ARUN MICROELECTRONICS LTD.

PRESSURE GAUGE CONTROLLER MODELS PGC1 and PGC1F.

INTERFACE MANUAL ISSUE 2

For use with Program Version 2.20 onward.

The information contained in this manual has been carefully checked and is believed to be correct. No responsibility is assumed for any errors. User comment and criticism is welcome: please write quoting the serial number of the instrument and the version number of the software as displayed by the instrument to:

Customer Services,
Arun Microelectronics Ltd.,
Fitzalan Road,
ARUNDEL,
West Sussex. BN18 9JS.
England.

Please direct other enquiries to the distributor or agent from whom you purchased the instrument.

CONTENTS

1. INTRODUCTION

This manual is intended to be used in conjunction with the PGC1 manual, issue 1.3. It describes the serial interface changes in program version 2.2. Some changes to the menus in the PGC1 have been made to accommodate the new interface protocol of V2.2.

Up to 8 PGC1 instruments can be connected to a single serial line. Line conditions are in electrical accordance with RS232C for PGC1 or RS485 for PGC1F. Instruments compatible with RS485 are downwardly compatible with RS422, since the drivers and receivers are connected to separate balanced lines (i.e. no transceivers are used). Each instrument is identified by a unique address code, selected from the numbers 0 to 7 inclusive. The address code is shown momentarily on the main LED display each time the instrument is switched on. Instruments connected to a single serial line are allowed to send characters only when addressed by the host computer. Either a short report giving current measured pressures or a full report of the status of the PGC1 can be requested. Current pressures are reported in filtered form.

Because the transmission rate is high and the quantity of data low the host computer can poll all instruments faster than any significant event in the vacuum system. The response time of an instrument to a host request is generally less than 1 millisecond.

Remote control is established and relinquished via the serial interface. Either an individually addressed instrument or all instruments may be switched to remote or local control by a single command. The status of any instrument is unchanged in every other respect after a change in control status.

The host computer can control:

Trip setpoints and relay status.
Ion gauge operating conditions in pressure measurement modes.
The content of the LCD display.
The sound generator.

and all commands may be directed to a single gauge or instrument or all instruments.

At switch-on or after a reset due to derangement of the embedded program or an external reset via the Auxiliary connector an instrument is reset into the local operation mode with the high voltage supplies switched off.

2. HARDWARE.

2:1 PGC1 Line Drivers and receivers.

The type of line drivers and receivers fitted to any particular PGC1 instrument may be determined by inspecting the model number inscribed on the rear panel. If this contains the suffix "F" then the line interface circuits are compatible with RS422/RS485. Otherwise they are RS232 types. Although the Remote Connectors fitted to the rear panel are the same type for the two interfaces. **ALL INSTRUMENTS AND HOST COMPUTER CONNECTED TOGETHER MUST HAVE THE SAME TYPES OF LINE DRIVERS AND RECEIVERS.** Driving RS485 receivers with RS232 drivers may cause damage to one or the other.

The type of line drivers selected will depend on the distance between the host computer and the most remote PGC1, the number of PGC1s sharing the same interface lines and the speed of response desired. The speed of response will normally be dominated by the transmission times, the latency of the PGC1 and host program should be small in comparison. Generally speaking, if the maximum distance is over 15 metres or there are more than six instruments sharing the same interface then RS485 drivers should be used.

2:2.

This section is deliberately left blank.

2:3 RS485/422 Line termination.

If the instrument has option "F" fitted it has RS422/RS485 drivers and receivers. The instrument which is furthest from the host computer should have a termination resistor connected across the "Received Data" lines.

Disconnect the power connector and remove the smaller screws at the sides of the instrument. Note that the ventilation slots are at the right side, when viewed from the front. Remove the cover in an upward direction.

