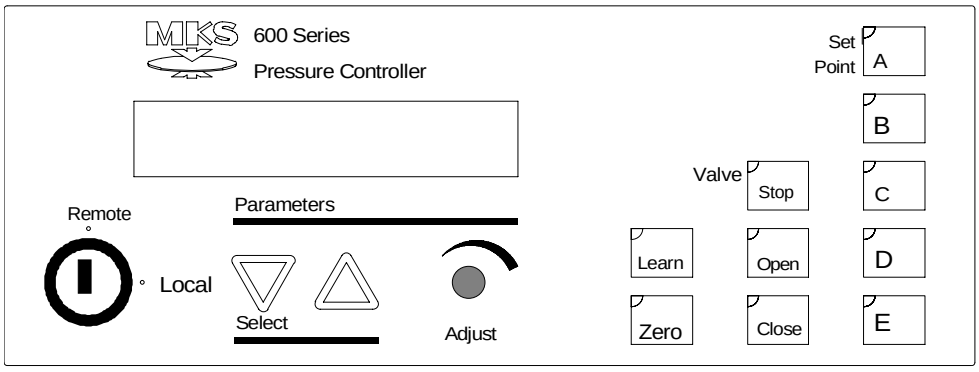
115484-P1
REV B, 2/94

MKS Type 655A
Pressure Controller



Please Note:
MKS Instruments provides these documents as the latest version for the revision indicated. The material is subject to change without notice, and should be verified if used in a critical application.

This manual is for firmware version 1.6x

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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 655A 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 655 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 655 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 655 instrument has a high-powered driver to operate the MKS Type 654 throttle valve, up to 100 mm (4") with vacuum shut-off capability, giving the unit a control range from 10^{-4} to 760 Torr with the appropriate pressure transducers. Appendix B, *Product Compatibility*, beginning on page 69, lists all MKS products that are compatible with the 655. All MKS linear Baratron® transducers are compatible with the 655 controller, which is equipped with a high-capacity power supply. The 655 unit contains a battery-backed memory module which stores configuration and *learned* system information while power is off. There is also an optional valve failsafe battery backup available. The optional battery backup allows user-configuration of the 655 instrument to drive a valve open or closed upon an AC power failure.

How This Manual is Organized

This manual is designed to provide instructions on how to set up and install a Type 655 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.

Chapter Three gives an *Overview* of the Type 655 Pressure Controller. It describes the components on both the front and rear panels and discusses local and remote operation. It also provides information about the electrical connections.

Chapter Four, *Setup*, explains how to connect a valve and set up the 655 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 RS-232 control and the digital logic operation.

Chapter Seven, *Maintenance,* provides instructions on how to replace the battery-backed memory module as well as the optional valve failsafe battery.

Appendix A lists *Product Specifications* for the Type 655 instrument.

Appendix B supplies information about MKS *Compatible Products*.

Appendix C describes the *Displayless* unit and how it differs from the standard 655 unit.

Appendix D, *Initial Settings,* lists the initial settings of the controller.

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 655 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 ensures 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 655 Pressure Controller.

1. Operating ambient temperature must be in the range of 15^0 - 40^0 C (15^0 - 35^0 C when equipped with the optional valve failsafe battery backup).

2. Humidity must be kept between 0 and 95%, non-condensing.

3. Position the unit with proper clearance, to allow air cooling, so that the unit can operate within the product temperature specifications listed above.

4. The 655 unit can be mounted in a panel cutout or in either a 9-inch deep or 12-inch deep rack. (The optional valve failsafe battery backup requires 12 inches).

   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 on page 7.

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 655 controller requirements refer to Appendix A, *Product Specifications,* beginning on page 67.

How to Unpack the Type 655 Pressure Controller

Care has been taken to pack the Type 655 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 655 instrument includes the following standard parts, plus any optional accessories ordered.

Standard Parts:

- The 655 instrument
- A power cord
- A key for the front panel Key Lock switch
- Instruction Manual (this manual)

Optional Accessories:

- 655-K1 accessory kit (includes an I/O connector for the rear panel of the unit, a connector cover for the I/O connector, and a screwlock assembly for the I/O connector cover)
- Cables for supported sensors and the MKS Types 654 valve
- RM-13 or RM-14 rack mount option
- Valve failsafe battery backup (installed in the unit at the factory)

Checking the Fuses and Line Voltage Selector Switch

The 655 unit is shipped with the line voltage set for 115 VAC. If you need to operate the unit with a 230 VAC line voltage, follow the instructions in this section. Refer to Table 1 for information on the fuses.

Nominal Line	Line Voltage Range	Fuse Type
115 VAC	90-132 VAC @48/62 Hz 150 VA (max)	1.25A (T), 250V, 5 x 20 mm
230 VAC	180-264 VAC @48/62 Hz 150 VA (max)	0.63A (T), 250V, 5 x 20 mm

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-T630 mA or equivalent for the 0.63 A fuse
- Bussmann GDC-T1.25 A or equivalent for the 1.25 A fuse

How to Replace the Fuses

1. Select the proper fuses.

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

2. Disconnect the power cord from the 655 unit.

Warning **To avoid an electrical shock, be sure to disconnect the power cord *before* proceeding.**

3. 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 for the location of the clip.

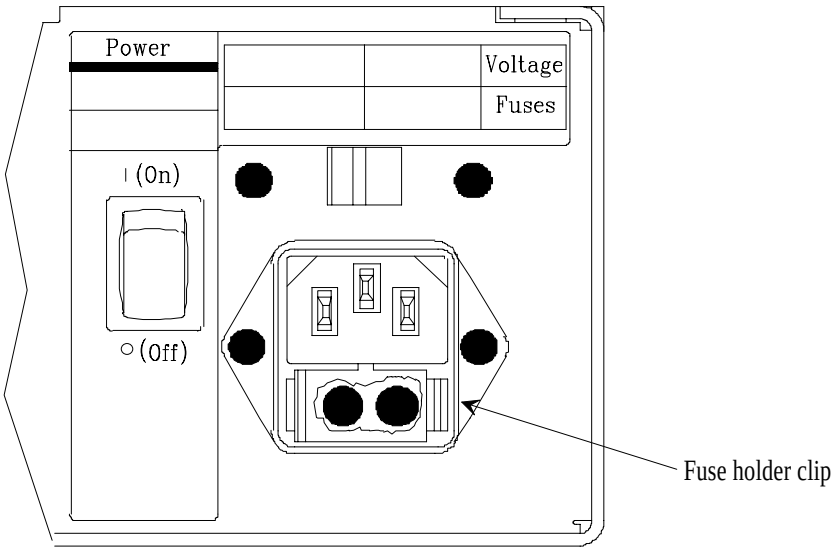

Figure 1: Fuse Holder

4. 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.)

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

How to Change the Line Voltage

1. Check the current line voltage setting.

   Refer to Figure 2 for the location of the voltage selector switch. The label above the switch (on either unit) shows the corresponding voltage range and fuse requirements for either voltage setting.

