Chapter 2

IGC100 Basics

This chapter describes the basic features and functionality of the IGC100 controller.

In This Chapter

IGC100 Overview

> **WARNING!**
> - Read the entire **Safety and Preparation for Use** section of this manual before using the IGC100.
>
> - Read Chapter 1 for detailed instructions and safety information regarding the installation and connection of gauges.

The IGC100 Ionization Gauge Controller is a fully programmable, microprocessor-based vacuum system controller.

The IGC100 is a high accuracy controller that measures pressures from Bayard-Alpert ionization gauges, convection-enhanced Pirani gauges and capacitance manometers, providing uninterrupted pressure readings from 1000 Torr to UHV. The IGC100 has a touchscreen LCD display, pressure vs. time plots, built-in relays for vacuum system control and several multipurpose (analog and digital) I/O ports. An RS-232 computer interface is standard in all controllers with optional upgrades to GPIB and Web (ethernet) interfaces.

Controller operation is simple and intuitive via a menu-driven touchscreen user interface. The screen displays readings in a large, easy-to-read numeric format, as well as in bar graph and trend formats. Readings are updated twice a second and pressures can be displayed in several units systems. Data Logging and Pressure vs. Time plots allow you to follow pump down and venting cycles and keep track of process relay activity, analog input signals and gauge operations, to within a fraction of a second.

For applications that benefit from the accuracy of calibrated ionization gauges, the IGC100 also offers the ability to store and use *gauge-specific* calibration.

Complete controller specifications are included in the introductory pages of this manual.

This section details the main features of the IGC100.

Ionization Gauge (IG1)

The basic IGC100 Ionization Gauge Controller is designed to operate a single, hot-cathode, ionization gauge of Bayard-Alpert design within the 10^{-11} and 10^{-1} Torr pressure range supported by its electrometer. Pressure readings are updated at a rate of 2 Hz.

The IGC100 is compatible with most commercially available Bayard-Alpert ionization gauge designs, including: glass-tubulated, nude, nude-UHV, STABIL-ION® (Granville-Phillips, Helix Corporation) and MICRO-ION® (Granville-Phillips, Helix Corporation) gauges. The menu-driven interface allows the operator to easily program all required Gauge Setup parameters into the controller. Additional controls are provided for overpressure protection and Auto-Start operation (see Pirani Gauge Capabilities below).

The IGC100 is designed to be accurate and stable. All ion gauge bias voltages and emission current supplies are accurate to better than 0.3% (see 'Specifications'). The IGC100 has a low noise, autoranging electrometer that delivers high accuracy pressure readings into the UHV. A low noise, direct current supply powers the filament and establishes the emission current. Precision electronics eliminate controller-to-controller variations and the measurement uncertainties (up to 15%) associated with traditional instruments. When necessary, biasing voltages are measured directly at the gauge head (4 wire measurements) making them independent of cable lengths. The effective measurement range for ionization gauge readings is ultimately limited by the gauge design. The accuracy level of the pressure readings is defined by the accuracy of the calibration data available for the gauge. The high accuracy and long term stability of the IGC100 electronics, justifies the presence of three significant digits in the pressure display.

Pressure measurement with Bayard-Alpert ionization gauges requires that the filament be turned on. The IGC100 includes an IG Control Keypad (IG1, IG2, DEGAS and IG AUTO buttons w/LEDs) on its front panel for manual activation of pressure measurements and degassing. Ionization gauges can also be activated remotely through (1) software control, (2) Remote TTL control (requires Process Control board, Opt 03), and (3) web-interface (requires Web Interface, Opt. 02). An Auto-Start Mode (see below) is available for controllers also connected to Pirani Gauges (see below).

Degassing is by electron bombardment, with user-programmable degas power and degas time. To degas, the gauge must be on and the pressure must be under 2×10^{-5} Torr. In order to remove filament damaging pressure bursts, the degas power ramps up and down at the beginning and end of the degas procedure. For convenience, and improved safety, degas power is constantly regulated throughout the degas procedure to prevent excessive pressure rise and reduce the possibility of a gas discharge.

For applications that benefit from gauge-to-gauge reproducibility and the accuracy of calibrated gauges, SRS offers NIST-Traceable calibrated ionization gauges through its High-Vacuum Calibration Facility. Full-range calibrations are available with 6% and 3% accuracy. All calibrated gauges are delivered with a Memory Card which contains calibration data specific to the gauge. The calibration data is easily uploaded into the controller via the front panel Memory Card module. Of course, the IGC100 also operates with uncalibrated gauges. In that case, the user must simply configure the controller based on the manufacturer's recommended parameter values or by recalling a factory pre-loaded Default Setup File compatible with the gauge.

Gauge connection cables must be purchased directly from Stanford Research Systems and are available for most gauge designs.

For More Information
Chapter 1 includes all the installation and setup information required to set up your IGC100 controller and its gauges. Chapter 3 describes, in detail, the menu-based user interface, including all menus required to configure the IGC100 for operation with ionization gauges. Chapter 6 provides a detailed description of the Memory Card module capabilities, including step-by-step instructions for uploading gauge calibration data into the controller. Consult Appendix A of this manual for general information on Bayard-Alpert ionization gauges, and Appendix B for a list of ionization gauges available directly from Stanford Research Systems (including detailed specifications,

Manufacturer's Cross Reference Table, connection cables and available Default Setup Files). Appendix F lists the gauge calibration options available through the SRS High-Vacuum Calibration Facility.

Pirani Gauges (PG1 and PG2)

The standard IGC100 controller has the capability to simultaneously operate two convection-enhanced Pirani Gauges, providing mid-pressure measuring capabilities between 10^{-4} and 1000 Torr. Pressure readings are continuously updated, at a rate of 2 Hz.

To complement the IGC100, Stanford Research Systems has designed its own line of Pirani gauges, models PG105 and PG105-UHV. However, the IGC100 is also compatible with well-established, third-party products such as: Convectron® (Helix Corporation, Granville Phillips) and Series 317 (MKS/HPS) convection gauges. Note that connector adapters (O105CA1 and O105CA2, respectively) are required to connect these third party gauges to the O105C4 dual-Pirani gauge cable.

The PG105-UHV is the only commercially available convection-enhanced Pirani gauge that can be operated directly in UHV environments and can be baked to 250°C without any disassembly.

Following factory assembly, each PG105 gauge tube is individually calibrated for nitrogen, and temperature compensated between 10° and 40°C. Individual factory calibration of the gauge response provides true 'plug-and-play' convenience and eliminates the need to readjust the controller each time a new gauge tube is connected. PG105 gauges and IGC100 controllers are completely interchangeable without any need for instrument adjustments.

The IGC100 controllers are factory preloaded with nitrogen and argon specific calibration curves for all compatible convection gauges. Look-up tables are available (Appendix I) to convert nitrogen-equivalent readings to other gases.

The calibration data loaded into all IGC100 controllers is based on the response of a new gauge, free of contaminants. If a tube becomes contaminated or does not seem to read correctly, the front panel readings can often be readjusted through the menu-based interface using the ZERO and ATM calibration sub-menus included in the Gauge Setup menus. Consult Chapter 3 for details on these two adjustment procedures.

As a special feature, IGC100 users can turn off their Pirani Gauges from the front panel-without having to physically disconnect them from the controller, i.e. the hot wire sensor is cooled down and pressure readings are no longer available. This is convenient for fail-safe process control setups to prevent hot Pirani gauge sensor wires from coming in contact with flammable or explosive gases. The Pirani gauge sensor wire can be turned off manually (front panel), or remotely through the computer interface or the Remote TTL Control Module (requires Process Control Board, Opt. 03).

For More Information
Chapter 1 includes all the basic information required to install and set up your IGC100 controller and its gauges, including Pirani gauges. Chapter 3 describes, in detail, the

menu-based user interface, including all menus required to turn Pirani gauges on/off, adjust Zero and ATM, and select N2/Ar cal curve. Consult Appendix H of this manual for general information on PG105 convection-enhanced Pirani gauges. Appendix I lists correction factors for some common gases.

IG Auto-Start mode (IG AUTO)

The common combination of one ionization gauge and two Pirani gauges, standard in all IGC100 controllers, allows you to monitor system pressures between atmosphere and UHV without any blind spots.

If one of the Pirani gauges is exposed to the same gas environment as the ionization gauge, the IG AUTO mode automatically turns the ionization gauge ON when the Pirani pressure readings drop below a user programmed threshold. IG AUTO continues to protect the filament during subsequent operation. The ionization gauge will be turned OFF if the Pirani pressure rises above 1.2 times the threshold. For example, if the threshold is 1.0×10^{-3} Torr, the ion gauge turns on below 1.0×10^{-3} and shuts off if the pressure ever rises back above 1.2×10^{-3} Torr.

The Auto-Start threshold and gauges are selected in the Gauge Setup menu of either ionization gauge. From the Gauge Setup menu, touch [Autostart] to display the Auto-Start setup menu. Choose which Pirani gauge is monitoring the Ion Gauge pressure and the safe pressure threshold for the Ion Gauge. In dual ionization gauge systems (with option O100IG) the user specifies the ionization gauge (IG1 or IG2) which will auto-start. Since the IGC100 only operates one ion gauge at a time, IG2 is automatically turned off if IG1 is put in Auto-Start (and vice-versa).

Auto-Start is activated/deactivated manually by pressing the IG AUTO button of the IG Control Keypad on the front panel. Pressing either IG1 or IG2 will deactivate IG AUTO operation. Auto-Start can also be activated remotely, through the computer interface.

Auto-Start is used to provide complete unattended system control, and protect the ionization gauge filaments, during system pumpdowns and ventings.

For More Information
Consult the 'Front Panel' section of this chapter for details on the IG AUTO button functionality, and Chapter 3 for information on the Auto-Start menu options available for ionization gauges.

Analog I/O Ports (AN1-4)

All IGC100 controllers have four analog input/output ports (BNC connectors) on the back panel. Their range is ±12 V with 14 bit input resolution and 12-bit output resolution. The update rate is 2 Hz. Each port is individually configured as an input or an output for complete I/O flexibility.

Input

Input signals (dc voltages) may be displayed on the Pressure or Gauge Display Screens, and monitored remotely through the computer and web interfaces. When Data Logging is enabled, all analog input voltages are stored in memory as part of the logging data set.

Use ANALOG I/O ports as inputs to read voltages from additional vacuum equipment such as capacitance manometers, thermocouples, mass flow controllers, turbo pump controllers, etc. Capacitance manometers must be connected to ANALOG I/O ports configured as inputs. Direct pressure readings are available only if their full scale pressure (Pmax) is programmed into the controller (see below).

Output

Analog output levels can be adjusted manually from the front panel, remotely through the computer interface, or they can be linked to the log pressure of the IG1, IG2, PG1 or PG2 gauges.

Use analog I/O ports as outputs to control auxiliary vacuum equipment such as heaters, actuators, ion sources, programmable logic controllers and throttle controllers.

For More Information
Consult Chapter 4 of this manual for a complete description of the ANALOG I/O capabilities of the IGC100, including specifications, connections, possible configurations, and capacitance manometer operation. Chapter 3 describes, in detail, the menu-based user interface, including all menus required to configure the IGC100 for proper operation of its ANALOG I/O ports.

Capacitance Manometers (CM1-4)

The standard IGC100 controller can display pressure as measured from standard capacitance manometers (CMs). Up to four independent CM readings can be monitored simultaneously using the four ANALOG I/O ports located on the back of the controller. Pressure readings are updated at 2 Hz. The IGC100 precisely measures the 0 to 10 Vdc linear output signal from the CM to determine pressure. Direct pressure readings are available only if the full scale pressure (Pmax) of the gauge is entered into the controller. Full-scale ranges up to 1000 Torr are supported by the controller.

For added convenience, the IGC100 also supplies an auxiliary (AUX) ±15 V, 100 mA power output. This is usually sufficient to operate up a pair of standard (i.e. non-heated) capacitance manometers.

For critical applications where repeatability, precision, and composition independent readings are required, a capacitance manometer gauge should be used to monitor and control the process pressure! This is particularly true if complex or changing gas mixtures are involved.

For More Information
Chapter 1 includes all the basic information required to install and set up your IGC100 controller and its gauges, including capacitance manometers. Consult Chapter 4 of this manual for further details on the operation of capacitance manometers and their proper connection to ANALOG I/O ports. Chapter 3 describes, in detail, the menu-based user interface, including all menus required to configure the IGC100 to display pressure readings from capacitance manometer gauges.

Data Logging (Charts and Tables)

All IGC100 controllers include Data Logging capabilities. When Data Logging is enabled, data from *all* gauges and *all* analog inputs are stored in a circular memory buffer at the rate specified by a user-programmable logging interval.

The logged data can be accessed through the touchscreen LCD - the logged data for the three Data Bars in the Pressure Display screen are presented in a single window. Both table and chart (P vs. Time) displays are available. The chart display includes convenient graphical tools such as (1) cursor, (2) zoom, (3) x,y scaling (manual and auto), and (4) cursor readings. Users can switch rapidly between current and logged readings for the pressures or analog signals of interest.

The data log can also be accessed remotely through the computer interface, or through the internet when using the optional embedded web server (Opt. 02).

The data log can be cleared manually, at any time, from the front panel (use Clear Log), remotely via the Remote TTL Control Module (requires Process Control board, Opt. 03), or via the computer interface.

Typical applications of the Data Logging capabilities include capturing pump-down or venting curves for vacuum system characterization, monitoring mass flow controller signals during deposition processes, and monitoring temperatures and other time dependent variables during bakeouts or heat treatments.

For More Information
Consult Chapter 3 of this manual for detailed information on the Data Logging capabilities of the IGC100 and Chapter 5 for information on the Remote TTL Control Module.

Security (Password Protection)

The IGC100 features password protection to prevent unauthorized users from altering important instrument parameters and vacuum system settings.

Use Security features to: (1) lock and unlock the system, (2) change the password, (3) use Password Cards, (4) password protect individual features.

As an example, a process supervisor might choose to lock the Process Control menus, or even the entire front panel, to prevent any changes by inexperienced or unauthorized operators.

For More Information
Chapter 3 describes, in detail, the menu-based user interface, including all menus required to program the security options and create Password cards. Consult Chapter 6 for additional information on Password Cards.

Display Formats

The IGC100 includes a very flexible Pressure Display that can present pressure and analog signals in a variety of numeric and graphical formats.
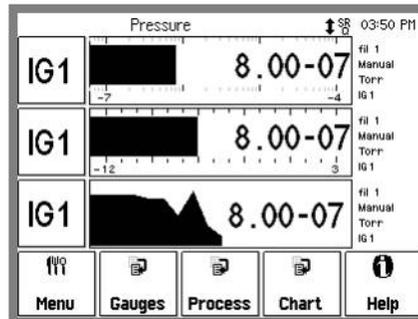

Figure 2-1. Pressure display using 3 different data display formats.

Big Numbers
Best for pressure readings. Easily visible across the room.

Trend Graph
A stamp-sized 'P vs. Time' plot of the most recent points, sampled at the logging interval. It also includes a small, instantaneous pressure display next to the plot. Best for trend analysis.

Auto Scaling Bar Graph
Three decade logarithmic bargraph display scaled about the current readings.

Full Range Bar Graph
Fifteen decade logarithmic bargraph display, covering the entire useful range of the instrument (10^{-12} to 10^3 Torr). The scale covers the entire range from UHV to atmosphere.

Status Information

Display additional information about the gauge status. Use this to troubleshoot fault conditions.

For More Information

Consult Chapter 3 for a complete listing of menu items related to data display formats. Chapter 1 discusses examples of common applications of the different display formats in its Pressure Measurement section.

Pressure Units

The factory default for pressure units is Torr (1 Torr = 1 mm Hg). Users may choose a different units system (micron, mbar, bar, and Pascal) in the Main Menu.

For More Information

Consult chapter 3 for a guide to the menus required to change pressure units. Appendix K lists conversion factors for all the pressure units supported by the IGC100.

On-Screen Help

On-screen help is available in all IGC100 controllers. Extensive Help information is readily available for menus, buttons, displays and even hardware. From any screen where it is displayed, touch the [Help] button and then any button for which help is required.

For More Information

Touch [Help], then [Help] again, for a complete description of the IGC100 help system.

Backlight Saver

The IGC100 touchscreen LCD is illuminated by a fluorescent lightbulb (physically located to the side of the screen). Use the Backlight Saver to extend the life of the bulb. All IGC100 features remain functional while the backlight is off.

When the Backlight saver is enabled, the light turns off when the touchscreen is inactive for period longer than a user-specified period. Turn-off and turn-on times can also be programmed into the controller to keep the backlight off overnight.

For More Information

Consult Chapter 3 for menu options related to the Backlight saver capabilities.

RS-232 Computer Interface

The IGC100 controller comes standard with an RS-232 communications port (DIN8 connector on the back panel with DIN8 to DB9 cable included). A host computer connected to the instrument can easily configure, diagnose and operate the ionization gauge controller using simple ASCII commands. An intuitive command set facilitates integration of all controller functions into any processing or diagnostic software.

The RS-232 interface is easily configured through the front panel user interface. A variety of baud rates, byte framing and handshaking options are available. The IGC100 buffers the most recent characters received and transmitted over the communication interface (RS-232, GPIB and Web). The Queue can be displayed on the front panel at any time (Queue display mode) simplifying testing and debugging of communication programs.

Note that the IGC100 is a stand-alone instrument - there is no need to connect the controller to an external computer to access its full performance and functionality. All instrument functions and parameters are manually accessible and easily modified through the front panel.

Computer interfacing is only required for: (1) Computer monitor/control of the IGC100 and vacuum system, (2) Remote access to data-logs and history lists, (3) calibration data uploads, and (4) firmware upgrades (for controller and web-server).

RS-232 is the standard interface in all IGC100 controllers. An additional GPIB interface is available as an option (see below).

For More Information

Consult Chapter 7 of this manual for more detailed information on the available computer interfaces (RS-232 and GPIB), programming options, complete command set, and firmware upgrade procedures. Consult Chapter 3 for information on menu items related to configuration of the RS-232 interface. A complete Command Set is also listed at the beginning of this manual.

Dual Ionization Gauge Operation (IG2) (Opt. O100IG)

A Dual Ionization Gauge Connector Box (SRS# O100IG), is available to connect two ionization gauges (IG1 and IG2) simultaneously to the back of the IGC100 unit. This popular option allows the controller to switch operation between two separate gauges from the front panel (i.e. sequential operation), and measure pressure at a second location at a small fraction of the cost of a second instrument.

For More Information

Chapter 1 includes all the information required to connect and set up your IGC100 controller and its gauges, including a second ionization gauge (IG2). Chapter 3 describes the menu setup of the IGC100 for operation with a second ionization gauge. Appendix L provides gauge-to-controller connection information specific to the Dual Gauge Connector Box, Option O100IG.

GPIB Interface (Opt. 01)

A GPIB (IEEE-488) interface is available as an option for the IGC100. The GPIB interface uses the industry standard 24-pin connector.

The same command set is shared between the RS232 and GPIB interfaces.

For More Information

Consult Chapter 7 of this manual for detailed information on computer interfaces (RS-232 and GPIB), programming options, command set, and firmware upgrade procedures (controller and web-server). Consult Chapter 3 for information front panel configuration of the GPIB interface.

Embedded Web Server (Opt. 02)

The optional Embedded Web Server (EWS), option 02, connects the IGC100 to the internet.

The EWS is a TCP/IP compatible web server that resides inside the IGC100 box, continuously gathering data from the instrument. When connected to an ethernet network with an internet gateway, the EWS can deliver IGC100 data to a user anywhere on the world wide web using a standard browser. Users can monitor your vacuum system from anywhere in the world. E-mail notification can notify a client list of potential or real system problems.

The EWS provides the most convenient way to access IGC100 data from a computer without writing custom serial or GPIB based software. The EWS can be configured to allow access to process control functions, so that a user can control their vacuum process from anywhere in the world.

Use the web-interface to monitor your vacuum system from your office or from home without having to pay periodic visits to your lab while waiting for your system to pump down. Use the control capabilities to turn heating jackets on/off or activate/deactivate valves or pumps and gauges from the comfort of your office.

For More Information

The individual functions of the EWS are described in detail in Chapter 8 of this manual. Consult Chapter 3 for information on menu items related to configuration of the web-interface.

Process Control Option (Opt. 03)

The process control option of the IGC100 provides eight channels of process control.

Each channel has a relay closure output and corresponding opto-isolated TTL output signal, that may be linked to a variety of input sources with intuitive user-programmable rules. Each channel can be linked to any pressure gauge or analog input, the system clock, gauge status or a TTL input trigger signal. Channel Rules apply in AUTO mode, and include all variables required for full process automation, including setpoint (level, polarity and hysteresis), delay settings and audio and front panel notification.

The Process Control option also includes 12 opto-isolated TTL level inputs, used to remotely control gauge on/off, degas on/off, filament selection, IG lockout, datalogging reset and touchscreen enable/disable functions.

Programmable audio alarms and on-screen text messaging alert the user when process control activity takes place.

During process control, the status of all eight channels can be monitored directly in real time on the LCD display. Eight dedicated LEDs located below the screen provide across-the-room indication of channel status.

Manual override is available for all channels, making it possible to manually control channel relays and TTL output levels directly from the front panel. Manual relay control makes it possible to use the IGC100 as a standalone controller capable of manually or automatically controlling the operation of any standard vacuum system.

All process control events are automatically time stamped and recorded in memory (Event Log) so they can be reviewed at any time. Use the History button on the Process Control panel to access the Process Control Event Log at any time.

Why Use Process Control?

One of the best ways to improve process yield and reduce system failure is through system automation. This is especially important in complex systems or in systems operated by inexperienced personnel. The process control capabilities of the IGC100 make it unnecessary for the operator to be physically present to open valves and actuate switches at the proper time. In fact, an IGC100 with an embedded web server provides remote control capabilities from anywhere in the world.

Use the IGC100 Process Control Option to...

- Automatically control vacuum components such as valves, heaters, power supplies, shutters and other process equipment.

- Interlock process control operations with external signals that are related to time, pressure, temperature, gauge status, system status, TTL logic levels and other parameters.

- Automatically control pumpdown, venting and load-lock procedures.

- Signal when a process is complete or alert operators to system conditions that require their attention.

- Link process control channels together to create powerful system logic to control a wide variety of functions.

- Perform repetitive operations.

- Use e-mail notification to warn operators about possible system problems over the internet (requires web-interface).

For More Information

Consult Chapter 5 of this manual for detailed connection, configuration and operation information for the Process Control option. Consult Chapter 3 for information on menu items related to the configuration and operation of the Process Control module.

Front Panel

All IGC100 functions can be manually configured and controlled through the instrument's intuitive front panel graphical interface.
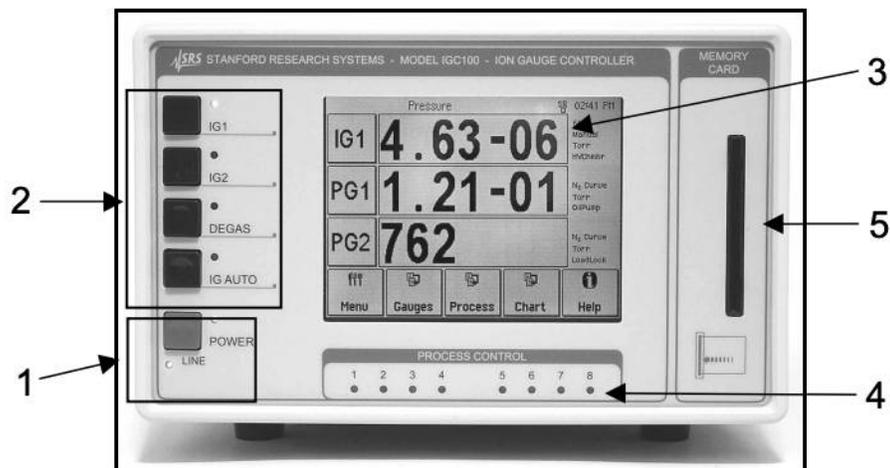

Figure 2-2. The IGC100 front panel.

Front panel components can be divided into five categories (see Figure 2-2) which are described individually in the following sections.

1. Power - LINE LED and POWER button with LED
2. IG Controls - IG1, IG2, DEGAS and IG AUTO buttons with LEDs
3. Touchscreen/LCD Display
4. Process Control LEDs
5. Memory Card Module

Power

LINE LED

The LINE LED (red) lights up to indicate that the IGC100 is connected to, and getting line power from, an AC outlet.

POWER Button and LED

Press the red POWER button to turn the IGC100 ON or OFF.

The green LED, located next to the POWER button, lights up to indicate that the IGC100 is fully powered and completely operational.

Reset

To reset the instrument to its default settings, turn the unit on (using the red POWER key) while holding down the IG AUTO key. This will erase all user entered parameters!

IG Controls

IG1 Button and LED

Press the black IG1 button to turn the IG1 filament emission on or off.

The green LED, located next to the button, lights up while the IG1 filament is emitting electrons and the unit is reading pressures from the ionization gauge IG1.

- The top Data Bar of the Pressure Display screen switches to IG1 when the IG1 button turns on a gauge.

- Filament emission must be turned on in order to acquire pressure readings with an ionization gauge.

- In units with a Dual Ionization Gauge Connector Box (O100IG) option, only one ionization gauge can be active at a time (i.e. sequential operation only).

- The IG1 button provides the *only* means to manually control the emission status of IG1.

- IG2 electron emission is automatically turned off when the IG1 button is pressed.

IG2 Button and LED

Press the black IG2 button to turn the IG2 filament emission on or off.

The green LED, located next to the button, lights up while the IG2 filament is emitting electrons and the unit is reading pressures from the ionization gauge IG2.

- The top Data Bar of the Pressure Display screen switches to IG2 when the IG2 button turns on a gauge.

- Operation of a second ionization gauge is optional in IGC100 controllers. See the Dual Ionization Gauge Connector Box (O100IG) option (Appendix L).

- Filament emission must be turned on in order to acquire pressure readings with an ionization gauge.

- In units with a Dual Ionization Gauge Connector Box (O100IG) option, only one ionization gauge can be active at a time (i.e. sequential operation only).

- The IG2 button provides the *only* means to manually control the emission status of IG2.

- IG1 electron emission is automatically turned off when the IG2 button is pressed.

DEGAS Button and LED

Press the black DEGAS button to start or stop degassing of the active ionization gauge.

The red LED, located next to the DEGAS button, lights up during ion gauge degassing.

- Degas must be Enabled in the Advanced Gauge Setup menu (IG1 or IG2).

- The ion gauge must be ON, emission established and the pressure read by the gauge must be $<2x10^{-5}$ Torr for degassing to start.

- The ion gauge pressure readings displayed during degas are only approximate and for reference only!

- Degassing is based on the electron bombardment method.

- No process control action is performed on based on ionization gauge readings while degassing.

IG AUTO Button and LED

Press the black IG AUTO button to activate, or deactivate, the IG Auto-Start mode.

- A Pirani gauge *must* share the same vacuum environment with the Ion Gauge for the IG Auto-Start mode to work correctly.

- See above for a quick description of the Auto-Start mode function.

- A specific ionization gauge (IG1 or IG2) must be linked to the Auto-Start mode whenever a Dual Ionization Gauge Connector Box (O100IG) option is installed. Consult Chapter 3 for details on this requirement.

- Pressing the IG1 or IG2 button will deactivate IG AUTO mode.

- While in IG AUTO mode, the ionization gauge is ON when the Pirani pressure is below the specified threshold and OFF when the Pirani pressure is more than 20% above the threshold.

Touchscreen/LCD Display

The IGC100 has a large backlit, touchscreen /LCD display. The resolution of the display is 320 x 240 pixels. Screen size is 4.7 in. (diagonal)

The LCD displays an intuitive menu-driven interface for instrument setup and operation. The pressure display shows large, easy to read, numeric readings from each gauge as well as bar graphs and trends. Full screen 'Pressure vs. Time' plots are available for all gauges and analog inputs.

Screen contrast is user adjustable and a screen saver is available to extend the life of the fluorescent backlight. A touchscreen calibration is available to align the touchscreen with the LCD display.

Use the Clean Screen menu to desensitize the touchscreen for 20 seconds while cleaning the touchscreen display.

Touchscreen Cleaning Procedure

For best results, use a clean, non-abrasive cloth towel and a commercial window cleaner to regularly clean the screen. The cleaning solution should be applied to the towel, not the surface of the touchscreen. Fluid may seep behind the panel if it is not cleaned properly. Perform the above procedure while the unit is off, or use the Clean Touchscreen menu, described in Chapter 3, to temporarily desensitize the touchscreen of a working instrument.

Process Control LEDs

The green Process Control LEDs are linked to the eight (8) process control channels available in units with the Process Control Option (Opt. 03).

Each LED is associated with a single process control channel and turns on to indicate when its channel output is ACTIVE. The LEDs are broken into two groups of four to facilitate visualization and channel identification from across the room.

Process Control channel status information can be quickly accessed on the LCD display by touching the [Process] QuickKey at any time. However, LEDs make it possible to view channel activities that might otherwise go undetected and have serious consequences on the vacuum system.

Memory Card Module

Insert Memory Cards into the MEMORY CARD slot, and follow the instructions in Chapter 6 to load ionization gauge calibration data or program and read Password cards.

Calibration Cards

For applications that benefit from gauge-to-gauge reproducibility and the accuracy of calibrated gauges, SRS offers NIST-traceable calibrated ionization gauges through its High Vacuum Calibration Facility. Full-range calibrations are available with 6% and 3% accuracy. All calibrated gauges are delivered with a Memory Card which contains calibration data specific to the gauge. The calibration data is easily uploaded into the controller via the front panel MEMORY CARD module.

See Appendix F for more information about calibrated ionization gauges.

Password Cards

Security passwords can be copied into special memory cards known as Password Cards. Password cards make it unnecessary to remember the password in order to unlock a controller. Simply insert the Password Card (loaded with the current password) into the memory card slot to unlock the controller. The controller returns to the locked state as soon as the card is removed

For More Information
Consult chapter 6 for detailed information on the MEMORY CARD module.

Back Panel

The back panel of the IGC100 includes all the electrical connectors required to (1) power and ground the controller, (2) power its gauges, (3) read pressure and analog signals, (4) connect the process control channels (relays and DIGITAL I/O) and remote TTL control pins and (5) interface to a host computer and/or the web. In addition, the back panel provides access to the DEGAS FUSE.

Back panel components specific to optional Dual Ionization Gauge Connector Box are described separately in Appendix L.

WARNING!

- Read the entire **Safety and Preparation for Use** section of this manual before using the IGC100.

- Read Chapter 1 for detailed instructions and safety information regarding the installation of the IGC100 and connection of gauges.

Figure 2-3. The IGC100 back panel.

Back panel components can be divided into six categories (see Figure 2-3) which are described individually in the following sections.

1. Power - Power Entry Module, CHASSIS GND, ±15 V (AUX power).

2. Ionization Gauge - COLLECTOR (BNC Ports 1 & 2), ION GAUGE.

3. Pirani Gauge - PIRANI.

4. Analog I/O - BNC Ports AN1-4

5. Computer Interfaces - RS-232, GPIB (IEEE-488) (Opt 01), and ethernet 10BASET (Opt 02).

6. Process Control (Opt. 03) - RELAY CONTACTS, DIGITAL I/O.

Power

Power Entry Module

Use the power entry module receptacle to power the IGC100 controller. Use the three-wire power cord provided by SRS to connect the instrument directly to a properly *grounded* AC outlet.

The IGC100 has a universal input (100 to 240 VAC, 46-63 Hz) and must have 500 W of power available.

WARNING!

Refer to Chapter 1 of this manual for instructions on connecting power to an IGC100 controller.

Chassis Gnd

Use this connector to safety ground the IGC100 chassis.

WARNING!

- The IGC100 *must* be grounded to the facility ground for safety. Do not rely on the power cord for this ground.

- Follow all the instructions in Chapter 1 for the proper grounding of the IGC100 controller.

±15 V (AUX power)

Use this 3-pin, ±15 V (100 mA max), connector to provide electrical power to standard (i.e. non-heated) capacitance manometers. For convenience, this connector includes a removable three (3) Position Screw Terminal Block Plug that can be detached from the back panel.

WARNING!

Follow all instructions in Chapter 1 for the proper connection of capacitance manometers to your vacuum system and the IGC100.
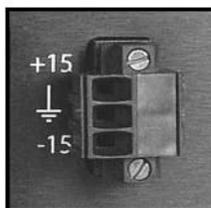

Figure 2-4. The AUX power connector.

Pin	Voltage (100 mA Max)
1	+15 Vdc
2	GND
3	-15 Vdc

Ionization Gauge

Collector (BNC Ports 1 & 2)

Figure 2-5. The Ion Gauge Collector BNC connectors.

Use the BNCs labeled COLLECTOR to connect the collectors of up to two ionization gauges to the IGC100. The upper connector is for IG1 (labeled '1'), the lower connector is for IG2 (labeled '2').

With a standard IGC100, use the upper IG1 connector only. If the Dual Gauge Option (SRS# O100IG) is installed, use both connectors.

For More Information
Consult Chapter 1 of this manual for complete ionization gauge connection details.

Ion Gauge Power

Use the 14-pin ION GAUGE connector to power an ionization gauge.

The ION GAUGE connector of a standard IGC100 is treated as the IG1 port. If the Dual Gauge Option (SRS# O100IG) is installed, this connector is used to power the option box. In this case, two gauges may be connected to the option box.
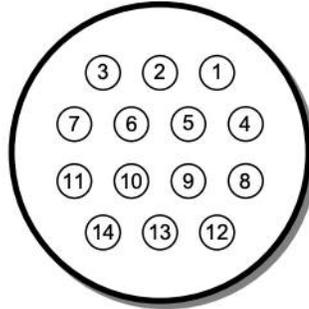
Figure 2-6. The Ion Gauge Power connector.

Pin	Description	Comments
1	O100IG_ID	This pin is used by the IGC100 to verify the presence of option O100IG (Dual Ion Gauge Connector Box)
2	unused	
3	O100IG_24V _SUPPLY	This pin provides 24 VDC (100 mA) to the relays of option O100IG when: (1) O100IG is detected (pin 1) and (2) IG2 is selected.
4	GND	Chassis Ground Connection
5	FIL_RETURN	Filament power return. Return path for the power provided by pins 8 and 11 (both filaments). +30 VDC bias, independently monitored through pin 6 at the gauge head.
6	BIAS_SUPPLY	Filament Bias Monitor +30 VDC bias.
7	O100IG_24V _RETURN	This pin provides the return path for the 24 VDC (100 mA) power provided by pin 3.
8	FIL2_SUPPLY	Filament 2 power supply [7 Amps DC, 7 VDC].
9	unused	
10	unused	
11	FIL1_SUPPLY	Filament 1 power supply [7 Amps DC, 7 VDC].
12	unused	
13	GRID_SUPPLY	Anode Grid Supply. +180 VDC (10 µA-12 mA), normal emission. ≈ 500 VDC (2-160 mA max), degas.
14	unused	

1) Use only O100C1, O100C2 and O100C3 signal cables provided by Stanford Research Systems to connect ionization gauges to the IGC100 controller.

2) The ION GAUGE connector is also compatible with the STABIL-ION® gauge signal cables (part numbers 360112, 360114 or 360116) available directly from Granville-Phillips (Helix Corporation), Longmont, CO, USA.

3) For maximum accuracy, independent of cable length, pins 5 and 6 of SRS ion gauge cables are connected together at the end that attaches to the gauge head.

4) Pins 1, 3 and 7 are for use by the optional Dual Ion Gauge Connector Box (O100IG). Do not make connections to those pins.

For More Information

Consult Chapter 1 for step-by-step ionization gauge connection instructions and warnings. Refer to Appendix A for details on the proper biasing and powering of a Bayard-Alpert ionization gauge. Consult Appendix L for the connection of a Dual Ionization Gauge Connector Box (Option O100IG) to the ION GAUGE port. Consult Appendix C for connection of the IGC100 to STABIL-ION gauges.

Pirani Gauge

PIRANI Connector

Use the DB-15 PIRANI port to simultaneously connect up to two PG105 Pirani gauges to the IGC100 controller.
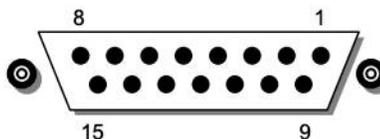

Figure 2-7. The Ion Gauge Power BNC connectors.

Pin	Pirani Gauge	Description
1		unused
2		unused
3	1	GND_Sense
4	1	GND_PWR
5	1	NULL (+) (filament side)
6	1	NULL (-) (divider side)
7	1	Vbr_PWR
8	1	Vbr_Sense
9	2	GND_PWR
10	2	GND_Sense
11	2	NULL (+) (filament side)
12	2	NULL (-) (divider side)
13	2	Vbr_PWR
14	2	Vbr_Sense
15		unused

Use only O105C4 Dual Pirani Gauge signal cables, available from Stanford Research Systems to connect PG105 Pirani Gauges to the IGC100 controller. Consult Chapter 1 for details.

For More Information

Chapter 1 includes all the basic information required to connect Pirani gauges to your IGC100 controller. Consult Appendix H of this manual for detailed electrical information on PG105 convection-enhanced Pirani gauges, including a full explanation of the pin nomenclature used in the table above.

Analog I/O

BNC Ports (AN1-4)

Use these four BNC ports to input (or output) analog signals into (or out of) the controller.

All IGC100 controllers have four analog input/output ports (BNC connectors) on the back panel. The range is ±12 V with 14 bit input resolution and 12-bit output resolution. The update rate is 2 Hz. Each individual port may be configured as an input or as an output for complete I/O flexibility.

Inputs

All inputs are logged in the Data Log, along with all pressure readings. These inputs may be displayed on the Pressure Display (in any format) and are available in either Table or Chart mode in the Data Log.

When used as inputs, these ports can read the output signals from standard capacitance manometers. The IGC100 will display the readings as pressures provided the full scale range (Pmax) of the gauge is programmed into the controller.

Inputs may be linked to Process Control channels (Opt. 03) to control relays or TTL outputs.

Outputs

All output voltages may be set manually or linked logarithmically to a pressure reading.

When an output port is linked to an ionization gauge (IG1 or IG2), the analog output behaves as follows:

$$P \text{ (Torr)} = 10^{V-12} \text{ for } 10^{-11} \text{ Torr} \leq P \leq 10^{-1} \text{ Torr}$$
0 V   indicates gauge off
12 V   indicates gauge fault

When an output port is linked to a Pirani gauge (PG1 or PG2), the analog output behaves as follows:

$$P \text{ (Torr)} = 10^{V-5} \text{ for } 10^{-4} \text{ Torr} \leq P \leq 10{,}000 \text{ Torr}$$
0 V   indicates gauge off
12 V   indicates gauge fault

For More Information

Consult Chapter 4 of this manual for a complete description of the Analog I/O capabilities of the IGC100, including specifications, connections, possible configurations, and capacitance manometer operation. Chapter 3 all menus required to configure the

IGC100 for proper operation of its Analog I/O ports, including direct pressure display from capacitance manometers.

Degas Fuse

At pressures of 5×10^{-4} Torr and higher, a Bayard-Alpert ionization gauge can generate sufficient plasma that significant electrical coupling can occur between the anode grid and the metal parts of the vacuum system. The DEGAS FUSE is a safety device, built into the IGC100 to prevent the development of such electrical discharges inside the ionization gauge head during degassing.

> **WARNING!**
> Gas discharges in high voltage devices such as ionization gauges can be lethal in vacuum systems which are not properly grounded. Consult, Charles F. Morrison, "Safety hazard from gas discharge interactions with the Bayard Alpert ionization gauge", J. Vac. Sci. Technol. A 3(5) (1985) 2032, for a detailed explanation of this effect.

The DEGAS FUSE is connected in series with the anode grid, and is designed to burn out as soon as the electrical current through that electrode exceeds 250 mA. Removal of the bias voltage (500 Vdc degas, 180 Vdc normal) from the anode grid causes the filament to shut down, and extinguishes any discharge supported by the electrode structure.

A blown DEGAS FUSE is easily detected. Any attempt to establish an electron emission results in the "EMISSION FAIL" Error Message being displayed on the front panel instead of the expected pressure measurements.

Consult Chapter 9 for instructions for replacing the Degas Fuse.

Computer Interfaces

RS-232

Figure 2-8. The DIN8 RS-232 connector.

Pin	Signal
1	handshake out
2	handshake in
3	Transmit data
4	ground
5	Receive data
6	unused
7	unused
8	ground

Most PC computers use DB9 ports for serial RS-232 communication. A DIN8-DB9 connector adapter cable is provided with every IGC100 controller. The female DB9 connector of the DIN8-DB9 connector adapter cable is configured as a DCE.

IMPORTANT
Make sure the adapter cable is connected to your controller at this time. Attaching the cable to the controller at this time minimizes the chances of misplacing the cable in your lab, and not being able to find it when you really need it.

For More Information
Consult Chapter 7 of this manual for information on the interfacing capabilities of the IGC100, including RS-232 communications.

GPIB/IEEE-488 (Opt. 01)

This port is available only in units containing the GPIB/IEEE-488 computer interface option (Opt. 01).

Use this 24-pin port (standard IEEE-488 connector) to interface your IGC100 to a host computer with a GPIB/IEEE-488 interface.

For More Information
Consult Chapter 7 of this manual for information on the interfacing capabilities of the IGC100, including GPIB communications.

Ethernet 10BASET (Opt. 02)

This port is only available in units containing the Embedded Web Server interface option (Opt. 02).

Use this RJ-45 Ethernet port to connect your IGC100 to your facility network (LAN) or directly to a host computer (cross-over cable). Use standard Ethernet cables, with RJ-45 connector ends, to connect your IGC100 to a network hub port.

For More Information

Consult Chapter 8 of this manual for information on networking the IGC100 and the capabilities of the Embedded Web Server.

Process Control (Opt. 03)

Relay Contacts

Use these two 12-Position Terminal Block Plugs to connect to the eight process control relays. All relays are SPDT, form C, 5A/250VAC/30VDC, resistive load only.

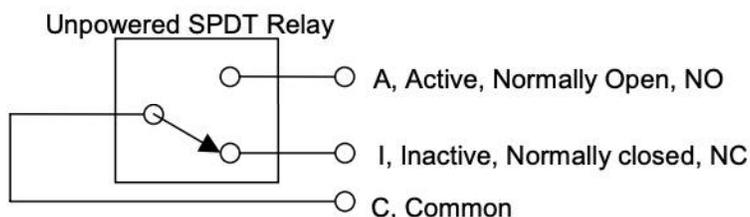Each process control channel has a relay closure output (SPDT relay) associated to it.

Unpowered SPDT Relay

A, Active, Normally Open, NO

I, Inactive, Normally closed, NC

C, Common

Figure 2-9. Process Control Relay connections.

When a process control channel is ACTIVE, the corresponding relay is powered, connecting its Common and Active (Normally Open, NO) pins. When a process control channel is INACTIVE, its relay is unpowered, connecting its Common and Inactive (Normally closed, NC) Pins. Inactive Pins are labeled 'I' and correspond to the NC pin of the relay. Active pins are labeled 'A' and correspond to the NO pin of the relay.

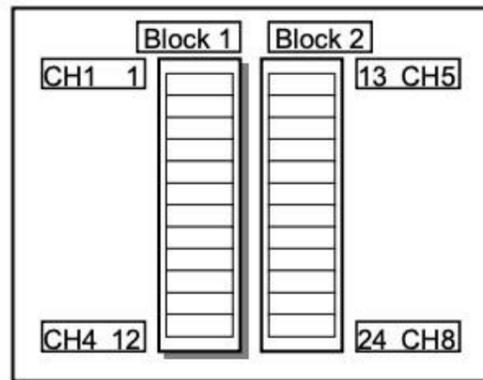| Process Action	Relay Common Connected to	Rear Panel Label
Inactive	Normally Closed pin (NC)	I
Active	Normally Open pin (NO)	A

Figure 2-10. The 2 12-position terminal blocks for process relay connections.

Block	Pin	Process Channel	Process Control Label	Relay Pin
1	1	1	Common (C)	C
	2		Inactive (I)	NC
	3		Active (A)	NO
	4	2	Common (C)	C
	5		Inactive (I)	NC
	6		Active (A)	NO
	7	3	Common (C)	C
	8		Inactive (I)	NC
	9		Active (A)	NO
	10	4	Common (C)	C
	11		Inactive (I)	NC
	12		Active (A)	NO
2	13	5	Common (C)	C
	14		Inactive (I)	NC
	15		Active (A)	NO
	16	6	Common (C)	C
	17		Inactive (I)	NC
	18		Active (A)	NO
	19	7	Common (C)	C
	20		Inactive (I)	NC
	21		Active (A)	NO
	22	8	Common (C)	C
	23		Inactive (I)	NC
	24		Active (A)	NO

For More Information

Consult Chapter 5 of this manual for complete details on the Process Control Module, including connection to the relay ports. Chapter 3 includes full descriptions of the menus required to program the Process Control Rules.

DIGITAL I/O

Use the female DB37 port to connect to the (1) eight Process Control TTL Outputs, (2) eight Process Control TTL inputs and (3) twelve Remote Control TTL inputs of the Process Control Board. A male DB37 connector is provided to facilitate connection to the controller.
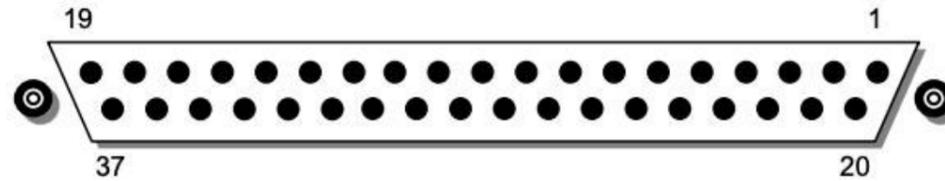

Figure 2-11. The DB37 DIGITAL I/O connector.

Pin	Module	Name	Description
1		IGC100 Vcc	+5 V OUT
2	**Remote Control TTL IN**	ANODE COM	External User +5 V IN
3		IG1_On	Edge trigger: ↓=IG1 On, ↑=IG1 Off
4		IG2_On	Edge trigger: ↓=IG2 On, ↑= IG2 Off
5		Degas_On	Edge trigger: ↓= Degas On, ↑=Degas Off
6		IG_Lockout	Level: LOW=IG1 and IG2 emission Off
7		IG_Key_Disable	Level: LOW=Disable front panel IG Keypad.
8		PG1_Off	Edge trigger: ↓=PG1 Off, ↑=PG1 On
9		PG2_Off	Edge trigger: ↓=PG2 Off, ↑=PG2 On
10		Clear_Data_Log	Edge trigger: ↓=clear the data log
11		IG_Remote_Enable	Level: HIGH=Ignore IG1_On, IG2_On, Degas_On, FIL1_On, FIL2_On pins.
12		FIL1_On	Edge trigger: ↓=FIL1 ON, ↑=FIL1 Off
13		FIL2_On	Edge trigger: ↓= FIL2 ON, ↑= FIL2 Off
14		Front_Panel_Disable	Level: LOW=Disable Touchscreen and Keypad
15		IGC100 Vcc	+5 V OUT
16	**Process Control TTL OUT**	TTL_OUT_5	TTL OUT for Channel 5. LOW=ACTIVE
17		TTL_OUT_6	TTL OUT for Channel 6. LOW=ACTIVE
18		TTL_OUT_7	TTL OUT for Channel 7. LOW=ACTIVE
19		TTL_OUT_8	TTL OUT for Channel 8. LOW=ACTIVE

Pin	Module	Name	Description
20	**Process Control TTL IN**	ANODE COM	External User +5 V IN
21		TTL_IN_1	TTL Input Signal for Channel 1. Active LOW
22		TTL_IN_2	TTL Input Signal for Channel 2. Active LOW
23		TTL_IN_3	TTL Input Signal for Channel 3. Active LOW
24		TTL_IN_4	TTL Input Signal for Channel 4. Active LOW
25		TTL_IN_5	TTL Input Signal for Channel 5. Active LOW
26		TTL_IN_6	TTL Input Signal for Channel 6. Active LOW
27		TTL_IN_7	TTL Input Signal for Channel 7. Active LOW
28		TTL_IN_8	TTL Input Signal for Channel 8. Active LOW
29		unused	
30		IGC100 Ground	
31		IGC100 Ground	
32	**Process Control TTL OUT**	COM_EMTR_REF	External User Ground
33		COM_COLTR_PULLUP	External User +5 V IN
34		TTL_OUT_1	TTL OUT for Channel 1. LOW=ACTIVE
35		TTL_OUT_2	TTL OUT for Channel 2. LOW=ACTIVE
36		TTL_OUT_3	TTL OUT for Channel 3. LOW=ACTIVE
37		TTL_OUT_4	TTL OUT for Channel 4. LOW=ACTIVE

Note: ↓=HIGH-to-LOW, ↑=LOW-to-HIGH transition.

Process Control TTL OUT

Each process control channel has a dedicated TTL output signal. Following common industry standards, all PC TTL output signals are Active Low: When a process control channel is ACTIVE, the corresponding TTL Output pin is logic LOW. INACTIVE means the channel's TTL Output pin is logic high.

These outputs are opto-isolated from the IGC100. For isolated operation of ALL outputs, connect pin 33 to the external +5 V supply and pin 32 to the external ground. For non-isolated operation of ALL outputs, connect pin 33 to IGC100 Vcc (pin 1 or 15) and pin 32 to IGC100 Ground (pin 30 or 31).

Process Control TTL IN

Each process control channel may be linked to a dedicated TTL Input signal. The user must program the channel rules to choose the polarity (HIGH or LOW) used to activate the channel during Channel Auto operation.

These inputs are opto-isolated from the IGC100. For isolated operation of ALL Process Control inputs, connect pin 20 to the external +5 V supply. Pull inputs to external ground for low inputs. For non-isolated operation of ALL Process Control inputs, connect pin 20

to IGC100 Vcc (pin 1 or 15) and pull inputs to IGC100 Ground (pin 30 or 31) for low inputs.

Remote Control TTL IN
The Process Control option also includes 12 logic inputs for remote, TTL control of various controller functions. Check the table above for pin-specific triggering specifications.

These inputs are opto-isolated from the IGC100. For isolated operation of ALL Remote Control inputs, connect pin 2 to the external +5 V supply. Pull inputs to external ground for low inputs. For non-isolated operation of ALL Remote Control inputs, connect pin 2 to IGC100 Vcc (pin 1 or 15) and pull inputs to IGC100 Ground (pin 30 or 31) for low inputs.

For More Information
Consult Chapter 5 of this manual for complete details on the Process Control module, including connection and use of the TTL IN, TTL OUT, and Remote Control TTL IN signals. Chapter 3 includes detailed explanations of the menus required to configure Process Control channels.

Maintenance and Service

1. The IGC100 does not have any user-serviceable parts and requires minimum routine maintenance.

2. Do not perform any unauthorized service, adjustment or modification of the controller.

3. Do not install any substitute parts.

4. Consult the 'Damage Requiring Service' section of this manual for instructions on how to return the instrument for authorized service and adjustment.

Chapter 3

Displays and Menus

The IGC100 has a menu driven, touchscreen user interface. To activate an on-screen button, simply touch the LCD display over the button area.

There are 5 main display screens – Pressure, Gauges, Logging, Process Control (optional) and Menus. These displays are the primary interface to the entire vacuum system. The Pressure Display presents the readings of 3 gauges or analog signals in a large, easy to read format. The Gauges Display shows the reading and state of all 8 ports (2 ionization and 2 Pirani gauges and 4 Capacitance Manometers or analog input/outputs). The Logging Display shows the stored Data Log in Table or Chart format. The Process Control Display shows the state of all 8 process control channels and relays. The Menu is used to setup various operating parameters of the IGC100 such as remote interfaces, time/date and security.

