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MKS

Instruction Manual

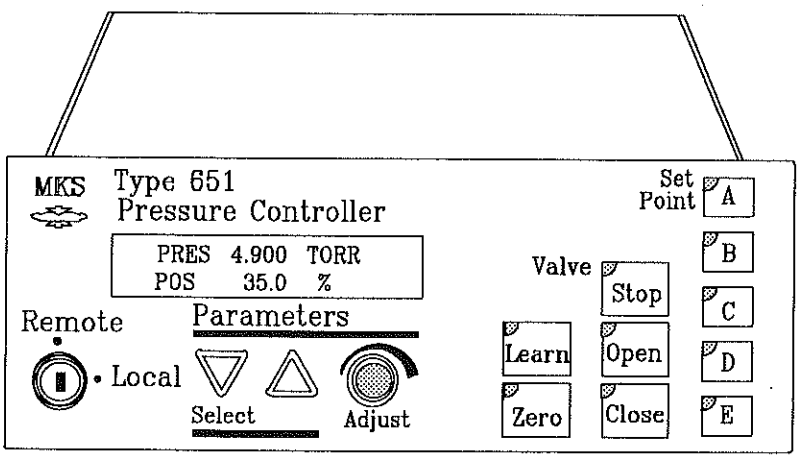
115247-P1
REV A, 11/92

MKS Type 651B Pressure Controller

SIX SHATTUCK ROAD, ANDOVER, MASSACHUSETTS 01810 (508) 975-2350 (800) 227-8766 FAX (508) 975-0093

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Safety Procedures and Precautions

The following general safety precautions must be observed during all phases of operation of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of intended use of the instrument. MKS Instruments, Inc. assumes no liability for the customer's failure to comply with these requirements.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to an MKS Calibration and Service Center for service and repair to ensure that all safety features are maintained.

SERVICE BY QUALIFIED PERSONNEL ONLY

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified service personnel only.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person capable of rendering first aid and resuscitation, is present.

GROUNDING THE PRODUCT

This product is grounded through the grounding conductor of the power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle before connecting it to the product input or output terminals. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

DANGER ARISING FROM LOSS OF GROUND

Upon loss of the protective-ground connection, all accessible conductive parts (including knobs and controls that may appear to be insulating) can render an electrical shock.

USE THE PROPER POWER CORD

Use only the power cord and connector specified for your product.
Use only a cord in good condition.

USE THE PROPER POWER SOURCE

This product is intended to operate from a power source that does not apply more than 250 volts rms between the supply conductors, or between either of the supply conductors and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

USE THE PROPER FUSE

Use only a fuse of the correct type, voltage rating, and current rating, as specified for your product.

KEEP AWAY FROM LIVE CIRCUITS

Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

Definitions of WARNING, CAUTION, and NOTE 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.

Note



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

Chapter One
General Information

Introduction

The Type 651 instrument is a self-tuning pressure controller for throttle valves. It can supply ±15 Volts to power and provide a readout for an attached capacitance manometer. The self-tuning feature of the Type 651 unit determines system characteristics necessary for control. This feature takes into account time constants, transfer functions of the valve and plumbing, valve gain, pump speed, and many other important parameters when determining the system characteristics. The 651 unit also includes an adjustable softstart function (to minimize turbulence in the chamber and contamination of the process), local/remote transducer zeroing capability, and two process limit relays to indicate if the pressure deviates from the desired trip points.

Located on the front panel is a key lock switch used to select front panel or rear panel control. The switch can lock the front panel controls as a safety measure to prevent accidental command entries. The default window display on the front panel shows the pressure readout and the valve position (% open). The pressure readout can be displayed in units of Torr, mTorr, mBar, µBar, Pascal, kPa, cmH_2O, or inH_2O. Five reprogrammable setpoints are provided, each one having the option of being setup for pressure or position control. Valve open, close, and stop functions are also provided on the front panel for use in system setup and diagnostics.

The 651 instrument has a high-powered driver to operate all MKS type throttle valves, including valves up to 4" (102 mm) with vacuum shut-off capability, giving the unit a control range from 10^{-4} to 760 Torr with the appropriate pressure transducers. All MKS unheated and 45° C temperature-controlled, linear Baratron transducers are compatible with the 651 controller, which is equipped with a low-capacity power supply. The 651 unit can be optionally equipped with a high-capacity power supply, enabling compatibility with 100° C temperature-controlled, linear Baratron transducers. The 651 unit also contains a battery-backed memory module which stores configuration and *learned* system information while power is off.

How This Manual is Organized

This manual is designed to provide instructions on how to set up and install a Type 651 Pressure Controller. Please be sure to read the *Safety Procedures* section at the beginning of this manual before unpacking or using the instrument.

Chapter Two, *Installation*, explains environmental requirements and practical considerations to take into account when selecting the proper setting for the pressure control instrument. Once the appropriate environment has been established, go to the next section for instructions on *How to Unpack the Type 651 Pressure Controller.* After unpacking the instrument, refer to the final section for information about *Checking the Fuses and Line Voltage Selector Switch.*

Chapter Three gives an *Overview* of the Type 651 Pressure Controller. It first describes the components on the front panel and discusses local and remote operation. It then describes the components on the rear panel and gives information about electrical connections.

Chapter Four, *Setup*, explains how to connect a valve and set up the 651 Pressure Controller using the menu selection prompts displayed on the front panel.

Chapter Five, *Local Operation*, describes how to operate the instrument from the front panel and includes detailed instructions for using each of the functions available in local mode.

Chapter Six, *Remote Operation*, describes how to operate the instrument from the rear panel and discusses RS-232 control and digital logic operation.

Chapter Seven, *Maintenance*, provides instructions on how to replace the battery-backed memory module.

Appendix A lists *Product Specifications* for the Type 651 instrument.

Appendix B supplies information about MKS *Compatible Products*.

Appendix C describes the *Displayless* version of the 651 unit and how it differs from the standard unit.

Customer Support

Standard maintenance and repair services are available at all of our regional MKS Calibration and Service Centers in North America, Europe, Israel, Japan, Korea, and Taiwan. In addition, MKS accepts the instruments of other manufacturers for recalibration using the Primary and Transfer Standard calibration equipment located at all of our regional service centers. Should any difficulties arise in the use of your Type 651 instrument, or to obtain information about companion products MKS offers, contact any authorized MKS Calibration and Service Center. If it is necessary to return the instrument to MKS, please obtain an ERA Number (Equipment Return Authorization Number) from the MKS Calibration and Service Center before shipping. The ERA Number expedites handling and assures proper servicing of your instrument.

Please refer to the inside of the back cover of this manual for a list of MKS Calibration and Service Centers.

Warning  **All returns to MKS Instruments must be free of harmful, corrosive, radioactive, or toxic materials.**

Chapter Two
Installation

Environmental Requirements

The following requirements should be adhered to when installing and using a Type 651 Pressure Controller.

1. Operating ambient temperature must be in the range of 15° - 40° C.
2. Humidity must be kept between zero and 95%, non-condensing.
3. Proper clearance must be supplied so that the unit can operate within product environmental specifications.
4. The 651 unit can be mounted in a panel cutout or in either a 9-inch deep or 12-inch deep rack.
   A. The RM-13 rack mount option supports a 9-inch deep rack.
   B. The RM-14 rack mount option supports a 12-inch deep rack.
5. Power and fuse requirements for both the low power and high power units are listed in the *Checking the Fuses and Line Voltage Selector Switch* section later on in this chapter.

Caution



A. Check to make sure the voltage setting is correct for your local electrical source.

B. Check to make sure the fuse type is appropriate for your voltage setting.

6. A solid system ground should be maintained for proper operation and safety to personnel.

For additional Type 651 controller requirements refer to Appendix A, *Product Specifications.*

How to Unpack the Type 651 Pressure Controller

Care has been taken to pack the Type 651 Pressure Controller so that it will reach you in perfect operating condition. Upon receiving the unit, however, you should check for defects, cracks, broken controls and connectors, etc. to be certain that damage has not occurred during shipment.

Note 

Do *not* discard any packing materials until you have completed your inspection and are sure the unit arrived safely.

If you find any damage, notify your carrier and MKS immediately. If it is necessary to return the instrument to MKS, obtain an ERA Number (Equipment Return Authorization Number) from the MKS Service center before shipping. Please refer to the inside of the back cover of this manual for a list of MKS Calibration and Service Centers.

Parts Checklist

The Type 651 instrument has the following standard parts:

1. The 651 instrument.
2. A power cord.
3. A key for the front panel key lock switch.
4. An I/O connector for the rear panel of the unit.
5. A connector cover for the I/O connector.
6. A screwlock assembly for the I/O connector cover.
7. User's Instruction Manual.

Optional accessories include:

8. Cables for supported sensors and the MKS Types 253, 653, and 654 valves.
9. RM-13 or RM-14 rack mount option.

Checking the Fuses and Line Voltage Selector Switch

If the 651 unit is ordered with a full configuration form filled out, it will arrive with the correct fuses and have the voltage switch set for proper AC voltage. There are no other adjustments required for system setup. If a full configuration form was *not* filled out, or to confirm the fuse type and voltage setting of the 651 unit, refer to Table 1, shown below, and follow the instructions in this section.

Supply Type	Nominal Line	Line Voltage Range	Fuse Type
Low power	115 VAC	90-132 VAC @50/60 Hz 75 VA (max)	0.63A (T), 250V, 5x20mm
	230 VAC	180-264 VAC @50/60 Hz 75 VA (max)	0.315A (T), 250V, 5x20mm
High power	115 VAC	90-132 VAC @48/62 Hz 150 VA (max)	1.25A (T), 250V, 5x20mm
	230 VAC	180-264 VAC @48/62 Hz 150 VA (max)	0.63A (T), 250V, 5x20mm

Table 1: Fuse Types

Note

The fuses are IEC rated (where the name plate value is the expected current *carrying* rating) and not UL or CSA rated (where the name plate value is nearly the current *blowing* rating). Use of UL or CSA rated fuses will cause unnecessary blowing at high loads.

