

NGC3 Ion Gauge Controller

UHV Dual Bayard-Alpert Ion Gauge Controller

USER MANUAL

ISSUE 202207019
For use with firmware version 7.x.x



1.	Introduction.....	4
1.1.	Scope of this manual.....	4
2.	Technical data	5
2.1.	Mechanical Data	5
2.2.	Electrical Supply.....	5
2.3.	Environment.....	5
2.4.	Electrometer.....	5
2.5.	Ion Gauge	6
2.6.	Pirani Gauge.....	6
2.7.	Active Gauge	6
2.8.	Process trips.....	6
2.9.	Bake-out	6
2.10.	Communications.....	6
3.	Warnings and safety.....	7
4.	Installation.....	8
4.1.	Instrument installation.....	8
4.2.	Ion Gauge Head installation	10
5.	Front panel.....	11
6.	Setup	12
6.1.	Switching on.....	12
6.2.	Setup, General description	12
	Password/Units.....	12
	Ion Gauge Mode	13
	Gauges.....	16
	Relay assignment.....	18
	Bake	18
	Degas	19
7.	Operation	20
7.1.	Use of the Function Switch in the operating positions	20
7.2.	Relay trip levels.....	20
7.3.	Display sequence when the function switch is in the OFF position	21
	Pirani.....	21
	Active Gauge	21
	IG Sensitivity.....	21
	Leak Detector.....	22
	Temperature	22
	Instrument ID.....	22
8.	Ion Gauge operation.....	23
8.1.	Display sequence when Ion Gauges are in emission.....	23
	Starting the Ion Gauge.....	23
	Manual Emission Change.....	24
8.2.	Changing Ion Gauge emission.....	24
8.3.	Prompted emission change.....	24
9.	Degassing	25
	Manual Degas	26
	Programmed Degas.....	26
	Quick Degas	26
10.	Bake	27
11.	Recorder Output	28
12.	External inhibit.....	28

13.	Windows Software	29
14.	Remote operation.....	32
14.1.	Introduction	32
14.2.	Interface protocol.....	32
14.3.	Local/remote control.....	32
14.4.	Host Computer Commands.....	33
14.5.	NGC3 Response	33
14.6.	Timing of Next Command.....	33
14.7.	State & Error byte coding.....	33
14.8.	Host Computer Command Characters.....	34
14.9.	<status> Status report.....	35
15.	Troubleshooting	36
15.1.	Fan slow / failed	36
15.2.	Temperature	36
15.3.	Emission Fault	36
15.4.	IG Fil O/C.....	36
15.5.	Password forgotten?	36
15.6.	Ion Gauge connections	37
16.	Assistance	37
Appendix A	Gauge Principles.....	38
A.1	Ionisation Gauges.....	38
A.2	Pirani Gauges.....	38
A.3	Capacitance manometers.....	38
Appendix B	List of NGC3 Error Messages.....	39

1. Introduction

The NGC3 process controller is a high-accuracy Bayard-Alpert (BA) Ion Gauge controller that offers integrated pressure measurement and process control. The controller operates from electrical supply voltages in the range 100 to 240 volts and frequencies of 48 to 65 hertz.

The controller may be used with UHV Ion Gauges incorporating tungsten or coated iridium filaments. The controller can operate two Ion Gauges sequentially, two AML Pirani Gauges and one Active Gauge Head via a standard RJ45 jack.

Four power relays for process control are provided as is an internal thermocouple amplifier for bakeout control.

1.1. Scope of this manual

This manual provides installation, operation and maintenance instructions for the Arun Microelectronics Ltd Ion Gauge Controller model NGC3. Please read this manual before attempting to install and operate the controller.

This manual contains essential safety information which supplements the safety features of the controller. Safety procedures are highlighted as WARNING instructions by the symbol below. Failure to observe the instructions could result in injury or death to persons.



2. Technical data

2.1. Mechanical Data

Dimensions	Width: 19" full-width rack (482.6 mm) Height: 1U (44.45 mm) Depth: 270 mm, excluding connectors
Weight	2.7 kg

2.2. Electrical Supply

Supply voltage	100 to 240 volts nominal at 48 to 65 hertz, auto-adjusting
Power consumption	Less than 20 W idle 90 W maximum
Fuse	2.0 A, 250 V (T), 5 x 20 mm
Supply socket	IEC 320-C14
Overvoltage category	II
Protection class	1

2.3. Environment

Operating temperature	5°C to 35°C for specified performance Operation is inhibited at greater than 40°C
Storage temperature	-10°C to 70°C
Relative humidity (non-condensing)	80% for temperatures up to 31°C, decreasing linearly to 50% at 40°C
Maximum operating altitude	2000 m
Pollution category – EN61010	1
Ingress protection	IP20

2.4. Electrometer

Logarithmic conformance¹

Range	21°C	+5°C to +35°C
1 mA to 350 pA	<1%	<1%
<350 pA to 10 pA	<1%	<4%
<10 pA to 2 pA	<10%	<20%

¹ Some reduction in performance may occur at 30 MHz to 1 GHz at high RF field strengths

2.5. Ion Gauge

Suitable type	UHV Bayard-Alpert Gauges with coiled filaments
Range	1×10^{-3} to below 3×10^{-11} mBar. Dependant on gauge head
Grid	+200 Vdc (+500 V at 60 mA in Degas)
Filament	Tungsten: ≤ 12 V at ≤ 4.2 A Coated iridium: ≤ 12 V at ≤ 2.6 A
	Filament power limited to >30 W Filament bias: +50 V
Collector	0 V (virtual earth)
Emission current	Soft-start emission control at 0.5 mA or 5 mA
Sensitivity adjustment	1 mBar^{-1} to 140 mBar^{-1}

2.6. Pirani Gauge

Suitable type	Constant-voltage, half bridge. Calibration at connector
Range	200 mBar to 1×10^{-3} mBar

2.7. Active Gauge

Suitable type	Self-powered or active gauge with +10 V full-scale output.
	Format selectable between linear (1, 10, 100, 1000 mBar or Torr full scale) or log (1 V/decade, 0.5 V at $1\text{E-}6$ mBar)
	The instrument provides a regulated +24 Vdc supply, 1.0 W maximum, protected by a 50 mA self-resetting fuse to power a connected active gauge.

2.8. Process trips

Relays	4 x single-pole, change-over. 5 A at 240 V maximum
Assignment	Independently assignable to any gauge

2.9. Bake-out

Thermocouple type	Mineral-insulated K-type with miniature flat-pin connector
Programme	Settable bake temperature (50°C to 250°C), bake time (1 hour to 90 hours) and overpressure limit

2.10. Communications

Interface	RS232C
Settings	1200, 2400, 4800 or 9600 (Default) baud, 8 data bits, 1 stop bit, no parity, no handshaking

3. Warnings and safety



WARNING – Safe operation of Ion Gauges requires grounding of all exposed conductors of the vacuum system, gauges and controller. LETHAL VOLTAGES may be established under some operating conditions unless correct grounding is provided. All exposed and isolated metal parts should be reliably grounded to a common system earth point via 4 mm² or thicker copper wire/braid, the integrity of which should be checked regularly. No ferrite components should be installed.



High voltages are present within the instrument when operating and for some seconds after switching off. Remove the mains lead before removing the cover for any reason. Ensure that maintenance is carried out only by suitably trained personnel.

Voltages up to 500 V in degas and 200 V in normal operation are present on the IG cable when the IG is on. Voltages up to 600 V are present within the instrument.

- This manual must be consulted in all cases where the warning symbol (shown above, left) appears on the instrument.
- The safety of any system incorporating the instrument is the responsibility of the assembler of the system.
- Use the instrument only as specified in this manual, or the protection provided by the instrument might be impaired.
- The mains lead must be adequately rated for the instrument.

Instruments are shipped with password protection disabled. If you set a password you must record what it is.

The conditions set at manufacture assume that you do not require any interlocks and that the Ion Gauges have a tungsten filament. You may fuse coated Ion Gauge filaments if you do not set up the instrument appropriately.

Allow several minutes for Pirani Gauges to reach operating temperature after switching on before using them for interlock, autostart or process control.

Two fans are used sequentially for cooling. Orange status LEDs on the front panel indicate which fan is being used. If a fan fails a message is displayed at the time of failure and the LED for that fan flashes thereafter. Operation with only one fan is permissible but the faulty fan should be replaced as soon as possible. If the remaining fan fails, operation of the Ion Gauges will be disabled. Replacement fans must conform to the specification printed on the rear panel and are available from AML.

Discharges from X-ray power supplies and other high-voltage and high-energy sources (which are commonly used in vacuum systems) into the Ion Gauge may damage the instrument. Such damage is not covered by the warranty. Discharge damage will be minimised by decreasing the impedance of the strap/cable from the earth stud on the instrument to the vacuum system earth distribution point. This connection may also be essential for operator safety: follow the safety instructions and recommendations of the supplier of any high-voltage equipment used in the vacuum system.

4. Installation

Checks on receipt of the instrument

On receipt of the instrument remove all packing material and check that all items on the shipping list have been received. Report any damage or shortages to the Company or the Distributor who supplied the instrument. The packing material has been specifically designed to protect the instrument and should be retained for possible future use.