Displays are accessed via the QuickKeys displayed at the bottom of most displays. This allows fast access to the most critical information in the vacuum system. Within each display, the individual Data Boxes where the data is presented are also buttons. For example, touch a box in the Gauges Display to configure a gauge port.

Help for any button or box is available on screen by touching the [Help] QuickKey, then touch any button or box for help about its function. Touch [done] to exit help.

In This Chapter

QuickKeys

Each display includes five QuickKeys lined up across the bottom of the screen. The QuickKeys presented in the main Pressure Display (below) provide fast access to the most important displays – Menu, Gauges, Process, Table/Chart and Help. Within any of these other displays, the QuickKeys may provide access to additional displays. In each case, use the Pressure or Back QuickKeys to return to the Pressure Display.

Use the Pressure Display as the main starting point in operating the IGC100.
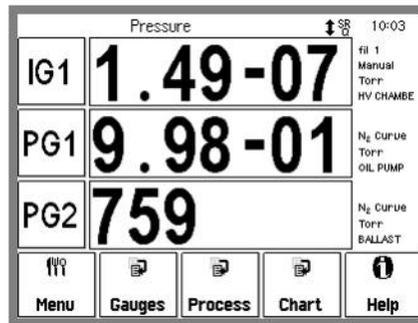
Figure 3-1. Pressure Display.

Pressure QuickKey

Show the main Pressure Display screen. The Pressure Display has three Horizontal Data Bars, each displaying a pressure (or analog input). Readings may be displayed in various formats and are updated twice a second.

The Pressure QuickKey is available in most displays.

Menu QuickKey
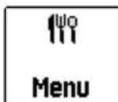
Access the IGC100 Menu. Use the Menu to modify important IGC100 parameters such as units, communications, clock, touchscreen, backlight, password protection, audio, etc.

The Menu QuickKey is available *only* in the Pressure Display.

Gauges QuickKey

Show the Gauges Display. The Gauges Display shows the pressure and analog readings from all eight available ports. Touch an individual Gauge Data Box to modify the gauge settings or analog I/O setup parameters.

The Gauges QuickKey is available in most displays.

Process QuickKey
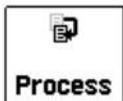
Process

Show the Process Control Display. The Process Control Display shows the current state of all eight process control channels. Touch an individual Channel Data Box to control a channel or modify its configuration.

The Process QuickKey is available in most displays.

Important

Process Control *requires* the 8-channel Process Control board (option 03). This option provides eight channels of process control. Each channel has a relay closure output, with corresponding opto-isolated TTL output. While in AUTO mode, each channel can be linked to any pressure gauge or analog input, the system clock, gauge status or a TTL input trigger signal through user-programmable Rules. The Process Control Display allows editing of channel Rules and Labels, as well as manual control of all channels.

If option 03 is NOT present, the IGC100 will not display this key. Instead, a key labeled 'No Proc' will be displayed.

Table/Chart QuickKey
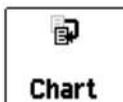
Chart

Display the Data Log in either Table or Chart format. Use the [Setup] button to choose the Default Display format, Table or Chart, and other data logging parameters.

The Table/Chart QuickKey is available *only* in the Pressure Display.

All IGC100 controllers include Data Logging. When Data Logging is enabled, data from all gauges and all analog inputs are stored in a circular memory buffer at the rate specified by the programmed logging interval.

History QuickKey
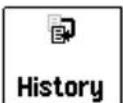
History

Display the Gauges or Process Control History log.

This key is available *only* in the Gauges and Process Control displays.

The IGC100 logs all important ion gauge events (power cycles, degasses, and overpressures) and all process control related events (manual/auto, de/activation) in two independent memory buffers. Use the information stored in these logs to track and diagnose system problems.

Important

History event logs are erased whenever the IGC100 is turned off.

Overview QuickKey

Display a complete Process Control Overview. Use the Overview to quickly review the state and rules for all process control channels in a single display screen.

The Overview QuickKey is *only* displayed in the Process Control display.

Back to Previous QuickKey
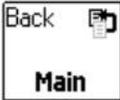
Return to the previous menu screen indicated in the button.

Help QuickKey
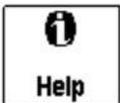
On-screen Help provides information on the operation of the IGC100. Help information is available for menus, buttons, displays and hardware.

To display help on an item...

first...   touch the Help QuickKey at the bottom-right corner of the screen. The button becomes highlighted.

next...   touch the button or box you wish to learn about. The screen changes to the Help Display Window and help text is displayed.

then...   use the [up] and [down] buttons to scroll through the text. Touch [done] to return to normal operation.

or...   touch [More] for a list of related topics. Choose a topic in the list to display its help.

then...   use [back] to display previous topics and [forward] to return to later topics.

Menu Buttons

The IGC100 uses various types of menu buttons identified by the icon in the upper right corner.

Submenu

Remote	📇

Display a submenu.

Use the submenu to access setup parameters that do not fit (or belong) on the top menu.

Choose (multiple choices)

Units	▤
Torr	
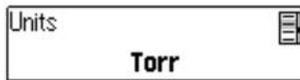
Display a multiple choice selection list.

Touch an item from the list to choose it.

Choose (two choices)

Ion gauge	▤
Normal	

Display a two choice selection list.

Touch one of the two items on the list to choose it.

Numeric Entry

Gas Correction Factor	1₂3
1.	
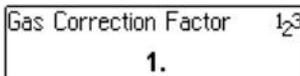
Display the numeric entry keypad.

Enter a parameter value using the touchscreen keypad, then touch [accept] to store it. The parameter valid range and current units are shown in the numeric entry box. Touch [cancel] to quit entry with no change.

Text Entry

IG1 Location	AᵦC
chamber	

Display the text entry keypad.

Enter a text string using the touchscreen keypad, and touch [ok] to to store it. Touch [abort] to quit entry with no change.

Action

Copy password to card ✳
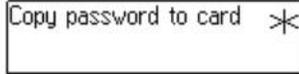
Perform the indicated action.

Touch the button to perform the action indicated. Further instructions may be presented on the screen.

Time/Date

11:05 AM 🕐
11mar00

Display the Time/Date entry keypad.

Enter the new time and date and touch [accept] to store the new settings. Touch [cancel] to quit entry with no change.

The clock is used ...

- to log pressure readings (data log)
- to log process control events (process history)
- to log gauge activity (gauge history)
- to trigger process control events at specific times.

The clock requires adjustment after daylight savings corrections take place.

Text Display

📄
Configuration

Display text data.

Touch the button to display text data on the screen. The text display includes scroll up/down and page up/down buttons.

This button is used to display large amounts of text information, such as annotated Data Log event entries (Table display format) and IGC100 configuration information (Utilities submenu).

Pressure Display

Use the Pressure Display as the main starting point in operating the IGC100. Use the [Pressure] or [Back to Pressure] QuickKeys to bring up the Pressure Display.
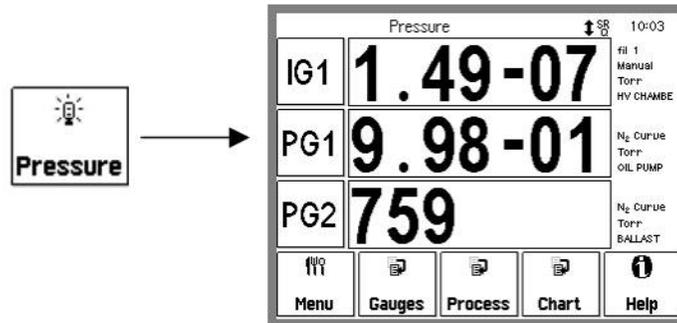
Figure 3-2. Use the [Pressure] QuickKey to bring up the Pressure Display.

This display has three horizontal Data Bars, each displaying a pressure (or analog input). Readings may be displayed in various formats and are updated twice a second.

Customize a Data Bar by touching the Port ID Box (left), the Port Data Box (center) or the Port Info Box (right).

The QuickKeys presented in the main Pressure Display provide fast access to the most important displays – Menu, Gauges, Process, Table/Chart and Help. Within any of these other displays, the QuickKeys may provide access to additional displays. In each case, use the Pressure or Back QuickKeys to return to the Pressure Display.

Port ID Box

The Port ID Box displays the source of the readings in the Data Bar. The source refers to a specific IGC100 port.

Touch the Port ID Box to display a list of available input ports. Select a port (any gauge or analog input) for the Data Bar.

Port Data Box

The Port Data Box displays the readings from the selected source.

Touch the Port Data Box to choose one of the five display formats.

Big Numbers

Figure 3-3. Big Numbers data display.

Best display for accurate, easy to view, pressure readings. Easily visible across the room.

Trend Graph

Figure 3-4. Trend Graph display.

Best display for trend analysis. A stamp-sized 'P vs. Time' plot of the most recent 10 readings, sampled at the data logging interval (see 'Data Logging'). It also includes a small instantaneous reading next to the plot. Use trend graphs to see pressure changes in time-dependent processes such as leak testing, pump downs, venting, bakeout, etc.

Auto Scaling Bar Graph
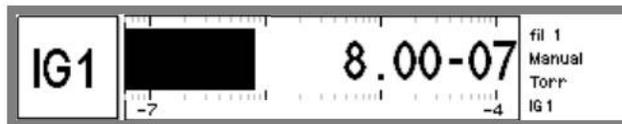
Figure 3-5. Auto Scaling Bar graph.

Best display to detect instantaneous changes in pressure readings. Three decade logarithmic bargraph display scaled about the current reading. Often used during leak testing procedures. This display preserves the 'feel' of the old analog needle displays preferred by some vacuum users.

Full Range Bar Graph
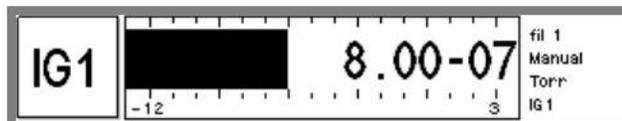
Figure 3-6. Full Range Bar Graph display.

Best display to view the overall status of your vacuum system at any given time. Fifteen decade logarithmic bargraph display, covering the entire useful range of the instrument

(10^{-12} to 10^3 Torr). The scale covers the entire range from UHV to atmosphere. For example, use the length of the bargraph of a Pirani gauge measurement to quickly determine whether the system is pumped down or at atmosphere, without having to read actual pressure values.

Status Information
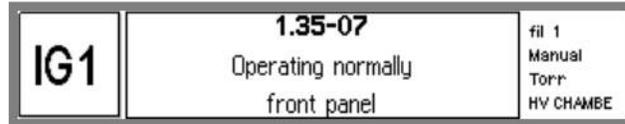
Figure 3-7. Status Information display.

Use this display to learn more about the state of a gauge. This is especially useful if the gauge is in a fault or error condition.

Port Info Box

fil 1
Manual
Torr
chmbr off

The Port Info Box shows additional gauge information.

Touch the Port Info Box to access the Setup menu for the displayed input port. This allows easy access to all setup parameters for the displayed gauge. See 'Gauge Display' for more information on setting up IGC100 gauges/ports.

The Port Info Box includes ...

- ion gauge filament
- ion gauge Manual/Auto-start
- units (pressure or voltage)
- calibration type
- location
- degas power
- remaining degas time

Pressure Units

The factory default for pressure units is Torr (1 Torr = 1 mm Hg). To change the units of the Pressure Display, use the Menu QuickKey, then touch [Units] in the menu. Choose a units system – Torr, micron, bar, mbar, or Pascal. All three Data Bars use the same units system.

Consult Appendix K for conversion factors between the different pressure units supported by IGC100.

Gauges Display

Use the [Gauges] or [Back to Gauges] QuickKey to bring up the Gauges Display.
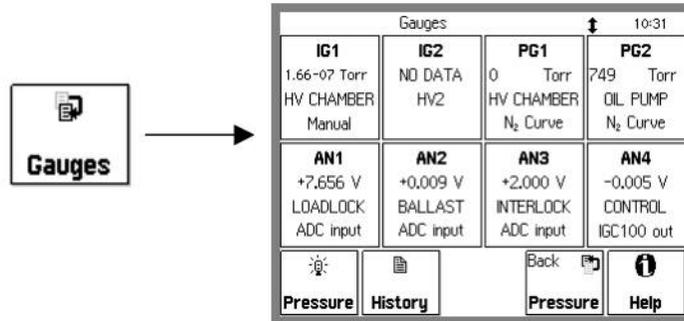
Figure 3-8. Gauges Display.

This display consists of eight rectangular Gauge Data Boxes, each displaying a pressure (or voltage) reading from a different signal port: IG1 and IG2 (ion gauges), PG1 and PG2 (Pirani gauges) and AN1-4 (analog I/O ports). Gauge location and important status/configuration information are also included in each box. This display allows fast access to the Gauge Setup menu of *any* IGC100 signal port. The Gauge Info Box in the main Pressure Display can only access the 3 displayed ports.

Touch a Gauge Data Box to display the Gauge Setup menu for that signal port. For example, touch the IG1 Data Box to modify the parameters used for operation of the ionization gauge connected to the IG1 port.

WARNING!

Gauge-specific information is required for the operation of any new, or replacement, gauge. Individual setup information is required for all gauges connected to the IGC100. Setup of a new gauge requires knowledge of the gauge's operating parameters. Recommended parameters should be listed in the specifications provided by the gauge manufacturer. Contact the gauge manufacturer directly for specifications.

Gauge History

All ion gauge related events (such as power on/off, degas on/off, overpressure, gauge fault, etc.) are time stamped and stored in the Gauges/History log. Touch the [History] QuickKey in this display to show the contents of this log.

Important
History event logs are erased whenever the IGC100 is turned off.

Gauge Data Box

```
    PG1
9.00-01 Torr
  OIL PUMP
  N₂ Curve
```

A Gauge Data Box displays the pressure (or analog voltage) reading and other relevant information from a gauge (or analog I/O) port.

Each Gauge Data Box contains four lines of information (top to bottom):

- Port name: IG1, IG2, PG1, PG2 or AN1-4.

- Reading/Status (port specific): pressure, voltage or gauge status.

- Location (user programmable): the gauge location string.

- Configuration/mode info (port specific).

    IG1(or IG2):   Manual, Auto

    PG1 (or PG2):   N2 Cal or Ar Cal

    AN1-4:   ADC input, CM pressure or Manual, IG1, IG2, PG1, PG2 out

Touch a Gauge Data Box to display the Gauge Setup menu for its signal port. For example, touch the IG1 Data Box to modify the setup parameters used for operation of the ionization gauge connected to the IG1 port.

Ion Gauge Setup Menu (IG1/IG2)

> **WARNING!**
> Read the entire **Safety and Preparation for Use** section of this manual before using the IGC100.
>
> Read Chapter 1 for detailed instructions and safety information regarding the installation and connection of gauges.

Access the Ion Gauge Setup menu from the Gauges Display (touch an IG Data Box) or from the Pressure Display (touch the Port Info Box of an ion gauge Data Bar). Each ion gauge port (IG1 and IG2) has its own setup menu. For standard IGC100 units, only the IG1 port is used. With the Dual Ionization Gauge Option (O100IG), both IG1 and IG2 may be used.
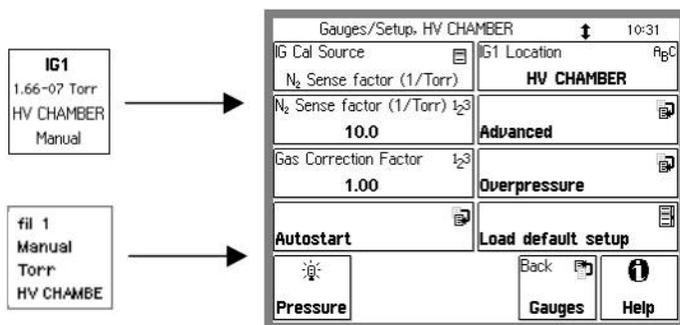
Figure 3-9. Ion Gauge Setup Menu.

For More Information

Chapter 1 includes all the installation and setup information required to set up your IGC100 controller and its gauges. Chapter 6 provides a detailed description of the Memory Card module capabilities, including step-by-step instructions for uploading gauge calibration data into the controller. Consult Appendix A of this manual for general information on Bayard-Alpert ionization gauges, and Appendix B for a list of ionization gauges available directly from Stanford Research Systems (including detailed specifications, Manufacturer's Cross Reference Table, connection cables and available Default Setup Files). Appendix F lists the gauge calibration options available through the SRS High-Vacuum Calibration Facility.

IG Cal Source

Select the calibration source used to calculate pressures from ion currents.

The calculation of pressure with a Bayard-Alpert ionization gauge relies on the knowledge of the gauge sensitivity factor, which is strongly dependent on (1) gauge geometry, (2) gas type, and, to a lesser extent , (3) pressure and (4) emission current.

Once the sensitivity factor is known, the pressure is calculated from the simple mathematical expression:

Pressure = (Ion Current) / [(Sensitivity Factor) x (Electron Current)]

A common approximation, adequate for many applications, is to treat the gauge sensitivity factor as a constant, independent of pressure and electron emission current. To choose this approach, select 'N2 Sense Factor (1/Torr)' as the Calibration Source. The pressure is then calculated from the single, pressure independent, nitrogen-based sensitivity factor displayed in the [N2 Sense Factor (1/Torr)] menu button.

For the highest pressure accuracy over the entire operating range of the gauge, it is necessary to use calibrated, pressure-dependent sensitivity factors. Full-range ion-gauge calibration curves can be stored in the IGC100. If a calibration curve is available, select Cal Curve as the Calibration Source to obtain gas-specific calibrated readings over the entire operating range of the gauge.

Note
The IGC100 stores a *single* calibration curve for each ion gauge port (IG1 and IG2). To use a different curve, load new calibration data using the Memory Card interface (Chapter 6).

N2 Sense Factor (1/Torr)

Enter the Nitrogen Sensitivity Factor for the ion gauge in units of 1/Torr (0.1 to 100). The Nitrogen Sensitivity Factor is used for pressure calculations when 'N2 Sense Factor (1/Torr)' is selected as the IG Cal Source.

Nominal nitrogen sensitivity factors for ionization gauges are available from all gauge manufacturers and are listed as part of the gauge specifications. Contact the gauge manufacturer directly for sensitivity data for your specific gauge. Nominal sensitivity factors for SRS Gauges (and for some cross-referenced third-party models) are listed in Appendix B.

Sensitivity factors can also be programmed into the controller by simply recalling a compatible Default Setup File (using [Load Default Setup]). Default Setup Files compatible with the most common commercial Bayard-Alpert gauge designs are pre-loaded at the factory.

Pressure readings based on the N2 Sense Factor are defined as nitrogen-equivalent readings and provide direct pressure measurements for N_2 gas only. A gas correction factor must be used to convert nitrogen-equivalent readings into direct readings for other gases.

Note
Nominal sensitivity factors provide reading accuracy adequate for rough pressure measurements (25 percent mid-range accuracy at best). For increased accuracy, calibrate the gauge's mid-range sensitivity factor against a certified high vacuum standard. For the highest accuracy, use fully calibrated gauges and select the Cal Curve as the Calibration Source.

Gas Correction Factor

Enter a Gas Correction Factor value (0.01 to 10). The Gas Correction Factor is used to convert nitrogen-equivalent pressure readings into direct readings for other gases. The nitrogen-equivalent pressure reading is **divided** by the gas correction factor and displayed as the pressure. Use a value of 1.0 when detecting nitrogen.

Factors for a few common gases are included here:

He	0.18	Ne	0.30
H_2	0.35	N_2	1.00
Air	1.0	Water	1.12
NH_3	1.23	Ar	1.29
CO_2	1.42	Kr	1.94
Xe	2.87		

A listing of gas correction factors is available in Appendix D.

Note

Do not use Gas Correction factors for accurate pressure measurements. Use full-range, gas specific calibration data (Cal Curve) as the calibration source when high accuracy is required.

The Gas Correction factor can only be modified when 'N2 Sense Factor' is selected as the IG Calibration Source. When 'Cal Curve' is used, the Gas Correction factor is fixed at 1.0.

IG1 (IG2) Location

Enter the Gauge Location name.

The IGC100 assigns a location name (text string) for each signal port. Location names are displayed in the Port ID Box of the Pressure Display and also in the Gauge Data Boxes of the Gauges Display.

The use of distinctive gauge location names makes it easy to identify the different readings in multiple gauge setups.

The default location is the name of the port ("IG1" or "IG2").

Note

Use the Gauge Location to differentiate between identical gauges in a dual gauge setup. For example, consider a vacuum system with two ion gauges- one connected to the high vacuum load lock (and the IG1 port) and the other one connected to the UHV chamber (and the IG2 port). Give IG1 the location name, "LdLock", and IG2 the name, "UHV". This labels the two readings with meaningful names.

Load Default Setup

Select a Default Setup File compatible with your ion gauge design. This updates the following Gauge Setup parameters ...

- N2 Sense Factor
- Emission Current
- Degas Power
- Degas Time
- Overpressure Threshold

Pre-loaded Default Setup Files are available for most modern Bayard-Alpert gauge designs and are tabulated below.

Table 3-1. Default Setup Files for Common Ionization Gauges							
Gauge Design	Setup File Name	N_2Sense Factor (1/Torr)	Emission Current [mA]	Degas Time (min)	Degas Power (Watts)	Over Pressure Threshold (Torr)	Gauge Protection
Glass-Tubulated	**GLASS**	10	10	10	40	5×10^{-3}	Normal
Nude (Bi-filar helix anode grid)	**NUDE**	10	10	10	40	5×10^{-3}	Normal
Nude-UHV (closed end anode grid)	**NUDE-UHV**	25	4	10	25	2×10^{-4}	Normal
STABIL-ION®-H (1) (5×10^{-8} – 5×10^{-3} Torr) Use for P >10^{-4} Torr	**STABIL-H**	46	0.1	10	40	2×10^{-2}	Normal
STABIL-ION®-L (1) (2×10^{-10} – 5×10^{-4} Torr) Use for P < 10^{-7} Torr	**STABIL-L**	42	4	10	40	1×10^{-3}	Normal
STABIL-ION®-UHV (2)	**STABIL-UHV**	21	4	10	25	10^{-4}	Normal
MICRO-ION® (3)	**MICRO**	20	0.02	2	3	5×10^{-2}	Micro-Ion

(1) Granville-Phillips Part# 360120 and 370120 (5×10^{-10} - 10^{-3} Torr). See Appendix C.
(2) Granville-Phillips Part# 370121 (5×10^{-11} - 2×10^{-5} Torr). See Appendix C.
(3) Granville-Phillips Part# 355001 (10^{-6} - 5×10^{-2} Torr). See Appendix M for additional setups.

IMPORTANT

Default Setup Files are compiled based on manufacturer's recommendations. However, it is recommended to always double check your gauge's specifications against the contents of the selected setup file after file selection is made and make modifications if necessary. This will assure the safest and most accurate operation of your gauge(s).

Consult your gauge manufacturer and Stanford Research Systems, Inc. if unsure about the compatibility of IGC100 default setup files with your third-party ionization gauge products.

NOTE

Whenever available, for improved reading accuracy, replace the nominal sensitivity factor (N2 Sense Factor) provided by a default setup file with the actual (known or calculated) gas-specific sensitivity factor for your gauge.

Advanced Submenu

Display the Advanced Setup submenu for the selected ion gauge.

Important

Changes in the Advanced Setup submenu can affect the accuracy of pressure readings as well as the lifetime and long term stability of the ion gauge. Advanced gauge parameters should only be modified by experienced vacuum users who understand their potential effects on process control, filament lifetime and measurement accuracy.

Emission Current

Enter the emission current in mA (0.01 to 12).

Important

The Emission Current can only be modified when 'N2 Sense Factor (1/Torr)' is selected as the IG Calibration Source. When a Cal Curve is used as the IG Calibration Source, the emission current is fixed by the Calibration Curve data.

Recommendations

Emission current settings can be selected by simply recalling a compatible Default Setup File. Factory recommended emission currents for the most common Bayard-Alpert gauge designs are included in the Default Setup Files (see Table 3-1).

Most Bayard-Alpert gauges require electron emission currents between 0.1 and 10 mA. As a general rule, 1 mA emission current is a reasonable choice for most gauge designs. Lower emission currents, 0.1 mA or less, are recommended for pressures above 10^{-4} Torr.

Many users prefer to set emission currents of 10 mA for glass-tubulated and nude gauges with 10/Torr sensitivity, and 4 mA for UHV-extended nude gauges (with 25/Torr sensitivity). These higher currents result in higher operating temperatures that can sometimes help minimize outgassing and ESD effects.

The IGC100 uses the actual emission current to calculate pressures from the ion current.

Filament

Select the filament used for electron emission (fil1, fil2 or both).

For ion gauges with a single filament, 'fil1' is the only valid choice. In this case, the gauge filament *must* be connected to the FIL1 and FIL RET connector pins of the O100C3 Signal Cable.

For gauges with dual filaments, filament selection is ONLY available when 'N2 Sense Factor' is used as the Calibration Source. The filament selection is fixed by the calibration data when Cal Curve is selected as the IG Calibration Source. This assures the maximum accuracy of the results obtained using Cal Curve Data.

Use both filaments for emission if you are trying to avoid condensation of impurities on the cold filament wire. Avoid using both filaments in dual tungsten filament gauges since

it defeats the ability of reserving the second filament as a backup in case of accidental filament burn-out.

Note
The sensitivity of a gauge can vary slightly when switching from one filament to the other in dual filament gauges. There will also be stabilization time requirement associated with the activation of any previously unused (or long retired) filament wire.

Important
The IGC100 does not know how many filaments an ion gauge has. The user is responsible for making sure only valid options are selected.

Degas Time

Enter the Degas Time (1 to 30 min).

To degas IG1 (or IG2), *the gauge must be on and the pressure must be under $2x10^{-5}$ Torr* and Degas Enable *must be set to Enable*.

The Degas Time specifies the duration of degassing for the ion gauge. Press the black [DEGAS] hardware button to initiate electron bombardment degassing. Degas power ramps up (1W/sec) to reduce pressure bursts. The remaining degas time is displayed on the screen during degas. Degas terminates after the Degas Time elapses or use the [DEGAS] hardware button to stop the degas process at any time.

Recommendation
A setting of 10 minutes is adequate for most applications and should not be extended unless proven to be insufficient.

Recommendation
Degas Time can be set by simply recalling a compatible Default Setup File. Factory recommended degas times for the most common Bayard-Alpert gauge designs are included in the Default Setup Files (see Table 3-1).

Degas is not gentle on thoriated filaments. Experiment with the Degas Time setting until you reach a good compromise between Degas Power and Degas Time. As a rule of thumb, choose the longest time you can wait and the minimum amount of power (under the manufacturer's maximum specification) that will be compatible with your contamination tolerance.

Degas Power

Enter the Degas Power in Watts (1 to 80).

To degas IG1 (or IG2), *the gauge must be on and the pressure must be under $2x10^{-5}$ Torr* and Degas Enable *must be set to Enable*.

The Degas Power is the power dissipated by the electrons during the degas process in the gauge. Press the black [DEGAS] hardware button to initiate electron bombardment degassing. Degas power ramps up (1W/sec) to reduce pressure bursts. The remaining

Degas Time is displayed on the screen during degas. Degas terminates after the Degas Time elapses.

Use the [DEGAS] hardware button to stop the degas process at any time.

The electron bombardment power delivered by the IGC100 is controlled during degas by adjusting the emission current. The actual power dissipated inside the gauge is displayed in the Pressure Display (in the Port Info Box of an ion gauge Data Bar). It is not unusual to see the power decrease as the pressure increases above 2×10^{-5} Torr.

Warning
The default factory setting of 40 Watts is adequate for most standard gauges, but too high for UHV (25 W max) and miniaturized gauges. Tiny gauges usually require less than 5 Watts of Degas Power (see Appendix M for details). Degas power above 40 W are not recommended for gauges with ThO_2Ir filaments.

Recommended Degas Powers are listed as part of the nominal specifications supplied by gauge manufacturers. Contact the manufacturer directly for gauge specific information.

Degas Power can be set by simply recalling a compatible Default Setup (see Table 3-1). Factory recommended degas powers for the most common Bayard-Alpert gauge designs are included in the Default Setup Files.

The maximum degas power available from the IGC100 may be limited when using long cables (>10 ft) or low efficiency filaments.

Recommendation
Degas is not gentle on thoriated filaments. Experiment with the Degas Time setting until you reach a good compromise between Degas Power and Degas Time. As a rule of thumb, choose the longest time you can wait and the minimum amount of power (under the manufacturer's maximum specification) that will be compatible with your contamination tolerance.

Degas Enable

Enable or Disable the front panel [DEGAS] hardware button. To prevent accidental degas cycles, set this to Disable. Disable also prevents degas from the remote interface.

Cal Curve Card

Display the header information for the Calibration Data stored in the Memory Card currently inserted in the MEMORY CARD Module.

A Memory Card containing full calibration data must be present in the MEMORY CARD module or an error report is displayed when this button is pressed.

Recommendation
A preview of the header information stored in the memory card reduces the chances of errors. Check the model and serial numbers of the ionization gauge connected (or to be

connected) to the controller against the card's header information before loading the card's Calibration Data into the controller.

Use the [Back] button to return to the Advanced submenu WITHOUT making any changes to the calibration information stored inside the controller.

Press [Load cur] to transfer the calibration data stored in the memory card into the internal memory of the controller. Note that the new calibration data OVERWRITES any previous calibration information available in the controller for the corresponding ionization gauge port.

The IGC100 can store a single full-calibration curve for each ionization gauge port (IG1 and IG2) in its internal memory. Confirm that the calibrated gauge is connected to the correct port after the calibration is loaded into the controller.

To use this new calibration data, choose 'Cal Curve' as the IG Cal Source in the IG Setup menu.

Consult Chapter 6 of this manual for detailed information on Memory Cards, including a step-by-step description of the procedure required to transfer gauge-specific calibration data from a memory card into the controller.

View Current Curve

Display the header information for the ionization gauge calibration data currently available for either IG1 or IG2.

The header information includes model/serial number as well as emission current, gas, filament selection, calibration temperature and expiration date.

Important
An "Empty" message is displayed if no calibration data is available.

Gauge Protection

Gauge Protection limits the amount of power that can be delivered to the filament. This limit is gauge specific and intended to reduce the chance of filament burnout when using gauges with delicate filaments such as MICRO-ION® gauges. See Appendix M for more information about using MICRO-ION® gauges.

When using a MICRO-ION® gauge, set Gauge Protection to 'Micro-Ion'. For normal ionization gauges, choose 'Normal'.

Important
Using the 'Micro-Ion' setting while connected to a normal ionization gauge may prevent the gauge from operating.

Overpressure Submenu

Display the Overpressure submenu for the selected ion gauge.

Several protection safeguards, designed to avoid burn-outs and extend the lifetime of ion gauge filaments, are built into the IGC100 controller. Overpressure Shutdown is probably the most important filament protection function.

When Overpressure Shutdown is Enabled, the IGC100 automatically shuts down the ion gauge emission current when the pressure exceeds the user specified Overpressure Threshold.

Overpressure Shutdown

If an overpressure event occurs, the Overpressure Shutdown mechanism (with adjustable threshold and delay) will automatically shut off the ion gauge emission, protecting the filament wire from burn out.

Enabled means that Overpressure Shutdown is active. Electron emission will shut off when the pressure exceeds the Threshold for a time longer than the Delay.

Disabled means that Overpressure Shutdown is NOT active. Emission will remain on, even if the pressure around the filament exceeds the Overpressure Threshold. In this case, emission will stop only with excessive pressure or filament failure.

Recommendation
Overpressure protection should ALWAYS be Enabled for ion gauges that operate with tungsten filaments.

Overpressure Threshold

Enter the Overpressure Threshold value in Torr (10^{-11} to 10^{-1}).

The Overpressure Threshold is the pressure at which the ion gauge filament emission is shut off when Overpressure Shutdown is Enabled.

Overpressure Threshold settings can be set by recalling a compatible Default Setup File. Factory recommended overpressure thresholds for the most common Bayard-Alpert gauge designs are included in the Default Setup Files.

Recommendation
A recommended value, good for most gauges, is 10^{-3} Torr for tungsten filaments, and 10^{-2} Torr for thoriated filaments. Consult the manufacturer directly for gauge specific recommendations. As a rule of thumb, the service life of tungsten filaments is estimated to be 10-20 hours at 10^{-2} to 10^{-3} Torr and about 1000 hours at 10^{-6} Torr.

Overpressure Delay

Enter the Overpressure Delay in seconds (0 to 60).

The Overpressure Delay is the amount of time that an overpressure condition must be present before Overpressure Shutdown shuts off the ion gauge emission current. The factory default value is zero seconds (no delay)

Recommendation

Use a non-zero value of Overpressure Delay in systems known to experience brief pressure bursts during normal operation. The addition of a delay will eliminate unnecessary filament shutdowns and provide smoother operation of the vacuum system, especially when process control is linked to the ion gauge.

Examples include systems which have load locks. It is not unusual for the pressure in the main chamber to briefly overshoot when it is first exposed to the load lock. However, this overpressure situation is often very brief and might not require a filament shutdown. This would be especially true if a thoriated filament is being used.

Audio Alarm

Select overpressure Audio Alarm On or Off.

When Audio Alarm is On, the IGC100 sounds an audible alarm every time emission is shut down due to overpressure. When Audio Alarm is off, no alarm is sounded.

Recommendation

Use the Audio Alarm to call attention to overpressure conditions while you are not close to the controller.

Auto-Start Submenu

The common combination of one ionization gauge and two Pirani gauges ports, standard in all IGC100 controllers, allows you to monitor system pressures between atmosphere and UHV without any blind spots. If a Pirani gauge is exposed to the same vacuum environment as the ionization gauge, the Auto-Start function will turn ON the ionization gauge filament when the Pirani readings are below a user-adjustable safe threshold and turn OFF the ionization gauge when the Pirani readings are more than 20% above the threshold.

Auto-Start provides added protection for the filament(s). Its use is highly recommended when using tungsten filament gauges.

Auto-Start is activated and de-activated by pressing the black [IG AUTO] hardware button on the front panel. The LED next to the button is on indicating Auto-Start operation is active.

The user must choose a Pirani gauge (PG1 or PG2) and a threshold value in the Auto-Start submenu.

In dual ionization gauge controllers (option O100IG), the user also needs to specify which ionization gauge (IG1 or IG2) will Auto-Start when the [IG AUTO] button is pressed. Since the IGC100 can only operate one ion gauge at a time, IG2 is automatically turned off if IG1 is put in Auto-Start mode, and vice-versa.

Recommendation
Use Auto-Start and/or Overpressure shutdown functions to prevent filament burn-outs.

Auto-Start Linked To

Link the Auto-Start function to the ionization gauge IG1 or IG2.

Since the IGC100 can only operate one ion gauge at a time, IG2 is automatically turned off if IG1 is put in Auto-Start mode, and vice-versa.

Auto-Start Monitor Gauge

Select the Auto-Start Gauge (Pirani gauge PG1 or PG2). In Auto-Start operation, the ion gauge will be turned ON when the pressure reading of the Auto-Start Pirani Gauge is below the Auto-Start Threshold,. When the Pirani pressure is more than 20% above the Auto-Start Threshold, the ion gauge will be turned OFF. If the Pirani gauge is off (for any reason), then the ion gauge will be turned OFF also.

Important
The Pirani gauge chosen for Auto-Start operation **MUST** be exposed to the same vacuum environment as the ion gauge linked to Auto-Start. *Check your Pirani gauge operation before switching to Auto-Start operation.* For example, if PG1 is selected to Auto-Start IG1, make sure that the Pirani gauge connected to the PG1 port and the ion gauge connected to the IG1 port actually share the same vacuum environment, and also confirm that the Pirani gauge is working properly!

Recommendation
Use PG105-UHV Pirani gauges in high vacuum systems where UHV compatibility and/or bakeability are a requirement.

Auto-Start Threshold

Enter the Auto-Start threshold value in Torr (10^{-3} to 10^{-1}).

In Auto-Start operation, the ion gauge will be turned ON when the pressure reading of the Auto-Start Pirani Gauge is below the Auto-Start Threshold,. When the Pirani pressure is more than 20% above the Auto-Start Threshold, the ion gauge will be turned OFF.

Recommendation
The recommended Auto-Start Threshold is 2×10^{-3} Torr. Higher values can significantly compromise the lifetime of the ion gauge filament. Lower values cannot be accurately read with Pirani gauges, and require that the Pirani Gauge Zero be checked consistently.

Pirani Gauge Setup Menu (PG1/PG2)

> **WARNING!**
>
> Read the entire **Safety and Preparation for Use** section of this manual before using the IGC100.
>
> Read Chapter 1 for detailed instructions and safety information regarding the installation and connection of gauges.

Access the Pirani Gauge Setup menu from the Gauges Display (touch a PG Data Box) or from the Pressure Display (touch the Port Info Box of a Pirani gauge Data Bar).
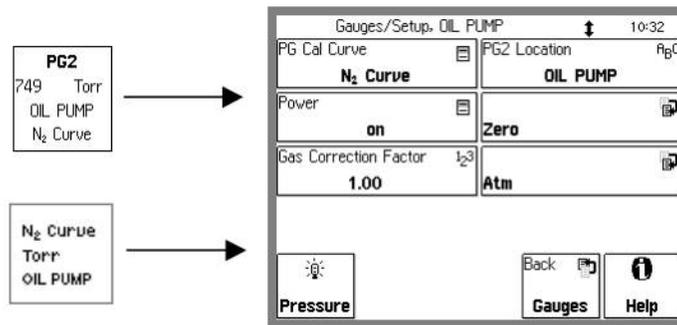
Figure 3-10. Pirani Gauge Setup Menu.

For More Information
Chapter 1 includes all the basic information required to install and set up your IGC100 controller and its gauges, including Pirani gauges. Consult Appendix H of this manual for general information on PG105 convection-enhanced Pirani gauges.

PG Cal Curve

Select the calibration used to calculate pressures from a Pirani Gauge signal (N$_2$ Curve or Ar Curve).

All IGC100 controllers are factory loaded with the required nitrogen and argon calibration curves required to convert Pirani gauge signals into nitrogen-equivalent or argon-equivalent pressure readings.

Use a Gas Correction Factor to convert readings for gases other than nitrogen or argon.

Gas Correction Factor

Enter a gas correction factor (0.01 to 10).

The IGC100 is factory-loaded with the calibration data required for direct Pirani gauge pressure measurements on N_2/Air or argon gases. At pressures below 1 Torr, a gas correction factor can be used to convert argon or nitrogen equivalent reading to direct readings for other gases. The nitrogen/argon equivalent reading is multiplied by the gas correction factor and displayed as the pressure.

The pressure reading is **multiplied** by the gas correction factor and displayed as the pressure.

Warning
Gas correction factors provide only rough accuracy results, and are only valid for pressure measurements in the pressure range from 10^{-3} to 1 Torr.

To convert nitrogen equivalent pressure into direct readings for other gases use the gas correction curves included in Appendix I.

PG1 (PG2) Gauge Location

Enter the Gauge Location name.

The IGC100 assigns a location name (text string) for each signal port. Location names are displayed in the Port ID Box of the Pressure Display and also in the Gauge Data Boxes of the Gauges Display.

The use of distinctive gauge location names makes it easy to identify the different readings in multiple gauge setups.

The default location is the name of the port ("PG1" or "PG2").

Note
Use the Gauge Location to differentiate between identical gauges in a dual gauge setup. For example, consider a vacuum system with two Pirani gauges - one connected to the high vacuum chamber (and the PG1 port) and the other one connected to the rough line (and the PG2 port). Give PG1 the location name, "HiVac", and PG2 the name, "Rough". This labels the two readings with meaningful names.

Power

Turn the Pirani gauge hot sensor wire On or Off.

When Power is On, the Pirani gauge sensor wire is powered and hot and the gauge is fully operational.

When Off, the Pirani Gauge sensor wire is turned off and no pressure readings are possible with the gauge.

When the Process Control Option is installed, a remote TTL input is available to control Pirani gauge power.

Recommendation
Use the Gauge Power Off setting to cool down the Pirani gauge hot wire while in the presence of flammable or explosive gases. This makes it possible to install Pirani gauges in systems that are intermittently filled with flammable gases. Manually turn off the gauge during exposure to dangerous gases instead of disconnecting the gauge from the controller.

Zero Submenu

Adjust the Pirani gauge Zero indication.

Follow the on screen directions to adjust the gauge readings at base pressure ($<10^{-5}$ Torr) levels.

Periodic Zero adjustments of the controller readings, to compensate against background drift, are required for operation in the millitorr and sub-millitorr range.

Note
The calibration data loaded into all IGC100 controllers is based on the response of a new gauge free of contaminants. If a tube becomes contaminated or does not seem to read correctly, the front panel readings can often be readjusted using the Zero and Atm submenus.

Atm Submenu

Adjust the Pirani gauge Atmosphere indication.

Follow the on screen directions to adjust the gauge readings at atmospheric pressure levels.

Adjustment of the Atm indication should not be required unless compensating for contamination, extremely long cables or small deviations from horizontal in mounting orientation.

Note
The calibration data loaded into all IGC100 controllers is based on the response of a new gauge free of contaminants. If a tube becomes contaminated or does not seem to read correctly, the front panel readings can often be readjusted using the Zero and Atm submenus.

Analog I/O Setup Menu (AN1-4)

> **WARNING!**
>
> Read the entire **Safety and Preparation for Use** section of this manual before using the IGC100.
>
> Read Chapter 1 for detailed instructions and safety information regarding the installation and connection of gauges.

Access the Analog I/O Setup menu from the Gauges Display (touch an ANalog I/O Data Box) or from the Pressure Display (touch the Port Info Box of an Analog Input Data Bar).
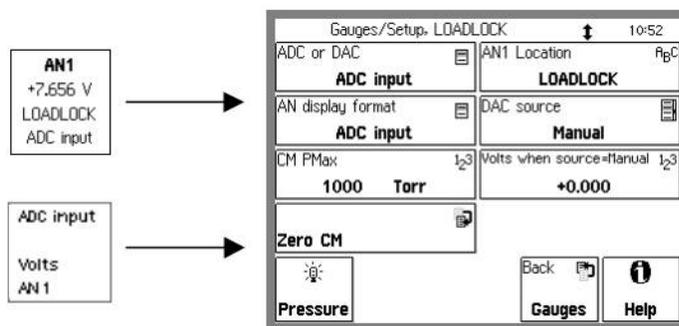
Figure 3-11. Analog I/O Setup Menu.

For More Information

Consult Chapter 4 for a complete description of the Analog I/O capabilities of the IGC100, including specifications, connections, possible configurations, and capacitance manometer operation.

About Capacitance Manometers

Capacitance Manometers (CMs), also known as capacitance diaphragm gauges, are the most accurate devices for measuring absolute and differential pressures of gases and vapors at the gauge's operating temperature. CM gauge heads are specified by their full scale pressure (Pmax). The gauge output is a dc voltage linearly related to the pressure. By industry standard , the output is 10 Vdc at Pmax. Dynamic range is typically 10^4.

Most gauge heads require ±15 Vdc (35 mA) to operate. Heated head assemblies require much higher power, and some models require higher voltages. Consult the gauge manual for power requirements and maximum pressure specifications. Most manufacturers list the maximum pressure, power requirements and connector pinouts right on the gauge body.

The IGC100 has a ±15 Vdc (100 mA) output connector on the back panel to directly power standard (non-heated) capacitance manometers.

Using capacitance manometers

The IGC100 is designed to read pressures from up to four capacitance manometers. To read CM pressures, the CM output signal must be connected to one of the four Analog I/O ports on the back panel. The analog port must be configured as an ADC input in the Analog I/O Setup menu. The full scale pressure of the CM (Pmax) must be set before pressure readings are correct.

CMs need to be periodically re-zeroed. A trim pot is built into most gauge heads for that purpose. However, if the trim pot is out of reach, use the Zero Manometer function in the Analog I/O Setup menu.

For More Information

Chapter 1 includes all the basic information required to install and set up your IGC100 controller and its gauges, including capacitance manometers. Consult Chapter 4 of this manual for further details on the operation of capacitance manometers and their proper connection to Analog I/O ports.

ADC or DAC

Configure the analog I/O port as either an ADC Input or a DAC Output.

ADC Input

When ADC Input is selected, the analog port is connected to a 14 bit , ±12 V full-scale, Analog-to-Digital Converter updated at 2 Hz. Input signals can be monitored through the Pressure Display (choose AN1-4 or CM1-4) or the Gauges Display.

Inputs may be linked to Process Control channels (Opt. 03) to control relays or TTL outputs.

All inputs are logged in the Data Log, along with all pressure readings.

Use analog inputs to read voltages from additional vacuum equipment such as capacitance manometers, thermocouples, mass flow controllers, turbo pump controllers, etc.

Capacitance manometers must be connected to Analog I/O ports configured as inputs. For direct pressure readings program the full scale pressure (Pmax).

DAC Output

When DAC Output is selected, the analog port is connected to a 12 bit , ±12 V full-scale, Digital-to-Analog Converter updated at 2 Hz.

Each DAC port may be programmed manually or linked to the log pressure readings of a gauge, either IG1, IG2, PG1 or PG2 (DAC Source). This provides logarithmic analog outputs compatible with programmable logic controllers and data loggers.

Use analog outputs to control auxiliary vacuum equipment such as heaters, actuators, ion sources and throttle controllers.

AN Display Format

Choose the display format for ADC Input readings.

Select ADC Input to display input signal levels as voltages (Vdc) in the Gauges Display. If a capacitance manometer is connected to the input, select CM Pressure to convert the input signal into a CM pressure reading and display the pressure in the Gauges Display.

In the main Pressure Display, choose AN1-4 in a Port ID Box to display voltage readings or CM1-4 to display CM pressure readings.

CM PMax

Enter the full scale range of the capacitance manometer (0-1000 Torr).

Note
The full scale ranges most commonly encountered in commercial CM gauges are 50 and 100 mTorr, and 1, 2, 10, 100 and 1000 Torr.

Important
Analog I/O ports connected to capacitance manometer signals must be configured as inputs (ADC Input) for pressure measurement to be possible. Direct pressure readings are possible only if PMax is programmed into the controller.

AN1-4 Location

Enter a Location name for the analog I/O port.

The IGC100 assigns a location name (text string) for each signal port. Location names are displayed in the Port ID Box of the Pressure Display and also in the Gauge Data Boxes of the Gauges Display.

The default location is the name of the port ("AN1").

Note
Use the Location name to differentiate between identical gauges in multiple gauge setups. For example, consider a vacuum system with two identical CM gauges- one connected to the High Vacuum Chamber (and the AN1 port) and the other one connected to the Rough Line (and the AN2 port). In this case, give the gauge connected to AN1 (CM1) the name "HiVac" and the CM2 gauge the name "Rough". This labels the two readings with meaningful names.

DAC Source

Link a DAC output to the pressure readings of IG1, IG2, PG1 or PG2 or choose Manual for front panel output level control.

The analog outputs may be linked to log pressure readings. These signals are often connected to devices such as programmable logic controllers, throttle valve controllers, and other common feedback controlled instruments.

When IG1 or IG2 is the DAC source, the analog output follows these parameters.

$$P \text{ (Torr)} = 10^{V-12} \text{ for } 10^{-11} \text{ Torr} \leq P \leq 10^{-1} \text{ Torr}$$
0 V   indicates gauge off
12 V   indicates gauge fault

When PG1 or PG2 is the DAC source, the analog output follows these parameters.

$$P \text{ (Torr)} = 10^{V-5} \text{ for } 10^{-4} \text{ Torr} \leq P \leq 10,000 \text{ Torr}$$
0 V   indicates gauge off
12 V   indicates gauge fault

When Manual is the DAC source, the analog output is set with the [Volts when source=Manual] menu button.

Volts When Source=Manual

Enter the voltage setting for the DAC Output when Source=Manual. The valid range is ±12V.

Zero CM Submenu

Adjust the Capacitance Manometer (CM) Zero indication.

Follow the on screen directions to adjust the zero of the capacitance manometer gauge.

Periodic Zero readjustments of the capacitance manometer readings, to compensate against background drift, are required for operation close to base pressures.

Important
Before making this adjustment, the CM must be connected to a vacuum system with a pressure lower than 0.01% of full scale (0.0001 x PMax).

Trim Pot Zero Adjustment
All capacitance manometers include a trim pot adjustment, used to adjust the output of the CM to zero at base pressure. Use the trim pot adjustment regularly to adjust the internal zero of the capacitance manometer head. The standard trim pot adjustment procedure is simple:

1. Connect the CM to a vacuum chamber with a pressure <0.01% of PMax

2. Switch the IGC100 to the Gauges Display.

3. Select AN Display Format = ADC Input for the appropriate Gauge Data Box (the analog port connected to the CM).

4. Turn the trim pot until the voltage displayed in the Data Box is zero.

5. Perform a Zero CM operation to adjust the IGC100 zero.

6. Switch the AN Display Format to CM Pressure to display pressure readings in the Gauges Display. The CM readings should be zero at base pressure.

Logging Display

Use the [Table] or [Chart] QuickKey to bring up the Logging Display. The data log is presented in either Table or Chart display formats. Select the format in the Logging Setup menu. This also changes the QuickKey between [Table] and [Chart].

The logged data for the three ports in the Pressure Display are displayed in a single screen. All inputs are logged – to display different ports, choose new ports in the Pressure Display (Port ID Boxes).

Chart
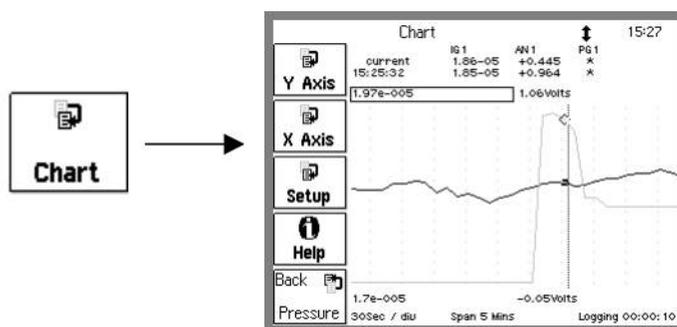
Figure 3-12. Chart Display.

Display the data log in graphical (P or V vs. Time) format.

The small table above the chart displays the most recent entry and the readings at the cursor position.

Pmax and Vmax are displayed above the graph, Pmin and Vmin below the graph.

The right edge is the most recent data point and the left edge is a Time Range ago. This resembles a chart recorder with new data appearing at the right edge. The X axis scale, span and logging interval are shown at the very bottom of the screen.

Touch [Setup] to display the Logging Setup menu. Touch [Y Axis] or [X Axis] to change the chart scales and time scale.

Moving the Cursor

To move the cursor, first touch the cursor readout above the graph (it highlights with a box). Touch the right half of the chart to move the cursor to the right, the left half to move it to the left. Touch close to the center to move slowly, farther from center to move quickly. Touch and hold to move continuously.

Changing the Graph

The chart scale parameters can be modified within the chart display. To adjust the graph scales, first touch the displayed scale parameter (it highlights with a box). For Pmax, Pmin, Vmax and Vmin, touch the upper half of the chart to adjust the parameter up, the lower half to adjust the parameter down. For the Time Range, touch the left half of the chart to increase the range, the right half to decrease the range. In both cases, touch close to the center to make small changes, farther from center for large changes.

Touch [Y Axis] or [X Axis] to change the chart scales and time range numerically. Touch [Setup] to display the Logging Setup menu.

Table

Figure 3-13. Table Display.

Column 1:   The absolute time (and date) at which the readings were logged.

Columns 2, 3, 4: Pressure or voltage readings from the three Data Bars of the Pressure Display.

