ARTISAN®
TECHNOLOGY GROUP

Your **definitive** source for quality pre-owned equipment.

**Artisan Technology Group**
(217) 352-9330 | sales@artisantg.com | artisantg.com

**Full-service, independent repair center**
with experienced engineers and technicians on staff.

**We buy your excess, underutilized, and idle equipment**
along with credit for buybacks and trade-ins.

**Custom engineering**
so your equipment works exactly as you specify.

- Critical and expedited services
- In stock / Ready-to-ship
- Leasing / Rentals / Demos
- ITAR-certified secure asset solutions

**Expert team | Trust guarantee | 100% satisfaction**

All trademarks, brand names, and brands appearing herein are the property of their respective owners.

Find the *MKS Instruments 647B8EON* at our website: *Click HERE*

**Multi Channel**
**Flow Ratio/Pressure Controller**

# Type 647B

**Instruction Manual**

MKS Instruments
Deutschland GmbH

Ausgabe 11/99
Rev.11.96

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

*Copyright © 1999 by MKS Instrument Deutschland GmbH.*

*Alle Rechte vorbehalten. Es ist nicht gestattet, Teile des vorliegenden Dokuments zu vervielfältigen oder in irgendeiner Form bzw. mit irgendwelchen elektronischen oder mechanischen Mitteln, einschließlich des Fotokopierens und der Aufzeichnung, bzw. mit Hilfe von Speicher- oder Informationswiedergewinnungs-systemen zu übertragen, sofern keine ausdrückliche schriftliche Genehmigung seitens der MKS Instruments Deutschland GmbH vorliegt.*

*Gedruckt in der Bundesrepublik Deutschland.*

Cajon® und VCR® sind eingetragene Warenzeichen der Cajon Company, Macedonia, Ohio

Kalrez® und Viton® sind eingetragene Warenzeichen der E. I. DuPont de Nemours und Co. Inc., Wilmington, Delaware

Neoprene® ist eingetragenes Warenzeichen der Vibration, Mountings & Controls, Inc., Bloomingdale, New Jersey

Swagelok® ist eingetragenes Warenzeichen der Crawford Fitting Company, Solon, Ohio

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

# Contents

1. General ..... 1
1.1The Multi Gas Controller (MGC) Type 647B ..... 1
1.2 CE conformity ..... 1
1.3 Options ..... 1
1.4 Software ..... 1
1.5 Technical Specifications ..... 2
1.6 Drawings ..... 3
1.6.1 Front Panel ..... 3
1.6.2 Rear Panel ..... 4
1.7 Safety Information ..... 5
1.7.1 Symbols Used in this Instruction Manual ..... 5
1.7.2 Safety Instructions ..... 6
1.8 Installation ..... 6
1.9 Symbols at the case ..... 7
1.10 Accessories ..... 7
1.11 Cables ..... 7
1.12 Service ..... 7

2. Operating Instructions ..... 8
2.1 The User Interface ..... 8
2.2 The Menu Tree ..... 9
2.3 Reset of System ..... 10
2.4 Display adjustment ..... 10

3. Functionality ..... 11
3.1 The MAIN MENU ..... 11
3.2 The USER DISPLAY menu ..... 11
3.3 The EXTENDED DISPLAY menu ..... 12
3.4 The PRESSURE CONTROL menu ..... 13
3.5 Tuning the PID Controller ..... 13
3.6 Diagnosis of System ..... 15
3.6.1 The ERROR LISTING menu ..... 15
3.6.2 The SIGNALS menu ..... 16



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.7 Instrument Setup....16
3.7.1 Range Selection....17
3.7.2 Gas Selection....18
3.7.3 Mode Selection....19
3.7.4 Zero Adjustment....21
3.7.5 Trip Limit Supervision....22
3.7.6 Gas Composition....23
3.8 System Setup....24
3.8.1 IEEE 488 Setup....24
3.8.2 RS232 Setup....26
3.8.3 System Parameters....29
3.9 Pressure Setup....30
3.10 Information about the System....31

4. Remote Control....31
4.1 Compatibility....31
4.2 Command Syntax....32
4.3 Table of Commands....33

5. Application of the 647B....38
5.1 Mass Flow Controllers....38
5.2 Trouble Shooting....39

6. Pin Assignment of rear connectors....40
6.1 RS232 connector....40
6.2 IEEE 488 connector....40
6.3 RELAYS connector....41
6.4 VIDEO connector....42
6.5 MFC connector: CH1 to CH8....42
6.6 ACCESS connector....43
6.7 PRESSURE connector....43

7. Gas Correction Table....44

INDEX....48



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

# 1. General

## 1.1The Multi Gas Controller (MGC) Type 647B

The 647B is designed to control Mass Flow Controllers (MFC) with complex requirements to the process. It allows different configuration.

**Warning**  **The safety instructions in this document must be kept. Please, take also a special note of all highlighted text in this document.**

- Various master/slave configurations within several groups of channels.
- External control of mass flow controllers.
- Regulation of the pressure with a constant gas flow ratio.

## 1.2 CE conformity

The device complies to the CE regulations and conformity is declared to the following standards:

- EN 55011 / 3.1991; Group 1; class B
- EN 50082-1 1992
- PrEN 50082-2 1992
- IEC 801-2, IEC 801-3, IEC 801-4
- EN 61010 ; 1993

## 1.3 Options

The following options are available for the 647B. Modules labeled with “(standard)” are part of the basic version:

647BE-X-X-P-X

- N=no Trip Relays; T=with Trip Relays
- R=RS232; E=IEEE Interface
- 4=4 Channels; 8=8 Channels

(X = any available model code)

The basic version can be extended later on with every proper combination.

## 1.4 Software

This manual meets software version V2.2.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## 1.5 Technical Specifications

| | |
|---|---|
| channels for gas flow<br>- max. number of channels<br>- input voltage<br>- output voltage<br>- error range<br>- temperature drift | <br>4 (optional 8)<br>-0.5 ... 5.5 V<br>-0.5 ... 5.5 V<br>+/- 1 digit<br>0.075 % / °C (7) |
| pressure channel:<br>- input voltage<br>- output voltage<br>- resolution<br>- error range<br>- temperature drift | max. 1 channel<br>-0.5 ... 10 V<br>-0.5 ... 5 V<br>16 bit<br>+/- 3 digit<br>0.075 % / °C (7) |
| external setpoint | -0.5 ... 5.5 V |
| measuring rate<br>output rate | 20 Hz / channel<br>20 Hz / channel |
| operation temperature<br>humidity | 15 ... 40 °C (5)<br>< 70 % (3) (4) |
| Power supply:<br>- voltage<br>- fuse<br>- frequency<br>- consumed power<br>power supply for sensors:<br>- voltages<br>- max. current per sensor<br>- max. total current | <br>110/220 V; +/- 10 %<br>F 5 A, 250 V (fast burn)<br>40 ... 70 Hz<br>300 W<br><br>+/- 15 V; +/- 5 %<br>500 mA (1)<br>4 A (2) |
| Dimensions<br>Weight | 19” x 3 HE x 342 mm (6)<br>8.8 kg 4 channel<br>9.2 kg 8 channel |

(1) Consider also the warming up period of the sensors.
(2) For all channels, i.e. gas flow and pressure
(3) Relative humidity within the specified temperature range.
(4) For use in closed heatable rooms, without condesation.
(5) Convectional cooling is assumed.
(6) Without connectors.
(7) For max. signal, within the range of operation temperature.

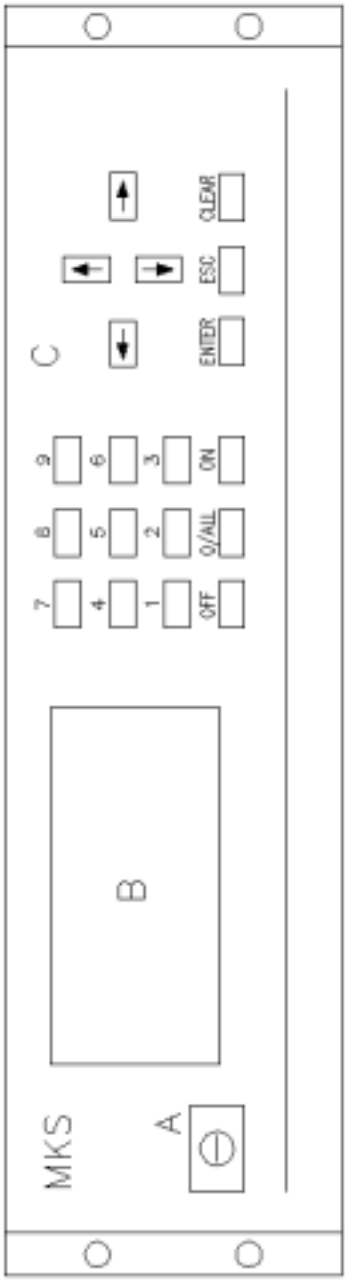
Figure 1



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## 1.6 Drawings

### 1.6.1 Front Panel




A = Key Switch

B = Monitor (LCD Display)

C = Keyboard

Figure 2



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

### 1.6.2 Rear Panel

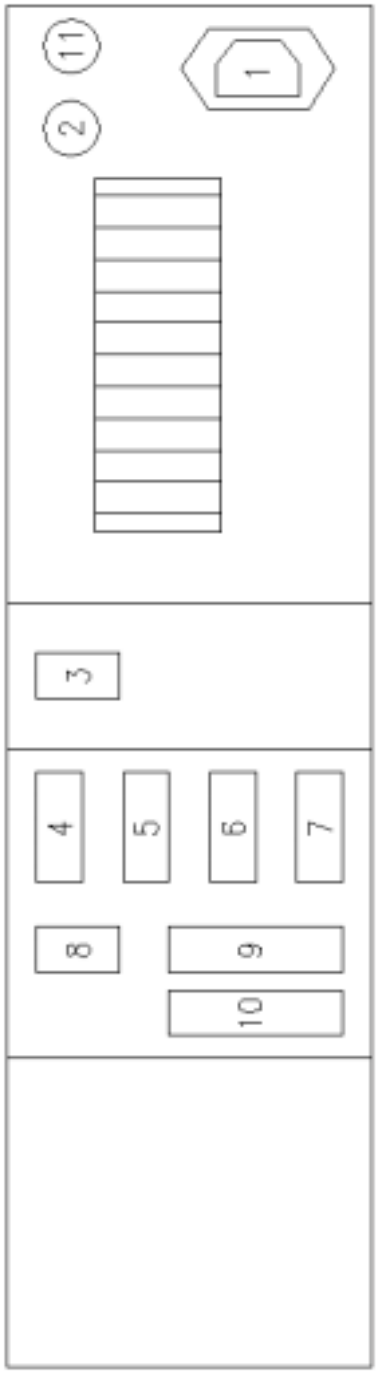



Figure 3

1 = Power Supply Connector
2 = Voltage Selector Switch
3 = RS 232 Interface (IEEE optional)
4 – 7 = Connectors for MFC's
8 = Connector PRESSURE for ext. pressure controller or transducer
9 = Connector ACCESS
10 = Connector RELAYS



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## 1.7 Safety Information

### 1.7.1 Symbols Used in this Instruction Manual

Definitions of WARNING, CAUTION, and ATTENTION messages used throughout the manual.

**Warning** 

**The WARNING sign denotes a hazard. It calls attention to a procedure, practice, condition, or the like, which, if not correctly performed or adhered to, could result in injury to personnel.**

**Caution** 

**The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of all or part of the product.**

**Attention** 

The NOTE sign denotes important information. It calls attention to a procedure, practice, condition, or the like, which is essential to highlight.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

### 1.7.2 Safety Instructions

**Attention:**  Please read this instruction carefully and follow it before using this device.

This device is state of the art and save. But danger may appear by the device, if not used according to the instructions or the professional knowledge.

Only spare parts of the manufacturer may be used for replacements.

The device must not be used in explosive environments.

Safety and reliability is only given in the following cases:

- the device is used according to the manual
- the device is serviced by personel of the manufacturer only.
- The installation of the device complies th the national derectives and standards.

Cleaning of the device must performed, if it is desconnected from power supply and if the cleaning is performed dry.

