be treated with caution, since it is toxic on ingestion**. The cylindrical grid assembly is an open mesh, usually manufactured from Mo, Ta or Pt. The fine wire collector runs down the centre of the grid to collect the ion currents generated the gauge.

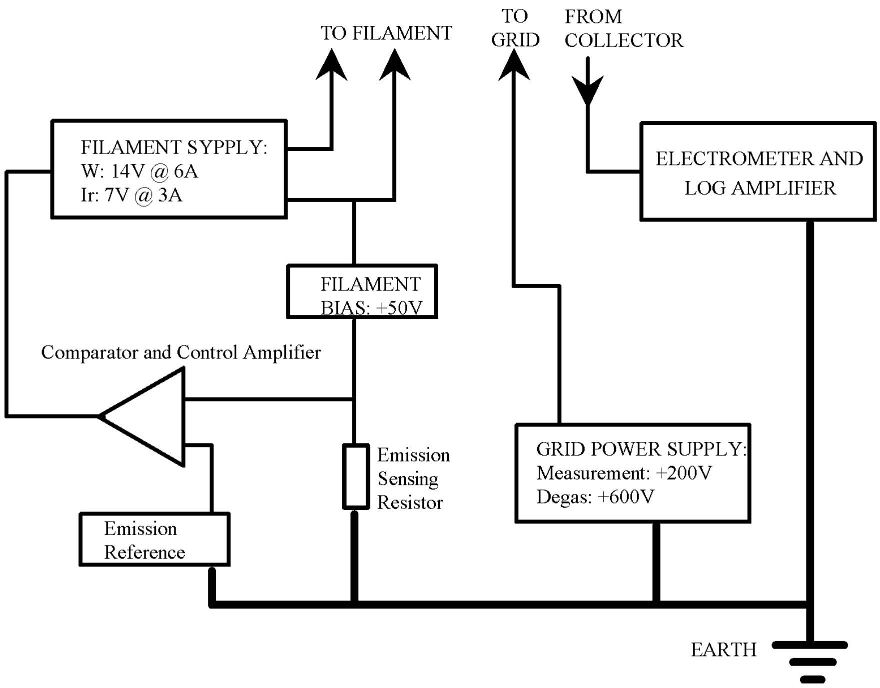
There are two modes of operation, pressure measurement and degas (discussed below). PVCs are able to measure pressure in both modes. During normal pressure measurement, the filament is at ~+38V, the grid at ~+180V and the collector at 0V with respect to ground. The filament emits electrons and these are accelerated towards the grid. The emission of electrons is kept constant at levels of 0.1, 0.2, 0.5, 1, 2, 5 or 10mA. There is a trade off between the optimum emission current and the efficiency of the gauge at measuring pressure. For typical UHV gauges, 0.1mA can be used down into the 10^{-9} mBar range, 1mA down into the 10^{-10} range and lower pressures require higher emission. To prolong filament life, low emission currents are required at high pressures. The PVCs protect the gauge, by tripping out above $1x10^{-2}$ for Ir @ 0.1mA, $1x10^{-4}$ for W @ 10mA, and $1x10^{-3}$ for all other filament type/emission current combinations. Auto-emission automatically selects the most appropriate emission for the measured pressure.

The emitted electrons cross the grid volume many times before being collected there. Few collide with the collector because of its small cross-section and negative bias with respect to the grid. If an electron collides with a gas molecule, an electron is lost by the molecule. These positive ions are attracted to the collector due to its bias, where they reclaim an electron and are thus measured as an ion current. Since the rate of collision between electrons and ions depends on the number of gas molecules (for a given emission current), the measured collector current scales with the vacuum pressure. The measured collector current also depends on other factors, including temperature and gas type and a simple correction factor is available for a range of gases. For example, with reference to N_2 (air) == 1; H_2=0.46, He=0.18, CO=1.05, H_2O=1.12, Ar=1.29, CO_2=1.42, etc.

The "geometry" of the gauge also affects efficiency of ion current generation; this "Sensitivity Factor" (typically between 5 and 30 $mBar^{-1}$) must be set into the parameter list to ensure correct conversion from ion current to measured pressure.