Use the up and down buttons to scroll through the entire log. Touch [Setup] to display the Logging Setup menu.

Logging Setup Menu

Touch [Setup] in either the Table or Chart Display to show the Logging Setup menu.
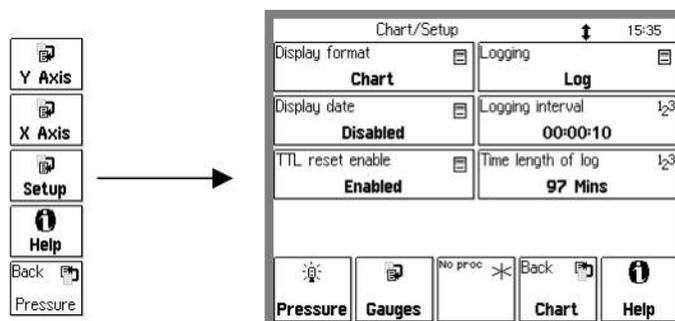
Figure 3-14. Logging Setup Menu.

Display Format

Select the log display format (Table or Chart). This also changes between the [Table] and [Chart] QuickKeys.

Important

The IGC100 always stores readings from *all* ports in the data log. However, the chart and table only show data from the three ports shown in the Pressure Display. To display other ports, change the Port ID Boxes in the Pressure Display.

Logging

Enable data logging (Log) or disable data logging (Pause).

Display Date

Enable or Disable the Date Display in the Table format.

Enabled means that the date will be included in the time stamp in the Table format display. This requires more lines per entry and fewer entries will be shown per page.

Disabled means that the date will not be included in the time stamp.

Enable this to keep track of the date through data logs that extend over more than one day.

Logging Interval

Enter the Logging Interval.

The Logging Interval is the time between data log entries. For example, a 5 minute setting indicates that a complete set of pressure and analog input readings are added to the data log every 5 minutes.

The Logging Interval affects the time length of the log. The data log stores a fixed number of entries, thus the Time Length of the data log and the Logging Interval are directly related. Use a small Logging Interval to record closely timed data points over a short period of time. Use a large Logging Interval to record data over a long period of time.

TTL Reset Enable

Enable or Disable data logging TTL Time Reset. This function requires the Process Control Option (opt. 03).

Enabled allows the Data Logging Time Reset input of the remote TTL control module to reset the data log.

Enable this to synchronize the start of the data log with an external event, such as the closing of a gate, the opening of a valve or the achievement of full speed in a turbo pump.

Disabled means that the Data Logging Reset input of the TTL control module does not have any effect on the data log.

Time Length of Log

This box displays the Time Length of the data log. This parameter can not be entered directly. The data log stores a fixed number of entries, thus the Time Length is determined by the Logging Interval.

The Time Length is the length of time covered by the data log. After this amount of time, the earliest data in the log will be overwritten by the newest data.

Chart Y Axis Menu

This button is only available from the Chart display.

Pmax
Pmin

Set the pressure corresponding to the top and bottom of the chart.

Note

All pressure readings are displayed with the *same* chart scale. The grid lines correspond to the values of Pmax and Pmin.

Vmax
Vmin

Set the voltage corresponding to the top and bottom of the chart.

Note

Voltage data from the analog I/O inputs is graphed according to Vmax and Vmin. *However, the grid lines correspond to the values of Pmax and Pmin.*

Autoscale

Autoscale the graph based on the data displayed in the graph.

This changes the values of Pmax, Pmin (and Vmax, Vmin) to use the entire vertical space of the chart display.

Chart X Axis Menu

This button is only available from the Chart display.

Chart Time Range

Set the time span of the chart.

The right edge of the chart is the most recent point, the left edge is a Time Range ago. The data moves across the chart as newer points are recorded, resembling a chart recorder.

Note
[Scale to Full] will set the Time Range to display all data points.

[Zoom to Cursor] will set the left edge of the chart to the cursor position. The right edge remains the most recent point.

Zoom to Cursor

Set the left edge of the chart to the cursor position. The right edge remains the most recent point.

Scale to Full

Set the Time Range to display all data points.

Process Control Display

Use the [Process] or [Back to Process] QuickKey to bring up the Process Control Display. *This is only available with the Process Control Option (opt. 03).*
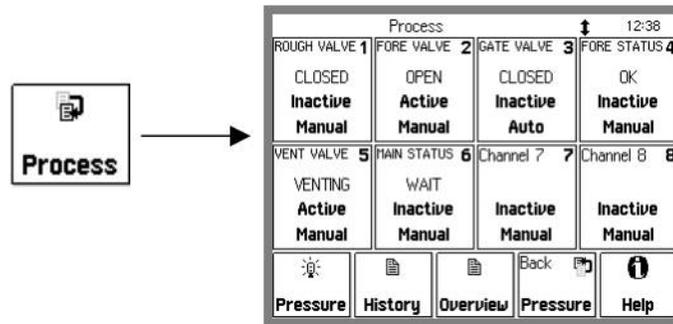
Figure 3-15. Process Display.

This display consists of eight rectangular Channel Data Boxes, each displaying state and mode information for a single process control channel. This display allows fast access to the state and configuration of all process control channels.

Touch a Channel Data Box to choose a channel state (Active, Inactive or Auto) or edit the channel rules and messages.

The 8 dedicated LEDs below the touchscreen provide across-the-room indication of channel output status (On = Active).

WARNING!

Using process control channels in your vacuum system requires careful programming and thorough testing. Double check all logic and wiring and use manual activation to test the action of each and every channel. Test all scenarios in a safe manner before relying on automatic, unattended operation.

About Process Control

The Process Control Option (Opt. 03) provides eight channels of process control. Each channel has a relay closure output, with corresponding opto-isolated TTL signal, that may be linked to a variety of input sources with intuitive user-programmable rules. Channel rules include all variables required for full process automation, including input source selection, activation threshold (level, polarity and hysteresis), delay settings and audio and text notification. The available input sources include any pressure gauge or analog input, the system clock, gauge emission status or a TTL input trigger signal.

This option also includes 12 opto-isolated TTL level inputs for triggering gauge on/off, degas on/off, fil1/fil2/both select, IG lockout, datalogging time reset and touchscreen enable/disable.

During process control, the output status of all eight channels can be monitored directly from the Process Control Display. In addition, the 8 dedicated LEDs below the touchscreen provide across-the-room indication of channel status.

Manual override is available for all channels, making it possible to control channel relays and TTL output levels directly from the front panel.

With this option, the IGC100 is a stand alone controller, capable of manual or automatic operation of any standard vacuum system.

All process control events are time stamped and recorded to be reviewed at any time. The process control log is also accessible remotely through the computer or web interfaces.

Active vs Inactive

When a process control channel is ACTIVE, the corresponding relay is powered, connecting the Common and Active (N.O.) relay pins, and the TTL output pin is logic low. INACTIVE means that the relay is unpowered, connecting the Common and Inactive (N.C.) relay pins, and the TTL output pin is logic high.

When a process control channel is in Auto mode, it becomes Active when the conditions specified by its rule's parameters are met. Rule parameters include setpoint, hysteresis, polarity (above or below), and delay.

Manual control of the channel output is also possible.

Process Control History
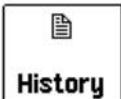
All process control events (channels active/inactive/auto) are time stamped and logged in the Process/History log. Touch the [History] QuickKey to display the contents of the process control event log.

Each line of the log is a change in either State or Mode of a process channel. For state changes (Active/Inactive), the bitfield shows the state of all channels (1=Active, 0=Inactive) starting with channel 1. For mode changes (Auto/Manual), the bitfield shows the mode of all channels (1=Auto, 0=Manual) starting with channel 1.

Important
History event logs are erased whenever the IGC100 is turned off.

Process Control Overview

Touch the [Overview] QuickKey to obtain a complete summary report of status and configuration information (including Rules) for all channels in a single screen.

Channel Data Box

GATE VALVE **1**

OPEN

Active

Manual

A Process Control Data Box displays the state (Active/Inactive), mode (Auto/Manual) and message for a single process control channel. Touch the Data Box to access the channel's rules and messages or to manually control its output.

Each Data Box contains four lines of information (top to bottom):

- Channel Number and Description.
- Channel Active/Inactive Message.
- Output status (Active or Inactive).
- Mode (Manual override or Auto).

Touch a Channel Data Box and choose an option to:

- Switch to Auto mode (channel controlled by its Rules).
- Deactivate the channel (manual override).
- Activate the channel (manual override).
- Edit the channel's Rules (for Auto mode).
- Edit the channel's Messages.

Auto/Manual Channel Control

To control a channel state manually, touch a Channel Data Box and choose 'Active' or 'Inactive'.

To switch a channel to Auto mode (controlled by its Rules), touch a Channel Data Box and choose 'Auto'.
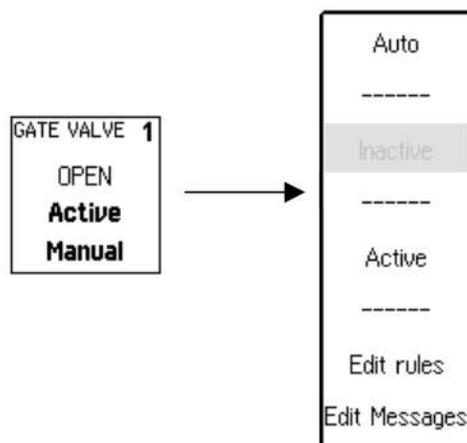
Figure 3-16. Manual Channel control.

Edit Rules Menu

Access the Edit Rules menu from the Process Control Display (touch a Channel Data Box) and choose 'Edit Rules'.
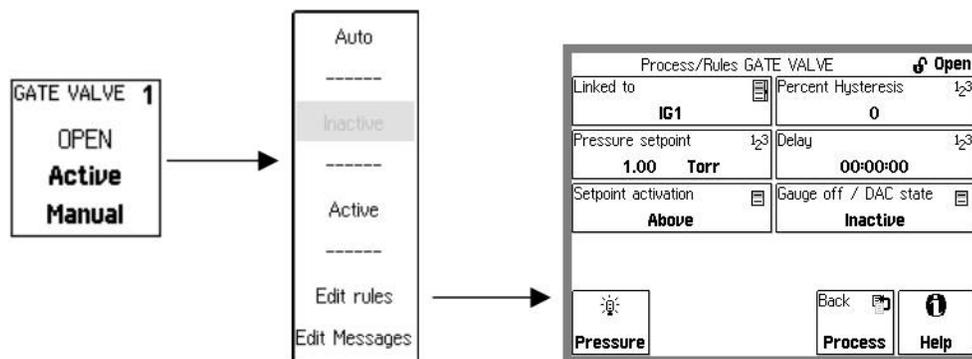
Figure 3-17. Edit Rules Menu.

Each process channel has its own rules. These rules determine the channel state when the channel is in Auto mode.

Linked To

Process control channels can be linked to

- any available pressure gauge (IG1, IG2, PG1, PG2, and CM1-4)

- any analog input port (AN1-4)

- the system clock (CLOCK)

- gauge status conditions (IG1 EMISSION, IG2 EMISSION, ANY IG EMISSION)

- the TTL channel input (TTL PIN)

For example, select PG1 to link the channel state to the readings of the Pirani gauge connected to the PG1 port.

Linked to IG1 (or IG2) EMISSION means that the channel remains ACTIVE as long as IG1 (or IG2) is turned on (i.e. electron emission is on). The channel becomes INACTIVE as soon as the gauge is turned off.

When using the Dual Ionization Gauge option (opt. O100IG),

- Linked to ANY IG EMISSION means that the channel is ACTIVE as long as either ion gauge (IG1 or IG2) is turned on. The channel becomes INACTIVE if both gauges are off.

Important

In addition to the Channel Source, the Pressure Setpoint, Setpoint Activation, Hysteresis, Delay and Gauge Off State must also be specified to complete the channel rules.

No process control actions take place based on ionization gauge readings while the gauge is degassing.

Pressure Setpoint

Enter the channel Pressure Setpoint (Torr) when the Channel Source is a pressure gauge (IG, PG or CM).

The Pressure Setpoint is the pressure threshold at which the channel becomes Active or Inactive. Set the Setpoint Activation to choose Active above or below this threshold. The Setpoint determines the exact level at which channel switching occurs. Use the channel Delay to ignore transient pressure levels.

Voltage Setpoint

Enter the channel Voltage Setpoint (Volts) when the Channel Source is an analog input (AD1-4).

The Voltage Setpoint is the voltage threshold at which the channel becomes Active or Inactive. Set the Setpoint Activation to choose Active above or below this threshold. The Setpoint determines the exact levels at which channel switching occurs. Use the Setpoint Delay to ignore transient voltages.

Setpoint Activation

Select the Setpoint Activation for the channel (Above or Below).

Above
The channel becomes ACTIVE when the pressure, or voltage, goes ABOVE the Setpoint.

The channel becomes INACTIVE when

the pressure goes BELOW {Setpoint / (1+Hysteresis_%/100)}

or

the input voltage goes BELOW {Setpoint – Hysteresis_V}.

Below
The channel becomes ACTIVE when the pressure, or voltage, goes BELOW the Setpoint.

The channel becomes INACTIVE when

the pressure goes ABOVE {Setpoint x (1+Hysteresis_%/100)}

or

the input voltage goes ABOVE {Setpoint + Hysteresis_V}.

Percent Hysteresis

Enter the Percent Hysteresis for the channel (0 to 999 %). Percent Hysteresis applies when the channel is linked to a pressure reading (IG, PG or CM). See 'Setpoint Activation' above for more information.

Hysteresis allows the process control channel to ignore normal, slow variations or drift in the readings. Use the Delay setting to ignore transient events.

Voltage Hysteresis

Enter the Voltage Hysteresis for the channel (0-12V). Voltage Hysteresis applies when the channel is linked to an analog input (AN1-4). See 'Setpoint Activation' above for more information.

Hysteresis allows the process control channel to ignore normal, slow variations or drift in the readings. Use the Delay setting to ignore transient events.

Delay

Enter the Setpoint Delay time.

The Setpoint Delay is the amount of time that a channel switching condition must be present before channel switching actually takes place.

Use the Setpoint Delay in systems known to experience brief pressure or voltage transients during normal operation. The addition of the delay eliminates unnecessary channel switching.

Gauge Off/DAC State

Specify the channel state (Active or Inactive) when the Channel Source pressure gauge is turned off or is in a fault condition (IG or PG) or when the analog port is overloaded or switched into DAC Output mode (while linked to CM or AN).

For Channel Sources IG1 and IG2, specify the desired channel state when the emission is turned off or a fault exists (no pressure readings available).

For Channel Sources PG1 and PG2, specify the desired channel state when the gauge is turned off or a fault exists (no pressure readings available).

For Channel Sources CM1-4, specify the desired channel state when its Analog I/O port is switched to DAC Output mode or the input is overloaded (no pressure readings available).

For Channel Sources AN1-4, specify the desired channel state when port is switched to DAC Output mode or the input is overloaded (no voltage readings available).

Activation Time
Deactivation Time

Enter the Channel Activation/Deactivation Time when the Channel Source is Clock.

The Activation Time is the exact time at which the channel switches to ACTIVE.

The Deactivation Time is the exact time at which the channel switches to INACTIVE.

All times are represented in 24hr format (18:30 is 6:30pm). The current time is displayed at the top of the screen in most displays.

Use the clock to control scheduled operations such as overnight system bakeouts. The channel Activation Time can start unattended system bakeout an hour after everybody leaves. Use the channel Deactivation Time to stop the bakeout, and allow the system to cool down, three hours before arriving in the morning.

Activate When TTL

Select the TTL Activation mode (High or Low).

Each channel has a dedicated TTL input pin (see Chapter 5). When the Channel Source is TTL, the level of this input controls the channel.

Activate When High means the channel is ACTIVE when the TTL input level is HIGH (and INACTIVE when LOW).

Activate When Low means the channel is ACTIVE when the TTL input level is LOW (and INACTIVE when HIGH).

Edit Messages Menu

Access the Edit Messages menu from the Process Control Display (touch a Channel Data Box) and choose 'Edit Messages'.
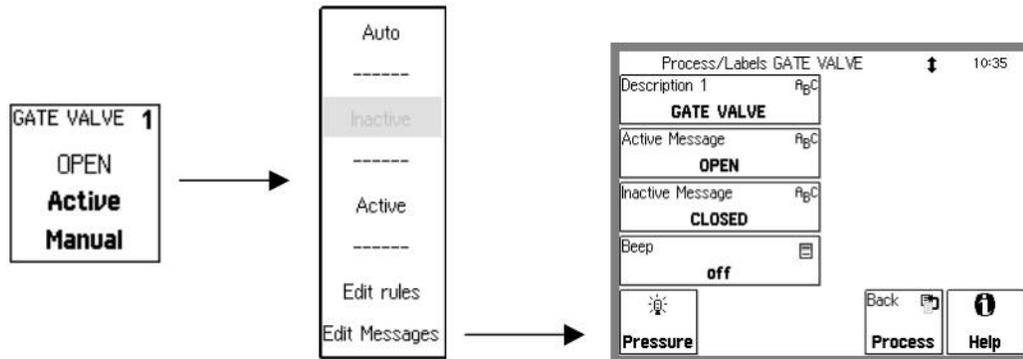
Figure 3-18. Edit Channel Messages Menu.

Each process channel has its own description and messages shown in the Channel Data Boxes. The messages are updated whenever the channel changes state.

Description

Enter a Channel Description.

The IGC100 assigns a Description (text string) to each process control channel. The Description is displayed at the top of each Channel Data Box (next to the channel #).

Assign Description to all channels used for process control. Descriptions such as "heater", or "gate valve" make it easier to visualize and control a system and minimize the chances of errors.

Recommendations

Combine Descriptions and Active/Inactive Messages to provide useful information about the status of your system. For example, for a channel controlling a gate valve (ACTIVE = valve open), use "gate valve" as the Description, "open" for the Active Message and "closed" for the Inactive Message. The Channel Data Box would then display "gate valve/open" or "gate valve/closed" depending on the state of the channel.

Active Message
Inactive Message

Enter the channel Messages.

The Active Message is displayed in the Channel Data Box whenever the channel is ACTIVE. The Inactive Message is displayed whenever the channel is INACTIVE.

Recommendations
Combine Descriptions and Active/Inactive Messages to provide useful information about the status of your system. For example, for a channel controlling a gate valve (ACTIVE = valve open), use "gate valve" as the Description, "open" for the Active Message and "closed" for the Inactive Message. The Channel Data Box would then read "gate valve / open" or "gate valve / closed" depending on the state of the channel.

Beep

Enable the Channel Beep (On or Off).

On means that a beep is sounded every time the channel changes states.

Off means that no beep is sounded.

Main Menu

Use the [Menu] or [Back to Main] QuickKey to bring up the Main Menu. This menu can only be accessed from the Pressure Display.
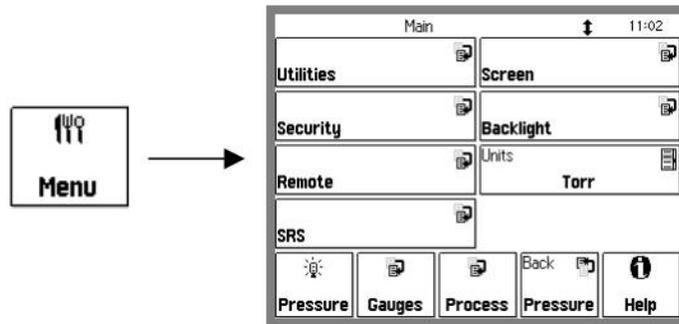
Figure 3-19. Main Menu.

The Main Menu provides access to many important IGC100 internal parameters and settings.

Units

Display the Units selection list.

Select from Torr, Micron, Bar, mbar or Pascal.

This units system is global to the IGC100. All pressure readings in the Pressure Display and data logs use these units. All pressure parameters in menus use these units.

This button is also available in the numeric entry keypad of pressure parameters.

See Appendix K for conversion factors.

SRS

Display contact information about Stanford Research Systems.

Utilities Menu

Touch [Utilities] in the Main menu to display the Utilities menu.

Time/Date

Adjust the time and date settings of the IGC100.

The clock is used to ...

- log pressure and voltage readings (data log).
- log process control events (process history).
- log gauge activity (gauges history).
- to trigger process control events at specific times.

All times are represented in 24hr format (18:30 is 6:30pm). The current time is displayed at the top of the screen in most displays.

The clock requires adjustment after daylight savings corrections take place.

Volume Control

Adjust the speaker volume (0 to 10).

The IGC100 speaker is used for different purposes, such as user interface feedback and sounding alarms during process control and overpressure events.

Configuration

Display the Configuration Report.

The Configuration Report shows a complete listing of all internal modules (standard and optional) detected when the unit was turned on.

Selftest Submenu

Display the Selftest menu.

System Selftest

Touch this button to perform the power-on test again. This also displays the firmware version and date.

Button & LED Test

Touch this button to test the BLACK hardware keys, the 8 process LEDS and the 4 ion gauge LEDS.

Xmit via RS-232

Transmit the string "SRS IGC100" over the RS-232 interface.

Security Menu

Touch [Security] in the Main menu to display the Security menu.

The IGC100 features password protection to prevent unauthorized users from altering important instrument parameters and vacuum system settings.

For example, a vacuum operator might need to lock the process control menus to avoid inadvertent switching of relays, while a supervisor might lock the entire front panel to avoid any unsupervised changes by inexperienced operators.

The security state of the IGC100 is indicated by an icon on the upper right corner of the screen. A padlock 🔒 indicates that the system is locked and password protected.

WARNING!

When the system is locked, security settings **CAN NOT** be changed. All IGC100 functions/parameters protected in the Security Settings menu can not be changed.

Once the IGC100 is locked, the user *must* know the current password in order to modify any security settings in the IGC100. Alternatively, the user may insert a valid Password Card into the memory card slot to enable changes to the security settings.

If You Forget the Password
The password "SRS IGC100" always unlocks the system. This password is all uppercase and has a space after "SRS".

Password Cards

Security passwords can be copied into special memory cards known as Password Cards. Password Cards make it unnecessary to remember the password in order to unlock a controller. Simply insert the password card (loaded with the current password) into the Memory Card Slot to automatically unlock the controller. The controller returns to the locked state as soon as the card is removed.

Enter Password to Lock/Unlock

Enter the password to unlock or lock the system.

If the unit is unlocked, enter the password to lock the security system. Check the Security Settings submenu to ensure the desired functions become locked.

If the unit is locked, enter the password to unlock the security system. You can also use a Password Card to unlock a protected controller.

Important
Password recognition is case sensitive.

Set Password

Program a new password.

The system must be unlocked in order to enter a new password.

Important
Password recognition is case sensitive and may include numbers and letters.

Copy Password to Card

Load the current password into a Password Card.

Important
A password card must already be loaded into the Memory Card Slot AND the system must be unlocked before using this function. See Chapter 6 for details.

Following the password copy, the security system is locked when the Password Card is removed. Insert the card to unlock the system without manually entering the password.

Security Settings Submenu

Display the Security Settings menu. Use this menu to select the desired level of security.

Settings in this menu may not be altered when the system is locked.

Ion Gauge Buttons

Select the ion gauge protection mode (Normal or Protected).

Protected means that the black front panel IG1, IG2, DEGAS and IG AUTO buttons are not functional when the system is locked. Use this option to eliminate unintentional manual gauge shutdowns.

Normal means that the IG control buttons are not affected by the security system.

Gauge Setup

Select the Gauge Setup protection mode (Normal or Protected).

Protected means that all gauge setup menus, required for proper gauge operation, cannot be modified when the system is locked. Use this option to eliminate accidental parameter changes.

Normal means that the gauge parameters are not protected by the security system.

Calibration

Select the Calibration protection mode (Normal or Protected).

Protected means that user gauge calibrations, such as Pirani gauge Zero and Atmosphere, are protected. Use this option to lock all calibration settings and eliminate accidental changes.

Normal means that the user calibration functions are not protected by the security system.

Process Setup

Select the Process Setup protection mode (Normal or Protected).

Protected means that all Process Control rules, accessible via the Process Control QuickKey, cannot be modified when the system is locked. Use this option to lock the process control rules and eliminate accidental changes.

Normal means that the process control rules are not protected by the security system.

Process Manual

Select the Process Manual protection mode (Normal or Protected).

Protected means that the state of Process Control channels (Active/Inactive/Auto) cannot be changed from the front panel. Use this feature to prevent accidental state changes in the process control relays.

Normal means that the Process Control channels are not protected by the security system.

Units/Time/Date

Select the Units/Time/Date protection mode (Normal or Protected).

Protected means that the Time/Date and Units settings are locked when the system is locked.

Normal means that the time/day settings are not protected by the security system.

Local Access

Select the Local Access protection mode (Normal or Protected).

Protected means that all front panel actions (including Power Off) are disallowed, except for the required security functions, when the system is locked. This is the most powerful protection option available.

Normal means that front panel actions are not affected by the security system.

Remote Access

Select the Remote Access protection mode (Normal or Protected).

Protected means that remote commands may only query the settings/readings of the IGC100 when the system is locked. Any command which tries to change a setting will result in an error. Use this option to prevent remote control of your instrument. The remote user may still unlock the system via the password.

Normal means that remote control actions are not affected by the security system.

Remote Menu

Touch [Remote] in the Main menu to display the Remote menu.

System Name

Enter a system name for this IGC100.

The system name identifies this unit over the remote interfaces. In addition, the name is displayed on all web pages served by this unit.

RS-232 Submenu

Display the RS-232 configuration menu.

This menu also includes a Rx/Tx display button which shows receive/transmit activity on the RS-232 port.

Baud Rate

Select the RS-232 (Serial) interface Baud Rate [300 – 115.2k].

The available baudrates are: 300, 1200, 2400, 9600, 19200, 38400, 57600 and 115200.

Most PC's use 9600 as a default.

Word Length

Select the RS-232 (Serial) interface Word Length [7 bits, 8 bits].

8 bits is standard.

Parity

Select the RS-232 (Serial) interface Parity [None, Even, Odd].

None is standard.

Flow Control

Select the RS-232 (Serial) interface Flow Control [None, Xon/Xoff, Hardware].

None is standard. At high baud rates (>19200), flow control may be necessary to prevent data loss. Check the host serial interface for the type of flow control in use.

RS-232 Queue

Display the RS-232 transmit and receive buffers. The IGC100 buffers the most recent characters received and transmitted over the interface. The Queue display shows the interface history.

The Queue display may slow down communications and should be displayed only when testing or debugging a host program.

Press a QuickKey to exit from this display.

The upper half of the Remote Queue display is the Receive Queue. These are the most recent characters which have been received by the IGC100 (displayed in UPPER case). Commands which have already been executed are shown in normal text. Commands which have not yet been executed are shown with a gray background. Command errors are shown in inverse text.

The lower half of the Remote Queue display is the Transmit Queue. These are the most recent characters which have been placed in the output buffer. Characters which have already been sent over the interface are shown in normal text. Characters which are waiting to be sent are shown with a gray background.

GPIB Submenu

Display the GPIB (IEEE-488) configuration menu.

This menu also includes a Rx/Tx display button which shows receive/transmit activity on the GPIB port.

Address

Select the IGC100 Device Address (1 to 30).

Before attempting to communicate with the IGC100 over the GPIB interface, the IGC100's device address must be set.

GPIB Queue

Display the GPIB transmit and receive buffers. The IGC100 buffers the most recent characters received and transmitted over the interface. The Queue display shows the interface history.

The Queue display may slow down communications and should be displayed only when testing or debugging a host program.

Press a QuickKey to exit from this display.

The upper half of the Remote Queue display is the Receive Queue. These are the most recent characters which have been received by the IGC100 (displayed in UPPER case). Commands which have already been executed are shown in normal text. Commands

which have not yet been executed are shown with a gray background. Command errors are shown in inverse text.

The lower half of the Remote Queue display is the Transmit Queue. These are the most recent characters which have been placed in the output buffer. Characters which have already been sent over the interface are shown in normal text. Characters which are waiting to be sent are shown with a gray background.

Web Submenu

Display the Web server configuration menu.

The parameters in this menu must be entered in order to use the web interface option (Opt. 02). This menu only applies if this option is installed. See Chapter 8 'Embedded Web Server' for more information on configuring the IGC100 for the internet.

Web Server

Enable or Disable the web server.

Important!
Use the web security measures in the Web/Control menu to prevent unauthorized control of the IGC100 via the web. Disable the server to prevent ALL web access to the IGC100.

IP Address

Enter the IP Address for the IGC100 web server.

Obtain a valid IP Address from your network administrator. Entering invalid addresses may disrupt your network.

When accessing the IGC100 from you browser, enter this IP address in the address box to display the web pages. Make a 'favorite' to provide one click access.

DNS

Enter a DNS Address for the IGC100 web server.

Obtain a valid Domain Name Server (DNS) Address from your network administrator.

The DNS is used by the web server's e-mail notification feature. The DNS allows e-mail addresses to be entered using full domain names.

Gateway

Enter a Gateway Address for the IGC100 web server.

Obtain a valid Gateway Address from your network administrator. The Gateway is used by the web server's e-mail notification feature.

Web Queue

Display the web transmit and receive buffers. The IGC100 buffers the most recent characters received and transmitted over the interface. The Queue display shows the interface history.

The Queue display may slow down communications and should be displayed only when testing or debugging a host program.

Press a QuickKey to exit from this display.

The upper half of the Remote Queue display is the Receive Queue. These are the most recent characters which have been received by the IGC100. Commands which have already been executed are shown in normal text. Commands which have not yet been executed are shown with a gray background. Command errors are shown in inverse text.

The lower half of the Remote Queue display is the Transmit Queue. These are the most recent characters which have been placed in the output buffer. Characters which have already been sent over the interface are shown in normal text. Characters which are waiting to be sent are shown with a gray background.

Port Number

Change the HTTP port number of the web server. The default port is 80 and should **NOT** be changed except in the following situations.

1. You are using multiple IGC100's in a network behind a NAT (network address translation) router. In this case, all of the IGC100's will appear at the same IP address to the outside world (they will have different IP addresses on the local network). Each IGC100 needs to be on a different port and the router must be configured to forward port requests to the correct IGC100. From the outside, each IGC100 is accessed at its own port number (but the same IP address).

2. If you are experiencing attacks on port 80 that block access to the IGC100. In this case, change the port to something else (like 8080). You will need to specify this port in your browser address window as 208.123.123.32:8080 where 208.123.123.32 is the IP address of the IGC100 and 8080 is the port number.

For more information about NAT routers and ports, see your network administrator.

Wait at least 30 seconds after changing the port number for the change to take effect.

Web Control Submenu

Display the Web/Control submenu.

The web server can disallow any user from controlling the IGC100 via the web. In this case, only monitoring is allowed from the web.

If web control is required, there are two types of security. Password security requires the user to enter the password from their browser and Trusted IP allows control only to those IP addresses entered in this menu. Both types can be used together.

See Chapter 8 'Embedded Web Server' for more information on configuring the IGC100 for the internet.

Web Control

Enable or Disable web control of the IGC100.

Disabled prevents any user from controlling the IGC100 via the web. In this case, only monitoring is allowed on the web. This provides the most security but only allows monitoring.

Enabled allows both monitoring and control of the IGC100.

Important

There are two types of security. Password security requires the user to enter the password from their browser and IP Checking allows access only to those IP addresses entered in this menu. Both types can used together. The IGC100 requires the use of at least one type of security.

Security Type

Choose the type of web security (Password, IP Checking or Both)

Password requires the entry of the Web Password from the user's browser before accessing any IGC100 web pages.

IP Checking only allows computers with trusted IP to access the web server. Only users with static IP addresses can use this feature. Do not use this if you use a dial-up account or DHCP account to access the internet. These accounts have dynamic (i.e. temporary) addresses.

Both requires the password AND a trusted IP address checking before web access to IGC100 is allowed.

Password

Enter a password for web access.

When accessing the IGC100 web server from your browser, it will ask for this password before any pages will be displayed.

Trusted IPs

Enter trusted IP addresses. When IP Checking security is enabled, the web server only allows access to those IP addresses entered in this menu.

A trusted range of IP addresses allows all users on a local network (or subnet) to access the web server. Use this in a laboratory environment where groups of computers and users are on a single subnet.

Enter individual IP addresses for remote users with static IP addresses.

IP Checking can not be used with users who have dial-up accounts. These accounts do not have a static, or permanent, IP address.

Start Trusted Range
End Trusted Range

Enter the Start and End of the Trusted IP Range.

Trusted IP Address

Enter individual Trusted IP addresses. Up to four individual addresses can be stored in the controller.

Screen Menu

Touch [Screen] in the Main menu to display the Screen menu.

Contrast Up
Contrast Down

Adjust the screen contrast according to your viewing needs.

Clean Touch Screen

Display the Touchscreen Cleaning display with countdown timer. This allows the user to clean the screen without turning the power off.

The cleaning display has no touch sensitive areas and can be wiped clean without changing any instrument settings. The touchscreen should be cleaned according to the procedure below and only while the Touchscreen Cleaning display is on (or the unit is off). The timer indicates the time remaining before returning to the menu.

Cleaning procedure

For best results, use a clean, non-abrasive cloth towel and a commercial window cleaner to regularly clean the screen. The cleaning solution should be applied to the towel, NOT the surface of the touchscreen. Fluid may seep behind the panel if it is not cleaned properly.

WARNINGS

Do not operate the touchscreen with the tips of pens or sharp objects that might permanently stain or damage the screen surface.

The surface of the touchscreen should be kept free of dirt, dust, fingerprints and other materials that could degrade its optical properties. Long term contact with abrasive materials will scratch the front surface and harm image quality.

Calibrate Touch Screen

Display the Touchscreen Calibration window.

If there is consistent misalignment between the LCD buttons and their touchsensitive areas, follow this calibration procedure to realign the LCD and touchscreen.

Test Touch Screen

Display the Touchscreen Test window. The cross-hairs on the screen should be aligned under the touch point across the entire screen. If the alignment is significantly off, use the Touchscreen Calibration window to re-calibrate.

Backlight Menu

Display the Backlight saver submenu.

The IGC100 has a back-lit LCD display. Backlighting is supplied by a fluorescent tube. Use the Backlight Saver feature to extend its useful lifetime by automatically turning it off after hours. Using the Backlight Saver can double the lifetime of the fluorescent tube.

All IGC100 controller functions remain functional while the backlight is off.

Backlight Saver

Select the Backlight Saver mode (Enabled or Disabled).

Disabled means that the backlight will never be turned off.

Enabled means that, between the Turnoff and Turnon times, the display backlight will turn off if the touchscreen is inactive for a period longer than the Backlight Saver Delay. All IGC100 controller functions remain functional while the backlight is off.

Important
Touch the LCD screen to restart the backlight.

Recommendation
Use the Backlight Saver to extend the life of the screen's backlight. Enable the backlight saver mode and program the on/off/delay times to shut off the light overnight.

Backlight Saver Delay

Enter the Backlight Saver Delay time.

If the Backlight Saver is enabled and the time of day is between the Turnoff and Turnon times, then the display backlight turns off if the touchscreen is inactive for the Backlight Saver Delay time.

TurnOff Time
Turnon Time

Enter the backlight Turnoff Time.

If the Backlight Saver is enabled and the time of day is between the Turnoff and Turnon times, then the display backlight turns off if the touchscreen is inactive for the Backlight Saver Delay time.

Recommendation
Set the Turnoff time to the time at which you leave the lab at night. Set the Turnon time to just before you return in the morning. There is no need to keep the light on when nobody is looking at the

Chapter 4

Analog Input/Output Ports

This chapter includes a complete description of the Analog I/O capabilities of the IGC100, including specifications, connections, possible configurations, and capacitance manometer operation.

In This Chapter

Analog I/O Ports (AN1-AN4)

All IGC100 controllers have four analog input/output ports (BNC connectors) on the back panel. Each port can be individually configured as an input or an output from the front panel or through the computer interface.

The specifications are identical for the four ports

Range	±12 V
Input resolution	14 bits
Input Impedance	1.2 MΩ
Output resolution	12 bits
Output impedance	100 Ω
Update Rate	2 Hz

Connection

The four Analog I/O ports are located on the back panel of the IGC100 and are easily identified as the vertical row of four BNC connectors, labeled ANALOG I/O 1 through 4.

Figure 4-1. Rear panel Analog I/O ports.

The BNC connectors are wired in the standard fashion, with the center pin connected to the signal (input or output) and outer shield connected to the signal return (ground).

Configuration

Each individual Analog I/O port may be programmed to perform one of many possible functions. To configure a port, touch the [Gauges] QuickKey to bring up the Gauges Display. Touch an analog port Data Box (AN1-AN4) to display the Analog Port Setup menu.
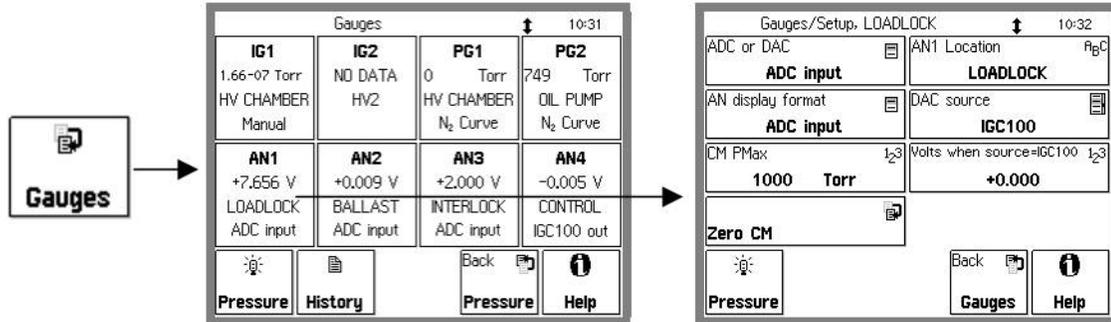
Figure 4-2. Analog I/O Port Setup.

The first, and most important, configuration option is selection of I/O mode, ADC Input (Analog to Digital Converter) or DAC Output (Digital to Analog Converter).

Input ports connected to the pressure signal of a capacitance manometer include the option to display the CM readings directly as pressures (AN Display Format), provided the full scale range (CM PMax) is programmed.

The level of a DAC output can be set manually (Volts When Source=Manual) or remotely (through the computer interface), or may be linked to the log pressure of the IG1, IG2, PG1 or PG2 gauges (DAC Source).

The IGC100 allows you to assign a descriptive Location name (text string) to each signal port. Locations are displayed in the Port Info box of the Pressure Display screen, and in the Port's Data Box of the Gauges Display. This makes it easy to identify the signal source.

For More Information

The menus used for Analog I/O port configuration are described in detail in the Gauges Display section of Chapter 3.

Analog Inputs

When an analog port is configured as an ADC Input, its signal levels (dc voltage or CM pressure) can be displayed on the front panel (Pressure and Gauges Display Screens) and/or monitored remotely through the computer and/or web interfaces.

When Data Logging is enabled, all analog input voltages are stored in memory as part of the data log.

Voltage levels beyond the ±12V range display the message 'OVERLOAD'.

Process Control Channels can be linked to ADC Input ports. Channel activation takes place above or below a user specified input signal level. For example, use the amplified voltage readings from a thermocouple gauge to prevent overheating of your sample during inductive heating.

Recommendation
Use Analog I/O ports as inputs to read voltages from additional vacuum equipment such as capacitance manometers, thermocouples, mass flow controllers, turbo pump controllers, throttle valve controllers, etc.

For More Information
Consult the Process Control Display section in Chapter 3 of this manual for information on how to link process control channels to analog input ports.

Analog Outputs

The level of a DAC output can be set manually (Volts When Source=Manual) or remotely (through the computer interface), or may be linked to the log pressure of the IG1, IG2, PG1 or PG2 gauges (DAC Source).

When IG1 or IG2 is the DAC source, the analog output follows these parameters.

$$P \text{ (Torr)} = 10^{V-12} \text{ for } 10^{-11} \text{ Torr} \leq P \leq 10^{-1} \text{ Torr}$$

0 V   indicates gauge off
12 V   indicates gauge fault

When PG1 or PG2 is the DAC source, the analog output follows these parameters.

$$P \text{ (Torr)} = 10^{V-5} \text{ for } 10^{-4} \text{ Torr} \leq P \leq 10,000 \text{ Torr}$$

0 V   indicates gauge off
12 V   indicates gauge fault

Recommendation
Use analog outputs to control auxiliary vacuum equipment such as heaters, actuators, ion sources and throttle controllers. Connect analog output signals to Programmable Logic Controllers to perform sophisticated process control.

Capacitance Manometers (CM1-CM4)

Basics

Capacitance manometers (CMs) are very accurate devices for measuring both absolute and differential pressures. They measure all gases and materials that are vapors at the gauge's operating temperature. Gauge heads are specified by their full scale range, Pmax (10,000 Torr - 0.1 Torr), and have a dynamic range of approximately 4 decades. The standard output is a dc analog voltage, independent of the gas, linear with pressure, and equal to 10 V at Pmax. Gauge volume is small, and response is fast. Capacitance manometers commonly offer accuracies of 0.25%, while high-accuracy products can offer 0.08%. Capacitance manometers are so accurate that gauge-head temperature variation is a critical source of error. The long-term accuracy of capacitance manometers (better than 1%) justifies their use as secondary standards and transfer gauges.

For critical applications where repeatability, precision, and composition independent readings are required, a capacitance manometer gauge should be used to monitor and control the process pressure! This is particularly true if complex or changing gas mixtures are involved.

Note

Capacitance manometers may be ordered from several commercial sources. Gauge heads can be purchased with two ports for differential measurements, or with an evacuated reference side for absolute pressure measurements.

Heated capacitance manometers, maintained at temperatures above ambient, are used extensively in chemical processes, gas handling systems, and semiconductor processing systems operating under two sets of conditions:

1. ambient temperature undergoes large fluctuations

2. system contains vapors that would otherwise condense on the sensor

Heated CMs are used in measuring pressures found in (1) chemical processes containing water vapor and organic materials that boil at modest temperatures, and
(2) semiconductor manufacturing processes, particularly aluminum etching where $AlCl_3$ vapor exists.

When heated sensor heads are used, the temperature of the sensor usually is greater than that of the chamber whose pressure is to be measured. The pressure reading will be a few percent high under some conditions due to an effect known as thermal transpiration.

For More Information

For additional information on CMs and the thermal transpiration effect consult :

1. "Foundations of Vacuum Science and Technology", Ed. J. M. Lafferty, John Wiley and Sons, NY, 1998, p. 384.

2. R. W. Hyland and R. L. Shaffer, "Recommended Practices for the Calibration and Use of Capacitance Diaphragm gauges as transfer standards", J. Vac. Sci. Technol. A 9 (1991) 2843.

CM Connection

The standard IGC100 controller can display pressures measured from standard capacitance manometers (CMs). Up to four independent CM readings can be monitored simultaneously using the four Analog I/O ports. Pressure readings are updated at 2 Hz. The IGC100 precisely measures the 0 to 10 Vdc linear output signal from the CM to determine pressure. Direct pressure readings are accurate only if the full scale range (PMax) of the gauge is entered into the controller. Full-scale ranges up to 1000 Torr are supported by the controller.

An 'OVERLOAD' message is displayed when the output signal from the CM exceeds 12 V.

For added convenience, the IGC100 also supplies an auxiliary ±15 Vdc/100 mA power output. This power is usually sufficient to operate a pair of standard (i.e. non-heated) capacitance manometers.

For More Information

Chapter 1 includes all the basic information required to install and set up your IGC100 controller and its gauges, including capacitance manometers. Chapter 3 describes, in detail, all menus required to configure the IGC100 to display pressure readings from capacitance manometer gauges.

Tips For Using CMs

1. Avoid overpressurizing the gauge head. Use pressure relief and isolation valves whenever required.

2. Maintain a stable temperature around non-heated gauges.

3. Allow long warm up times for heated gauge heads. Consult manufacturer's recommendations.

4. Avoid contamination and particulate buildup inside the gauge since that could affect diaphragm motion. Some gauge designs offer special features to avoid such buildup.

5. Avoid mechanical vibrations.

6. Eliminate any chances of mechanical stress to the gauges. Use bellows if necessary.

7. Recalibrate frequently. Rezero often.

Chapter 5

Process Control

This chapter provides the basic guidelines required to successfully interface and program the automation features built into the Process Control option (Opt. 03) of the IGC100 controller. If this option is installed, the [Process] QuickKey is available in the Pressure Display and all features described in this chapter are available. If this option is not installed, this QuickKey becomes [No Proc] and no process control features are available.

In This Chapter

Process Control Warnings

- It is the user's responsibility to ensure that the automatic control signals provided by the process control option (Opt. 03) of the IGC100 are always used in a safe manner.

- Carefully check the programming of the system, and test every individual channel connection under MANUAL control, before switching to AUTO Mode operation.

- When an equipment failure or power shutdown condition could cause a hazardous situation, always provide fail-safe precautions. As an example, a pressure relief check valve should be used in conjunction with an automated backfill valve when the risk of dangerous overpressure is possible.

- Use the security features built into the IGC100 to lock the Process Control Display and avoid potentially hazardous changes to your system by inexperienced users.

- Even if the control logic seems simple and obvious, we recommend that you always develop a logic diagram (flowchart) of the process control function you wish to implement. See the Automated Pumpdown Example at the end of this chapter.

- To minimize programming and connection errors, prepare a Specification Table which lists the rule parameters, measurement sources, and connection scheme for each channel. An example is presented in this chapter.

- Keep a copy of the circuit schematic, which illustrates how each piece of equipment is connected to the process control module, in this manual.

- Carefully consider the response of your process control setup during and after power losses. A properly wired setup should protect the system and operators from hazardous conditions whenever power is lost, and should remain in a safe state after power is reestablished.

- Keep in mind that all process control channels are set to Manual Mode, INACTIVE, every time the IGC100 controller is powered up (this should be considered a Fail-safe state). You must switch the appropriate channels to Auto Mode to restart automated operation after every power up.

- No process control actions take place based on ionization gauge readings while the gauge is establishing emission current or while the gauge is degassing.

- To prevent relay arcing, use transient absorbers when connecting inductive loads, such as motors or solenoids, to the process relays. It may be necessary in some cases to use an external power relay driven by a process relay to switch a device on and off.

Why Use Process Control?

Fully automatic vacuum system operation is universally recognized as the most effective way to provide:

- Reproducible process conditions   → increased productivity

- Fault protection   → decreased down-time

- Unattended operation   → more efficient use of operators' time

- Safe operation in the hands of inexperienced users   → reduced chances of errors and accidents

- System automation for repetitive processes   → automate repetitive events such as sample loadings and pump downs

One of the best ways to improve process yield and reduce system failure is through automation. Process automation is most important in complex systems or in systems operated by inexperienced personnel. The process control capabilities of the IGC100 make it unnecessary for the operator to be physically present to operate valves and/or actuate switches at the right time. In fact, an IGC100 with an embedded web server (Opt. 02) provides remote control capabilities from anywhere in the world.

The IGC100 Process Control Option is commonly used to,

- Automatically control vacuum components such as valves, heaters, power supplies, shutters and other process equipment.

- Interlock process control operations with external signals that are related to time, pressure, temperature, gauge status, system status, TTL logic levels and other parameters.

- Automatically control pumpdown, venting and load-lock procedures.

- Signal when a process is complete or alert operators to system conditions that require their attention.

- Link process control channels together to create powerful system logic to control a wide variety of functions.

- Automate repetitive operations.

- Use e-mail notification to warn operators about possible system problems over the internet (requires Web-interface, Opt. 02).

- Control a system remotely through the computer or web interfaces.

Process Control Basics

An IGC100 controller fitted with a Process Control Board, Opt. 03, becomes a powerful and versatile vacuum system controller. The process control board provides eight independent channels for system automation. Each channel has a relay closure output, and associated opto-isolated TTL output logic signal, that may be linked to a variety of input sources through user-programmable rules.

When in AUTO mode, the state of a channel is linked to the readings from an input source. This input source can be:

- any pressure gauge or analog input
- the system clock
- ion gauge emission status
- a dedicated TTL input pin

Channel Rules define the exact conditions under which channels change state during automated operation. The parameters required to fully specify a rule include:

- input source
- setpoint (level, polarity and hysteresis)
- setpoint delay
- channel description and labels
- audio alerts

Process control programming is fast, straight-forward and designed for non-programmers. A complete listing of the Rule editing menus can be found in Chapter 3 of this manual, and will not be reproduced in this chapter.

During automated operation, the output status of all eight channels can be monitored in real time from the front panel (see Process Control Display in Chapter 3). Also, eight dedicated Process Control LEDs (located below the screen) and programmable audio alarms are available to announce process control events.

Manual Override is available for all channels. This allows channel relays and their TTL outputs to be operated directly from the front panel.

All process control events are automatically time stamped and recorded in the Process Control Log. Use the [History] QuickKey in the Process Control Display to review the log. Note that the log is erased when the power is turned off.

The Process Control option also includes 12 opto-isolated TTL inputs. These inputs can be used to remotely control various controller functions including:

- gauge on/off
- degas on/off
- IG filament select
- IG lockout
- Data Log reset
- touchscreen disable

ACTIVE vs INACTIVE

The state of a process control channel is either ACTIVE or INACTIVE.

ACTIVE

When a process control channel is ACTIVE,

- its TTL output is logic low
- its relay is energized or on - the Common and Active (normally open, N.O.) pins are connected together
- its channel LED on the front panel is ON

INACTIVE

When a process control channel is INACTIVE,

- its TTL output is logic high
- its relay is de-energized or off - the Common and Inactive (normally closed, N.C.) pins are connected together
- its channel LED on the front panel is OFF

When a process control channel is in Auto mode, it becomes ACTIVE when the conditions specified by its rule's parameters are met.

Manual operation of the channel output is possible using Manual Override from the front panel or over a computer interface.

Power-On State

All process control channels are set to Manual Mode and INACTIVE, when the IGC100 is powered up. The user must switch the required channels back to Auto Mode to restart automated operation every time the unit is powered up.

Programming Rules

The process control board provides eight independent channels for system automation. Each channel has a relay closure output and associated opto-isolated TTL output signal.

The channel state may be controlled (1) manually (Manual Override below) or (2) automatically, by linking its state to an input source through user-programmable rules.

While in AUTO mode, the state of a channel can be linked to the readings from (1) any pressure gauge or analog input, (2) the system clock, (3) ion gauge status and (4) a dedicated TTL input pin.

Channel Rules define the exact conditions under which channel state activation or deactivation takes place during automated operation. The parameters required to fully specify a rule include (1) input signal (source), (2) activation setpoint (level, polarity and

hysteresis), (3) delay and (4) audio alerts. For channels linked to gauges, the user must also specify a channel state for when the gauge is off or in a fault condition.

Process control programming is fast, straight-forward and designed for non-programmers. Rule editing menus do not require any prior programming experience, and present choices in a simple format.

The variety of signal sources available to every channel provides process control versatility that extends beyond what has been traditionally expected from vacuum gauge controllers. For example, one channel could open the main gate valve every time the PG1 readings from the main chamber drop below a user-specified level, while the next channel controls overnight bakeouts, by using the clock to power a heating envelope during off-hours.

For More Information
Consult Chapter 3 of this manual for a complete description of the Process Control menus, parameters and displays used to program, monitor and control the process control module. See Chapter 7 for information about controlling the process channels over a remote computer interface.

Manual Override

Manual Override is available for all channels, making it possible to manually operate channel relays and TTL outputs directly from the front panel.

Manual control of the channels is performed from the Process Control Display.