**Warning**  The device may be opened by MKS service personel only. If the device is open, danger for life (by high voltage) may occur.

## 1.8 Installation

The device must be used in a dry and heated room (see ambient temperature).

The device produces heat due to the power consumption. In order to avoid overheating the opening of the fan and all other openings in the case must not be closed. Air must circulate through this openings without any blocking.

**Attention:**  The correct setting of the power voltage setting must be checked before power is applied to the device.

Follow the steps below. For installation of the device:

- Hook the device to the power plug. If you use a transformer, it must be able to supply 300 Watt.
- Hook the instruments to the device, according to the pinout of the connectors or use the appropirate cables.
- Switch the device on, and perform the setup in the menues INSTRUMENT SETUP and SYSTEM SETUP.
  If the digital interface is used (RS232, IEEE), the setup in the SYSTEM SETUP menu is of special importance.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

- If you have problems booting the system, you should read the chapter “Reset of System” and “Applications of the 647B”.

## 1.9 Symbols at the case

The device shows some symbols, which are explained here:

- The “!” (⚠) says to watch the documentation/manual.
- The type label gives information about the device type, the serial number and some technical date.
- The label close to the fuse holder tells the specification of spare fuses: F 5A, 250V.

## 1.10 Accessories

The 647B comes with the following accessories:

- Sub-D connector sets for the instruments:

  | | |
  |---|---|
  | 4 channel device: | ZB-19 |
  | 8 channel deivce: | ZB-20 |

- Power cable: Y-0984492
- Manual: Y-1957647
- 2*handles for the case: Y-5150011
- 4*screws for the handles: Y-1600005

## 1.11 Cables

Refer to the instruction manuals of the respective mass flow meters, mass flow controllers and pressure transducers for cable information.

## 1.12 Service

In case of problems or failure of the device, please contact your local MKS representative. The last page of this manual contains a list of service and calibration centers.



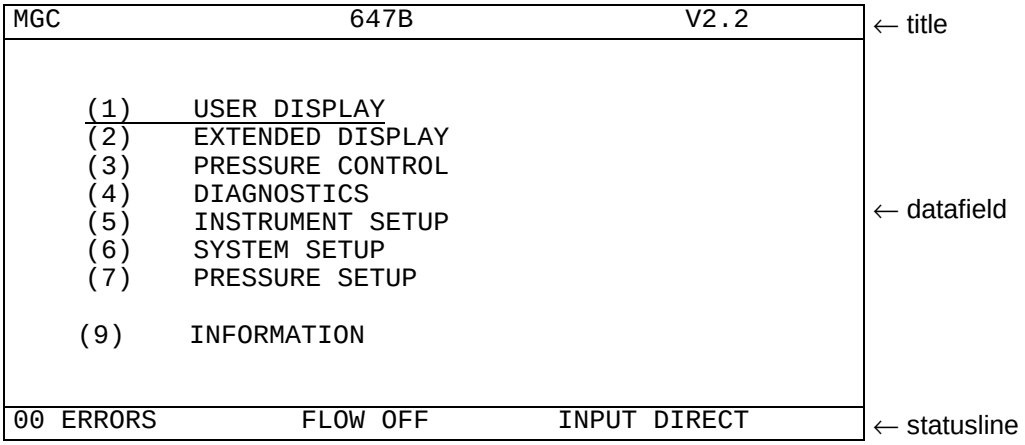
Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

# 2. Operating Instructions

## 2.1 The User Interface

The device is operated via menus. A menu consists of submenus, input fields or display fields. Submenus can be reached by typing the number labeling them on the screen or selecting them with the cursor and typing <0>. They can be exited pressing the <ESC> button. Input fields are highlighted by a cursor frame, when they are selected for input. Using the cursor keys different input fields can be selected (i.e. the cursor keys move the cursor on the screen). The input fields allow values to be edited or selected by scrolling up and down through a table. In some cases certain input fields are not active.

The top line of the screen (title) displays the device type (MGC = **M**ulti **G**as **C**ontroller) and software version. The status line on the bottom of the screen displays the number of errors, the status of the main valve and the input status of the keyboard (see also MAIN MENU).




(comment: the cursor is shown as underline in this document)

Figure 4

If errors occured, detailed error descriptions are available through the menu ERROR LISTING, see page 15.

In order to turn off all gas flows at once there are the main valve functions. The main valve is switched on with the key combination <ON><ALL> and switched off with key combination <OFF><ALL>. The current state of the main valve is displayed as FLOW ON (open) and FLOW OFF (closed), respectively.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

The state of the keyboard is displayed in the “INPUT” field of the status line.

| | |
|---|---|
| DIRECT | = input from keyboard enabled |
| ON | = last input was <ON> |
| OFF | = last input was <OFF> |
| LOCKED | = The keyboard is locked through RS232 or IEEE |
| MEMORY | = A stored gas menu is active |

In the 8 channel version, it is not possible to display all channels simultaneously on the display. Therefore it is possible to scroll through the channels display horizontally.

## 2.2 The Menu Tree

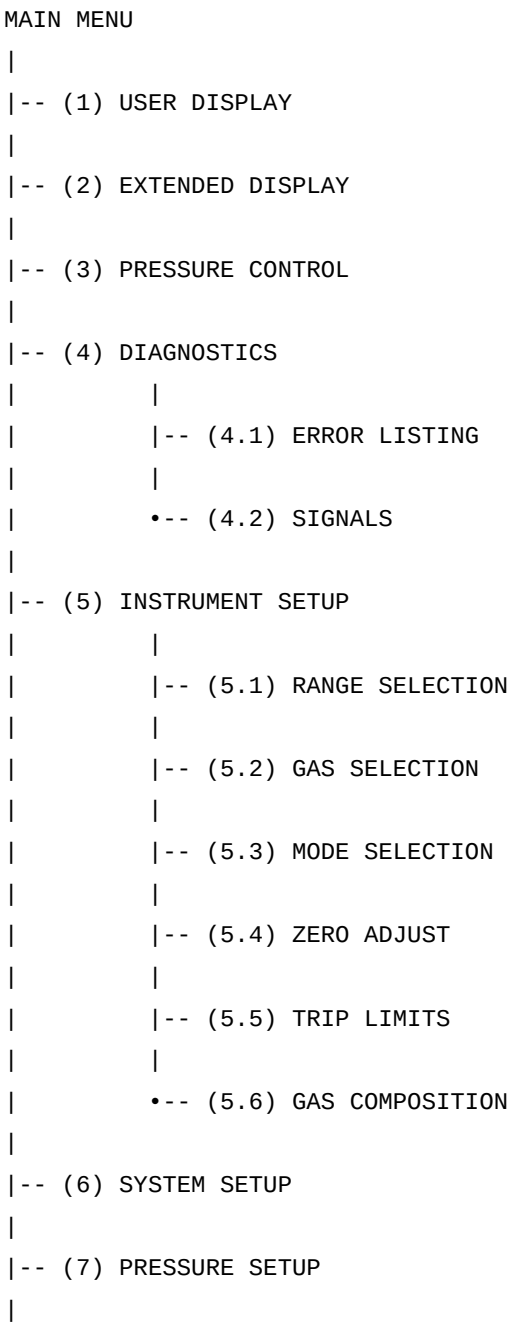



Figure 5



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## 2.3 Reset of System

There are four types of Reset:

- First Start Reset
- Power Up Reset
- Hardware Reset
- Reset to Default

**Attention:**  All of the above resets will switch off all gas flow controllers.

**First Start Reset** will appear if the system is started for the first time or if the RAM has been replaced. This has usually already taken place at the factory. All data in the RAM are initialized with this reset. A quick tap on keys <7> and <9> will force the system to First Start Reset.

If the device refuses to come up on power on, press button <8> while switching the device on in order to perform a total reset (equal to First Start Reset). This problem can have 2 reasons:

- Data in memory was destroyed through a transient. The described procedure will fix this problem.
- There is an error in the hardware. If the Start Up problem occurs more than once contact your local MKS service center.

**Power Up Reset** is performed everytime the system is switched on. It resets all data which are needed for system administration. Data of process parameters are not affected.

**Hardware Reset** is similar to Power Up Reset. It is triggered by the keys <OFF> and <cursor right> pressed at the same time. In any case Power Up or Hardware Reset leads to the MAIN MENU.

**Reset to Default** sets all process parameters to their default value. This reset is triggered in SYSTEM SETUP menu.

After the device has been turned off, one should wait for ca. 15 seconds before turning it on again.

## 2.4 Display adjustment

The viewing angle of the LCD display and the timeout setting of its back light saver, may be set in SYSTEM BACKUP menu.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

# 3. Functionality

## 3.1 The MAIN MENU

After turning on the power switch (1) the MAIN MENU is displayed. From this menu the different submenus are accessible. (See also figure 4).

## 3.2 The USER DISPLAY menu

```
MGC                        647B                        V2.2

    CH1          CH2           CH3          CH4

  0.000        1.750         1.400        0.000
   SCCM         SCCM           SLM          SLM

    CH5          CH6           CH7          CH8

  0.000        0.000         0.000        0.000
   SLM          SCCM           SCCM         SCCM

 PRESSURE    0000.0 mbar
 TOTAL FLOW:  001.4 SLM                GAS MENU: X

00 ERRORS              FLOW ON              INPUT DIRECT
```

Figure 6

The USER DISPLAY menu allows monitoring the system during operation. It displays all gas flows of the connected Mass Flow Controllers.

All gas flow values are displayed in a 4 digit format without limiting the resolution. Additionally the physical unit of the gas flow is shown below. The sum of all gas flow values (TOTAL FLOW) is displayed additionally. The unit of the total flow can be selected through the keyboard.

The user can select one out of five predefined composition ratios (see also GAS COMPOSITION menu) through the GAS MENU parameter. The stored composition ratios are labled with numbers 1 to 5. X means that none of the stored ratios is activated. In this case the setpoints for the mass flow controllers are the ones defined in EXTENDED DISPLAY.

The displayed value of TOTAL FLOW is the sum of all single gas flows. Because flow units of different decades (e.g. SCCM and SLM) are added, it might come to discrepancies between the two displays, which are due to rounding errors. Step through the flow units of the TOTAL FLOW, in order to optimize TOTAL FLOW display.

Since negative flow values are not added to TOTAL FLOW, channels wich are turned off can not cause errors.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## 3.3 The EXTENDED DISPLAY menu

| MGC | | 647B | | V2.2 |
|---|---|---|---|---|
| | CH1 | CH2 | CH3 | CH4 |
| ACT.FLOW | 0.000 | 1.750 | 1.400 | 0.000 |
| SETPOINT | 4.500 | 1.750 | 1.400 | 0.728 |
| UNIT | SCCM | SCCM | SLM | SLM |
| RANGE FS. | 5.000 | 5.000 | 1.4000 | 1.450 |
| GAS | USER | AIR | $CO_2$ | He |
| MODE | INDEP. | INDEP. | INDEP. | SLAVE |
| STATUS | OFF | ON | ON | ON |
| PRESSURE | 0000.0 mbar | | | |
| 00 ERRORS | | FLOW ON | | INPUT DIRECT |

Figure 7

The EXTENDED DISPLAY menu allows controlling the system before and during operation. It contains the most important information needed to control the system.

Here the setpoints of all channels can be set and changed. The setpoints are selected by using the cursor keys. The input is done either numerically by typing in the values or by scrolling using the cursor keys. If MEMORY is displayed in the INPUT field of the status line, a predefined gas menu has been selected in the previosly described USER DISPLAY menu. In this case the set points of the channels cannot be changed.

Due to instabilities at the lower end of MFC range, the lowest setpoint is limited to 1%. Setpoints less than that are displayed as zero and an output value of –0.5 V is transferred to the MFC.

The displayed full scale ranges (RANGE FS.) are the ranges of each controller scaled with the gas correction factors. E.g. channel 4 controls a MFC with a range of 1 slm, calibrated in nitrogen. The regulated gas is helium and has a correction factor of 1.450 with respect to the calibration gas nitrogen, i.e. the actual full scale range is: RANGE FS. = 1 * 1.45 = 1.45 slm.

The actual gas flow of each channel is displayed in the line ACT.FLOW. Here the correction factors and ranges of the selected gases are also automatically taken into account. Values higher than 110% are displayed as an overflow through dashes: “-.---“. The lowest displayed flow value is –10%. (See also Zero Adjust).