Appropriate replacement fuses include:

- Bussmann GDC-T315 mA or equivalent for the .315 A fuse
- Bussmann GDC-T630 mA or equivalent for the .63 A fuse
- Bussmann GDC-T1.25 A or equivalent for the 1.25 A fuse

To replace fuses:

1. Select the proper fuses. All units should have two fuses installed to *fuse both sides* of the line.

Warning **Be sure the power cord is disconnected before proceeding.**

2. Insert a small device, for example, a screwdriver, in the fuse holder clip on the right side of the fuse holder. Refer to Figure 1, shown below, for the location of the clip.

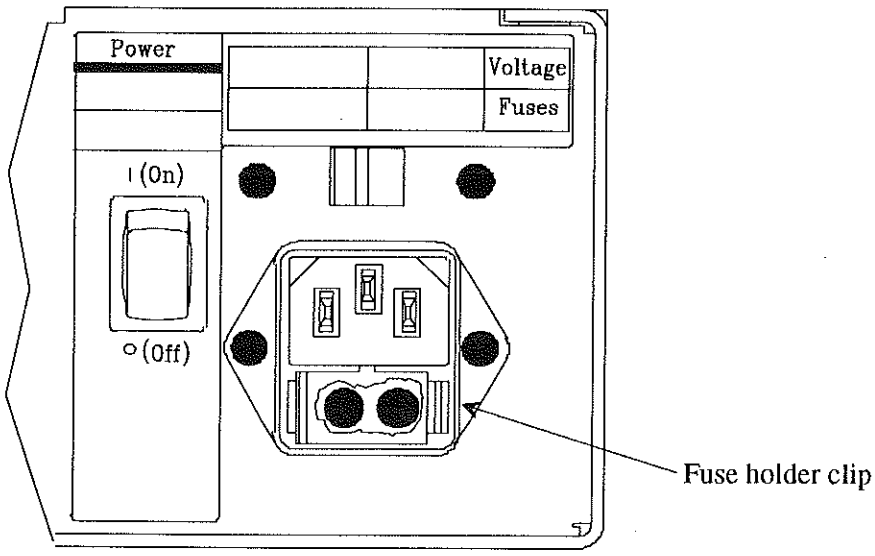


Figure 1: Fuse Holder

3. Gently press against the clip and push up with the screwdriver until the plastic fuse holder pops out. (It may be necessary to repeat steps 2 and 3 on the left side to release the fuse holder.)

4. Replace the old fuses with new ones and gently snap the fuse holder back into place.

5. Check the setting of the AC line voltage select switch.

   A. Refer to Figure 2, shown below, for the location of the voltage selector switch on the *low power* unit, or to Figure 3, on the following page for the location of the switch on the *high power* unit. The label above the switch (on either unit) shows the corresponding voltage range and fuse requirements for either voltage setting.

   B. Use a small device, for example, a screwdriver, to set the switch to the left position for operation in the 115V range, or to the right position for operation in the 230V range.

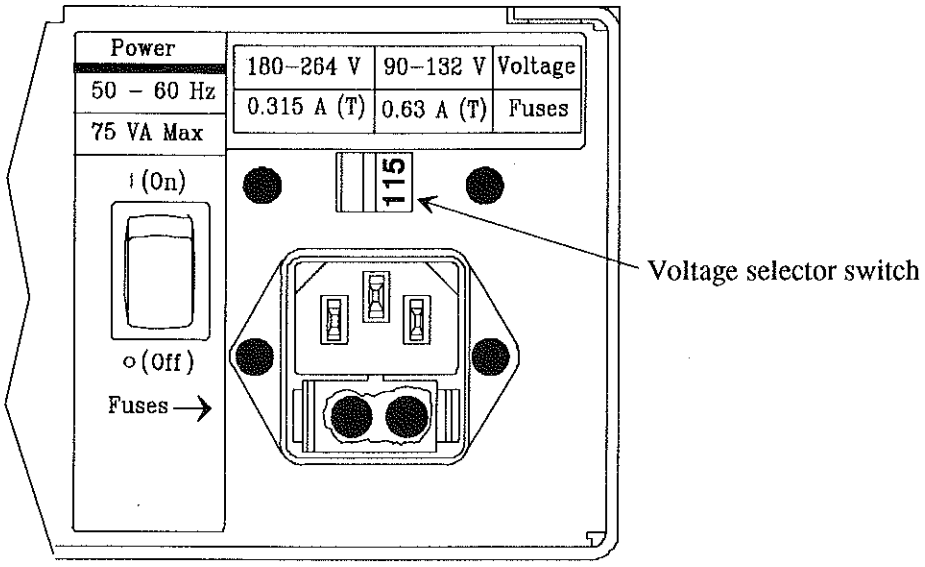


Figure 2: Voltage and Fuse Data for the Low Power Unit

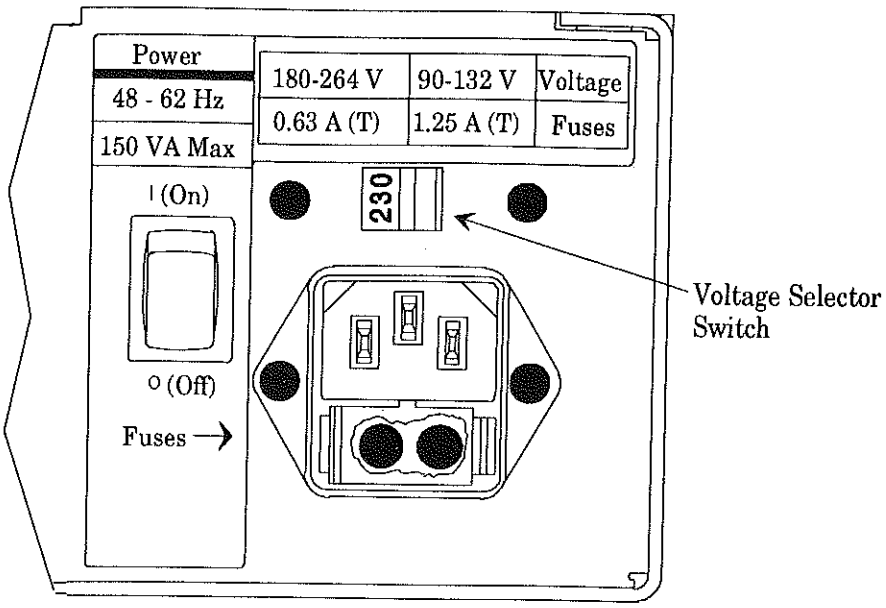


Figure 3: Voltage and Fuse Data for the High Power Unit

The Type 651 pressure controller is now ready for valve connection and system setup. Refer to Chapter Three for an overview of the controller and to Chapter Four for instructions on how to setup and operate the unit.

Chapter Three
Overview

Front Panel

Front Panel Components

Figure 4, shown below, labels all the components located on the front panel of the 651 instrument. Table 2 on the following page summarizes the functions of the front panel components.

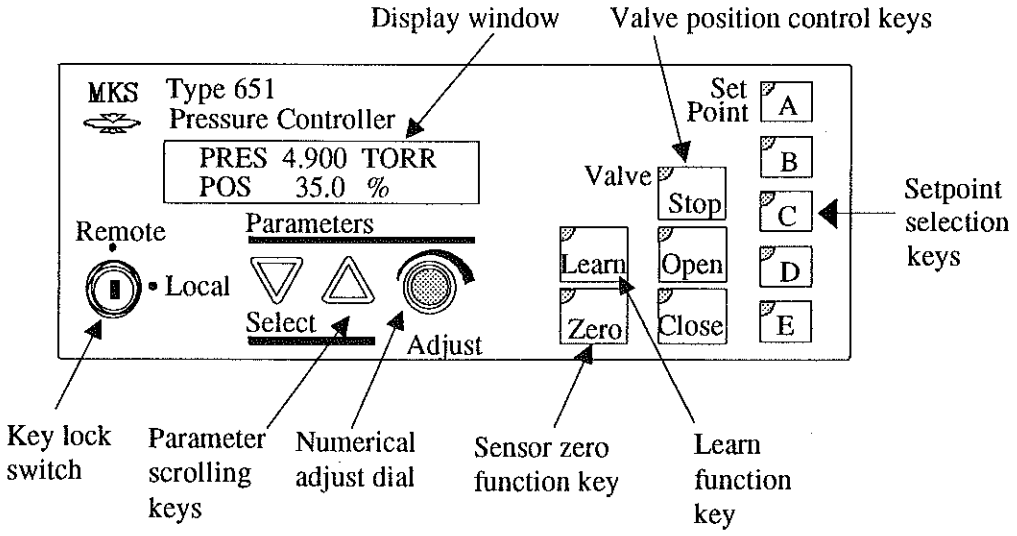


Figure 4: Front Panel of the Type 651 Instrument

Front Panel Display

The front panel display shows pressure and valve position by default. The down scrolling key, ▽, selects the previous display in the display list. The up scrolling key, △, scrolls to the next display in the display sequence.

Front Panel Component	Function
Key lock switch	Switches between local (front panel), and remote (rear panel), control. The switch must be set to remote to remove the key.
Display window	Displays pressure and the valve position by default. Other displays include information such as setpoints, trip limits, and softstart rate.
Parameter scrolling keys	Used to scroll through displays: down, ▽ and up, △.
Numerical adjust dial	Used to enter parameter values.
Learn function key	Used to enable the learn function within the 651 unit. In a control system with a positive flow rate, the 651 learn function determines the system characteristics necessary for self-tuning control.
Sensor zero function key	Used to zero an attached sensor.
Valve position control keys	Used to select the valve position. The possibilities are open, close, and stop.
Setpoint selection keys	Used to select which setpoint (A - E), is the active setpoint.
Lights	The lights on the front panel are not visible unless lit. They indicate which parameter(s) (ex. setpoint A), or function(s) (ex. learn) is currently active.