4.1. Instrument installation

Mounting

The instrument is suitable for mounting in a standard 19" rack and occupies 1U (1.75", 44.45 mm) of the rack. The mounting holes in the front panel are intended for retaining the instrument in the rack and will not support its weight. Additional support is required toward the rear and various arrangements are provided by rack manufacturers for this purpose.

Cleaning

If the instrument requires cleaning, wipe it down with a cloth slightly dampened with water or a mild detergent.

Ventilation

The instrument is forced air ventilated through grilles on the sides and a vent in the rear panel. Mount it in a location where there is an adequate supply of air as close as possible to cool room ambient temperature. The instrument is tolerant of and is compensated for operation at elevated ambient temperatures up to 40°C. Long term accuracy and reliability will be enhanced by operation at the lowest possible temperature, within the operating temperature range. If there are other instruments in the rack which generate significant amounts of waste heat, try to ensure that this is deflected away from this instrument.

Line Power Connection

The NGC3 operates from a 100 to 240 volts nominal AC power source having a line frequency of 48 to 65 Hz. Use a three-wire power cord to connect to a properly grounded wall outlet.

Line Fuse

There is a line fuse (Rating: 2.0 A, 250 V, (T)) located on the inside of the instrument on the rear of the power inlet connector.



High voltages are present within the instrument when operating and for some seconds after switching off. Remove the mains lead before removing the cover for any reason. The top cover is connected to the enclosure with a wire to ensure earth continuity. Do not remove this wire, ensure it is intact before replacing the lid, taking care to avoid pinching the wire between the lid and enclosure base.

Grounding



The instrument earth stud (right side when viewing the rear panel, and identified by the symbol) must be connected directly to the vacuum system earth distribution point with a low-impedance strap/cable ($\geq 4 \text{ mm}^2$ or $\leq 12 \text{ AWG}$). There must be no ferrite components installed on it.



Ion Gauge 1 & 2

Use AML-approved gauges with properly-screened leads. The ground braid of the Ion Gauge cable must be connected to the instrument ground stud.

Ion Gauge leads should not be installed close to cables carrying high alternating currents or through areas where there are significant alternating magnetic fields. They should be constrained, since movement or vibration will generate charges or currents and these may disturb UHV pressure readings.

Third-party Ion Gauge cables may not allow compliance with EU EMC Directives and may lead to unstable emission. As a minimum, there must be an overall screen on the lead and an inner screen on the collector connected to the BNC shell. These screens must not connect either to the vacuum chamber or to each other. Interlock pins 1 & 3 must be connected together.

Pirani 1 & 2

AML Pirani Gauges PVU and PVB are suitable for use with this instrument. Pirani 1 pressure may be used for Ion Gauge Interlock and Autostart functions and should be installed in the same chamber as the Ion Gauge if used for this purpose. Pirani 2 is normally used for backing-line pressure measurement.

Process control relays



The terminal block cover (supplied) must be fitted to restrict access to the terminals if they are used with voltages greater than 24 V. Take appropriate action to strain-relieve the wiring.

Four single-pole, change-over relays are provided for process control and can be independently assigned to any gauge. Contacts are rated at 5 A, 240 V maximum. The contacts of the relays are shown diagrammatically on the rear panel legend, in the de-energised condition, adjacent to the terminal blocks to which they are connected.

Inductive loads, including contactor coils, should have “snubber” networks connected in parallel to avoid arc generation which could interfere with the operation of this and other equipment. The external wiring is connected to the instrument through a two-part pluggable terminal block. This can be removed and wired independently of the instrument. Ensure that external wiring is of adequate cross-section for the load current. Strip and twist the wires (do not tin them) and poke into the receptacle in the terminal block. Close the leaf on the wire by tightening the screw immediately above. Take appropriate action to strain-relieve the wiring nearby and to restrict access to the terminals if harmful voltages are to be present. Fit the terminal block cover supplied.

If the Bake function is to be used then Relay D must be assigned to Bake. It is used to switch on the Bake heaters when energised. Do not connect heaters directly to Relay D; use a contactor and fit a snubber directly across its coil. The pressure measurement during the bake cycle is read from Ion Gauge 1 only.

Bake Thermocouple

The K thermocouple tip must be isolated from the vacuum chamber and situated where it accurately represents the Bake temperature. Mineral-insulated thermocouples with a miniature flat-pin thermocouple connector should be used.

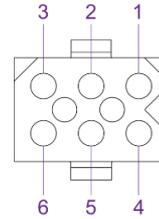


Figure 1 Ion Gauge Connector pinout

- | | |
|---|--------------------|
| 1 | Interlock |
| 2 | Grid |
| 3 | Interlock |
| 4 | Filament
Common |
| 5 | Filament 1 |
| 6 | Filament 2 |

Auxiliary Connector

The Auxiliary (AUX) connector is a plug-in terminal block. Connect the recorder between Recorder and 0 V (Refer to section 11). Connecting Ext. Inhibit to 0 V will prevent Ion Gauge emission (Refer to section 12). A screened cable must be used, with the screen connected to 0 V.

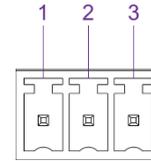


Figure 2 AUX Connector pinout

Active Gauge Connector

The Active Gauge connector is an 8P8C RJ45 jack. It is intended for connection of the AML AGP-1 MEMS Pirani Gauge, but other similarly low-powered Active Gauges may be used. A screened patch cable must be used.

The connector provides a 24 Vdc supply, between +24 Vdc and PGND, protected by an internal 50 mA self-resetting fuse. Do not use this supply for any other purpose.

Connect the gauge signal between the Signal and Signal GND pins. Do not connect Signal GND and PGND, as measurement errors may result. The input range is 0 – 10 V.

The NGC3 displays the measured voltage as a pressure. There are two selectable formats, log and linear (Refer to Section 6.2, 'Gauges'). Additional formats can be accommodated if required; contact AML for more information.

Active Gauge pressure may be used for Ion Gauge Interlock and Autostart functions, as an alternative to Pirani 1.

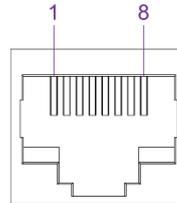


Figure 3 Active Gauge socket pinout (RJ45)

1	+24 Vdc	5	Signal GND
2	PGND	6	NC
3	Signal	7	NC
4	NC	8	NC

Serial Connector

The serial interface is RS232-compatible and only one instrument may be connected to each computer serial port (a USB to RS232 serial adaptor may be required).

The connector is a 9-way "D" type female connector. The pin numbering has been chosen so that a 9-way 'straight-through' male-to-female cable will be satisfactory for use with a PC serial port.

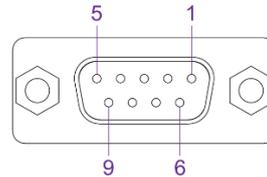


Figure 4 Serial connector pinout

1	NC	6	NC
2	Tx	7	NC
3	Rx	8	NC
4	NC	9	NC
5	GND		

4.2. Ion Gauge Head installation

Consult the information supplied with the gauge head for advice on flanges, gaskets and adaptors for mechanical fixing.

Mount the gauge head in a position where the free electrons generated in its vicinity will not affect other equipment. The performance of the Ion Gauge may be affected by other electron or ion generating processes within the vacuum chamber: should shielding of the gauge head be necessary, ensure that the conductance between the gauge head and volume of interest is not significantly decreased by its presence. The orientation of the gauge head should be such that the filament is to the side of, or below, the grid structure. This will ensure that if the filament should sag or break it will not short circuit to the grid. The gauge and controller are protected from all normal failure modes of either.

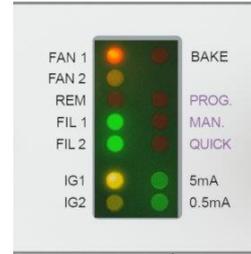
Users should be aware of potential hazards from other equipment, particularly those introducing high voltages into the vacuum chamber.

5. Front panel

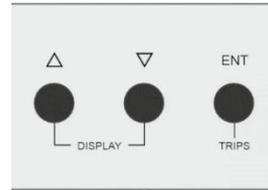
The rotary Function Switch has two sets of positions: for setup and operating. The SETUP locations are labelled in orange print. The switch must be stationary for a brief period of time before any action results.



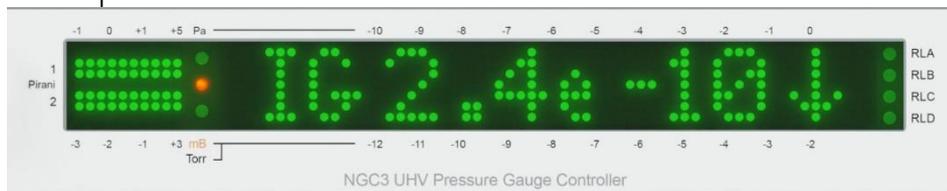
A set of status LEDs are situated in the Status Window. The LEDs on the right side of the window show further information about operations involving the Ion Gauges, such as the Degas program in use. The LEDs on the left side indicate the status of the instrument, the fans and the number of the filament and gauge in use. Flashing of the display or of individual LEDs either require a response by the user or indicate an error/fault condition.



INC, DEC and ENT are pushbutton switches with tactile feedback. They select the format of pressure display, modify setups and change parameters before and during Ion Gauge operation. Only press one switch at a time.



The legends above and below the display window indicate the units and the exponent scale for interpreting the bar graph displays of Ion Gauge pressure.