Typing <ON><x> turns on the valve of channel x and causes its set point to be sent to the mass flow controller. In addition to provide the possibility of turning on and off all controllers at the same time, there is the switch <ON/OFF><ALL>. The green LED (GAS ON) indicates that at least one mass flow controller is active.

A blinking red LED indicates that the software is working without problems (STAND BY).



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## 3.4 The PRESSURE CONTROL menu

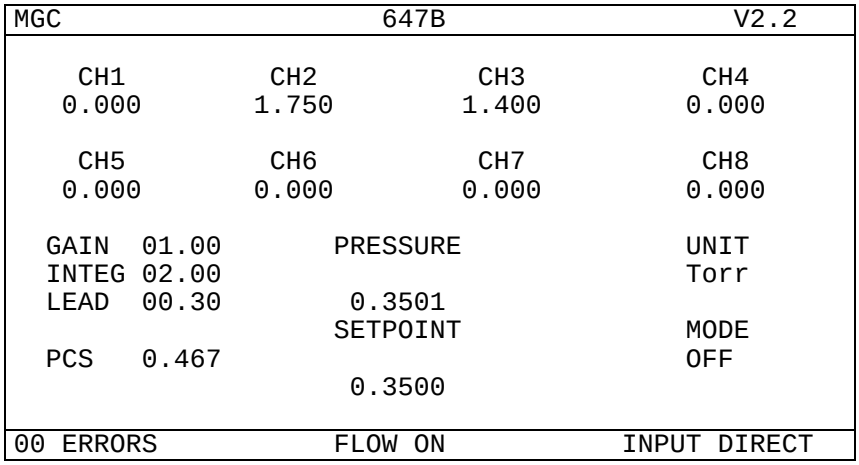



Figure 8

The PRESSURE CONTROL menu displays the actual flows and the actual pressure with its unit. During an application with an external pressure controller, the corrective action is also shown in PCS (**P**ressure **C**ontrol **S**ignal).

The pressure is controllable through the pressure setpoint and the two pressure modes:

OFF - set point for pressure regulation is turned off.

AUTO - set point for pressure regulation is turned on.

All parameters are edited as usual.

## 3.5 Tuning the PID Controller

There are three additional parameters to setup the PID algorithm, with the PID optional only.

The best procedure to tune the PID controller, is to make the step response of the application, evaluate the parameters dead time (Tt) and rise time (Ts) and then calculate the PID parameters.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

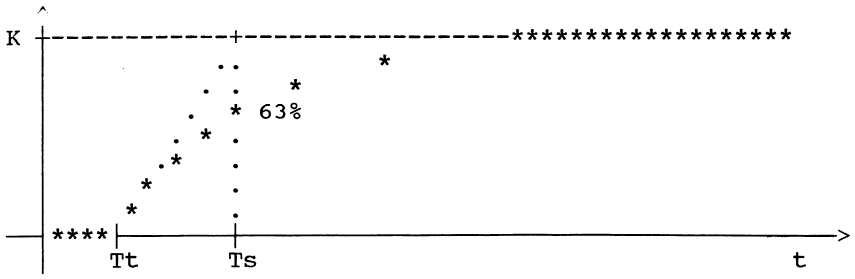



Figure 9

tuning for optimal step response:

- gain = 0.6 / K
- integral action = 1 * Ts
- lead = 0.5 * Tt

tuning for optimal disturbance response:

- gain = 0.95 / K
- integral action = 2.4 * Ts
- lead = 0.42 * Tt

K is the relation of actual pressure to actual total flow, both are to be taken as percent of full scale.

To improve the speed of your application, first increase the value of the gain parameter, then change the integral action.

If you cannot record a step response of your process, it is also possible to estimate the necessary values. Measure the time between the opening of the valves and the beginning change of the actual pressure as Tt. Then measure the time until pressure has gained 63% of the final pressure value.

Configuration of an Application:

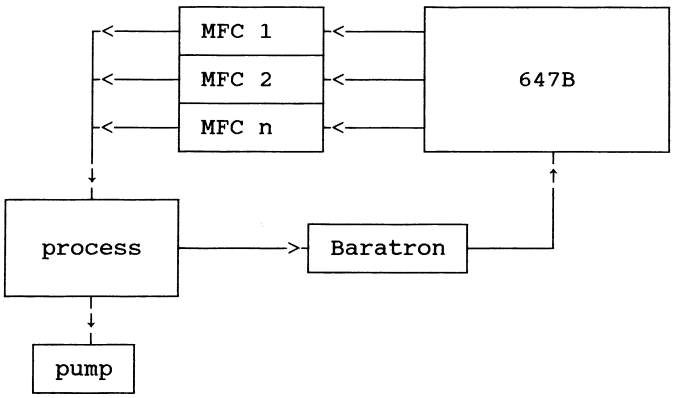



Figure 10



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## 3.6 Diagnosis of System

### 3.6.1 The ERROR LISTING menu

If the status line indicates the occurrence of errors, details about these errors and the affected channels can be retrieved from the ERROR LISTING menu.

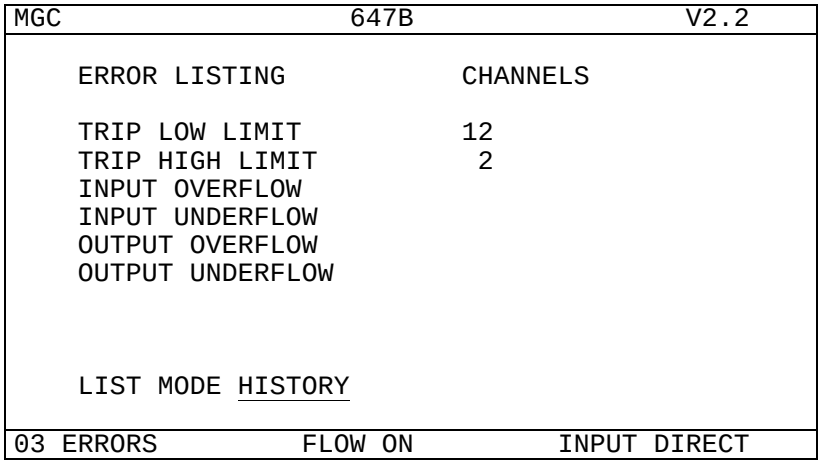



Figure 11

Error messages:

- TRIP LOW LIMIT
  The actual flow is lower than the low limit. (see also TRIP LIMITS menu, page 22)
- TRIP HIGH LIMIT
  The actual flow is higher than the high limit. (see also TRIP LIMITS menu, page 22)
- INPUT OVERFLOW / INPUT UNDERFLOW
  The input signal of the displayed channel is higher than 10V or lower than –10V.
- OUTPUT OVERFLOW / OUTPUT UNDERFLOW
  The output signal is higher than 10 V or lower than –10V.
  Since the calculated value cannot be transmitted to the controller, this can disturb the regulation behavior of closed loops.

Two display modes are possible in ERROR LISTING. The HISTORY mode stores all errors having occured until leaving the error listing. In the ACTUAL mode only actual valid errors are displayed.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

### 3.6.2 The SIGNALS menu

```
MGC                    647B                    V2.2

          OUTPUT     INPUT     EXTERN
CH1       -00250     -0250     -0250
CH2       001746     01746     01746
CH3       005002     05002     05002
CH4       -00500     -0500     -0500
CH5       -00500     -0500     -0500
CH6       -00500     -0500     -0500
CH7       -00500     -0500     -0500
CH8       -00500     -0500     -0500
PRES      -00250     -0015
PCS                  -0250

SIGNAL PROCESSING RUNNING

00 ERRORS          FLOW ON          INPUT DIRECT
```

Figure 12

**Attention:** When stopping signal processing the process is also stopped.

This menu is designed for test and maintenance purposes only. It displays all signals of the interface to the process. The display unit is mV. It is possible to enter setpoints in mV directly, if the signal processing is stopped. If you leave the signals menu then signal processing is restarted. This avoids problems concerning general 647B usage.

## 3.7 Instrument Setup

```
MGC                    647B                    V2.2

    (1)   RANGE SELECTION
    (2)   GAS SELECTION
    (3)   MODE SELECTION
    (4)   ZERO ADJUST
    (5)   TRIP LIMITS
    (6)   GAS COMPOSITION

00 ERRORS          FLOW ON          INPUT DIRECT
```

Figure 13

The instrument setup contains all parameters which are related to the process.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

### 3.7.1 Range Selection

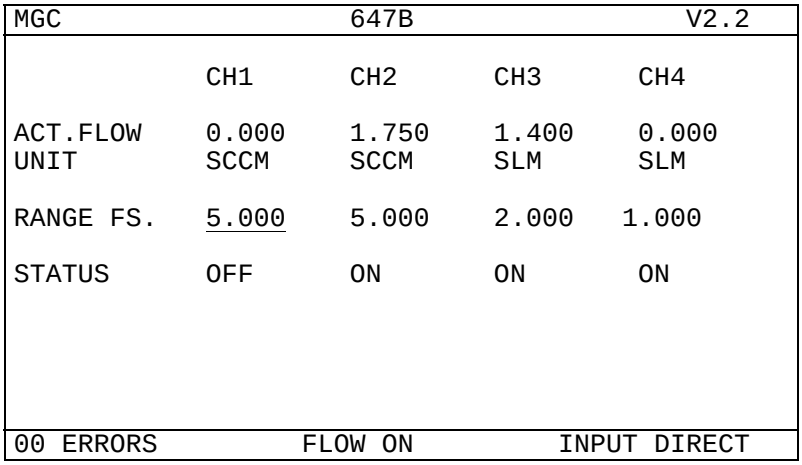



Figure 14

The following ranges are available:

| | | | | |
|---|---|---|---|---|
| 1 sccm, | 2 sccm, | 5 sccm, | | |
| 10 sccm, | 20 sccm, | 50 sccm, | | |
| 100 sccm, | 200 sccm, | 500 sccm, | | |
| 1 slm, | 2 slm, | 5 slm, | | |
| 10 slm, | 20 slm, | 30 slm, | 50 slm, | |
| 100 slm, | 200 slm, | 300 slm, | 400 slm, | 500slm, |
| 1 scmm, | | | | |
| 1 scfh, | 2 scfh, | 5 scfh, | | |
| 10 scfh, | 20 scfh, | 50 scfh, | | |
| 100 scfh, | 200 scfh, | 500 scfh, | | |
| 1 scfm, | 2 scfm, | 5 scfm, | | |
| 10 scfm, | 20 scfm, | 50 scfm, | | |
| 100 scfm, | 200 scfm, | 500 scfm, | | |

sccm = standard cubic centimeter per minute
slm = standard cubic liter per minute
scmm = standard cubic meter per minute
scfh = standard cubic feet per hour
scfm = standard cubic feet per minute



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## 3.7.2 Gas Selection

| MGC | | 647B | | V2.2 |
|---|---|---|---|---|
| | CH1 | CH2 | CH3 | CH4 |
| ACT.FLOW | 0.000 | 1.750 | 1.400 | 0.000 |
| UNIT | SCCM | SCCM | SLM | SLM |
| GAS | USER | AIR | $CO_2$ | He |
| FACTOR | 1.000 | 1.000 | 0.700 | 1.450 |
| STATUS | OFF | ON | ON | ON |
| 00 ERRORS | | FLOW ON | | INPUT DIRECT |

Figure 15

This menu contains the table of Gas Correction Factors (GCF) for mass flow controllers, which are calibrated in nitrogen under standard conditions (DIN 1871). In this case standard pressure means 1013 mbar and standard temperature is 0 degree centigrade.

The cursor keys (UP/DOWN) are used to scroll through the table entries of each channel.

For gases which are not included in the table, there is the position USER, which allows a direct numerical input of the GCF of any gas. For a description how to calculate GCF see the manual of the mass flow controllers. A direct numerical input of the GCF is also allowed for the gases helium and hydrogen, which are normally calibrated directly with these gases.