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

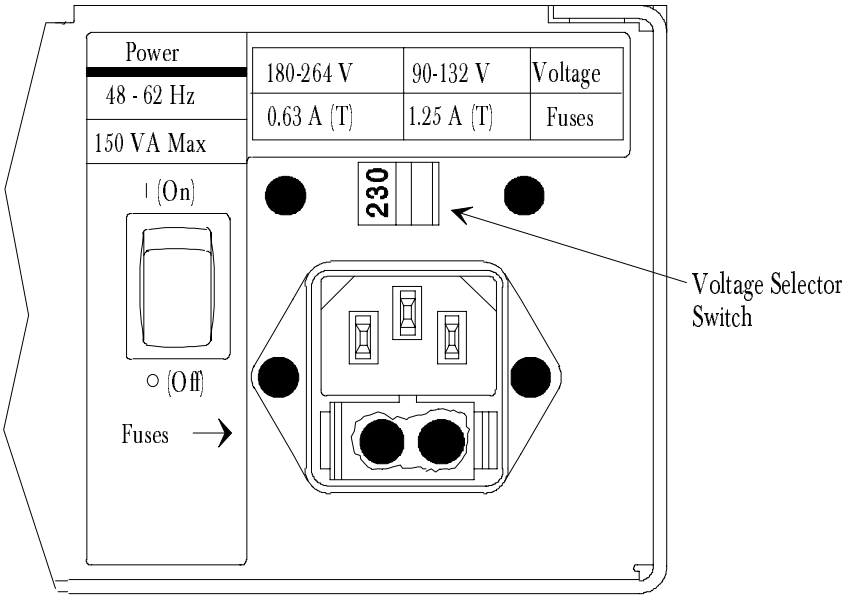

Figure 2: Voltage and Fuse Data

The Type 655 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.

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Chapter Three
Overview

Front Panel

Front Panel Components

Figure 3 labels all the components located on the front panel of the 655 instrument. Refer to Table 2, page 12, summarizes the functions of the front panel components.

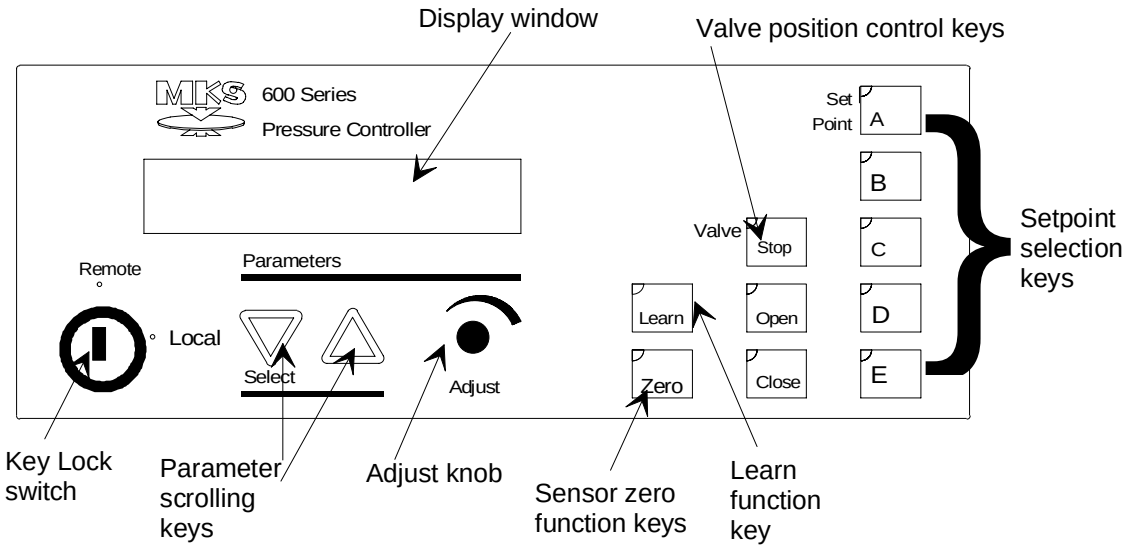


Figure 3: Front Panel of the Type 655 Instrument

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. Holding both scrolling keys down simultaneously for approximately three seconds brings up the Setup menu. See Chapter Four, *System Setup*, for information on the Setup menu.

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, battery voltage, and softstart rate (depending on how the unit is configured).
Parameter scrolling keys	Used to scroll through displays: [▽] down, and [△] up.
Adjust dial	Used to enter parameter values.
Learn function key	Used to enable the learn function within the 655 unit. In a control system with a positive flow rate, the 655 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 655 unit *responses*, however, may still be sent through the Serial Interface connector on the rear panel. Refer to Table 12, beginning on page 47, 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 4, on page 15, for the location of the connectors and to Tables 4 and 6, beginning on page 16, for the pin assignments. Chapter Six, *Remote Operation,* beginning on page 41, contains more detailed information about RS-232 control and digital logic operation.

Command Priority

The 655 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 655 will respond to the last command issued in remote until a new command is issued in local. In switching from local to remote, the 655 will continue to respond to the last command issued in local until a new command is issued in remote.

Self-Tuning/PID Control

The Type 655 instrument can control a vacuum system in one of two ways. When used in the *self-tuning* control mode, the 655 unit determines control parameters based upon the system's characteristics using a unique control algorithm, and does not require the input of lead or gain values. To activate this feature from the front panel, be sure the key lock switch is set to local, and hold down both scrolling keys simultaneously for approximately three seconds, to enter the Setup menu. Scroll through the Setup menu until the Control mode entry appears. The Control mode screen is shown on page 23. To change from PID to Adaptive, turn the Adjust knob counterclockwise. Then press 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, on page 35, for more information about the [Learn] key.

When used in the *PID* control mode, the 655 unit employs a **P**roportional, **I**ntegral, and **D**erivative (PID) algorithm for control. In the 655 unit, PID control requires the input of user-defined lead and gain values. Each setpoint uses its own lead and gain values to optimize response from setpoint to setpoint. Although there are default values for lead and gain, user-defined values must be supplied for optimum control. To enter lead and gain parameters, the key lock switch must be set to local. Select PID from the Setup menu to set the lead and gain values. (To enter the Setup menu, hold down both scrolling keys simultaneously for approximately three seconds. Scroll through the Setup menu until the Control mode entry appears. To change from Adaptive to PID , turn the Adjust knob clockwise.) Once the lead and gain parameters have been entered, the 655 unit can operate with the key lock switch set to either local or remote. Refer to the *How To Set Lead and Gain Parameters* section, on page 40, for instructions on setting lead and gain parameters.

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.

Battery Backups

There are two types of batteries used in the 655 instrument - a lithium battery and an optional lead-acid battery. The lithium battery is included inside each 655 unit and is used to power memory for storage of configuration and learned system information while power is off. The optional lead-acid battery allows user-configuration of the 655 instrument to drive a valve open or closed upon an AC power failure. If the battery backup option is not installed, the valve will maintain its position upon an AC power failure.

Rear Panel

Rear Panel Components

Figure 4 labels all the components located on the rear panel of the 655 instrument. The power on/off switch and the line voltage selector switch are on the back of the 655 unit. The four Type "D" connectors are also located on the rear panel.

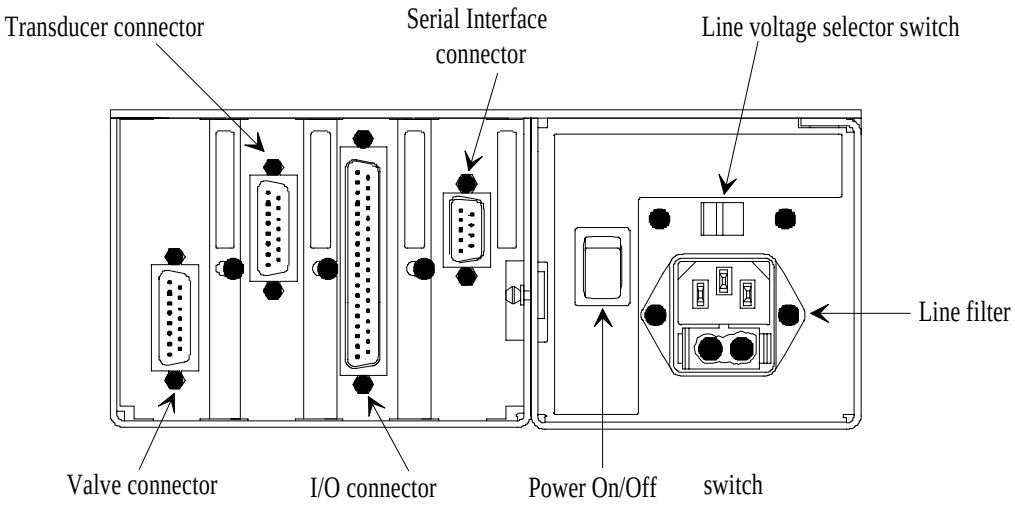


Figure 4: Rear Panel of the Type 655 Instrument

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

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 Number	**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	CB655-10-10
655 Serial Communications to 25-pin serial port (pins 2 and 3 reversed)	CB655-11-10