The units of the pressure display are indicated by one of three LEDs in the display area. The centre orange LED indicates that mBar has been selected, the green LED above it indicates Pascal and the green LED below indicates Torr.

LEDs indicate the status of the four relays available for pressure-related and Bake control. Each LED illuminates when the associated relay is energised.

6. Setup

New users should explore and familiarise themselves with the use of the controls and displays before connecting any gauges or wiring to the rear panel.

6.1. Switching on

Turn the Function Switch to the OFF position. Connect and switch on the mains supply and wait for the start-up messages to clear (approx. 5 seconds). During this time, both fans are checked for correct operation. The last display in the sequence will show Pirani 1 pressure or Active Gauge pressure (if enabled). Pirani Gauges take some time to stabilise before they indicate correct pressure. If Pirani 1 is not connected the display will show 'PG1 >200mB'. By default, if the Function Switch is at a position calling for emission at switch-on, emission is inhibited and 'Switch Em Off' is displayed. See section 'Ion Gauge Mode' for alternative modes of operation.

6.2. Setup, General description

Instrument settings are accessible by selecting one of the six SETUP switch locations. There is no restriction on when, how many times, or in what order you can enter a particular setup.

You may move the Function Switch part-way through a sequence if you do not wish to modify subsequent settings within a setup. For example, in SETUP → GAUGES you may change the filament in use without progressing through filament material, overpressure, etc.

If the instrument is waiting for a response from you then part of the display will flash, indicating that a choice can be made, or a setting edited. Δ and ∇ modify the choice or setting and ENT confirms it. If you do not modify the displayed setting for a few minutes the instrument will beep periodically. If you do not respond for a further few seconds then the current display will be replaced by 'Setup Aborted' and the setting or choice at the aborted stage will revert to its former setting.

If you move the Function Switch after modifying a choice or value but have not confirmed it with ENT then the existing choice or value is unchanged.

If you do not require Bake, it can be disabled by not assigning a relay to that function.

Setups and access to operating parameters and functions can be password-protected to prevent unauthorised use.

Password/Units



Set Password?
Press Δ or ∇ to select if a password is to be used. Press ENT to confirm.



If a password is to be used.
Change each character with Δ or ∇ and confirm with ENT.



Select the units of pressure display (mBar, Pa or Torr). The current selection will flash on the main display.



Press Δ or ∇ to select 1 or 2 decimal places to be shown on the Ion Gauge pressure display.



Select if gauge pressures greater than 1 mB should be displayed in scientific notation or decimal notation.



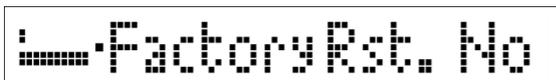
Select 'Yes' to assign a 3-7 character instrument ID.



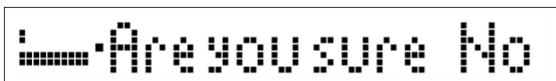
Change each character with Δ or ∇ and confirm with ENT. If enabled this ID will be shown during start-up and is available as an item in the main display sequence.



Select the baud rate. 9600 baud is the default for all AML software.



Select 'Yes' and confirm to return the instrument to its factory default settings. All user settings will be lost.



Ion Gauge Mode

Select and configure the Ion Gauge mode. Four modes of operation are available; Interlock, Autostart, Manual and Ext. Inhibit. Note that when starting emission remotely, either via the <Gauge on> command (see section 14.8) or the supplied software (see section 13) the behaviour of the chosen mode still applies; therefore manual mode is usually the best choice as this starts and stops the ion gauge immediately on command.

- The chosen mode applies to both Ion Gauge 1 and Ion Gauge 2.
- Regardless of the selected mode, the external inhibit signal on the AUX connector (see section 12) is always respected.
- Only Interlock and manual modes have any function when running bake or degas. If any other mode is selected when running bake or degas, the behaviour of manual mode applies.
- Any fault occurring in emission turns off the Ion Gauge, and the Function Switch must be returned to OFF before another attempt can be made to start emission.



Manual mode

Ion Gauge starts immediately when Function Switch is turned to an emission position.

- Ion Gauge starts when the Function Switch is turned to an emission position, one of IG1, IG2, DEGAS or BAKE.
- If the Function Switch is in an emission position when the instrument is powered on, a warning message appears and the Function Switch must be turned to a non-emission position before startup continues.
- External inhibit is considered as a fault, with the same behaviour as when a fault occurs in emission.

IG · M = Interlock

┌─ Gauge PG1

┌─ Gauge AG

┌─ I/kP = 1E-3

┌─ PG1 Interlock

┌─ AG Interlock

· Set AG Used Yes

· Switch PGn On

┌─ · PG1 Failed o/c

Interlock mode

Prevents Ion Gauge from starting, or stops emission, if Interlock gauge pressure is above a specified threshold, preventing restart without user intervention.

The behaviour of manual mode applies, in addition:

- An Interlock gauge is selected, either Pirani 1 or the Active Gauge.
- An Interlock pressure is specified.
- Ion Gauge is only allowed to start if the Interlock gauge measures a pressure less than the Interlock pressure at the time when the Function Switch is turned to an emission position.
- If the Interlock gauge measures a pressure greater than or equal to the Interlock pressure, then emission is prevented from starting (if the Function Switch was just turned to an emission position) or stopped immediately (if emission was in progress) and a warning message is displayed according to the chosen Interlock gauge.
- Once in the Interlocked state, the Function Switch must be returned to OFF before another attempt can be made to start emission.
- If the Interlock gauge is not switched on (Pirani 1) or not used (Active Gauge) then a warning message is shown and emission cannot be started.
- If the Interlock gauge is Pirani 1, and Pirani 1 fails open circuit, emission will be aborted if in progress, or prevented from starting. This is considered a fault condition, requiring the Function Switch to be returned to OFF before another attempt can be made to start emission.

IG · M = Autostart

┌─ Gauge PG1

┌─ Gauge AG

┌─ AsP = 1E-3

As · AG 1.6E-3

As · AG Autostart

· Set AG Used Yes

· Switch PGn On

┌ · PG1 Failed o/c

Autostart mode

Automatically start and stop IG1 or IG2 based on Autostart gauge pressure. If Autostart criteria are met, start and stop IG1 based on external inhibit signal.

Only applicable to IG1 and IG2 Function Switch positions. In BAKE or DEGAS Function Switch positions, the behaviour is as Manual mode.

- An Autostart gauge is selected, either Pirani 1 or Active Gauge.
- An Autostart pressure is specified.
- When the Autostart gauge pressure is less than the Autostart pressure, the Ion Gauge will start automatically.
- If the Autostart gauge pressure rises above the threshold:

$$P > 10^{(\log_{10} AsP) + 0.3}$$

Where P is the Autostart gauge pressure and AsP is the Autostart pressure, then emission is suspended and the display alternates between showing the Autostart gauge pressure and an Autostart warning message. Emission will restart when the Autostart gauge pressure falls below the Autostart pressure.

- External inhibit is not considered a fault. If external inhibit is present, a warning message is displayed and emission is suspended. Once external inhibit is removed and Autostart gauge pressure is below the Autostart pressure, emission will resume.
- Functions at startup. If the Function Switch is in IG1 or IG2 position at startup, the Ion Gauge will start, provided the Autostart criteria as described above are met.
- If the Interlock gauge is not switched on (Pirani 1) or not used (Active Gauge) then a warning message is shown and emission cannot be started.
- If the Interlock gauge is Pirani 1, and Pirani 1 fails open circuit, emission will be aborted if in progress, or prevented from starting. This is considered a fault condition, requiring the Function Switch to be returned to OFF before another attempt can be made to start emission.

IG · M = Ext. Inhibit

IG Gauge PG1

IG Gauge AG

EI · Ext Inhibit

EI · AG 3.0E-5

External Inhibit mode

Automatically start and stop IG1 or IG2 based on the state of the external inhibit signal on the AUX connector (See section 12)

Only applicable to IG1 and IG2 Function Switch positions. In BAKE or DEGAS Function Switch positions, the behaviour is as Manual mode.

- An external inhibit gauge is chosen, either Pirani 1 or Active Gauge. The pressure from this gauge will be shown when the external inhibit signal is present.
- The external inhibit gauge pressure is only used for the purpose described above.
External inhibit gauge pressure is not used as a condition to start or stop emission.
- When the external inhibit signal is present, emission is suspended, and the display alternates between showing the external inhibit gauge pressure, and external inhibit warning message.
- When the external inhibit signal is not present, emission restarts.
- Functions at startup.
- Not reliant on the external inhibit gauge; if the chosen external inhibit gauge is switched off (Pirani 1), not used (Active Gauge) or open circuit (Pirani 1) then only the external inhibit warning message is displayed during external inhibit.

Gauges

IG1 use FIL 1

IG2 use FIL 1

IG1 Tungsten

IG2 Iridium

Select the filament in use for each Ion Gauge.

Change of the filament in use is allowed without entering the password if set.

Define the filament material type for each gauge. This automatically sets the current limits for the filaments.

Use the Iridium setting for Thoria or Ytria-coated Iridium filaments.

IG1 Ovp = 1E-3

IG2 Ovp = 1E-3

Auto Em ↑↓ Yes

Dsp. Ion C. Yes

PGn On

AG Used Yes

Format Lin

AG F5 Units mB

AG F5 = 1000mB

Format Log

Set the Ion Gauge overpressure trips (OVP) to suit the filament material and your customary practice. The OVP will automatically restrict the maximum trip pressure of any relay assigned to that gauge to half the OVP.