The 647B automatically calculates the actual range of each mass flow controller (RANGE FS.) from the product GCF x RANGE. E.g. for a flow controller, which is calibrated in 1 slm nitrogen, at a correction factor of 0.72 (methane) the actual flow range (RANGE FS.) displayed in EXTENDED DISPLAY menu is 0.720 slm.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

### 3.7.3 Mode Selection

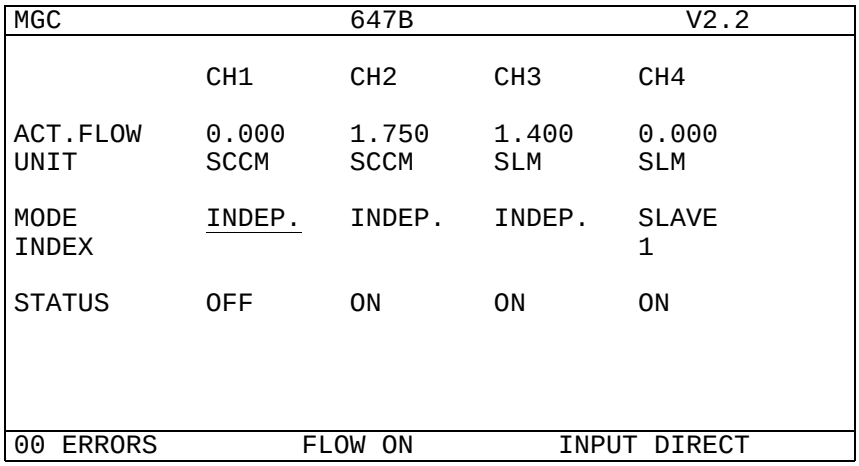



Figure 16

The Mode Selection defines the source of setpoint for each MFC channel. Possible modes are:

- INDEP = independent
- SLAVE = dependent to the actual flow of another channel
- EXTERN = external source for setpoint
- PCS = external controller
- PID = built in PID controller
- TEST = test for maintenance and installation

#### 3.7.3.1 Independent Mode

In the independent mode a MFC is driven by the entered setpoint which is constant.

#### 3.7.3.2 Slave Mode

In the Master/Slave configuration the ratio between the setpoints of the slaves and the setpoint of the master is kept at the selected ratio of gas composition. If the setpoint of the master is changed, the 647B also changes the setpoints for the slaves according to this ratio. Additionally in this mode the master channel governs the gas flows of the slave channels. I.e. the setpoints for the slave channels are calculated from the ACTUAL FLOW of the master channel according to the desired composition ratio and transmitted to the controllers, instead of the setpoints displayed on the screen. If, for instance, the gas flow of the master decreases because of a fault in the process, the gas flows of the slaves are also brought down, as can be seen from the ACT.FLOW display. If the gas flow of a slave is disturbed, however, the composition ratio for this channel is incorrect.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

E.g. a ratio of 5:1 (master:slave) means:

Setpoint of slave = act. flow of master * 0.2

The master channel is determined by the index which is associated with the slave channel. The advantages hereby are that the master remains free for declaration in other modes and more than one master is possible. With this declaration technique, however, useless circular reference chains, which might even be dangerous for the application, could appear. In order ro avoid this, the software checks out each input and rejects it if necessary. Therefore, this solution offers full advantages without risks.

Example 1: (menu extract)

| | CH1 | CH2 | CH3 | CH4 |
|---|---|---|---|---|
| MODE | INDEP. | SLAVE | SLAVE | INDEP. |
| INDEX | | 1 | 2 | |

In this example channel 1 is master of channel 2, which is master of channel 3. This is an open reference chain. The index number of a slave indicates its master channel. This declaration technique applicated to channel 2 as master has the advantage, that this channel may be declared as slave while being a master. Channel 4 is independent.

Example 2: (menu extract)

| | CH1 | CH2 | CH3 | CH4 |
|---|---|---|---|---|
| MODE | SLAVE | SLAVE | SLAVE | INDEP. |
| INDEX | 3 | 1 | 2 | |

This example shows a circular reference chain, which will never appear on 647B screen. The software prevents its appearance by consequently rejecting wrong input. This is the reason why some of the user's input might be rejected.

### 3.7.3.3 External Mode

This mode enables external control of the MFCs through the auxiliary connector. The MFC's setpoint is caculated as the product of setpoint in menu EXTENDED MENU and the signal at the auxiliary input. E.g.

Setpoint of MFC = setpoint in EXTENDED MENU * auxiliary input / 5 V

### 3.7.3.4 PCS Mode

In the PRESSURE CONTROL mode (PCS) the 647B serves as the regulating unit for a pressure controller (e.g. type 250). All gas flow channels which are configured in the PCS mode are regulated through the pressure control signal (PCS) according to the ratio of their set points.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

### 3.7.3.5 PID Mode

In this mode MFCs are driven by a PID algorithm (see also menu: PRESSURE CONTROL). This mode is only available with the PID option.

### 3.7.3.6 Test Mode

In this mode the 647B generates a test signal, which may be useful for installation procedures. The test signal is a saw tooth beetween zero and 100% with a period of 4 sec.

## 3.7.4 Zero Adjustment

```
MGC                    647B                    V2.2

              CH1       CH2       CH3       CH4

ACT.FLOW      0.000     1.750     1.400     0.000
UNIT          SCCM      SCCM      SLM       SLM

ZERO VALUE    0.005     -.004     0.002     -.002
ZERO ADJUST   EXEC      EXEC      EXEC      EXEC

STATUS        OFF       ON        ON        ON




00 ERRORS            FLOW ON            INPUT DIRECT
```

Figure 17

To trigger the Auto Zero function, the status needs to be changed from EXEC (executable) to ACT (active) through the cursor keys. The status DONE or FAIL displays the completition of the function. The status FAIL indicates that the offset was too large and a new zero value was not generated. FAIL status may also appear if the channel is switched on. The status ACT appears on the screen for a very short time, so that it is usually not noticed.

The measured value (the zero offset of the sensor of the mass flow controller) is displayed in the field ZERO VALUE. In order to correct the zero offset, this value is subtracted from actual flow and added to the setpoint output. This way the controller gets a corrected setpoint and thus equalizing the sensor signal's error.

If necessary, one can enter the zero offset directly.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

### 3.7.5 Trip Limit Supervision

```
MGC                    647B                    V2.2

              CH1       CH2       CH3       CH4

ACT.FLOW      0.000     1.750     1.400     0.000
UNIT          SCCM      SCCM      SLM       SLM

MIN.LIMIT     3.000     0.750     0.000     0.000
MAX.LIMIT     4.000     0.250     1.400     1.450
SUPERVIS.     LIMIT     BAND      SLEEP     SLEEP

STATUS        OFF       ON        ON        ON



00 ERRORS            FLOW ON            INPUT DIRECT
```

Figure 18

There are three modes to supervise the process.

- SLEEP mode
- LIMIT mode
- BAND mode

In SLEEP mode no supervision is performed. In LIMIT mode the actual flow is supervised to remain between the trip limits. If the actual flow exceeds the high limit or falls below the low limit an error will be generated. The limits are considered as absolute values. The BAND mode is similar to LIMIT mode, but the limits are considered as deviation to the setpoint. The low limit represents negative deviation.

The supervision becomes active 1 second after the selection of a mode.

Two relays are driven by each channel, if the Relay Option is used. The logic of the relays depends on the actual Supervision Mode:

- SLEEP mode
  In this mode relay 1 represents the status of the channels's valve. Relay 2 is idle.
- BAND mode
  In this mode relay 1 also represents the status of the channel's valve. Relay 2, however, will become active if the actual flow is outside of the defined band.
- LIMIT mode
  If the actual flow is below low limit, relay 1 will become active, and if it is above high limit relay 2 will become active.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Truth Table:

| Mode | Relay # | Valve | Low limit | High limit | Relay status |
|---|---|---|---|---|---|
| SLEEP | 1 | OFF | X | X | inactive |
| SLEEP | 1 | ON | X | X | active |
| SLEEP | 2 | X | X | X | inactive |
| BAND | 1 | OFF | X | X | inactive |
| BAND | 1 | ON | X | X | active |
| BAND | 2 | X | not exceeded | not exceeded | inactive |
| BAND | 2 | X | X | exceeded | active |
| BAND | 2 | X | exceeded | X | active |
| LIMIT | 1 | X | not exceeded | X | inactive |
| LIMIT | 1 | X | exceeded | X | active |
| LIMIT | 2 | X | X | not exceeded | inactive |
| LIMIT | 2 | X | X | exceeded | active |

X = any condition

Figure 19

### 3.7.6 Gas Composition

```
MGC                    647B                    V2.2

            CH1       CH2       CH3       CH4

SET 1       1.000     1.700     0.000     0.000
SET 2       1.010     1.750     0.000     0.000
SET 3       1.020     1.800     0.000     0.000
SET 4       1.040     1.850     0.000     0.000
SET 5       0.000     0.000     0.000     0.000

UNIT        SCCM      SCCM      SLM       SLM

STATUS      OFF       ON        ON        ON


00 ERRORS          FLOW ON          INPUT DIRECT
```

Figure 20

Up to 5 different gas compositions (SET 1 to SET 5) can be defined here, which can be selected in the menu USER DISPLAY through the item GAS MENU.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## 3.8 System Setup

### 3.8.1 IEEE 488 Setup

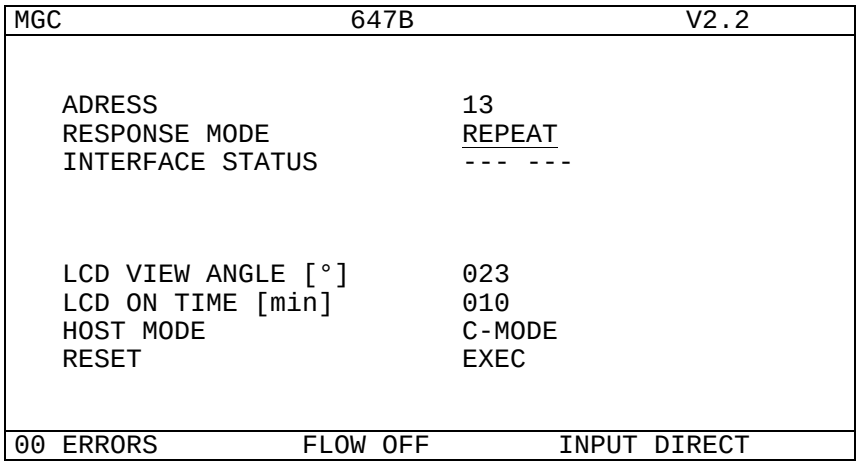



Figure 21

This menu is available instead of RS232 setup, if the IEEE option is installed only.

The IEEE interface is designed to meet the functional requirements for talker and listener functional requirements as specified by IEEE Standard 488-1978.

Functional capabilities:

- SH1 source handshake
- AH1 acceptor handshake
- L3 listener
- T5 talker
- RL1 remote/local
- DC1 device/clear

The implemented commands are the same as in a RS232 device.

#### 3.8.1.1 IEEE Adress

The address setup specifies the IEEE address of the device. Possible adresses range from 0 to 30. An address value may only be used once in a bus system.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

### 3.8.1.2 Response Modes

There are three modes, that specify the 647B's reaction to a data request of the bus controller.

- QUIET
- POLLING
- REPEAT

In the QUIET mode, the 647B only responds to a command if data are pending. There is no response if errors occur or if a command results in no data at all.

In the POLLING mode each command results an a response. Either data, an error string or an empty acknowledge (i.e. <CR><LF>) is sent back to the controller.

Both modes QUIET and POLLING do not respond if there has been no request through a previous command.

The REPEAT mode is similar to POLLING, but it responds to each data request of the bus controller. If the controller has not sent a command before the request, the 647B repeats the last given command. If there has been no last command e.g. after power up, the command "ID" is performed.

### 3.8.1.3 Interface Status

The interface status displays two flags, the adress status and the communication status.

- adress status: ---, TLK, LSN
- communication status: ---, RMT, LLO

TLK means that the device is adressed as talker, LSN means an adressing as listener. Three dashes (---) are displayed if any other device is adressed.

The bus controller is able to set the device to remote (RMT) or local (---) status. If the device is in remote status it is not possible to operate it through the keyboard, but it can be switched back to local by the <ESC> key until the next command appears. If the device is set to local lockout (LLO) status by the controller there is no reset to local status through the keyboard possible.