Table 5: Cable Numbers for RS-232 Serial Communications

Caution

The MKS RS-232 Serial Communications cable (CB655-10-10) *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 position setpoint (low). For analog setpoint only, select simultaneously with pin 11.
7	Softstart (low)
8	Close valve (low)
9	Reserved
10	Analog setpoint ÷ 10
11	Select analog setpoint (low). For analog position, select simultaneously with pin 6.
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	Valve open status (hi = open)
20	PLO relay #1 - common contact
21	PLO relay #2 - common contact
22	PLO relay #2 - NO contact
23	Valve closed status (hi = closed)
24	Reserved
25	Remote zero (low)

Table 6: I/O Connector Pinout

(Continued on next page)

I/O Connector Type “D” 37-Pin Female *(Continued)*	
Pin Number	**Function**
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 Number	**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
122AA	CB112-2-10
122BA/622/626	CB259-5-10
127/627	CB259-5-10
128/628	CB259-5-10
220	CB112-10-10
121/221	CB112-14-10
124/223/224	CB112-2-10
120	CB120-1-10
623/624/625	CB112-2-10

Table 8: Cable Numbers for MKS Transducers

Valve Connector Type "D" 15-Pin Female	
Pin Number	**Function**
1	Motor winding A feed
2	Motor winding A return
3	Motor ground
4	Motor winding B feed
5	Motor winding B return
6	Open limit switch signal
7	Closed limit switch signal
8	Limit switch ground
9	Motor winding A feed
10	Motor winding A return
11	Motor ground
12	Motor winding B feed
13	Motor winding B return
14	+5V @50 mA (for Opto switches)
15	Keyed Position

Table 9: Valve Connector Pinout

Valve Type Number	Cable Number
654A	CB654-1-10

Table 10: Cable Numbers for MKS Throttle Valves

Caution 

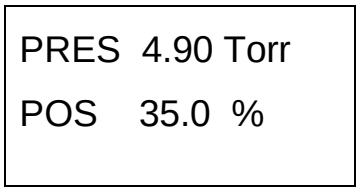
If you attempt to make a cable to connect the valve to the 655, you must physically remove pin 15 on the cable connector. Pin 15 on the 655 valve connector is keyed, so that a pin cannot be inserted into it. This eliminates the possibility that the 15-pin transducer cable will be inadvertently connected to the 15-pin valve connector. Plugging the transducer cable into the valve connector will damage the transducer.

Chapter Four
System Setup

Overview

The 655 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 display screen, listing 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 configured).



Valve Selection and Calibration

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

Caution 

This procedure involves cycling the valve from the open to close position. Be certain that the system can withstand valve cycling *before* proceeding. This test can be performed prior to installing the 655 and valve in the system.

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

VALVE TYPE:
654-40

3. Use the 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:

   654-40

   654-50/80

   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 655 pressure controller will not function properly.

Setup Menu

The setup menu enables you to change the configuration of the 655 controller. The initial configuration is listed in Appendix D, beginning on page 73. The instructions in this section assume that you will enter the commands from the front panel, so be sure that the key lock switch is set to local.

The setup menu allows you to choose the settings for the following topics:

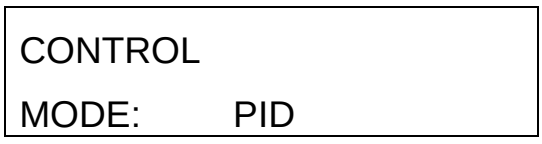
- PID or Adaptive (self-tuning) Control mode
- Baud rate, parity, and delimiter
- Sensor range and pressure units of measure
- Sensor signal and type
- Analog setpoint input range and valve signal output
- Setpoint types A - E, pressure or valve position
- Softstart rates for setpoints A - E, analog 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 Adjust dial to select the desired parameters.

Control Mode

The 655 controller is initially configured for PID control. Follow the steps below to change the control mode setting.

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



2. Use the Adjust dial to choose either *PID* or *adaptive* control.

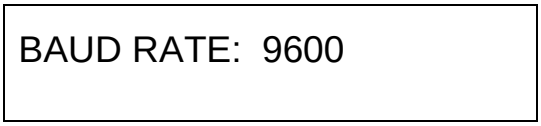
3. If you choose Adaptive control, press the [Learn] key for roughly three seconds.

   The 655 unit will learn the characteristics of your valve. Once the learn process is complete, you can operate the 655 unit in either the Local or Remote mode.

RS-232 Communications

The 655 controller is initially configured with a baud rate of 9600, no parity, 8 data bits, and CRLF delimiter. Follow the steps below to change any of the RS-232 communication parameters.

1. From the *control mode* display, scroll to the next topic in the setup menu.



2. Select the desired baud rate.

   The display list includes the following baud rate settings:

   300

   1200

   2400

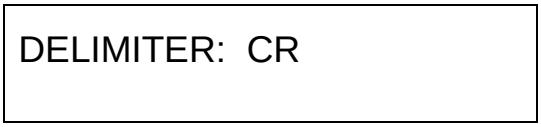
   4800

   9600*

   * *initial setting*

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. The initial setting is 8 data bits, no parity.



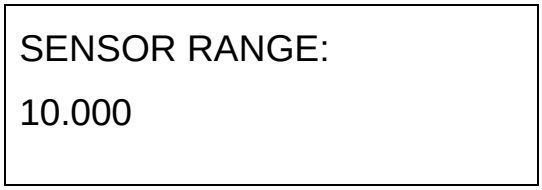
5. Choose either CRLF (carriage return/line feed), or CR (carriage return). The initial delimiter is CRLF.

Sensor Setup

The 655 controller is initially configured to use Torr as the pressure units, 100 Torr as the sensor full scale range, 0 to 10 Volts for the sensor input signal, and 0 to 5 Volts for the analog setpoint input. Follow the steps below to change any of these parameters.

1. Be sure that the sensor is connected to the 655 unit.

2. From the *delimiter* display, scroll to the next topic.



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

** initial setting*

4. Scroll to the next topic.

PRESSURE UNITS:
Torr

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

   ** initial setting*

6. Scroll to the next topic.

SENSOR SIGNAL:
10 VOLTS

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*

   ** initial setting*

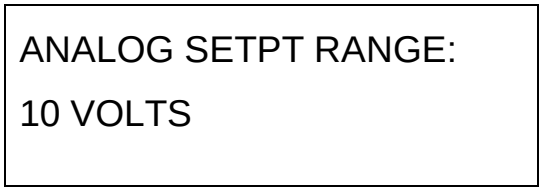
8. Scroll to the next topic.

SENSOR TYPE:
ABSOLUTE

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

Analog Setpoint

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

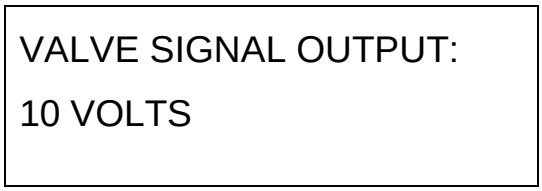


2. Choose either 5 Volts or 10 Volts full scale signal.

   The initial setting is 0 to 5 Volts. Refer to the *How to View the Analog Setpoint* section in Chapter Five, *Local Operation,* beginning on page 38, 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.