On exposure to air, ion gauges become "contaminated" by physisorption/chemisorption of gas onto the grid and collector, usually leading to an under-estimate of the pressure. "Degassing" provides a method of cleaning the gauge by heating the grid and collector above red heat to desorb contamination. PVC requires the measured pressure to be < $1x10^{-5}$ mBar before degas can be started, though this can be over-ridden by the user. Preferably, the system should be baked before degas, which should be scheduled whilst the system is still warm.

During degas, the grid voltage is set to >+600V. PVC*i* offers 7 and the PVC*i*Duo 6 degas levels corresponding to emission currents ranging from ~3mA to ~65mA. PVC continues to measure pressure during degas; however, the measurements are less accurate and reproducible due to the local degassing from the gauge head and the non-ideal operating conditions.



The PVC controllers contain 2 main section of electronics associated with the ion gauge, the power supplies and the collector electrometer. The filament supply (capable of delivering up to 14V at 6A for W filaments and 7V at 3A for Ir filaments) is controlled by the emission control circuitry. This compares the emission current flowing from grid to filament with an emission reference to generate an "error" signal to keep the emission stable.

The grid supply generates +180V during normal measurement and +600V during degas and is capable of sustaining a current up to ~250mA (as required for Degas high setting) – LETHAL!

The collector current passes to the highly sensitive electrometer capable of measuring currents down to 1pA (10^{-12} Amps). The electrometer also performs a logarithmic conversion on the input current to generate a scaled output of 1V for every decade change in pressure. The electrometer is of an advanced design, and carefully calibrated before shipping.

The output from the electrometer feeds an A/D converter for digital processing, where pressure conversion, correction of emission current, sensitivity etc, are performed. The ion gauge pressure is sent to the analogue output via a 12 bit D/A converter.

16. SHORT-CUTS

Turn Emission On: → 0.1/0.2/0.5/1/2/5/10/Auto

Change Emission/ Degas: → OFF/0.1/0.2/0.5/1/2/5/10/Auto/Degas/QkDg

Emission Off: + or → OFF

Menus PVC*i*: Emission IG Menu Slot A* Slot B* Trip 1 ... Trip 7 Dig In 1

Menus PVC*i*Duo: Emis IG1 Emis IG2 IG1 Menu IG2 Menu Slot A* Slot B* Trip 1 ... Trip 7 Dig In 1 Dig In 2 Bake-Out D/A Output Setup

* Menus for Slot A and Slot B only appear if the slots are populated with types "T", "V" or "U" modules