Regardless of the IEEE status, the keyboard is also disabled by the command "KD" and enabled by "KE". In order to work with the keyboard it must be enabled from command level (i.e. "KE") and bus level (i.e. local).

The status is updated 5 times a second, but as the communication could be faster than that, it is possible that not all changes of status will be visible.

### 3.8.1.4 Examples

The following examples show the usage of a 647B through the IEEE interface. The examples are given in HP85 basic.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Program to display the act. flow of channel 1 using QUIET mode:

```
10   LOCAL 7                    ! keyboard remains enabled
20   OUTPUT 713; "ID"           ! request for the advice ID
30   ENTER 713; A$              ! bus request for ID data
40   DISP A$                    ! display ID on the HP85 screen
50   OUTPUT 713; "FS 1 0500"    ! set setpoint to 50%
60   OUTPUT 713; "ON 1"         ! switch channel on
70   OUTPUT 713; "ON 0"         ! ditto
80   OUTPUT 713; "FL 1"         ! request of 1st channels act.flow
90   ENTER 713; A$              ! bus request
100  DISP A$                    ! display of act.flow
110  GOTO 80                    ! repeat act flow request
```

Same program but with REPEAT mode and keyboard disabled:

```
10   REMOTE 7                   ! keyboard remains enabled
20   OUTPUT 713; "ID"           ! request for the advice ID
30   OUTPUT 713; "FS 1 0500"    ! bus request for ID data
40   OUTPUT 713; "ON 1"         ! switch channel on
50   OUTPUT 713; "ON 0"         ! ditto
60   OUTPUT 713; "FL 1"         ! request of 1st channels act.flow
70   WAIT 1000                  ! wait until commands are accepted
80   ENTER 713; A$              ! bus request
90   DISP A$                    ! display of act.flow
100  GOTO 80                    ! repeat act flow request
```

For interface language see chapter Remote Control

### 3.8.2 RS232 Setup

```
MGC                        647B                        V2.2


   BAUDRATE                    9600
   PARITY                      ODD
   BITS                        8 bit
   STOPBITS                    1 bit
   HANDSHAKE                   NONE
   RS232 STATUS                -- -- --

   LCD VIEW ANGLE [°]          023
   LCD ON TIME [min]           010
   HOST MODE                   C-MODE
   RESET                       EXEC


00 ERRORS            FLOW OFF           INPUT DIRECT
```

Figure 22

The 647B implements a standard V24, RS232 interface with standard parameters.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

### 3.8.2.1 Baudrate

The baudrate defines the transfer speed of characters on the line. The transfer rate of commands and data is determined by this baudrate and by the processing speed of 647B. The first 30 commands will be directed to a buffer at maximum speed, while the transfer of further commands is controlled by a handshake protocol. The baudrate must fit to the baudrate of the host computer.

- supported baud rates:
  50, 75, 110, 150, 300, 600, 1200,
  1800, 2000, 2400, 3600, 4800, 7200, 9600 Baud

### 3.8.2.2 Data Link Parameters

The data link parameters must fit to setup of the host computer. Change it according to the setup of the host.

- word length
  7 bit
  8 bit
- parity
  NONE
  EVEN
  ODD
- stop bits
  1 bit
  2 bit

### 3.8.2.3 Handshake Protocol

The handshake protocol synchronizes different processing speeds of 647B and host computer. If the receiving device is busy with calculating and therefore not ready to accept more date it stops the transfer through a handshake protocol. The 647B can accept 30 commands at maximum speed until it stops the transfer.

There are three kinds of handshake modes for the communication with the host computer:

- no handshake
- software handshake (XON, XOFF)
- hardware handshake (RTS, CTS)

The usage of one of the above modes depens on the connection to the computer. If the communication is run without handshake and the calculating speed do not match, loss of data may appear.

### 3.8.2.4 Interface Connections

When the 647B software is booting (e.g. at power on or hardware reset) it detects the handshake mode through the cable type on the RS232 line. This mode is displayed in the menu.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

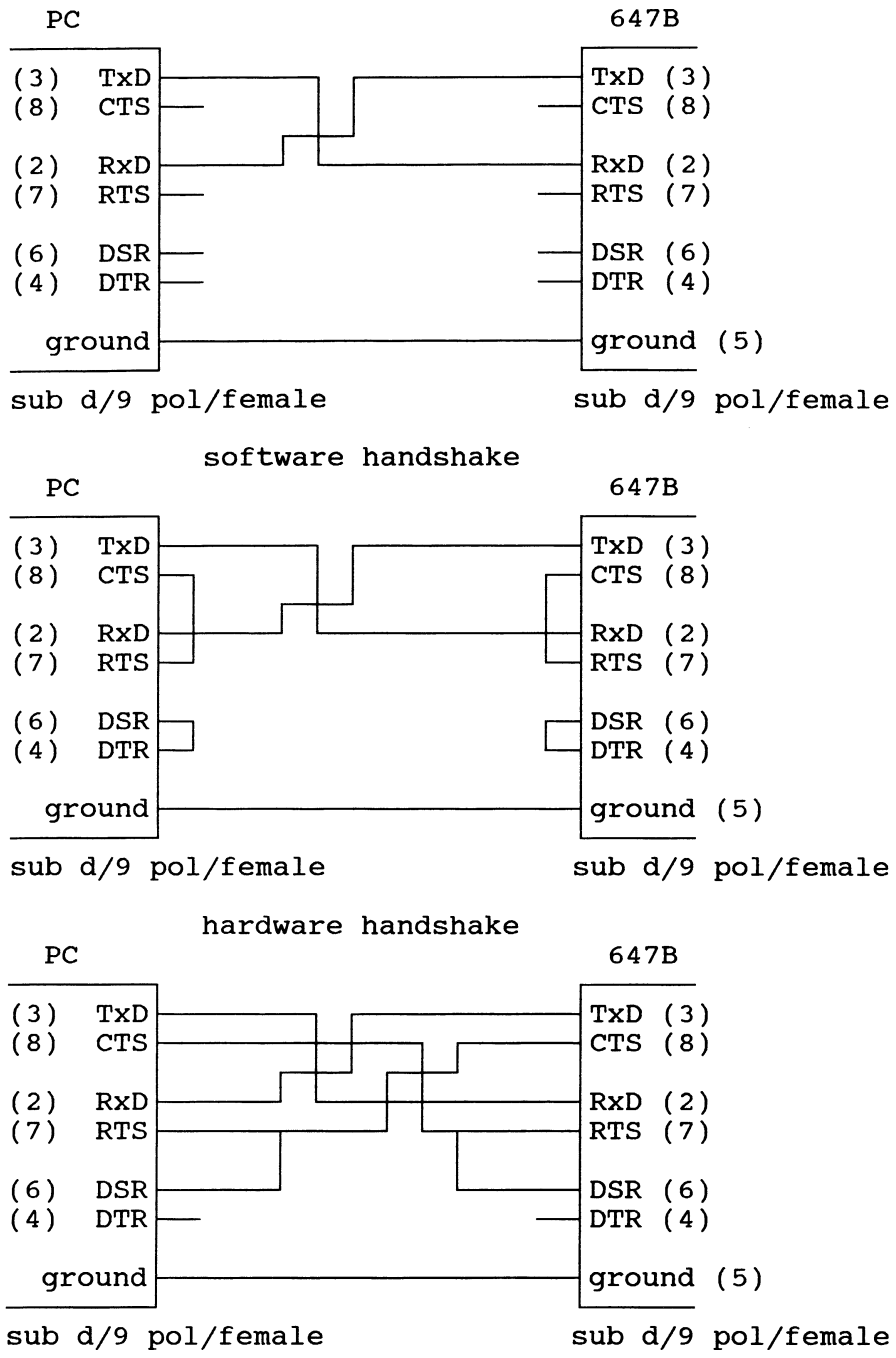



Figure 23

A typical error in handling the RS232 line is to plug in the cable, after having switched the device on before. As a result, the 647B works with no handshake although the host computer expects a handshaking. At installation time it may be helpful to check the actual handshake mode.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

### 3.8.2.5 RS232 Line Status

In order to make the debugging of a RS232 installation easier, a status display is inserted in the SYSTEM SETUP menu. The so called RS232 STATUS display three events on the RS232 line:

- OE: overrun error: (bytes were lost)
  Bytes were lost on the input line of 647B. This is typical if the handshake protocol does not work. Check for the correct connection on the line and for fitting handshake protocols.
- PE: parity error: (the parity check failed)
  A byte was transferred with a parity error. This is typical for noise on the line. Check the ground line.
- FE: framing error: (recognition of stopbit failed)
  Synchronization of bytes did not work (i.e. stop bit was not present). This is typical for noise on the line. Check the ground line.
- "- -": "two dashes"
  no error occured

### 3.8.2.6 Example

The following examples show the usage of a 647B through the RS232 interface. The examples are given in Power BASIC.

Program to display the act. flow of channel 1:

```
10   OPEN "COM2: 9600, 0, 8, 1" AS #1
20   PRINT #10, "ID"
30   INPUT #10, A$
40   PRINT A$
50   PRINT #10, "FS 1 0500"
60   PRINT #10, "ON 1"
70   PRINT #10, "ON 0"
80   PRINT #10, "FL 1"
90   INPUT #10, A$
100  PRINT A$
110  GOTO  80
120  END
```

## 3.8.3 System Parameters

For description of the parameter HOST MODE see chapter "Remote Control", page 30.

For the description of RESET function in SYSTEM SETUP menu, see the chapter "Reset of System", page 9.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## 3.9 Pressure Setup

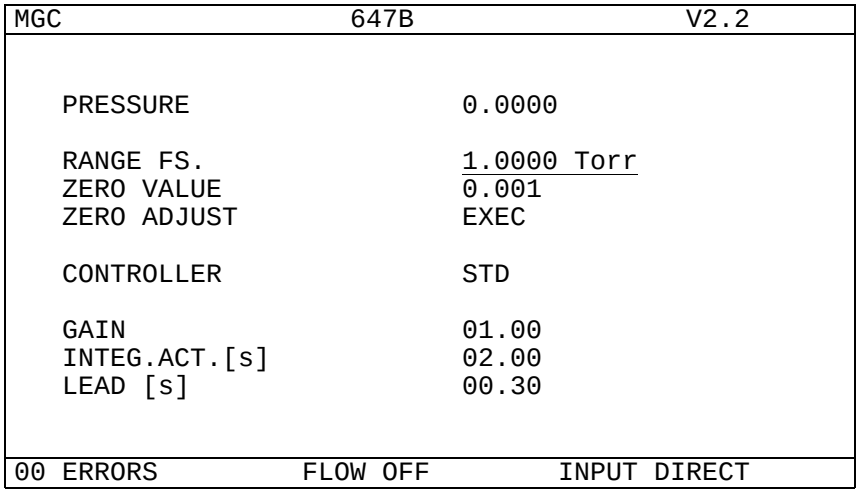



Figure 24

The 647B supports several pressure ranges listed below:

| | | | |
|---|---|---|---|
| 1.0000 mTorr, | 10.000 mTorr, | 100.00 mTorr, | 1000.0 mTorr, |
| 1.0000 Torr, | 10.000 Torr, | 100.00 Torr, | 1000.0 Torr, |
| 1.0000 kTorr, | 10.000 kTorr, | 100.00 kTorr, | |
| 1.0000 uBar, | 10.000 uBar, | 100.00 uBar; | 1000.0 uBar, |
| 1.0000 mBar, | 10.000 mBar, | 100.00 mBar, | 1000.0 mBar, |
| 1.0000 Bar, | 10.000 Bar, | 100.00 Bar, | |
| 1.0000 Pa, | 10.000 Pa, | 100.00 Pa, | |
| 1.0000 kPa, | 10.000 kPa, | 100.00 kPa, | 1000.0 kPa, |

The zero adjust works similar to that of an MFC channel (see chapter “Zero Adjust”, page 20).

Different external pressure controllers such as 250, 152, 153, 652 or 146 type may be used. The setup must show the applicated controller type. (652 is valid also for 651 controller).