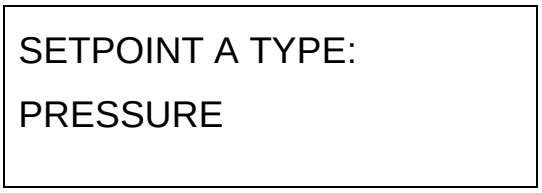


2. Choose either 5 Volts or 10 Volts full scale for valve position output.

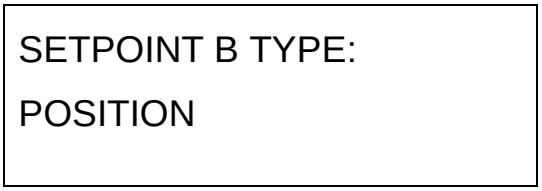
Setpoints A - E, Pressure/Position Selection

The 655 controller is initially configured to use *pressure* control for all setpoints, A through E. Follow the steps below to change configuration of any of the setpoints.

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.



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

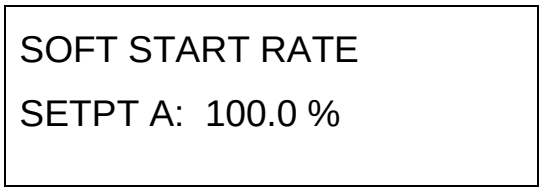
4. Continue to scroll through the menus in the manner just described, until setpoints A - E have each been set at either *pressure* or *position*. Refer to the *How to View and Adjust Setpoints*, beginning on page 32, for more information about setpoints.

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.

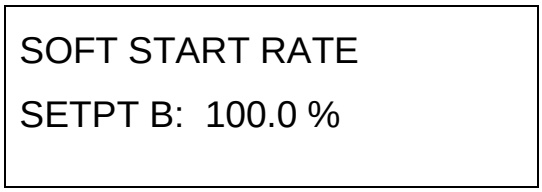
Softstart Rates

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.



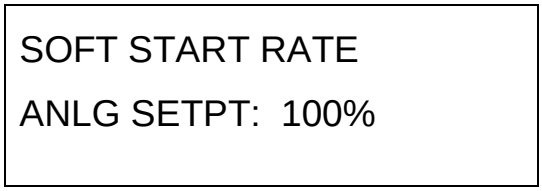
2. Select the softstart rate (between 0.1 and 100%) desired for setpoint A, then scroll to the next topic.



3. Select the softstart rate (between 0.1 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.



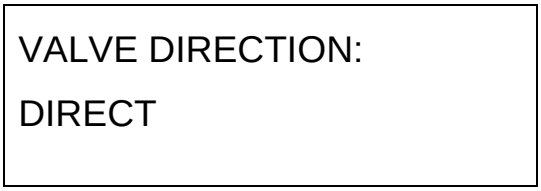
6. Select the softstart rate (between 0.1 and 100%) desired for analog setpoint.

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* action of valve control is defined as valve open at 100% of F.S. and valve close at 0% of F.S. *Reverse* action of valve control is defined as valve open at 0% of F.S. and valve close at 100% of F.S. The 655 controller is initially configured to use direct action to control the valve.

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, *Local Operation,* beginning on page 31, discusses operating via the front panel and Chapter Six, beginning on page 41, provides information about *Remote Operation* of the Type 655 Pressure Controller.

Chapter Five
Local Operation

Overview

Local operation of the 655 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, how to zero it, and how to calibrate it to full scale span
- How to view and adjust lead and gain parameters

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 655 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.

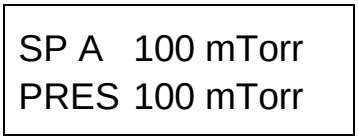
1. Hold down both arrow keys, [▽] and [△] for approximately three seconds to enter the Setup menu.

2. Scroll to the Control mode screen appears and verify that PID is selected.

3. If Adaptive is selected, turn the Adjust knob clockwise to select PID control.

4. Scroll to the Setpoint A screen.

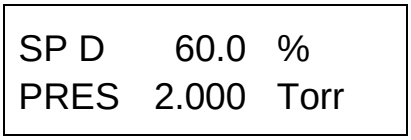
   A sample display of setpoint A (SP A) is shown below. In this example, setpoint A is defined as 100 mTorr, and the system *pressure* at this time is also 100 mTorr.



5. Adjust the displayed setpoint with the Adjust knob 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 655 unit to control with that setpoint. To activate a setpoint, press the appropriate setpoint key (A through E).

The system responds by illuminating a light 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.

SP A	3.000 Torr
PRES	+++++++

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

PRES	- - - - - - Torr
POS	0.0 %

How To Control the Valve

The 655 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 655 unit to identify important system characteristics for self-tuning control. Use the learn function whenever the 655 controller is used in a new vacuum system or when processing conditions are changed (i.e., changed flow rate, new or refurbished pump, or piping modifications). 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 illuminating 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 the [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, below the resolution of the sensor.

   In order to achieve a proper zero, the pressure of the system must be *lower* than the resolution of the Baratron® used to measure system pressure. If the pressure reading (at base pressure) is greater than 4% of full range, the sensor will not be zeroed.
4. Press 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 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 [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] key and the [Zero] key 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 655 controller. Each relay has two trip limits: a high trip limit, and a low trip limit. Refer to Table 6, beginning on page 17, for the pinout of the I/O 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 and Adjust the Analog Setpoint

The 655 controller is capable of accepting one analog setpoint through the I/O connector on the rear panel. The 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 655 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 655 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.

ANALOG SETPOINT
VALUE: 50.0 %

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).

How To Zero the Analog Setpoint

1. From the default display, *pressure* and *position*, press [△] and the [Stop] key simultaneously for about three seconds until the following display appears.

CAUTION
CALIBRATION MODE

2. Press [Setpoint B] key. The analog setpoint display appears.

ANLG SP: -2.99%
LEARN+ZERO to CAL

3. Press the [Learn] key and the [Zero] key simultaneously for about three seconds until the analog setpoint goes to zero.
4. Press any key to return to the default display, *pressure* and *position*.

Note The maximum adjustment for zero is 15% of full scale.

How To Calibrate Full Scale Span for the Analog Setpoint

The 655 units are calibrated at the factory for 10 Volt full scale input; if actual input applied is 10 Volts, the analog setpoint display shows a value of 100%. To reconfigure a 655 unit to operate at a different full scale input, for example, 9.5 Volts, apply 9.5 Volts to the I/O connector on the rear panel and follow the steps below.

1. From the default display, *pressure* and *position*, press [△] and the [Stop] key simultaneously for about three seconds until the following display appears.

CAUTION
CALIBRATION MODE

2. Press [Setpoint D] key. The following display appears.

ANLG SP:	99.90%
FULL SPAN:	20015

3. Use the Adjust dial to change the value of the analog setpoint to 100%. The 9.5 Volt input to the Interface connector on the rear panel is now the full scale value.

Note 

To ensure that the analog set point is adjusted correctly, turn the Adjust dial until the reading flickers between 99.99% and 100.00%. The display reads 100.00% for an overrange reading as well as a true 100% reading.

4. Press any key to return to the default display, *pressure* and *position*.

Note 

The maximum adjustment for full scale span is 15% of full scale.

How To Set Lead and Gain Parameters

When the 655 unit is configured for PID control, separate lead and gain parameters are maintained for each pressure setpoint. Setpoint A is associated with Lead A and Gain A. Setpoint B is associated with Lead B and Gain B, and so forth.