A maximum OVP of 1E-3 mB/Torr is recommended for an AIG17G with Tungsten filaments or 1E-2 mB/Torr with coated filaments.

Define whether you require the instrument to change emission current automatically. If set to 'No' the instrument will suggest when a manual change in emission current is appropriate. Refer to section 8.2 for Ion Gauge emission details.

Define whether you wish to add ion current to the Gauges Display Sequence. Ion current in Amps will be displayed following numeric Ion Gauge pressure.

Pirani Gauges can be switched on or off. Switching off suspends the operation of Interlock and Autostart functions when Pirani 1 is selected as the Interlock or Autostart gauge.

Define whether you have an Active Gauge connected. Selecting 'No' suspends the operation of Interlock and Autostart functions when Active Gauge is selected as the Interlock or Autostart gauge.

Then, choose the analogue input format of the Active Gauge. The options are:

- **Linear**, in which 0 to 10 V is mapped to a range of 0 to a selectable full-scale pressure value.

Specify the full-scale units, either mB or Torr, and the full-scale value, either 1, 10, 100 or 1000.

- **Log**, in which 0 to 10 V is mapped to pressure according to:

$$P = 10^{U-6.5}$$

Where P is the pressure in mB, and U is the voltage.

Use this mode for the AML AGP-1 Pirani Gauge.

┌─┐·GaugeLabels Yes

Select 'Yes' to change the default gauge labels.

┌─┐·IG1 Label Yes

Each gauge can have a user-defined, three-character gauge label. Select each gauge in turn and change each character with Δ or ∇ and confirm with ENT.

┌─┐·IG1 Label _____

Relay assignment

┌─┐·Relay A = IG1

You can assign any relay to any gauge or to 'None'. Relays assigned to 'None' are permanently de-energised.

┌─┐·Relay B = IG2

Trip levels are set to maximum on assignment.

┌─┐·Relay C = PG1

Trip levels for relays are set using the TRIPS push-button and can be modified when the Function Switch is at position IG1, OFF or IG2. Refer to section 7.2 for instructions on trip settings.

┌─┐·Relay D = AG

┌─┐·Relay D = Bake

Relay D can also be assigned to Bake.

Bake

┌─┐·BkTemp = 200°C

Set the bake temperature setpoint (50 to 250°C), total bake time (1 Hr to 90 Hrs) and overpressure setpoint as required.

┌─┐·BkTime = 24Hr

During Bake, relay D is energised when both the temperature and pressure are below their setpoints. The hysteresis on temperature is 5°C and on pressure is 50%. Refer to section 10 for more information.

┌─┐·BkOvp = 1E-5

Degas

Quick = 20w

Prog. = 25w

Prog. = 2w5/m

Prog. = 25min

Setup Finished

The settings for degas parameters should not be changed until manual degas has been run (see section 9) and settings appropriate for your chamber and usage have been derived.

Quick Degas.

Set the maximum power used in quick degas.

Programmed Degas.

Set the maximum power used in programmed degas, the rate of power increase and the dwell time once maximum power is reached.

7. Operation

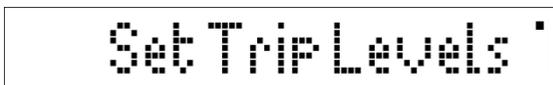
7.1. Use of the Function Switch in the operating positions

The Function Switch must be stationary for a brief period of time before any action results. This allows you to rotate the switch through various operating positions without starting the Ion Gauge or other functions. The Ion Gauge will be started about one second after rotating it to the corresponding IG position. As additional security, Bake or Degas will not start unless you enter the password (if set) and then select and/or confirm your requirement.

7.2. Relay trip levels

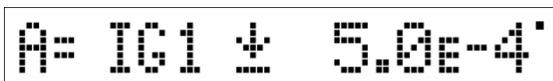
Relay trip levels can be reviewed and modified in the IG1, OFF and IG2 positions of the Function Switch by pressing ENT when a pressure reading is being displayed. If a password has been set you must enter it to be able to modify settings. If the password is set and you do not enter it you may view the settings but cannot change them.

If you make no response at any stage of the sequence the display 'times-out' to the pressure display that was current before the start of the sequence and the setting at the interrupted stage is unchanged.



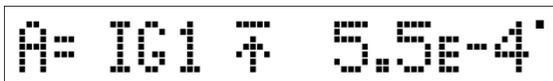
Set Trip Levels

The relay trip levels or their assignment to Bake are displayed in sequence, starting with Relay A and progressing to Relay D. The next in the sequence is shown each time that you press ENT. The status LED for the relay and the numeric setting of the trip level flash if trip modification is allowed. Modify the displayed setting by pressing Δ or ∇ , then press ENT to confirm it and display the next.



A= IG1 \pm 5.0E-4

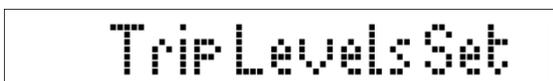
Relays assigned to a gauge are energised when the pressure falls below the "Low" setpoint.



A= IG1 ∇ 5.5E-4

The assigned relays are de-energised when the pressure rises above the "High" setpoint. The minimum allowed hysteresis is 10% of the low setpoint.

If a trip level is set at the upper limit of its range the relay is permanently de-energised. If a trip level is set at the lower limit of its range the relay is permanently energised. Setting trip levels at these limits do not cancel the assignment of the relay. Relays assigned to 'None' are de-energised.



Trip Levels Set

The maximum setting for any relay assigned to the Ion Gauge is half the overpressure trip setting. Changing the overpressure trip may cause the status of relays assigned to the Ion Gauge to change if the current pressure is between the former and new overpressure, after emission is re-started.

Numeric values of trip levels will change automatically if the units of measurement are changed, in order to maintain the trip levels at the same pressures.

7.3. Display sequence when the function switch is in the OFF position

The following displays can be selected sequentially by pressing INC or DEC.

Pirani



The display shows a bar graph icon, 'PG1', a value of '1.0E-3', and a downward arrow indicating a falling pressure trend.

Pirani 1 pressure with falling pressure trend indicator. The Pirani Gauge low-resolution bar graphs are also permanently displayed whenever the Pirani Gauges are operating.



The display shows a bar graph icon, 'PG2', and '>200 mB'.

>200 mB is displayed if the Pirani pressure is above its upper limit or disconnected.

Active Gauge



The display shows a bar graph icon, 'AG', and '900 mB'.

Active Gauge pressure is only available in numeric format and only if the gauge has been setup.



The display shows a bar graph icon, 'AG', and '<1.0E-6'.

Pressures less than or equal to 1E-6 mB are clamped to 1E-6 mB, and prefixed with the less than character. This may indicate the Active Gauge is not connected.

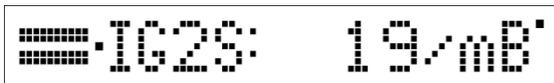
When log format is selected, the pressure value is rounded according to the following rules:

- $P \geq 1000$ mB, rounded to closest 10 mB
- $200 \text{ mB} \leq P < 1000$ mB, rounded to closest 5 mB
- $P < 200$ mB, rounded to closest 0.1 of a decade.

IG Sensitivity



The display shows a bar graph icon, 'IG1S', and '19/mB'.



The display shows a bar graph icon, 'IG2S', and '19/mB'.

Ion Gauge sensitivity can be modified by pressing ENT, then Δ or ∇ to change the number and then ENT again to confirm the new setting. The units of sensitivity are the reciprocal of the units of pressure display you have set up and are dependent on the gauge in use and the gas species. For nitrogen and carbon monoxide the sensitivity for AML AIG17G gauges is 19 mB^{-1} (= 26 Torr^{-1} or 0.19 Pa^{-1}). If the units of measurement are changed the numeric value of sensitivity is changed to make the pressure readings consistent.

Leak Detector



The leak detector operates on the Ion Gauge pressure if the Ion Gauge is in emission, otherwise, it operates on Pirani 1 pressure.

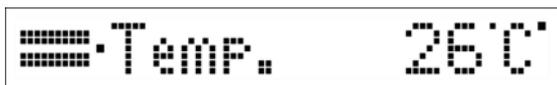
The display is a histogram of the rate of pressure change with baseline restoration and is accompanied by a tone whose frequency is modulated by the offset of the histogram.

Use a probe gas, e.g. helium, or volatile blocking agent, e.g. acetone, at the suspected leak site. If a pressure change is produced there may be a leak.

Allow the baseline restoration to restore the histogram and tone close to the centre before continuing probing.

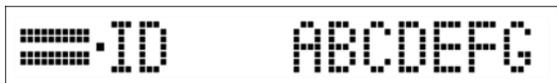
Pressing ENT will change the sensitivity of the leak detector. The height of the pair of dots to the right of 'Leak' in the display indicates the sensitivity. Three levels of sensitivity are provided for the Ion Gauge and two for Pirani 1.

Temperature



The ambient temperature inside the instrument near the electrometer is monitored and may be displayed.

Instrument ID



The programmed instrument ID is displayed if defined in SETUP → PASSWORD/UNITS.

8. Ion Gauge operation

8.1. Display sequence when Ion Gauges are in emission

In emission, the LEDs in the Status Window show the Ion Gauge in use, the emission current and the number of the filament in use.