Table 2: Summary of Front Panel Components

Local and Remote Operation

The key lock switch is used to select front panel control (local) or rear panel control (remote). When set to local, control command input and setpoint parameter modification must be entered via the front panel. Information *requests* (not commands) and 651 unit *responses*, however, may still be sent through the Serial Interface connector on the rear panel. Refer to Table 12, beginning on page 40, for a listing of the request and return message protocol.

When the key lock switch is set to remote, the front panel becomes locked out. This is a useful feature for preventing accidental command entries. It is still possible, however, to scroll through the displays to view existing parameters using the ▽ and △ keys. When in remote mode, control command input and setpoint parameter modification must be entered via the rear panel either by RS-232 command protocol at the Serial Interface connector or through digital logic levels at the I/O connector. Refer to Figure 5 on page 14 for the location of the connectors and to Tables 4 and 6, beginning on page 15, for the pin assignments. Chapter Six, *Remote Operation,* contains more detailed information about RS-232 control and digital logic operation.

Command Priority

The 651 pressure controller responds to the most recent command, whether it is issued in local mode or remote mode. In switching from remote to local, the 651 will respond to the last command issued in remote until a new command is issued in local. In switching from local to remote, the 651 will continue to respond to the last command issued in local until a new command is issued in remote.

Self-Tuning

The Type 651 instrument controls a vacuum system via *self-tuning* control. It determines control parameters based upon the system's characteristics, and does not require lead or gain values. To activate this feature from the front panel, be sure the key lock switch is set to local and then press down the learn key for about three seconds. Once the unit has *learned* the system characteristics, it can operate with the key lock switch set to either local or remote. Refer to the *How To Activate the Learn Function* section, in Chapter Five, *Local Operation*, for more information about the learn key.

Softstart Control

The softstart feature is used to reduce the rate at which a control valve moves toward setpoint. The rate is given as a percent of full speed and can be used on either a pressure or position setpoint. Once setpoint is achieved under softstart control, the valve is free to move at full speed. Softstart control can be applied to setpoints A - E, analog setpoint, valve open, and valve close. Refer to Chapter Four, *System Setup*, for instructions on how to set softstart rates from the front panel.

If a setpoint is established via RS-232 input, the softstart rate for that setpoint is selected through use of the [I6][*value*][CR][LF] RS-232 command. If an analog setpoint is established via digital logic input, the softstart rate for the analog setpoint is controlled by digital logic input (digital input #4). To achieve softstart control of digital logic or analog setpoints, the *softstart line must be held low*. If the line is *not* held low, the valve will move at 100% full speed. Refer to Chapter Six, *Remote Operation*, for additional information about softstart control via the rear panel.

Rear Panel

Rear Panel Components

Figure 5, shown below, labels all the components located on the rear panel of the 651 instrument. The power on/off switch and the line voltage selector switch are on the back of the 651 unit. The four Type "D" connectors are also located on the rear panel.

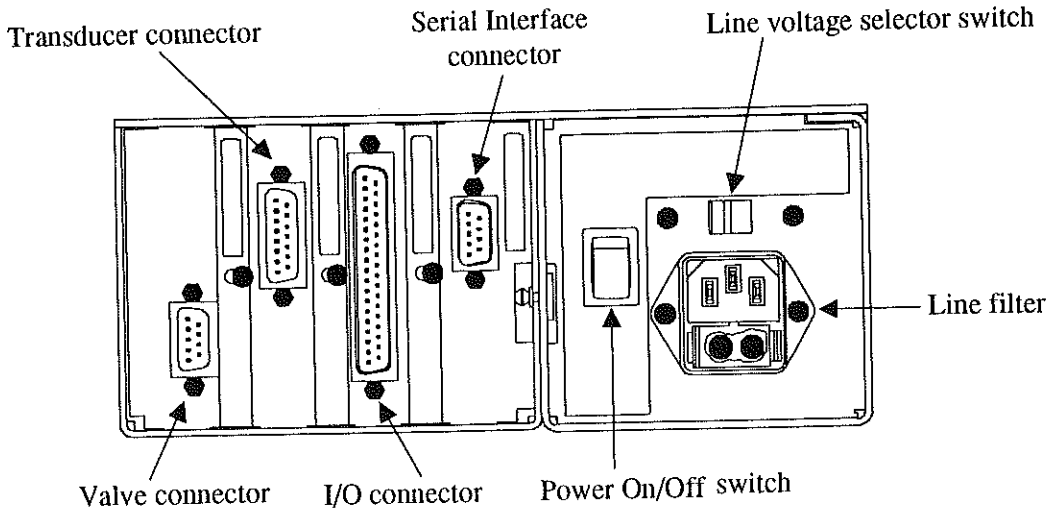


Figure 5: Rear Panel of the Type 651 Instrument

The connectors are numbered on the rear panel, as listed in Table 3, shown below.

Slot	Label
Serial Interface connector	1
I/O connector	2
Transducer connector	3
Valve connector	4

Table 3: Slot Labels

Electrical Connections

Tables 4 through 10 on the following pages list each connector's pinout as well as corresponding MKS cable numbers.

Serial Interface Connector (RS-232) Type "D", 9-Pin Male	
Pin #	**Function**
1	No connection
2	Transmit data
3	Receive data
4	No connection
5	Digital ground
6	Reserved
7	Reserved
8	No connection
9	No connection

Table 4: Serial Interface Connector Pinout

Serial Interface Cable	Cable Number
RS-232 Serial Communications	CB651-10-10
651 Serial Communications to 25-pin serial port (pins 2 and 3 reversed)	CB651-11-10

Table 5: Cable Numbers for RS-232 Serial Communications

Caution 

The MKS RS-232 Serial Communications cable (CB651-10-10) *must* be used for the 9-pin, Serial Interface connector. Unlisted pins on this connector are not compatible with the current Type "D", 9-pin, industry-standard cable.

I/O Connector Type "D", 37-Pin Female	
Pin #	**Function**
1	PLO relay #1 - NC contact
2	PLO relay #1 - NO contact
3	PLO relay #2 - NC contact
4	Digital ground
5	Learn system (low)
6	Select analog setpoint position (low). Must be selected simultaneously with pin #11.
7	Softstart (low)
8	Close valve (low)
9	Reserved
10	Analog setpoint ÷ 10
11	Select analog setpoint (low). Must be selected simultaneously with Pin #6 for position control.
12	Select setpoint E (low)
13	Select setpoint D (low)
14	Select setpoint C (low)
15	Select setpoint B (low)
16	Select setpoint A (low)
17	Reserved
18	Reserved
19	Reserved
20	PLO relay #1 - common contact
21	PLO relay #2 - common contact
22	PLO relay #2 - NO contact
23	Reserved
24	Reserved
25	Remote zero (low)
26	Stop valve (low)
27	Open valve (low)

28	PLO #2 status (low = out of limit)
29	PLO #1 status (low = out of limit)
30	+15V Output
31	-15V Output
32	Power ground
33	+ Setpoint input
34	- Setpoint input
35	Analog ground
36	Pressure output voltage
37	Position output voltage

Table 6: I/O Connector Pinout

Transducer Connector Type "D", 15-Pin Female	
Pin #	**Function**
1	+15V Supply
2	+ Pressure input
3	Reserved
4	Reserved
5	Power ground
6	-15 V Supply
7	+15 V Supply
8	Reserved
9	-15 V Supply
10	Reserved
11	Digital ground
12	- Pressure input
13	Reserved
14	Reserved
15	Chassis ground

Table 7: Transducer Connector Pinout

Transducer Type Numbers	Cable Numbers
122	CB112-2-10
127	CB147-1-10
128	CB147-1-10
220	CB112-10-10
221	CB112-14-10
124,223,224,225	CB112-2-10
120	CB120-1-10

Table 8: Cable Numbers for MKS Transducers

Valve Connector Type "D", 9-Pin Female	
Pin #	**Function**
1	Motor winding A return
2	Motor winding A feed
3	Limit switch ground
4	Open limit switch signal
5	Closed limit switch signal
6	Motor winding B feed
7	Motor winding B return
8	+15V @25mA (for Opto switches)
9	Motor ground

Table 9: Valve Connector Pinout

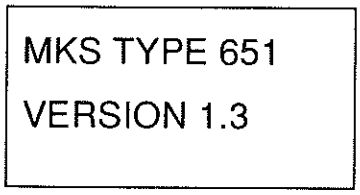
Valve Type Number	Cable Number
253A	CB652-2-10
653A	CB652-1-10

Table 10: Cable Numbers for MKS Throttle Valves

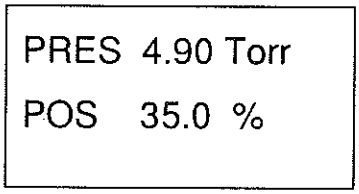
Chapter Four
System Setup

Overview

The 651 pressure controller is set up entirely through menu selection via display lists that appear on the front panel. It is not necessary to open the unit to set any switches. Valve connection and calibration, sensor range and pressure units, etc. are selected by scrolling through the display lists and making adjustments using the controls on the front panel. At initial power up, the following display (with the current software/firmware version) appears for about five seconds:



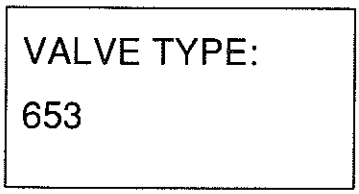
The system then defaults to its *pressure and position* display and is ready for valve connection and setup (or normal operation once the system has been set up).



Valve Selection and Calibration

Prior to its use, the appropriate valve must be connected and identified to the system.

1. Be sure that the valve is connected to the unit and the key lock switch is set to local.
2. Press △ and the valve close key simultaneously for about three seconds.