Use the [Process] or [Back to Process] QuickKey to bring up the Process Control Display screen. This display consists of eight Channel Data Boxes, each displaying state and configuration information for a process control channel.
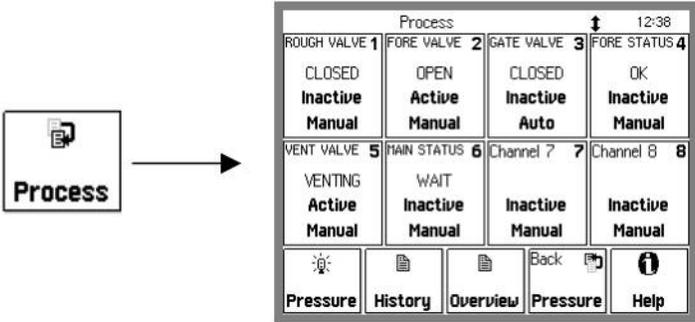
Figure 5-1. Process Control Display.

Touch a Channel Data Box to choose a channel state (Active, Inactive or Auto) or edit the channel rules and labels.
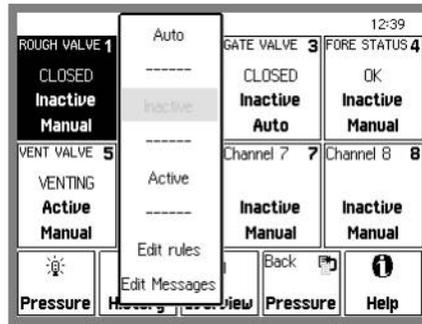
Figure 5-2. Channel Options.

Choose...

> 'Inactive' to manually DEACTIVATE the channel
>
> 'Active' to manually ACTIVATE the channel
>
> 'Auto' to switch the channel to Auto mode - its state is now controlled by the channel rules
>
> 'Edit Rules' to edit the channel rules
>
> 'Edit Labels' to edit the text and audio options for the channel

Recommendations

Always use Manual Operation to test your process control connections before switching to (and relying on) automatic rules for channel operation.

Use Manual Override to quickly switch an automated procedure to manual control in an emergency.

Use Channel Labels to display real system names and states for each channel. This eliminates confusion over which channel is connected to which device.

All process control channels default to Manual Mode, INACTIVE, when the IGC100 controller is first turned on.

For More Information

Consult the Process Control sections of Chapter 3, including descriptions of the Process Control Display, Channel Data Boxes and Rules Editing menus.

Fail-Safe Logic

WARNING!
When equipment malfunction or power loss could cause a hazardous situation, always provide fail-safe operation.

Fail-Safe logic must be very carefully planned, designed and tested before reliance on process automation is allowed.

IGC100 users must carefully consider the behavior of their process control setup during, and after,

- system failures
- equipment malfunctions
- operator errors
- power losses

Typical "unsafe" situations that must be anticipated and accounted for in logic designs, include,

- Gauges, used as input sources for process control channels, can turn off in the middle of a process due to overpressure, gauge failure, Auto-Start events or operator error.

- Input Analog I/O ports, used as channel sources, can be mistakenly switched into outputs in the middle of a process.

- Complete power loss can result in total system shutdown.

A properly designed process control setup must respond to all of the above conditions by immediately shifting the system into a fail-safe state.

A carefully wired and programmed fail-safe state should be available to protect the equipment and operators from danger under any one of the potentially dangerous events described above.

Fail-Safe logic must be very carefully planned, designed and tested before reliance on process automation is allowed.

The following guidelines MUST be considered during fail-safe logic design,

- Channels linked to gauge readings include the "Gauge-Off/DAC State" rule. *This must be specified* to provide the proper fail-safe response in case the gauge shuts down and no pressure readings are available to the channel.

- Channels linked to analog input readings (AN1-4 and CM1-4) also include the "Gauge Off/DAC State" rule. *This must be specified* to provide the proper fail-safe response in case the analog port is mistakenly configured into an output and no voltage or capacitance manometer readings are available to the channel. This rule also applies when the analog input is in overload.

- During a power shutdown all relays are de-energized and in the INACTIVE state - Common and Inactive pins connected. *This must be carefully considered* during the design and implementation of your process control setup, to assure proper fail-safe operation during and after power losses.

- The IGC100 controller *does not automatically turn back on* once power is re-established after power loss. Instead, the user must turn the unit back on manually. During this time, all relays are de-energized and in the INACTIVE state.

- *When the IGC100 is turned on, all channels are set to Manual Mode and INACTIVE. This is considered the fail-safe operating mode.* The user must set the required process control channels back to Auto to restart automated process control every time the IGC100 controller is turned on.

Relay Connections

Each process control channel has an associated relay. The relay specifications are:

Configuration	SPDT (Single Pole, Double Throw)
Contact Rating	5 A, 250 VAC/30 VDC, resistive load only
Contact Material	AgSnOInO

Use the two 12-Position Terminal Block Plugs located on the back panel to connect to the eight process control relays. Relay pins are labeled I (Inactive), C (Common) and A (Active) for easy association to channel states.
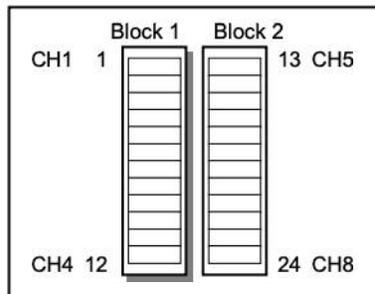
Figure 5-3. The 2 12-position terminal blocks for process relay connections.

Block	Pin	Process Channel	Process Control Label	Relay Pin
1	1	1	Common (C)	C
	2		Inactive (I)	N.C.
	3		Active (A)	N.O.
	4	2	Common (C)	C
	5		Inactive (I)	N.C.
	6		Active (A)	N.O.
	7	3	Common (C)	C
	8		Inactive (I)	N.C.
	9		Active (A)	N.O.
	10	4	Common (C)	C
	11		Inactive (I)	N.C.
	12		Active (A)	N.O.
2	13	5	Common (C)	C
	14		Inactive (I)	N.C.
	15		Active (A)	N.O.
	16	6	Common (C)	C
	17		Inactive (I)	N.C.
	18		Active (A)	N.O.
	19	7	Common (C)	C
	20		Inactive (I)	N.C.
	21		Active (A)	N.O.
	22	8	Common (C)	C
	23		Inactive (I)	N.C.
	24		Active (A)	N.O.

Note: Block #2 must be removed in order to be able to access its side screws.

Connection Basics

When a process control channel is ACTIVE its relay is energized, or on, connecting the Common and Active (N.O.) pins. Active Pins are labeled 'A' on the back panel, and correspond to the Normally Open pin of the SPDT relay.

SPDT Relay

○ A, Active, Normally Open, N.O.

○ I, Inactive, Normally Closed, N.C.
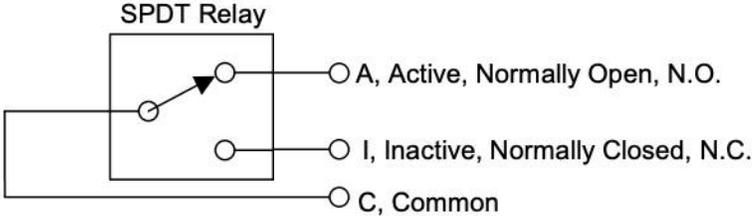
○ C, Common

Figure 5-4. Active relay connection.

When a process control channel is INACTIVE its relay is de-energized, or off, connecting the Common and Inactive pins. Inactive Pins are labeled 'I' on the back panel, and correspond to the Normally Closed pin of the SPDT relay.

SPDT Relay

○ A, Active, Normally Open, N.O.

○ I, Inactive, Normally Closed, N.C.
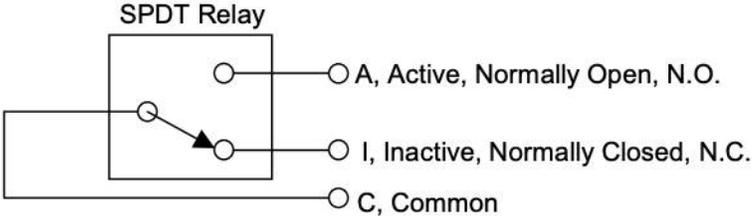
○ C, Common

Figure 5-5. Inactive relay connection.

Connection Schemes

Process control relays have three pins and three connection schemes are possible.

Active-Common

The relay is wired as a single throw switch, with connections to the Active and Common pins only. Contact closure takes place during the ACTIVE state of the channel. Contact is open during the INACTIVE state of the channel and during power shutdowns. For example, use this connection to turn a heater on and off, using the relay as a power switch. Heat is available only when the channel state is ACTIVE.

SPDT Relay

Active

Inactive

Common

Power

Ground

Heater
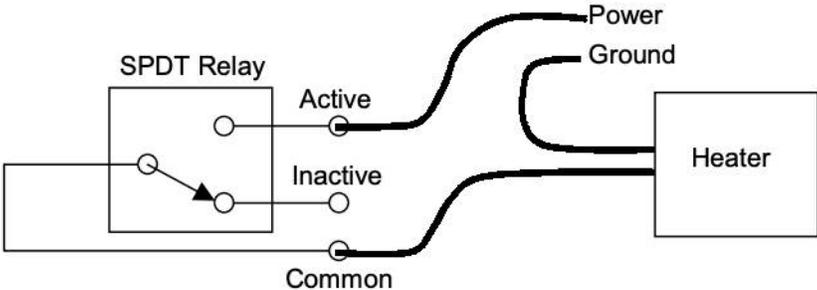
Figure 5-6. Using a relay as a power switch. (Shown in Inactive state.)

In this case, the Active and Common connections may be swapped. Connecting as shown prevents power from appearing on the Inactive pin when the channel is Inactive.

Inactive-Common

The relay is also wired as a single throw switch, but with connections to the Inactive and Common pins. Contact closure takes place during the INACTIVE state of the channel. Contact between the pins is also established during power shutdowns (fail-safe state). For example, use this connection scheme to turn an auxiliary power supply on after a main power failure. As the main power shuts down, the relay is deactivated, delivering backup power to the experiment. In general, use this connection scheme whenever you need a contact to open during the active state of the channel.
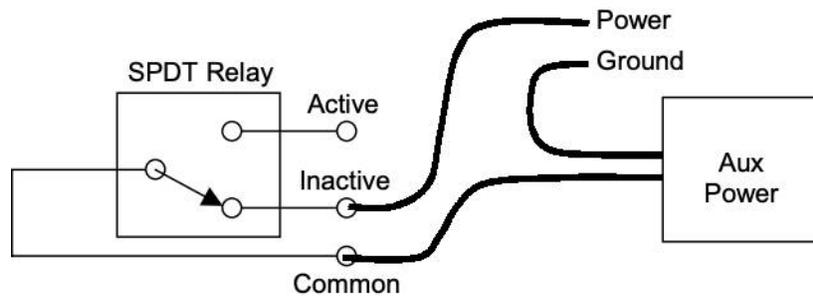
Figure 5-7. Using a relay as a back-up power switch. (Shown in Inactive, power-off state.)

In this case, the Inactive and Common connections may be swapped. Connecting as shown prevents power from appearing on the Active pin when the channel is Active.

Active-Common-Inactive

The relay is used as a true double throw switch, with connections to its three pins. As an example, consider a system where an electrical power source is shared between two instruments (#1 and #2), but only one instrument is powered at a time (sequential operation). In this scheme, the supply wire is connected to the Common pin and the Active and Inactive pins are connected to the power input pins of instruments #1 and #2, respectively. Switching the channel state between ACTIVE and INACTIVE redirects the power from instrument #1 to instrument #2.
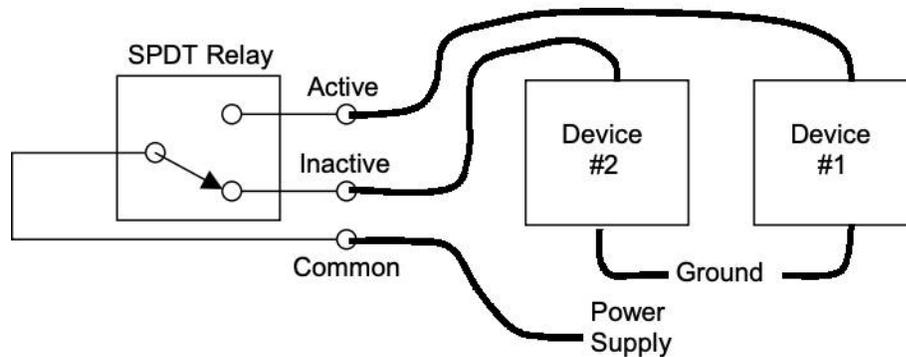
Figure 5-8. Using a relay as a power multiplexer. (Shown in Inactive, power-off state.)

A similar scheme could be used to monitor (sequentially) two separate sensors from a single-input reader (signal multiplexing). In this case, the reader's input is connected to Common, and sensors 1 and 2 connect to pins A and I of the relay, respectively. Activate the channel to monitor sensor 1, or deactivate the channel to switch to sensor 2.
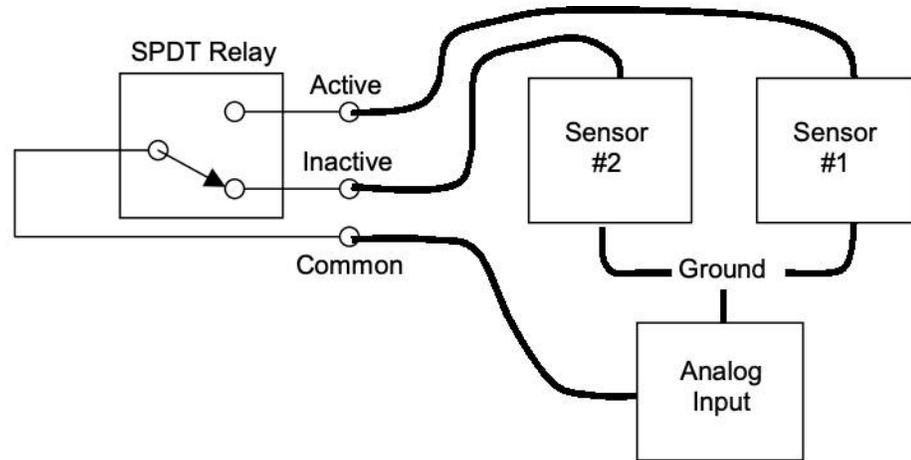
Figure 5-9. Using a relay as a signal multiplexer. (Shown in Inactive, power-off state.)

Connection Tips

- Both Terminal Block Plugs can be disconnected from the back panel, making it possible to transfer the controller to a different location without having to undo the relay connections. Spare Terminal Blocks are also available from Stanford Research Systems for lab environments where more than one wire connection scheme is used.

- Make sure all wire ends are securely fastened to the Terminal Block Plugs, always tighten the wire-lock screws.

- Block #2 (Relays 5-8) must be disconnected from the process control board in order to be able to access its side wire-lock screws. Gently pry the block out with a small screwdriver using the access slots in the panel above and below the connector.

- Relays are used in vacuum systems for many different purposes:

  - Power distribution/switching to system components such as gate valve actuators, heating jackets, etc.

  - Interlocking. Many pump controllers include relay closure detection ports designed for interlocking purposes.

  - Signal multiplexing. For example, it is not unusual to multiplex a single input temperature reader between two temperature sensors.

  - Sound alarms on/off.

  - Start/stop processes

- In order to prevent costly mistakes, label every cable connected to the process control relays with an unambiguous name. Include the pin#, pin label, and channel# in case the cable comes loose and needs to be reattached to the controller.

- Do not exceed the relay ratings: 5 A/250 VAC/30 VDC, resistive load, during operation.

- Use transient absorbers when connecting inductive loads, such as motors or solenoids, to the process relays. It may be necessary in some cases to use an external power relay driven by a process relay to switch a device on and off.

- Ensure that all process control channels are under manual control, and in the desired state, prior to connecting a wired terminal block plug into the process control board's receptacle.

- During a power shutdown, all relays are de-energized and switch to their INACTIVE state - i.e. Common and Inactive pins connected. This must be carefully considered during the design of your process control setup, to assure proper fail-safe operation during and after power losses.

Channel Linking

Process control relays can be linked together to create powerful system logic and control complicated functions. As an example, consider the implementation of an overnight bakeout system with over-temperature protection. Since heating jackets have been known to runaway and cause serious system damage, it is always a good precaution to add a safeguard system that will shut down the heating power if the temperature generated by the heater exceeds the maximum allowed threshold. This is easily implemented with the IGC100 if a thermocouple is attached to the vacuum system and its amplified voltage signal is monitored through one of the Analog I/O ports of the controller. A straightforward implementation of this function might be: (1) link channel 1 to the clock and program its activation period throughout the middle of the night, (2) link channel 2 to the AN1 thermocouple readings and program it to activate at voltage readings below the maximum allowed temperature value, (3) connect the channel 1 and channel 2 relays in series, using the Active-Common connection described above, and use the dual-switch combination as a power switch for the heater's power cord. Under this configuration, heating is only possible if channel 1 AND Channel 2 are both simultaneously Active. If the temperature exceeds the maximum specified value (channel 2 deactivated), or the bakeout time expires (channel 1 deactivated), no electrical power can flow into the heating jacket and the bakeout is interrupted.
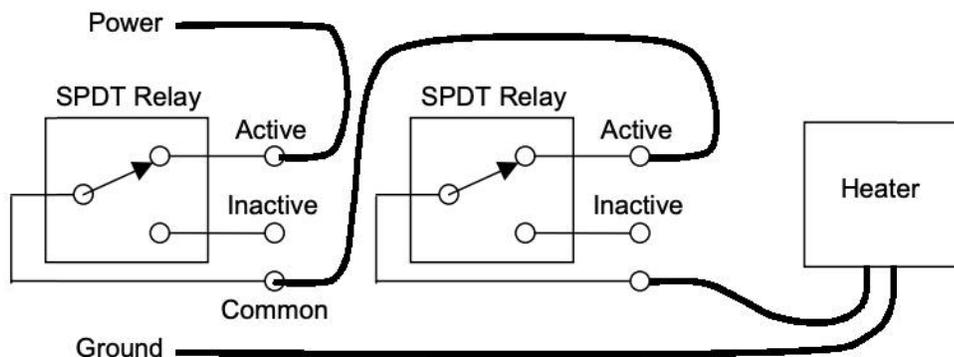
*Figure 5-10. Using two relays in series to provide an interlock function.
(Both relays shown in Active state.)*

Remote Operation

Channel relays can be operated remotely through the computer (RS-232 or GPIB) and web (Opt. 02) interfaces. Use this convenient feature to control experiments or processes from anywhere in the world. For example, turn off your bakeout jackets from home before leaving for work, so that the system can cool down during your commute and is ready to start an experiment as you get into the lab.

Figure 5-11. IGC100 web page showing relay status and control via the internet.

Digital I/O Module

The DIGITAL I/O module included with the Process Control board supports three types of logic signals. The TTL signals are opto-isolated from the IGC100 chassis. The inputs may be electrically floated as a group. The outputs may be electrically floated as a group, separate from the inputs.

TTL Input (8 pins)

Each process control channel has a dedicated TTL input pin. While in AUTO mode, channel control can be linked to this TTL input. The logic level (TTL HIGH or LOW) responsible for channel activation must be specified by the user (factory default setting is active low, meaning that the channel is ACTIVE when the logic level on the pin is LOW.)

TTL Output (8 pins)

Each process control channel has a dedicated TTL output signal. Following common industry standards, all process control TTL output signals are Active Low - when a process control channel is ACTIVE, the corresponding TTL output is logic LOW. INACTIVE means the channel's TTL output pin is logic high.

Remote Control Input (12 pins)

The Process control option also includes 12 TTL logic inputs for remote logic control of various controller functions.

- Ionization gauge IG1/IG2 On/Off
- Degas On/Off
- Ionization gauge filament selection
- Ionization gauge lockout
- Ionization gauge keypad disable
- Pirani gauge PG1/PG2 On/Off
- Data log clear/reset
- Touchscreen disable

Recommendation

Use the Remote Control TTL inputs to control important IGC100 functions remotely, without the need for a computer interface. A common application is clearing the data logging buffer to synchronize the start of the data log with a particular event, such as (1) the opening of a gate valve or (2) the achievement of full speed by a turbo pump. Gate valve and turbo pump controllers often provide logic outputs compatible with the remote control module. Remote control inputs can also be interfaced with Programmable Logic Controllers' signals.

Digital I/O Connections

Use the female DB37 port located on the back panel of the IGC100 controller (labeled DIGITAL I/O) to connect to the (1) eight PC TTL Output, (2) eight PC TTL input, and (3) 12 Remote Control TTL input pins of the Process Control Board.

Note

A Male DB37 connector is included with every IGC100 controller shipped directly from Stanford Research Systems to facilitate interfacing of the TTL I/O port to your system.
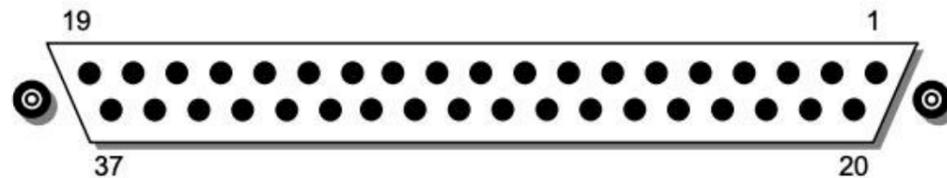
Figure 5-12. DB37 TTL I/O connector.

TTL I/O Pin Assignments

Pin	Module	Name	Description
1		IGC100 Vcc	+5 V OUT
2	**Remote Control TTL IN**	ANODE COM	External User +5 V IN
3		IG1_On	Edge trigger: ↓=IG1 On, ↑=IG1 Off
4		IG2_On	Edge trigger: ↓=IG2 On, ↑= IG2 Off
5		Degas_On	Edge trigger: ↓= Degas On, ↑=Degas Off
6		IG_Lockout	Level: LOW=IG1 and IG2 emission Off
7		IG_Key_Disable	Level: LOW=Disable front panel IG Keypad.
8		PG1_Off	Edge trigger: ↓=PG1 Off, ↑=PG1 On
9		PG2_Off	Edge trigger: ↓=PG2 Off, ↑=PG2 On
10		Clear_Data_Log	Edge trigger: ↓=clear the data log
11		IG_Remote_Enable	Level: HIGH=Ignore IG1_On, IG2_On, Degas_On, FIL1_On, FIL2_On pins.
12		FIL1_On	Edge trigger: ↓=FIL1 ON, ↑=FIL1 Off
13		FIL2_On	Edge trigger: ↓= FIL2 ON, ↑= FIL2 Off
14		Front_Panel_Disable	Level: LOW=Disable Touchscreen and Keypad
15		IGC100 Vcc	+5 V OUT

Pin	Module	Name	Description
16	**Process Control TTL OUT**	TTL_OUT_5	TTL OUT for Channel 5. LOW=ACTIVE
17		TTL_OUT_6	TTL OUT for Channel 6. LOW=ACTIVE
18		TTL_OUT_7	TTL OUT for Channel 7. LOW=ACTIVE
19		TTL_OUT_8	TTL OUT for Channel 8. LOW=ACTIVE
20	**Process Control TTL IN**	ANODE COM	External User +5 V IN
21		TTL_IN_1	TTL Input Signal for Channel 1. Active LOW
22		TTL_IN_2	TTL Input Signal for Channel 2. Active LOW
23		TTL_IN_3	TTL Input Signal for Channel 3. Active LOW
24		TTL_IN_4	TTL Input Signal for Channel 4. Active LOW
25		TTL_IN_5	TTL Input Signal for Channel 5. Active LOW
26		TTL_IN_6	TTL Input Signal for Channel 6. Active LOW
27		TTL_IN_7	TTL Input Signal for Channel 7. Active LOW
28		TTL_IN_8	TTL Input Signal for Channel 8. Active LOW
29		unused	
30		IGC100 Ground	
31		IGC100 Ground	
32	**Process Control TTL OUT**	COM_EMTR_REF	External User Ground
33		COM_COLTR_PULLUP	External User +5 V IN
34		TTL_OUT_1	TTL OUT for Channel 1. LOW=ACTIVE
35		TTL_OUT_2	TTL OUT for Channel 2. LOW=ACTIVE
36		TTL_OUT_3	TTL OUT for Channel 3. LOW=ACTIVE
37		TTL_OUT_4	TTL OUT for Channel 4. LOW=ACTIVE

Note

↓=HIGH-to-LOW, ↑=LOW-to-HIGH

Unconnected inputs are HIGH.

Input Circuit

The TTL inputs are opto-isolated from the IGC100. The schematic of a TTL input is shown below.
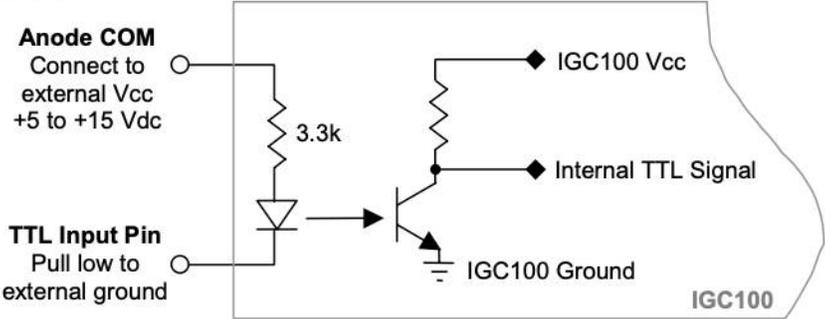
Figure 5-13. TTL input pin schematic.

For isolated operation of ALL TTL inputs, connect ANODE_COM (pins 2 and 20) to the external Vcc supply (+5 to +15 Vdc). Pull inputs to external ground for low inputs.

For non-isolated operation of ALL TTL inputs, connect ANODE_COM (pins 2 and 20) to IGC100 Vcc (pin 1 or 15) and pull inputs to IGC100 Ground (pin 30 or 31) for low inputs.

In both cases, leaving an input unconnected or open is equivalent to a HIGH input.

Output Circuit

The TTL outputs are opto-isolated from the IGC100. The schematic of a TTL output is shown below.
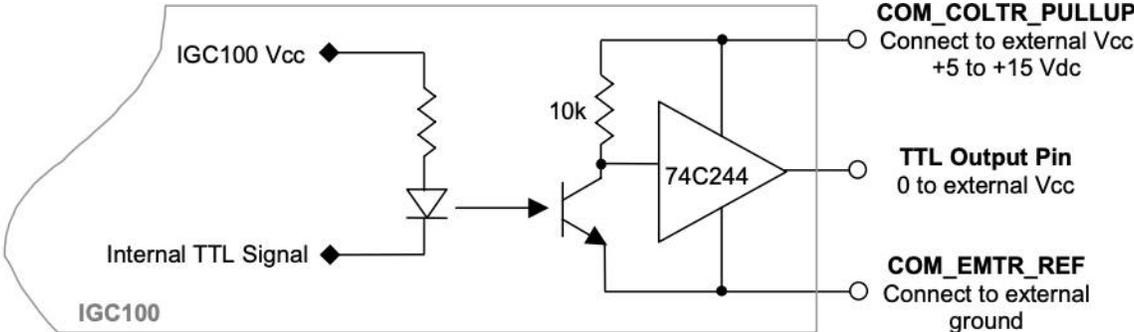
Figure 5-14. TTL output pin schematic.

For isolated operation of ALL TTL outputs, connect COM_COLTR_PULLUP (pin 33) to the external Vcc supply (+5 to +15 Vdc) and COM_EMTR_REF (pin 32) to the external ground. The TTL output will be external 0 V or Vcc (low or high).

For non-isolated operation of ALL TTL outputs, connect COM_COLTR_PULLUP (pin 33) to IGC100 Vcc (pin 1 or 15) and COM_EMTR_REF (pin 32) to IGC100 Ground (pin 30 or 31). The TTL output will be external 0 V or 5 V (low or high).

Connection Tips

- All TTL inputs may be connected to respond to relay closure signals, such as those provided by the mechanical position indicators of gate valves, or full speed indicators of turbomolecular pump controllers.

- Input and output pins can be linked together to create powerful system logic and control a wide variety of system functions. For example, Process Control TTL outputs can be connected to Remote Control TTL inputs and used to control functions such as powering gauges on/off or clearing the Data Log.

- The use of external TTL logic circuitry to provide additional logic manipulation of the TTL I/O signals complements the process control capabilities of IGC100. For example, connect the TTL I/O pins to an external PLC (programmable logic controller) or a home-built logic circuit to extend the capabilities of the process control ports.

- Use the TTL output signals to operate external relays, with ratings exceeding those of the built-in relays.

- Use the TTL outputs to indicate the status of the individual process control channels to external devices such as computers, logic analyzers and PLCs.

Debounce Time

A 50 ms debounce time is standard for ALL TTL inputs (Process Control and Remote Control). This prevents spurious glitches on the TTL lines from triggering process control events or controller functions.

For a level-triggered input, the debounce time is the minimum amount of time the input signal must remain unchanged, at the new logic level, before that level is recognized by the IGC100 and triggers a process control event or controller function.

For an edge-triggered Remote Control input, the debounce time is the length of time during which the input signal must remain unchanged following a level transition, before the edge is validated by the IGC100 and triggers a controller function.

Remote Control Inputs

IG_On

Pins: 3 for IG1; 4 for IG2
Trigger mode: Edge, ↓= ON, ↑= OFF
Debounce time: 50 ms

Prerequisites:
- Pressure in the IG is adequately low
- IG_Remote_Enable is logic LOW
- IG_Lockout is logic HIGH

Pulling an IG_On control line LOW, after it has been high for at least 50 ms, and holding the line LOW for at least 50 ms, turns the gauge on. The input must remain LOW until it is required to turn the IG off.

Either IG can be turned off through the remote input by
- Switching the IG_On input HIGH after it has been LOW for at least 50 ms
- Turning the other ionization gauge on
- Pulling the IG_Lockout pin LOW

Degas_On

Pin: 5
Trigger mode: Edge, ↓= ON, ↑=OFF
Debounce time: 50 ms

Prerequisites:
- IG is turned on
- IG pressure is below 5×10^{-5} Torr
- IG_Remote_Enable is logic LOW
- IG_Lockout is logic HIGH

Pulling the Degas_On control line LOW, after it has been high for at least 50 ms, and holding the line LOW for at least 50 ms, starts the degassing process on the active IG. The input must remain LOW for the duration of the degas process. Degassing takes place for a period specified by the Degas Time.

Degas can be terminated before the Degas Time has elapsed through the remote input by
- Switching the Degas_On input HIGH after it has been LOW for at least 50 ms
- Turning the ionization gauge off
- Pulling the IG_Lockout pin LOW.

IG_Lockout

Pin: 6
Trigger mode: Level. LOW = IG1 and IG2 off, HIGH = Normal IG operation.
Debounce time: 50 ms

Prerequisites:
   • IG_Remote_Enable is logic LOW

HIGH allows normal IG operation (unconnected default).

LOW forces the IGs to turn off, and stay off - any request to turn an IG on is denied as long as the IG_Lockout line remains LOW. This applies to requests from the front panel keys and the computer interfaces.

Recommendation
IG_Lockout is one of the most useful remote control lines and is often used to interlock IG emission. For example, the IG_Lockout line is often connected to the logic output of the mechanical position indicator of a load lock's vent valve. If the vent valve is opened (indicating that high pressure is present in the load lock chamber), the IG shuts down, and any attempt to turn it back on is denied, effectively protecting its filament.

Fil_On

Pins: 12 for Filament 1; 13 for Filament 2
Trigger mode: Edge, ↓= ON, ↑=OFF
Debounce time: 50 ms

Prerequisites:
   • IG_Remote_Enable is logic LOW

Pulling the Fil1_Onf control line LOW after it has been high for at least 50 ms, and holding the line LOW for at least 50 ms, selects Filament 1 for IG emission. The input must remain LOW until it is required to turn the filament off.

Pulling the Fil2_On remote control line LOW after it has been high for at least 50 ms, and holding the line LOW for at least 50 ms, selects Fil2 for IG emission. The input must remain LOW until it is required to turn the filament selection off.

Select Filament 1 and Filament 2, as described above, to use both filaments in the IG emission.

Turning both filaments off turns off the gauge.

IG_Remote_Enable

Pin: 11
Trigger mode: Level. HIGH = ignore IG1_On, IG2_On, Degas_On, Fil1_On and
                        Fil2_On pins.
Debounce time: 50 ms

Prerequisites:
- None

The IG_Remote_Enable line must be LOW for the IGC100 Remote Control Module to acknowledge the edge triggers from the IG1_On, IG2_On, Degas_On, Fil1_On and Fil2_On pins.

If unconnected, this pin will be HIGH and remote control is disabled (default).

Recommendation

This pin is often used to enable/disable Remote Control of ionization gauge functions. For example, it might be useful to lock the remote control signals during an electrically noisy process to prevent logic glitches from accidentally affecting IG operation.

IG_Key_Disable

Pin: 7
Trigger mode: Level, LOW = Disable front panel IG Keypad.
Debounce time: 50 ms

Prerequisites:
- None

HIGH allows manual operation of ionization gauges from the front panel IG Keypad (IG1, IG2, DEGAS, and IG AUTO buttons).

If unconnected, this pin will be HIGH and the IG Keypad is operational (default).

LOW locks out the IG keypad: the IG1, IG2, DEGAS and IG AUTO keys have no function as long as this line remains LOW.

Recommendation

IG_Key_Disable is often used to lock the front panel IG keypad during a process or experiment, and block inexperienced users from ruining a run.

PG_Off

Pins: 8 for PG1; 9 for PG2
Trigger mode: Edge, ↓= PG OFF, ↑= PG ON
Debounce time: 50 ms

Pulling the PG_Off control line LOW after it has been high for at least 50 ms, and holding the line LOW for at least 50 ms, turns the Pirani gauge off. The input must remain LOW until it is required to turn the PG on.

The Pirani gauge can be turned on by switching the PG_Off control line HIGH after it has been LOW for at least 50 ms. The input must remain HIGH until it is required to turn the PG off.

Recommendation
Use the PG_Off lines to control Pirani gauges in the presence of dangerous gases. For example, connect the PG_Off line to the mechanical position indicator of a valve used to deliver flammable gases, so that the PG is turned off whenever flammable gas is flowing into the chamber.

Clear_Data_Log

Pin: 10
Trigger mode: Edge, ↓= Clear the data log.
Debounce time: 50 ms.

Pulling the Clear_Data_Log control line LOW after it has been high for at least 50 ms, and holding the line LOW for at least 50 ms, clears and resets the data log.

Recommendation
Use this input to synchronize the start of data logging with an important event such as a gate valve closing, a turbo pump achieving full rotational speed or a heating cycle getting started. For example, connect the Clear_Data_Log line to the logic output of your gate valve's mechanical position indicator to restart the data log buffer every time the gate valve is opened. This is useful for the collection of pump down curves. Connect the Clear_Data_Log line to a logic signal from your temperature controller indicating the start of a heating ramp, to monitor the entire temperature profile of a TPD experiment.

Front_Panel_Disable

Pins: 14
Trigger mode: Level, LOW = Disable front panel touch screen LCD and keypad
Debounce time: 50 ms

HIGH allows normal operation of the touchscreen display (unconnected default).

LOW locks the touchscreen LCD. The display does not respond to touches.

Recommendation
The Front_Panel_Disable signal is often used to lock the front panel and block unauthorized changes to the controller during a process or experiment.

Automated Pumpdown Example

The following example is intended to provide ideas on how to use the IGC100 process control capabilities to automate vacuum system procedures.

The same basic control concepts can be applied to almost any kind of system ranging from the simple experimental setups found in research labs to the more complex vacuum equipment used in production environments.

> **WARNING**
> Since the operating conditions of a process vary according to (1) the application, (2) the system configuration and (3) the user's preferences, the example provided should only be used as general guideline and should not be applied without the appropriate modifications to any real system.

Recommendation
The process control capabilities of the IGC100 are not limited to vacuum system control only. IGC100 controllers are also routinely used to automate, and/or control, many other lab related processes such as (1) laser firing and interlocking, (2) mass spectrometer sample loading and automated data acquisition, (3) mass spectrometer detector and ionizer protection, (4) heat treatment cycles, (5) signal multiplexing in multiple input measurements, etc. It is very likely that many repetitive procedures you currently perform during your daily lab routine could be automated, and even controlled remotely, with the help of an IGC100.

Pumpdown Automation

This example is intended to provide ideas on how to automate the most universal high vacuum repetitive procedure - Main Chamber Pumpdown from atmosphere.

The steps controlled by the IGC100 involve:
1. Roughing the chamber
2. Switching to turbo pumping at the cross-over pressure
3. Turning the ionization gauge on
4. Sending e-mail notification when the chamber pressure goes below 2×10^{-5} Torr or when dangerous overpressure is detected in the foreline (requires Web interface Opt. 02).

When implemented properly, a procedure such as this will allow any IGC100 user to start a main chamber pumpdown and then walk-away, while the IGC100 does all the work. Pumpdown completion is notified via e-mail. There is no need to constantly revisit the lab to check on the pressure. Use any internet browser to check on the system while pump down is in progress. As examples, automated pumpdown is very useful in a mass spectrometer after a new sample is loaded into the vacuum chamber, and also in a processing setup after a new substrate is loaded into a coating machine.
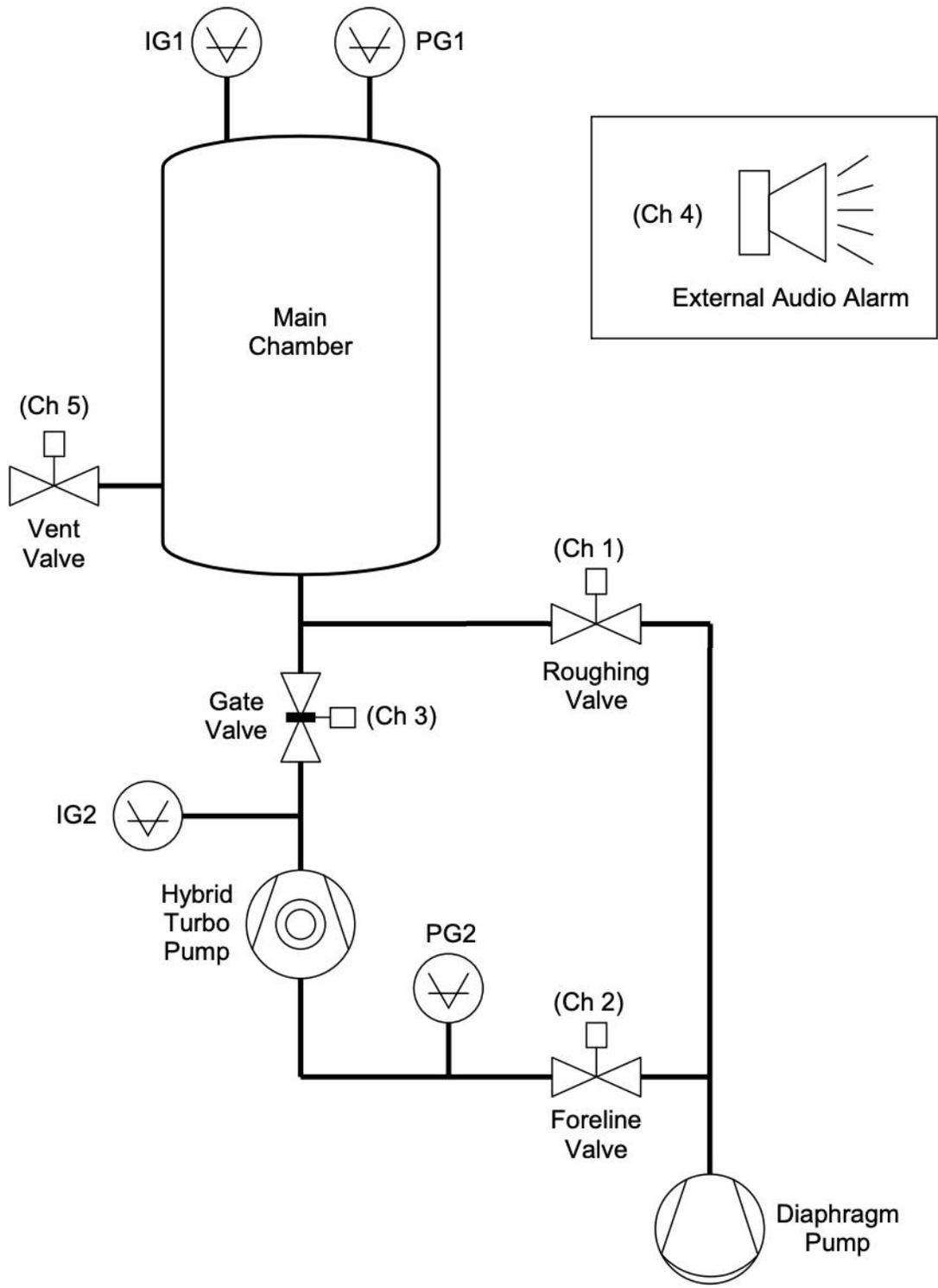
Vacuum System Diagram

Figure 5-15. Example vacuum system diagram.

Components

PG1 - Pirani Gauge - Main Chamber
Monitors the Main Chamber pressure between 10^{-4} and 1000 Torr. A PG105-UHV gauge is used for compatibility with UHV construction.

IG1 - Ionization Gauge - Main Chamber
Monitors the Main Chamber pressure between $2x10^{-10}$ and $2x10^{-3}$ Torr. Operated in Auto-Start mode, its filament turns on automatically when PG1 pressure falls below $2x10^{-3}$ Torr during automated pumpdown.

IG2 - Ionization Gauge – Turbo Pump
Monitors the Turbo Pump pressure below the Gate Valve. It is not used by the automated pumpdown procedure, but is an essential component of this vacuum setup.

PG2 - Pirani Gauge - Foreline
Monitors the Foreline pressure, which should never exceed 1 Torr (except briefly) in this system.

Roughing Valve
Pneumatically actuated valve controlled by process channel 1, programmed to close automatically after PG1 pressure drops below 0.1 Torr (cross over pressure) while in Auto mode. Channel description: Rough Valve

Foreline Valve
Pneumatically actuated valve controlled by process channel 2, programmed to open 30 seconds after the PG1 pressure drops below 0.1 Torr (cross over pressure) while in Auto mode. The 30 second delay avoids pressure surges into the back of the turbo pump after the valve is opened. Channel Description: Fore Valve

Gate Valve
Pneumatically actuated valve controlled by process channel 3, programmed to open 60 seconds after PG1 pressure drops below 0.1 Torr (cross over pressure) while in Auto mode. The 60 second delay provides 30 seconds additional delay from the time the foreline valve is opened, and assures complete stabilization of the turbo pump speed before its inlet is exposed to the main chamber. Channel description: Gate Valve.

External Audio Alarm
Controlled by process channel 4, programmed to sound a loud alarm when the PG2 pressure exceeds 1 Torr for longer than 30 seconds. This warns of potential problems, since such large foreline pressures should never develop during normal pumpdown. An e-mail notification message should also be linked to channel 4 activity if a Web Interface connection is available and the user is planning to be away from the vacuum lab during parts of the process.

Vent Valve
Pneumatically actuated valve controlled by process channel 5, operated manually and only opened to pressurize the main chamber to atmosphere during ventings. This valve remains closed and under Manual control throughout the entire Pumpdown procedure. Channel Description: Vent Valve.

Connections

All valves used in the system considered here are pneumatically actuated and require +24 Vdc power to be delivered to the air control solenoid valve to open. All valves are connected following the Active-Common scheme (described earlier), with the channel relay acting simply as a switch between the +24 Vdc line from the power supply and the solenoid valve. The +24 Vdc power supply wire connects to the Active pin and the solenoid power input is connected to the Common pin of the relay. As a result, all valves are OPEN in the ACTIVE state of their channel. When the power is off, all channels are INACTIVE and all valves will be CLOSED.
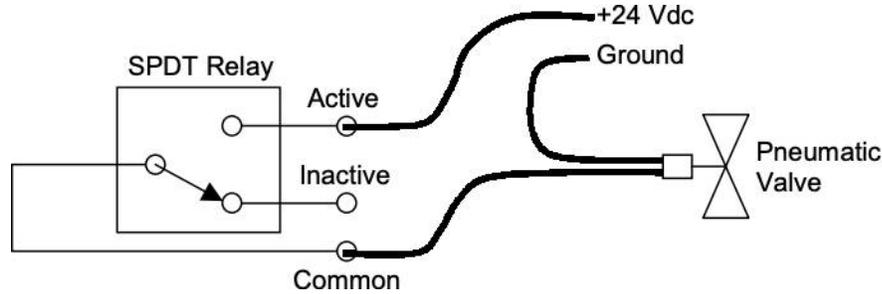
Figure 5-16. Pneumatic valve to relay connections (shown in INACTIVE or closed state).

The external alarm is controlled by channel 4 and requires +24 Vdc power to sound. It is connected to the relays in the same way as the valves - the alarm sounds when the channel goes ACTIVE.

Process Specification Table

The following table lists the parameter values used to program the rules of the six process control channels used by the Automated Pumpdown Procedure.

The channel descriptions and ACTIVE/INACTIVE messages are selected to be informative of the status of the process. For example, channel 1 is described as "Rough Valve" and programmed to display a "Roughing" message while its valve is open. Similarly, channel 6 is described as "Main Status" and displays a "Wait" message while the pressure in the Main Chamber remains above the 2×10^{-5} Torr setpoint.

Figure 5-17. Process Control Display showing Channel Data Boxes with messages and descriptions for this example.

No electrical connections are made to the channel 6 outputs since it is only used for status notification through the front panel and e-mail messaging.

Channel 4 controls a loud external alarm and sends an e-mail message when it goes ACTIVE. E-mail notification through the Web interface (requires Option 02 installed) makes it possible to be away from the lab while the pump down takes place.

Process Name: **Pumpdown**										
Channel# (Description)	Linked to...	Setpoint (above / below)	Hyst (%)	Delay (sec)	Off-State	E-mail (✓)	Beep (✓)	Active Msg	Inactive Msg	Relay Wiring pin
1 (Rough Valve)	PG1	0.1 Torr (above)	0	0	INACTIVE		✓	Roughing	Closed	1 (C) Solenoid
										2 (I)
										3 (A) +24Vdc
2 (Fore Valve)	PG1	0.1 Torr (below)	0	30	INACTIVE		✓	Open	Closed	4 (C) Solenoid
										5 (I)
										6 (A) +24Vdc
3 (Gate Valve)	PG1	0.1 Torr (below)	0	60	INACTIVE		✓	Open	Closed	7 (C) Solenoid
										8 (I)
										9 (A) +24Vdc
4 (Fore Status)	PG2	1 Torr (above)	0	30	INACTIVE	✓	✓	Problem	OK	10 (C) Alarm pwr
										11 (I)
										12 (A) +24Vdc
5 (Vent Valve)	Manual mode only	( )					✓	Venting	Closed	13 (C) Solenoid
										14 (I)
										15 (A) +24Vdc
6 (Main Status)	IG1	2×10^{-5} Torr (below)	0	0	INACTIVE	✓	✓	Ready	Wait	16 (C)
										17 (A)
										18 (I)
7 ( )		( )								19 (C)
										20 (A)
										21 (I)
8 ( )		( )								22 (C)
										23 (I)
										24 (A)

Process Flow Diagram

IMPORTANT

No matter how simple a process appears to be, it is always recommended to develop a logic diagram to check and step through the process.

```
                    ┌──────────────────────────────────┐
                    │              START                │
                    │ • Main Chamber at Atmosphere      │
                    │ • Vent Valve    (Ch 5)  OPEN   (Manual) │
                    │ • Rough Valve   (Ch 1)  CLOSED (Manual) │
                    │ • Gate Valve    (Ch 3)  CLOSED (Auto)   │
                    │ • Fore Valve    (Ch 2)  OPEN   (Manual) │
                    └──────────────────────────────────┘
                                     │
                    ┌──────────────────────────────────┐
                    │ Close Vent Valve Manually (Ch 5 INACTIVE) │
                    └──────────────────────────────────┘
                                     │
                    ┌──────────────────────────────────┐
                    │ Switch Foreline Valve to AUTO (Ch 2) │
                    └──────────────────────────────────┘
                                     │
                    ┌──────────────────────────────────┐
                    │ PG1 pressure > 0.1 Torr           │
                    │ Ch 2 delay starts (30 s)          │
                    └──────────────────────────────────┘
                                     │
                         < Ch 2 delay over? >── No ──[ Wait ]
                                     │ Yes
                    ┌──────────────────────────────────┐
                    │ Channel 2 closes Foreline Valve (INACTIVE) │
                    └──────────────────────────────────┘
                                     │
                    ┌──────────────────────────────────┐
                    │ Switch Roughing Valve to AUTO (Ch 1) │
                    └──────────────────────────────────┘
                                     │
                    ┌──────────────────────────────────┐
                    │ PG1 pressure > 0.1 Torr           │
                    │ Ch 1 opens Roughing Valve (ACTIVE)│
                    └──────────────────────────────────┘
                                     │
                         < PG1 < 0.1 Torr? >── No ──[ Wait ]
                                     │ Yes
                    ┌──────────────────────────────────┐
                    │ Ch 1 closes Roughing Valve (INACTIVE) │
                    │ Ch 2 (30 s) and Ch 3 (60 s) delays start │
                    └──────────────────────────────────┘
                                     │
                         < Ch 2 delay over? >── No ──[ Wait ]
                                     │ Yes
```

Full Auto Mode   (1)

Full Auto Mode   (1)

Channel 2 opens Foreline Valve (ACTIVE)

Ch 3 delay over? — **No** → Wait

Yes

Channel 3 opens Gate Valve (ACTIVE)
Turbo pumping on main chamber starts

PG1 < 2×10^{-3} Torr? — **No** → Wait

Yes

Auto-Start turns IG1 filament ON

IG1 < 2×10^{-5} Torr? — **No** → Wait

Yes

Channel 6 goes ACTIVE
User is notified that pumpdown is complete

Pumpdown complete

Process Steps

1. The sequence is started by closing the Vent valve manually and switching the Foreline valve (Ch 2) to AUTO mode.

2. Since the pressure on PG1 is at atmosphere (above the Ch 2 setpoint), the Foreline valve automatically closes after 30 seconds (Ch 2 INACTIVE).

3. Once the Foreline Valve closes, switch the Roughing Valve (Ch 1) to AUTO.

4. Since the pressure at PG1 is atmosphere (above the Ch 1 setpoint) the Roughing valve is automatically opened (Ch 1 ACTIVE) and rough pumping of the Main Chamber starts. The Gate valve and the Foreline valve remain safely closed while the chamber pumps down. *At this point the IGC100 automation capabilities take over and no more user involvement will be required.* The Roughing, Foreline and Gate valves are under full automatic control.

5. The pressure in the main chamber drops as it is pumped out through the roughing line. As soon as the pressure on PG1 goes below the cross over value, (0.1 Torr), the Roughing valve is closed (Ch1 INACTIVE), and delays are triggered for the Fore valve (Ch2, 30 seconds) and Gate valve (Ch 3, 60 seconds).

6. After a 30 second delay, the Foreline valve is opened, switching the roughing line to the back of the turbo pump (Ch 2 ACTIVE). The short delay is enough to assure proper stabilization of the roughing line pressure before exposing the turbo pump to the diaphragm pump.

7. After an additional 30 seconds, and once the turbo pump speed has stabilized, the Gate valve opens exposing the main chamber to the turbo pump inlet (Ch 3 ACTIVE).

8. At this point the system starts pumping down towards its 2×10^{-5} Torr target, monitored through channel 6.

9. Once the pressure in the main chamber reaches the 2×10^{-3} Torr value (as measured by PG1), the IG Auto-Start turns on the IG1 filament and pressures are now tracked through the ionization gauge. Note that this does not involve any process control channels.