When an analog setpoint is used with PID control, the lead and gain parameters associated with any of the pressure setpoints (setpoints A through E) may be used. To specify which setpoint's lead and gain parameters to use, apply a TTL low level signal to the I/O connector pin assigned to the desired setpoint. Refer to Table 12, beginning on page 54, for a description of the pin assignments for the digital inputs. The TTL low level signal (0 to 0.8 Volts) is "level sensitive" meaning that once the signal is held low, the 655 unit may take up to 50 milliseconds to recognize the command. The line must be held low *continuously* for the 655 unit to use the selected parameters. Once the signal goes high, the instrument will default back to setpoint A parameters within 50 milliseconds. For example, to apply the lead and gain parameters associated with setpoint C to the analog setpoint, apply a 0 to 0.8 Volt signal to pin 14 (on the I/O connector) for as long as you wish to use those parameters.

1. Hold down both arrow keys, [▽] and [△] for approximately three seconds to enter the Setup menu.

2. Scroll to the Control mode screen appears and verify that PID is selected.

3. If Adaptive is selected, turn the Adjust knob clockwise to select PID control.

4. Adjust the setpoint lead and gain parameters.

   By careful adjustment of the lead and gain parameters, it is possible to achieve optimum control throughout a wide range of pressure regions. Examples of Lead and Gain for setpoint A are shown below.

LEAD A	1.25 SEC.
PRES	350 Torr

GAIN A	25.0%
PRES	350 Torr

5. Use the Adjust knob to enter the desired lead and gain parameters.

The 655 unit will use the lead and gain values associated with setpoint A by default.

If a setpoint is configured as a valve position, then *no* lead or gain parameters are associated with it.

Chapter Six
Remote Operation

Overview

Remote operation of the 655 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.

The *RS-232 Communication* section, on page 24, discusses the initial settings for the communication parameters.

RS-232 Control

An RS-232 port is available on the rear panel of the Type 655 controller at the Serial Interface connector. It is from here that commands can be executed and information requested. Refer to Table 4, page 16 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 655 instrument causes it to send back information. Refer to Table 12, beginning on page 47, for a listing of the request and return message protocol.

Commands

A *command* sent to the 655 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 43, 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, Table 11 beginning on page 43, and Table 12 beginning on page 47, list RS-232 protocol for sending commands and requests to the 655 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

Table 11: RS-232 Protocol for Sending Commands to the 655 Controller

(Continued on next page)

RS-232 Command Protocol *(Continued)*	
Command Protocol	**Function**
[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

Table 11: RS-232 Protocol for Sending Commands to the 655 Controller

(Continued on next page)

RS-232 Command Protocol *(Continued)*	
Command Protocol	**Function**
[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 = 654-40 2 = 654-50/80 3 = 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

Table 11: RS-232 Protocol for Sending Commands to the 655 Controller

(Continued on next page)

RS-232 Command Protocol *(Continued)*	
Command Protocol	**Function**
[N][*value*][CR][LF]	Direct/reverse control 0 = direct 1 = reverse
[U][*value*][CR][LF]	Sensor type 0 = absolute 1 = differential
[X1][*value*][CR][LF]	Set lead of setpoint A
[X2][*value*][CR][LF]	Set lead of setpoint B
[X3][*value*][CR][LF]	Set lead of setpoint C
[X4][*value*][CR][LF]	Set lead of setpoint D
[X5][*value*][CR][LF]	Set lead of setpoint E
[M1][*value*][CR][LF]	Set gain of setpoint A
[M2][*value*][CR][LF]	Set gain of setpoint B
[M3][*value*][CR][LF]	Set gain of setpoint C
[M4][*value*][CR][LF]	Set gain of setpoint D
[M5][*value*][CR][LF]	Set gain of setpoint E
[V0][CR][LF]	Select adaptive control
[V1][CR][LF]	Select PID control
[K0][CR][LF]	Disable battery backup
[K1[CR][LF]	Select valve to open upon power fail
[K2[CR][LF]	Select valve to close upon power fail

Table 11: RS-232 Protocol for Sending Commands to the 655 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 $\leq$ 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]

Table 12: RS-232 Protocol for Receiving Messages from the 655 Controller
(Continued on next page)

RS-232 Request and Return Messages Protocol *(Continued)*		
Request Protocol	**Function of Request**	**Return Message Displayed as:**
[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]

Table 12: RS-232 Protocol for Receiving Messages from the 655 Controller
(Continued on next page)

RS-232 Request and Return Messages Protocol *(Continued)*		
Request Protocol	**Function of Request**	**Return Message Displayed as:**
[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 01 = .2 02 = .5 03 = 1 04 = 2 05 = 5 06 = 10 07 = 50 08 = 100 09 = 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
[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

Table 12: RS-232 Protocol for Receiving Messages from the 655 Controller
(Continued on next page)

RS-232 Request and Return Messages Protocol *(Continued)*		
Request Protocol	**Function of Request**	**Return Message Displayed as:**
[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]
[R39][CR][LF]	Status of battery used in optional valve failsafe backup	BT = Battery is bad BT1 = Battery is good BT2 = Option is not installed
[R40][CR][LF]	Valve response to power fail (when using the optional valve failsafe backup)	K0 = Option is disabled (or not installed) K1 = Valve opens at power fail K2 = Valve closes at power fail
[R41][CR][LF]	Lead A value	[X1][*value*][CR][LF]
[R42][CR][LF]	Lead B value	[X2][*value*][CR][LF]
[R43][CR][LF]	Lead C value	[X3][*value*][CR][LF]
[R44][CR][LF]	Lead D value	[X4][*value*][CR][LF]

Table 12: RS-232 Protocol for Receiving Messages from the 655 Controller

(Continued on next page)

RS-232 Request and Return Messages Protocol *(Continued)*		
Request Protocol	**Function of Request**	**Return Message Displayed as:**
[R45][CR][LF]	Lead E value	[X5][*value*][CR][LF]
[R46][CR][LF]	Gain A value	[M1][*value*][CR][LF]
[R47][CR][LF]	Gain B value	[M2][*value*][CR][LF]
[R48][CR][LF]	Gain C value	[M3][*value*][CR][LF]
[R49][CR][LF]	Gain D value	[M4][*value*][CR][LF]
[R50][CR][LF]	Gain E value	[M5][*value*][CR][LF]
[R51][CR][LF]	Type of control	[V][*value*][CR][LF] 0 = Adaptive 1 = PID
[R45][CR][LF]	Lead E value	[X5][*value*][CR][LF]

Table 12: RS-232 Protocol for Receiving Messages from the 655 Controller

Digital Logic Control

Digital and analog control of the 655 unit is accomplished via the I/O connector located on the rear panel. Refer to Table 6, beginning on page 17, 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, pull the appropriate input pin low (0 to 0.8 Volts). The TTL low signal is "level sensitive" meaning that once the signal is held low, the 655 unit may take up to 50 milliseconds to recognize the command. The line must be held low *continuously* for the 655 unit to use the selected parameters. Once the signal goes high, the instrument will default back to the state associated with the high signal within 50 milliseconds. Each input consists of a single pole filter and pull-up resistor as shown in Figure 5.

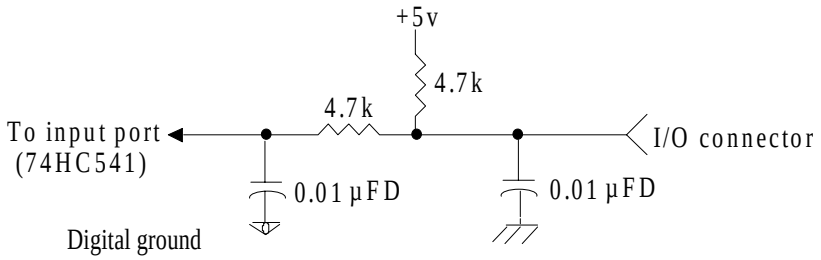


Figure 5: I/The I/O board contains 6 type 74HC digital *o*O Board Digital Input Circuitry

utputs, each having the capacity to drive one standard TTL load. The approximate time constant of the outputs are 250 nanoseconds. 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.