3. Use the numerical adjust dial to scroll through the display list until the type of valve connected to your unit appears.

   The display list includes the following valves:

253 STD	654-40
253 FAST	654-50/80
653	654-100

4. With the correct valve type displayed, press the valve stop key to select and calibrate the appropriate valve. The valve will move (open and close) as it is being calibrated, then stop at completion.

Note Be sure to select the correct valve, otherwise the 651 pressure controller will not function properly.

Setup Menu

If the 651 unit is ordered with a full configuration form filled out, it will arrive with the requested setup. If a full configuration form was *not* filled out, or to change the requested or default settings, follow the instructions in this section (be sure the key lock switch is set to local).

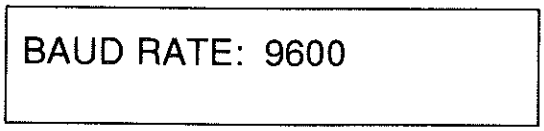
The setup menu includes display lists from which selections can be made under the following topics:

- Baud rate, parity, and delimeter
- Sensor range and pressure units of measure
- Sensor signal and type
- Analog setpoint input range and valve signal output
- Setpoint types A - E, pressure or valve position
- Softstart rates for setpoints A - E, analog setpoint, valve open, and valve close
- Direction of valve control

It is possible to exit the setup menu and return to the system's default display, *pressure and position*, by pressing any key at any time. Setup menu input can be resumed or restarted by pressing ▽ and △ simultaneously for about three seconds. Press ▽ or △ to scroll to the previous or next topic in the setup menu and use the numerical adjust dial to select the desired parameters.

RS-232 Communications

1. Press ▽ and △ simultaneously for about three seconds. The following display appears.



2. Use the numerical adjust dial to scroll through the display list to select the desired baud rate. The display list includes the following baud rate settings:

   300

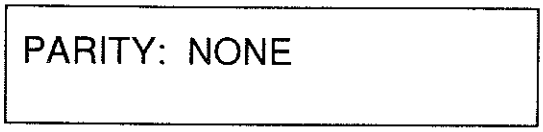
   1200

   2400

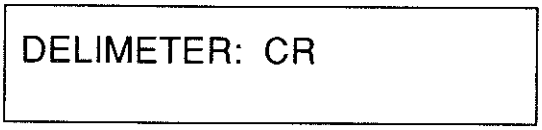
   4800

   9600

3. Scroll to the next topic.



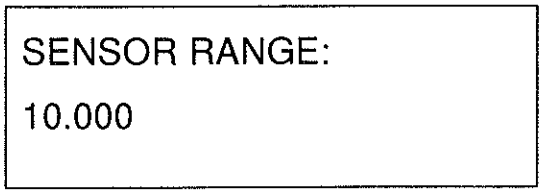
4. Choose either *none* (8 data bits, no parity) or *even* (7 data bits, even parity) and scroll to the next topic.



5. Choose either CR (carriage return), or CRLF (carriage return/line feed).

Sensor Setup

1. Be sure that the sensor is connected to the unit.
2. From the *delimeter* display, scroll to the next topic in the setup menu.



3. Scroll through the display list until the range of the sensor connected to the unit appears.

Note

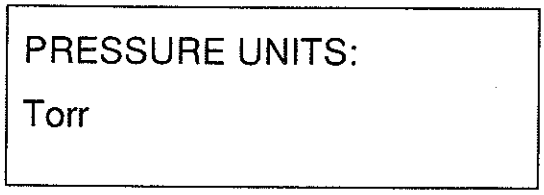
To view the range of a sensor in pressure units of *mBar* for a sensor calibrated in *Torr*, select the equivalent mBar unit of measure. For example, select 13.332 for a sensor calibrated to 10.000 Torr.

To display a 1 Torr sensor in *mTorr*, the appropriate sensor range and pressure unit must be entered during setup. For example, 1000 *mTorr* must be entered to display a 1 Torr sensor in *mTorr*.

The display list includes the following sensor ranges:

.10000	
.20000	
.5000	
1.0000	1.3332
2.0000	2.6664
5.000	
10.000	13.332
50.00	
100.00	133.32
500.0	
1000.0	1333.2
5000	6666
10000	13332

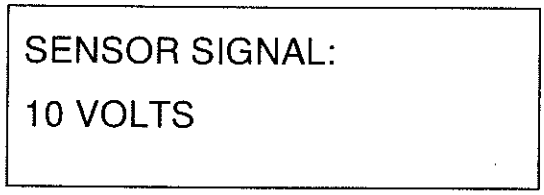
4. Scroll to the next topic.



5. Scroll through the display list until the unit of measure that the sensor has been calibrated to, appears. The display list includes the following pressure units:

Torr	kPa
mTorr	Pa
mBar	cmH_2O
µBar	inH_2O

6. Scroll to the next topic.



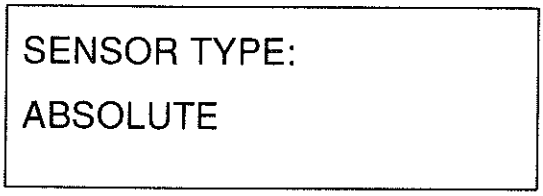
7. Scroll through the display list until the sensor full scale voltage appears. The display list includes the following selections:

   1 Volt

   5 Volts

   10 Volts

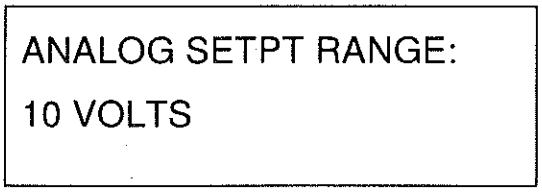
8. Scroll to the next topic.



9. Choose either *absolute* or *differential.*

Analog Setpoint

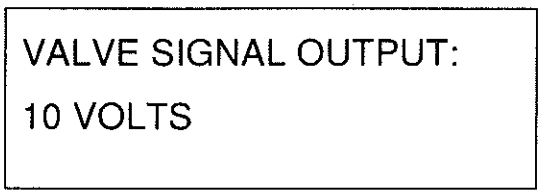
1. From the *sensor type* display, scroll to the next topic in the setup menu.



2. Choose either 5 volts or 10 volts full scale signal. Refer to the *How to View the Analog Setpoint* section in Chapter Five, *Local Operation,* for more information about analog setpoint.

Valve Position Output

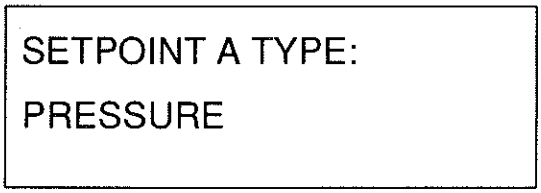
1. From the *analog setpt range* display, scroll to the next topic in the setup menu.



2. Choose either 5 volts or 10 volts full scale for valve position output.

Setpoints A - E, Pressure/Position Selection

1. From the *valve signal output* display, scroll to the next topic in the menu selection.



2. Choose either *pressure* or *position* for setpoint A and scroll to the next topic.

SETPOINT B TYPE:
POSITION

3. Choose either *pressure* or *position* for setpoint B.

4. Continue to scroll through the menus in the manner just described, until setpoints A - E have each been set at either *pressure* or *position*. Refer to the *How to View and Adjust Setpoints*, in Chapter Five, *Local Operation*, for more information about setpoints.

Note 

The function of the analog setpoint, *pressure* or *position*, is controlled by the digital logic level on I/O Pin #6. Refer to the *Digital Logic Control* section in Chapter Six, *Remote Operation*, for information about establishing the analog setpoint.

Softstart Rates

Softstart rates for setpoints A - E, analog setpoint, valve open, and valve close can be established via the setup menu. If it is not necessary to utilize softstart control in your process, the softstart rate should be left at 100% (of F.S.).

1. From the setpoint E *pressure* or *position* display, scroll to the next topic in the menu selection.

SOFT START RATE
SETPT A: 100.0 %

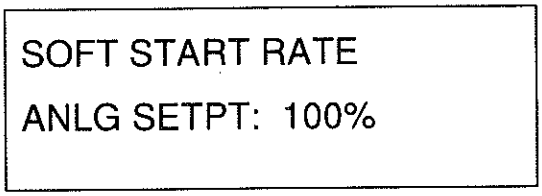
2. Select the softstart rate (between 1 and 100%) desired for setpoint A, then scroll to the next topic.

SOFT START RATE
SETPT B: 100.0 %

3. Select the softstart rate (between 1 and 100%) desired for setpoint B.

4. Continue to scroll through the menus in the manner just described, until setpoints A - E have each been set at the desired softstart rates.

5. From the *softstart rate* selected for setpoint E display, scroll to the next topic in the menu selection.



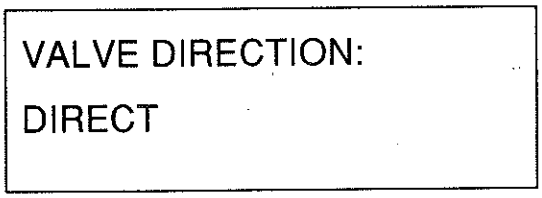
6. Select the softstart rate (between 1 and 100%) desired for analog setpoint.

7. Continue to scroll through the menus in the manner just described, to set the softstart rates for valve open and valve close.

Valve Control

A valve can be controlled to open and close in a *direct* or *reverse* direction. *Direct* direction of valve control is recognized as valve open at 100% of F.S. and valve close at 0% of F.S. *Reverse* direction of valve control is recognized as valve open at 0% of F.S. and valve close at 100% of F.S.

1. From the valve close *softstart rate* display, scroll to the next topic in the menu selection.



2. Choose either *direct* or *reverse* direction.

System setup is now complete. Press the valve stop key to exit the setup menu and return to the default display, *pressure* and *position*. Chapter Five discusses *Local Operation* via the front panel and Chapter Six provides information about *Remote Operation* of the Type 651 Pressure Controller.