10. As soon as the main chamber pressure measured by IG1 drops below the 2×10^{-5} Torr target, channel 6 activates and an e-mail message is sent out to the prespecified address list to announce the achievement of base pressure. The process is now completed.

11. Upon completion of pumpdown, it is common practice in this system to switch the Roughing valve (Ch 1) to Manual Control and INACTIVE, so that the Roughing valve remains closed if the Vent valve is accidentally opened. It is also recommended to eliminate the delays from channels 2 and 3 to provide immediate Gate valve and Foreline shutdowns (pressure interlock) in the event of an overpressure.

Process Control Worksheet

Process Name:										
Channel# (Description)	Linked to…	Setpoint (above / below)	Hyst (%) (V)	Delay (sec)	Off-State	E-mail (✓)	Beep (✓)	Active Msg	Inactive Msg	Relay Wiring pin
1										1 (C)
										2 (I)
										3 (A)
2										4 (C)
										5 (I)
										6 (A)
3										7 (C)
										8 (I)
										9 (A)
4										10 (C)
										11 (I)
										12 (A)
5										13 (C)
										14 (I)
										15 (A)
6										16 (C)
										17 (A)
										18 (I)
7										19 (C)
										20 (A)
										21 (I)
8										22 (C)
										23 (I)
										24 (A)

Chapter 6

Memory Card

IGC100 includes a MEMORY CARD module on its front panel. This module consists of a long vertical slot specifically designed to accept a special type of information storage device referred to as Memory Card throughout this manual.

In This Chapter

Introduction
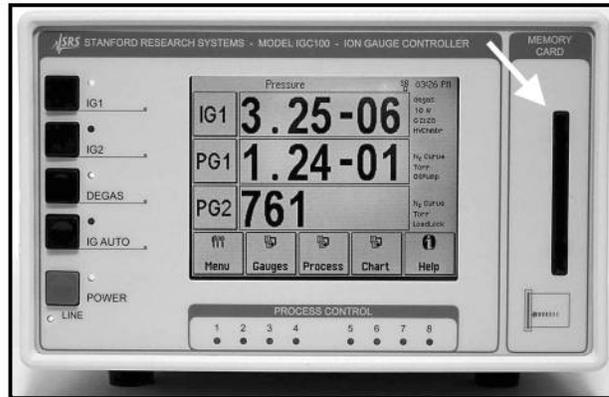
Figure 6-1. Front panel Memory Card module.

There are two kinds of Memory Cards compatible with IGC100:

Calibration Cards

For applications that benefit from gauge-to-gauge reproducibility and the accuracy of calibrated gauges, SRS offers NIST-traceable calibrated ionization gauges through its High-Vacuum Calibration Facility. Full-range calibrations are available with 6% and 3% accuracy. Gauge-specific calibration data, including all relevant controller setup information, is factory loaded into a Memory Card provided with the calibrated gauge. The calibration data is easily uploaded into the controller via the front panel MEMORY CARD module. See Calibration Storage in the IGC100 and Cal Curve Loading sections below for additional details.
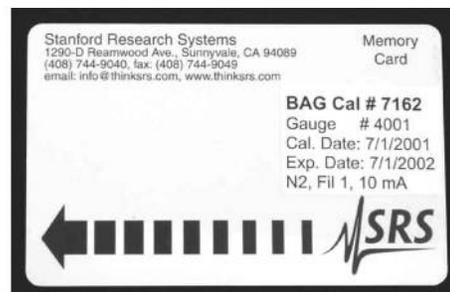
Figure 6-2. Calibration Card.

Password Cards

Security Passwords can be copied into special memory cards known as Password Cards. Password cards make it unnecessary to remember the password in order to unlock a controller. Simply insert the Password Card (preloaded with the current password) into the memory card slot to unlock the controller at any time. The controller returns to the locked state as soon as the card is removed.
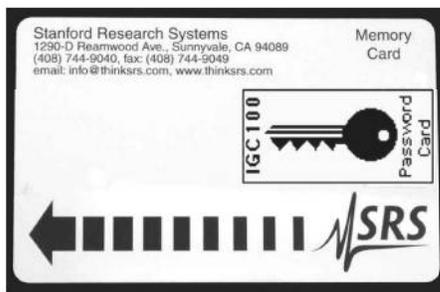
Figure 6-3. Password Cards.

TIP

Three blank Password Cards are provided with every IGC100 controller. Consult the Security Menu section of chapter 3 for details on the security options built into the IGC100 controller.

Calibration Storage in the IGC100

The IGC100 controller has the capability to store in memory a full-range calibration curve and a sensitivity constant (for nitrogen) for each ionization gauge connected to its back panel. An intuitive, front-panel menu selection allows the user to switch effortlessly between the two calibration sources during pressure measurements.

IGC100 users can have their ionization gauges calibrated at the certified SRS High Vacuum Calibration Facility. The BAG response is calibrated below 10^{-3} Torr by comparison against a NIST-traceable secondary standard and the information is stored in a Memory Card that is returned to the user with the gauge. The calibration curve, including all relevant instrument setup information, can then be easily transferred into the controller using the Memory Card Module built into the front panel of the instrument. For details on calibration options consult the Calibration Procedure section of appendix F.

Since all SRS IGC100 instruments offer identical electrical performance, calibrated gauges can be operated from any IGC100 controller without any significant change in the accuracy of the results. For the same reason, the actual IGC100 controller used for real measurements does not need to be present at the SRS High Vacuum Calibration Facility during the calibration procedure.

IGC100 uses full-range calibration data to display accurate pressure readings in real time without the need for pressure-dependent corrections outside the box. The estimated expiration date for the gauge calibration is stored in the memory card and transferred to the controller along with the rest of the calibration header information.

Although in principle it should be possible to calibrate a gauge for one gas and use this calibration for another by simply multiplying by the corresponding gas correction factor, investigations have shown that this is not the case if high accuracy (<10%) is required. Specific calibration for each specific gas is recommended in that case.

Loading a Calibration Curve

The IGC100 controller has the capability to store in memory a full-range calibration curve for each ionization gauge connected to a back panel port (IG1 or IG2).

All calibrated ionization gauges are delivered from the factory with a Memory Card which contains calibration data specific to the gauge. The calibration data stored in a Memory Card is easily transferred into the controller through the MEMORY CARD interface of the front panel using the step-by-step procedure described below:

Step 1. Insert the gauge's Memory Card into the MEMORY CARD slot located on the front panel of the instrument.

Figure 6-4. Insert the card into the controller.

Step 2. Starting from the Pressure Display Screen, touch the [Gauges] QuickKey to access the Gauge Display.
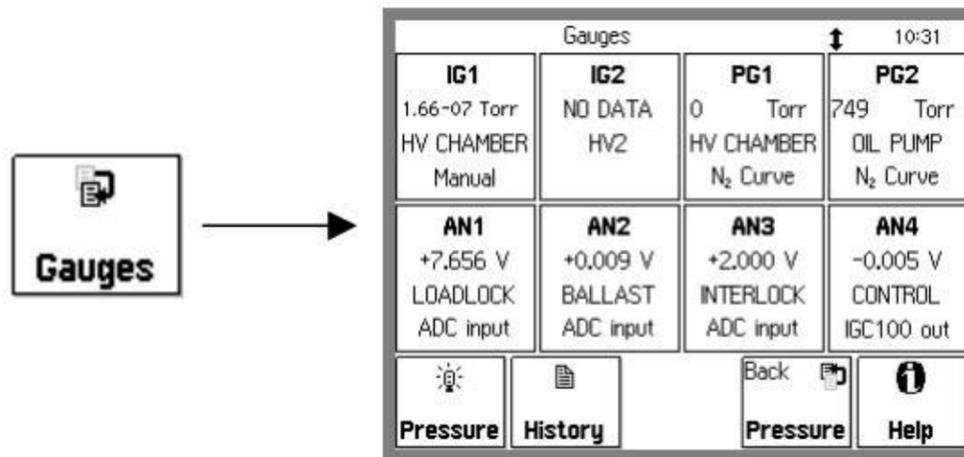

Figure 6-5. Gauge Display.

Step 3. Select the gauge's port (IG1 or IG2) by touching its display button (Data Box). This brings up a Gauge Setup menu for the ionization gauge's port.
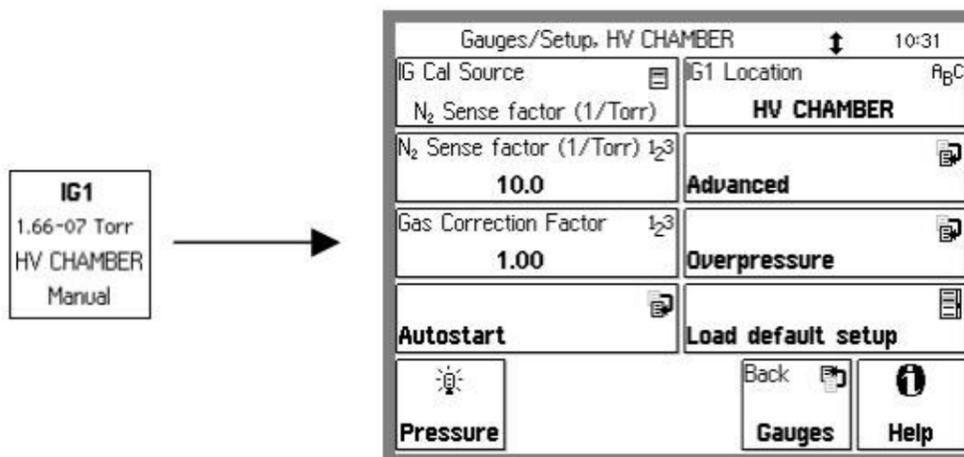

Figure 6-6. Gauge Setup menu.

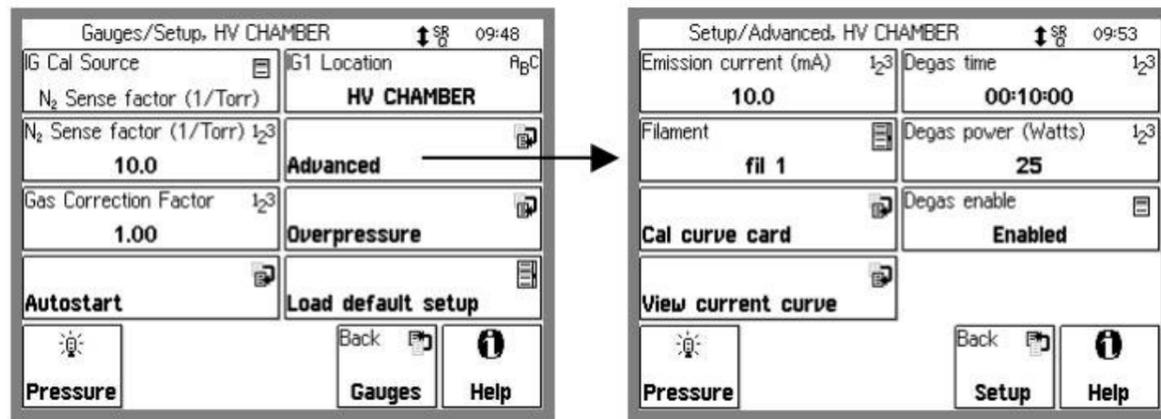Step 4. Touch [Advanced] to display the Advanced submenu for the gauge's port.

Figure 6-7. Advanced Ion Gauge Setup menu.

Step 5. Touch [Cal Curve Card] to display header information for the Calibration data stored in the memory card.

TIP

A preview of the header information stored in the memory card is a very convenient feature designed to eliminate the chances of errors. Check the model and serial numbers of the ionization gauge connected (or to be connected) to the controller against the card's header information before uploading the card's Calibration Data into the controller.
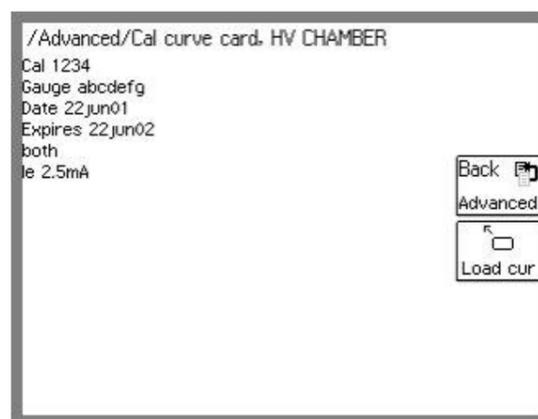

Figure 6-8. Preview the Calibration Card header info.

Step 6. Touch [Load Cur] to transfer the Calibration data into the controller's memory.

Step 7. Pull the Memory Card out of the front panel and store it in a safe place.

Once the calibration data is successfully loaded into the controller, choose Cal Curve as the IG Cal Source in the gauge setup menu of the port, and the IGC100 will automatically be configured to match the setup conditions required for the calibration data.

TIP

Consult appendix F of this manual for details on the ionization gauge calibration options available from the High Vacuum Calibration Facility at Stanford Research Systems.

Password Card Programming

Security Passwords can be copied into special memory cards known as Password Cards using the procedure described below.

IMPORTANT

The security system must be unlocked before using this function. Unlock the security system at this time if necessary . Follow the instructions in the Security Menu section of Chapter 3 to unlock the system.

Step 1. Insert a blank Password Card into the MEMORY CARD module slot.

Step 2. Starting from the Pressure Display Screen, touch the [Menu] QuickKey to access the Main Menu.
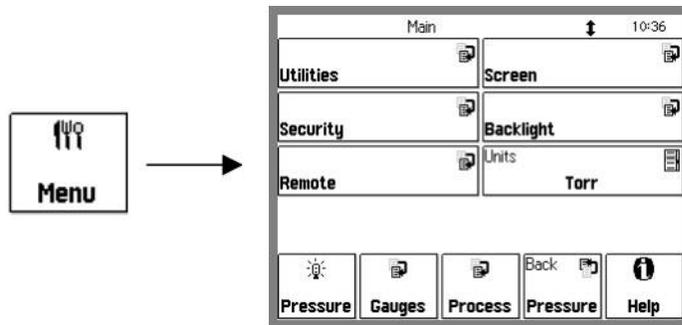
Figure 6-9. Main Menu.

Step 3. Touch [Security] to display the Security submenu.
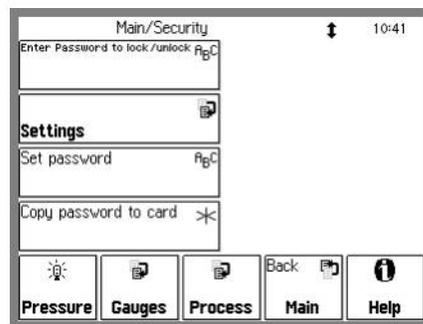
Figure 6-10. Security menu.

Step 4. Touch [Set Password] and enter a new password using the alphanumeric keypad.

Step 5. Touch [Copy Password to card] to store a copy of the password in the memory card (i.e. password card).

Step 6. Remove the card from the MEMORY CARD Slot. The controller reverts to a locked state as soon as the card is removed.

Password cards make it unnecessary to remember the password in order to unlock a controller. Simply insert the Password Card (preloaded with the current password) into the memory card slot to unlock the controller at any time. The controller returns to the locked state as soon as the card is removed. A unit locked after removing a password card can also be unlocked by manually typing the password through the security menu.

Chapter 7

Remote Programming

In This Chapter

Index of Commands

Important

Always use the GPMU command at the start of a program to ensure that the desired units are in effect. Use front panel lockout if a units change would result in system malfunction.

Use VERB 0 to set the RS-232 interface to terse mode for computer programs. Use VERB 1 to use verbose mode for console communications.

Variables

i, j, d, n, p	integers
x	real number
s, t	text strings

Gauges and Measurement

GPMU (?) {n} {s}	7-17	Pressure Units
GPBA (?) n {, i}	7-17	Data Bar Assign
GPDF (?) n {, i}	7-17	Display Format
GDAT ? p	7-18	Read Gauge/Port
GDTX ? p	7-18	Read Gauge/Port With Units
GDES (?) p {, s}	7-18	Gauge Location
GSTA ? p	7-18	Gauge Status
GSTT ? p	7-19	Gauge Status Time

Ion Gauge Setup

GPOW (?) p {, i}	7-20	Power
CSEN (?) p {, x}	7-20	Sensitivity Factor
CGCF (?) p {, x}	7-20	Gas Correction Factor
CRVI (?) p {, i}	7-20	Calibration Source
IGEC (?) p {, x}	7-20	Emission Current
GFIL (?) p {, i}	7-21	Filament Select
GPLV (?) p {, i}	7-21	Gauge Protection
GOSD (?) p (, i}	7-21	Overpressure Shutdown
GOTH (?) p {, x}	7-21	Overpressure Threshold
GODE (?) p {, n}	7-21	Overpressure Delay
GOAA (?) p {, i}	7-22	Overpressure Audio Alarm
DGAS (?) {i}	7-22	Degas On/Off
DENA (?) {i}	7-22	Degas Enable/Disable
DPOW (?) p {, n}	7-22	Degas Power
DTIM (?) p {, x}	7-22	Degas Time
AOPG (?) {i}	7-23	Auto-Start Pirani Gauge
AOIG (?) {i}	7-23	Auto-Start Ion Gauge
AOTH (?) {x}	7-23	Auto-Start Threshold
AOCN (?) {i}	7-23	Auto-Start On/Off
GHGF ?	7-23	Read Gauge History First
GHGN ?	7-23	Read Gauge History Next

Pirani Gauge Setup

GPOW (?) p {, i}	7-24	Power
CGCF (?) p {, x}	7-24	Gas Correction Factor
CRVP (?) n {, i}	7-24	Calibration Curve

Alphabetical List of Commands

Important
Always use the GPMU command at the start of a program to ensure that the desired units are in effect. Use front panel lockout if a units change would result in system malfunction.

Use VERB 0 to set the RS-232 interface to terse mode for computer programs. Use VERB 1 to use verbose mode for console communications.

Variables

i, j, d, n, p	integers
x	real number
s, t	text strings

*

*CLS	7-47	Clear Status
*ESE (?) {i} {, j}	7-49	Standard Event Enable
*ESR ? {i}	7-48	Read Standard Event Status
*IDN ?	7-42	Identification
*OPC (?)	7-42	Operation Complete
*PSC (?) {i}	7-47	Power-On Status Clear
*RST	7-42	Reset
*SRE (?) {i} {, j}	7-48	Serial Poll Enable
*STB ? {i}	7-47	Read Serial Poll Status
*TST ?	7-41	Self-Test
*WAI	7-43	Wait to Continue

A

ANDF (?) n {, i}	7-25	Display Format
AOCN (?) {i}	7-23	Auto-Start On/Off
AOIG (?) {i}	7-23	Auto-Start Ion Gauge
AOPG (?) {i}	7-23	Auto-Start Pirani Gauge
AOTH (?) {x}	7-23	Auto-Start Threshold

B

BLEN (?) {i}	7-37	Backlight Saver Enable
BLIT (?) {i}	7-37	Backlight On/Off
BLOF (?) {n} {s}	7-37	Backlight Turn-Off Time
BLON (?) {n} {s}	7-37	Backlight Turn-On Time
BLTD (?) {n}	7-37	Backlight Delay

C

CGCF (?) p {, x}	7-20	Gas Correction Factor
CGCF (?) p {, x}	7-24	Gas Correction Factor
CMPX (?) n {, x}	7-25	CM PMax
CPWD	7-38	Copy Password to Card
CRVI (?) p {, i}	7-20	Calibration Source
CRVP (?) n {, i}	7-24	Calibration Curve
CSEN (?) p {, x}	7-20	Sensitivity Factor

Introduction

The IGC100 Ion Gauge Controller may be remotely programmed via either the standard RS-232 serial interface or the optional GPIB (IEEE-488) interface. Any computer supporting one of these interfaces may be used to program the IGC100. All installed interfaces are active at all times.

> **WARNING!**
> The VERB command sets the instrument's RS-232 verbosity level. When set to 0 (FALSE), the instrument uses terse return values and error messages for RS-232 computer programs. When set to 1 (TRUE) the instrument uses descriptive return values and error messages for human remote operators. *Set VERB first when connecting to the instrument via RS-232.*

Communicating With RS-232

The IGC100 uses a DIN8 connector for serial communications. Most PC computers use DB9 ports. Use the DIN8-DB9 adapter cable provided with the IGC100 to connect to a PC. The female DB9 connector is configured as a DCE (transmit on pin 2, receive on pin 3) device and supports CTS/DTR hardware handshaking. The CTS signal (pins 1, 6 and 8) is an output indicating that the IGC100 is ready, while the DTR signal (pin 7) is an input that is used to control the IGC100's data transmission. Ground is pin 5. If desired, the handshake pins may be ignored and a simple 3 wire interface (pins 2, 3 and 5) may be used. The RS-232 interface Baud Rate, Word Length, Parity and Flow Control must be set in the Main/Remote/RS-232 menu.

Communicating With GPIB

With Option 01 installed, the IGC100 supports the IEEE-488.1 (1978) interface standard. It also supports the required common commands of the IEEE-488.2 (1987) standard. Before attempting to communicate with the IGC100 over the GPIB interface, the IGC100's Device Address must be set in the Main/Remote/GPIB menu.

Screen Indicators And Queues

To assist in programming, the IGC100 has an interface activity indicator displayed in the upper right corner of the screen (next to the time). The arrow symbol ↕ flashes whenever there is interface activity (transmit or receive). The **X** symbol indicates a computer interface error has occurred, such as an illegal command or out of range parameter is received. The **SRQ** indicator is on when the IGC100 generates a GPIB service request. **SRQ** stays on until a GPIB serial poll is completed.

To help find program errors, the IGC100 can display the interface buffers on the screen. This screen is accessed by touching [Queue] in the Main/Remote/RS-232 or GPIB menus. The Queue display may slow down communications and should be displayed only when testing or debugging a host program. Press a QuickKey to exit from this display.

The upper half of the Queue display is the Receive Queue. These are the most recent characters which have been received by the IGC100 (displayed in all UPPER case). Commands which have already been executed are shown in normal text. Commands which have not yet been executed are shown with a gray background. Command errors are shown in inverse text.

The lower half of the Queue display is the Transmit Queue. These are the most recent characters which have been placed in the output buffer. Characters which have already been sent over the interface are shown in normal text. Characters which are waiting to be sent are shown with a gray background.

Command Format

Communications with the IGC100 uses ASCII characters. Commands may be in either UPPER or lower case. A command to the IGC100 consists of a four character command mnemonic with optional ?, arguments if necessary, and a command terminator. The command, arguments and terminator may be separated by spaces. The terminator must be a linefeed <lf> or carriage return <cr> on RS-232, or a linefeed <lf> or EOI on GPIB. No command processing occurs until a terminator is received. Commands function identically on GPIB and RS-232 whenever possible. Command mnemonics beginning with an asterisk '*' are IEEE-488.2 (1987) defined common commands. These commands also function identically on RS-232 whenever possible. Commands may require one or more parameters. Multiple parameters are separated by commas (,).

Multiple commands may be sent on one command line by separating them with semicolons (;). In this case, no commands are executed until a terminator is received.

There is no need to wait between commands. The IGC100 has a 256 character input buffer and processes commands in the order received. If the buffer fills up, the IGC100 will hold off handshaking on the GPIB and attempt to hold off handshaking on RS-232. Similarly, the IGC100 has a 256 character output buffer to store output until the host computer is ready to receive it. If either buffer overflows, both buffers are cleared and an error reported.

The present value of a particular parameter may be determined by querying the IGC100 for its value. A query is formed by appending a question mark '?' to the command mnemonic and omitting the desired parameter from the command. Values returned by the IGC100 are sent as a string of ASCII characters terminated by a carriage return <cr> on RS-232 and by a line-feed <lf> on GPIB. If multiple query commands are sent on one command line (separated by semicolons, of course), the answers will be returned individually, each with a terminator.

Examples of Commands

GADM 4, 1 <lf>	Set Analog Port 4 to DAC output mode
GADM? 4 <lf>	Query the mode of Analog Port 4
GDAT? 1 <lf>	Query the reading of IG1
*IDN ? <lf>	Query the Device Identification String

Command Synchronization

IFC (Interface Ready, bit 7) in the Serial Poll status signals that the IGC100 is ready to receive and execute a command. When a command is received, this bit is cleared, indicating that command execution is in progress. No other commands will be processed until this command is completed. Commands received during this time are stored in the buffer to be processed later. Only GPIB serial polling will generate a response while a command is in progress. When all pending commands have executed, the IFC bit is set again. By checking IFC with serial polls, a host computer can ensure that all previously sent commands have finished before sending a new command.

Since most commands execute very quickly, the host computer does not need to continually check the IFC bit. Commands may be sent one after another and they will be processed immediately.

However, some commands, such as memory card and data transfer operations, may require a long time to execute. In addition, the host program may need to check that these operations executed without error. In these cases, after the command is sent, the status should be queried.

When using the GPIB interface, serial polling may be used to check the IFC bit in the Serial Poll status while an operation is in progress. After the IFC bit becomes set, signaling the completion of the command, then the ESB (Event Status) bit may be checked to verify successful completion of the command.

If the RS-232 interface is used, or serial polling is not available, then the *STB? query command may be used to read the Serial Poll status word. However, *STB *NEVER* returns the IFC bit set (since *STB is itself a command).

Since the IGC100 processes one command at a time, status queries will not be processed until the previous operation is finished. Thus a response to a status query in itself signals that the previous command is finished. The query response may then be checked for various errors.

Command Syntax

The four letter mnemonic (shown in CAPS) in each command sequence specifies the command. The rest of the sequence consists of parameters. Parameters shown in { } are not always required. Generally, parameters in { } are required to set a value in the IGC100. Multiple parameters are separated by commas. Multiple commands may be sent on one command line by separating them with semicolons (;).

The present value of a parameter may be determined by sending a query command.

- Commands that MAY be queried show a question mark in parentheses (?) after the mnemonic.

- Commands that are ONLY queries have a '?' after the mnemonic, with no parentheses.

- Commands that MAY NOT be queried have no '?'.

A query is formed by including the question mark ? after the command mnemonic and omitting the queried parameter from the command. The query parameters shown in { } are NOT sent with a query. The query returns the value of these parameters. Values are returned as a string of ASCII characters (unless otherwise noted).

Do NOT send ( ) or { } as part of the command.

For example, the command sequence GADM (?) i {, j} is used as follows.

> GADM 1, 0   Set the Analog Port 1 to ADC Input mode.
> GADM ? 1   Query the mode of Analog Port 1.

Variables are defined as follows.

> i, j, d, n, p   integers
> x   real number
> s, t   text strings

Commands to set values which may be different for each port require the p parameter. These values must be queried separately for each port.

All numeric variables may be expressed in integer, floating point or exponential formats (i.e. the number five can be either 5, 5.0, or 0.5E1). Strings are sent as a sequence of ASCII characters.

Pressure Units

The entire IGC100 operates with a **SINGLE** units system. All commands that query or set pressure parameters use the global units system of the IGC100. The units may be changed in the Main Menu or with the GPMU command.

For example, if the IGC100 units are Torr, all commands that query pressures will return values in Torr. All commands that set pressures must send values in Torr.

All pressure parameters have minimum and maximum allowed values. These values are converted to the current units and may not be exceeded in a command. These limits are displayed in the entry screen when entering new values from the front panel.

WARNING!

Always use the GPMU command at the start of a program to ensure that the desired units are in effect. Use the Local Access Security feature if a units change would result in system malfunction. See Chapter 3 (Security Menu) for details.

Gauge and Measurement Commands

GPMU (?) {n} {s}	**Pressure Units**

The GPMU command sets (queries) the system pressure units. The parameter n selects the units system below, or use string s ("micron", "bar", etc.). Do not use both n and s.

n	units
0	Torr
1	micron
2	bar
3	mbar
4	Pascal

Example

GPMU?	Returns the pressure units n.
GPMU 1	Sets the pressure units to microns.
GPMU pascal	Sets the pressure units to Pascal.

GPBA (?) n {, i}	**Data Bar Assign**

The GPBA command sets (queries) the Data Bar assignments in the Pressure Display (Port ID). The parameter n selects Upper (0), Middle (1) or Lower (2) Data Bar and is required. The parameter i selects a signal port below.

i	port	i	port	i	port
1	IG	4	CM1	8	AN1
2	PG1	5	CM2	9	AN2
3	PG2	6	CM3	10	AN3
		7	CM4	11	AN4

Example

GPBA? 0	Returns the Port ID i of the upper Data Bar.
GPBA 2, 3	Sets the lower Data Bar to PG2.

GPDF (?) n {, i}	**Display Format**

The GPDF command sets (queries) the Display Format of a Data Bar. The parameter n selects Upper (0), Middle (1) or Lower (2) Data Bar and is required. The parameter i selects a Display Format below.

i	format
0	Big Numbers
1	Trend Graph
2	Auto Scaling Bar Graph
3	Full Range Bar Graph
4	Gauge Status Information

Example

GPDF? 0	Returns the display format i of the upper Data Bar.
GPDF 2, 3	Sets the lower Data Bar to Full Scale Bar Graph.

GDAT ? p	**Read Gauge/Port**

The GDAT? query returns the reading from port p in the current units. The parameter p selects a signal port below and is required.

p	port	p	port	p	port
1	IG1	5	CM1	9	AN1
2	IG2	6	CM2	10	AN2
3	PG1	7	CM3	11	AN3
4	PG2	8	CM4	12	AN4

The returned string has the form "1.00" with current units implied.

Example

GDAT? 1   Returns the reading of IG1 in the current units.

GDTX ? p	**Read Gauge/Port With Units**

The GDTX? query returns the reading from port p with units. The parameter p selects a signal port below and is required.

p	port	p	port	p	port
1	IG1	5	CM1	9	AN1
2	IG2	6	CM2	10	AN2
3	PG1	7	CM3	11	AN3
4	PG2	8	CM4	12	AN4

The returned string has the form "1.00   micron".

Example

GDTX? 1   Returns the reading of IG1 *with* the current units.

GDES (?) p {, s}	**Gauge Location**

The GDES command sets (queries) the Gauge (Port) Location string. The parameter p selects a gauge port below and is required. The string s is the location name.

p	port	p	port	p	port
1	IG1	5	CM1	9	AN1
2	IG2	6	CM2	10	AN2
3	PG1	7	CM3	11	AN3
4	PG2	8	CM4	12	AN4

Example

GDES 3, pump   Sets the location name of PG1 to "PUMP".
GDES? 3   Returns the location name of PG1 ("PUMP" in this case).

GSTA ? p	**Gauge Status**

The GSTA? query returns the status of gauge port p. The parameter p selects a gauge port below and is required.

p	port	p	port	p	port
1	IG1	5	CM1	9	AN1
2	IG2	6	CM2	10	AN2
3	PG1	7	CM3	11	AN3
4	PG2	8	CM4	12	AN4

The returned value is an integer n described below.

n	description
0	The gauge is operating normally.

Values greater than 1 – gauge/port may still operate.

2	The gauge reading is underrange.
3	The gauge reading is overrange.
4	The gauge reading is not yet accurate.
5	There is no data from the gauge.

Values greater than 6 – gauge displays no data.

7	ADC is overloaded.
8	The A/D is in DAC output mode. CM gauge not running.
9	No Pirani gauge detected.

Values greater than 10 – gauge shuts down.

11	There is no data to display.
12	The Pirani gauge is off.
13	All ion gauges are off.
14	No IG filament is detected.
15	Auto-Start PG is off.

Values greater than 16, IG Auto-Start turned off.

17	An IG overpressure condition occurred.
18	The controller cannot establish IG emission current.
19	A TTL port was used to turn the gauge off.
20	The controller detected a fault.
21	There is no hardware to run the gauge.

See the GSTT? command.

Example

GSTA? 1   Returns 0 if IG1 is operating normally.

GSTT ? p

Gauge Status Time

The GSTT? query returns the time and date that gauge p last changed status. The parameter p selects a gauge port below and is required.

p	port	p	port	p	port
1	IG1	5	CM1	9	AN1
2	IG2	6	CM2	10	AN2
3	PG1	7	CM3	11	AN3
4	PG2	8	CM4	12	AN4

See the GSTA? command.

Example

GSTT? 1   Returns a string of the form "10:22 AM 22may01".

Ion Gauge Setup Commands

GPOW (?) p {, i}	**Power**

The GPOW command sets (queries) the power state for gauge port p. The parameter p selects IG1 (1), IG2 (2), PG1 (3) or PG2 (4) and is required. The parameter i selects ON (1) or OFF (0).

Note
IG1 and IG2 can not be on simultaneously.

Example
GPOW? 1   Returns 1 if IG1 is on, 0 if IG1 is off.
GPOW 1, 1   Turns on IG 1.

CSEN (?) p {, x}	**N2 Sensitivity Factor**

The CSEN command sets (queries) the N2 Sensitivity Factor for ion gauge p. The parameter p selects IG1 (1) or IG2 (2) and is required. The parameter x is the Sensitivity Factor in $Torr^{-1}$.

Example
CSEN? 2   Returns the N_2 Sensitivity Factor x of IG2 in $Torr^{-1}$.
CSEN 1, 10.0   Sets the IG1 N_2 Sensitivity Factor to 10.0 $Torr^{-1}$.

CGCF (?) p {, x}	**Gas Correction Factor**

The CGCF command sets (queries) the Gas Correction Factor for gauge p. The parameter p selects IG1 (1), IG2 (2), PG1 (3) or PG2 (4) and is required. The parameter x is the Gas Correction Factor (unitless).

Example
CGCF? 2   Returns the Gas Correction Factor x of IG2.
CGCF 1, 2.0   Sets the IG1 Gas Correction Factor to 2.0.

CRVI (?) p {, i}	**Calibration Source**

The CRVI command sets (queries) the Cal Source for ion gauge p. The parameter p selects IG1 (1) or IG2 (2) and is required. The parameter i selects N_2 Sense Factor (0) or Cal Curve (1).

Example
CRVI? 2   Returns the Cal Source i of IG2.
CRVI 1, 0   Sets the IG1 Cal Source to N_2 Sense Factor.

IGEC (?) p {, x}	**Emission Current**

The IGEC command sets (queries) the Emission Current of ion gauge port p. The parameter p selects IG1 (1) or IG2 (2) and is required. The parameter x is the emission current (milliamps) from 0.01 to 12.0.

Example
IGEC? 2   Returns the Emission Current x of IG2 in mA.
IGEC 1, 1.00   Sets IG1 Emission Current to 1.00 mA.

GFIL (?) p {, i}	**Filament Select**

The GFIL command sets (queries) the Filament of ion gauge p. The parameter p selects IG1 (1) or IG2 (2) and is required. The parameter i selects Filament 1 (0), Filament 2 (1) or Both (2).

Example

GFIL? 1	Returns the filament i of IG1.
GFIL 2, 0	Sets IG2 to use Filament 1.

GPLV (?) p {, i}	**Gauge Protection**

The GPLV command sets (queries) the Gauge Protection of ion gauge p. The parameter p selects IG1 (1) or IG2 (2) and is required. The parameter i selects Normal (0) or Micro-Ion (1).

Example

GPLV? 1	Returns the protection level i of IG1.
GPLV 2, 1	Sets the protection of IG2 to Micro-Ion.

GOSD (?) p (, i}	**Overpressure Shutdown**

The GOSD command sets (queries) the Overpressure Shutdown of ion gauge p. The parameter p selects IG1 (1) or IG2 (2) and is required. The parameter i selects Disabled (0) or Enabled (1).

Example

GOSD? 1	Returns Overpressure Shutdown mode i of IG1.
GOSD 1, 1	Enables Overpressure Shutdown for IG1.

GOTH (?) p {, x}	**Overpressure Threshold**

The GOTH command sets (queries) the Overpressure Threshold of ion gauge p. The parameter p selects IG1 (1) or IG2 (2) and is required. The parameter x is the Overpressure Threshold expressed in the current system units.

Example

GOTH? 1	Returns the Overpressure Threshold for IG1 in the current units.
GOTH 1, 1.2E-3	Sets the Threshold of IG1 to 0.0012 in the current units.

GODE (?) p {, n}	**Overpressure Delay**

The GODE command sets (queries) the Overpressure Delay of ion gauge p. The parameter p selects IG1 (1) or IG2 (2) and is required. The parameter n is the Overpressure Delay in milliseconds.

Note

Times are stored in milliseconds, but this timer is only accurate to within a second.

Example

GODE? 1	Returns the Overpressure Delay for IG1 in ms.
GODE 1, 60000	Sets the Delay of IG1 to 1 minute (60,000 ms).

GOAA (?) p {, i}	**Overpressure Audio Alarm**

The GOAA command sets (queries) the Overpressure Audio Alarm mode for ion gauge p. The parameter p selects IG1 (1) or IG2 (2) and is required. The parameter i selects Off (0) or On (1).

Example

GOAA? 1	Returns the Audio Alarm mode i for IG1.
GOAA 1, 1	Turns IG1 Audio Alarm On.

DGAS (?) {i}	**Degas On/Off**

The DGAS i command turns Degas On (i=1) or Off (i=0). An ion gauge must be on for degas to turn on. In a dual ion gauge system, whichever ion gauge is on is degassed. Degas will not turn on unless the pressure is below $2x10^{-5}$ Torr. DGAS? queries whether degas is on or off.

Degas will not turn on until the ion gauge is on and stabilized. Do not issue the DGAS 1 command immediately after turning a gauge on. Wait until the pressure readings have stabilized.

Example

DGAS?	Returns 1 if Degas is on, 0 if Degas is off.
DGAS 1	Turns Degas on for the active ion gauge.

DENA (?) {i}	**Degas Enable/Disable**

The DENA i command Enables Degas (i=1) or Disables Degas (i=0). When disabled, degas cannot be turned on from the front panel or remote command. DENA? queries whether degas is enabled or disabled.

Example

DENA?	Returns 1 if Degas is enabled, 0 if Degas is disabled.
DENA 1	Enables Degas.

DPOW (?) p {, n}	**Degas Power**

The DPOW command sets (queries) the Degas Power for ion gauge p. The parameter p selects IG1 (1) or IG2 (2) and is required. The parameter n is an integer number of Watts.

Example

DPOW? 1	Returns the Degas Power for IG1 in Watts.
DPOW 1, 20	Sets the Degas Power for IG1 to 20 Watts.

DTIM (?) p {, x}	**Degas Time**

The DTIM command sets (queries) the Degas Time for ion gauge p. The parameter p selects IG1 (1) or IG2 (2) and is required. The parameter n is the Degas Time in milliseconds.

Note

Times are stored in milliseconds, but this timer is only accurate to within a second.

Example

DTIM?	Returns the Degas Time in ms.
DTIM 1, 600000	Sets the IG1 Degas Time to 10 minutes (600,000 ms).

AOPG (?) {i}	**Auto-Start Pirani Gauge**

The AOPG command sets (queries) the Auto-Start Pirani Gauge. The parameter i selects PG1 (0) or PG2 (1).

Example
AOPG?	Returns the IG1 Auto-Start Pirani Gauge i.
AOPG 0	Sets the IG1 Auto-Start Pirani Gauge to PG1.

AOIG (?) {i}	**Auto-Start Ion Gauge**

The AOIG command sets (queries) the Auto-Start Ion Gauge. The parameter i selects IG1 (0) or IG2 (1). This is the ion gauge which will auto-start when the Auto-Start Pirani Gauge pressure is below threshold.

Example
AOIG?	Returns Auto-Start Ion Gauge i.
AOIG 0	Sets the Auto-Start Ion Gauge to IG1.

AOTH (?) {x}	**Auto-Start Threshold**

The AOTH command sets (queries) the Auto-Start Threshold. The parameter x is the Auto-Start Threshold expressed in the current system units.

Example
AOTH?	Returns the Auto-Start Threshold for IG1 in the current units.
AOTH 1.2E-3	Sets the Auto-Start Threshold of IG1 to 0.0012 in the current units.

AOCN (?) {i}	**Auto-Start On/Off**

The AOCN i command turns Ion Gauge Auto-Start On (i=1) or Off (i=0). When Auto-Start is On, the IG AUTO LED is on. AOCN? queries whether IG Auto-Start is on or off.

Example
AOCN?	Returns 1 if Auto-Start is on, 0 if off.
AOCN 1	Turns IG Auto-Start On.

GHGF ? **GHGN ?**	**Read Gauge History**

The IGC100 logs all ion gauge events in the Gauges/History. To read the log, use the GHGF? query to return the most recent entry in the log. Then issue GHGN? repeatedly to get the rest of the entries, until the string "&" is returned, signaling that all entries have been read.

This command pair retrieves the history as it was when the GHGF? command was received. Log entries created while you download the log do not appear in it. If you try to retrieve history over two interfaces at the same time you will not get the complete history on either.

The returned string is in CSV spreadsheet format, "<date>, <time>, <event description>".

Example
GHGN?	Returns a string of the form: "01jan01, 06:22 AM, Instrument turned on"

Pirani Gauge Setup Commands

GPOW (?) p {, i}   **Power**

The GPOW command sets (queries) the power state for gauge port p. The parameter p selects IG1 (1), IG2 (2), PG1 (3) or PG2 (4) and is required. The parameter i selects ON (1) or OFF (0).

Example
GPOW? 3   Returns 1 if PG1 is on, 0 if PG1 is off.
GPOW 3, 1   Turns on PG1.

CGCF (?) p {, x}   **Gas Correction Factor**

The CGCF command sets (queries) the Gas Correction Factor for gauge p. The parameter p selects IG1 (1), IG2 (2), PG1 (3) or PG2 (4) and is required. The parameter x is the Gas Correction Factor (unitless).

Example
CGCF? 3   Returns the Gas Correction Factor x of PG1.
CGCF 3, 2.0   Sets the PG1 Gas Correction Factor to 2.0.

CRVP (?) n {, i}   **Calibration Curve**

The CRVP command sets (queries) the Cal Source for Pirani gauge n. The parameter n selects PG1 (1) or PG2 (2) and is required. The parameter i selects N_2 Curve (0) or Ar Curve (1).

Example
CRVP? 2   Returns the Cal Source i of PG2.
CRVP 1, 0   Sets the PG1 Cal Source to N_2 Curve.

Analog Port Setup Commands

GADM (?) n {, i}	**I/O Mode**
	The GADM command sets (queries) the I/O Mode of analog port n. The parameter n (1-4) selects AN1-AN4 and is required. The parameter i selects ADC Input (0) or DAC Output (1).

Example

GADM? 4	Returns the AN4 I/O Mode i.
GADM 4, 1	Sets AN4 into DAC Output mode.

GDAS (?) n {, i}	**DAC Source**
	The GDAS command sets (queries) the DAC Source for analog port n. The parameter n (1-4) selects AN1-AN4 and is required. The parameter i selects Manual (0), IG1 (1), IG2 (2), PG1 (3) or PG2 (4).

Example

GDAS? 1	Returns the AN1 DAC Source i.
GDAS 1, 2	Sets the AN1 DAC Source to IG2.

ANDF (?) n {, i}	**Display Format**
	The ANDF command sets (queries) the AN Display Format for analog port n. The parameter n (1-4) selects AN1-AN4 and is required. The parameter i selects CM (0) or ADC (1).

Example

ANDF? 1	Returns the AN1Display Format i.
ANDF 1, 0	Sets the AN1 Display Format to CM.

GDAV (?) n {, x}	**Output Value**
	The GDAV command sets (queries) the DAC output value for analog port n. This is the output voltage when the analog port is a DAC Output and the DAC Source is Manual. The parameter n (1-4) selects AN1-AN4 and is required. The parameter x is an output voltage (in Volts).

Example

GDAV? 1	Returns the AN1 DAC output value in Volts.
GDAV 1, 2.5	Sets the AN1 DAC output value to 2.5 V.

CMPX (?) n {, x}	**CM PMax**
	The CMPX command sets (queries) the Maximum Pressure (Pmax) of capacitance manometer n (1-4 for CM1-4). The parameter x is the pressure Pmax in the current units.

Example

CMPX 1, 100.0	Set Pmax of CM1 to 100.0 in the current units.
CMPX? 1	Return the value of Pmax for CM1 in the current units.

Logging Commands

PLDS (?) {i}	**Chart/Table Display**

The PLDS command sets (queries) the Log Default Display to Chart (i=0) or Table (i=1).

Example
PLDS 0   Sets the log display to Chart.

PLCL	**Clear Data Log**

The PLCL command clears the Data Log. All entries in the Data Log are lost after sending the PLCL command.

PLGF ? **PLGN ?**	**Read Data Log**

The IGC100 logs all gauge readings in the Data Log. To read the log, use the PLGF? query to return the most recent entry in the log. Then issue PLGN? repeatedly to get the rest of the entries, until the string "&" is returned, signaling that all entries have been read.

This command pair retrieves the log as it was when the PLGF? command was received. Log entries created while you download the log do not appear in it. If you try to retrieve history over two interfaces at the same time you will not get the complete history on either.

WARNING!
The Embedded Web Server continually issues PLGF and PLGN. If you have the web server option, you must disable it (from the Remote/Web menu or with the WSEN command) to use these commands.

These commands return a string with the following fields separated by commas:

- Date in format "30oct01".
- Time in format "06:42 PM".
- IG1 data.
- IG2 data.
- PG1 data.
- PG2 data.
- CM1 data.
- CM2 data.
- CM3 data.
- CM4 data.
- AN1 data.
- AN2 data.
- AN3 data.
- AN4 data.

- Process control bitfield. The first digit is channel 8, the last digit is channel 1. A '1' means the channel is active, '0' means inactive.
- TTL input bitfield. The first digit is channel 8, the last digit is channel 1. A '1' means the input is high, '0' means low.

Data that isn't available shows up as an asterix '*'.

All pressure readings are expressed in the current units. All ADC inputs are in Volts.

Example
The returned string

"30oct01,06:42 PM,1.64-06,*,*,2.34-01,*,*,*,*,0.046,7.34,-0.029,-0.029, 00000100,1111111"

has the following interpretation:

- This data was sampled at 6:42 PM on October 30, 2001.
- IG1 read 1.64e-6 in the current units.
- IG2 and PG1 were off (no data available).
- PG2 read 2.34e-1 in the current units.
- All capacitance manometers were off.
- AN1 read 0.046V.
- AN2 read 7.34 V.
- AN3 and 4 read –0.029 V
- Process control channel 3 is active, all others are inactive.
- All Process TTL inputs are high (inactive).

PLIN (?) {n}   **Logging Interval**

The PLIN command sets (queries) the Logging Interval. The parameter n is the Logging Interval in milliseconds. This command will change the Log Length as well.

Note
Times are stored in milliseconds, but this timer is only accurate to within a second.

Examples
PLIN?	Returns the Logging Interval n in ms.
PLIN 60000	Sets the Logging Interval to 1 minute (60,000 ms).

PLWT (?) {n}   **Log Length**

The PLWT command sets (queries) the Log Length. The parameter n is the Log Length in seconds. This command will change the Logging Interval.

Examples
PLWT?	Returns the Log Length n in seconds.
PLWT 3600	Sets the Log Length to 1 hours (3600 sec).

PLEN (?) {i}	**Logging Enable**

The PLEN command sets (queries) whether Data Logging is enabled. The parameter i selects Log/Enabled (1) or Pause/Disabled (0).

Examples

PLEN?	Returns 1 if logging is enabled, 0 if disabled.
PLEN 1	Turns data logging on.

PLDD (?) {i}	**Display Date**

The PLDD command sets (queries) whether Date Display (in Table display format) is Enabled (i=1) or Disabled (i=0).

Examples

PLDD?	Returns 1 if Date Display is enabled, 0 if disabled.
PLDD 1	Turns Date Display on.

PLTR (?) {i}	**TTL Reset Enable**

The PLTR command sets (queries) whether the TTL Log Reset input is Enabled (i=1) or Disabled (i=0).

Examples

PLTR?	Returns 1 if TTL Log Reset input is enabled, 0 if disabled.
PLTR 1	Enables TTL Log Reset input.

Charting Commands

LCPN (?) {x}   **Pmin**

The LCPN command sets (queries) the value of the Chart Y-Axis Pmin. The parameter x is a pressure expressed in the current units.

Examples
LCPN?   Returns the value of Pmin in the current pressure units.
LCPN 1.3e-10   Sets Pmin to 1.3×10^{-10} in the current units..

LCPX (?) {x}   **Pmax**

The LCPX command sets (queries) the value of the Chart Y-Axis Pmax. The parameter x is a pressure expressed in the current units.

Examples
LCPX?   Returns the value of Pmax in the current pressure units.
LCPX 1.3e-6   Sets Pmax to 1.3×10^{-6} in the current units.

LCVN (?) {x}   **Vmin**

The LCVN command sets (queries) the value of the Chart Y-Axis Vmin. The parameter x is expressed in Volts.

Examples
LCVN?   Returns the value of Vmin in Volts.
LCVN −10.0   Sets Vmin to -10.0 Volts.

LCVX (?) {x}   **Vmax**

The LCVX command sets (queries) the value of the Chart Y-Axis Vmax. The parameter x is expressed in Volts.

Examples
LCVX?   Returns the value of Vmax in Volts.
LCVX 10.0   Sets Vmax to +10.0 Volts.

LCSA   **Autoscale Y-Axis**

The LCSA command Autoscales the Chart Y-Axis. This command has no effect unless the chart display is on the screen. This command has no parameters and no query.

LCRG (?) {n}   **Time Range**

The LCRG command sets (queries) the Chart X-Axis Time Range. The parameter n is a number of seconds.

Examples
LCRG?   Returns the X-Axis Time Range in seconds.
LCRG 600   Sets the X-Axis Time Range to 10 minutes (600 s).

LCSF **Scale X-Axis to Full**

The LCSF command Scales the X-Axis to Full. This sets Time Range to display all of the data in the log. This command has no effect unless the chart display is on the screen. This command has no parameters and no query.

Process Control Commands

These commands require the Process Control Option installed in the IGC100.

RDES (?) d {, s}   **Channel Description**

The RDES command sets (queries) the process channel Description string. The parameter d selects a process channel (1-8) and is required. The string s is the channel description.

Example

RDES 3, pump	Sets the Description of process channel 3 to "PUMP".
RDES? 3	Returns the Description of channel 3 ("PUMP" in this case).

RLCL (?) d {, s}   **Channel Active Message**

The RLCL command sets (queries) the process channel Active Message. The parameter d selects a process channel (1-8) and is required. The string s is the label.

Example

RLCL 1, on	Sets the Active Label of process channel 1 to "ON".
RLCL? 1	Returns the Active Label of channel 1 ("ON" in this case).

RLOP (?) d {, s}   **Channel Inactive Message**

The RLOP command sets (queries) the process channel Inactive Message. The parameter d selects a process channel (1-8) and is required. The string s is the label.

Example

RLOP 1, off	Sets the Inactive Label of process channel 1 to "OFF".
RLOP? 1	Returns the Inactive Label of channel 1 ("OFF" in this case).

RBEP (?) d {, i}   **Channel Beep**

The RBEP command sets (queries) whether the Beep (channel audio alert) is On (i=1) or Off (i=0). The parameter d selects a process channel (1-8) and is required.

Example

RBEP? 1	Returns 1 if channel 1 Beep is on, 0 if off.
RBEP 1, 1	Turns channel 1 Beep on.

RMOD (?) d {, i}   **Channel Mode**

The RMOD command sets (queries) whether the mode of process channel d is Auto (i=1) or Manual (i=0). The parameter d selects a process channel (1-8) and is required. If the channel is Auto, its state is controlled by its process rules. If the channel is Manual, use the RSTA to set the channel state active or inactive.

Example

RMOD? 2	Returns 1 if channel 2 is Auto, 0 if Manual.
RMOD 2, 1	Sets channel 2 to Auto mode.