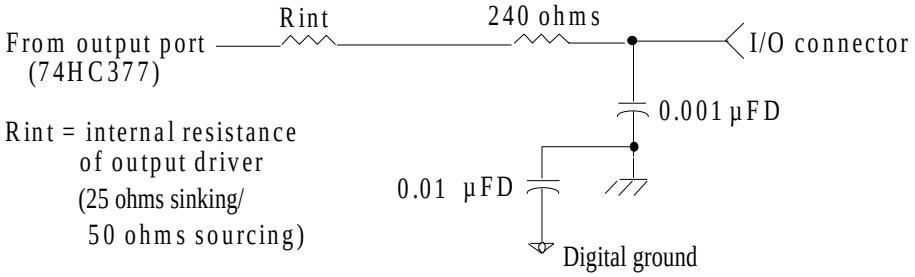


Figure 6: I/O Board Digital Output Circuitry

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 Table 13.

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	11	Select analog setpoint
9	16	Select setpoint A
10	15	Select setpoint B
11	14	Select setpoint C
12	13	Select setpoint D
13	12	Select setpoint E

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 milliseconds. 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 12, shown below, lists the specific function of each digital input, and Table 15, shown on page 56, lists the specific function of each digital output. The first column in each table, lists the I/O port number assignment. This number is useful primarily for software engineers.

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

Table 14: Digital Input Functions

(Continued on next page)

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

Table 14: Digital Input Functions

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

Replacing the Battery-Backed Memory Module

The 655 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 655 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 655 unit has lethal voltages inside. Servicing of the unit must be performed by qualified personnel only.

To avoid an electrical shock, disconnect the power line *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 655 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 provides the location of the battery-backed memory module on the CPU board.

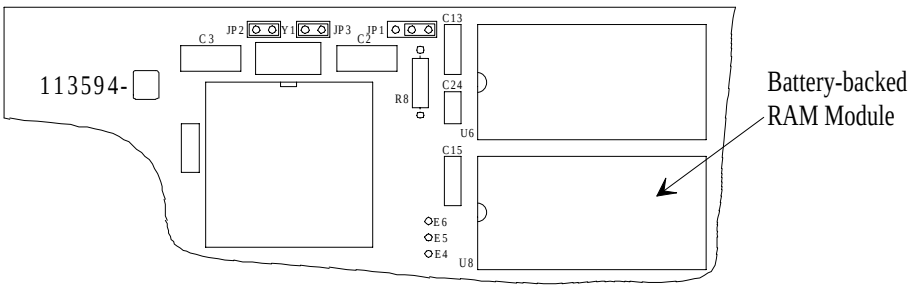


Figure 7: Location of the Battery-backed RAM Module

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, ensuring 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 ensures 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.

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Chapter Eight
Optional Valve Failsafe Battery Backup

General

An optional Valve Failsafe Battery Backup (lead-acid battery) provides full valve drive capability for about one minute after an AC power failure. The 655 instrument can be set to drive the valve open, closed, or hold it in its current position upon a power loss. This optional battery is a rechargeable, 12 Volt, 2 amp-hour, sealed lead-acid battery (MKS part no. 003-1109451).

Note 

The lead-acid battery is also available from the following sources:

- Power Sonics (PS-1220)
- Panasonic (LCR 12 V2.2P)

If a Valve Failsafe Battery Backup is installed, an **ATTENTION** label is affixed to the side of the 655 unit. The label states that the unit contains a lead-acid battery which is maintained in a properly charged state while the instrument is powered on. Basic maintenance information is also provided. Since the lead-acid battery is continually recharged while the 655 unit is powered and operating, the battery is typically maintenance free and needs attention only when it must be replaced. The upper limit of the ambient temperature range of a 655 unit, equipped with a Valve Failsafe Battery Backup option is 35° C versus 40° C for a unit without the option.

Battery Operation

In units containing the Valve Failsafe Battery Backup option, the battery voltage is automatically measured upon power up. After the initial display (with the current software/firmware version) appears, the following display(s) provide information about the battery backup. For example, if the battery is low, a display similar to the one shown below appears.

```
***Battery is low***
Press key to continue
```

The system allows for continued operation. Depending upon your process, the battery voltage level may not need to be addressed immediately. ***It is important to note however, that this battery backup feature functions as a UPS line, and in fact supports your entire system, not the valve position alone.***

Under normal operating procedures where the battery is not low, a display similar to the one shown below appears. The display provides the actual voltage level of the battery backup along with the desired valve position upon loss of power.

```
BATTERY   13.5V
BACKUP:   OPEN
```

The normal voltage level of the battery backup ranges from 11 V to 15.5 V.

Note 

A voltage level *below* 11 V indicates a discharged battery. A voltage level of *above* 15.5 V indicates an open fuse, a disconnected battery, or a defective charger.

Battery Response After an AC Power Failure

When AC power is lost, the valve battery backup drives the valve to full open or full closed within 20 seconds. An AC power failure typically results in a 30% discharge of the battery. Under this condition, the battery life is at least 1000 cycles, and should be able to recharge within a few hours after power returns. Battery life under several conditions is listed in Table 16.

Expected Cycles	% Discharge with each Battery Use
1000	30
400	50
200	100
2-3 years if unused and charge is maintained	

Table 16: Expected Battery Life given a Percent Discharge from Battery Use

When AC power returns, the battery recharges, provided that the 655 instrument is turned on. From a full discharge condition, the voltage typically increases from about 11 Volts to 15.5 Volts over a five hour period. The voltage is maintained at about 14.5 Volts for another five hours then gradually drops to 13.5 Volts. The 13.5 Volt charge is maintained in a trickle charge state (a top charged state) until there is an AC power failure. The recharge time for a completely discharged battery is a maximum of 12 hours.

Battery Storage

If the 655 unit is stored with no power connected, the battery ***does*** lose its capacity. In fact, the higher the ambient temperature, the faster the capacity is lost. The following table shows the time it takes for the battery to fall to fifty percent of its full capacity at various ambient temperatures.

Ambient Temperature (° C)	No. Days to 50% Capacity
20	500
30	250
40	150
50	75

Table 17: Capacity Loss of Stored Battery

Battery Replacement

Opening the Unit

Warning 

The 655 unit has lethal voltages inside. Servicing of the unit must be performed by qualified personnel only.

To avoid an electrical shock, disconnect the power line *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 655 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.
6. Locate the area of the unit where the chassis splits (to the rear of the front panel). Remove the two screws on both sides of the front panel as well as the two screws on both sides of the battery backup housing.
7. Slide the front panel out far enough to enable the ribbon cable to lay flat.
8. Slide the battery backup housing out about an inch.
9. Disconnect the battery power bus interface from the battery backup circuit board.
10. Unsnap the ribbon cable connector.
11. Pull both the front panel module and the battery backup housing away from the card cage/power assembly.
12. Remove the screw located on the left side of the housing.

13. Orient the housing on its side, and remove the two visible screws.

14. Pull the front panel module completely forward and remove the battery circuit board assembly.

Installing the New Battery

1. Disconnect the two insulated clips from the battery terminals.

Caution 

Do not allow anything to short across the battery terminals; for example, a screwdriver.

2. Push the battery straight up (from underneath) and out.

3. With the new battery positioned such that the terminals are at the rear and + is on the right-hand side, reconnect the two insulated clips. Be sure that + is connected to + and - is connected to - .