Starting the Ion Gauge.



IG1 em 0.5mA

Turning the function switch to IG1 or IG2 always starts emission at 0.5 mA. Until the filament reaches emission temperature the display shows the emission current.

If Interlock, Autostart, or Ext. Inhibit is preventing emission from starting, or a fault occurs, the appropriate warning message is displayed.



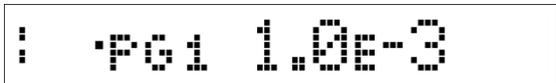
IG1 5.2E-8

The initial display of pressure is in numeric format. Subsequent pressing of the Δ push button will cycle through the Pirani & Active Gauge pressure displays, the leak detector and IG Sensitivity.



IG1 504nA

Ion gauge current display can be enabled by setting "Dsp.IonC." to 'Yes' in SETUP \rightarrow GAUGES.



PG1 1.0E-3



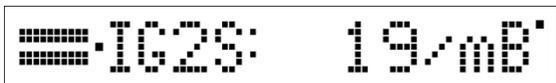
AG 900mB



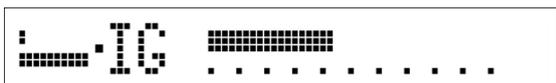
PG2 >200mB



IG1S: 19/mB

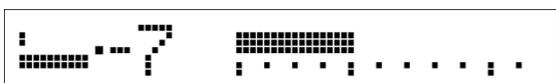


IG2S: 19/mB



IG [bar graph]

Ion Gauge pressure can also be displayed in single-decade, auto-ranging bar-graph or full-range bar-graph formats. These can be invoked by pressing the Δ pushbutton.



? [bar graph]



IG1leak [bar graph]

Manual Emission Change



The Emission current can be changed manually when an Ion Gauge is in operation if Auto Emission is set to 'No' in SETUP → GAUGES (see section 8.2).

WARNING: Changing emission current to 5.0 mA at inappropriate vacuum levels could damage the Ion Gauge filaments.

To change emission current manually, press ENT.

An analogous display is shown to decrease emission current.

8.2. Changing Ion Gauge emission

For most practical purposes the default emission current of 0.5 mA is satisfactory and desirable. This is because the performance of the electrometer is much better than that of older instruments, and there are disadvantages to changing the emission current. Increasing emission will give a pressure burst and the recorder output will also be shifted by +1 volt, either of which may be problematic. Because the filament is permanently hotter at 5 mA emission the indicated pressure will normally be slightly above that at 0.5 mA, after the burst subsides.

At extreme UHV a higher emission current may be desired. If "Auto Em" is set to 'Yes' in SETUP → GAUGES then the instrument will change emission current automatically when appropriate. If "Auto Em" is set to 'No' the instrument will suggest when a manual change in emission current is appropriate.

It is not necessary to increase emission current, I_e , until the collector current, I_c , is less than 100 pA. The pressure, P , corresponding to these currents is dependent on the sensitivity, s , according to:

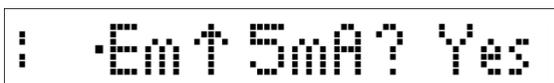
$$P = \frac{I_c}{(s \times I_e)}$$

If the collector current falls below 1 pA, "Low Ion C." will be displayed, instead of the pressure display, to indicate the instrument is beyond its usable range for the set emission current.

If the pressure burst produced after an increase in emission lasts for more than a few minutes then degassing of the Ion Gauge may be required. The set-point to decrease emission current is set to occur at plus half a decade in mB, to ensure a consistent amount of hysteresis between the two thresholds.

8.3. Prompted emission change

If "Auto Em" is disabled in SETUP → GAUGES the instrument will suggest when a change in emission current is appropriate.



This display is shown periodically when the collector current is below 100 pA. Pressing ENT while it is present cancels the display, but does not change emission. In order to change emission, press Δ to change 'No' to 'Yes' and then press ENT. The filament takes a second to stabilise at the new emission temperature.

Analogous displays suggest when emission should be decreased.

If ENT is pressed when 'No' is selected, this display will not be shown again this cycle.

9. Degassing

Read this entire section before attempting degas. Degas is required in UHV systems periodically. It is not desirable to degas at high vacuum and above as this could damage the gauge or affect other operations in the vacuum chamber.

Degas increases the emission current and grid voltage so that the grid is heated to drive off adsorbed gas. The degas power should be increased slowly to allow the gas evolved to be pumped away. If power is increased too rapidly plasma will be produced, which will short the grid to the filament or ground. The instrument will detect this and degas will be aborted to protect the gauge and instrument.

The instrument only allows degas to start:

- When a valid password has been entered (if password use is enabled).
- If the gauge has run in emission for at least 5 continuous minutes in the preceding 30 minutes.

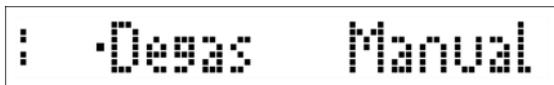
If any condition prevents degas starting then "Degas Denied" will be displayed. Move the Function Switch to OFF.

If the Ion Gauge is in emission when degas is selected, emission will not be interrupted (unless degas is denied) and degas will seamlessly start when the mode has been selected. If the Ion Gauge is not in emission when degas is selected, emission is run automatically at 0.5 mA and then 5 mA for a few seconds before degas power is applied.

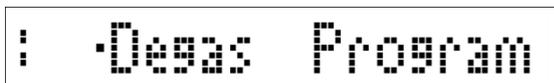
A fixed degas overpressure trip ($1E-5$ mBar) is active for a few seconds at 5 mA. Degas is aborted if the pressure exceeds that level. In all modes, degas power is changed in 2.5 W steps.

In Program and Quick modes, the pressure can continue to be read during degas by returning the Function Switch to the corresponding IG position. If the Function Switch is left in the IG position when degas finishes, normal emission will resume seamlessly. If the Function Switch is left in the DEGAS position when degas finishes, emission will cease.

Relay operations are suspended during degas.



: ·Degas Manual



: ·Degas Program



: ·Degas Quick

Move the Function Switch to the DEGAS position to select the required mode. Select Manual, Program or Quick with Δ or ∇ and confirm by pressing ENT.

In program or quick modes, the grid power is increased automatically. Use Manual Degas to derive safe rates of power increase and maximum power to set up the other modes in SETUP \rightarrow DEGAS.

Once UHV has been established most systems will only require an occasional Quick Degas.

Manual Degas

: ·Dg em 0.5mA

: ·Dg em 5.0mA

: ·101 6.0E-11

: ·Dg 2w5 0:09

: ·Dg 5w0 1:01

: · Degas Finished

In manual mode the degas grid power is increased by 2.5 W every time Δ is pressed. If Δ is pressed several times the instrument stores up to five steps and increases power at five-second intervals. This is not recommended. If a request to increase cannot be implemented or stored, a sound is made. The maximum degas power is 30 W and the maximum degas time is 10 minutes.

The degas power is shown at the centre of the display. The time on the right of the display is in minutes and seconds. In manual mode this is the time elapsed since the start of degas. In other modes it is the time remaining until completion of degas.

Pressing ∇ in manual mode decreases the grid power by 2.5 W immediately.

After 10 minutes of manual degas "Degas Finished" is displayed. Turn the Function Switch to OFF.

Programmed Degas

: ·Dg 15w -0:57

Programmed degas follows the profile set in SETUP → DEGAS and is intended for gentler degassing over longer periods during pump-down of a vacuum system.

Quick Degas

Quick Degas increases the power rapidly to the level set in SETUP → DEGAS and holds it for one minute.

If a fault occurs during degas "Degas Aborted" is displayed.

10. Bake

Baking is necessary for ultra-high vacuum systems to reach their ultimate pressure. Typically, the complete vacuum system will be heated to 200°C and maintained at that temperature for at least 24 hours. In addition to a temperature set-point there is a pressure set-point so that if excessive gas is evolved, the heaters are switched off to avoid overloading the pumps. As there are risks involved, systems should only be baked after they have been pumped close to the best vacuum they can achieve without baking. Bake should be competently supervised. Setting the password will enable only operators who know the password to initiate or terminate bake. The pressure should be significantly lower than the bake pressure set-point before starting a bake, as there will be a significant pressure rise as the system heats.

A rectangular LCD display showing the text "Bake 24h Yes" in a pixelated font.

Start Bake by turning the Function Switch to BAKE and press ENT.

Relay D must be assigned to the Bake function as it is used to switch on the heaters via a contactor. If Relay D is not so assigned the display will prompt you to re-assign Relay D. If the password is enabled you are required to enter it. If the entered password fails three times "Bake Denied" is displayed. The Bake program operates with the pressure from Ion Gauge 1 only.

A rectangular LCD display showing the text "Bk IGem 0.5mA" in a pixelated font.

If all conditions are satisfied the Ion Gauge starts emission and then Bake starts. The progress of Bake is shown as a percentage of total time in the bar graph to the top left of the pressure reading. The ON/OFF status of the heater is shown below this bar graph. The Bake LED in the Status Window flashes during Bake.

A rectangular LCD display showing a bar graph on the left, the text "6.1E-11" in the middle, and "24°C" on the right.

A rectangular LCD display showing a bar graph on the left, the text "6.1E-8" in the middle, and "206°C" on the right.