For the parameters of the PID controller see chapter Pressure Control, page 13.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## 3.10 Information about the System

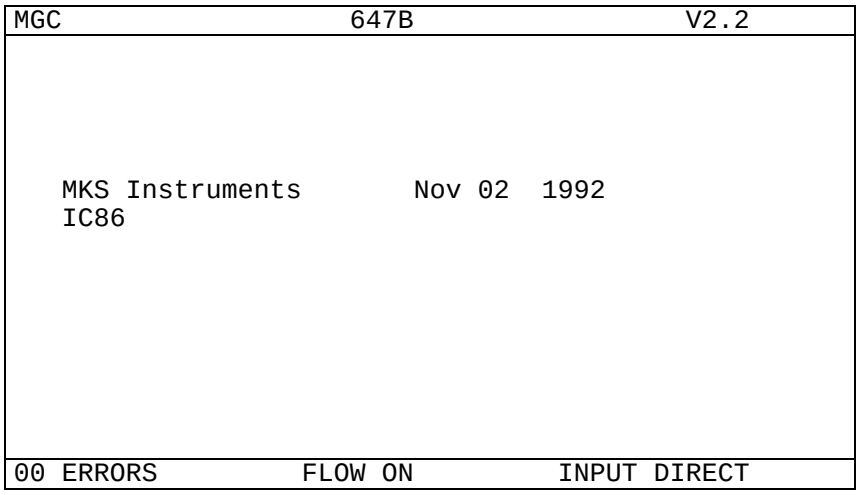



Figure 25

This menu gives information about the device such as:

- company
- software release code
- internal code

If you call MKS for support in case of problems, please be prepared to give this information to MKS.

# 4. Remote Control

## 4.1 Compatibility

The 647B offers more functionality than the 147B, which leads to some incompatible constructs in the remote control syntax. To avoid this incompatibility, the 647B distiguishes two host modes:

- C-MODE offers actual 647B commands
- B-MODE offers 147B commands

In B-MODE the device is compatible with 147B, so it is possible to use old configuration software without any changes. The full 647B functionality is only available in C-MODE.

In the beginning the C-MODE will be initialized and the device will act like an actual 647B. If a 147B command is used, the 647B will switch to B-MODE (e.g.: MO c 1, PL 1 3). It is also possible to switch to B-MODE through menu SYSTEM SETUP and vice versa.

For setup see chapter System Parameters, page 28.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## 4.2 Command Syntax

In general all commands are transmitted in ASCII format. Each command string must be terminated by a carriage return and there is no discrimination between upper and lower case letters. In order to improve readability, blanks (20 hex) may be included as delimiters between command, channel number and command parameters, however, this is not necessary. All parameters can be read by the host. For this purpose a “R” (for “Request”) is transmitted instead of the command parameter.

**Cmd cn {R | p1 [p2] [p3]} <cr> [<nl>]**

```
Cmd           = command, 2 bytes (see table of commands)
Cn            = channel number (1 – 4/8)
P1, p2, p3    = parameters, numerical input is always in
                decimal ASCII format
R             = request of the parameters
<cr>          = carriage return (0D hex) for terination
<nl>          = new line (0A hex) optional
```



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## 4.3 Table of Commands

```
                  Select gas menu
GM s                gas menu X, normal setpoints are used
  s = 0             gas menu 1-5
  s = 1..5        check for gas menu, result: s
GM R

                  enter setpoint of a channel
FS c xxxx           channel
  c = 1..8          setpoint in 0.1 percent of full scale
  x = 0..1100     check for setpoint, result: xxxxx
FS c R

                  check for actual flow of a channel, result: xxxxx
FL c

                    channel
  c = 1..8          actual flow in 0.1 percent of full scale
  x = 0..1100

                  enter pressure setpoint
PS xxxx             setpoint in 0.1 percent of full scale
  x = 0..1100     check for pressure setpoint, result: xxxxx
PS R

                  check for pressure, result: xxxxx
PR                  actual pressure in 0.1 percent of full scale
  x = 0..1100

                  check for PCS, result: xxxxx
PC                  actual PCS signal in 0.1 percent of full scale
  x = 0..1100

                  enter pressure mode
PM m                mode = off
  m = 0             mode = auto
  m = 1           check for pressure mode, reult: m
PM R

                  enter range
RA c rr             channel
  c = 1..8          range code:
  r = 0..39
                         0 = 1.000 SCCM,   20 = 1.000 SCFH
                         1 = 2.000 SCCM,   21 = 2.000 SCFH
                         2 = 5.000 SCCM,   22 = 5.000 SCFH
                         3 = 10.00 SCCM,   23 = 10.00 SCFH
                         4 = 20.00 SCCM,   24 = 20.00 SCFH
                         5 = 50.00 SCCM,   25 = 50.00 SCFH
                         6 = 100.0 SCCM,   26 = 100.0 SCFH
                         7 = 200.0 SCCM,   27 = 200.0 SCFH
                         8 = 500.0 SCCM,   28 = 500.0 SCFH
                         9 = 1.000 SLM,    29 = 1.000 SCFM
                        10 = 2.000 SLM,    30 = 2.000 SCFM
                        11 = 5.000 SLM,    31 = 5.000 SCFM
                        12 = 10.00 SLM,    32 = 10.00 SCFM
                        13 = 20.00 SLM,    33 = 20.00 SCFM
                        14 = 50.00 SLM,    34 = 50.00 SCFM
                        15 = 100.0 SLM,    35 = 100.0 SCFM
                        16 = 200.0 SLM,    36 = 200.0 SCFM
                        17 = 400.0 SLM,    37 = 500.0 SCFM
                        18 = 500.0 SLM,    38 = 30.00 SLM
                        19 = 1.000 SCMM,   39 = 300.0 SLM

RA c R                  check for range, result: rr
GC c fff          enter gas correction factor
  c = 1..8          channel
  f = 10.180        factor in percent
GC c R            check for gas correction factor, result: fffff
```



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

```
MO c m [i]          enter mode
  c = 1..8            channel
  m = 0               mode = independent
  m = 1               mode = slave
  m = 2               mode = extern
  m = 3               mode = PCS
  m = 9               mode = test
  i = 1..8            modeindex, reference to master
                        (only if m equal 1)
MO c R              check for mode, result: m [i]

AZ c                zero adjust MFC, result: xxxxx
  c = 1..8            channel
  x = -500..500       offset value in mV
  x = "E5"            error occured

HL c xxxx           enter high limit
  c = 1..8            channel
  x = 0..1100         high limit in 0.1 percent of full scale
HL c R              check for high limit, result: xxxxx

LL c xxxx           enter low limit
  c = 1..8            channel
  x = 0.1100          low limit in 0.1 percent of full scale
LL c R              check for low limit, result: xxxxx

TM c m              enter mode for trip limits
  c = 1..8            channel
  m = 0               mode = SLEEP
  m = 1               mode = LIMIT
  m = 2               mode = BAND
TM c R              check for trip limit mode, result: m

GP c s xxxx         enter setpoint in a gas set
  c = 1..8            channel
  s = 1..5            gas set 1 to 5
  x = 0..1100         setpoint in 0.1 percent of full scale
GP c s R            check for setpoint in gas set, result: xxxxx

PZ                  zero adjust pressure, result: xxxxx
  x = -500..500       offset value in mV
  x = "E5"            error occured

GT c                pressure controller
  c = 0..5            controller code
                         0 = STD (i.e. standard)
                         1 = 250
                         2 = 152
                         3 = ---
                         4 = 652
                         5 = 146
CT R                check for pressure controller, result: c

PU uu               pressure unit
  u = 0..28           unit code:
                         0 = 1.0000 mTorr         15 = 1.0000 mBar
                         1 = 10.000 mTorr         16 = 10.000 mBar
                         2 = 100.00 mTorr         17 = 100.00 mBar
                         3 = 1000.0 mTorr         18 = 1000.0 mBar
                         4 = 1.0000 Torr          19 = 1.0000 Bar
                         5 = 10.000 Torr          20 = 10.000 Bar
                         6 = 100.00 Torr          21 = 100.00 Bar
                         7 = 1000.0 Torr          22 = 1.0000 Pa
                         8 = 1.0000 kTorr         23 = 10.000 Pa
```



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

```
                      9 = 10.000 kTorr         24 = 100.00 Pa
                     10 = 100.00 kTorr         25 = 1.0000 kPa
                     11 = 1.0000 uBar          26 = 10.000 kPa
                     12 = 10.000 uBar          27 = 100.00 kPa
                     13 = 100.00 uBar          28 = 1000.0 kPa
                     14 = 1000.0 uBar
PU R                 check for pressure unit, result: rr

ON c                 open valve
  c = 0                main valve (corresponds to: ON ALL)
  c = 1..8             channel valve

OF c                 close valve
  c = 0                main valve (corresponds to: OFF ALL)
  c = 1..8             channel valve

ST c                 check for status of a channel, result: xxxxx
                       (incompatible)
  c = 1..8             channel
  x = 0..FFFFH         status value: bit 0  <- 0/1 channel off/on
                                     bit 4     <- trip limit low
                                     bit 5     <- trip limit high
                                     bit 6     <- overflow in
                                     bit 7     <- underflow in
                                     bit 8     <- overflow out
                                     bit 9     <- underflow out
                                     bit 15    <- not used

KD                   keyboard disable, display is switched to user
                       menu

KE                   keyboard enable, display is switched back to previous
                     menu

DF                   sett all parameters to default

RE                   perform a hardware reset (like power up)

ID                   check for indetification,
                       result: MGC 647B V2.2 – mm dd yyyy
  mm                   month of release
  dd                   day of release
  yyyy                 year of release
```



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

The following host commands, respectively the command extensions, are only available with the PID option.

```
GN xxxx             enter PID parameter, gain
  xxxx = 0..9999      gain in percent
GN R                check for PID parameter gain, result: xxxxx

IA xxxx             enter PID parameter, integral action
  xxxx = 0..9999      integral action in 10 ms
IA R                check for PID parameter integ. act.,
                      result: xxxxx

LD xxxx             enter PID parameter, lead
  xxxx = 0..9999      lead in 10 ms
LD R                check for PID parameter lead, result: xxxxx

MO c m [i]          enter mode                    (extended command)
  c = 1..8            channel
  m = 0               mode = independent
  m = 1               mode = slave
```

and new line. If no result value is available also an empty response (<cr> <nl>) is possible.

If an error has been detected in the command string, an error message is sent before the acknowledge signal. In this case the command has not been executed.

**[  {v1 [v2]} | {E ec}  ] <cr> <nl>**

```
v1, v2        = result values
E             = indicator for an error
ec            = error code
                0 = Chnnel error:
                    A invalid channel number was specified in the
                    command or the channel number is missing.
                1 = Unknown Command:
                    A command has been transmitted which is unknown
                    to the 647B.
                2 = Syntax error:
                    Only one character has been sent instead of
                    the expected 2 byte command.
                3 = Invalid expression:
                    The command parameter does not have decimal
                    form, or invalid characters were found
                    within the parameter (e.g. 100.3: the decimal
                    point is an invalid character).
```



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

```
                4 = Invalid value:
                    The transmitted parameter is outside the
                    parameter range (e.g. 1200 is outside the range
                    of a set point)
                5 = Autozero error:
                    There was a trial to set the zero offset of an
                    active channel. Before setting the zero offset,
                    either the channel (OF #) or the gas (OF 0) has
                    to be switched off.

<cr>          = carriage return (0D hex) for termination
<nl>          = new line (0A hex)
```



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

# 5. Application of the 647B

## 5.1 Mass Flow Controllers

The mass flow controllers must have a linear DC voltage output of 0 – 5 V. The input impedance must not be lower than 1 MOhms. Some mass flow controllers of other manufacturers can be damaged by a constant set point < 0 V. Other possible symptoms are undesired oscillations, when the setpoint is varied, or disturbances of the regulation loop.