RSTA (?) d {, i}	**Channel State**

The RSTA command sets (queries) the state of process channel d when its mode is Manual. The parameter d selects a process channel (1-8) and is required. The parameter i selects Inactive (0) or Active (1). This command requires that channel d is in Manual mode (RMOD command).

Example

RSTA? 7	Returns 0 if channel 7 is Inactive, 1 if Active.
RSTA 7, 0	Deactivates process control channel 7.

RAMS (?) d {, i}	**Channel Input**

The RAMS command sets (queries) the process control input (channel Linked To) for process channel d. The parameter d selects a process channel (1-8) and is required. The parameter i selects a control input below.

i	input
0	IG1
1	IG2
2	PG1
3	PG2
4	CM1
5	CM2
6	CM3
7	CM4
8	AN1
9	AN2
10	AN3
11	AN4
12	CLOCK
13	TTL PIN
14	ANY IG EMISSION
15	IG1 EMISSION
16	IG2 EMISSION

Examples

RAMS? 2	Returns the control input i for process channel 2.
RAMS 2, 3	Sets the control input for channel 2 to PG2.

RGOS (?) d {, i}	**Gauge Off State**

The RGOS command sets (queries) the Gauge Off State for process channel d. The parameter d selects a process channel (1-8) and is required. The parameter i selects Inactive (0) or Active (1).

Example

RGOS? 2	Returns 1 if channel 2 Gauge Off State is Active, 0 if Inactive.
RGOS 2, 1	Sets channel 2 Gauge Off State to Active.

RTRP (?) d {, x}	**Pressure Setpoint**

The RTRP command sets (queries) the Pressure Setpoint for process channel d. The parameter d selects a process channel (1-8) and is required. The parameter x is the Pressure Setpoint expressed in the current units.

Example

RTRP? 8	Returns the Pressure Setpoint for channel 8 in the current units.
RTRP 8, 1.0e-3	Sets the Pressure Setpoint for channel 8 to 1.0×10^{-3} in the current units.

RTRV (?) d {, x}	**Voltage Setpoint**

The RTRV command sets (queries) the Voltage Setpoint for process channel d. The parameter d selects a process channel (1-8) and is required. The parameter x is the Voltage Setpoint in Volts.

Example

RTRP? 8	Returns the Voltage Setpoint for channel 8 in Volts.
RTRP 8, 5.2	Sets the Voltage Setpoint for channel 8 to 5.2 V.

RPHY (?) d {, n}	**Percent Hysteresis**

The RPHY command sets (queries) the Percent Hysteresis for process channel d. The parameter d selects a process channel (1-8) and is required. The parameter n is the hysteresis percentage.

Example

RPHY? 8	Returns the hysteresis percentage for channel 8.
RPHY 8, 10	Sets the Setpoint Hysteresis for channel 8 to 10%.

RVHY (?) d {, x}	**Voltage Hysteresis**

The RVHY command sets (queries) the Voltage Hysteresis for process channel d. The parameter d selects a process channel (1-8) and is required. The parameter x is the hysteresis voltage.

Example

RVHY? 8	Returns the hysteresis percentage for channel 8.
RVHY 8, 1.2	Sets the Voltage Hysteresis for channel 8 to 1.2V.

RPOL (?) d {, i}	**Setpoint Activation**

The RPOL command sets (queries) the Setpoint Activation for process channel d. The parameter d selects a process channel (1-8) and is required. The parameter i selects Active Below (0) or Above (1).

Example

RPOL? 6	Returns 1 if channel 6 is active Above, 0 if Below.
RPOL 6, 1	Sets channel 6 to Active Above the setpoint.

RDEL (?) d {, n}	**Setpoint Delay**

The RDEL command sets (queries) the Setpoint Delay for process channel d. The parameter d selects a process channel (1-8) and is required. The parameter n is the Delay in milliseconds.

Note

Times are stored in milliseconds, but this timer is only accurate to within a second.

Example

RDEL? 5	Returns the Setpoint Delay of channel 5 in ms.
RDEL 5, 10000	Sets Setpoint Delay of channel 5 to 10 seconds (10,000 ms).

RTCL (?) d {,n} {,s}	**Activation Time**

The RTCL command sets (queries) the Activation Time of day for process channel d. The parameter d selects a process channel (1-8) and is required. The parameter n is the time of day in milliseconds from midnight or the string s is the time in the format "9:30PM". Do not use both n and s in the command. The RTCL? query returns the value n in ms.

Example

RTCL? 4	Returns the Activation Time of channel 5 in ms.
RTCL 4, 9:30pm	Sets the Activation Time of channel 4 to 9:30 PM.
RTCL 4,77400000	Sets the Activation Time of channel 4 to 77,400,000 ms after midnight (9:30 PM).

RTOP (?) d {,n} {,s}	**Deactivation Time**

The RTOP command sets (queries) the Deactivation Time of day for process channel d. The parameter d selects a process channel (1-8) and is required. The parameter n is the time of day in milliseconds from midnight or the string s is the time in the format "9:30PM". Do not use both n and s in the command. The RTOP? query returns the value n in ms.

Example

RTOP? 4	Returns the Deactivation Time of channel 5 in ms.
RTOP 4, 9:30pm	Sets the Deactivation Time of channel 4 to 9:30 PM.
RTOP 4,77400000	Sets the Deactivation Time of channel 4 to 77,400,000 ms after midnight (9:30 PM).

RTIL (?) d {, i}	**TTL Activation Level**

The RTIL command sets (queries) the TTL Activation Level for process channel d. The parameter d selects a process channel (1-8) and is required. The parameter i selects Active when TTL input Low (0) or High (1).

Example

RTIL? 3	Returns 1 if channel 3 is active when TTL Input High, 0 if Low.
RTIL 3, 1	Sets channel 3 to active when TTL Input High.

TTLL ?   **Read TTL Inputs**

The TTLL? query returns the decimal value of a 24 bit binary number representing the state of the process control TTL Inputs as listed below.

Each bit is 0 if the input is TTL low, and 1 if the input is TTL high. All unused bits are 0.

bit	description
0	IG1_On
1	IG2_On
2	Degas_On
3	IG_Lockout
4	IG_Key_Disable
5	PG1_Off
6	PG2_Off
7	Clear_Data_Log
8	IG_Remote_Enable
9	Fil1_On
10	Fil2_On
11	Front_Panel_Disable
12	unused
13	unused
14	unused
15	unused
16	Process control TTL input #1
17	Process control TTL input #2
18	Process control TTL input #3
19	Process control TTL input #4
20	Process control TTL input #5
21	Process control TTL input #6
22	Process control TTL input #7
23	Process control TTL input #8

Example
If the returned value is 197136, the hex equivalent is 030210H indicating that all bits are low except bits 4, 9, 16 and 17.

RHGF ?   **Read Process Log**
RHGN ?

The IGC100 logs all process control events. To read the process log, use the RHGF? query to return the most recent entry in the log. Then issue RHGN? repeatedly to get the rest of the entries, until the string "&" is returned, signaling that all entries have been read.

This command pair retrieves the log as it was when the RHGF? command was received. Log entries created while you download the log do not appear in it. If you try to retrieve history over two interfaces at the same time you will not get the complete history on either.

WARNING!
The Embedded Web Server continually issues RHGF and RHGN. If you have the web server option, you must disable it (from the Remote/Web menu or with the WSEN command) to use these commands.

The returned string has one of the formats below.

State or Mode change:
When a channel changes state or mode, an entry is returned with the following format.

> "<date> <time> <StateBits (LSB first)> <ModeBits (LSB first)> <channel #> <State or Mode> <new State or Mode>"

For example, the returned string

> "23jun01 12:15:49 PM 10100000 01000000 #2 Mode Auto"

indicates the date/time that channel 2 was switched to Auto mode. The first bitfield shows 2 channels are active (1 and 3). The second bitfield shows that only channel 2 is in Auto mode.

Another example, the returned string

> "23jun01 10:42:35 AM 10000000 00000000 #1 State Active"

indicates the date/time that channel 1 switched to the Active state. The first bitfield shows that only channel 1 is active. The second bitfield shows that no channels are in Auto mode.

Event format:
When an event occurs, an entry is returned with the following format.

> "<date> <time> <event description>"

For example, the returned string

> "22may01 04:36:25 PM Instrument turned on"

indicates the date/time that the unit was turned on.

RHCL

Clear Process Log

The RHCL command clears the Process Log. All entries in the Process Log are lost after sending the RHCL command.

RBAD ?

Relay Failure Status

RBAD? query returns the decimal value of an 8 bit binary number representing the state of the process control relays. Bit 0 corresponds to Channel 1 and bit 7 corresponds to Channel 8. If the bit is 0, the relay is ok. If the bit is set, the relay is not trustworthy.

Backlight Commands

BLEN (?) {i}   **Backlight Saver Enable**

The BLEN command sets (queries) the Backlight Saver. The parameter i selects Disabled (0) or Enabled (1).

Example
BLEN?   Returns 1 if the Backlight Saver is Enabled, or 0 if Disabled.
BLEN 1   Enables the Backlight Saver.

BLIT (?) {i}   **Backlight On/Off**

The BLIT command sets (queries) the state of the LCD screen backlight. The parameter i selects On (1) or Off (0).

Example
BLIT?   Returns 1 if the backlight is On, or 0 if Off.
BLIT 1   Turns the screen backlight On.

BLOF (?) {n} {s}   **Backlight Turn-Off Time**

The BLOF command sets (queries) the Backlight Turn-Off Time of day. The parameter n is the time of day in milliseconds from midnight or the string s is the time in the format "9:30PM". Do not use both n and s in the command. The BLOF? query returns the value n in ms.

Example
BLOF?   Returns the Turn-Off Time in ms.
BLOF 9:30pm   Sets the Turn-Off Time to 9:30 PM.
BLOF 77400000   Sets the Turn-Off Time to 77,400,000 ms after midnight
                   (9:30PM).

BLON (?) {n} {s}   **Backlight Turn-On Time**

The BLON command sets (queries) the Backlight Turn-On Time of day. The parameter n is the time of day in milliseconds from midnight or the string s is the time in the format "9:30PM". Do not use both n and s in the command. The BLON? query returns the value n in ms.

Example
BLON?   Returns the Turn-On Time in ms.
BLON 9:30pm   Sets the Turn-On Time to 9:30 PM.
BLON 77400000   Sets the Turn-On Time to 77,400,000 ms (9:30PM).

BLTD (?) {n}   **Backlight Delay**

The BLTD command sets (queries) the Backlight Saver Delay. The parameter n is the Delay in milliseconds.

Example
BLTD?   Returns the Backlight Saver Delay in ms.
BLTD 300000   Sets Delay to 5 minutes (300,000 ms).

Security Commands

LOCK ?	**Query Locked**
	The LOCK? query returns the security state of the unit, Locked (1) or Unlocked (0). This is a query only command.

PWDL i, s	**Lock/Unlock**
	The PWDL command locks and unlocks the unit. The parameter i selects the action Switch State (0), Unlock (1) or Lock (2). The string s is the password.
	The string s is converted to UPPER case. If you enter the password from the front panel, be sure that the password is all UPPER case before using this command.

Example

PWDL 1, secret	Unlocks the system if the password is "SECRET".
PWDL 0, secret	Switches the state (Locks if unlocked, unlocks if locked) if the password is "SECRET".

CPWD	**Copy Password to Card**
	The CPWD command copies the password to a Memory Card. This card can then be used as a key to unlock the unit without knowing the password.
	A memory card must be inserted in the card reader before sending this command.

STPW s	**Set Password.**
	The STPW s command sets the password to the string s. This is a set only command. The password may not be queried.
	Passwords may include letters and numbers. The string s is converted to UPPER case.
	This command has no effect unless the unit is UNLOCKED.

Example

STPW secret	Sets the password to "SECRET".

SECF (?) d {, i}	**Security Flags**
	The SECF command sets (queries) the security setting for feature d listed below. The parameter i selects Normal (0) or Protected (1).
	Protected features may not be changed when the system is locked. Normal features are not affected by system locking.

d	feature
0	Ion gauge control keys
1	Gauge setup.
2	Gauge calibration.
3	Process control setup.
4	Process control operation.
5	Time & Date.
6	Local user lockout. Prevents changes from the touch screen.
7	Remote user lockout. Prevents changes from the remote interfaces.

Note
Do not lock out the remote interface (d=7) from a computer program.

Example
SECF? 3   Returns 1 if process control setup is Protected, 0 if Normal.
SECF 0, 1   Sets Ion Gauge Control to Protected.

WSEN (?) {i}   **Web Server Enable**

The WSEN command sets (queries) whether the Web Server Option is Enabled (i=1) or Disabled (i=0). Disable the web server to prevent web users from interfering with local computer control. It may take up to 10 seconds for this to take effect.

Example
WSEN?   Returns 1 if web server is Enabled, 0 if Disabled.
WSEN 0   Disables the web server option.

System Commands

NAME (?) {s}

System Name

The NAME command sets (queries) the System Name. The string s is the name and is converted to UPPER case.

Example
NAME?   Returns the System Name.
NAME my igc   Sets the Name to "MY IGC".

SNUM ?

Serial Number

The SNUM? query returns the unit serial number.

TIME (?) {s}

Time

The TIME command sets (queries) the System Time of day. The string s is the time in the format "9:30PM".

Example
TIME 9:30pm   Sets the system time to 9:30 PM.
TIME?   Returns "09:30 PM".

DATE (?) {s}

Date

The DATE command sets (queries) the System Date. The string s is the date in the format "ddMMMyy" where "MMM" are the first 3 letters of the month (jan, feb, mar, etc.).

Example
DATE 23may01   Sets the system date to May 23, 2001.
DATE?   Returns "23may01".

VOLC (?) {n}

Volume

The VOLC command sets (queries) the system audio Volume. The parameter n is the volume setting from 0 to 10.

Example
VOLC?   Returns the Volume setting.
VOLC 9   Sets the Volume to 9 (loud).

MENU d

Display Screen

The MENU d command changes the screen to the display listed below.

d	feature
0	Pressure Display
1	Gauges Display
2	Process Display
3	Chart Display
4	Table Display

Example
MENU 2   Shows the Process Display on the screen.

MESG (?) {s}	**Message**

The MESG s command sends the message string s to the screen. The user must clear this message by touching a button.

The MESG? query returns 1 if the message has not been cleared and 0 if all messages have been cleared.

Example

MESG warning	Displays the message "WARNING" on the screen.
MESG?	Returns 1 if until the message has been cleared from the front panel, and 0 when all messages have been cleared.

DHWR ? d	**Detect Hardware**

The DHWR? d command returns 1 if component d (listed below) is present, 0 if not installed. This is a query only command.

d	component
6	Process Control option
9	RS-232 interface
14	GPIB (IEEE-488) interface
17	Web Server

Example

DHWR? 6	Returns 1 if the Process Control Option is installed.

*TST ?	**Self-Test**

The *TST ? query performs a self-test and returns 0 if the test passes.

Returned values which are warnings are listed below.

value	description
1	Unable to perform all tests
2	Flash memory needs to be programmed
3	Excess load on Aux ±15 V supply
4	Relay failure
5	Communication port problem

If *TST ? returns any other value contact Stanford Research Systems for further instructions.

FREV ?	**Firmware Revision**

The FREV? query returns the IGC100 firmware revision code.

VRDT ?	**Firmware Build**

The VRDT? query returns the date of the IGC100 firmware revision.

Interface Commands

VERB (?) {i}	**Verbose RS-232**

The VERB command sets (queries) the verbose serial communication mode. The parameter i selects Verbose (1) or Terse (0). This command only affects the RS-232 interface. The GPIB interface is always in Terse mode.

Use Terse for programming. All responses to queries are as documented in this chapter. **Use the Verb 0 command at the start of all programs.**

Use Verbose for terminal applications or debugging. All terse responses are followed with a verbose message which explains the response.

For example, a query might return "0" (terse) or "0 off" (verbose).

Example
VERB?   Returns 1 if verbose mode, 0 if terse mode.
VERB 0   Use terse responses.

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*IDN ?	**Identification**

The *IDN ? query returns the IGC100's device identification string. This string is in the format "Stanford_Research_Systems,IGC100,s/n0,ver001". In this example, the serial number is 0 and the firmware version is 001.

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*RST	**Reset**

The *RST command resets the IGC100 to its default configurations. The communications setup is not changed. All other modes and settings are set to their default conditions and values. This command takes some time to complete.

Do not send other commands on the same command line after *RST. Do not send another command until *RST is complete. This takes about 10 seconds. You can send a query command (like *OPC?) and wait for the response. When the response comes, the unit is ready.

---

*OPC (?)	**Operation Complete**

*OPC is a GPIB command which is implemented for compatibility with the IEEE-488 standard. It is for operations that take time to complete. Upon receipt of the *OPC command, the instrument should set the OPC bit in the Standard Event Status register (bit 0) when all pending operations have been completed.

If the host sends *OPC, the IGC100 sets the OPC bit when all pending operations complete. Since the IGC100 completes all commands in the order received, the bit is set when the *OPC command completes.

The *OPC ? query returns 0 if any previous commands are still executing, 1 if all previous commands are complete. Since the IGC100 completes all commands in the order received, the *OPC ? query always returns 1. For commands that take a long time to complete execution, follow the command with a *OPC? query. The response (1) signals that the previous command is completed.

*WAI   **Wait to Continue**

The *WAI command prevents the instrument from executing any other commands or queries until all pending commands and queries are complete. Since the IGC100 executes commands to completion in the order received, the IGC100 operates in this manner for all commands (not just *WAI). This command has no parameters or return value.

Status Reporting

The IGC100 reports on its status by means of five status registers: the Serial Poll, Standard Event, Error, Gauge and Process Control status registers.

Status Registers

In the IGC100, a status register is a read-only, 16 bit word where the state of each bit indicates a specific instrument state or condition.

Bits in status registers are set when their corresponding condition or status is met. Once set, bits remain set until cleared by reading them with the appropriate status reporting command. *Whenever a status bit is set, it remains set until read.*

Some status bits report that a bit is set in another status register.

Resetting the IGC100, turning it off, or issuing *RST do not clear the status registers. Reading the status registers or issuing *CLS clears the status registers. Powering-up with *PSC enabled also clears the status registers.

This instrument extends the IEEE-488 specification by allowing you to check and clear individual bits in a status register.

Status Enable Registers

Status enable registers let you decide which conditions you care about and check them all with one *STB? query or GPIB serial poll.

The Standard Event, Error, Gauge and Process status registers all have a corresponding status enable register. Each bit in the enable register matches with a bit in the corresponding status register. Bits in the enable registers are set with the status enable commands. The enable bits do not affect the value of the status register and are not affected by status reads.

When a bit in *BOTH* a status register *AND* its enable register are set, then a bit in the Serial Poll Status register will become set. This mechanism reports underlying status conditions to a single status register (Serial Poll Status).

Serial Poll Status Register

The Serial Poll Status register is a special status register. It is a single byte (8 bits) and contains bits corresponding to the other four status registers. When a status bit (in another status register) *and* the matching enable bit (in its corresponding enable register) are *both* set, a bit is set in the Serial Poll Status register. This allows a single read of the Serial Poll Status to determine if any enabled bits in *all* of the other status registers is set. These bits in the Serial Poll Status *are not* cleared by reading. They remain set as long as the enabled bit in the other status register is set. Read the other status registers to determine which bit(s) are set and clear them.

The Serial Poll Status register has a matching Serial Poll Enable register. When a bit in *both* becomes set, the Service Request, or SRQ, bit will be set. This causes an IEEE-488 bus service request. When an enabled Serial Poll bit becomes set, a single service request is generated.

*STB? to Read the Status

The Serial Poll Status register is *NOT* cleared by reading the status using *STB?. A bit stays set as long as the status condition exists. This is true even for bit 6 (SRQ). Bit 6 will be set whenever the same bit in the Serial Poll Status *AND* Serial Poll Enable registers is set.

Serial Poll to Read the Status

Except for SRQ, a bit in the Serial Poll Status is *NOT* cleared by GPIB serial polling the status register. A bit stays set as long as the status condition exists.

When reading the status using a GPIB serial poll, the SRQ bit signals that the IGC100 is requesting service. The SRQ bit will be set the *first* time the IGC100 is polled following a service request. The serial poll automatically clears the service request. Subsequent serial polls will return SRQ cleared until another service request occurs. Polling the status word and reading it with *STB? can return different values for SRQ. When serial polled, SRQ indicates a service request has occurred. When read with *STB?, SRQ indicates that an enabled Serial Poll Status bit is set.

Service Request

A GPIB service request (SRQ) will be generated whenever a bit in both the Serial Poll Status register *AND* Serial Poll Enable register is set. Use *SRE to set bits in the Serial Poll Enable register.

A service request is only generated when an enabled Serial Poll Status bit becomes set (changes from 0 to 1). An enabled status bit which becomes set and remains set will generate a single SRQ. This prevents a single, persistent condition, such as overload, from generating an endless stream of service requests.

If another service request from the same status bit is desired, the requesting status bit must first be cleared. In the case of the PCSQ, GERR, IERR and ESB bits, this means clearing the enabled bits in the Process, Gauge, Error or Standard Event Status registers (by reading them) or clearing the appropriate bits in the corresponding enable registers. Multiple enabled bits in these status registers will generate a single SRQ. Another SRQ (from PCSQ, GERR, IERR or ESB) can only be generated after clearing the PCSQ, GERR, IERR or ESB bits in the Serial Poll Status.

The controller should respond to the SRQ by performing a serial poll to read the Serial Poll Status to determine the requesting status bit. Bit 6 (SRQ) will be reset by the serial poll. The controller should then investigate the appropriate status register to find the requesting status bit. The SRQ handler should deal with the actual problem (e.g. removing an overload condition), NOT just clear the bit and continue. This can lead to repeated SRQ events.

Power-On Status

Powering on does not clear the status registers. Reading status registers or issuing *CLS clears status registers.

Upon power-on, the IGC100 may either clear all of its status *enable* registers or maintain them as they were on power-off. The *PSC command determines which action will be taken.

Status Reporting Commands

*CLS	**Clear Status**

The *CLS command clears all status registers. The enable registers are *not* changed.

*PSC (?) {i}	**Power-On Status Clear**

The *PSC command sets the value of the power-on status clear bit.

If i=1 the power-on status clear bit is set and all status registers and enable registers are cleared on power up.

If i=0 the bit is cleared and all enable registers are stored at power down. The status registers are cleared and the enable registers are restored to their stored values on power up. This allows a service request to be generated at power up.

The default value is 0.

*STB ? {i}	**Read Serial Poll Status**

The *STB? query returns the value of the Serial Poll Status register. The value is returned as a decimal number from 0 to 255. The *STB? i query returns the value (0 or 1) of bit i (0-7). The conditions for each bit are listed below.

bit	name	set when
0	PCSQ	An enabled bit in the Process Control Status is set.
1	IERR	An enabled bit in the Error Status is set.
2	GERR	An enabled bit in the Gauge Status is set.
3	Unused	never
4	MAV	Data is available in the GPIB output buffer.
5	ESB	An enabled bit in the Event Status is set.
6	SRQ	Service request occurs.
7	IFC	No Command Execution is in progress.

The value of bit 6 (SRQ) when read using *STB? returns 1 if a bit is set in BOTH the Serial Poll Status register AND the Serial Poll Enable register. This is independent of serial polling and GPIB service requests. Bit 6 is the SRQ bit only when serial polled.

*STB? has no effect on the value of the Serial Poll Status register. To clear a bit in the Serial Poll Status, the condition which causes it to be set must be cleared. For the PCSQ, GERR, IERR or ESB bits, this is accomplished by clearing the enabled status bits in the Process, Gauge, Error or Standard Event status words (by reading them).

Example

*STB?	Returns the Serial Poll Status register (0-255).
*STB? 2	Returns 0 if bit 2 (GERR) is clear, 1 if it is set.

| *SRE (?) {i} {, j} | **Serial Poll Enable** |

The *SRE i command sets the Serial Poll Enable register to the decimal value i (0-255). The *SRE i, j command sets bit i (0-7) to j (0 or 1).

The *SRE? query returns the value (0-255) of the Serial Poll Enable register. The *SRE? i query returns the value (0 or 1) of bit i (0-7).

When a bit becomes set in BOTH the Serial Poll Status register AND the Serial Poll Enable register, an SRQ (GPIB service request) is generated. The SRQ is cleared by performing a serial poll. The bit in the Serial Poll Status which caused the SRQ must be cleared before this bit can cause another SRQ. To clear this bit, the condition which causes it to be set in the Serial Poll Status needs to be cleared. For the PCSQ, GERR, IERR or ESB bits, this is accomplished by clearing the enabled status bits in the Process, Gauge, Error or Standard Event status words (by reading them).

Example

*SRE?	Returns the Serial Poll Enable register (0-255).
*SRE? 2	Returns 0 if bit 2 is clear, 1 if it is set.
*SRE 40	Sets the Serial Poll Enable register to 40 decimal (bits 3 and 5 set).
*SRE 1, 0	Clears bit 1 of the Serial Poll Enable register.

| *ESR ? {i} | **Read Standard Event Status** |

The *ESR? query returns the value of the Standard Event Status register. The value is returned as a decimal number from 0 to 255. The *ESR? i query returns the value (0 or 1) of bit i (0-7).

*ESR? clears the entire register while *ESR? i clears just bit i.

The conditions for each bit are listed below.

bit	name	set when
0	OPC	The *OPC command completes.
1	Unused	
2	Unused	
3	Unused	
4	EXE	A command cannot be executed.
5	CME	A command syntax error occurs.
6	Unused	
7	PON	Unit turns on.

The Standard Event Status is defined by IEEE-488.2 (1987) and is used primarily to report errors in commands received over the interface. These bits remain set until read, cleared by *CLS or power-up with *PSC enabled.

Example

| *ESR? | Returns the Standard Event Status register (0-255). |
| *ESR? 5 | Returns 0 if bit 5 (CME) is clear, 1 if it is set. |

*ESE (?) {i} {, j}	**Standard Event Enable**

The *ESE i command sets the Standard Event Enable register to the decimal value i (0-255). The *ESE i, j command sets bit i (0-7) to j (0 or 1).

The *ESE? query returns the value (0-255) of the Standard Event Enable register. The *ESE? i command queries the value (0 or 1) of bit i (0-7).

When a bit becomes set in BOTH the Standard Event Status register AND the Standard Event Enable register, bit 5 (ESB) of the Serial Poll Status is set. This causes an SRQ if bit 5 in the Serial Poll Enable register is set. To clear a bit in the Standard Event Status, use *ESR?.

Example

*ESE?	Returns the Standard Event Enable register (0-255).
*ESE? 2	Returns 0 if bit 2 is clear, 1 if it is set.
*ESE 48	Sets the Standard Event Enable register to 48 decimal (bits 4 and 5 set).
*ESE 7, 0	Clears bit 7 of the Standard Event Enable register.

ERSW ? {i}	**Read Error Status**

The ERSW? query returns the value of the Error Status register. The value is returned as a decimal number from 0 to 65535. The ERSW? i query returns the value (0 or 1) of bit i (0-15).

ERSW? clears the entire register while ERSW? i clears just bit i.

The conditions for each bit are listed below.

bit	name	set when
0	Tst_Err	Selftest fails.
1	Math_Err	An internal math error occurs.
2	RAM_Err	The RAM checksum fails.
3	ROM_Err	The ROM checksum fails.
4	Batt_Err	Data in battery backed-up RAM was lost.
5	Stk_Err	An internal stack error occurs.
6	Heap_Err	An internal heap error occurs.
7	Rly_Err	A process control relay failure is detected.
8	Com_Err	An error with a communications port occurs.
9	Mnt_Err	A selftest requests routine maintenance.
10	Elec_Err	An internal electronics fault occurs.
11	PG1_Err	PG1 has a controller electronics fault.
12	PG2_Err	PG2 has a controller electronics fault.
13	Reset_Err	A Watchdog timer reset has occured.
14-15	Unused	

These bits **REMAIN SET** until read, cleared by *CLS or power-up with *PSC enabled.

Example

ERSW?	Returns the Error Status register (0-65535).
ERSW? 10	Returns 0 if bit 10 (Flt_Err) is clear, 1 if it is set.

ERSE (?) {i} {, j}   **Error Status Enable**

The ERSE i command sets the Error Status Enable register to the decimal value i (0-65535). The ERSE i, j command sets bit i (0-15) to j (0 or 1).

The ERSE? query returns the value (0-65535) of the Error Status Enable register. The ERSE? i query returns the value (0 or 1) of bit i (0-15).

When a bit becomes set in BOTH the Error Status register AND the Error Status Enable register, bit 1 (IERR) of the Serial Poll Status is set. This causes an SRQ if bit 1 in the Serial Poll Enable register is set. To clear a bit in the Error Status, use ERSW?.

Example

ERSE?	Returns the Error Status Enable register (0-65535).
ERSE? 2	Returns 0 if bit 2 is clear, 1 if it is set.
ERSE 48	Sets the Error Status Enable register to 48 decimal (bits 4 and 5 set).
ERSE 12, 0	Clears bit 12 of the Error Status Enable register.

GSSW ? {i}   **Read Gauge Status**

The GSSW? query returns the value of the Gauge Status register. The value is returned as a decimal number from 0 to 65535. The GSSW? i query returns the value (0 or 1) of bit i (0-15).

GSSW? clears the entire register while GSSW? i clears just bit i.

The conditions for each bit are listed below.

bit	name	set when
0	IG_Lock	IG TTL lockout occurs.
1	IG_Rng	IG reading is out-of-range.
2	IG_Err	IG fault occurs, perhaps an open or shorted gauge.
3	IG_Over	IG overpressure shutdown occurs.
4	AN1_Rng	AN1 reading is out-of-range.
5	AN2_Rng	AN2 reading is out-of-range.
6	AN3_Rng	AN3 reading is out-of-range.
7	AN4_Rng	AN4 reading is out-of-range.
8	Unused	
9	PG1_Rng	PG1 reading is out-of-range.
10	PG1_Err	PG1 fault occurs, perhaps an open or shorted gauge.
11	Unused	
12	Unused	
13	PG2_Rng	PG2 reading is out-of-range.
14	PG2_Err	PG2 fault occurs, perhaps an open or shorted gauge.
15	Unused	

These bits **REMAIN SET** until read, cleared by *CLS or power-up with *PSC enabled. For example, if AN1 is out-of-range, bit 4 will become set. Reading this status register will clear the bit. However, if AN1 remains out-of-range, then bit 4 will become set again (within 0.5 second). This can lead to repeated SRQs if the appropriate enable bits are set. In this case, the SRQ handler should not just read

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the status to clear the bit but also deal with the actual cause, in this case, why is the signal at AN1 out of range?, and remove the source of the problem.

Example

GSSW?	Returns the Gauge Status register (0-65535).
GSSW? 10	Returns 0 if bit 10 (PG1_Err) is clear, 1 if it is set.

GSSE (?) {i} {, j}   **Gauge Status Enable**

The GSSE i command sets the Gauge Status Enable register to the decimal value i (0-65535). The GSSE i, j command sets bit i (0-15) to j (0 or 1).

The GSSE? query returns the value (0-65535) of the Gauge Status Enable register. The GSSE? i query returns the value (0 or 1) of bit i (0-15).

When a bit becomes set in BOTH the Gauge Status register AND the Gauge Status Enable register, bit 2 (GERR) of the Serial Poll Status is set. This causes an SRQ if bit 2 in the Serial Poll Enable register is set. To clear a bit in the Gauge Status, use GSSW?.

Example

GSSE?	Returns the Gauge Status Enable register (0-65535).
GSSE? 2	Returns 0 if bit 2 is clear, 1 if it is set.
GSSE 48	Sets the Gauge Enable register to 48 decimal (bits 4, 5 set).
GSSE 12, 0	Clears bit 12 of the Gauge Status Enable register.

RSSW ? {i}   **Read Process Status**

The RSSW? query returns the value of the Process Status register. The value is returned as a decimal number from 0 to 65535. The RSSW? i query returns the value (0 or 1) of bit i (0-15).

RSSW? clears the entire register while RSSW? i clears just bit i.

The conditions for each bit are listed below.

bit	name	set when
0	Ch1_Chg	Process control channel 1 changes state.
1	Ch2_Chg	Process control channel 2 changes state.
2	Ch3_Chg	Process control channel 3 changes state.
3	Ch4_Chg	Process control channel 4 changes state.
4	Ch5_Chg	Process control channel 5 changes state.
5	Ch6_Chg	Process control channel 6 changes state.
6	Ch7_Chg	Process control channel 7 changes state.
7	Ch8_Chg	Process control channel 8 changes state.
8	Ch1_Act	Process control channel 1 is active.
9	Ch2_Act	Process control channel 2 is active.
10	Ch3_Act	Process control channel 3 is active.
11	Ch4_Act	Process control channel 4 is active.
12	Ch5_Act	Process control channel 5 is active.
13	Ch6_Act	Process control channel 6 is active.
14	Ch7_Act	Process control channel 7 is active.
15	Ch8_Act	Process control channel 8 is active.

The Process Control Status reflects the current process control state and indicates channels that have changed state (1 or more times) since the last time the status was read.

The lower 8 bits are set when a channel changes state and **REMAIN SET** until read, *CLS executes, or power-on with *PSC enabled. These bits can be enabled to generate an SRQ. Reading this register will clear these bits and they will remain cleared until the relay changes state again.

The upper 8 bits always reflect the state of the process control channels **at the time this status is read.** These bits should **NOT** be enabled to generate an SRQ. Reading this register will clear these bits but if the relay remains active, the bit will immediately be reset and generate another SRQ.

Example

RSSW?	Returns the Process Control Status register (0-65535).
RSSW? 10	Returns 0 if bit 10 (Ch3_Act) is clear, 1 if it is set.

RSSE (?) {i} {, j}   **Process Status Enable**

The RSSE i command sets the Process Status Enable register to the decimal value i (0-65535). The RSSE i, j command sets bit i (0-15) to j (0 or 1).

The RSSE? query returns the value (0-65535) of the Process Status Enable register. The RSSE? i query returns the value (0 or 1) of bit i (0-15).

When a bit becomes set in BOTH the Process Status register AND the Process Status Enable register, bit 0 (PCSQ) of the Serial Poll Status is set. This causes an SRQ if bit 0 in the Serial Poll Enable register is set. To clear a bit in the Process Status, use RSSW?.

Example

RSSE?	Returns the Process Status Enable register (0-65535).
RSSE? 2	Returns 0 if bit 2 is clear, 1 if it is set.
RSSE 48	Sets the Process Status Enable register to 48 decimal (bits 4 and 5 set).
RSSE 12, 0	Clears bit 12 of the Process Status Enable register.

Chapter 8

Embedded Web Server (EWS)

The embedded web server (EWS) is a factory installed option for the IGC100. The EWS provides an ethernet connection between the IGC100 and a network. The EWS allows monitoring and control of the IGC100 (and vacuum system) from a local network or the world wide web.

The EWS allows you to

- Monitor and control the IGC100 from virtually anywhere in the world.
- View vacuum system data using a standard web browser.
- Get log data from the IGC100 without writing a custom program.

In This Chapter

EWS Quick Start

If you are comfortable with networking and wish to get your EWS up and going as quickly as possible, use the Quick Start instructions here. Please read the rest of this chapter for a more complete description of the EWS features and capabilities.

Connect the IGC100 to Your Network

> **Warning!**
> - Connecting your vacuum system to the world-wide-web can expose it to unauthorized access, resulting in harm to personnel as well as equipment.
>
> - Network security is a serious matter. Consult your network administrator for more information about using web-enabled instruments in your lab.

Use a CAT5 ethernet cable to connect your hub or switch to the ethernet connector on the back of the IGC100 (with EWS installed). *Do not use a crossover cable.*

Bring up the Web setup menu by pressing the [Menu] QuickKey (in the Pressure Display), choosing [Remote] and then [Web].

Set the Network Addresses

For full use of the EWS, you will need a static IP (Internet Protocol) address, subnet mask, DNS (Domain Name Server) address, and gateway address. See your network administrator to obtain addresses appropriate for your network environment. If you already know the IP address you will be using, you may be able to find your subnet mask and gateway by typing "ipconfig" from your workstation's command line prompt.

Enter these values in the Main/Remote/Web menu of the IGC100.

Set the Security Level

To quickly allow access to all EWS features, go to the Main/Remote/Web/Control submenu and set Web Control to Enabled and Security Type to Password. The default password is "igc100".

Read the section 'Configuring EWS Security' later in this chapter for a complete description of EWS security features.

Enable the EWS

Return to Main/Remote/Web and set Web Server to Enabled. Your EWS stores the network addresses into non-volatile memory, then gathers data on your IGC100 setup (gauge and relay descriptions, etc.). Allow the EWS about 30 seconds before continuing.

To make sure the EWS is functioning, touch the [Web Queue] button. If commands are streaming across the display, the EWS is communicating with the IGC100.

Access the Web Page

Start your web browser and in the location (URL) bar, type the IP address you assigned to the EWS. Make sure JavaScript is not disabled in your browser. You should see a web page similar to below. Relay status is displayed only if Option 03 (Process Control) is installed in the IGC100.
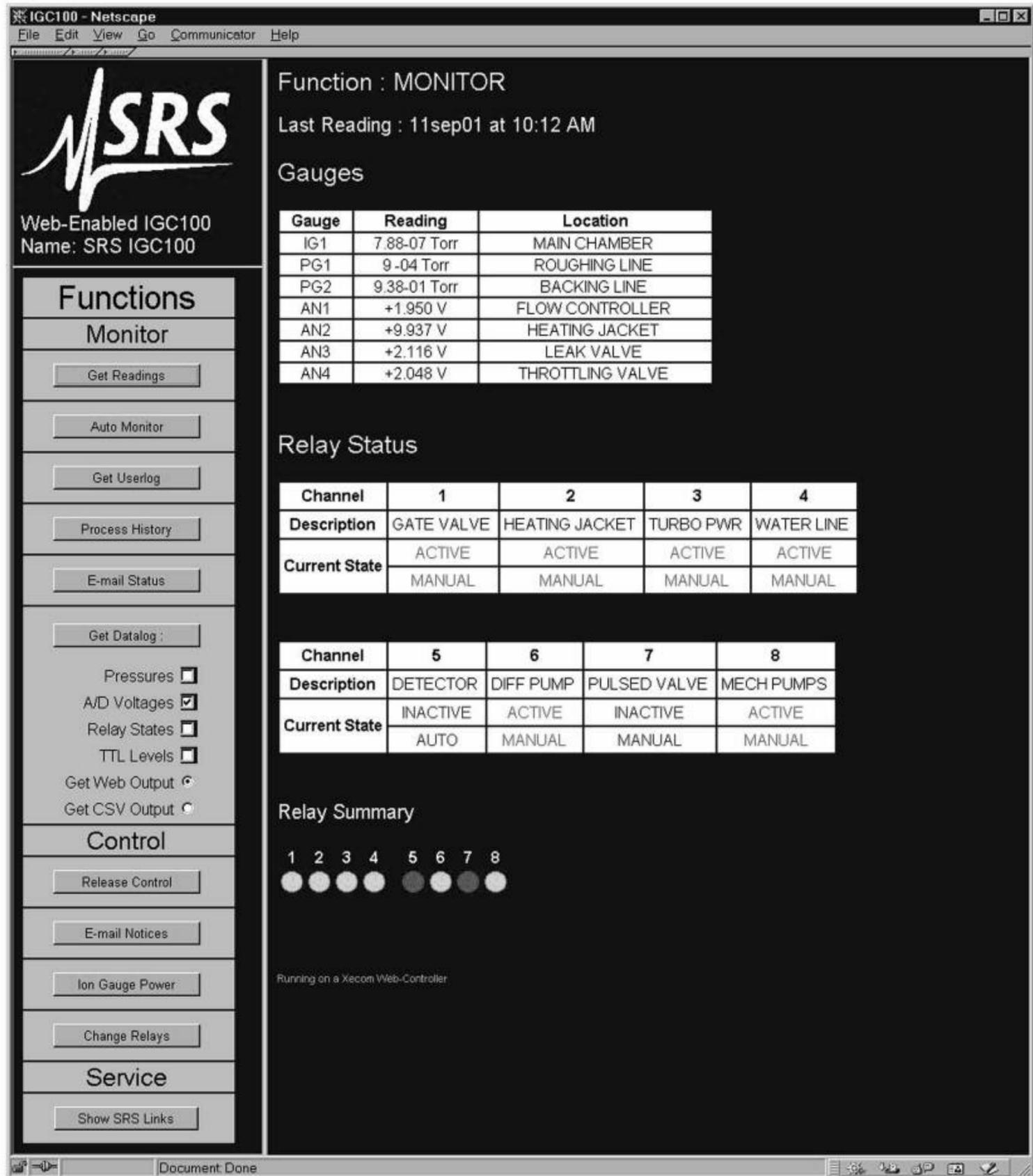

Figure 8-1. EWS web page.

Installing the EWS

This section covers the network installation and configuration of the Embedded Web Server option. While this option adds powerful functionality to the IGC100, *connecting your vacuum system to the world-wide-web can expose it to unauthorized access, resulting in harm to personnel as well as equipment.*

> **Warning!**
> Network security is a serious matter. Consult your network administrator for more information about using web-enabled instruments in your lab.

Network Administration Concerns

Your network administrator has a difficult job. In addition to making sure your network is always running smoothly, she also needs to keep track of which IP addresses are assigned to which machines. This prevents IP address collisions (where more than one computer has the same IP address), as well as maintains the security of the network.

Your administrator may have a limited number of free IP addresses, and may show concern about having an instrument on the network in the first place.

Some of the first questions she may ask include:

- Why does an instrument need an IP address?

- Why does it need a static IP address?

- What happens if everyone in the department wants instruments with IP addresses?

- What is the MAC address for this instrument?

- What kind of security measures are in place?

These are all very valid concerns. You will need to explain what you want to do, and allow your administrator enough leeway to accomplish your goals while still satisfying theirs. Some of the information in this chapter may help you both.

Static IP

The reason your instrument needs a static IP address is because it is a *server*. You need your server to be at the *same* address all the time, so you always know where to point your browser. The server does not use a conventional file system. It is likely that once your instrument is running, it will remain on 24 hours a day, 7 days a week. This makes using a dynamic IP address (one that changes with each power up sequence) somewhat infeasible.

Port Number

The default port is 80 and should **NOT** be changed except in the following situations.

1. If IP addresses are scarce in your network environment, consider using a network address translation (NAT) router. With such a device, several IGC100's can 'share' a single IP address. Each IGC100 is assigned a 'fictitious' IP address and the router presents a single IP address to the rest of the world. In this case, all of the IGC100's will appear at the same IP address to the outside world (they will have different IP addresses on the local network). Each IGC100 needs to be on a different port and the router must be configured to forward port requests to the correct IGC100. From the outside, each IGC100 is accessed at its own port number (but the same IP address).

2. If you are experiencing attacks on port 80 that block access to the IGC100. In this case, change the port to something else (like 8080). You will need to specify this port in your browser address window as 208.123.123.32:8080 where 208.123.123.32 is the IP address of the IGC100 and 8080 is the port number.

For more information about NAT routers and ports, see your network administrator.

Setting Network Addresses

To enter network addresses into the IGC100, press the [Menu] QuickKey from the Pressure Display, then choose [Remote] from the Main Menu. Finally, choose [Web] in the Remote Menu.
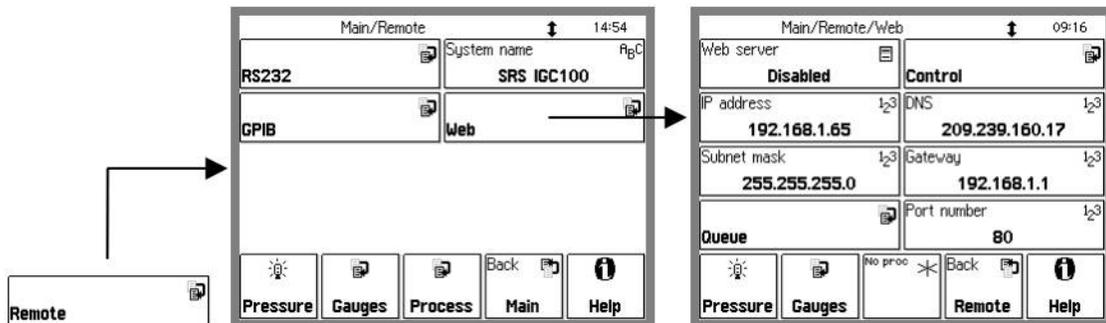

Figure 8-2. Getting to the Web menu.

In order to use the EWS option, you will need to have a connection to the internet and some information about your network environment.

The best source of information about your network environment is your network administrator. Here is a list of information you will need from that person:

1) An IP (Internet Protocol) address for the instrument
2) The IP address of a domain name server (DNS)
3) The IP address of the gateway
4) The IP address of a simple mail transfer protocol (SMTP) server
5) The Subnet mask

An IP address is made up of four bytes. It is often expressed as a set of three digit numbers separated by a '.' such as 209.239.160.084. The Internet protocol maps each machine's individual media access control (MAC) address to an IP address. Every page you are served from the world wide web is actually from a machine with a particular IP address.

People have a difficult time remembering and using long strings of numbers, so domain name servers (DNS) are in use. You can think of these machines as a kind of telephone book; they associate a particular IP address (209.239.160.084) with a string of characters (www.thinksrs.com). A DNS is not required to use the EWS, but it can make your life a little easier.

Next we need to consider the gateway. The gateway is simply the machine that connects your network to the outside world. It is the link between two networks, routing data traffic between those networks. For this reason, a gateway is sometimes referred to as a router. Its IP address is required for you to be able to send email from the EWS. If you will not be using the email notices feature of the EWS, and you will always be contacting the EWS from a machine on the same network, this IP address is not required.

A simple mail transfer protocol (SMTP) server often has one purpose in life: to relay email from one machine to another. It follows some simple rules for how the information that makes up the email is exchanged between the machine sending the email and the machine that will relay the message to its destination. This address is not required if you will not be using the email feature of the EWS.

Lastly, the subnet mask is required. In a network, there are quite often sub-networks. The subnet mask is required to let the EWS know which subnet it will be on.

Enable the EWS

After entering network addresses, set the Web Server to Enabled. Your EWS stores the network addresses into non-volatile memory, then gathers data on your IGC100 setup (gauge and relay descriptions, etc.). Allow the EWS about 30 seconds before continuing.

To make sure the EWS is functioning, touch the [Web Queue] button. If commands are streaming across the display, the EWS is communicating with the IGC100.

Important
Whenever network setup information is changed, you must wait at least 5 seconds for the changes to take effect.

System Name

The System Name (Menu/Remote/System Name) identifies this IGC100 on the web. This is important if your setup includes multiple web-enabled IGC100's. The system name is displayed in the web pages to identify the source of the data.

MAC Address

Your administrator may want to know the media access control (MAC) address of your instrument. The MAC is a unique address used at a lower layer of the internet protocol. Each IP address is mapped to a unique MAC address. Administrators often like to know this address as a crosscheck for the IP address (both should be unique). Knowing the MAC address also provides some extra security; if the administrator finds a MAC address that isn't listed in their directory, it could be an unauthorized user. When you put a server on a network, you are essentially inviting people to come and get information. Your administrator will want to make sure that this server doesn't create a security risk for the rest of the network.

To find the MAC address of your IGC100 from a networked PC (which can access the IGC100 via the web) :

Type in the IGC100's IP address (and port if not 80) in your browser's address window. This should bring up the IGC100 web page. Click on "Get Userlog" on the left. This displays the network settings of the IGC100 including its MAC address.

Choosing a Network Configuration

This section illustrates some possible network configurations for the EWS. This may help in choosing the best network configuration for your EWS.

Crossover Cable Configuration

This setup uses a crossover ethernet cable that allows the EWS to connect to a single computer without a network. A crossover cable is wired differently than regular network cables. A normal ethernet cable is wired 'straight through' (Tx to Tx, Rx to Rx), while a crossover cable is connects transmit to receive (Tx to Rx, Rx to Tx). *To use this configuration, make sure you use a crossover cable!*

This configuration will **NOT** allow email, use of a DNS, or access from more than one computer. It will **NOT** allow the computer connected to the IGC to connect to the internet. However, it does allow you to use a standard web browser to monitor, control and receive data from the IGC100.
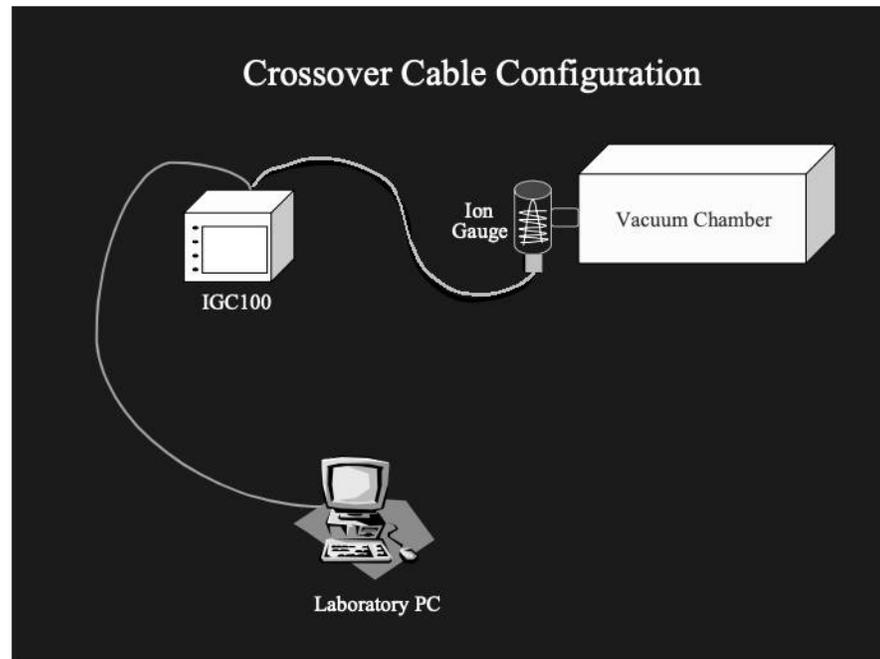
Figure 8-3. Crossover Cable Configuration

This configuration does **NOT** allow access to the IGC100 from the outside world. However, if security is a concern, this limitation is a strong reason for its use. The only security question to ask is "who will have access to this computer?". Since there is no intermediate connection, or dependence on outside hardware, this is also a very reliable connection. Furthermore, since the EWS will not actually be on the internet, you do not need a 'real' IP address. You can simply choose your own IP (on the same subnet as the PC).

Internal LAN Configuration

You can retain the security of the crossover connection and still allow more than one computer to access the IGC100. An ethernet hub will allow you to make a local area network (LAN) that can use fictitious IP addresses in order to access the instrument (as well as other computers on the LAN). The figure below shows a conceptual diagram of this configuration. While the IP addresses are fictitious, other networking parameters are still required and your network administrator can help you set up this type of LAN.
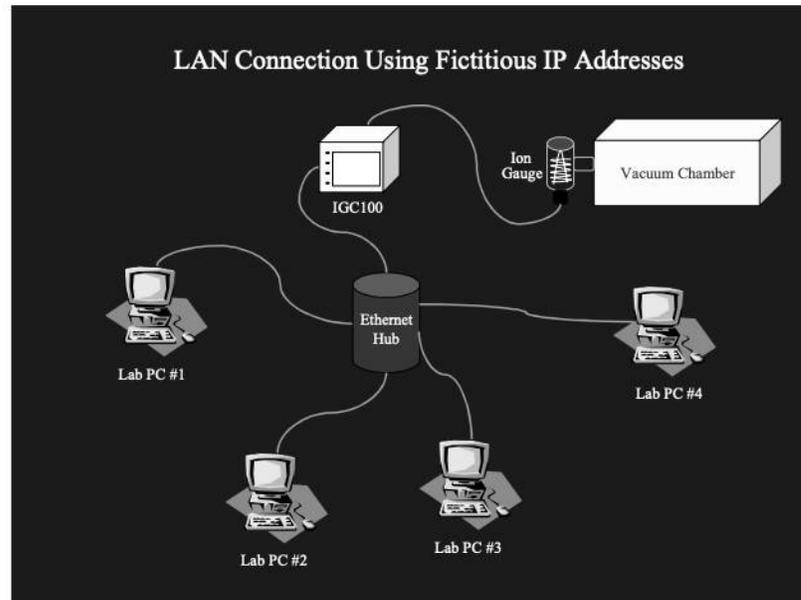
Figure 8-4. Internal LAN Configuration

Note that no connection to the internet is made in this LAN. The network is completely within your laboratory or plant floor, so security from an outside attack on this LAN is not a concern. Of course this also means that *you* cannot access the LAN outside of the workplace. However, the IGC100 *can* be accessed from other computers on the same LAN.