A rectangular LCD display showing a bar graph on the left, the text "23:57" in the middle, and "Ht Off" on the right.

Pressing and holding the ENT button will display the time remaining and heater status.

When Bake is finished you can leave the Function Switch on BAKE to monitor the temperature and pressure as the system cools.

A rectangular LCD display showing a bar graph on the left and the text "Move Function" on the right.

Moving the Function Switch off the BAKE position alone cannot terminate a bake cycle. However, if you do this you will be asked to return it to BAKE and then to confirm whether you want to terminate the bake.

A rectangular LCD display showing a bar graph on the left and the text "Switch to Bake" on the right.

A rectangular LCD display showing a bar graph on the left, the text "Abort Bake" in the middle, and "No" on the right.

If the password is enabled you will then be required to enter it. This procedure discourages an inadvertent termination of a bake. If Bake is terminated manually it can be resumed by pressing the ENT button.

· Bake 24h

· Manual Abort

· 23.56 remain

· ENT to resume

· Finished

Bake will be terminated automatically if a gauge fails or the pressure exceeds the Ion Gauge overpressure limit or if the thermocouple measuring the temperature fails or is disconnected.

The display will show the cause of the termination, alternating with bake duration remaining.

11. Recorder Output

An analogue voltage representing the base-10 logarithm of collector current is available on the auxiliary connector. This is scaled at 1 V per decade and 0 V represents 1E-13 A. The output increases by 1 V when emission is increased from 0.5 to 5 mA. The output resistance is padded to 1 kΩ.

As the recorder output is related to collector current it has to be combined with sensitivity and emission current to derive pressure:

$$Pressure = \frac{10^{(V-13)}}{s \times I_e}$$

where V is the recorder output voltage, s is the sensitivity and I_e is the emission current in amps.

12. External inhibit

Operation of the Ion Gauge may be inhibited by an external contact closure, which prevents starting of the Ion Gauge by any means. If the Ion Gauge is operating, the Ion Gauge will be switched off.

- In Manual and Interlock Ion Gauge modes, external inhibit is latching, and once triggered requires the Function Switch to be returned to OFF before another attempt can be made to start emission.
- In Autostart and Ext. Inhibit mode, emission can restart automatically once the criteria for that mode are met and the external inhibit condition is removed. In these modes, external inhibit can act as a trigger to start and stop the Ion Gauge.

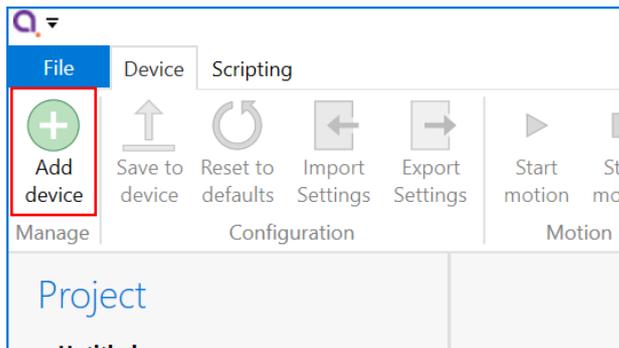
See section 'Ion Gauge Mode' for more information regarding Ion Gauge modes.

13. Windows Software

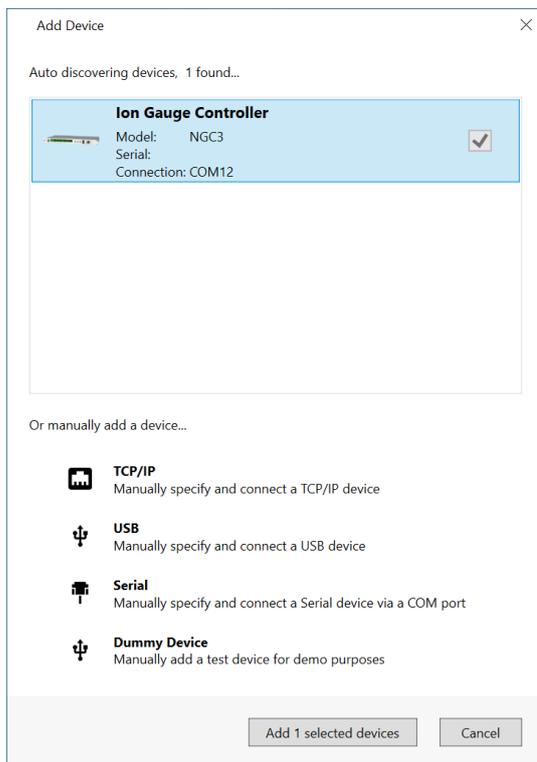
13.1. Installation and setup

The NGC3 is compatible with AML Device Control software, which can be downloaded from the Software page on our website: <https://arunmicro.com/documents/software/>

- Connect all NGC3 devices to your computer, using a serial lead, and power them on.
- Start the AML Device Control software and click 'Add device' in the top left corner

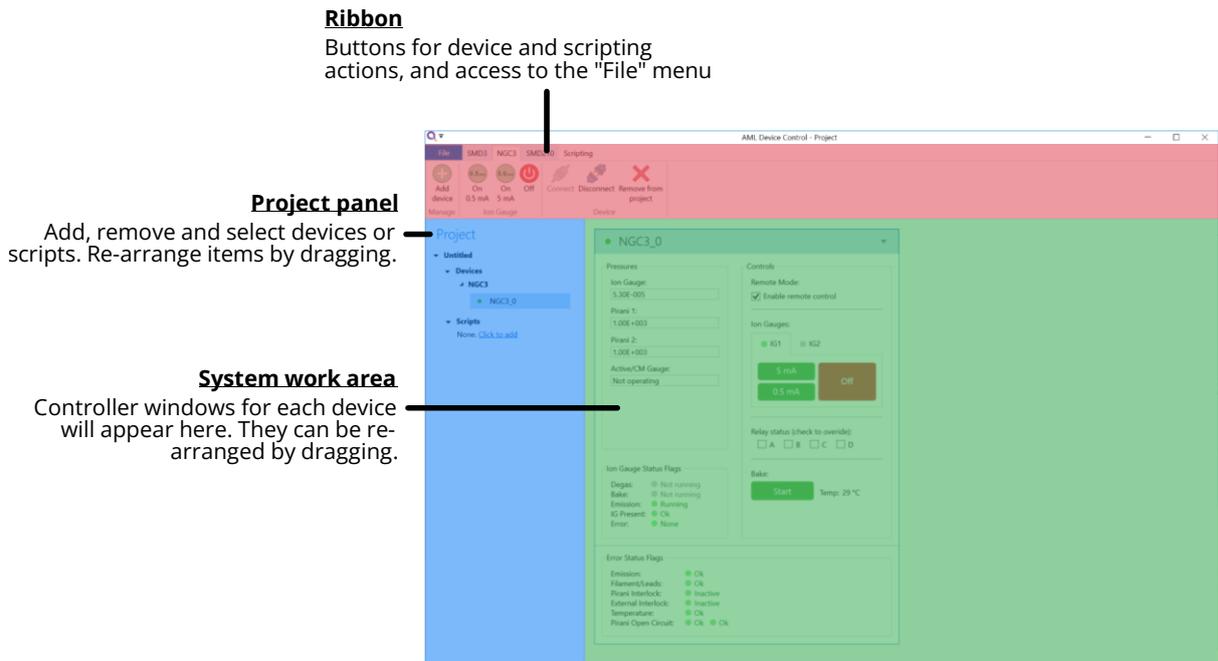


- Connected NGC3 devices should automatically appear in the list. Select all devices that you wish to add and click "Add n selected devices"



13.2. Overview

The default layout of the software is shown below.

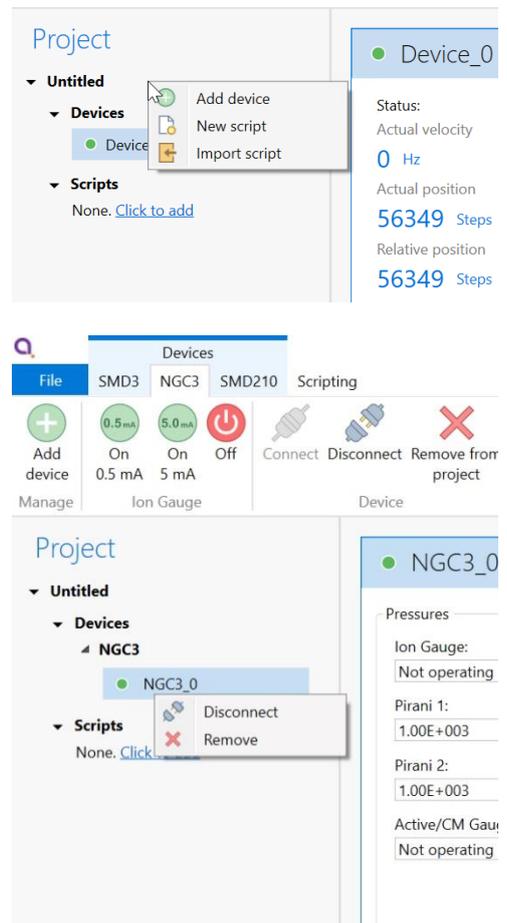


Project panel

Shows a list of the devices and scripts in the project. Currently selected devices are highlighted. Multiple devices can be selected by holding down CTRL and clicking. The device properties panel shows the properties for the selected device(s).