Scroll through menus/submenus

Decrement/Increment value

OK/Enter the value

Cancel/Return to previous value

17. MENU STRUCTURE

Ion Gauge Menu {default value}:	**Degas Ramp Time** (minutes): 2 – 999. {2} **Degas Time** (minutes): 1 – 999 minutes {5} **Degas Power** (W): PVC*i*: 1, 2, 3, 6, 12, 20, 30 {30}. PVC*i*Duo: 1, 2, 3, 6, 15, 30 {30} **Degas Protect**: On/Off {On} **Minimum Emission** (mA): 0.1 to Maximum Emission value. {0.1} **Maximum Emission** (mA): Minimum Emission value to 10 {10} **Digital Input 1 Mode:** None, Emission On, Emission Toggle, Degas On, Degas Toggle {None} **Digital Input 2 Mode:** [As Digital Input 1 Mode] **Filament Number:** 1, 2 {1} **Filament Type** [PVC*i* only]: Tungsten (W) or Iridium (Ir) {Ir} **Sensitivity** (mBar^{-1}): 1.0 – 99.9 {19.0} **Electrometer Calibration Factor:** 1– 999 {Factory Set} **Filter Time Constant**: OFF, 0.1 – 9.9 {2.0} **Ion Gauge Decimal Places:** 1, 2 {1} **Ion Gauge Run Time** (Hours): Time ion gauge has been running, or "Reset" {Run Time}
Slot A and B Menus (only for types "U", "V" and "T" modules)	**TYPES "V" and "T":** **Pirani Calibration** (au): 1 – 500. {50} **TYPE "U":** **Function:** Lin or Log **Min Pressure:** 10^{-13} to 10^{+6} pressure units **Max Pressure:** 10^{-13} to 10^{+6} pressure units **Min voltage:** 0.000V to Max Voltage **Max voltage:** Min voltage to 9.999V
Trip 1…7 Menu:	**Trip State**: Trip, Inhibit, Override {Trip} **Trip Allocation:** None, Ion Gauge [1], Slot A, Slot B, Pump Down [PVC*i*], Fixed On [PVC*i*Duo], Bake-Out, Timer [PVC*i*], Ion Gauge 2 [PVC*i*Duo], Degas {None} **Trip State During Degas**: OFF, Protect {Protect} **Trip Direction:** <, > {<} **Trip Level** (units): 1.0E-13 to 1.0E+6 {1.0E-11} **Trip Hysteresis**: x1.0 to x99.0 {x1.1}
Dig 1…2 Menu:	**Digital Input State**: Trip, Inhibit, Override {Trip}
Pump Down Menu: (PVC*i* only) [Pirani in Slot A]	**Operation**: Start, Stop {Start} **Digital Input Protect**: None, DigIn1, DigIn2, Both {None} **Start Pressure** (units): 1.0E-13 to 1.0+6 {1.0E-11} **Delay Time** (seconds): 0 to 999 seconds {10} **Number of Attempts**: 1 to 9 {1}
Bake-out Menu: Menu only appears if a thermocouple module in Slot B	**Operation**: Start, Stop {Start} **Step Temperature 1…6**: 0 – 600 {0} **Step Time 1…6** (hours): 0.0 to 99.9 {0.0} **Ion Gauge (1) Pressure Limit**: 1.0E-13 to 1.0E+6 {1.0E-7} **Ion Gauge (1) Pressure Action:** Ignore, Normal, Suspend, Abort {Normal} **Ion Gauge (2) Pressure Limit** [PVC*i*Duo]: 1.0E-13 to 1.0E+6 {1.0E-7} **Ion Gauge (2) Pressure Action** [PVC*i*Duo]: Ignore, Normal, Suspend, Abort {Normal} **Digital Input Protection:** None, DigIn1, DigIn2, Both {None} **Digital Input Action:** Normal, Suspend, Abort {Normal} **Hysteresis temperature** (°C): 0 to 99 {1}
Analogue Output Menu:	**Allocation**: Minimum, Ion Gauge (1), Slot A, Slot B, IG1 + Slot A, External, 1Hz [PVC*i*], Ion Gauge 2 [PVC*i*Duo], Maximum **Pressure Minimum** (units): 1.0E-13 to 1.0+6 {1.0E-12} **Pressure Maximum** (units): 1.0E-13 to 1.0+6 {1.0E-2} **Output Minimum:** 0 to 4095 {20 corresponding to ~0.0V} **Output Maximum:** 0 to 4095 {4026 corresponding to ~10.0V) **Pressure to Output Function**: Linear or Logarithmic {Logarithmic}
Timer Menu: (PVC*i* only)	**Skip timer to start of period**: OFF or ON. Pressing enter causes skip to start of that period **OFF duration** (mins): 0.0 to 1440.0 {0.1} **ON duration** (mins): 0.0 to 1440.0 {0} **Ion Gauge pressure Limit** (units): 1.0E-13 to 1.0+6 {1.0E-12} **Digital Input interlock**: None, DI1, DI2 or both
Setup Menu:	**4 character Instrument Name**: ASCII characters in range 20h ' ' to A7h 'z' are available. {"IG "} **Pressure Units**: mBar, Torr, Pascal {mBar} **Display Brightness**: 25, 50, 75 and 100% {50%} **Communications address**: 1 – 99 {1} **Communications Protocol**: MODBUS **Communcations Baud Rate**: 4800, 9600, 19200, 38400 {19200} **Communications Parity**: None, Odd, Even {None} **Instrument Software version number:** *xx.yy* {Diagnostics only} **Heatsink Temperature** (°C): 0 – 100°C {Diagnostics only}