Chapter Five
Local Operation

Overview

Local operation of the 651 Pressure Controller is similar to *System Setup* outlined in the previous chapter, in that all functions of the controller can be accessed via display lists, and they respond according to information entered at the front panel. The system software includes display lists from which selections can be made under the following topics:

- How to view and adjust setpoints, as well as how to activate setpoints
- How to identify an out-of-range condition
- How to control the valve
- How to activate and stop the learn function
- How to zero a sensor, use special zero, and remove zero
- How to view and adjust process limit relays, as well as how to enable and disable them
- How to view the analog setpoint

Be sure the key lock switch is set to local and use ▽ or △ to scroll to the appropriate function.

How To View and Adjust Setpoints

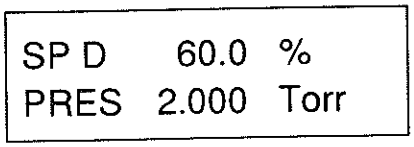
The 651 instrument provides five user-definable setpoints (setpoint A - setpoint E). Each setpoint can be configured as a *pressure* setpoint or a valve *position* setpoint. Pressure setpoints are displayed in units of Torr, mTorr, mBar, µBar, Pascal, or kPa. Position setpoints are displayed in % open of F.S., where 0 = closed, and 100 = open.

Only one setpoint can be designated as the active setpoint. The active setpoint (or valve position) is indicated by a light in the appropriate setpoint key. A sample display of setpoint A (SP A) is shown below. In this example, setpoint A is defined as 100 mTorr, and the system *pressure* at this time is also 100 mTorr.

```
SP A  100 mTorr
PRES 100 mTorr
```

Adjust the displayed setpoint with the numerical adjust dial on the front panel. The system responds by immediately storing the setpoint value. The system pressure does not change however, unless the displayed setpoint is the active setpoint.

The display shown below provides another example of a setpoint display. In this case, setpoint D (SP D) is configured as a valve *position* setpoint. The valve position is indicated in % open of F.S., where 0 = closed, and 100 = open. In this example, setpoint D is configured for a valve position of 60.0% open of F.S., and the system pressure is shown as 2.000 Torr.



How To Activate Setpoints

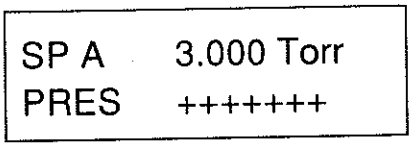
Activating a setpoint causes the 651 unit to control with that setpoint. To active a setpoint, press the appropriate setpoint key (A through E).

The system responds by turning a light on in the setpoint key and controlling according to the selected setpoint. The front panel display changes to reflect the activated setpoint. That is, the display at the top shows the actual pressure and the display at the bottom shows the valve position.

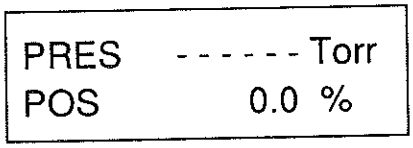
The light remains lit in the setpoint key until another setpoint (or valve function), is chosen.

How To Identify an Out-of-Range Condition

An out-of-range condition occurs at ±105% of F.S (±10.5 volts at sensor input) and is displayed as a positive or negative polarity. An example of a positive out-of-range condition for a setpoint is shown below.



An example of a negative out-of-range condition displayed on the default screen is shown below.



How To Control the Valve

The 651 unit can drive the throttle valve to full open or full close, or freeze it at its current position.

How To Open the Valve

To drive the valve to full open, press the open key. The system responds by turning a light on in the open key, and driving the throttle valve to full open. The front panel window returns to the default display of pressure and valve position, if it is not already showing the default display.

The open command overrides the active setpoint. Pressing any other key on the front panel (except zero or learn), cancels the open command.

How To Close the Valve

To drive the valve to full close, press the close key. The system responds by turning a light on in the close key, and driving the throttle valve to full close. The front panel window returns to the default display of pressure and valve position, if it is not already showing the default display.

The close command overrides the active setpoint. Pressing any other key on the front panel (except zero or learn), cancels the close command.

How To Stop the Valve

To stop the valve in its current position, press the stop key. The system responds by turning a light on in the stop key, and freezing the throttle valve in its current position. The front panel window returns to the default display of pressure and valve position, if it is not already showing the default display.

The stop command overrides the active setpoint. Pressing any other key on the front panel (except zero or learn), cancels the stop command.

How To Activate the Learn Function

The learn function, activated by pressing the learn key, enables the 651 unit to identify important system characteristics for self-tuning control. Use the learn function whenever the 651 controller is used in a new vacuum system. The learning process may take several minutes to complete.

Note 

The system pressure will vary during the learn cycle to as low and high as is possible for the current flow rate.

1. Initiate the proper gas flow into the system.
   A. Gas flow rate should be close to that used for the actual process (use the maximum flow rate if several flow rates are used in the process).
   B. Do not vary the gas flow rate during learning.
2. Press the learn key for about three seconds.

   The system responds by turning on a light in the learn key, and initiating the learning process. The front panel window displays the changing values of pressure and position as the instrument learns the system. The light stays on until the learn function is complete.

How to Stop the Learn Function

It is recommended that the learn function go through to completion. However, if your process is slow to reach its highest pressures *and* your process will not be operating at those pressures, it is possible to stop the learn function.

Caution 

Do not stop the learn function until it is well above the highest pressure at which the process will be operating.

Press the learn key and stop key simultaneously for about three seconds. The system responds by stopping the learn function and returning to its prior operation. For example, if the valve was closed before the learn key was pressed, the valve will now close.

How To Zero a Sensor

Zeroing a sensor is performed to correct sensor zero offsets.

1. Turn the gas flow off.
2. Fully open the control valve.
3. Wait until the system is pumped down to base pressure.

   If the pressure reading (at base pressure) is greater than 4% of full range, the sensor will not be zeroed.
4. Press and hold the zero key for at least three seconds.

   The system responds by flashing on a light in the zero key, and zeroing the sensor. The front panel window shows a pressure reading of zero.

   The front panel display changes to reflect a change in system pressure as soon as a change occurs.

How to Use Special Zero

The special zero function is used to zero base pressure in systems where the known pressure is not *at*, but *near* zero (displayed on another readout in the system).

1. Press △ and the zero key simultaneously for about three seconds, until the front panel displays *zero base pressure* and the pressure level.
2. Use the numerical adjust dial to reconcile the pressure reading on the display with the known base pressure reading (displayed on another readout in the system).
3. Press the valve stop key to exit.

How to Remove Zero

The remove zero function removes the zero correction factor stored in memory, and is used to determine the uncorrected signal from the pressure transducer. Each time a sensor is zeroed, the offset changes. In some applications it may be important to keep the zero offset within a specific range.

Press the stop and zero keys simultaneously for about three seconds until the front panel display changes from a zero pressure reading to the uncorrected signal level.

How To Set a Process Limit Relay

There are two process limit (PLO) relays in the 651 controller. Each relay has two trip limits: a high trip limit, and a low trip limit. Refer to Table 6, beginning on page 16, for the pinout of the Interface connector to determine which pins are for relay one, and which are for relay two. Use the appropriate pins to configure the relays for normally-open or normally-closed operation.

While the pressure remains within PLO limits, the relay is actuated (a normally-open contact closes, and a normally-closed contact opens). Whenever the pressure crosses *above* the *high* trip point, or *below* the *low* trip point, the corresponding relay becomes de-actuated (a normally-open contact opens, and a normally-closed contact closes).

To View/Adjust a Process Limit Relay

1. Scroll to process limit 1.

PROCESS LIMIT 1
HIGH 50.0 mTorr

2. Select the desired pressure value for the high trip point of process limit 1.
3. Scroll to the next display.

PROCESS LIMIT 1
LOW 30.0 mTorr

4. Select the desired pressure value for the low trip point of process limit 1.
5. Continue to scroll through the menu selections in the manner just described, to set the desired pressure values for process limit 2, high and low trip points.

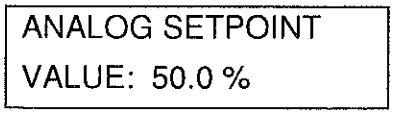
To Disable a Process Limit Relay

To disable a high limit trip point, set it to full scale.

To disable a low limit trip point, set it to negative full scale.

How To View the Analog Setpoint

The 651 controller is capable of accepting one analog setpoint through the Interface connector on the rear panel. Analog setpoint can be configured for 5 volt or 10 volt full scale input. The *analog setpoint* display reflects the voltage percent of the actual input. For example, if the 651 unit is configured for 5 volt full scale input, and the actual input applied is 3 volts, the analog setpoint display indicates that input by showing a value of 60%. Similarly, if the 651 unit is configured for 10 volt full scale input, and the actual input applied is 5 volts, the analog setpoint display indicates that input by showing a value of 50%. An example of the analog setpoint display is shown below.



There is no light on the front panel to indicate that the system is under analog setpoint control (in fact, all lights on the front panel go out).

Chapter Six
Remote Operation

Overview

Remote operation of the 651 Pressure Controller is accomplished via the rear panel either by RS-232 command protocol at the Serial Interface connector or through analog or digital logic levels at the I/O connector. When the key lock switch is set to remote, all control commands and parameter modifications must be sent through the connectors. The front panel becomes locked; however, it is still possible to scroll through and view current setpoints (pressure and position). This chapter contains information about RS-232 and analog or digital logic control.

RS-232 Control

An RS-232 port is available on the rear panel of the Type 651 controller at the Serial Interface connector. It is from here that commands can be executed and information requested. Refer to Table 4, page 15 for a pinout of this connector.