4. Feed the ribbon cable through the slot. Be sure to keep the cable away from the heatsink.

5. Replace the two screws that attach the circuit assembly to its chassis and the screw removed from the left side of the housing.

6. Position the front panel module and battery backup housing so that the ribbon cable connector can be plugged into the card cage.

7. Plug the bus connector into the circuit board located in the battery backup housing.

8. Slide the battery backup housing into position and snap it into place.

9. Replace the two screws on each side of the battery backup housing.

10. Push the front panel module slightly back and fold the ribbon cable.

11. Slide the front panel module into the battery backup housing and snap into place.

12. Replace the two screws on both sides of the front panel module.

13. Replace the top cover and its two screws.

The unit is now ready to be plugged in and powered up.

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Appendix A
Product Specifications

Pressure input signal Over-range	-10 to 10 Volts ±10.5 Volts
Input power	90-132 or 180-264 VAC @48/62 Hz 150 VA (max)
Fuses 90-132 VAC 180-264 VAC	 1.25A (T), 250V, 5 x 20 mm 0.63A (T), 250V, 5 x 20 mm
External setpoint signal	0-5 Volts or 0-10 Volts, selectable
Ambient temperature	15 - 40° C (60 - 104° F) 15 - 35° C (60 - 95° F) with optional valve failsafe battery backup
Controller repeatability	±0.1% of F.S.
Output power	±15 VDC @ 1.0 Amps (max)
Analog output signal Position Pressure	 0-5 Volts or 0-10 Volts, selectable 0-100% F.S. pressure, same range as sensor
Interface RS-232 Analog Digital	 Inputs (16): HCMOS pulled high with a 4.7k resistor to be TTL compatible. Driver must sink 1 mA 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 nanoseconds
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	5, each one pressure or position selectable
External	1, pressure or position selectable
Size	3½”H x 9½”W x 9”D 12 ”D with optional valve failsafe battery backup
Weight	
High power unit	6 lbs. *plus* 3 lbs. 8 oz. for optional valve failsafe battery backup
Connectors	
Valve	15-pin Type “D” female
I/O	37-pin Type “D” female
Transducer	15-pin Type “D” female
RS-232 Serial Communications	9-pin Type “D” male

Due to continuing research and development activities, these specifications are subject to change without notice.

Appendix B
Product Compatibility

Valves

MKS *downstream* control valves compatible with the 655 unit include:

Types 654-40, 654-50/80, 654-100

Transducers

Table 18 lists the current available to a transducer from a 655 controller (and its specific valve configuration).

Valve Configuration	Line Voltage Range	Transducer Current Available
All 654 valves	90-132 VAC 48/62 Hz	1.0 A
	180-264 VAC 48/62 Hz	1.0 A

Table 18: Transducer Current Available

MKS transducers compatible with the 655 unit include:

Types 120, 121, 122, 124, 127, 128, 220, 221, 223, 224, 622, 623, 624, 625, 626, 627, and 628.

Adapter Cables

The 655 Pressure Controller (used with the 654 valve) can replace the 152, 252, and 652 controllers (used with other MKS valves). It may, however, be necessary to fit the Type "D" connectors on the 655 unit with adapter cables. Refer to Table 20 for a listing of the appropriate cable numbers.

655 Adapter Cables		
From	**To**	**Cable Number**
252,252+VPO 252+MSO	655 I/O 655 I/O	CB655-12-1 CB655-13-1
252+PLO 252+PLO+VPO	655 I/O	CB655-14-1
252+MSO+PLO 252+MOS+VPO 252+MSO+VPO+PLO	655 I/O	CB655-15-1
152 PC/VPO 152 PC/VPO+RS-232	655 I/O	CB655-16-1
152 RZ/VPO RZ/VPO+RS-232	655 I/O	CB655-17-1
152/252 Sensor Cables	655 Sensor	CB655-18-1
25-Pin Serial Cable[1]	655 Serial	CB655-19-1
652 I/O	655 I/O	CB655-20-1
152/252 Valve Cable	655 Valve	CB652-2-1

Table 19: Adapter Cables for the Type 655 Pressure Controller

655 Serial Communications Cables	
655 Serial Communications to 9-pin serial port (pins 2 and 3 straight through)	CB655-10-10
655 Serial Communications to 25-pin serial port (pins 2 and 3 reversed)	CB655-11-10

Table 20: Serial Communications Cables for the Type 655 Pressure Controller

[1]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 655 Displayless Unit

The displayless unit is a standard 655 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
  This port is intended to be used in conjunction with a lap-top or notebook computer.
- The baud rate is set at 9600 with no parity and [CR][LF] delimiter

To put the Type 655 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.

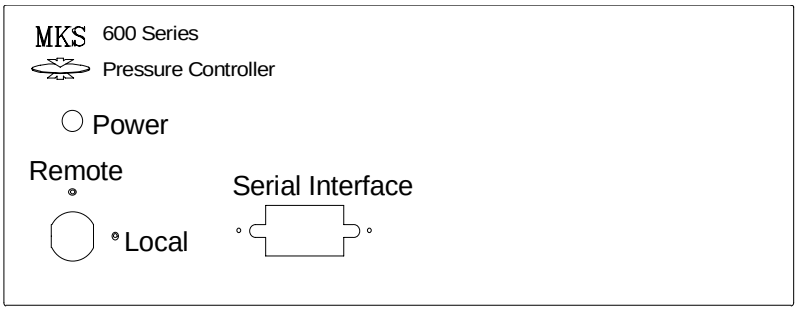

Figure 8: Front Panel of the Type 655 Displayless Unit

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Appendix D
Initial Settings

Your 655 controller is shipped with the following initial configuration. This configuration is not a default configuration, however, since the 655 unit stores most of the configuration settings in non-volatile RAM. Settings stored in non-volatile RAM are not lost when the power is turned off. When the power is restored, the 655 unit "remembers" the latest configuration, not the initial configuration. Refer to Table 21, for a complete list of the initial configuration settings. The last column lists the page number for information on each entry, should you wish to change the setting.

Initial Settings			
Parameter	**Default**	**Options**	**Page**
Control Mode	PID	Adaptive	23
Internal Setpoints	A Pressure	Position	28
	B Pressure	Position	
	C Pressure	Position	
	D Pressure	Position	
	E Pressure	Position	
Gain and Lead Values	A Gain = 100 Lead = 10	User selectable	
	B Gain = 100 Lead = 10		
	C Gain = 100 Lead = 10		
	D Gain = 100 Lead = 10		
	E Gain = 100 Lead = 10		
Line Voltage (VAC)	115 VAC	230 VAC	9
Sensor Full Scale (Torr)	100	10000, 5000, 1000, 10, 2, 1, 0.1	26

Table 21: Initial Settings
(Continued)

Initial Settings *(Continued)*			
Parameter	**Default**	**Options**	**Page**
Display Units	Torr	mTorr, mbar, µbar, Pa, kPa, cmH_2O, inH_2O	25
Analog Setpoint Input	0 - 5 V	0 - 10 V	27
Pressure Sensor Input	0 - 10 V	0 - 5 V, 0 - 1 V	26
Analog Output	Pressure: 0 - 10 V Position: 0 - 10 V	No option 0 - 5 V	27
Control Mode	Direct Acting	Reverse	30
RS-232 Baud Rate Parity/Data Bits Delimiter	 9600 None/8 CRLF	 4800, 2400, 1200, 300 Even/7 CR	24
Battery Backup Failsafe Mode	None	Close valve, Open valve, Disable	61

Table 21: Initial Settings

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MKS Type 655A
Pressure Controller

Supplement 3

This supplement contains important information about the valve failsafe battery back-up option for the 655 controller. Specifically, it provides instructions on how to check your controller to ensure that it recognizes when the battery back-up module is present, and how to configure the valve position upon a power loss when using either Local or Remote operation.