To operate mass flow controllers it is important, that the allowed maximum of input signals are not exceeded. The mass flow controllers must have a linear DC voltage input and output of 0 – 5 V. MKS mass flow controllers types 0258A/B/C, 0358B/C , 179A can be operated with the connector cables for MKS mass flow controllers types 259, 1259, 2259, 1159, 1179A, 2179A, 1479A, 1359, 1559 and 2159.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## 5.2 Trouble Shooting

| Symptom | Possible Causes and Remedies |
|---|---|
| 1. No display. | Power Failure<br>- Wrong position of voltage selector switch.<br>- Loose mains connection.<br>- No power in the outlet<br>– Fuse is defective<br>– Power supply is broken. |
| 2. Display of gas flow is close to zero or not correct. | - Loose connecton.<br>– Power supply is broken.<br>– Mass flow controller is warming up.<br>– Set point is not being transmitted.<br>– Valve in the supply line is closed. |
| 3. Display of gas flow is on for a short time and goes back to zero. | Defect in the pipe line system.<br>– Supply line valve is closed.<br>– Pressure is down (check gas supply).<br>– No differential pressure (e.g. pump is turned off). |
| 4. There are periodical peak pulses at constant gas flow. | - Pressure regulator is defect, (frequent defect, varying supply pressure may help. It is recommended to replace the pressure regulator)<br>– Disturbance by external sources (change the path of power lines, sreen sources of disturbance). |
| 5. Entering data is not possible or there are unreadable characters on the display | – There is probably iconsistent data in battery backuped RAM. The First Start Reset will fix this problem. |

If the trouble is limited to a part of the eight possible channels, it is recommended to localize the source of trouble by exchanging mass flow controllers and their connecting cables.

In any case check the setup of the device.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

# 6. Pin Assignment of rear connectors

## 6.1 RS232 connector

Sub-D male 9 pol.

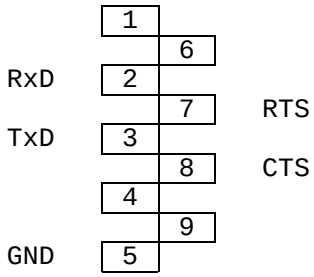



Figure 26

## 6.2 IEEE 488 connector

| | | | |
|---|---|---|---|
| DIO 0 | 1 | 13 | DIO 4 |
| DIO 1 | 2 | 14 | DIO 5 |
| DIO 3 | 3 | 15 | DIO 6 |
| DIO 4 | 4 | 16 | DIO 7 |
| EOI | 5 | 17 | REN |
| DAV | 6 | 18 | ground |
| NRFD | 7 | 19 | ground |
| NDAC | 8 | 20 | ground |
| IFC | 9 | 21 | ground |
| SRQ | 10 | 22 | ground |
| ATN | 11 | 23 | ground |
| shield | 12 | 27 | ground |

Figure 27



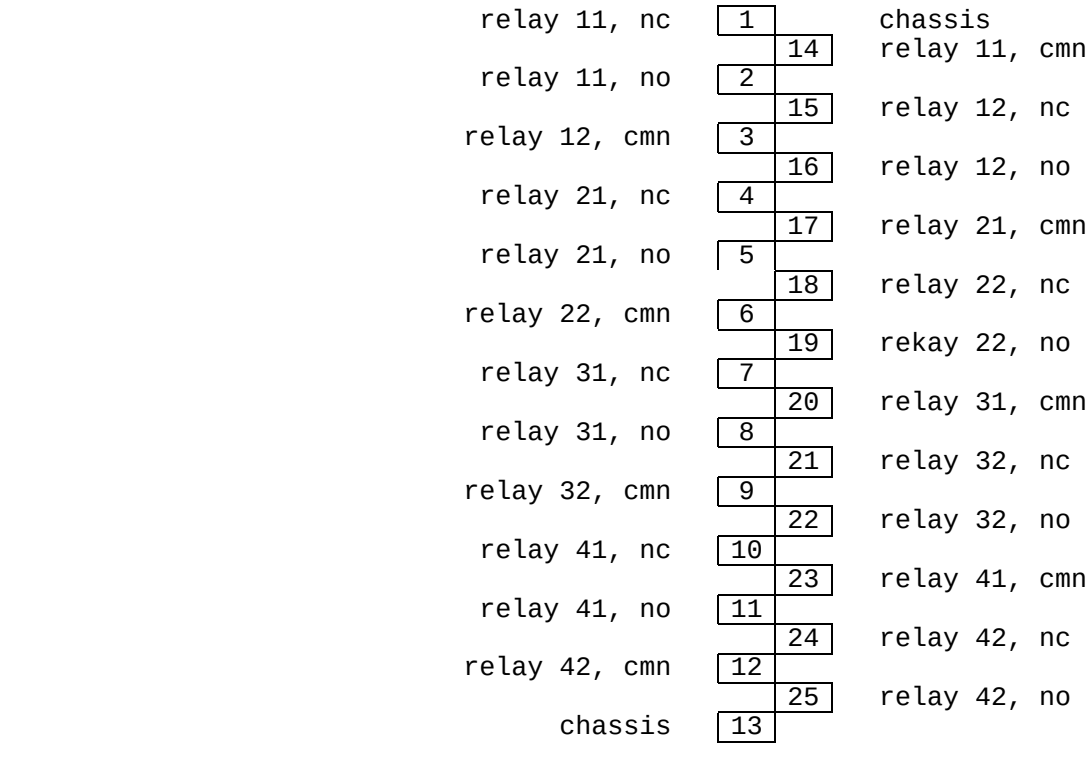
Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## 6.3 RELAYS connector

Two relays are available for each channel. The relay data are:

| | |
|---|---|
| - type of relay: | 1 switch with n.o. and n.c. position (SPDT) |
| - max. switch voltage: | 100 V |
| - max. power: | 3 W |
| – max. switch load: | 250 mA |
| - max. response time: | 55 ms |

Sub-D female 25 pol.




legend: nc = normally closed
no = normally open
cmn = common pin

relay 12 = relay 2 of channel 1

Figure 28



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## 6.4 VIDEO connector

Sub-D female 9 pol.

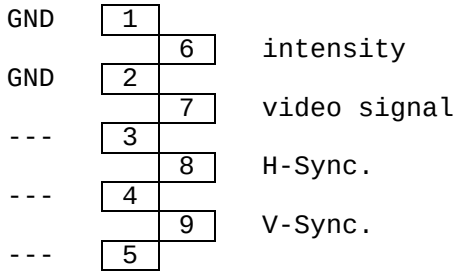
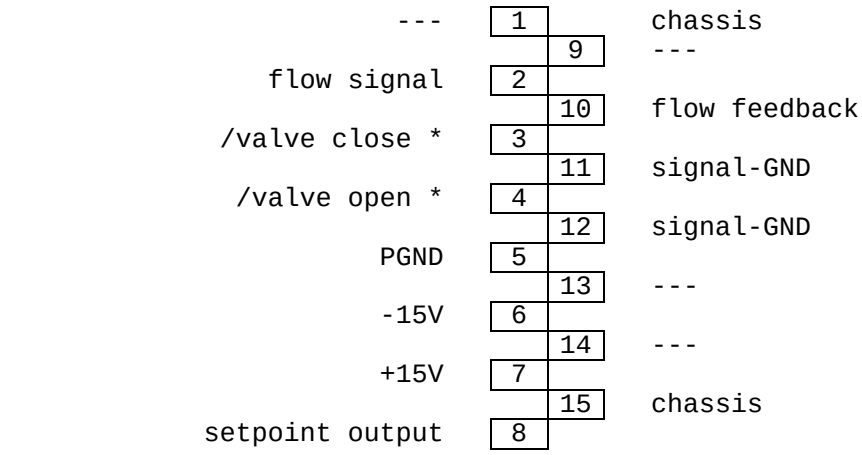



Figure 29

## 6.5 MFC connector: CH1 to CH8

Sub-D female 15 pol.




* = for use with cable type CB147-1

Figure 30



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## 6.6 ACCESS connector

Sub-D female 25 pol.

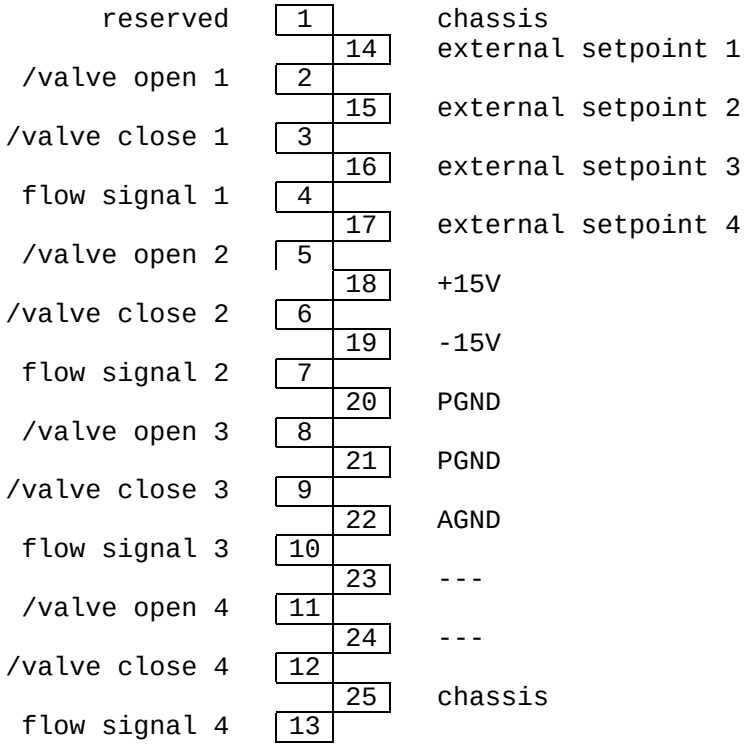



Figure 31

## 6.7 PRESSURE connector

Sub-D female 9 pol.

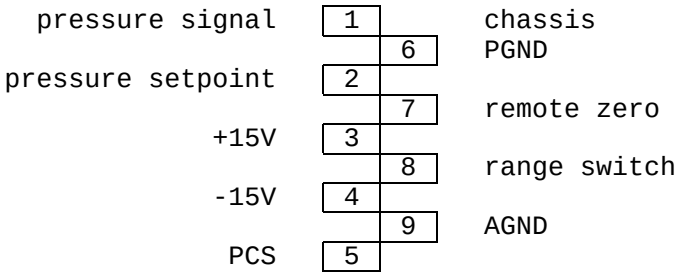



Figure 32



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

# 7. Gas Correction Table

**Conversion factors are related to calibration in nitrogen or air.**

| GAS | SYMBOL | SPECIFIC HEAT, Cp cal/g$^{o}$C | DENSITY g/l @ 0$^{o}$C | CONVERSION FACTOR |
|---|---|---|---|---|
| Acetylene | $C_2H_2$ | 0.383 | 1.171 | 0.58 |
| Air | - - - | 0.240 | 1.293 | 1.00 |
| Ammonia | $NH_3$ | 0.492 | 0.760 | 0.73 |
| Argon | Ar | 0.1244 | 1.782 | 1.39[1] |
| Arsine | $AsH_3$ | 0.1167 | 3.478 | 0.67 |
| Boron Trichloride | $BCl_3$ | 0.1279 | 5.227 | 0.41 |
| Bromine | $Br_2$ | 0.0539 | 7.130 | 0.81 |
| Carbon Dioxide | $CO_2$ | 0.2016 | 1.964 | 0.70[1] |
| Carbon Monoxide | CO | 0.2488 | 1.250 | 1.00 |
| Carbon Tetrachloride | $CCl_4$ | 0.1655 | 6.86 | 0.31 |
| Carbon Tetraflouride (Freon - 14) | $CF_4$ | 0.1654 | 3.926 | 0.42 |
| Chlorine | $Cl_2$ | 0.1144 | 3.163 | 0.86 |
| Chlorodifluoromethane (Freon - 22) | $CHClF_2$ | 0.1544 | 3.858 | 0.46 |
| Chloropentafluoroethane (Freon - 115) | $C_2ClF_5$ | 0.164 | 6.892 | 0.24 |
| Chlorotrifluoromethane (Freon - 13) | $CClF_3$ | 0.153 | 4.660 | 0.38 |
| Cyanogen | $C_2N_2$ | 0.2613 | 2.322 | 0.61 |
| Deuterium | $D_2$ | 1.722 | 0.1799 | 1.00 |
| Diborane | $B_2H_6$ | 0.508 | 1.235 | 0.44 |
| Dibromodifluoromethane | $CBr_2F_2$ | 0.15 | 9.362 | 0.19 |
| Dichlorodifluoromethane (Freon - 12) | $CCl_2F_2$ | 0.1432 | 5.395 | 0.35 |
| Dichlorofluoromethane (Freon - 21) | $CHCl_2F$ | 0.140 | 4.592 | 0.42 |
| Dichloromethysilane | $(CH_3)_2SiCl_2$ | 0.1882 | 5.758 | 0.25 |