Information Requests

Information is available through the Serial Interface at any time, regardless of the position of the local/remote switch. A request to the 651 instrument causes it to send back information. Refer to Table 12, beginning on page 40, for a listing of the request and return message protocol.

Commands

A *command* sent to the 651 unit instructs it to perform a task or change a setting. Commands are grouped into two categories: *control commands* and *parameter commands.*

Control commands directly control the actions of the valve. Valve open, valve close, and valve stop, as well as selection of the controlling setpoint are examples of these types of commands.

Parameter commands determine the settings in the operating system's data base. Setpoint levels, softstart rates, and sensor full scale are examples of these types of commands.

Refer to Table 11, beginning on page 37, for a listing of the RS-232 command protocol.

Priority of Command Execution

Each RS-232 command is executed in the order that it is received. There is no prioritization of RS-232 commands as is the case with digital logic commands. In fact, the appropriate RS-232 command will override a *high priority* digital logic command. For example, a valve being held closed with a digital logic command can be commanded to control to the level of setpoint A with the appropriate RS-232 command.

The RS-232 commands generally execute within 25 mSec or less with the exception of the following:

- *T* (setpoint type) and *F* (pressure unit) commands can take up to 100 mSec to execute.
- *J* (valve calibration) and *L* (learn function) commands can take several seconds to execute.

Command Syntax

As previously mentioned, Tables 11 and 12 on the following pages list RS-232 protocol for sending commands and requests to the 651 unit. It is not necessary to add any spaces between the command or request elements, nor are the commands case sensitive. In both tables, each command or request element is separated with square brackets [ ] for clarity. For example, the command to assign setpoint A a value of 20 is shown in Table 11 as:

[S1][*value*][CR][LF]	and the actual keys pressed would be:
S120[CR][LF]	where [CR] is carriage return, and [LF] is line feed.

Note 

Unless specified otherwise, the [*value*] of a setpoint command should be indicated as a % of F.S. For example, to assign a setpoint of 3 Torr to a 10 Torr sensor, send a [*value*] of 30%.

RS-232 Command Protocol	
Command Protocol	**Function**
[S1][*value*][CR][LF]	Set level of setpoint A
[S2][*value*][CR][LF]	Set level of setpoint B
[S3][*value*][CR][LF]	Set level of setpoint C
[S4][*value*][CR][LF]	Set level of setpoint D
[S5][*value*][CR][LF]	Set level of setpoint E
[S6][*value*][CR][LF]	Set F.S. level of analog setpoint 0 = 100% of controlling transducer's range 1 = 10% of controlling transducer's range
[D1][CR][LF]	Select setpoint A
[D2][CR][LF]	Select setpoint B
[D3][CR][LF]	Select setpoint C
[D4][CR][LF]	Select setpoint D
[D5][CR][LF]	Select setpoint E
[D6][CR][LF]	Select analog setpoint
[E][*value*][CR][LF]	Sensor range 0 = .1 1 = .2 2 = .5 3 = 1 4 = 2 5 = 5 6 = 10 7 = 50 8 = 100 9 = 500 10 = 1000 11 = 5000 12 = 10000 13 = 1.33 14 = 2.66 15 = 13.33 16 = 133.3 17 = 1333 18 = 6666 19 = 13332

[F][*value*][CR][LF]	Pressure units 0 = Torr 1 = mTorr 2 = mBar 3 = µBar 4 = kPa 5 = Pa 6 = cmH_2O 7 = inH_2O
[G][*value*][CR][LF]	Sensor voltage range 0 = 1 Volt 1 = 5 Volts 2 = 10 Volts
[O][CR][LF]	Open valve
[C][CR][LF]	Close valve
[H][CR][LF]	Hold valve
[I1][*value*][CR][LF]	Set softstart rate of setpoint A
[I2][*value*][CR][LF]	Set softstart rate of setpoint B
[I3][*value*][CR][LF]	Set softstart rate of setpoint C
[I4][*value*][CR][LF]	Set softstart rate of setpoint D
[I5][*value*][CR][LF]	Set softstart rate of setpoint E
[I6][*value*][CR][LF]	Set softstart rate of analog setpoint
[I7][*value*][CR][LF]	Set softstart rate of open valve
[I8][*value*][CR][LF]	Set softstart rate of close valve
[P1][*value*][CR][LF]	Set low threshold for process limit #1
[P2][*value*][CR][LF]	Set high threshold for process limit #1
[P3][*value*][CR][LF]	Set low threshold for process limit #2
[P4][*value*][CR][LF]	Set high threshold for process limit #2
[Z1][CR][LF]	Zero the sensor
[Z2][*value*][CR][LF]	Special zero (where *value* is in % F.S. of the base pressure reading)
[Z3][*value*][CR][LF]	Remove the zero correction factor

[L][CR][LF]	Learn the system (self- tune)
[Q][CR][LF]	Stop the learn function (while in process)
[J][*value*][CR][LF]	Calibrate the valve 1 = Std 253 2 = Fast 253 3 = 653 4 = 654-40 5 = 654-50/80 6 = 654-100
[A][*value*][CR][LF]	Analog setpoint range 0 = 5 Volts 1 = 10 Volts
[T1][*value*][CR][LF]	Setpoint A type 0 = position 1 = pressure
[T2][*value*][CR][LF]	Setpoint B type 0 = position 1 = pressure
[T3][*value*][CR][LF]	Setpoint C type 0 = position 1 = pressure
[T4][*value*][CR][LF]	Setpoint D type 0 = position 1 = pressure
[T5][*value*][CR][LF]	Setpoint E type 0 = position 1 = pressure
[T6][*value*][CR][LF]	Setpoint analog type 0 = position 1 = pressure
[B][*value*][CR][LF]	Valve position indicator range 0 = 5 volts 1 = 10 volts
[N][*value*][CR][LF]	Direct/reverse control 0 = direct 1 = reverse
[U][*value*][CR][LF]	Sensor type 0 = absolute 1 = differential

Table 11: RS-232 Protocol for Sending Commands to the 651 Controller

RS-232 Request and Return Messages Protocol		
Request Protocol	**Function of Request**	**Return Message Displayed as:**
[R0][CR][LF]	Analog setpoint *value*	[S0][*value*][CR][LF]
[R1][CR][LF]	Setpoint A *value*	[S1][*value*][CR][LF]
[R2][CR][LF]	Setpoint B *value*	[S2][*value*][CR][LF]
[R3][CR][LF]	Setpoint C *value*	[S3][*value*][CR][LF]
[R4][CR][LF]	Setpoint D *value*	[S4][*value*][CR][LF]
[R5][CR][LF]	System pressure *value*	[P][*value*][CR][LF]
[R6][CR][LF]	Valve position *value*	[V][*value*][CR][LF]
[R7][CR][LF]	Alternate system status (for compatibility)	[M][*XYZ*][CR][LF] For the *value* of *X:* 0 = analog setpoint 1 = setpoint A 2 = setpoint B 3 = setpoint C 4 = setpoint D 5 = setpoint E For the *value* of *Y:* 0 = controlling 2 = valve open 4 = valve close For the *value* of *Z:* 0 = pressure ≤ 10% F.S. 1 = pressure > 10% F.S.
[R10][CR][LF]	Setpoint E *value*	[S5][*value*][CR][LF]
[R11][CR][LF]	Low threshold process limit #1	[P1][*value*][CR][LF]
[R12][CR][LF]	High threshold process limit #1	[P2][*value*][CR][LF]
[R13][CR][LF]	Low threshold process limit #2	[P3][*value*][CR][LF]
[R14][CR][LF]	High threshold process limit #2	[P4][*value*][CR][LF]

[R15][CR][LF]	Report back softstart rate for setpoint A	[I1][*value*][CR][LF]
[R16][CR][LF]	Report back softstart rate for setpoint B	[I2][*value*][CR][LF]
[R17][CR][LF]	Report back softstart rate for setpoint C	[I3][*value*][CR][LF]
[R18][CR][LF]	Report back softstart rate for setpoint D	[I4[*value*][CR][LF]
[R19][CR][LF]	Report back softstart rate for setpoint E	[I5][*value*][CR][LF]
[R20][CR][LF]	Report back softstart rate for analog setpoint	[I6][*value*][CR][LF]
[R21][CR][LF]	Report back softstart rate for valve open	[I7][*value*][CR][LF]
[R22][CR][LF]	Report back softstart rate for valve close	[I8][*value*][CR][LF]
[R23][CR][LF]	Valve type	[J][*type*][CR][LF]
[R24][CR][LF]	Analog setpoint range	[A][*range*][CR][LF] 0 = 5 Volts 1 = 10 Volts
[R25][CR][LF]	Analog setpoint type	[T0][*type*][CR][LF]
[R26][CR][LF]	Setpoint A type	[T1][*type*][CR][LF]
[R27][CR][LF]	Setpoint B type	[T2][*type*][CR][LF]
[R28][CR][LF]	Setpoint C type	[T3][*type*][CR][LF]
[R29][CR][LF]	Setpoint D type	[T4][*type*][CR][LF]
[R30][CR][LF]	Setpoint E type	[T5][*type*][CR][LF]
[R31][CR][LF]	Position indicator range output	[B][*value*][CR][LF] 0 = 5 Volts 1 = 10 Volts
[R32][CR][LF]	Direct/reverse control	[N][*value*][CR][LF] 0 = direct 1 = reverse

[R33][CR][LF]	Sensor range	[E][*value*][CR][LF] 00 = .1 10 = 1000 01 = .2 11 = 5000 02 = .5 12 = 10000 03 = 1 13 = 1.33 04 = 2 14 = 2.66 05 = 5 15 = 13.33 06 = 10 16 = 133.3 07 = 50 17 = 1333 08 = 100 18 = 6666 09 = 500 19 = 13332
[R34][CR][LF]	Pressure units	[F][*value*][CR][LF] 00 = Torr 01 = mTorr 02 = mBar 03 = µBar 04 = µPa 05 = Pa 06 = cmH_2O 07 = inH_2O
[R35][CR][LF]	Sensor voltage range	[G][*value*][CR][LF] 0 = 1 Volt 1 = 5 Volts 2 = 10 Volts
[R36][CR][LF]	Sensor type	[U][*value*][CR][LF] 0 = absolute 1 = differential

[R37][CR][LF]	System status	[M][*XYZ*][CR][LF] For the *value* of *X*: 0 = local 1 = remote For the *value* of *Y*: 0 = not learning 1 = learning system 2 = learning valve For the *value* of *Z*: 0 = open 1 = close 2 = stop 3 = setpoint A 4 = setpoint B 5 = setpoint C 6 = setpoint D 7 = setpoint E 8 = Analog setpoint
[R38][CR][LF]	Software version	[H][*version identifier string*] [CR][LF]

Table 12: RS-232 Protocol for Receiving Messages from the 651 Controller

Digital Logic Control

Digital and analog control of the 651 unit is accomplished via the I/O connector located on the rear panel. Refer to Table 6, beginning on page 16, for a pinout of this connector.