Conventional LAN Configuration

Chances are good that you are currently using a LAN with real IP addresses that is also connected to the internet through a firewall. A firewall is a piece of hardware designed to exclude unwanted data traffic coming from the outside world. A gateway is often employed in order to allow data traffic from the LAN to reach the outside world. Within a LAN that is using real IP addresses, you need to contact your network administrator in order to set up your EWS. For details, see the section 'Network Administration Concerns'.

This configuration allows anyone on your LAN to use the EWS. With a gateway in place, it also allows the EWS to send out email to a computer which is outside the LAN. However, this configuration may not allow you to monitor or control your vacuum system from outside your workplace. Talk with your network administrator for their advice on setting up this configuration to allow outside access to the IGC100. To maintain the security of the LAN, your administrator may wish to place the IGC100 outside the firewall, as described in the next section.
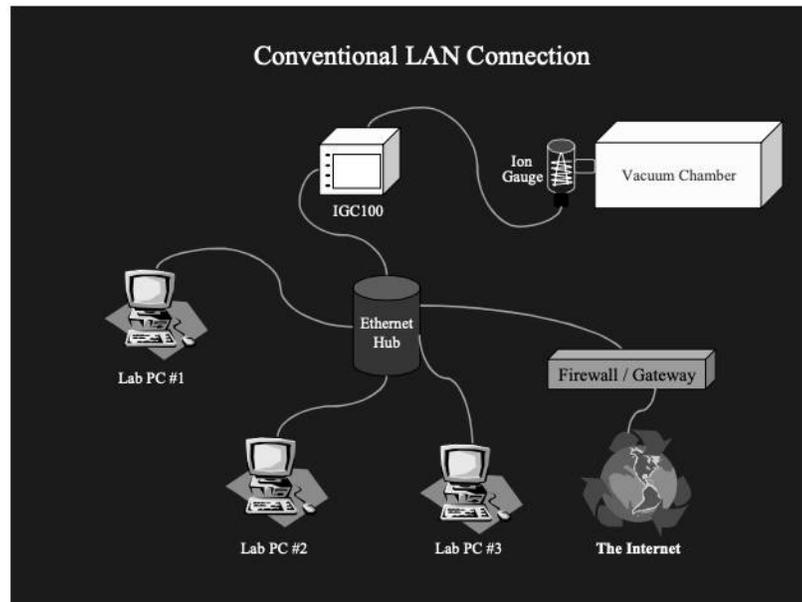

Figure 8-5. Conventional LAN Configuration

Outside Firewall Configuration

Here, the IGC100 is connected to the world wide web via a router outside the workplace firewall. This connection requires setting up real network parameters (as discussed in the previous sections) and your network administrator should work with you to set this type of connection. This configuration allows you to interact with your instrument from any computer, anywhere on the internet, via a standard browser. You can monitor your data, control relay states, and even receive email notification about relay state changes, from any location. There is a trade-off for all this flexibility and power. Once your instrument is accessible throughout the world, security issues must be addressed. See 'Configuring EWS Security' later in this chapter.
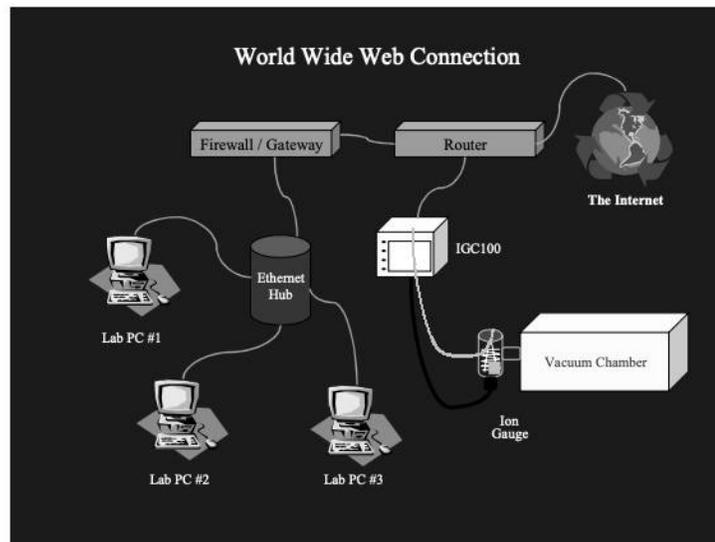
Figure 8-6. Outside Firewall Configuration

Testing with a Crossover Cable

Before putting your instrument on the web, it is best to test it via a direct PC to instrument connection. You will need an ethernet crossover cable, and a computer with a network card, already configured with network parameters. If you need to set up a computer for networking, contact your network administrator. Please do not contact SRS for support of your network. A workstation attached to the same network you wish to use the EWS with is ideal for this test. If the computer is already hooked up to a network, make sure disconnecting it will not cause problems for others on that network.

In this crossover configuration, real networking parameters (Subnet mask, DNS, Gateway) are not required.

1) Make sure the IGC100 is powered up and running normally.

2) Disconnect the computer from its ethernet network.

3) Connect the IGC100 EWS to the computer using a crossover cable.

4) From the command line prompt of your workstation, enter the command 'ipconfig'. This command will report the workstation's IP address.

5) On the IGC100, go to the Main/Remote/Web menu. Make sure the EWS is Disabled.

6) For this test, the IP address can be 'fictitious'. Set the EWS to use a fictitious address by subtracting one from the IP address of your workstation. For example, if your workstation IP address was reported as 111.111.111.111, use 111.111.111.110 for your fictitious EWS IP address. This is the only networking parameter required for this crossover test.

7) In the IGC100 Main/Remote/Web menu, set EWS to Enabled. This sets the IP addresses in the EWS and starts the EWS.

8) Under Main/Remote/Web, touch [Web Queue]. This screen should show web server activity as it queries the IGC for information. Allow the web server to gather information from the IGC for several seconds.

9) Run a web browser on your workstation. At the browser's "http://" prompt, type the fictitious IP address you set on the IGC100 front panel and hit the return key. In a moment, you should see the opening screen of the web page.

If you did not see the opening screen within a few seconds, make sure of the following:

• The web server is enabled. Check Main/Remote/Web/Web Queue (see above) for activity.

• When the cable is plugged in and the server is enabled, a green activity light on the ethernet connector on the rear panel should be illuminated. Verify this light is on. If it does not light, there may be a hardware problem with the crossover cable or your PC network card.

• The IP address on the front panel of the IGC100 matches the IP address you typed in on your browser.

• The crossover cable is connected directly from the PC to the IGC (no hub or switch is in the path).

- The cable is wired as a crossover cable.

- If the web page display seems garbled or if parts are incomplete, try waiting a few seconds and reloading the page in your browser. The most likely cause for this problem is that the web server has not had time to initialize.

Testing Within a Network

In order to test your EWS with a real network, you will need an IP address from your network administrator. You will also need the subnet mask, and IP address of the default gateway machine. You can get these addresses from the administrator. If you wish to use electronic mail, you may also wish to obtain the address of a domain name server (DNS).

1) Make sure the EWS is Disabled (Go to the Main/Remote/Web menu on the IGC100 if necessary).

2) Set the IP address.

3) Set the gateway address and subnet mask.

4) Connect the IGC100 EWS to a hub (or other network connection) with a standard ethernet network cable. *Do not use a crossover cable.*

5) In the IGC100 Main/Remote/Web menu, set EWS to Enabled. This sets the IP addresses in the EWS and starts the EWS.

6) Under Main/Remote/Web, touch [Web Queue]. This screen should show web server activity as it queries the IGC for information. Allow the web server to gather information from the IGC for several seconds.

7) Run a web browser on your computer. At the browser's "http://" prompt, type the IP address you entered on the IGC100 front panel and hit the return key.

If you did not see the opening screen within a few seconds, make sure of the following:

- The web server is enabled. Check Main/Remote/Web/Web Queue (see above) for activity.

- When the cable is plugged in and the server is enabled, a green activity light on the ethernet connector on the rear panel should be illuminated. Verify this light is on. If it does not light, there may be a hardware problem with the crossover cable or your PC network card.

- The IP address on the front panel of the IGC100 matches the IP address you typed in on your browser.

- The ethernet cable is connected from the IGC100 to a hub or other ethernet port (not directly to a PC).

- The cable is *NOT* a crossover cable.

- If the web page display seems garbled or if parts are incomplete, try waiting a few seconds and reloading the page in your browser. The most likely cause for this problem is that the web server has not had time to initialize.

Note
Your local network environment may prohibit your ability to get web pages from the EWS from outside your facility. See the section below entitled 'Network Configurations' and consult your network administrator for possible solutions.

Configuring EWS Security

You must decide if the IGC100/EWS offers enough security for your application. The EWS employs a number of security measures, however, *no network can be made entirely secure!* All security measures are implemented from the front panel of the IGC100 and cannot be changed via the web interface. This ensures that only authorized users set security levels.

Monitoring of the IGC100 through the EWS is allowed from all users. The security measures are designed to prevent unauthorized users from making changes to the IGC100 settings.

Web Server Enable

If you use your EWS only during certain hours, simply disable it when not in use. No web monitoring or control of the IGC100 is possible when the EWS is disabled. This setting can only be changed from the front panel.
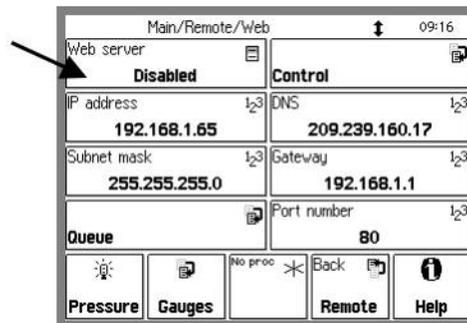

Figure 8-7. Web server enable/disable.

Important
Whenever network setup information is changed, you must wait at least 5 seconds for the changes to take effect.

Web Control Enable

If you only wish to monitor your vacuum system from the web, you should disable Web Control. Web Control of the IGC100 includes setting relay states and turning ion gauges on and off. When control is disabled, the EWS does not allow changes to the IGC100 settings. If you allow web control, make sure that the security features below are enabled.

Touch [Control] in the Main/Remote/Web menu to access the control and security features of the EWS.
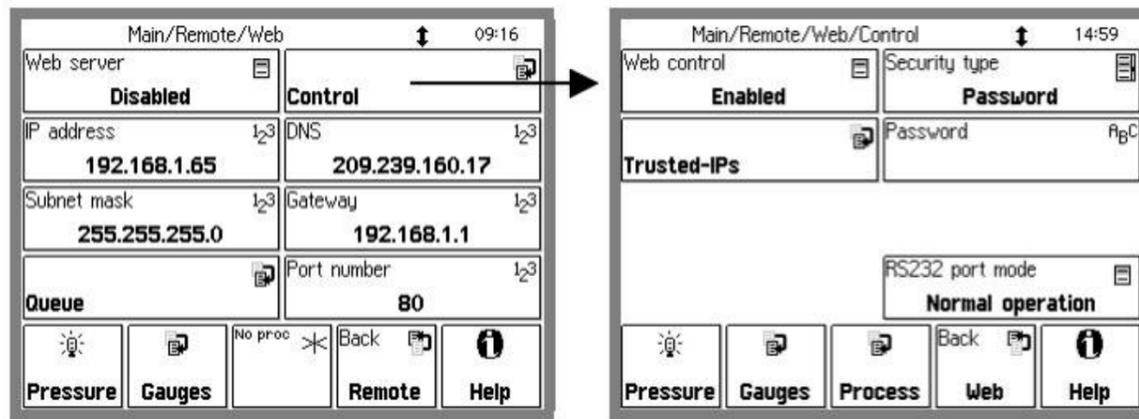
Figure 8-8. Web Control menu.

Security Type

The IGC100 offers a choice of security options when web control is enabled.

IP Checking

Within a networking environment in which the IP addresses do not change (the IP addresses are static), you can limit who has access to the instrument by checking the IP address of users asking for data.
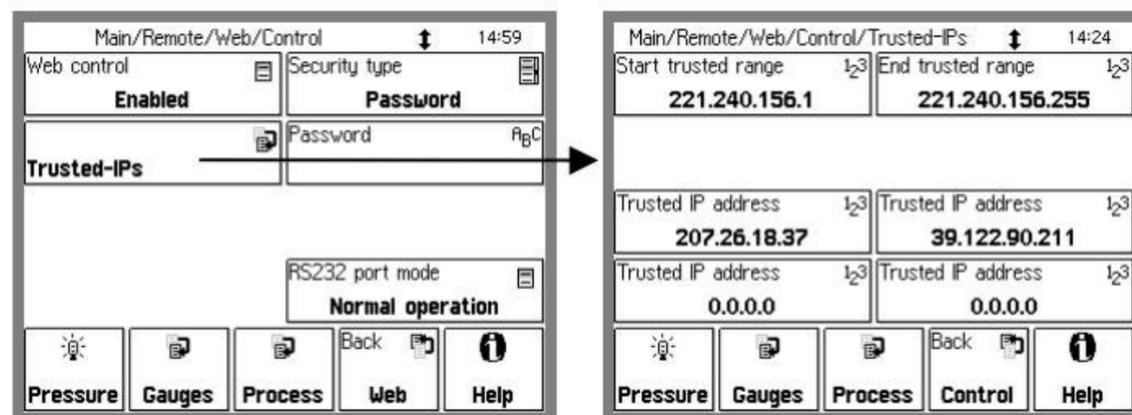

Figure 8-9. Trusted-IP setup menu.

The IGC100 allows you to specify the IP addresses that will be allowed to access the instrument over the web. You may specify a range of addresses as well as four addresses that are outside that range. The addresses outside the range are for trusted users outside the local network with static IP addresses. If your network uses dynamic IP addresses, but they always fall in the same range, you can still use IP checking security. If you do not require access to the EWS via a dial-up connection, this is the security measure to use.

Note that no password is required - if the IP address is trusted, control access is granted.

IP and Password Checking

As an extra measure of security in addition to IP checking, you can also assign a password to gain access to control of the IGC100. If you have set special parameters that are to remain unchanged even by in-house personnel, this is this measure to use.

Password Checking Only

This is the lowest level of security for the IGC100's control functions. However, if you require access to the control functions over a dial-up connection to the instrument, this is the method to use. A dial-up connection almost always assigns a different IP address to your connection each time you log on to your internet service provider (ISP). This means IP checking is not a feasible option.

Note

The password exchange is not encrypted. This means that if someone is monitoring your communication with the EWS, they will see your password.

Using the EWS

To view the EWS web pages, simply type the IP address of the EWS into your web browser.

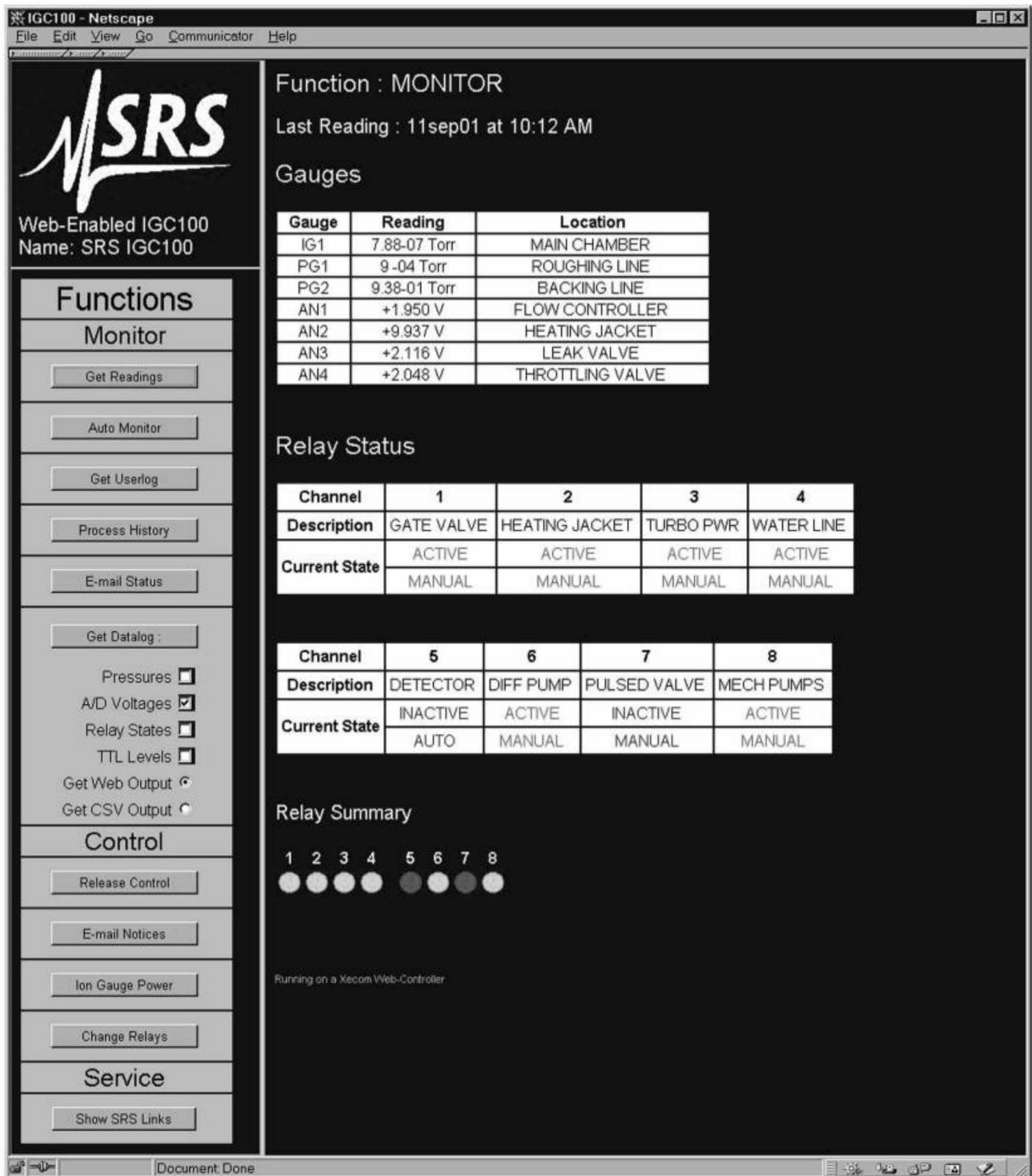*Figure 8-10. Enter the IGC100's IP address into your browser.*

Figure 8-11. Main EWS web page.

Bookmarking the IGC100

You can add a bookmark to the IGC100 in your browser. Be sure to rename the bookmark to something meaningful. If you are accessing multiple IGC100's, make sure each bookmark is unique.

Monitoring the IGC100

The simplest use of the EWS is to monitor your data. The EWS offers three distinct ways to monitor.

- Display a page with all active gauges and current relay states

- Monitor selected parameters in an automatically updated window

- Display the data log to see how your system is behaving over time.

Get Readings

Get Readings reports the value of all inputs that are not in an error state as well as the process control relay states. If a gauge reading does not appear, use the Auto Monitor function described below to display the error state of the gauge. Note that all analog ports which can be converted to capacitance manometer readings are listed twice, as the analog voltage and the corresponding pressure value.

The system name (default "SRS IGC100") can be changed in the Main/Remote menu of the IGC100. This is important if you are monitoring multiple units.

This screen only updates when you click Get Readings. For continuous updates, use Auto Monitor.
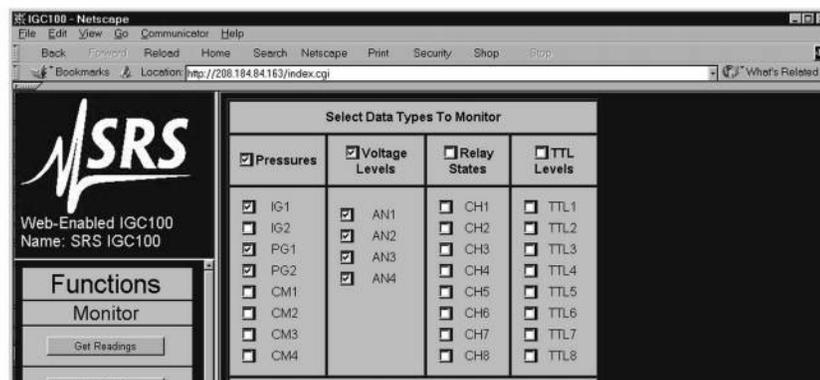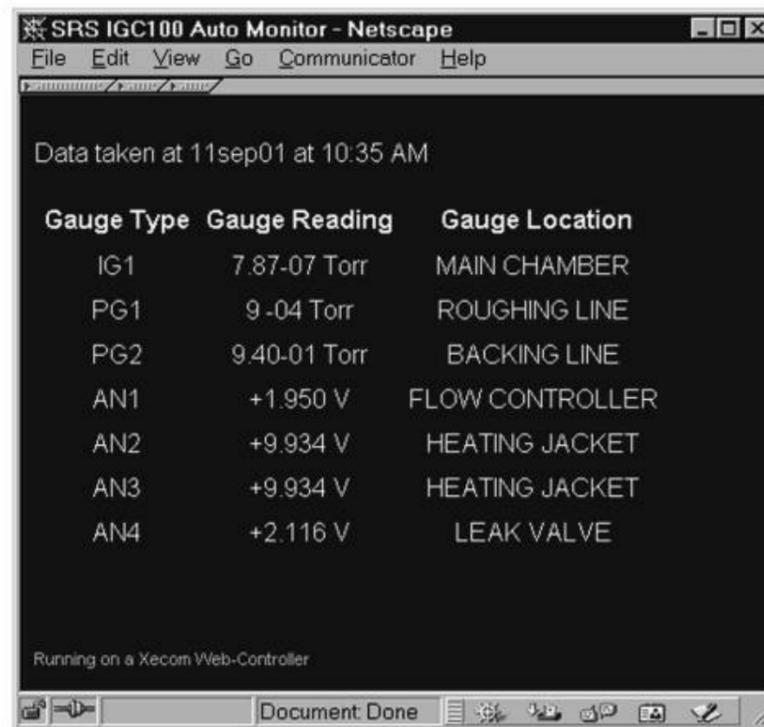
Auto Monitor

Figure 8-12. Auto Monitor menu.

This function allows automatic monitoring of specific inputs or values. Select the quantities you wish to monitor from the menu and how often you wish the display to update. A new browser window will be created displaying only the selected data. This

window will refresh every 20 seconds (depending upon network availability). The auto monitor function will show the status of a gauge that cannot report a value.

The auto monitoring window can be on your desktop while you work, allowing you to keep tabs on critical parameters (see below). You can create multiple windows to group critical parameters by type, or use a single window and look at several types of data at once. This feature can be especially useful when a relay state is tied to a pressure reading; you can make absolutely sure that the relays are functioning correctly with the given pressure input. These same ideas can be applied to the analog inputs to monitor parameters such as temperature.
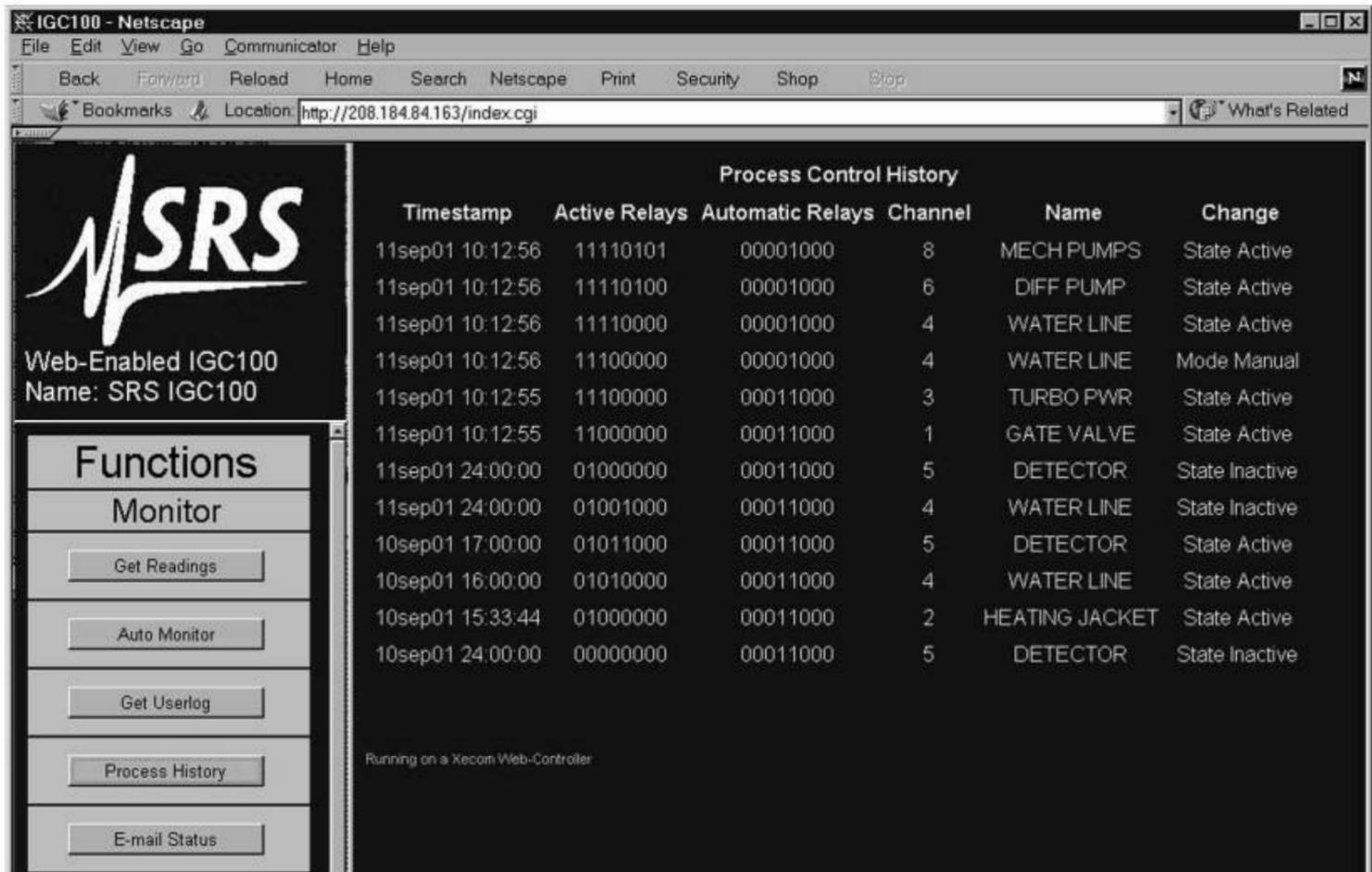

Figure 8-13. Auto Monitor window.

Process History

If your IGC100 is equipped with a Process Control option, this function will return up to the last 20 events in the process history. Each entry of the history has a timestamp, a listing of what relays were active at that moment, a listing of what relays were under automatic control at that moment, and what change took place at that moment. By examining the process history, you can trace how your vacuum system arrived in its current state. Often, you can quickly diagnose a problem in your vacuum system when you learn which interlocks were activated and the order in which they were activated.


Figure 8-14. Process History.

Get Datalog

The Get Datalog function downloads IGC100 log data to your computer, via the web. You can select data from four categories, pressures, analog port values, relay states, and TTL levels. The data is downloaded either as a web page or as a comma separated variable (.csv) file compatible with Microsoft Excel.

Web Output

The number of log points in a web page is fixed at 10 points per data type.

Datalog Generated at 11sep01 at 10:44 AM
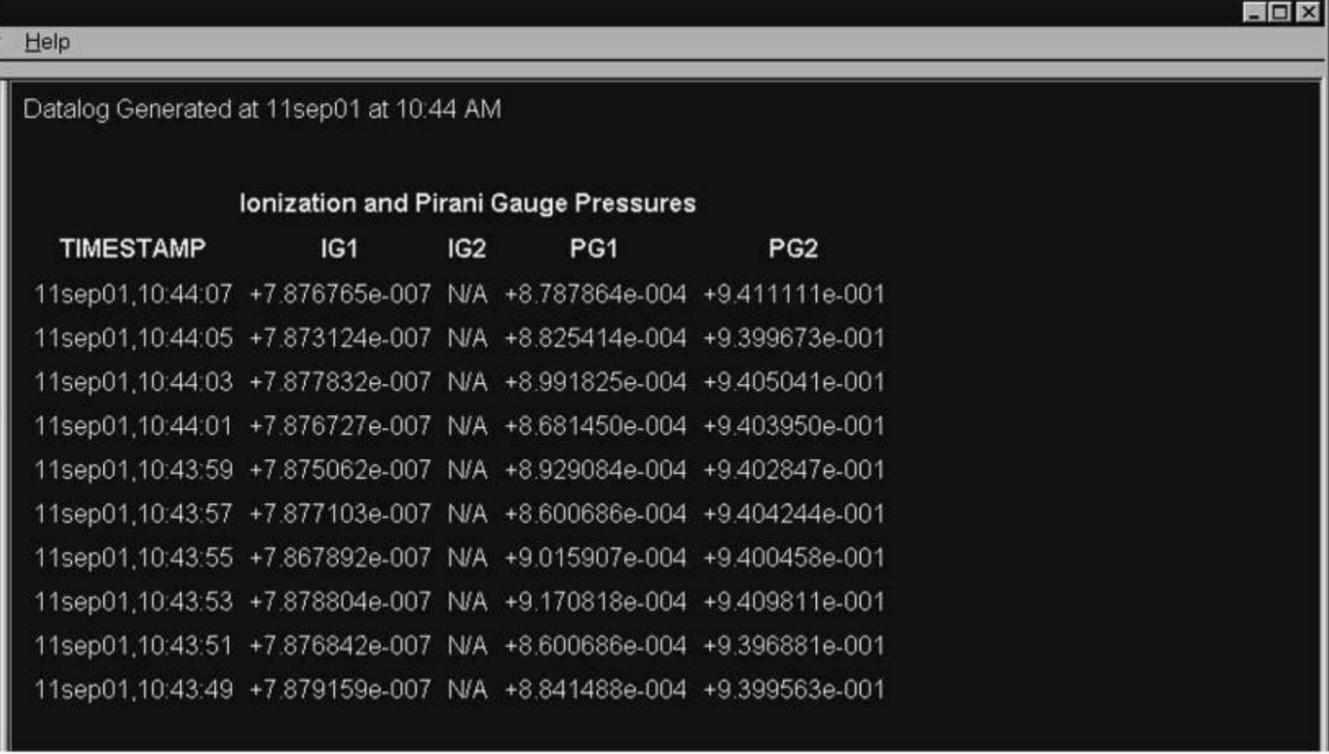
Ionization and Pirani Gauge Pressures

TIMESTAMP	IG1	IG2	PG1	PG2
11sep01,10:44:07	+7.876765e-007	N/A	+8.787864e-004	+9.411111e-001
11sep01,10:44:05	+7.873124e-007	N/A	+8.825414e-004	+9.399673e-001
11sep01,10:44:03	+7.877832e-007	N/A	+8.991825e-004	+9.405041e-001
11sep01,10:44:01	+7.876727e-007	N/A	+8.681450e-004	+9.403950e-001
11sep01,10:43:59	+7.875062e-007	N/A	+8.929084e-004	+9.402847e-001
11sep01,10:43:57	+7.877103e-007	N/A	+8.600686e-004	+9.404244e-001
11sep01,10:43:55	+7.867892e-007	N/A	+9.015907e-004	+9.400458e-001
11sep01,10:43:53	+7.878804e-007	N/A	+9.170818e-004	+9.409811e-001
11sep01,10:43:51	+7.876842e-007	N/A	+8.600686e-004	+9.396881e-001
11sep01,10:43:49	+7.879159e-007	N/A	+8.841488e-004	+9.399563e-001

Figure 8-15. Web Output of datalog.

CSV Output

The CSV file is downloaded when you click Get Datalog. If the browser is not setup to automatically handle a .csv file, the data will be displayed in the browser. Users of Netscape Navigator can easily configure the browser to automatically launch Excel (or another graphing program) whenever a .csv file is downloaded.

In Navigator:

1) Go to Edit in the menu bar, and choose Preferences.

2) In the Category pane, double click on Navigator, then click on Applications.

3) Click on New Type. Enter the description "comma separated values", file extension "csv", MIME type "text" and browse to your application. Do not type the quote symbols!

4) Click OK.

5) Download the CSV data and your chosen application should open. Remember, the application must be able to handle data in this format!

Internet Explorer uses the Windows file associations. Installing Excel usually associates .csv files to Excel. If you need to add the association, go to Windows Explorer or My Computer. Go to View in the menu bar, then choose Options. Click on the File Types tab. Either edit an existing entry or add a new one.

If Internet Explorer will not automatically open Excel, try saving the downloaded csv data to a file. To do this, right-click on the downloaded data frame and choose view source. This usually opens a Notepad window with the data in it. Save this file to disk. Either double-click on this file to launch Excel or open it from within Excel.

Note
The EWS is limited in how much data it can send out at a time. Selecting fewer quantities (for example, pressures only instead of pressures and relay states) will increase the number of log points you acquire in a single CSV download.

Get Userlog

This feature is simply for security purposes. It displays the recent activity on the EWS and it shows the IP address and files accessed.

The network settings of the IGC100 are also displayed, including the MAC address.

E-Mail Status

E-mail notification is available in units with the Process Control option.

This page displays information about e-mail notification including a summary of the e-mail setup and a list of e-mails which have been sent from the IGC100. In addition, the number of messages sent is shown along with the maximum number allowed.

For more information about setting up e-mail, see the next section 'Controlling the IGC100'.

Controlling the IGC100

The world wide web allows the ultimate in remote control. You can change parameters of the instrument from virtually any location. For security purposes, the EWS only allows control of relay states, email configuration, and ion gauge power. All the control functions are under the security layer and require either the correct trusted IP address and/or password in order to gain access.

Request Control

If web control is disabled from the front panel of the IGC100, the control functions do not appear on the EWS web pages. If control is disabled while someone is browsing the page, the control functions will still be in the web page, but any control operation is prevented.

You must logon as the controller before any of the control functions can be accessed. Click this button to logon as the controller. Once you log in, the page reloads, and this button is re-drawn as 'Release Control'. *Only one user can have control of the EWS at a time.*

The logon prompt depends upon the type of security selected on the IGC100. If you have selected password or both password and IP checking security, you will have to enter the password. If you are just using IP checking for security, no password is required. In both cases, you will need to enter a controller name for identification purposes.

If someone is already controlling the instrument, you will be informed of their logon name, their IP address, and how long it has been since that controller performed a control function (their idle time). If the current controller has been idle for hours, it is likely they simply forgot to logout by clicking 'Release Control'. For this reason, *you are allowed to take control from an idle user, provided you know the password and/or have a trusted IP.*

Release Control

Click this button to logoff as the controller of the instrument.

Note
E-mail notification will remain enabled after control is released.

E-Mail Notices

This function allows configuration of the e-mail notification feature. In order to use e-mail, you must have entered a valid gateway address in the IGC100. A valid Simple Mail Transfer Protocol server (SMTP) address is also required. The gateway address is required so the EWS can access the SMTP server. The SMTP server is the machine (typically outside your network) that accepts e-mail and routes it to the appropriate address. These addresses should be obtained from your local network administrator.

Remember, e-mail is inherently unreliable - SMTP servers fail, delivery time is inconsistent, you don't read your mail regularly, etc. *Use e-mail notification as a backup*

to an interlock system, not in replacement of one. Since the only purpose of e-mail is to alert users to process control changes, this button will be functional only if the IGC100 has the Process Control option.

E-Mail Configuration		
SMTP Server: (IP or mnemonic)	`129.156.023.040`	
From: (Set if needed)	`igc100@fablab.net`	
Send Email To: (Primary addr.)	`st1@fablab.net`	
Cc Email To: (Secondary addr.)	`let@fablab.net`	
Send at most :	`16` E-mail notices	
E-mail is :	⦿ Disabled	○ Enabled
Send A Test Message :	`Type a test message here.`	
CH#/Desc.	**Event:**	**Message Text (up to 50 chars)**
☑ CH1 GATE VALVE	Activation	`Gate valve closed! Call x244!`
	Deactivation	`Gate valve open`
☑ CH2 HEATING JACKET	Activation	`Heating Jacket back on`
	Deactivation	`Heat Jacket is off; check wires`
☑ CH3 TURBO PWR	Activation	`Turbo pump running.`
	Deactivation	`Turbo pump is off! Call x244!`
☐ CH4 WATER LINE	Activation	
	Deactivation	

Figure 8-16. E-Mail configuration web page.

Testing the E-Mail Function

It is very important to test the e-mail function before using it routinely. If any address is incorrect, you will never get an e-mail notice.

1. Set the SMTP address. Make sure you type it correctly. If you are using a verbose address (relay.mailhandling.com), make sure the DNS address was entered correctly on the IGC100.

2. Set the "from" address. The SMTP may require a "from" address that has a certain domain name. The domain name is typically the string after the '@' sign in an e-mail

address. For example, if your e-mail address is me@mycompany.com, you may wish to use igc100@mycompany.com as the "from" address. Ask your network administrator if a particular domain name is required is required to use your SMTP server.

3. Set the "to" address; this is the e-mail address where you want notifications to be sent.

4. Click the 'Send A Test Message' button.

To learn the fate of your e-mail message, click 'E-Mail Status'. Your sent e-mail and the reply from the SMTP server will be listed there. Any reply other than "250 - OK" is an error. Click 'E-Mail Status' again to refresh the status if it was listed as "-2 -Awaiting reply". If the SMTP reply is "-1 : No Reply", a connection to the SMTP server was never made. Re-check your physical network connection as well as the gateway and SMTP addresses. If no error occurs, but you still do not receive the email, check the "from" and "to" addresses used.

Using the E-Mail Function
Once you have successfully tested the e-mail function, you can set a carbon copy (CC) address to send a copy of the notice to another user. Use only one e-mail address in the CC field.

1. Set the e-mail notices to "Enabled". A test message can always be sent by clicking the "Send A Test Message" button, even if e-mail notification is disabled. If you will be unable to receive e-mail for an extended period, it is a good idea to disable relay-linked e-mail notification.

2. Set the maximum number of relay-linked e-mail notices the EWS is allowed to send. This feature prevents accidental flooding of your mailbox. The default is 16. You probably wish to limit this number even further. The maximum cannot be set higher than 32.

3. Link process relays to e-mail notices by clicking their checkboxes. The subject line of each e-mail will be the channel number of the relay that changed and its new state, e.g. "Channel 1 : Inactive".

4. Enter a message you wish to send in the notification for both the activation and deactivation of the relay. Note the message cannot be more than 50 characters long.

5. Click "Use This E-Mail Configuration" to store your e-mail setup in the EWS. Verify the configuration is correct by clicking "E-Mail Status".

6. Test that your configuration by manually changing the state of a linked relay from the front panel.

If you wish to clear the configuration when you begin a new process, click "Erase This E-Mail Configuration".

To reset the e-mail count after a number of e-mails have been sent, disable then re-enable e-mail.

Note
E-mail notification remains enabled after control is released.

Ion Gauge Power

> **Warning!**
> Turning an ion gauge on or off from a remote interface can be dangerous. Make sure you understand your vacuum system and any process controls that depend upon ion gauge data before using this feature.

This function allows you to turn an ion gauge on or off, as well as choose the filament usage mode.

Figure 8-17. Controlling the Ion Gauge.

Change Relays

> **Warning!**
> Changing relay states from a remote interface can be dangerous. Make sure you understand your vacuum system and all process controls you have in place before using this feature. This feature will not be functional if the IGC100 does not have the process control option.

By clicking this button, you receive a web page showing the current state of all eight relays of process control. You can set a relay to be active, inactive, or under automatic control. To send your desired relay states to the IGC100, click the button labeled "Click Here To Set All 8 Relays".

Function : CONTROL

Process Control Status at 11sep01 at 11:00 AM

Channel	1	2	3	4
Description	GATE VALVE	HEATING JACKET	TURBO PWR	WATER LINE
Current State	ACTIVE	ACTIVE	ACTIVE	ACTIVE
	MANUAL	MANUAL	MANUAL	MANUAL
Desired State	○ Inactive ⊙ Active ○ Auto	○ Inactive ⊙ Active ○ Auto	○ Inactive ⊙ Active ○ Auto	○ Inactive ⊙ Active ○ Auto

Click Here To Set All 8 Relays

Channel	5	6	7	8
Description	DETECTOR	DIFF PUMP	PULSED VALVE	MECH PUMPS
Current State	INACTIVE	ACTIVE	INACTIVE	ACTIVE
	AUTO	MANUAL	MANUAL	MANUAL
Desired State	○ Inactive ○ Active ⊙ Auto	○ Inactive ⊙ Active ○ Auto	⊙ Inactive ○ Active ○ Auto	○ Inactive ⊙ Active ○ Auto

Figure 8-18. Relay control web page.

Networking Terms

Some terms that are used throughout this chapter are defined here.

Server
A server is simply a computer capable of delivering data to another computer. Typically, the server is *only* used to deliver data and all its resources are allocated to that task.

IP Address
Each computer that is connected to the world wide web needs to have a unique address in order for other machines to access that computer. An IP address is made up of four bytes. It is often expressed as a set of three digit numbers separated by a '.', e.g. 209.239.160.084.

Static IP Address
A static IP address never changes. Static IP addresses are often used for servers, so that computers on the web can find them.

Dynamic IP Address
A dynamic IP address changes frequently. Often, clients have dynamic IP addresses that are assigned to them when they boot up. When you use a dial-up connection, an IP address is assigned to you each time. This means you get a different IP address every time you logon from a dial-up connection.

Fictitious IP Address
Networks that are not directly connected to the world wide web sometimes use fictitious IP addresses valid only for local communication. Machines connected to this type of network are not directly accessible from outside that network. This improves security of the network and conserves the number of real IP addresses required for a facility. A network of fictitious addresses can be connected to the web using a router.

MAC Address
The media access control (MAC) address is another unique address that belongs to the physical network interface card. It is sometimes called an 'ethernet address'. It is often expressed as a series of hexadecimal codes separated by a dash (for example, 00-00-1A-18-FF-00). The Internet Protocol (IP) maps each machine's individual MAC address to an IP address.

DNS Address
People have a difficult time remembering and using long strings of numbers, so domain name servers are in use. You can think of these machines as a kind of telephone book - they associate a particular IP address (209.239.160.084) with a string of characters (www.thinksrs.com). A DNS is not required to use the EWS, but it can make your life a little easier.

SMTP Address
In order to send e-mail, a special machine called a Simple Mail Transfer Protocol server is often used. These servers respond to commands for sending e-mail and will forward your messages to the recipient's local mail handling machine.

Chapter 9

Troubleshooting and Maintenance

Troubleshooting a vacuum system can be a complex and daunting task. This chapter contains troubleshooting information for the IGC100 and some typical gauges. Please read and follow all warnings presented in this chapter. See 'Safety and Preparation for Use' at the beginning of this manual to remind yourself of some of the dangers involved in working with vacuum systems.

In This Chapter

Warnings

- **Read and follow all 'Safety and Preparation for Use' warnings before handling this product (see front of this manual).**

- Dangerous voltages, capable of causing injury or death, are present in this instrument. Use extreme caution whenever troubleshooting any of its parts.

- Do not substitute parts or modify the instrument. Do not use the product if it has unauthorized modifications. Return the product to Stanford Research Systems for service and repair to ensure that safety features are maintained.

- Use only SRS supplied replacement/accessory parts.

- The IGC100 controller does not have any serviceable parts other than the Degas Fuse.

- Consult the 'Damage Requiring Service' section at the end of this chapter for instructions on how to return the instrument for authorized service and adjustment.

Resetting the IGC100

If the unit appears to be 'hung' and unresponsive to front panel inputs, disconnect and then reconnect line power.

To reset the instrument to its default settings, turn the unit on (using the red POWER key) while holding down the IG AUTO key.

Error Detection

Important
Diagnose and troubleshoot problems as soon as they are detected.

Even though the hardware tests built into the IGC100 can test the instrument for a large variety of problems, they cannot detect all possible error conditions.

If system downtime is of prime concern, it is recommended that a spare IGC100 unit be available for immediate replacement in the cause of failure or problems.

Built-in Checks

Several built-in hardware test procedures automatically check the IGC100 when the instrument is turned on, and continuously monitor the internal workings of the unit during operation.

All detected errors are immediately reported through on-screen messages, audio alarms or over the computer interfaces.

Error Messages
Text error messages are shown in the Data Bars and Data Boxes of the IGC100 display. Consult the 'Error Messages' section of this chapter for more information.

IG1	**EMISSION OFF**	fil 1 Manual Torr HV CHAMBE

Touch the Data Box and choose 'Status Information' to display an explanation of the gauge status.

IG1	1.35-07 Operating normally front panel	fil 1 Manual Torr HV CHAMBE
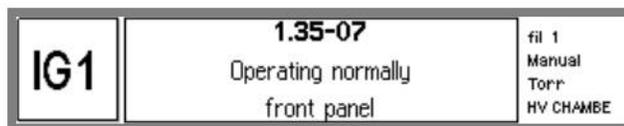
Audio Alarms
Sounds are used to draw the user's attention to potentially serious problems.

Error Status Words
Internal status words signal all status and error conditions through the computer interfaces.

Event Logging

All gauge related events (such as power on/off, degas on/off, overpressure shutdown, etc.) are stored in the Gauge History log. Use the [History] QuickKey in the Gauges Display to trace the gauge history and diagnose gauge failures and problems.

All Process Control events are stored in the Process History log. Use the [History] QuickKey in the Process Control Display to trace all channel actions and debug your process control settings. Use the [Overview] QuickKey to list the state and rules for all the Process Control channels.

Filament Protection

Use 'Overpressure Shutdown' and/or 'IG Auto-Start' to provide effective protection of delicate ion gauge filaments against accidental overpressure.

For More Information

Consult Chapter 3 for details on the proper implementation of 'Overpressure Shutdown' and 'IG Auto-Start'.

Remote Status Checking

Status reporting commands are available to query the Gauge and Process Control Status through the computer interfaces. Users developing their own control software should integrate status checking commands into their programs and use them to monitor the condition of their system. Status checking and error reporting should be an integral part of any custom-built control software.

For More Information

Consult Chapter 7 for a complete listing of the error checking commands and status registers.

Interface Queues

The IGC100 buffers the most recent characters received and transmitted over the RS-232, GPIB and Web interfaces. A Queue Display, accessed through the Remote submenu of the Main Menu, shows the interface history for both transmitted and received data. Use this feature to troubleshoot communications during the development of your custom control software.

For More Information

Consult the RS-232, GPIB and Web Queue menu items in Chapter 3 of this manual. Consult Chapter 7 for communications troubleshooting information.

Error Messages

Error Messages alert IGC100 users of instrument malfunctions detected during normal operation. They are short descriptive messages (one or two words) displayed within a Port Data Box or Data Bar where measurements are normally displayed. Touch the Data Box and choose 'Status Information' to display a more complete description of the problem.

The following tables list all Error Messages, along with possible causes and recommended solutions.

Pressure/Voltage Display

Error Message	Cause	Solution
UNDERRANGE	The IGC100 cannot display a number this small.	
OVERRANGE	The reading exceeds the range of the controller.	Reduce the pressure or voltage in your system.
NEGATIVE	The IGC100 cannot display negative numbers in this display mode.	Rezero the controller. Choose a different display mode.
OVERLOAD	The input voltage is beyond the ±12V range of the analog I/O port.	Limit the voltage range of the input signal. Use a voltage divider if necessary. Reduce the pressure of the capacitance manometer connected to the port.
FAULT	There is a serious system hardware problem in the controller that needs immediate attention.	Contact SRS. Do NOT use the IGC100 until the problem is diagnosed.
RESET	There has been no data to display since the unit was turned on.	Contact SRS.
ADC PROBLEM	The CM is connected to an analog I/O port configured as an output.	Configure the capacitance manometer port as an input so that you can read pressures directly.
WAIT	The controller is computing the answer. Emission current is being established in the ionization gauge.	Wait for the answer. Wait for the emission current to stabilize.
NOT SELECTED	The gauge has not been selected.	Select the gauge.

Gauges

Error Message	Cause	Solution
NO HARDWARE	The hardware required to operate the gauge is not present, or is not being recognized by the controller.	Contact SRS.
NO GAUGE	No Pirani gauge is detected.	Connect a gauge.
	Pirani gauge is unplugged.	Plug in the gauge.
	Signal cable (O105C4) is damaged or not properly connected.	Check the cable connection at both ends. Switch connectors (dual cable). Try a different O105C4 cable if available.
	Open sensor wire.	Perform Gauge Test Procedure (see Maintenance).
		Replace gauge head.
POWER OFF	Pirani Gauge power is turned off. No pressure readings are available.	Turn Pirani Gauge on from its Gauge Setup menu. (NOT in the presence of flammable or explosive gases).
EMISSION OFF	All ionization gauges are turned off.	Turn an ionization gauge on using the IG1 (or IG2) button on the front panel.
NO FILAMENT	IGC100 failed to detect a filament after the gauge emission was turned on.	IMPORTANT! Use only ionization gauge signal cables provided by Stanford Research Systems.
	Ionization gauge is unplugged.	Connect the gauge to the controller using proper signal cable.
	Nude ionization gauge pins improperly connected to O100C3 signal cable connectors.	Check instructions in Chapter 1 for proper connection of O100C3 cable to a nude gauge.
	Wrong signal cable is being used.	Use Appendix B to find the correct signal cable for your gauge.
	Defective Signal cable or connector.	Check for continuity between both ends. Try a different cable if available.
	Open filament in the gauge.	Inspect the filament visually (glass gauge), or with an ohmmeter (nude gauge) Consult appendix B for pin assignments. Try the second filament in a dual gauge system. Replace the filament assembly if possible. Get a new gauge if necessary.
	Defective Gauge tube.	Replace the gauge.
PG OFF	The Pirani gauge linked to Auto-Start function was off when the IG AUTO button was pressed.	Turn the PG on, and press the IG AUTO button again.