Locate the interface PCB by following the wires from the 'remote' connector. It is a small PCB inserted into an IC socket near the rear of the instrument. Fitting a termination is accomplished by moving the link fitted to the interface PCB from the "OFF" or "NO" position to the "ON" or "85" position (only one of these alternative legends will be present, according to the issue of the PCB). **Only one PGC1 receiver termination should be fitted per serial interface, all others should have links in the "OFF" position.**

For compliance with RS485 conditions lines should be terminated at both extremities. Termination of the most remote PGC1 transmitter must be done outside the instrument.

If a PGC1 fitted with a RS485 interface is to be used without being connected to a host computer it is recommended that a termination be fitted in order to decrease its sensitivity to radiated noise.

2:4 Cable construction and installation.

Twisted-pair cables are recommended for both RS232 and RS422/RS485 lines. Pairs of 7 x 0.2mm ($0.22mm^2$) PVC equipment wire twisted about 1 revolution per 1 to 1½ cm are suitable. This results in a characteristic impedance of around 100 ohms and is a reasonable match to the RS422/RS485 terminations. An overall screen is recommended and should be connected to the signal ground pin on the connectors. There is a 100 ohm, 1 watt resistor included in series with this connection in order to limit circulating currents due to ground line differences. In order to eliminate ground currents completely you may, for example, connect the incoming screen and leave the outgoing screen disconnected at each connector on the daisy-chain. The allowable common mode differences in the RS485 specification is 7 volts, and the PGC1 complies with this. Connector pin numbers are defined in Appendix B. Each used pin should be connected to all similarly-numbered pins at every PGC1 and host computer connector on the interface. The wiring should be daisy-chained from the host computer to each instrument in turn; no branches or spurs should be allowed. The most remote PGC1 should have a termination connected, as described in section 2:3, above.

2:5 Host computer line drivers and receivers.

It is advisable to check certain conditions in the host computer line drivers and receivers, even if these are guaranteed to comply with the relevant standards.

If facilities exist for terminating lines at the receiver this should be done. For compliance with RS485 the line driver should also be terminated.

Consideration should be given to the receiver output state when the all the PGC1s are silent and their lines are in the "TRI-STATE" condition.

For RS422/RS485 the commonly used DS75176, SN75176 and similar transceivers do not guarantee that the output state of a receiver is defined when the inputs are terminated, but undriven, because of the ±200 millivolt offset of the receiver. The claim on the data sheet that "The receiver incorporates a fail-safe feature which guarantees a high output state when the inputs are left open" refers to a condition without termination. Connection of a termination, external cables or a driver with its outputs in the "TRI-STATE" condition will give unpredictable results and result in transmission errors. Normally, a 1 kilohm pullup resistor connected between the RXD+ line and the receiver +5 volt supply and a 1 kilohm pulldown from RXD- to the 0 volt supply line will ensure a high output state under properly terminated conditions.

For RS232 receivers an open-circuit input normally ensures a high output state. If this is not the case then adding a 10 kilohm pulldown resistor between the received data line and the receiver negative supply voltage will correct this.

Because the number of PGC1 instruments driving an interface may be between 1 and 8 it is not possible to fit these additional components on the drivers in the PGC1.

2:6 Demonstration software.

A demonstration programs is available for IBM PC XT, AT or compatible computers. The computer requires DOS 3.0 or higher, a colour display and a free serial port. Further information is contained in files included on the demonstration disc.

3. INTERFACE PROTOCOL.

9600 baud, 8 data bits, 1 stop bit, no parity, no handshaking.

Up to eight instruments can be connected to a single RS232 or RS422/RS485 party line.

Each instrument maintains its transmit line in a high-impedance state except when transmitting data in response to a request from the host computer. Each instrument has a unique address, set from the 'setup' menu.

3:1 General Command and Response formats.

3:1.1 Host Computer Commands.

The host computer sends commands to instruments in the following format:

First byte: '*' (ASCII 47)

Second byte: Command character. All commands are represented by a single character.

Third byte: Instrument address. Instruments are identified by a single character from '0' - '8' corresponding to addresses 0 - 8. Some commands can be addressed to all connected instruments by 'X'.

Optional ASCII parameters: Additional command parameters may be single ASCII characters, or character strings (a series of ASCII characters followed by a delimiting character (any of ASCII 0, 13, or ',').