Digital *inputs* and *outputs* are designed to interface with low power TTL and CMOS logic families. They also include additional components to protect against damage from ESD or transient voltages. A brief description of the digital circuitry of the I/O board is provided in the following section.

I/O Board Digital Circuitry

The I/O board contains 16 type 74HC *inputs*. To select an input function, it is necessary to pull the appropriate input pin low (0 to 0.8 volts) and hold for a minimum of 50 mSec. Each input consists of a single pole filter and pull-up resistor as shown in the figure on the following page.

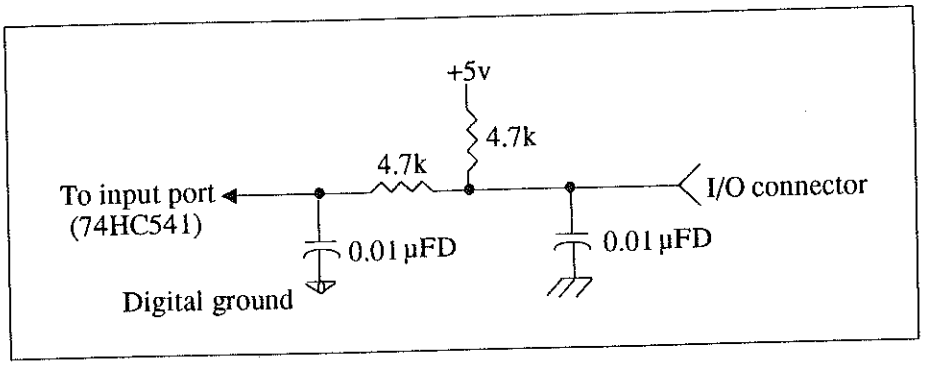


Figure 6: I/O Board Digital Input Circuitry

The I/O board contains 6 type 74HC digital *outputs*, each having the capacity to drive one standard TTL load. The approximate time constant of the outputs are 250 nSec. Each output includes a 240 ohms series resistor to protect it against line surges and spikes. Additionally, there is a 0.001 µFD capacitor connected to the chassis as shown in the figure below.

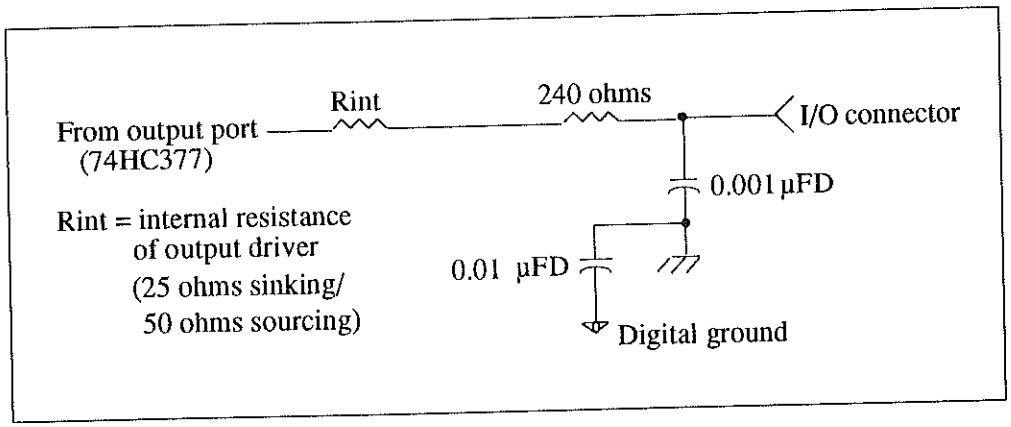


Figure 7: I/O Board Digital Output Circuitry

Digital Input Priorities

Digital inputs are scanned and selected in a prioritized manner, enabling a higher priority request to override a lower one. The order of priority is shown in the table on the following page.

Priority of Digital Inputs		
Order of Priority	**I/O Pin No.**	**Digital Input Function**
1	6	Analog setpoint (pressure or position)
2	10	Control range of analog setpoint
3	25	Remote zero
4	5	Learn system
5	8	Close valve
6	27	Open valve
7	26	Stop valve
8	16	Select setpoint A
9	15	Select setpoint B
10	14	Select setpoint C
11	13	Select setpoint D
12	12	Select setpoint E
13	11	Select analog setpoint

Table 13: Priority of Selection of Digital Inputs

The order of priority of digital inputs is based on the analog setpoint line (pin #11) being tied low to continuously select it, then overriding that command to open, close, zero, etc. the valve.

Note 

Activating both the *open* and *close* commands simultaneously, causes the valve to *stop*.

Digital Functions

Most digital input functions are activated by pulling the input to a TTL low level (0 to 0.8 volts) for a minimum of 50 mSec. If a higher priority function has not already been selected, the requested function will be activated. When the input is brought high (+2.4 to +5 volts), any lower priority functions that have been selected will now be activated. If no lower priority functions have been selected, the function most recently requested remains in effect. Table 14, shown below, lists the specific function of each digital input, and Table 15, shown on page 48, lists the specific function of each digital output.

Digital Input Functions

Digital Input No.	I/O Pin No.	Digital Input Function
Input No. 1 Low High	Pin No. 27	 Open the valve No function
Input No. 2 Low High	Pin No. 8	 Close the valve No function
Input No. 3 Low High	Pin No. 26	 Stop the valve No function
Input No. 4 Low High	Pin No. 7	 Softstart is *active* for selected command function Softstart is *inactive* for selected command function (used in conjunction with another valve control function)
Input No. 5 Low High	Pin No. 25	 Performs the *remote zero* function No function
Input No. 6 Low High	Pin No. 6	 Analog setpoint to *position* Analog setpoint to *pressure*
Input No. 7 Low High	Pin No. 24	 No function No function
Input No. 8 Low High	Pin No. 5	 Performs the *learn* system function No function

Input No. 9 Low High	Pin No. 16	 Selects setpoint A No function
Input No. 10 Low High	Pin No. 15	 Selects setpoint B No function
Input No. 11 Low High	Pin No. 14	 Selects setpoint C No function
Input No. 12 Low High	Pin No. 13	 Selects setpoint D No function
Input No. 13 Low High	Pin No. 12	 Selects setpoint E No function
Input No. 14 Low High	Pin No. 11	 Selects analog setpoint No function
Input No. 15 Low High	Pin No. 10	 F.S. analog setpoint yields 1/10 the F.S. pressure of the controlling transducer or 10% position F.S. analog setpoint yields F.S. pressure of the controlling transducer or 100% position (Pressure/position function controlled by input #6)
Input No. 16 Low High	Pin No. 9	 No function No function

Table 14: Digital Input Functions

Digital Output Functions		
Digital Output No.	**I/O Pin No.**	**Digital Output Function**
Output No. 1 Low High	Pin No. 29	Pressure outside of PLO#1 band (relay is *not* energized) Pressure inside of PLO#1 band (relay *is* energized)
Output No. 2 Low High	Pin No. 28	Pressure outside of PLO#2 band (relay is *not* energized) Pressure inside of PLO#2 band (relay *is* energized)
Output No. 3 Low High	Pin No. 23	No function No function
Output No. 4 Low High	Pin No. 19	No function No function
Output No. 5 Low High	Pin No. 18	No function No function
Output No. 6 Low High	Pin No. 17	No function No function

Table 15: Digital Output Functions

Analog Setpoint Inputs

The analog setpoint inputs, +setpoint (I/O pin #33) and -setpoint (I/O pin #34), are fully differential. The -setpoint must be connected to a ground to work correctly, and it is recommended that it be connected to ground at the source of the setpoint signal.

To achieve softstart control of analog (or digital logic) setpoints, the *softstart line (I/O pin #7) must be held low*. If the line is *not* held low, the valve will move at 100% full speed.

If an analog setpoint is established via RS-232 input, the softstart rate for the analog setpoint is selected through use of the [I6][*value*][CR][LF] RS-232 command.

Chapter Seven
Battery Maintenance

Battery-Backed Memory Module

The 651 pressure controller has a battery-backed memory module which stores configuration and *learned* system information while power is off. The battery-backed memory module (MKS part no. 037-9227) is specified to provide at least seven years of memory storage under all operating conditions. No maintenance should normally be required during this period.

Note 

The module is also available from the following sources:

- Bench Marq (BQ 4011MA-100)
- SGS-Thompson (MK 48Z32B-10)
- Dallas Semiconductor (DS 1230AB-100)

Eventually, the memory module will need to be replaced. If the 651 unit continually requires relearning at each power cycle (power off then on again), it may be time to replace it. The memory module is located on the CPU board inside the electronics unit and may be replaced by MKS or other qualified personnel.

Opening the Unit

Warning 

The 651 unit has lethal voltages inside. Servicing of the unit must be performed by qualified personnel only.

To avoid the danger of electrical shock, the power line must be disconnected before opening the unit.