Right-clicking on an empty area within the project panel presents a context menu, with options to add new devices, new scripts or importing scripts.

The right-click context menu on each device provides access to disconnect or remove the device.



A status indicator next to each device shows the current status of each device according to these colours:

Colour	Description
 Green	Device connected and ready
 Blue	Bake mode running
 Red	Device in a fault state
 Grey	Device disconnected

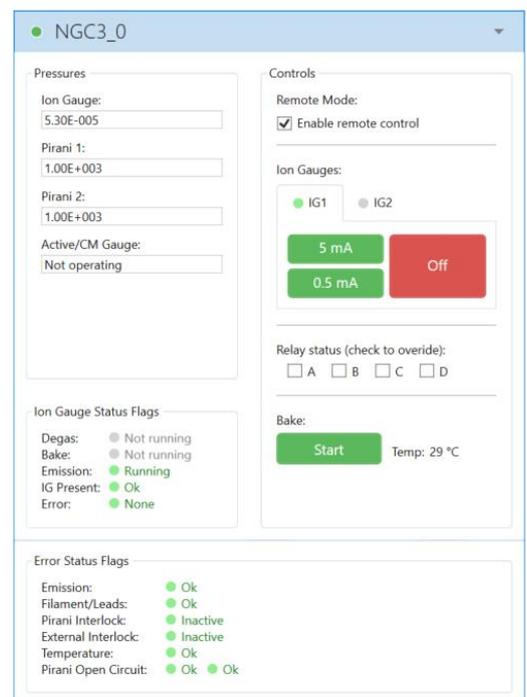
System work area

Controller windows for each device appear in this area. Windows can be arranged as desired and will automatically 'snap' to a grid making it easy to keep them neatly organised.

Controller window

Shows a status summary for the selected device, providing essential information such as gauge pressures and error status.

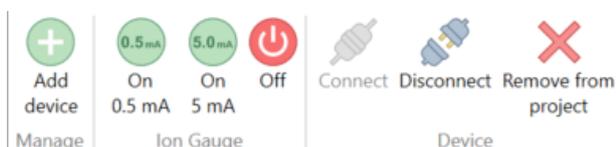
For controlling an NGC3, use the buttons on the Controller window or Ribbon:



INFORMATION: Ion Gauge two decimal place pressure display is not compatible with this software.

Ribbon

Contains buttons for all actions. Within the software, buttons can be hovered over for more information.



14. Remote operation

14.1. Introduction

The serial interface is RS232-compatible and only one instrument may be connected to a computer serial port.

At switch-on, the NGC3 is reset to local operation mode with the Ion Gauge switched off.

14.2. Interface protocol

1200, 2400, 4800 or 9600 (default) baud, 8 data bits, 1 stop bit, no parity, no handshaking.

14.3. Local/remote control

An NGC3 starts operation in local control, i.e. using the front panel. In local mode the NGC3 responds only to commands without parameters (<poll>, <control>, <status> and <reset error>). The <control> command puts the NGC3 into remote mode, and all the other commands can then be used. The front panel can still be used to change the display but not to control gauges or change set-points. When a host takes control of the NGC3 emission is stopped, and any current Setup operation is cancelled. When the host returns the NGC3 to local control, emission is again stopped. The host must terminate any running bake cycle before returning the NGC3 to local control.

If any relay is permanently Energised or De-energised while in remote control the setpoint for that relay is changed to the limit so the status of the relay is no longer affected by pressure, either in remote control or on return to local control.

14.4. Host Computer Commands

The host computer sends commands in the following format:

First byte:	'*' (0x2A)
Second byte:	Command character. All commands are represented by a single character.
Third byte:	Ignored on NGC3 (character '0' to '8' (0x30 to 0x38) or 'X' (0x58)). This ensures compatibility with PGC1, which had a multi-drop capability where instruments were addressable (all the examples below use '0').
Optional parameter:	Additional command parameters, single ASCII characters.

14.5. NGC3 Response

The NGC3 responds to the <poll> command with the **state byte** and **error byte**, followed by a CR-LF (0x0D, 0x0A). The NGC3 responds to the <status> command as detailed on the following pages. All other commands are processed by the NGC3 without a response being issued.

14.6. Timing of Next Command

Following the transmission of a <poll> or <status> command, the host computer should not begin transmitting a new command until a CR-LF has been received, signalling the end of transmission. It is not necessary to poll the NGC3 more than 4 times per second, and we strongly recommend that a delay of at least 100 ms is implemented before the next report request. The response to commands is typically less than 1 second.

14.7. State & Error byte coding

State byte:	Bits 3-0 :	Instrument type (00102 – NGC3)
	Bit 4 :	0 = local mode, 1 = remote mode
	Bit 5 :	1
	Bit 6 :	0 = IG 1 selected, 1 = IG 2 selected
	Bit 7 :	Ion Gauge disconnected
Error byte:	Bit 0 :	gauge - specific error
	Bit 1 :	over temperature trip
	Bit 2 :	bake error
	Bit 3 :	temperature warning
	Bit 4 :	0
	Bit 5 :	0
	Bit 6 :	1

The value in the error byte is maintained until reset by a <reset error> command.

14.8. Host Computer Command Characters

Command parameters are single printable ASCII characters.

Relays are addressed by uppercase letters 'A' to 'D'.

Command	Char.	Ignored	Para.	Description
<poll>	P	0		Poll instrument (returns state and error byte). (e.g. *P0)
<control>	C	0		Remotely control NGC3. (e.g. *C0)
<release>	R	0		Return NGC3 to local control. (e.g. *R0)
<reset error>	E	0		Reset all error flags. (e.g. *E0)
<status>	S	0		Request a report of operating status for all gauges. (e.g. *S0)
<Gauge on>	i	0	n	Switch on Ion Gauge emission. n = '0' 0.5 mA n = '1' 5 mA (e.g. *i00)
<Select IG>	j	0	n	n = '1' Ion Gauge 1 selected. n = '2' Ion Gauge 2 selected.
<Gauge off>	o	0		Switch off Ion Gauge. (e.g. *o0)
<override>	O	0	R	Permanently energise relay R. R = 'A' to 'D' (e.g. *O0A)
<inhibit>	I	0	R	Permanently de-energise relay R. R = 'A' to 'D' (e.g. *I0A)
<bake>	b	0	n	n = '1' Start bake cycle. n = '0' Stop bake cycle.

14.9. <status> Status report

The status report gives the operating status and pressure of each gauge in the NGC3.

State byte: See section 14.7.

Error byte: See section 14.7.

Relay status byte: The relay status byte is of the form 0100XXXX2, where the least significant 4 bits indicate the state of relays A to D (1 = energised) with relay 'A' indicated by the least significant bit.

An unused byte: '0'

Gauge record: For each gauge in the NGC3:

Byte	Name	Details
1	Header byte	'G'
2	Gauge type	'I': Ion Gauge 'P': Pirani 'M': Active Gauge
3	Gauge number	'1': Ion Gauge 1 '2': Pirani 1 '3': Pirani 2 '4': Active Gauge '5': Ion Gauge 2
4	Gauge status	All bits are set to 0 unless stated otherwise: Ion Gauge Status Bit 0: gauge in emission Bit 1: 0 Bit 2: gauge controlling bakeout Bit 3: gauge in degas Bit 4: 0 Bit 5: filament 2 Bit 6: 1 Pirani Gauge Status Bit 0: gauge operating
5	Gauge error	Ion Gauge error Bit 0: filament open-circuit Bit 1: overemission Bit 2: underemission Bit 3: overpressure Bit 4: Interlock/Autostart prevents starting Bit 6: 1 Bit 7: Filament/leads Pirani Gauge error Bit 0: Pirani Gauge open-circuit Bit 6: 1 Bit 7: 0
6-13	Pressure	Comma-delimited string in scientific notation, e.g. "1.3E-07," If the gauge is not operating the string consists of spaces only.
14	Units	'T' = Torr, 'P' = Pascal, 'M' = mBar
15	Unused	'0'
16-17	CR-LF	

Bake Temperature: Three bytes of temperature followed by 'C'

CR-LF

15. Troubleshooting

15.1. Fan slow / failed

Fans are used alternately on a periodic cycle. A fan that is running slowly will cause an occasional 'Fan 1 slow' or 'Fan 2 slow' message to be displayed during its cycle. Fan speed is dependent on environmental factors and a warning may not be present in every cycle for a marginal fan. Fans reported as failed may still be working, but are too slow to be effective. If a fan is reported as slow ensure that you have a replacement ready. Replace a failed fan as soon as convenient. Replacement fans are available from AML, and are supplied with instructions for correct installation.

15.2. Temperature

If the ambient temperature exceeds 40°C the Ion Gauge is automatically switched off to protect the instrument and a temperature warning will be displayed in place of the pressure reading. Turn the instrument off and wait for the ambient temperature to decrease before re-starting.

15.3. Emission Fault

Ion Gauge faults can have multiple causes, some of which are transient or simultaneous. The most common causes of persistent problems in emission are unsuitable gauges, unsuitable leads or incorrect installation. Other possible causes:

- Excess emission current may be caused by a grid-to-filament short, production of a plasma in degas or another source of ions or electrons nearby.
- Low emission current may be caused by a grid-to-ground short, magnetic or electric fields, an unsuitable filament, loss of filament coating or incorrect setup of filament type.
- When using Yttria filaments, if the filament worked previously then the coating may have deteriorated. If the filament has been exposed to air it will have adsorbed moisture: attempt emission several times to drive it off. Unsuitable or contaminated filaments operated at high local pressure may also cause this display.