3:1.2 PGC1 response

If the command was addressed to all instruments there is no response. Otherwise, the instrument addressed responds with a status byte and an error byte (see next page) followed by a CR-LF (ASCII 13, 10). If a status report was requested the status and error bytes are followed by the report, a checksum and then the CR-LF.
All responses terminate in CR-LF.

Instrument status byte coding:

Status byte:

	Bits 3-0 :	Instrument type 0100_2 - PGC1
	Bit 4 :	0 = local mode, 1 = remote mode
	Bit 5 :	1
	Bit 6 :	0
	Bit 7 :	0

Error byte:	Bit 0 :	gauge - specific error
	Bit 1 :	over temperature trip
	Bit 2 :	internal settings were lost and restored to factory default
	Bit 3 :	temperature warning
	Bit 4 :	auto emission error
	Bit 5 :	host command not accepted
	Bit 6 :	always set to 1

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

3:1.3 Timing of Next Command.

The host computer should not begin transmitting a new command until a CR-LF has been received, signalling the end of transmission, or two instruments may conflict on the serial line. It is not necessary to poll the PGC1 more than 4 time per second, and we strongly recommend that a delay of at least 100ms is implemented before the next report request.

3:2 PGC1 Response time.

For the commands <poll>, <control>, <release>, <long>, <short> and <reset error>, which do not require any extra parameters, the instrument addressed will begin transmitting a response within about 200 µs. The response to other commands is sent as quickly as possible (typically 1 - 5 ms) but a minimum response time cannot be specified. The transmission time taken for a report to be sent is determined principally by the baud rate (9600).

3:3 Local/remote control.

An instrument starts operation in local control, i.e. using the front panel. In local mode the instrument responds only to commands without parameters (<poll>, <control>, <long>, <short> and <reset error>). The <control> command puts the instrument into remote mode, and all the other commands can then be used. The front panel can still be used to change the display but not to start gauges or change setpoints. When a host takes control of the PGC1 emission is stopped, and any current Setup operation is cancelled. When the host returns the instrument to local control, emission is again stopped.

3:4 Host Computer Command Format.

Gauges within the instrument are addressed by a numeric character, found from the status report. In a PGC1 instrument the ion gauge is numbered '1', the two pirani gauges '2' and '3' and the capacitance manometer gauge by '4'.

Relays are addressed by uppercase letters starting with 'A'. A PGC1 instrument contains relays 'A' to 'D'.

Command parameters may be single printable ASCII characters or ASCII strings (terminated by a delimiter). Numbers in scientific notation must be sent as ASCII strings of the form "9.9E±99,"; other ASCII strings can be of any length, including zero.

The error byte should be checked after sending a command to ensure that the command has been understood and carried out.

In the following tables, the different parameter types are called 'Char' (single character, no terminator), 'Value' (ASCII string with terminator) and 'SN Value' (ASCII string with terminator in scientific notation form). All pressure values read from the PGC1 or sent as commands must be in the PGC1's current display units.

Command	Char	Parameters	Description
<poll>	P	Instr	Poll instrument (return status and error byte)
<control>	C	Instr[1]	Remotely control an instrument
<release>	R	Instr[1]	Return instrument to manual control
<reset error>	E	Instr[1]	Reset all error flags
<short>	S	Instr	Request a short status report from an instrument reporting operating status of all gauges
<long>	L	Instr	Request a long status report from an instrument.
<Gauge on>	i	Instr[1] N	Switch on ion gauge. Emission current: N = '0' 100uA N = '1' 1mA N = '2' 10mA N = '3' auto emission control

<Gauge off>	o	Instr[1]	Switch off ion gauge.
<Overpressure>	p	Instr[1] SN Value	Set the ion gauge overpressure trip
<filament>	f	Instr[1] F	Select filament F = '1' or '2'
<filter time constant>	s	Instr[1] T	Select filter time constant where T = '0':off, '1', '2', '4' or '8' seconds
<setpoint>	r	Instr Relay SN Value	Change a relay setpoint pressure.
<override>	O	Instr[1] Relay	Permanently energise relay. Command <setpoint> restores normal operation.
<inhibit>	I	Instr[1] Relay	Permanently de-energise relay. Command <setpoint> restores normal operation.
<display>	d	Instr[1] Text	Displays message "Text" up to 24 characters on the PGC1 LCD display. A blank message clears the display.
<sound>	n	Instr[1] D,T	Using divisor D to divide a frequency of 921600 Hz, produce a tone for T ms.