*(Table continued on next page)*



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

| GAS | SYMBOL | SPECIFIC HEAT, Cp cal/g$^{o}$C | DENSITY g/l @ 0$^{o}$C | CONVERSION FACTOR |
|---|---|---|---|---|
| Dichlorosilane | $SiH_2Cl_2$ | 0.150 | 4.506 | 0.40 |
| 1,2-Dichlorotetrafluoroethane (Freon - 114) | $C_2Cl_2F_4$ | 0.160 | 7.626 | 0.22 |
| 1,1-Difluoroethylene (Freon - 1132A) | $C_2H_2F_2$ | 0.224 | 2.857 | 0.43 |
| 2,2-Dimethylpropane | $C_5H_{12}$ | 0.3914 | 3.219 | 0.22 |
| Ethane | $C_2H_6$ | 0.4097 | 1.342 | 0.50 |
| Fluorine | $F_2$ | 0.1873 | 1.695 | 0.98 |
| Fluoroform (Freon - 23) | $CHF_3$ | 0.176 | 3.127 | 0.50 |
| Freon - 11 | $CCl_3F$ | 0.1357 | 6.129 | 0.33 |
| Freon - 12 | $CCl_2F_2$ | 0.1432 | 5.395 | 0.35 |
| Freon - 13 | $CClF_3$ | 0.153 | 4.660 | 0.38 |
| Freon - 13 B1 | $CBrF_3$ | 0.1113 | 6.644 | 0.37 |
| Freon - 14 | $CF_4$ | 0.1654 | 3.926 | 0.42 |
| Freon - 21 | $CHCl_2F$ | 0.140 | 4.592 | 0.42 |
| Freon - 22 | $CHClF_2$ | 0.1544 | 3.858 | 0.46 |
| Freon - 23 | $CHF_3$ | 0.176 | 3.127 | 0.50 |
| Freon - 113 | $C_2Cl_3F_3$ | 0.161 | 8.360 | 0.20 |
| Freon - 114 | $C_2Cl_2F_4$ | 0.160 | 7.626 | 0.22 |
| Freon - 115 | $C_2ClF_5$ | 0.164 | 6.892 | 0.24 |
| Freon - 116 | $C_2F_6$ | 0.1843 | 6.157 | 0.24 |
| Freon - C318 | $C_4F_8$ | 0.1866 | 8.93 | 0.164 |
| Freon - 1132A | $C_2H_2F_2$ | 0.224 | 2.857 | 0.43 |
| Helium | He | 1.241 | 0.1786 | - - - 2 |
| Hexafluoroethane (Freon - 116) | $C_2F_6$ | 0.1843 | 6.157 | 0.24 |
| Hydrogen | $H_2$ | 3.419 | 0.0899 | - - - 2 |
| Hydrogen Bromide | HBr | 0.0861 | 3.610 | 1.00 |

*(Table continued on next page)*



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

| GAS | SYMBOL | SPECIFIC HEAT, Cp cal/g$^{o}$C | DENSITY g/l @ 0$^{o}$C | CONVERSION FACTOR |
|---|---|---|---|---|
| Hydrogen Chloride | HCl | 0.1912 | 1.627 | 1.00 |
| Hydrogen Fluoride | HF | 0.3479 | 0.893 | 1.00 |
| Isobutylene | $C_4H_8$ | 0.3701 | 2.503 | 0.29 |
| Krypton | Kr | 0.0593 | 3.739 | 1.54 |
| Methane | $CH_4$ | 0.5328 | 0.715 | 0.72 |
| Methyl Fluoride | $CH_3F$ | 0.3221 | 1.518 | 0.56 |
| Molybdenum Hexafluoride | $MoF_6$ | 0.1373 | 9.366 | 0.21 |
| Neon | Ne | 0.246 | 0.900 | 1.46 |
| Nitric Oxide | NO | 0.2328 | 1.339 | 0.99 |
| Nitrogen | $N_2$ | 0.2485 | 1.250 | 1.00 |
| Nitrogen Dioxide | $NO_2$ | 0.1933 | 2.052 | .- - -2 |
| Nitrogen Trifluoride | $NF_3$ | 0.1797 | 3.168 | 0.48 |
| Nitrous Oxide | $N_2O$ | 0.2088 | 1.964 | 0.71 |
| Octafluorocyclobutane (Freon - C318) | $C_4F_8$ | 0.1866 | 8.93 | 0.164 |
| Oxygen | $O_2$ | 0.2193 | 1.427 | 1.00 |
| Pentane | $C_5H_{12}$ | 0.398 | 3.219 | 0.21 |
| Perfluoropropane | $C_3F_8$ | 0.194 | 8.388 | 0.17 |
| Phosgene | $COCl_2$ | 0.1394 | 4.418 | 0.44 |
| Phosphine | $PH_3$ | 0.2374 | 1.517 | 0.76 |
| Propane | $C_3H_8$ | 0.3885 | 1.967 | 0.36 |
| Propylene | $C_3H_6$ | 0.3541 | 1.877 | 0.41 |
| Silane | $SiH_4$ | 0.3189 | 1.433 | 0.60 |
| Silicon Tetrachloride | $SiCl_4$ | 0.1270 | 7.580 | 0.28 |
| Silicon Tetrafluoride | $SiF_4$ | 0.1691 | 4.643 | 0.35 |
| Sulfur Dioxide | $SO_2$ | 0.1488 | 2.858 | 0.69 |

*(Table continued on next page)*



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

| GAS | SYMBOL | SPECIFIC HEAT, Cp cal/g$^{o}$C | DENSITY g/l @ 0$^{o}$C | CONVERSION FACTOR |
|---|---|---|---|---|
| Sulfur Hexafluoride | $SF_6$ | 0.1592 | 6.516 | 0.26 |
| Trichlorofluoromethane (Freon - 11) | $CCl_3F$ | 0.1357 | 6.129 | 0.33 |
| Trichlorosilane | $SiHCl_3$ | 0.1380 | 6.043 | 0.33 |
| 1,1,2-Trichloro - 1,2,2-Trifluoroethane (Freon - 113) | $CCl_2FCClF_2$ or ($C_2Cl_3F_3$) | 0.161 | 8.360 | 0.20 |
| Tungsten Hexafluoride | $WF_6$ | 0.0810 | 13.28 | 0.25 |
| Xenon | Xe | 0.0378 | 5.858 | 1.32 |

[1] Empirically defined

[2] Consult MKS Instruments, Inc. for special applications.

NOTE: Standard Pressure is defined as 760 mmHg (1013.25 mbar). Standard Temperature is defined as 0$^{o}$C.

Note: This table may contain more (or less) gases than that of the unit.

Figure 33



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

# INDEX

Actual gas flow 12
ACTUAL mode 15
ASCII format 32
BAND 22
baudrate 27
B-MODE 31
C-MODE 31
**Commands** 33
dead time 13
device/clear 24
DIN 1871 18
DIRECT 9
ERROR LISTING 15
EXTENDED DISPLAY 12
EXTERN 19
**External Mode** 20
First Start Reset 10
FLOW OFF 8
FLOW ON 8
framing error 29
gain 14
**Gas Composition** 23
GAS COMPOSITION 11
Gas correction factor 44
Gas Correction Factors 18
**Gas Correction Table** 44
GAS MENU 11
GAS ON 12
GCF 18
handshake 27
hardware handshake 27
Hardware Reset 10
helium 18
HISTORY mode 15
HOST MODE 29
hydrogen 18
IEEE 488 24
independent mode 19
INPUT OVERFLOW 15
INPUT UNDERFLOW 15
integral 14
**Interface Connections** 27
interface status 25
lead 14
LED green 12
LED red 12
LIMIT 22
listener 24
local lockout (LLO) 25
LOCKED 9
MAIN MENU 10
main valve 8
Master/Slave 19
MEMORY 9
MFC range 12
OUTPUT OVERFLOW 15
OUTPUT UNDERFLOW 15
overrun error 29
parity 27
parity error 29
PCS 20
PID 19
**PID Controller** 13
**Pin Assignment** 40
POLLING mode 25
**Power Up Reset** 10
PRESSURE CONTROL 13
PRESSURE CONTROL mode 20
QUIET mode 25
**Range Selection** 17
Relay Option 22
remote/local 24
REPEAT mode 25
**Reset to Default** 10



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

rise time 13
RS232 26
**RS232 Line Status** 29
RTS, CTS 27
Safety information 5
Setpoints 12
**SIGNALS menu** 16
SLAVE 19
SLEEP 22
software handshake 27
software release 31
step response 14
stop bits 27
talker 24
TEST 19
test signal 21
TOTAL FLOW 11
TRIP HIGH LIMIT 15
**Trip Limit** 22
TRIP LOW LIMIT 15
**Trouble Shooting** 39
Truth Table 23
USER 18
USER DISPLAY menu 11
word length 27
XON, XOFF 27
**Zero Adjustment** 21
ZERO VALUE 21



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

# Customer Support Centers

## *UNITED STATES*

**MKS Instruments, Inc.**
**Corporate Service Center**
651 Lowell Street
Methuen, MA 01844
Fon: (978) 682-4567
Fax: (978) 682-8543

**MKS Instruments, Inc.**
**HPS Division,**
**Vacuum Components,**
**Valves & Gauging**
5330 Sterling Drive
Boulder, CO 80301
Fon: (303) 449-9861
(800) 345-1967
Fax: (303) 442-6880

## *CANADA*

**MKS Instruments, Canada Ltd.**
30 Concourse Gate
Nepean, Ontario, Canada K2E 7V7
Fon: (613) 723-3386
(800) 267-3551 (CAN only)
Fax: (613) 723-9160

## *FRANCE*

**MKS Instruments, France s.a.**
43, Rue du Commandant Rolland
B.P. 41
F-93352 Le Bourget, Cedex,
France
Fon: 33(1)48.35.39.39
Telex: 233817 F
Fax: 33(1)48.35.32.52

## *GERMANY/BENELUX*

**MKS Instruments,**
**Deutschland GmbH**
Schatzbogen 43
D-81829 München
Fon: 49-89-420008-0
Fax: 49-89-42-41-06
E-Mail: mks49@aol.com

## *ITALY*

**G. Gambetti Kenologia Srl.**
Via A. Volta No. 2
20082 Binasco (MI), Italy
Fon: 39-2-90093082
Fax: 39-2-905.2778

## *JAPAN*

**MKS Japan, Inc.**
Harmonize Building
5-17-13, Narita-Higashi
Suginami-Ku, Tokyo 166, Japan
Fon: 81-3-3398-8219
Fax: 81-3-3398-8984

## *KOREA*

**MKS Korea Co., Ltd.**
2nd Floor Shin Young Bldg.
257-4 Yangjae-Dong
Seocho-Ku
Fon: 82-2-529-0713/4
Fax: 82-2-529-0715

## *UNITED KINGDOM*

**MKS Instruments, U.K. Ltd.**
2 St. George´s Court
Dairyhouse Lane
Altrincham, Cheshire
WA14 5UA, England
Fon: 44-161-929-5500
Fax: 44-161-929-5511



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

**Artisan Technology Group** is an independent supplier of quality pre-owned equipment

## Gold-standard solutions

Extend the life of your critical industrial, commercial, and military systems with our superior service and support.

## We buy equipment

Planning to upgrade your current equipment? Have surplus equipment taking up shelf space? We'll give it a new home.

## Learn more!

Visit us at **artisantg.com** for more info on price quotes, drivers, technical specifications, manuals, and documentation.

Artisan Scientific Corporation dba Artisan Technology Group is not an affiliate, representative, or authorized distributor for any manufacturer listed herein.

We're here to make your life easier. How can we help you today?

(217) 352-9330 | sales@artisantg.com | artisantg.com

ARTISAN® TECHNOLOGY GROUP