Error Message	Cause	Solution
EMISSION FAIL	IG will not turn on or turns on briefly then shuts off.	
	Badly contaminated filament will not support the emission.	Bakeout the gauge overnight (if possible). Replace the filament or the gauge if emission still cannot be turned on. Identify the contamination source and eliminate it.
	Badly damaged filament will not support the emission.	Replace the filament or the gauge. Filaments are easily damaged during degas and in the presence of corrosive and reactive gases. Check gauge history for overuse of degas cycles and recurring overpressures.
	IG at too high pressure.	Reduce the pressure in your system. Check for leaks and contamination sources, use an RGA or leak tester if available.
	Defective Gauge tube.	Try another tube.
	Gauge cable too long.	Use a shorter cable.
	Degas power too high.	Reduce degas power setting.
		Reduce ion gauge cable length.
		Switch to single filament operation in the ionization gauge.
	Degas Fuse is blown.	Replace the Degas Fuse. See Maintenance for procedure.
	Incorrect Gauge Protection Mode.	Use the proper Gauge Protection setting for the gauge.
	Controller failure.	Contact SRS
OVERPRESSURE	Overpressure Shutdown function is turning off the gauge.	Increase the Overpressure Threshold.
		Increase the Overpressure Delay to ignore short pressure bursts.
		Eliminate the source of the pressure burst.
TTL LOCKOUT	The ionization gauges are turned off by the IG_Lockout pin of the TTL Remote Control Module (opt 03). The IG1 and IG2 gauges remain off as long as this pin is held LOW, and IG_Remote_Enable is LOW.	Set the IG_Lockout pin high or disable Remote Control (set IG_Remote_Enable=High).

Basic Troubleshooting

This section documents symptoms, causes and possible solutions for some of the common problems encountered during the operation of an IGC100 controller.

Note
The problems listed below DO NOT GENERATE Error Messages.

Input Power

Power Problems		
Symptom	**Possible Cause**	**Solution**
LINE LED is off	No AC power available to the controller	Check your connection to the AC power outlet.
		Look for defective power outlet, defective power cord or power cord not connected.
	Defective internal power supply module	If AC power is available to the controller but the LED is still off, contact SRS.

Ionization Gauge

Ionization Gauge Problems		
Symptom	**Possible Cause**	**Solution**
Pressure reading is very inaccurate	Defective collector cable	Try a different cable.
	Electrical leakage in the gauge head	Bakeout the gauge. Replace the gauge if no change.
	Defective electrometer circuit	Contact SRS.
	Tube sensitivity improperly programmed	Reprogram the gauge's sensitivity factor.
	Incompatible gauge settings	Select settings compatible with your gauge.
	Contaminated gauge head	Bakeout and/or degas the gauge. Replace the gauge if no change.
	Unknown gas composition	Use an RGA to analyze gas composition. Use Gas Correction Factor to adjust readings to the gas. Look for leaks or contamination sources
	Poor conductance in gauge's connection to vacuum system	Move the gauge to the point-of-measure and/or increase conductance.
	Cross-talk with other ion sources	Separate the ionization gauge from other ion sources such as magnetrons, RGA's, ion pumps, ion guns, etc.

Ionization Gauge Problems		
Symptom	**Possible Cause**	**Solution**
Pressure reading too low	Collector cable disconnected or damaged	Check the signal cable connections. Replace the cable if necessary.
	Defective electrometer circuit	Contact SRS.
	Defective gauge head	Replace the gauge.
Pressure readings erratic	Gauge head badly contaminated	Bakeout, and/or degas, Replace the gauge if no change.
	Improper grounding	Perform a Proper Grounding Test (see Chapter 1).
	Bad collector cable or connection	Check connection or try a different cable.
	Faulty electrometer	Contact SRS.
	Cross-talk with other ion sources	Turn off all other sources of ions. Separate/shield the gauge from other ionization gauges, RGA's, ion pumps, etc.
Filament is unusually bright as soon as power is applied to IG	Contaminated filament	Bakeout, degas or replace the gauge. Try alternate filament if available. Identify and eliminate any source of contamination.
	Pressure is too high	Reduce the pressure at the gauge.
	Defective power supply	Contact SRS.
Degas will not turn on	IG not turned on	Turn on the ionization gauge before pressing the DEGAS switch.
	Pressure is above 2×10^{-5} Torr	Degas will not start if the pressure is above 2×10^{-5} Torr.
	Defective switch or power supply	Contact SRS.
IG shuts off after degas is initiated	Badly damaged filament	Replace the filament assembly or the gauge.
	Pressure rises above 5×10^{-5} Torr during degas	Reduce the initial pressure at the gauge.
	Badly contaminated tube	Bakeout or replace the tube.
	Degas power too high for gauge	Lower the degas power setting.
		Switch to single filament operation.
		Reduce the cable length.
	Incorrect Gauge Protection setting	Choose the proper Gauge Protection setting for the gauge.
	DEGAS FUSE blown	Replace the fuse (See Maintenance).
Degas power fluctuates during degas	Pressure rises above 2×10^{-5} Torr during degas	Reduce initial pressure at the gauge.

Pirani Gauge

Pirani Gauge Problems		
Symptom	**Possible Cause**	**Solution**
Pressure reading grossly in error	Gauge contaminated	Perform Pirani Gauge Cleaning Procedure and/or Bakeout the gauge (PG105-UHV only).
	Unknown gas type	Identify the gases in your system, use an RGA if available.
	Improper tube orientation	Mount tube horizontally for pressure readings above 1 Torr.
	Sensor damaged	Replace the tube.
	Excessive mechanical vibration	Remove the vibrations or mechanically isolate.
	Out of range temperature.	Control the temperature around the gauge.
	Wrong calibration curve	Check the calibration source.
	Poor conductance in gauge's connection to vacuum system	Move the gauge to the point-of-measurement, or increase conductance.
	Controller out of calibration or faulty electronics	Contact SRS.
Gauge zero reading is off	Gauge out of calibration	Adjust ZERO setting (using the Gauge Setup menu).
	Gauge contaminated	Perform Pirani Gauge Cleaning/Bakeout Procedure. See Maintenance.
Gauge atmosphere reading is off	Gauge out of calibration	Adjust ATM setting (using the Gauge Setup menu).
	Gauge not mounted horizontally	Mount gauge horizontally.
	Excessive vibration	Isolate the gauge from the source of vibrations.
Gauge Zero out of calibration range	The gauge is severely contaminated and the ZERO adjustment can no longer compensate for drift.	Perform Pirani gauge Cleaning/bakeout Procedure, or replace the gauge.
	The controller is faulty	Contact SRS.

Capacitance Manometer

Capacitance Manometer Problems		
Symptom	**Possible Cause**	**Solution**
Pressure reading grossly in error	Gauge contaminated or damaged	Consult your gauge manual or manufacturer for possible solutions.
	Excessive mechanical vibration	Remove the vibrations or mechanically isolate.
	Wrong full range (CM Pmax) setting	Check the CM Pmax value, and adjust if necessary.
	Poor conductance in gauge's connection to vacuum system	Move the gauge to the point-of-measurement, or increase conductance.
	Gauge needs to warm up	Temperature compensated gauges need up to one hour to completely warm up.
	Controller out of calibration or faulty gauge electronics	Contact SRS.
	Wrong supply voltage	Check power supply voltage and current limit settings. Do not use the AUX ±15V supply for heated gauges.
Gauge zero is off	Zero drifted off	Adjust the Zero calibration (using the Gauge Setup menu).
		Perform a Trim-Pot Zero Adjustment. Consult Chapter 3 for details.
Gauge Pmax reading is Off (Vout ≠10V when P=Pmax)	The gauge's gain calibration has drifted. This is a rare problem.	Follow the manufacturer's recommendations to adjust your gauge's calibration trim pots.
Gauge reading is too low and unresponsive to pressure changes	Gauge is unpowered	Check your cable and connections, check the current limit in your power supply, check the power supply operation.
	Gauge output circuit is faulty	Contact the gauge manufacturer.
Gauge reading is 'OVERLOAD'	The pressure output signal from the CM exceeds 12V	Reduce the pressure at the CM until it is below Pmax.

Process Control

Process Control Problems		
Symptom	**Possible Cause**	**Solution**
Channel output does not respond to input signal	Incorrect rules	Review the Channel Rules.
	Bad connection	Check the channel connections.
	Delay is too long	Reduce the Delay setting.
	Hysteresis is too large	Reduce the Hysteresis setting.
Channel activates at wrong setpoint or time	Incorrect rule	Check the Channel Rules – Setpoint, Hysteresis and Delay settings
Relay closure does the opposite of what is expected	Wrong connection	Check the relay connection. Each SPDT relay has three connection pins, make sure you are connected to the right ones.
Relay contact opens and closes intermittently around the setpoint	Hysteresis percentage setting is too small	Increase the Hysteresis Percentage setting. Check for excessive noise in the input signal. Filter if necessary.

Analog I/O

Analog I/O Problems		
Symptom	**Possible Cause**	**Solution**
The analog output does not follow the log of the pressure of the gauge	The Analog I/O port is not configured properly.	Make sure the analog I/O port is configured as an Output and linked to the right gauge.
Analog reading is 'OVERLOAD'	The input signal exceeds ±12V range.	Reduce the input voltage until it is between –12V and +12V.

Maintenance

IGC100 Controller

IMPORTANT
The IGC100 controller box does not have any serviceable parts (other than the Degas Fuse) and requires no scheduled maintenance.

The IGC100 is only recommended for use in a clean, dry laboratory environment. Operation in other environments may cause damage to the controller and reduce the effectiveness of the safety features.

In all cases provide adequate ventilation for the control unit to dissipate heat - ≈1 inch clearance around the side ventilation slots is recommended. Allow at least 6 inches at the back of the controller for cable routing. Do not mount the unit above other equipment that generates excessive heat.

The IGC100 is designed to operate over the range 0-40°C. Ambient temperatures above that value might damage the product. For optimum electrometer stability (particularly while using calibrated gauges) the control unit ambient temperature should be 25±5°C.

Touchscreen

The surface of the touchscreen should be kept free of dirt, dust, fingerprints and other materials that could degrade its optical properties. Long term contact with abrasive materials will scratch the front surface and harm image quality.

Do not operate the touchscreen with the tips of pens or sharp objects that might permanently stain or damage the screen surface.

Use a clean, non-abrasive cloth towel and a commercial window cleaner to regularly clean the screen. The cleaning solution should be applied to the towel, NOT the surface of the touchscreen. Fluid may seep behind the panel if it is not cleaned properly. Turn off the unit or activate the Clean Touchscreen (Main menu, then Screen menu) while wiping the screen's surface.

Degas Fuse Test/Replacement

At pressures of 5×10^{-5} Torr and higher, a Bayard-Alpert ionization gauge can generate sufficient plasma that significant electrical coupling can occur between the anode grid and the metal parts of the vacuum system. The DEGAS FUSE is a safety device, built into the IGC100 to prevent the development of such electrical discharges inside the ionization gauge head during degassing.

> **WARNING!**
> Gas discharges in high voltage devices such as ionization gauges can be lethal in vacuum systems which are not properly grounded. Consult, Charles F. Morrison, "Safety hazard from gas discharge interactions with the Bayard Alpert ionization gauge", J. Vac. Sci. Technol. A 3(5) (1985) 2032, for a detailed explanation of this effect.

The DEGAS FUSE is connected in series with the anode grid, and is designed to burn out as soon as the electrical current through that electrode exceeds 250 mA. Removal of the bias voltage (500 Vdc degas, 180 Vdc normal) from the anode grid causes the filament to shut down, and extinguishes any discharge supported by the electrode structure.

A blown DEGAS FUSE is easily detected. Any attempt to establish an electron emission results in the "EMISSION FAIL" Error Message being displayed on the front panel instead of the expected pressure measurements.

In order to test and/or replace the DEGAS FUSE:

1. Disconnect the unit from its AC power cord.

2. Using a flat head screwdriver, remove the plug from the DEGAS FUSE receptacle on the back panel (quarter turn counterclockwise).

3. Remove the fuse, and use an ohmmeter to test electrical continuity between its ends.

4. If continuity is intact (i.e. fuse is OK) the emission problem is somewhere else. Consult the Troubleshooting section above.

5. If the fuse is blown (i.e. no electrical continuity between its ends) replace the fuse with a new one: DEGAS FUSE: 250mA, NB, Littelfuse 312.250

6. Replace the fuse plug and then the AC power cord.

7. Try turning a filament on to make sure emission is now possible.

Note

If the new fuse burns out as soon as emission is established, do not insert a new one until the cause for the failure is identified first. Contact Stanford Research Systems for additional help.

If emission is still not possible after replacing the fuse, consult the troubleshooting section above.

Ionization Gauges

Filament replacement, overnight bakeout and sensitivity adjustment are the three typical maintenance procedures performed on ionization gauges.

Filament Replacement

Since the electrodes are exposed, and easily accessible, most Nude ionization gauges are designed with replacement filament assemblies. This allows filaments to be replaced after a burnout without having to dispose of the entire gauge (an important cost saving feature!).

Contact Stanford Research Systems or your gauge manufacturer directly to order filament replacement kits for your gauges. Gauge refurbishing services, including both filament and electrode replacement options, are available from several vacuum hardware vendors.

Warning
Replacing the filament assembly in a nude ionization gauge will generally affect the sensitivity of the gauge.

Recommendation
Dual filament assemblies provide security against filament burnout if the system cannot be brought to atmosphere to change the filament or the gauge. They are the most cost-effective alternative for glass tubulated gauges where filament replacement is not an option. Do not expect both filaments to give identical readings in a dual filament gauge unless a high-accuracy gauge is being used.

Consult Appendix A of this manual for an in-depth discussion of the merits of different filament materials.

Use the Overpressure Shutdown and IG Auto-Start functions described in Chapters 2 and 3 to protect tungsten filaments against overpressures.

Bakeout

Outgassing is a pervasive effect that is observed in even the most carefully handled ionization gauges. An aggressive and prolonged degassing and/or bakeout can dramatically reduce gauge outgassing, but it will rarely completely eliminate it.

The most effective way to reduce the contribution of gauge outgassing is to bake out the gauge, along with as much of the rest of the vacuum system as possible, for an extended period of time (i.e. overnight typical).

Maximum recommended bakeout temperatures are: 450°C max for nude (all-metal) gauges, and 250°C for glass-tubulated gauges. Consult your gauge's specifications, or contact the manufacturer directly, for bakeout recommendations.

Frequently, an ion gauge is automatically degassed and/or the system baked after the gauge is exposed to ambient, or after surface contamination is suspected. Gauges will be

unstable for several hours following degassing until the chemical composition and adsorbed layers on the newly cleaned surfaces reach equilibrium. This effect must be carefully considered for high accuracy measurements.

Degas or Bake Out?

The recommendation from the NIST High Vacuum Group is to eliminate degassing by high temperature heating of the grid (whether resistive or electron bombardment). For baked systems, their observation is that gauges can be effectively outgassed by simply operating them at normal emission currents while the gauge and vacuum system are baked. For unbaked systems, the gauge can be baked and outgassed by thermally insulating it with fiberglass or similar material. Degassing by electron bombardment is only recommended if (1) the gauge is heavily contaminated or (2) after exposure to surface active gases such as O_2.

Sensitivity Adjustments

As an ionization gauge ages, its sensitivity drifts and its measurements become inaccurate. Long-term stability of its readings is affected by the gauge design, but most importantly, by its usage history. In most cases, ionization gauge sensitivity decreases with time.

It is highly recommended to check the accuracy of ionization gauge readings on a regular basis, by comparison against a secondary or working standard, and to keep track of the changes in sensitivity of each gauge with time. Sudden changes in the sensitivity may be indicative of increases in vacuum system contamination levels.

In order to check and/or readjust the sensitivity of your gauge, the following steps must be followed. Depending on the circumstances: (1) connect the secondary or working standard to your gauge's vacuum system, or (2) transfer your test gauge to a separate vacuum system (i.e. calibration station) containing the secondary or working standard. Make sure your gauge and the standard are exposed to the same pressure (within the tolerance of your measurements).

Pressurize the vacuum system with nitrogen up to a pressure level around the mid-range of your gauge. Typical pressures used are around 5×10^{-6} to 10^{-5} Torr (and at least 2 decades above base pressures)

Compare your test gauge readings (P_{gauge}) against those of the standard (P_{std}).

Uncalibrated Gauges

Uncalibrated gauges rely on the mid-range N2 Sense factor (stored in the controller) to calculate pressures from ion currents. Small drifts in sensitivity are common and can be easily compensated by adjusting the value of the sensitivity factor.

After recording the pressure measurements of your gauge against the calibration standard, calculate the sensitivity factor value for the test gauge based on the equation below and enter the new N2 Sense Factor into the controller.

$$N_2 \text{ Sense Factor (new)} = N_2 \text{ Sense Factor (old)} \times (P_{gauge} - P_{0g} / P_{std} - P_{0std})$$

where P_{0g} and P_{0std} are the background pressure as measured by the gauge and the standard. Note that this same procedure can be used to calibrate the N2 Sense Factors for gauges (1) when only nominal values (as provided by the manufacturer) are known or (2) where calibration for a different gas is required.

Tip

For maximum accuracy and to eliminate the effects of background gases, use pressure steps in the above equation to calculate the new sensitivity factor.

Calibrated Gauges

Calibrated gauges rely on data downloaded from a Memory Card to provide accurate pressures from ion signals. Small drifts in sensitivity with time are unavoidable, and are accepted as long as they do not extend beyond the accuracy tolerance of your measurement scheme. However, if comparison against a secondary or working standard indicates large drops in sensitivity, beyond acceptable levels, the gauge will need to be recalibrated. For information on ionization gauge calibration options available from Stanford Research Systems, consult appendix F of this manual.

Pirani Gauges

Zero and ATM adjustments.

The PG105 Pirani gauge calibration data loaded into all IGC100 controllers is based on the response of a new gauge free of contaminants. If a tube becomes contaminated or does not seem to read correctly, the front panel readings can often be adjusted using the 'ZERO and 'ATM' calibration menus. The ZERO and ATM adjustments built into the IGC100 make it possible to accommodate considerable drifts in PG105 calibration while retaining acceptable measurement accuracy.

To access the Zero and Atm calibration menus, bring up the Gauge Setup menu for the Pirani gauge port (PG1 or PG2), then touch [Atm] or [Zero] and follow the on-screen instructions.

Note

For accurate results in the 10^{-4} Torr range, ZERO readjustments of the gauge's readings should be performed periodically.

Use the Cleaning and Bakeout procedures described below if the calibration adjustments fail to correct for drifts in the calibration.

Cleaning Procedure

IMPORTANT!

- This cleaning procedure should only be used on severely contaminated gauges, when the ZERO and ATM calibration adjustments can no longer correct for drifts in the calibration.

- Stanford Research Systems does not guarantee that this procedure will remove contamination from a PG105 convection gauge.

- Use this cleaning method as a last resort only!

Warning!
The fumes from acetone and isopropyl alcohol can be dangerous to your health if inhaled and are highly flammable. Work in well ventilated areas and away from ignition sources!

Materials:

- Isopropyl alcohol or acetone, electronic grade or better.

- Wash bottle with long thin neck

Procedure

1. Disconnect the gauge from the O105C4 cable and from the vacuum system port. Disconnect the detachable plastic connector from the back of the gauge tube and store it in a safe and clean place. See Figure 9-1.

2. Hold the metal gauge tube in a horizontal position with the side port pointing upwards at a 45° angle. Slowly fill the volume of the gauge with solvent using the wash bottle to squirt the liquid into the side tube. Let the solvent stand inside the gauge for at least 10 minutes. Do not shake the gauge, since that might cause damage to the sensor wire. To drain the gauge, position it horizontally with the side port facing downward. Slightly warming the gauge will help dry the gauge. Allow the gauge tube to dry overnight with the port facing downward. Before reattaching the gauge to the system, be certain no solvent odor remains.

3. Viton O-rings soaked in organic liquids can outgas solvent molecules for extended periods of time. Solvent outgassing rates can be significantly diminished: (a) baking the gauge tube overnight in a vacuum oven between 100-110°C before gauge installation or (b) baking out the gauge while attached to the vacuum system and before reconnecting its plastic connector.

Bakeout Procedure

WARNING!
The detachable plastic connector must be physically disconnected from the PG105 gauge head during bakeout.
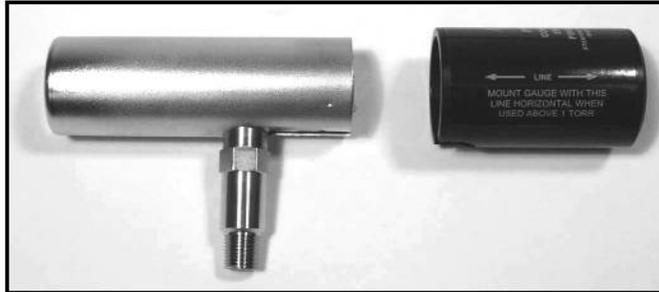

Figure 9-1. Side view of the PG105 gauge tube with the detachable plastic connector disconnected.

Periodic, overnight, gauge bakeouts provide an effective way to minimize contamination buildup problems. Maximum bakeout temperatures are 110°C for standard (i.e. Viton O-ring sealed) heads, and 250°C for metal-gasket sealed tubes (PG105-UHV) used in UHV or low contamination applications.

NOTE
An overnight bakeout, at 200-250°C, is the only recommended cleaning procedure for PG105-UHV gauges in direct contact with ultra high vacuum environments.

PG105 Gauge Test Procedure

Breakage of the small diameter sensor wire located inside the tube is a common failure mechanism for all Pirani gauges. Fortunately it is very easy to test the PG105 gauges for electrical continuity, to determine the integrity of both the sensor and temperature compensation wires.

WARNING!
Use an ohmmeter that cannot apply more than 0.1 V when the gauge is at vacuum or 2 V when at atmospheric pressure.
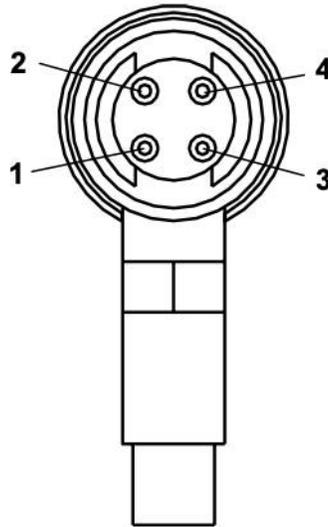

Figure 9-2. Back view of the PG105 tube, with the plastic connector removed.

1. Disconnect the Detachable Plastic Connector from the PG105 gauge head. Four feedthru connector pins are now easily accessible from the back of the gauge tube as schematically represented in Fig. 9-2.

2. Following the pin assignments of Fig. 9-2, measure the resistance between pins 1 and 4 and between pins 2 and 3. The nominal wire resistances are:

Pins	Wire	Expected value (Ohms)
1 to 4	Sensor	20 – 22
2 to 3	Compensate	35 - 40

3. Gauge wires are not replaceable! Replace the gauge head if the wire resistance values do not fall within the ranges specified above.

Damage Requiring Service

Caution
Do not use this product if it has unauthorized modifications. Unauthorized modifications may result in fire, electric shock and other hazards.

Do not use accessories not recommended in this manual as they may be hazardous.

Note
Within this section, the word 'product' specifically refers to the IGC100 Ion Gauge Controller, any of its accessories, or any SRS manufactured vacuum gauge.

Contact the factory for instructions on how to return the instrument for authorized service and adjustment.

Service of this product, by Authorized Service Personnel only, may be required under any of the following conditions:

- Any cable or plug is damaged.

- The product does not operate properly even after strictly following the operating instructions.

- The product exhibits a distinct change in performance.

- A liquid has spilled inside the product.

- The product has been exposed to rain or water.

- An object has fallen into the product.

- The product has been dropped or the enclosure has been damaged.

- The product contains unauthorized modifications. Do not substitute parts or modify the product. No user-serviceable parts are inside the controller. All service and repair information in this manual is for the use of Authorized Service Personnel only.

- The repair and/or service of products exposed to vacuum systems can only be carried out if a completed Declaration of Contamination (at front of manual) has been submitted. Stanford Research Systems reserves the right to refuse acceptance of vacuum equipment where the Declaration of Contamination has not been fully or correctly completed. SRS also reserves the right to deny return authorizations for any vacuum equipment that could potentially be harmful to the personnel carrying out the repair and service of the product.

Chapter 10

Testing

The performance tests described in this section are designed to verify to a high degree of confidence that the unit is performing within its published specifications.

The result of each test may be recorded on the Test Sheet included at the end of this section.

In This Chapter

Warnings

- **Read and follow all 'Safety and Preparation for Use' warnings before handling this product (see front of this manual).**

- **These tests should only be performed by qualified trained electronics technicians.**

- **Dangerous voltages, capable of causing injury or death, are present in this instrument.** Use extreme caution whenever troubleshooting any of its parts.

- Do not substitute parts or modify the instrument. Do not use the product if it has unauthorized modifications. Return the product to Stanford Research Systems for service and repair to ensure that safety features are maintained.

- Use only SRS supplied replacement/accessory parts.

- The IGC100 controller does not have any serviceable parts other than the Degas Fuse.

- Consult the 'Damage Requiring Service' section at the end of Chapter 9 for instructions on how to return the instrument for authorized service and adjustment.

Getting Ready

Necessary Equipment

The following equipment is necessary to complete the Performance Tests described in this chapter. The suggested equipment, or its equivalent, should be used.

DC Multimeter

DC Voltage Range [resolution]: 1000 V [1 mV]
Accuracy: 0.005%
DC Current Range [resolution]: 1 A [1nA]
Accuracy: 0.005%

Recommended: Hewlett-Packard HP 3458A Multimeter

DC Calibrator/Source

Voltage range: -20V to 20V
Accuracy: 0.02%
Current range: 2pA-20mA
Accuracy: 0.1% above 1 nA, 0.5% below 1 nA.

Recommended: Keithley Model 263 Calibrator/Source.

Low Noise Coaxial Cable

Used to connect the DC Calibrator to the IGC100.

Recommended: Belden 9239 Low Triboelectric Noise cable.

Sealed Ionization Gauge and Signal Cable

In order to eliminate the need for the presence of a vacuum system during performance testing, all ionization gauge related electrical specifications are tested using a sealed ionization gauge connected to the proper signal cable.

Note
The sealed ionization gauge can be replaced with any Bayard-Alpert type ionization gauge, connected to a vacuum system and exposed to base pressure ($<10^{-5}$ Torr).

Signal Cable
Stanford Research Systems Model# O100C3, 10 foot long.

Sealed Gauge
Sealed test gauges (Fig. 10-1) are available from several third party sources:

Duniway Stockroom – Part # I-SLD-N (www.duniway.com)

Kurt J. Lesker – Part # G075S (www.lesker.com)

ETI Gauges- Part # 4336S (www.etigauges.com)

Sealed gauges can also be special ordered from Stanford Research Systems.

Figure 10-1. Sealed ionization gauge.

The Test Record

Make a copy of the IGC100 Performance Test Record at the end of this section. Fill in the results of the tests on this form. The Test Record will allow you to determine whether the tests pass or fail and also preserve proper test documentation.

If a Test Fails

If a test fails, you should check the settings and connections of any external equipment and, if possible, verify its operation using a DVM, scope or some other piece of test equipment.

After checking the setup, repeat the test from the beginning to make sure that the test was performed correctly.

If the test continues to fail, contact Stanford Research Systems for further instructions. Make sure that you have the units serial number and firmware revision code handy. Have the test record on hand as well.

Front Panel Overview

All IGC100 functions can be manually configured and controlled through the instrument's front panel interface. The front panel components can be divided into five categories:
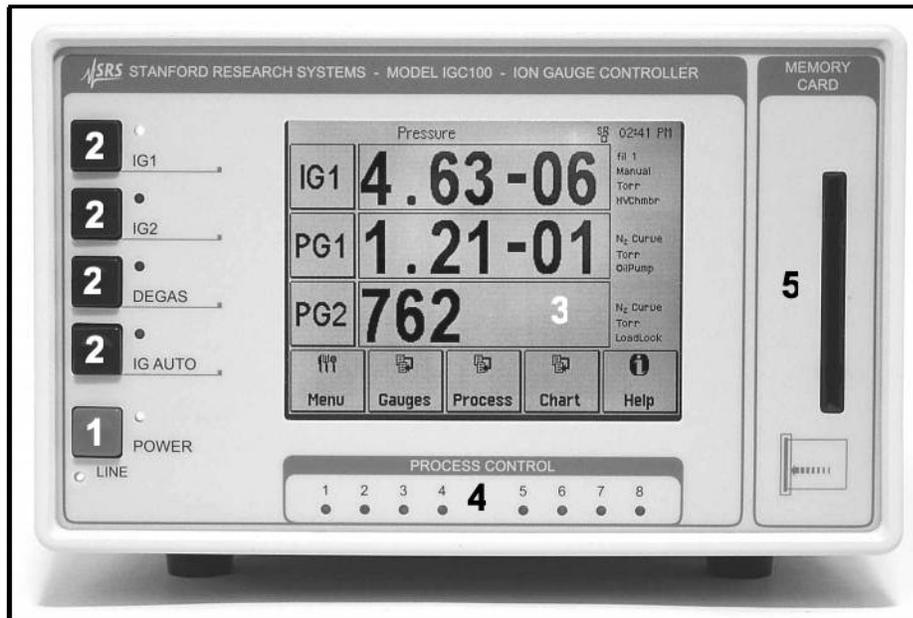
Figure 10-2. IGC100 front panel controls.

1. IGC Power - LINE LED and POWER button with LED

The LINE LED (red) lights up to indicate that the IGC100 is connected to, and getting power from, an AC outlet. Press the red POWER button to turn the IGC100 on/off.

2. Ionization Gauge Controls - IG1, IG2, DEGAS and IG AUTO buttons with LEDs.

Press the black IG1 (IG2) button to turn the IG1 (IG2) filament on/off. Press the black DEGAS to start/stop degassing of the active ionization gauge.

3. Touchscreen/LCD display

The LCD displays an intuitive menu-driven interface for instrument setup and operation. To activate an on-screen button, simply touch the LCD display over the button area. Help for any button or box is available on screen by touching the [Help] button, then touch any button or box for help about its function.

4. Process control LEDs

5. Memory Card Module

Preparation for Testing

> **Warning!**
> Before any tests are performed, make sure that the IGC100 has a sealed ionization gauge (or ionization gauge connected to a functioning vacuum system) connected to the rear panel ion gauge connector. In addition, make sure that the line power connection includes a proper ground.

Ionization Gauge Connection

> **Warning!**
> Sealed Ionization Gauges are very fragile and contain a high vacuum. Breakage of the glass envelope can result in implosion and the associated risk of flying glass.
>
> In order to eliminate the risk of electrocution, the IGC100 controller must be unpowered (i.e. LINE LED off) during the following connection procedure. Check your unit, and disconnect the IGC100 from its power source (i.e. wall outlet) at this time if necessary.

This section describes the procedure required to connect the sealed ionization gauge to the IGC100 controller with the SRS# O100C3 signal cable.

Procedure

Connect the 7-pin plug of the O100C3 cable to the ION GAUGE receptacle on the back panel of the IGC100 controller. Align the connector with the receptacle and then turn the plastic-ring clockwise to fasten the connection. Do not connect the signal cable's BNC connector to the controller since it is not required for the Performance Tests. Figure 10-3 shows the finalized connections on the back of an IGC100 box.

Figure 10-3. The 7-pin plug of the O100C3 cable is connected to the ION GAUGE receptacle on the back of the IGC100. The collector BNC is left unconnected.

The test gauge recommended for the Performance Tests is a sealed, single filament, glass-tubulated gauge easily identified by the in-line, 4-pin arrangement at the base connector of the gauge envelope. The pin assignments are detailed in Fig. 10-4.
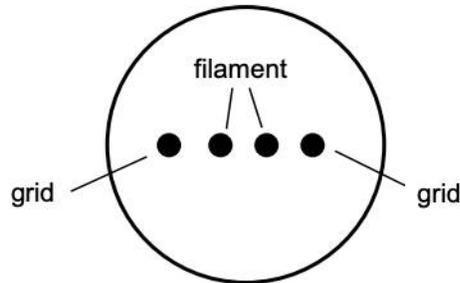

Figure 10-4 . 4 pin connector at bottom of gauge.

The O100C3 cable is compatible with ionization gauges with both single and dual filament electrode structures. The unattached end of the O100C3 cable connects to the gauge head and has six (6) individual push-on connectors housed inside a plastic connector-shield (see Fig. 10-5). Only three of the push-on connectors are used.

Figure 10-5. Gauge connectors of O100C3 cable.

In order to easily identify which cable connector attaches to which pin on the ion gauge, five (5) of the connectors are labeled and color coded: GRID [red], FIL 1 [yellow], FIL 2 [green], FIL RET [black], and FIL RET [black]. The sixth connector, is black, unlabelled and is not used in these tests.

Note
The plastic connector-shield, is not required for these tests either and can be pushed back or removed completely if necessary.

Connect the cable connectors to the appropriate pins on the base of the ionization gauge: (1) Connect Fil 1 and one of the FIL RET connectors to the Filament pins on the gauge, and (2) push the GRID connector onto one of the two Grid Pins on the gauge. Consult Fig. 10-6 for a completed connection.

Figure 10-6. Connection of O100C3 cable to the gauge head.

Note

Both FIL-RET cable connectors are identical and only one needs to be connected to the gauge (Fold the unconnected FIL RET cable connector back into the connector-shield with its end facing away from the gauge, and secure with electrical tape) . Only one of the grid pins on the gauge head needs to be connected (cut the unused pin or cover it with heat-shrink insulating tube to avoid the risk of high voltage electrocution while testing). Push all connectors into the pins until they seat firmly in place.

Line Power Connection

The IGC100 operates from 100V, 120V, 220V or 240V nominal AC power source having a line frequency of 50 or 60 Hz.

Procedure

Use the power entry module on the back panel of the IGC100 to power the unit from a wall outlet. Make sure that suitable power is available for the controller: 100-240 Vac, 50-60Hz, 500 W. Use the three-wire power cord, provided by Stanford Research Systems, to connect the IGC100 to a **properly grounded** wall outlet. Contact Stanford Research Systems if a power cord compatible with your outlets was not included with your unit.

The availability of LINE power to the box is clearly indicated by a lighted LINE LED (red) located under the POWER switch at the lower left corner of the front panel.

Power-On Reset

Before any tests are performed, the IGC must be powered up into a factory preset state.

Procedure

While holding down the IG AUTO Button, press the red POWER button located at the lower left corner of the front panel. The green POWER LED turns on, a brief Power-On Self Test (POST) procedure is executed and the pressure display screen is displayed on

the touchscreen-LCD. Any problems detected during the Power-On Selftest procedure are prompted on the screen at this time and must be recorded in the Test Record.

IMPORTANT
Holding down the IG AUTO button during power-up reverts the controller to its factory-preset settings, a condition required by all the tests in this chapter.

Screen Contrast Adjustment

If the screen needs to be adjusted to your viewing needs after the power-on reset, adjust the contrast by touching the on-screen buttons:

> [Menu]
>> [Screen]
>>> [Contrast Up] or [Contrast Down]

Touch the [Pressure] button to return to the Pressure display screen at the end of the adjustment.

Serial Number

If you need to contact Stanford Research Systems, please have the serial number of your unit available. The serial number is printed on a label affixed to the rear panel. The serial number is also accessible through the touchscreen interface. To display the serial number as part of the Configuration Report, start from the Pressure Display Screen (default power-on screen) and touch the on-screen buttons:

> [Menu]
>> [Utilities]
>>> [Configuration]

Touch the [Pressure] button to return to the Pressure display screen at the end.

Firmware Revision

The firmware revision code, along with the update date, is briefly displayed on the LCD screen as part of the Self-Test Report when the unit is turned on. The revision code is also displayed with the serial number in the Configuration Report screen described above.

1. Self-Tests

Several Self-Test procedures are built into the IGC100 controller. These are functional tests and do not relate to the specifications. These tests should be run before any other tests.

Setup

No external setup is required for these tests. No warm-up is required for these tests.

Power-On Selftest (POST)

The IGC100 automatically performs a Power-On Selftest on its hardware every time it is powered up. Enter the results of the Power-on Selftest in the Tests Record at the end of this chapter.

System Self-Test

Starting from the Pressure Display screen (Power-on default Screen) press:

> [Menu]
> > [Utilities]
> > > [Selftest]
> > > > [System Selftest]

A brief Selftest procedure is performed and a Report is displayed on the LCD screen. Record any failures in the test record at the end of this section.

Button & LED Selftest

Return to the Selftest menu by pressing the [Back] button on the System Selftest Report screen and press [Button & Led Test].

All front panel LEDs light up at this time. Press the black Ion Gauge buttons (IG1, IG2 and DEGAS) to toggle their LEDs on/off.

Important
Act promptly since this test mode is abandoned after a seven seconds delay, and the display automatically reverts to the main Selftest menu. Repeat the test if you run out of time.

Enter the results of the Buttons Selftest in the test record at the end of this section. Report any defective LEDs.

Press the [Pressure] button on the lower left corner of the LCD screen to revert to the Pressure Display screen.

2. Analog I/O Tests

These tests measure the accuracy of the Analog I/O ports located on the back panel of the IGC100 (see Fig. 10-7). Each port is individually tested.

Figure 10-7. The four analog I/O ports.

Input Test

The four Analog I/O ports are factory preset to operate as inputs. Each input port is individually tested.

Warning!
Perform a Power-On reset as described above if you are uncertain about the state of your analog I/O ports at this time.

Setup

Use the DC Calibrator/Source to produce a voltage to measure with the Analog I/O input ports. Each port is tested individually.

Starting from the pressure display screen, press the [Gauges] button to access the Gauges Display. The Gauge Data Boxes labeled AN1, AN2, AN3 and AN4 display the voltage levels present at the input ports.

Procedure

1. Connect the output of the Voltage Calibrator/ Source to analog I/O port 1.

2. Set the output of the calibrator to +10.000 V, record the AN1 reading of the Gauges Display in the Test Report.

3. Repeat step 2 for source voltages +5.000, 0.000, -5.000 and –10.000 V.

4. Repeat steps 1,2 and 3 for analog I/O ports 2, 3 and 4.

Record all results in the Test Record.

Remain in the Gauges Display screen. Disconnect the calibrator from the IGC100.

Output Test

The four Analog I/O ports are factory preset to operate as inputs, so they must first be programmed to operate as outputs before the following tests are performed. Each port is individually tested.

Setup

We will use the DC Multimeter to measure the voltage sourced by the Analog I/O ports configured as outputs. Each port is individually tested. Configure the Multimeter to measure DC voltages at this time.

Procedure

Connect the DC Volt input of the multimeter to analog I/O port 1.

Touch the AN1 button on the Gauges Display screen to configure the port.

1. Touch [ADC or DAC] and choose "DAC Output".
2. Touch [DAC Source] and choose "Manual".
3. Touch [Volts When Source=Manual] and enter –10.
4. Measure the port's output voltage with the DC Multimeter.
5. Repeat steps 3 and 4 for output voltages –5.000, 0.000, +5.000 and +10.000 V.
6. Touch [Back] to return to the Gauges Display screen. Select AN2, AN3 and AN4 and repeat steps 1 through 5 connecting the multimeter to analog I/O ports 2, 3 and 4.

Record all results in the Test Record.

Remain in the Gauges Display screen.

+/- 15V AUX POWER Test

The IGC100 includes a +/-15V (100 mA max) auxiliary power output. This output will be tested with the digital multimeter.

Setup

Locate the +/- 15V AUX POWER output port in the back panel of the IGC100. Configure the DC Multimeter for voltage measurement.

Note

The +/- 15V AUX POWER includes a three (3) position Terminal Bock plug for easy connection to capacitance manometers.
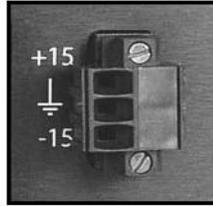

Figure 10-8. Aux Power connector.

Procedure

Measure the -15 V output. Enter test result in Test Record.

Measure the +15 V output. Enter test result in Test Record.

3. Ion Gauge Tests

IG Turn-on/Warm-up

Procedure

Press the IG1 button on the front panel of the IGC100 to activate the gauge's filament emission. The filament lights up, the gauge electrodes are biased, and a 0.1 mA filament emission current is established. Zero (nominal) is displayed in the IG1 data box of the Gauges Display, since no collector current is available (collector input is open).

1. From the main Pressure Display screen, touch [Gauges] to bring up the Gauges display.

2. Touch the IG1 Data Box in the Gauges Display to access the IG1 Setup Menu.

3. Touch the [Advanced] button to access the Advanced submenu.

4. Touch [Emission Current (mA)] and enter 10 mA.

5. Return to the Gauges Display by touching the [Back] button twice.

6. Allow the IGC100 to warm up for 1.5 hours before performing any of the following tests.

Enter any problems or failures reported by the controller in the Test Record.

Anode Grid Bias Voltage Test

This test measures the bias voltage on the anode grid electrode of the ionization gauge **while the gauge is turned on** (i.e. its filament is emitting electrons).

> **Warning!**
> Dangerous voltages capable of causing injury and even death are present during this test. Please take all necessary precautions to avoid the risk of electrocution.

Setup

Configure the DC Multimeter to measure voltages as large as +500 VDC.

Be very careful to eliminate the chances of personal injury due to electrocution during this test.

Connect the (LO) input of the multimeter to the Grounding Lug on the back of the IGC100. Use the (HI) input of the multimeter to probe the Grid pin of the ionization gauge head. **Beware that the gauge is ON and extremely hazardous high voltages are present!**
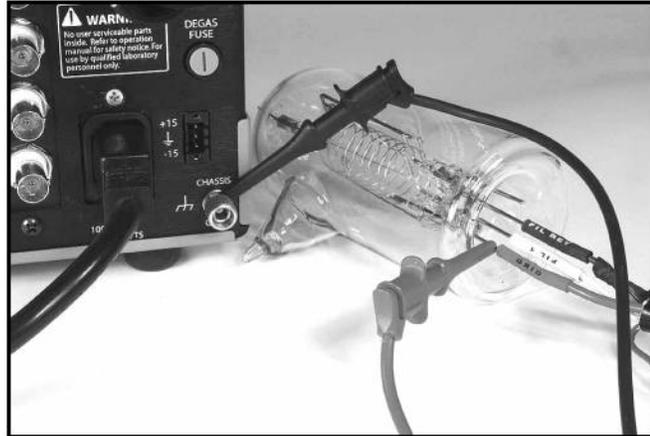
Figure 10-9. Anode Grid Bias Voltage Test. Multimeter Hi input connected to Grid pin on the gauge head and LO input connected to IGC100 Grounding Lug.

Procedure

Measure the voltage on the anode grid, under normal operating conditions. Enter the reading in the Test Record.

Press the DEGAS button and wait for degassing conditions to be established. Allow 5 minutes of warm-up and measure the voltage on the anode Grid again. Enter the reading in the Test Record.

Press the DEGAS Button to turn Degassing off. **The gauge will remain on.**

Filament Bias Voltage Test

This test measures the bias voltage on the Filament Return electrode of the ionization gauge **while the gauge is turned on** (i.e. its filament is emitting electrons).

> **Warning!**
> Dangerous voltages capable of causing injury and even death are present during this test. Please take all necessary precautions to avoid the risk of electrocution.

Setup

Configure the DC Multimeter to measure voltages as large as +50 VDC.

Be very careful to eliminate the chances of personal injury due to electrocution during this test.

Connect the (LO) input of the multimeter to the Grounding Lug on the back of the IGC100. Use the (HI) input of the multimeter to probe the Fil pin of the ionization gauge head connected to the FIL RET connector of the O100C3 cable. **Beware that the gauge is ON and extremely hazardous high voltages are present!**
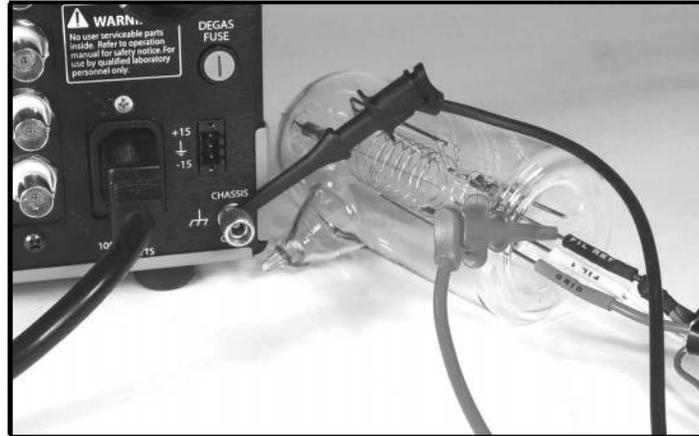
Figure 10-10. Filament Bias Voltage Test. Multimeter HI input connected to FIL RET pin on the gauge head and LO input connected to IGC100 Grounding Lug.

Procedure

Measure the voltage on the FIL RET pin, under normal operating conditions. Enter the reading in the Test Record.

Press the DEGAS button and wait for degassing conditions to be established. Allow 5 minutes of warm-up and measure the voltage on the FIL RET pin again. Enter the reading in the Test Record.

Press the DEGAS button to turn the degassing off. **The gauge will remain on.**

Filament Emission Current Test

This test measures the electron current emitted by the filament and collected at the anode Grid of the ionization gauge **while the gauge is turned on** (i.e. its filament is emitting electrons).

Warning!
Dangerous voltages capable of causing injury and death are present during this test. Please take all necessary precautions to avoid the risk of electrocution.

Setup

Configure the DC Multimeter to measure DC current.

Procedure

Press the POWER button to momentarily turn off the ionization gauge controller, **wait for 30 seconds for the electrical voltage to dissipate from the electrodes.**

Acting promptly to keep the IGC100 warmed-up, disconnect the (red) GRID push-on connector from the Grid pin of the ionization gauge and re-route the electrical connection

through the current measurement inputs of the electrometer (i.e. the current flowing into the anode grid can now be measured by the DC current meter). See Fig. 10-11.
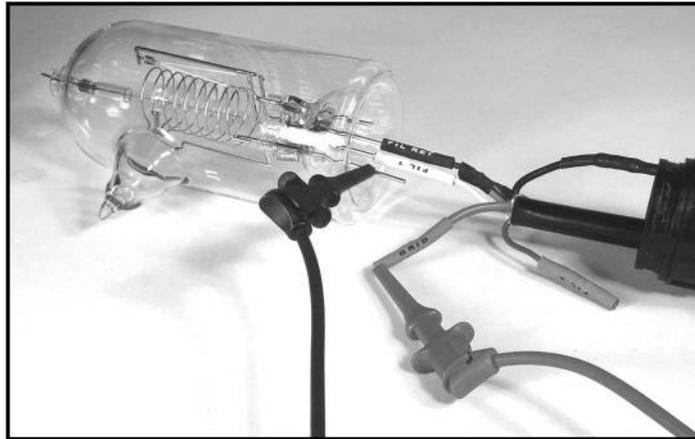
Figure 10-11. Connection for electron emission current measurement.

1. Press the POWER button to turn the controller back on.

2. Press the IG1 button to re-establish the emission current (10 mA). Allow 30 minutes of warm up time.

3. Touch the [Gauges] button to access the Gauges Display Screen.

4. Touch the [IG1 Data Box] on the Gauges Display screen to access the IG1 setup menu.

5. Touch the [Advanced] button to show the Advanced menu.

6. Touch the [Emission current (mA)] button and enter an emission current setting of 0.05 mA.

7. Wait 5 minutes for the current to stabilize.

8. Enter the emission current displayed by the multimeter into the Test Record.

9. Repeat steps 6 through 8 for emission currents: 0.5, 5 and 10 mA.

Leave the ionization gauge on, with 10 mA of emission current as a filament setting.

Remain in the Advanced Gauge Setup Menu.

Electrometer Test

This test measures the accuracy of the electrometer used to measure ion currents produced by the ionization gauge.

Setup

We will use the DC Calibrator/Source to inject a small current into the collector input 1 of the controller.

Important

Use the Low Noise Coaxial cable to complete the connection, and assure noise-free measurements below the 1 nA range.

Procedure

Connect the DC Calibrator/Source to the Collector port (BNC) labeled 1 on the back panel of the controller through the low-noise coaxial cable.

Starting from the Advanced IG1 setup submenu, touch the [Back] button to return to the main IG1 Setup Menu. Or starting from the main Pressure Display, touch [Gauges] and then [IG1].

In the IG1 Setup Menu,

Touch [N2 Sense Factor (1/Torr)] and enter 10.

Touch [Gas Correction Factor] and enter 10.

Touch the [Pressure] button to show the Pressure Display screen.

Important!

Under this setup, the magnitude of the pressure displayed on the IG1 data bar is identical to the magnitude of the collector current (in Amps) measured by the electrometer. For example, a 10^{-9} Torr IG1 reading is displayed for a 1 nA collector current.

Using the IG1 data bar as the display, measure the collector current readings for source currents: 1 nA, 10 nA, 100 nA, 1 µA, 10 µA, 100 µA and 1 mA. Enter the results in the Test Record.

This completes all the required tests.

Press IG1 to turn off the ion gauge, and the POWER button to turn off the controller.

Wait 30 seconds for electrical voltages to dissipate from the gauge before disconnecting any connectors.

IGC100 Performance Test Record

Serial #		Firmware Revision	
Tested By		Firmware Updated	
Date			
Equipment Used			

Self Tests

Test	Pass	Fail	Comment
Power-On Selftest			
System Seltest			
Button & Led test			

Analog I/O Tests

Input Port	Voltage	Lower limit	Reading	Upper Limit
1	10.000	9.980		10.020
	5.000	4.980		5.120
	0.000	-0.020		0.020
	-5.000	-5.020		-4.980
	-10.000	-10.020		-9.980
2	10.000	9.980		10.020
	5.000	4.980		5.120
	0.000	-0.020		0.020
	-5.000	-5.020		-4.980
	-10.000	-10.020		-9.980
3	10.000	9.980		10.020
	5.000	4.980		5.120
	0.000	-0.020		0.020
	-5.000	-5.020		-4.980
	-10.000	-10.020		-9.980
4	10.000	9.980		10.020
	5.000	4.980		5.120
	0.000	-0.020		0.020
	-5.000	-5.020		-4.980
	-10.000	-10.020		-9.980

Analog I/O Tests

Output Port	Voltage	Lower limit	Reading	Upper Limit
1	10.000	9.980		10.020
	5.000	4.980		5.120
	0.000	-0.020		0.020
	-5.000	-5.020		-4.98
	-10.000	-10.020		-9.980
2	10.000	9.980		10.020
	5.000	4.980		5.120
	0.000	-0.020		0.020
	-5.000	-5.020		-4.98
	-10.000	-10.020		-9.980
3	10.000	9.980		10.020
	5.000	4.980		5.120
	0.000	-0.020		0.020
	-5.000	-5.020		-4.98
	-10.000	-10.020		-9.980
4	10.000	9.980		10.020
	5.000	4.980		5.120
	0.000	-0.020		0.020
	-5.000	-5.020		-4.98
	-10.000	-10.020		-9.980
Aux Power Connector		**Lower Limit**	**Reading**	**Upper Limit**
-15 V Test		-17.5 V		-12.5 V
+15 V Test		+12.5 V		+17.5 V

Ion Gauge Tests

Ion Gauge Turn-On/Warm-up				
Comments				
Anode Grid Test		**Lower Limit**	**Reading**	**Upper Limit**
Normal Operation		179.5 V		180.5 V
Degas Mode		498.5 V		501.5 V
Filament Bias Test		**Lower Limit**	**Reading**	**Upper Limit**
Normal Operation		29.91 V		30.09 V
Degas Mode		29.91 V		30.09 V

Ion Gauge Tests

Emission Current	Lower Limit	Reading	Upper Limit
0.05 mA	0.0495 mA		0.0505 mA
0.5 mA	0.495 mA		0.505 mA
5 mA	4.95 mA		5.05 mA
10 mA	9.90 mA		10.1 mA
Electrometer Current	**Lower Limit**	**Reading**	**Upper Limit**
1 nA	9.90e-10		1.01e-9
10 nA	9.90e-9		1.01e-8
100 nA	9.90e-8		1.01e-7
1 µA	9.90e-7		1.01e-6
10 µA	9.90e-6		1.01e-5
100 µA	9.90e-5		1.01e-4
1 mA	9.90e-4		1.01e-3

Tester's Final Comments