Please read the information carefully and make the following additions to your 655A, Revision B instruction manual (MKS p/n 115484-P1).

Six Shattuck Road
Andover, MA 01810-2449
(800) 227-8766 or (978) 975-2350

Fax: (978) 975-0093
E-mail:mks@mksinst.com
Web site: http://www.mksinst.com

This manual is for firmware/software version 1.8x.

Introduction

The optional valve failsafe battery back-up provides full valve drive capability for approximately 30 seconds after an AC power failure.

This supplement provides instructions on how to check your controller to ensure that it recognizes when the battery back-up module is present, and how to configure the valve position upon a power loss when using either Local or Remote operation.

Note 

For complete, detailed information on the battery back-up option, refer to *Chapter Eight: Optional Valve Failsafe Battery Backup,* in Revision B of the 655A instruction manual.

Battery Voltage

The normal voltage level of the battery ranges from 11 V to 15.5 V. A voltage level *below* 11 V indicates a discharged battery. A voltage level *above* 15.5 V indicates an open fuse, a disconnected battery, or a defective charger.

Valve Positions

The controller can be configured so that the valve will be driven fully open, fully closed, or will be disabled upon an AC power failure.

Open: The controller opens the valve at power down. In the event that the valve is already open, the module provides power for approximately 1 second before turning off.

Closed: The controller closes the valve at power down. In the event that the valve is already closed, the module provides power for approximately 1 second before turning off.

Disable: The option is disabled and will not perform any function at power down. The controller turns off in a normal manner.

When the controller is configured to open or close the valve, it will perform the operation whenever power to the controller is turned off, regardless of whether the power is turned off via the power switch or by a power failure.

Note 

If for any reason the controller cannot open or close the valve within 30 seconds of a power failure, the battery back-up module automatically turns off. This prevents the battery from discharging when no valve is present or if the valve is defective in some way.

Startup

Threshold Voltage Check

When the 655 controller is turned on, it measures the voltage at the input port assigned to the battery back-up module. When the voltage level at the port exceeds a factory set minimum threshold value, the controller recognizes that the battery back-up is present, and the software menus which support the module are installed. Should the voltage level be below the threshold, the controller does not recognize the module and the software menus are not installed.

Once the 655 unit has been powered up and the battery back-up module has been recognized, the actual voltage of the battery is measured.

Battery Voltage Within Range

If the battery voltage is within the acceptable range of 11 V to 15.5 V, the instrument revision and the current software/firmware version appears on the front panel display for about five seconds, before advancing to the default *Pressure and Position* screen:

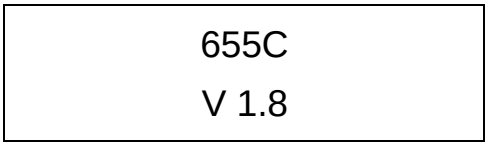


Figure 1: Initial Display Screen

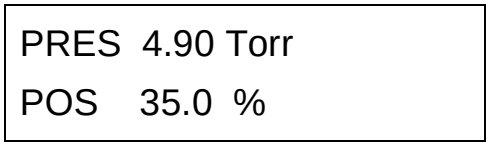


Figure 2: Default Pressure and Position Screen

The controller is now ready for valve connection and setup (or normal operation once the system has been configured). The 655 unit does not display a status screen to indicate that the battery voltage is within range.

Battery Voltage Out-of-Range

If the battery voltage is out-of-range, the instrument revision and the current software/firmware version appears on the front panel display for about five seconds (refer to Figure 1, page 4), followed by the appropriate error message, rather than advancing to the default *Pressure and Position* display screen (refer to Figure 2, page 4).

If the battery voltage is below 11 V, the screen displays:

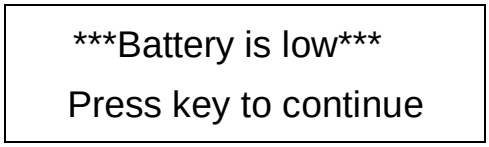


Figure 3: Battery Voltage Low Message

If the battery voltage is above 15.5 V, the screen displays:

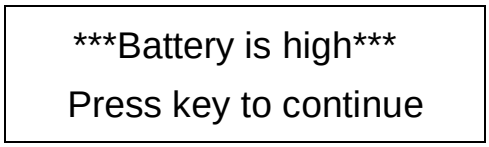


Figure 4: Battery Voltage High Message

The system allows for continued operation when the battery voltage is out-of-range, since your process may not require that the battery voltage level be addressed immediately. To continue operation, press any key to advance to the default *Pressure and Position* display screen.

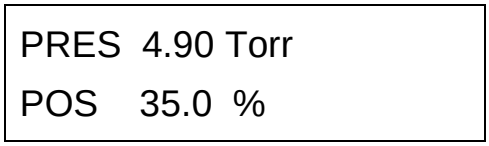
Note It is important to note that in addition to supporting the controller's valve position, the battery back-up feature powers the controller, and any pressure transducer or valve connected to it.

Operation

How To Check the Battery Voltage

To ensure that the 655 unit has recognized the battery back-up module, or to view the actual battery voltage and the current valve configuration without entering the software menus (regardless of whether you are using Local or Remote operation):

1. Ensure that the default *Pressure and Position* screen appears on the display:

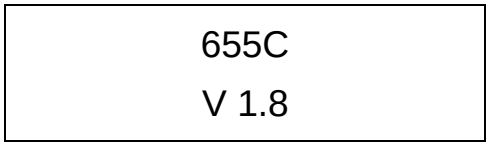


2. Press the [▽] key one time.

   If the battery back-up module has been recognized, the screen displays:

   This screen allows you to view the actual battery voltage and the current valve configuration. The valve configuration cannot be changed from this screen. Refer to *How To Set The Battery Back-up Valve Control*, page 7, for instructions on how to change the valve configuration; the battery voltage cannot be adjusted. Press any key to return to the default *Pressure and Position* screen.

   If the battery back-up module has *not* been recognized, the screen reverts to the initial display screen which lists the instrument revision and the current software/firmware version:



   Press any key to return to the default *Pressure and Position* screen.

How To Set The Battery Back-up Valve Control

Local Operation

1. Ensure the Key Lock Switch is set to Local and that the default *Pressure and Position* display appears on the screen.

PRES 4.90 Torr
POS 35.0 %

2. Press the [△] and [▽] keys simultaneously for about 3 seconds to enter the Setup menu.

   The screen displays:

CONTROL
MODE: PID

2. Press the [△] or [▽] down arrow key to scroll through the menu until the battery back-up option selection screen appears on the display.

   The screen displays:

BATTERY 13.5V
BACK-UP: OPEN

   The screen displays the actual voltage level of the battery along with the position the valve is currently set to drive to upon a power loss.

   Select whether the valve will be driven fully open, fully closed, or will be disabled upon an AC power failure by turning the Adjust knob on the front panel to the desired setting. Choose from the options of open, closed, or disable (initial).

Note Press any key to exit the Setup menu and return to the default *Pressure and Position* display screen.

Remote RS-232 Operation

The command [**K** ***value***] defines the direction of valve control upon power failure, where:

value: 0 = disable option
1 = open valve at power failure
2 = close valve at power failure

To check the type of valve battery back-up control, issue the request:

R 40

The controller responds with the message [K *value*], where:

value: 0 = option disabled
1 = valve opens at power failure
2 = valve closes at power failure

An example response, if the valve is set to open upon a power failure, is:

K *1*

To change the valve control so that it closes upon a power failure, enter:

K *2*