Failure of Pirani Gauge 1 will stop the Ion Gauge operating if Interlock or Autostart Ion Gauge modes are in use, and the Interlock or Autostart gauge is set to Pirani 1, regardless of any other conditions. Operation of the Ion Gauge can be restored after failure of Pirani 1 (if it is safe to do so) by switching the Pirani Gauges off and disabling Interlock and Autostart, if appropriate.

15.4. IG Fil O/C

If "IG fil x o/c" (IG filament open circuit) is shown the filament has probably failed or there is a poor connection to the cable. In some cases if there is a high resistance connection or the cable is long or of inadequate cross-section this fault may be reported after some period of normal operation.



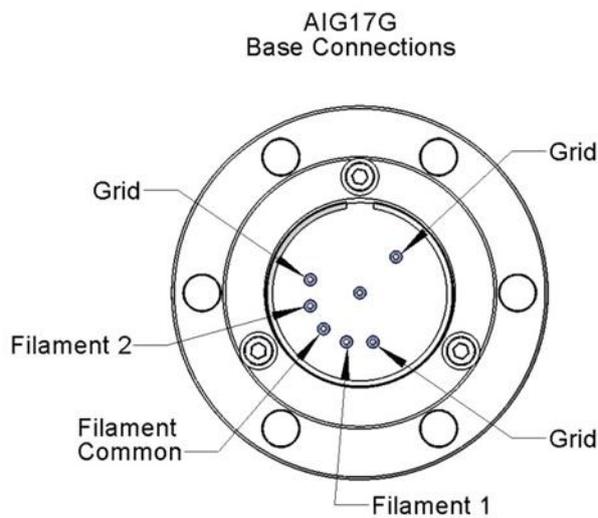
Disconnect the mains power connector before checking any cables.

15.5. Password forgotten?

To recover from a forgotten password the instrument will need to be reset to factory defaults. This will return all parameters to their default state, so all user settings must be re-entered.

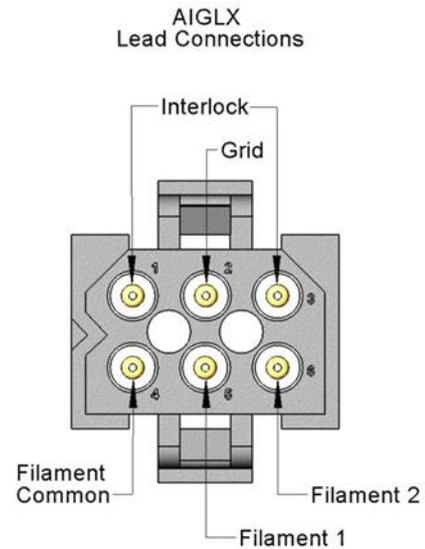
Turn the function switch to SETUP → PASSWORD/UNITS, then press and hold the ENT button while turning the function switch back to the OFF position until the factory reset option is shown.

15.6. Ion Gauge connections



Base connections of AIG1x gauges.

If you probe the pins with an ohmmeter, take care not to stress them, as this may cause a leak.



Connections at the controller end of an AIGLx lead.

The cold filament resistance is very low. The grid, collector and filaments should be isolated from each other and from the chamber.

16. Assistance

In the first instance, contact the distributor or supplier of the equipment. Always quote the serial number of the instrument and the version number of the program. Provide a written description of the problem. If the problem is related to gauges and leads quote the serial numbers and filament type used. Do not return products to AML without prior approval.

Arun Microelectronics Ltd
Tel: +44 (0)1903 884141
Email: info@arunmicro.com
Website: arunmicro.com



In the United Kingdom (UK) and European Union (EU), waste from electrical and electronic equipment (WEEE) is subject to legislation designed to prevent the disposal of such waste and to encourage proper treatment measures to minimize the amount of waste ultimately disposed to landfill. To view AML's WEEE policy please visit: https://arunmicro.com/documentation/WEEE_procedure.pdf

Appendix A Gauge Principles

A.1 Ionisation Gauges

Ionisation Gauges are thermionic triode devices. The appropriate choice for UHV use is the Bayard-Alpert type. This consists of a very thin collector wire mounted along the axis of a cylindrical mesh grid. The filament is outside the grid and usually parallel to it. The grid is voltage biased positively with respect to the filament, and the collector negatively.

A stabilised emission current is established between the incandescent filament and the grid structure. Electrons oscillate on long paths through the open grid structure, being repelled from the central collector and attracted to the grid. A proportion of the electrons encounter gas molecules before reaching the grid. These molecules are ionised by the collision and those within the grid volume are attracted to the collector to form a current, which is proportional to the concentration of gas molecules over a very wide range.

Pressure may be derived from the ion current by solving the equation:

$$Pressure = \frac{Ion\ current}{Sensitivity \times Emission\ current}$$

where the units for the two currents are the same and the sensitivity is a quoted constant for a particular gauge head and gas species.

The impact of electrons on the grid structure generates soft X-rays; some of these impinge on the collector and release photoelectrons. These form a small current in the same direction as the ion current. When this 'photocurrent' becomes significant in relation to the 'true' ion current, the gauge ceases to function as a reliable pressure transducer and is said to have reached its 'X-Ray limit'.

A.2 Pirani Gauges

The Pirani Gauge is a thermal conductivity gauge. A tungsten filament in the vacuum space is heated from a constant voltage source and is incorporated in a Wheatstone bridge. The electrical resistance of the filament depends on its temperature and this, in turn, depends on the rate at which heat is conducted away from the filament by residual gas. The thermal conductivity of a gas depends on its pressure (below about 1 mBar) and the nature of the residual gas. The Pirani Gauge unbalances the Wheatstone bridge and the voltage across the bridge represents pressure over the range of 200 mBar to about 1×10^{-3} mBar.

The lower pressure limit is determined by the heat loss due to radiation becoming significant compared to that due to thermal conductivity. The radiant heat loss depends on the emissivity of the filament. A new filament is bright but can become blackened by deposits from decomposed rotary pump oils and the lower limit of pressure readings will rise. It is possible to clean filaments.

A.3 Capacitance manometers

Capacitance manometers operate by measuring the deflection of a thin, circular, radially tensioned membrane between the vacuum space and a reference volume at a pressure substantially below the operating range of the transducer. The deflection is measured as a modulation of the electrical capacitance between the membrane and a fixed plate and converted to a voltage proportional to the pressure difference across the membrane.

Appendix B List of NGC3 Error Messages

Error Message	Description	Notes
Accuracy ↓	Accuracy degraded (internal temperature > 35°C, ion current < 10 pA)	See section 4.1
AG Interlock	Ion gauge emission prevented/stopped, interlock pressure met or exceeded	See section 6.2
Emission Fault	Ion gauge emission fault	See section 15.3
Emission High	Excess ion gauge emission current	
Emission Low	Low ion gauge emission current	
Fan 1 slow	Fan slow	See section 15.1
Fan 2 slow	Fan slow	
Fans Failed	Both fans failed (alternates with "Switch Off" error message)	
IG fil 1 o/c	Ion gauge filament open circuit	See section 15.4
IG fil 2 o/c	Ion gauge filament open circuit	
IG XS pressure	Measured ion gauge pressure exceeds the set threshold (overpressure limit)	See section 6.2
Low Ion C.	Ion collector current below 1 pA (emission current too low for pressure)	See section 8.2
No ion gauge?	Ion gauge not detected	Check that the ion gauge is connected to the controller
PG1 Failed o/c	Pirani gauge failed open circuit	See section 6.2
PG1 Interlock	Ion gauge emission prevented/stopped, interlock pressure met or exceeded	See section 6.2
PG2 Failed o/c	Pirani gauge failed open circuit	See section 6.2
Remote Mode On	Function switch moved while remote mode is active	See section 14.3
Set AG Used	Function requires active gauge (such as interlock and autostart)	See 6.2
Switch PGn On	Function requires Pirani gauge (such as interlock and autostart)	See 6.2
Temp. >40°C	Internal temperature exceeds 40°C, emission disabled	See section 15.2



This declaration of conformity is issued under the sole responsibility of the manufacturer.

Manufacturer: Arun Microelectronics Limited
Address: Unit 2, Bury Mill Farm, Bury Gate, Pulborough, RH20 1NN, United Kingdom
Object: Pressure Gauge Controller
Part No.: NGC3

The object of the declaration described above is in conformity with the relevant UK Statutory Instruments (and their amendments), and the relevant European Union harmonisation legislation:

Statutory Instruments: 2016 No. 1091 The Electromagnetic Compatibility Regulations 2016
2016 No. 1101 The Electrical Equipment (Safety) Regulations 2016
2012 No. 3032 The Restriction of Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012

Directives: 2014/30/EU EMC Directive
2014/35/EU Low Voltage Directive
2015/863 RoHS Directive

Standards: Harmonised and international/national standards and specifications:
EN 61010-1:2010 Safety requirements for electrical equipment for measurement, control and laboratory use
EN 61326-1:2013 Electrical equipment for measurement, control and (Class B Emissions) laboratory use – EMC requirements

Signature

Mr. P Brooker, Managing Director

Place, Date Pulborough, October 2019