[1] these instrument addresses may be global, i.e. 'X'.

Examples:

*C2 control instrument 2
*CX control all instruments
*S0 get a short status report from instrument 0
*i01 turn on IG in instrument 0 at 1 mA
*n1 turn off IG in instrument 1
*r6C2.0E-10, setpoint relay C, instrument 6 2.0e-10 mbar

3:5 Status reports.

There are two types of status report. The **short** status report gives the operating status and pressure of each gauge in the instrument. The **long** status report lists the configuration of each gauge, each relay and the instrument. The information given by the long status report only needs to be read once after taking control of an instrument; its information may change during operation, but only predictably in response to host computer commands. The short report can be requested as often as required.

Pressures.

The pressure measurement for each gauge in the instrument is updated 4 times a second. Pirani and capacitance manometer gauge pressures are displayed and reported without filtering. Ion gauge pressures can be filtered with a time constant of 1, 2, 4 or 8 seconds, but filtering can be turned off if desired. The pressure field for a non-operating gauge is filled with spaces.

Status report formats.

All status reports begin with the status and error characters described above, and terminate with a checksum and CR-LF combination. The checksum is formed by adding all the preceding bytes, starting with the status byte, taking the two's complement of the least significant 8 bits. It is sent in hexadecimal as two characters, the most significant 4 bits first.

Status reports can be read in two ways:

(a) because the CR-LF terminator can only occur at the end of a report the report can be read into a buffer until the terminator is seen. The report is then decoded into gauge, relay or system records. This is the best approach on slower machines (such as IBM PCs).

(b) alternatively, the report can be read intelligently and decoded record by record. As each record has a header character ('G', 'R' or 'S'), and the records are of fixed length, the first character of the checksum signals the end of the report.

3:5.1 Short status report.

Status byte.

Error byte.

A relay status byte:

> The relay status byte is of the form $0100XXXX_2$, where the least significant 4 bits indicate the state of each relay (1 = energised). The relay status byte indicates the status of relays 'A' to 'D', with relay 'A' indicated by the least significant bit. The status of a relay assigned to the ion gauge when it is not in emission is defined in the setup menu; this setting is given in the long status report (see below).

An unused byte.

Then, for each gauge in the instrument, a gauge record:

Byte	Name	Details
1	Header byte	'G'
2	Gauge type	'I' : Bayard-Alpert 'P' : Pirani 'M' : capacitance manometer
3	Gauge number	'1' ...
4	Gauge status	Bit 6: always set to 1 Bit 5: gauge externally inhibited Bit 4: gauge in leak detect Bit 3: gauge in degas Bit 2: gauge controlling bakeout Bit 1: gauge starting Bit 0: gauge operating (can combine with bits 2 - 4)
5	Gauge error	**Bayard-Alpert Gauge error:** Bit 0 : gauge filament open-circuit Bit 1 : gauge overemission Bit 2 : gauge underemission Bit 3 : maximum pressure exceeded Bit 4 : pirani interlock prevents starting Bit 6 : 1 Bit 7 : 0 **Pirani Gauge error:** Bit 0 : Pirani gauge open-circuit Bit 6 : 1 Bit 7 : 0
6-13	Pressure	Comma delimited string in scientific notation, e.g. "1.3E-07,". If the gauge is not operating the string consists of spaces only, i.e. " ,"

Two-byte checksum.

CR, LF

3:5.3 Long status report.

Status byte.

Error byte.