1. Turn the power off.
2. Disconnect the AC power cord.

Caution 

To avoid damage to sensitive internal components, personnel should be grounded through a safety impedance while working inside the 651 unit, and the unit itself must be static-free.

3. Remove the two phillips screws located at the top of the rear panel.

4. Disengage the cover from the rear chassis by lifting it up from the clips.

5. Remove the top cover by firmly pulling it up and back to clear the top of the connector plates.

Removing the CPU Board and Memory Module

1. Locate the CPU board. It is labeled on the rear panel as the Serial Interface Connector (1).

2. Remove the screw to the left of the connector.

3. It may be necessary to remove the clamping spring that holds the card cage to the power supply. If so, use needle-nose pliers or a screwdriver to pull the clamping spring straight back and out.

4. Grasp each end of the board and rock it until it loosens from its position. Lift the board up and out of the unit.

5. Figure 8, shown below, provides the location of the battery-backed memory module on the CPU board.

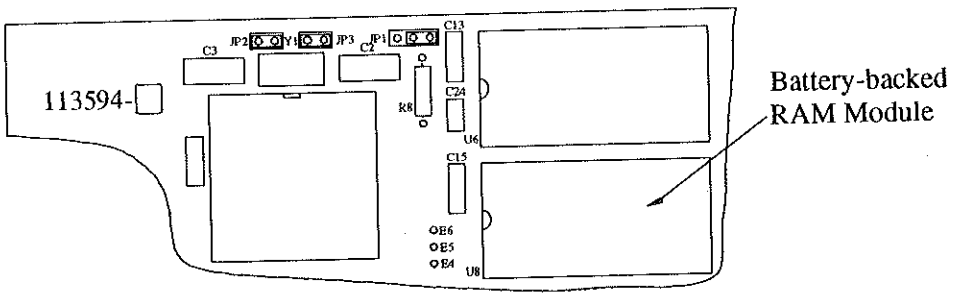


Figure 8: Location of the Battery-backed RAM Module

6. Use needle-nose pliers, a screwdriver, or an IC puller to remove the memory module from its socket.

Installing a New Memory Module and Replacing the CPU Board

1. Position the new memory module over the socket, being careful to line up the pins correctly (pin 1 is located directly to the left of the notch). Snap the module firmly into place.

2. Position the CPU board over its slot in the unit, insuring that the board's edge is behind the next connector's edge. Push on the bottom tab to snap the board into the slot.

3. Use any instrument to gently seat the clamping spring firmly in place. A metal tab prevents the spring from sliding in completely. (The space left by the tab enables a small screwdriver to be inserted into the space for easy board removal the next time.)

Replacing the Cover

1. Using the clips on the cover as a guide, slide the cover (from rear to front) into place at the front panel.

2. Position the cover so that the cover slots engage the top of the connector plates. From the front (looking at the top of the unit toward the rear), push the cover toward the front while incrementally tightening the screws. (This insures good electrical connection between the top cover and rear connector plates.)

3. Reconnect the AC power cord.

4. Turn the power on.

Note 

All user configuration settings may have to be reset and the control system may have to be relearned after replacement of the memory module.

Appendix A

Product Specifications

Pressure input signal Over-range	-10 to 10 Volts ±10.5 Volts
Input power Low power unit High power unit	 90-132 or 180-264 VAC @50/60 Hz 75 VA (max) 90-132 or 180-264 VAC @48/62 Hz 150 VA (max)
Fuses Low power unit 90-132VAC 180-264VAC High power unit 90-132VAC 180-264VAC	 0.63A (T), 250V, 5x20mm 0.315A (T), 250V, 5x20mm 1.25A (T), 250V, 5x20mm 0.63A (T), 250V, 5x20mm
External setpoint signal	0-5 Volts or 0-10 Volts, selectable
Ambient temperature	15 - 40° C (60 - 104° F)
Controller repeatability	±0.1% of F.S.
Output power Low power unit High power unit	 ±15 VDC @ 0.5 Amps (max)[1] ±15 VDC @ 1.5 Amps (max)
Analog output signal Position Pressure	 0-5 Volts or 0-10 Volts, selectable 0-100% F.S. pressure, same range as sensor

[1]Derated to 0.4 Amps with 90-99 or 180-198 VAC input.

Interface RS-232 Analog Digital	 Inputs (16): HCMOS pulled high with a 4.7k resistor to be TTL compatible. Driver must sink 1mA and hold low for > 50 msec to select function. Outputs (6): HCMOS with 240 ohm series protection resistor. Will sink & source 1 TTL load. Time constant < 500 nsec.
Display	2 line LCD with 4½ place readout
Display units	Torr, mTorr, mBar, µBar, Pascal, kPa, cmH_2O, inH_2O
Process limit relays (2)	24 Volts AC/DC @ 1 Amp resistive (contact ratings)
Setpoints Internal External	 5, each one pressure or position selectable 1, pressure or position selectable
Size	3½"H x 9½"W x 9"D
Weight Low power unit High power unit	 7 lbs. 3 oz. 6 lbs.
Connectors[2] Valve I/O Transducer RS-232 Serial Communications	 9-pin Type "D", female 37-pin Type "D", female 15-pin Type "D", female 9-pin Type "D", male

Specifications subject to change without notice

[2]Interconnecting cables between the Type 651 and the valve, sensor, and serial communications are available at an additional charge. Please consult factory for ordering information. Necessary adapter cables are included when retrofitting MKS Type 152, 252, and 652 controllers.

Appendix B

Product Compatibility

Valves

MKS *downstream* control valves compatible with the 651 unit include:

Types 253, 653, and 654

Transducers

Table 16, shown below, lists the current available to a transducer from a 651 controller (and its specific valve configuration).

Valve Configuration	651 Supply type	Line voltage Range	Transducer Current Available
253/653	Low power	90-99 VAC 50/60 Hz	400 mA
		180-198 VAC 50/60 Hz	400 mA
		100-132 VAC 50/60 Hz	500 mA
		200-264 VAC 50/60 Hz	500 mA
253/653	High power	90-132 VAC 48/62 Hz	1.5 A
		180-264 VAC 48/62 Hz	1.5 A
654	High power	90-132 VAC 48/62 Hz	800 mA
		180-264 VAC 48/62 Hz	800 mA

Table 16: Transducer Current Available from Low and High Power Units

MKS transducers compatible with the *low power* 651 unit include:

Types 122, 124, 127, 128[3], 220, 121, and 223.

MKS transducers compatible with the *high power* 651 unit include:

Types 120, 122, 124, 127, 128, 220, 121, 223, and 621.

[3]To ensure proper operation of the Type 128 transducer in the (90-99/180-198) power line voltage range, it is recommended that the *high power* 651 unit be used. Above 100/200 volts, the *low power* unit provides adequate power.

Adapter Cables

The 651 Pressure Controller can replace the 152, 252, and 652 controllers. It may, however, be necessary to fit the Type "D" connectors on the 651 unit with adapter cables. Refer to Table 18, shown below, for a listing of the appropriate cable numbers.

651 Adapter Cables		
From	**To**	**Cable Number**
252,252+VPO 252+MSO	651 I/O 651 I/O	CB651-12-1 CB651-13-1
252+PLO 252+PLO+VPO	651 I/O	CB651-14-1
252+MSO+PLO 252+MOS+VPO 252+MSO+VPO+PLO	651 I/O	CB651-15-1
152 PC/VPO 152 PC/VPO+RS-232	651 I/O	CB651-16-1
152 RZ/VPO RZ/VPO+RS-232	651 I/O	CB651-17-1
152/252 Sensor Cables	651 Sensor	CB651-18-1
25-Pin Serial Cable[4]	651 Serial	CB651-19-1
652 I/O	651 I/O	CB651-20-1
152/252 Valve Cable	651 Valve	CB652-2-1

Table 17: Adapter Cables for the Type 651 Pressure Controller

651 Serial Communications Cables	
651 Serial Communications to 9-pin serial port (pins 2 and 3 straight through)	CB651-10-10
651 Serial Communications to 25-pin serial port (pins 2 and 3 reversed)	CB651-11-10

Table 18: Serial Communications Cables for the Type 651 Pressure Controller

[4]Pins 2 and 3 not reversed. This cable is a 651 to 652 serial port converter cable. The 25-pin end simulates a 652 controller, and the opposite end connects to the 651 serial port.

Appendix C

Type 651 Displayless Unit

The displayless unit is a standard 651 unit with the following differences:

- there is no front panel display
- it has an additional RS-232 serial port which is located on the front panel
- it is intended to be used in conjunction with a lap-top or notebook computer connected to this RS-232 port
- the baud rate is set at 9600 with no parity and [CR][LF] delimeter

To put the Type 651 displayless unit into operation via the RS-232 port on the front panel, set the switch to the local position. When set to the local position, TTL input and the rear serial communications port become locked out. Conversely, when set to the remote position, the front serial communications port becomes locked out, and the unit can be controlled either by TTL input or through the serial communications port on the rear panel.

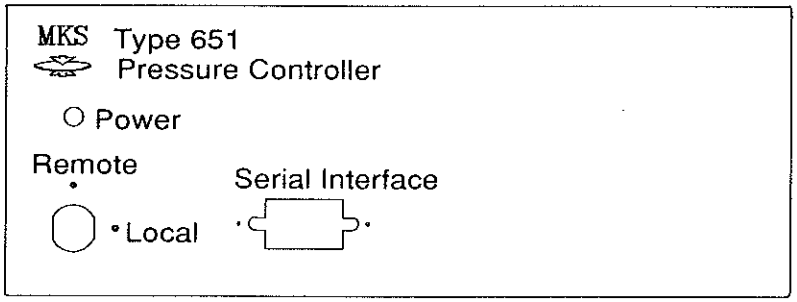


Figure 9: Front Panel of the Type 651 Displayless Unit

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