For each gauge, a gauge configuration record:

Byte	Name	Details
1	Header byte	'G'
2	Gauge type	'I' : Bayard-Alpert 'P' : Pirani 'M' : capacitance manometer
3	Gauge number	'1' ...
4	LP filter TC	'0','1','2','4' or '8' (seconds) (BA gauge only)
5	Filament number	'1' or '2' (BA gauge only)
6	Filament type	'0' = Iridium, '1' = Tungsten (BA gauge only)
7	Emission current	'0' = 100uA, '1' = 1mA, '2' = 10mA, '3' = Auto (BA gauge only)
8-9	unused	
10-17	Maximum pressure (mbar) (cold-cathode and BA gauges)	"N.Ne-NN,"

For each relay, a relay configuration record:

Byte	Name	Details
1	Header byte	'R'
2	Relay letter	'A' - 'D'
3	Status	'0' : associated with gauge '2' : inhibited (de-energised) '1' : over-ride (energised)
4-11	Setpoint	Pressure in scientific notation "N.NE±NN,"
12	Associated gauge or function	'1' = BA gauge '2' or '3' = Pirani gauges '4' = Capacitance Manometer 'T' = TSP control 'B' = Bakeout control

System configuration record:

Byte	Name	Details
1	Header byte	'S'
2	Pirani 1 interlock	'0' : disabled '1' : enabled
3	Relay configuration	'0' : Ion gauge relay de-energised when ion gauge is off '1' : Ion gauge relay is energised when ion gauge is off
4	Units of measurement	'M' (mbar) 'P' (pascal) or 'T' (torr)
5-9	Program version	4-character ASCII string, e.g. "1.03,"
10-18	Program date	8-character ASCII string, i.e. "DD/MM/YY,"
19-21	Ambient temperature	"NNN" (degrees)
22-25	Capacitance manometer full scale	"NNNX" where NNN is "1", "10" or "100" and X is either 'M' (mbar) or 'T' (torr)
26-28	Ion gauge sensitivity	"NNX" where NN is the sensitivity and X is 'M' (mbar) 'P' (pascal) or 'T' (torr)
29-40		Additional system parameters may be defined in future

Two-byte checksum.

CR, LF

Appendix A. Example of a host/PGC1 dialogue.

Source	ASCII	Hex	Description
Host	*P5	2A 50 35	Host polls instrument 5
Instr 5	$@ CR-LF	24 40 0D 0A	PGC1 under local control
Host	*P1	2A 50 31	Host polls instrument 1
Instr 1	4A CR-LF	34 41 0D 0A	PGC1 under host control, Gauge-specific error occurred
Host	*S1	2A 53 31	Host requests short report
Instr 1	4A m@ GI1 A A 2.7E-03, GP2 A@ 7.5E-03, GP3 A@ 1.0E+03, 8D __	31 41 6D 40 47 43 31 41 41 32 2E 37 45 2D 30 33 2C 47 50 32 41 40 37 2E 35 45 2D 30 33 2C 47 50 33 41 40 31 2E 30 45 2B 30 33 2C 38 44 0D 0A	Status and error bytes Relays A,C,D energised Gauge : Bayard-Alpert gauge 1 On Error = over emission Pressure Gauge record : Pirani Gauge 1 running Gauge record : Pirani Gauge 2 running at atmosphere Checksum End of report
Host	*E1	2A 45 31	Host acknowledges and clears Instr 1 error flag
Instr 1	4@ CR-LF	34 40	Instrument clears its error byte and indicates readiness to accept a new command
Host	*o1	2A 6E 31	Host turns off gauge
Instr 1	4@ CR-LF	34 40 0D 0A	Instrument 1 status byte. No error

Appendix B. Remote connector.

This is a 9 way "D" type male connector. Used pin connections and signal names for **RS232** are:

3	Received Data
2	Transmitted data
5	Signal ground

If option F is present (as indicated by the suffix F in the model number on the rear panel) then the pin connections and signal names are compatible with **RS422 or RS485** as follow:

6	Received data +
7	Received data -
8	Transmitted data +
9	Transmitted data -
5	Signal ground
1	Protective ground