Instruction Manual

DynaMass™
Flow Control System

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Introduction

This manual provides the necessary instructions and procedures to operate the DynaMass Flow Control System manufactured by Vacuum General Inc. The manual is divided into sections which describe the DynaMass features, functional operation, front panel programming, RS-232C installation, interfacing, and programming, TTL interfacing and error messages.

Section 1 introduces the user to DynaMass. The available configurations, features and electrical specifications are given.

Section 2 outlines the functional operation of the individual modules and assemblies which comprise DynaMass systems. The use and operation of each module in the system is explained.

Section 3 demonstrates how to program the DynaMass using the front panel modules. Definitions of MODES, their associated values and Programs are explained.

Section 4 acquaints the user to the CI-4RS RS-232C Serial Interface Module and the required configurations for operation. How to install and configure the CI-4RS module is covered.

Section 5 covers RS-232C interface programming. Available commands, their syntax and proper usages are described with working examples.

Section 6 covers the TTL port locations and available functions. Pin out information and suggested TTL uses are discussed.

Section 7 lists the possible error messages, their causes and some solutions.

Appendix A lists the known gas calibration factors for a variety of gases. These calibration factors are used for programming values in the CAL Mode.

1.1 General Description

DynaMass is an modular, expandable flow control system which provides exceptional performance with all of the operating conveniences of microprocessor based technology. DynaMass is capable of monitoring and controlling up to eight flow devices simultaneously depending on the series purchased. Control of the DynaMass is accomplished using the front panel modules or an optional RS-232C serial interface.

DynaMass was designed using a modular concept to allow expandability when required. A minimum configuration can initially be purchased with the ability to add low cost flow channel modules at any time as requirements demand. These modules can be installed by the user without electrical recalibration or adjustments to the system.

The KM-4 Keyboard module alows easy access to the many programmable system functions available with DynaMass. It is required with all systems and is the primary control panel for the system.

The FM-4 and FM-8 Flow/Ratio modules allow the monitoring and controlling of each flow device in the system. Each flow device in the system may be turned on or off, set as an individual FLOW channel, set to RATIO to a selected RATIO BASE channel or selected as a RATIO BASE channeel to which other channels may ratio against.

The TM-4 Totalizer module may be used to display the sum of all "on" Flow/Ratio modules in the system or may be used as a total flow RATIO BASE to which all ratioing channels will ratio a percentage of the total flow.

Two basic DynaMass systems are available: an expandable four channel system (DM-1XXX Series) and an expandable eight channel system (DM-2XXX Series). Both systems offer identical front panel control abilities and RS-232C interface commands. The only control exceptions are the additional TTL functions available only with the DM-2XXX series. Each DynaMass version has a mounting location for one KM-4 Keyboard module and four Flow/Ratio modules or three Flow/Ratio modules and one Totalizer module.

1.2 The DM-1XXX Series System

The DM-1XXX Series system has the ability to monitor and control one, two, three or four flow devices simultaneously.

The FM-4 Flow/Ratio modules and TM-4 Totalizer module are used with the DM-1XXX Series. A typical system includes an RF-4 Rack Frame assembly, a KM-4 Keyboard module, one to four FM-4 Flow/Ratio modules and possibly a TM-4 Totalizer module.

The KM-4 module is located leftmost at the front panel. FM-4 Flow/Ratio modules are then added left to right beginning directly adjacently to the KM-4 module. When used, the TM-4 Totalizer module is always located at the far right of the front panel. Because the TM-4 module requires the same panel space as a FM-4 module, only three FM-4 modules can be used in a system when a TM-4 module is used. This limits the number of flow channels to three.

1.3 The DM-2XXX Series System

The DM-2XXX Series system has the ability to monitor and control one to eight flow devices simultaneously. The FM-8 Flow/Ratio modules and TM-4 Totalizer module are used with the DM-2XXX Series. A typical system includes an RF-8 Rack Frame assembly, a KM-4 Keyboard module, one to four FM-8 Flow/Ratio modules and possibly a TM-4 Totalizer module. Each FM-8 module monitors and controls two flow channels. A system with four FM-8 modules can therefore operate eight flow channels.

The KM-4 module is located leftmost at the front panel. FM-8 Flow/Ratio modules are then added left to right beginning directly adjacently to the KM-4 module. When used, the TM-4 Totalizer module is always located at the far right of the front panel. Because the TM-4 module requires the same panel space as a FM-8 module, only three FM-8 modules can be used in a system when a TM-4 module is used. This limits the number of flow channels to six.

1.4 Features

DynaMass has the ability to monitor and control up to eight flow devices simultaneously. Control of the flow devices includes selective ratioing of channels, flow ramping, automatic zeroing and automatic flow reporting. Following is a description of DynaMass features.

1.4.1 Programmability

Four independent programs are avialable to store values for MODES selected using the front panel or optional RS-232C interface. The programs are stored using non-volatile memory allowing immediate recall and storage, but without the risk of losing information in the event of power loss.

1.4.2 Independent Flow

All channels in the system can be set to flow independent of each other regardless of range or flow setpoint. Channels may be turned on or off independently as desired without affecting other channels.

1.4.3 Selective Ratioing

Any available channel in the system can be used as a RATIO BASE or Master channel to which any number of remaining channels can be ratioed against. Ratioing channels are set to ratio as a percentage of the actual flow of the selected RATIO BASE channel.

1.4.4 Total Flow Ratioing

The total flow in the system can be controlled by setting the sums of selected ratioing channels equal to 100 percent. The proportion of total flow for each channel is therefore fixed and the total flow can be set as desired.

1.4.5 Flow Ramping

Individual channels in the system may be set to ramp up in flow from zero flow to the selected setpoint for a period of 0 to 30 seconds. Each channel may be set independently of all others.

1.4.6 Automatic Zeroing

Each channel in the system may be AUTO ZEROED when conditions are correctly set. This eliminates manually zeroing the flow devices prior to their use.

1.4.7 RS-232C Interface

All functions available at the front panel of DynaMass are also available using the optional RS-232C interface. The interface uses standard protocol and can operate at 300, 1200, 4800 or 9600 baud. The interface module, the CI-4RS, may be purchased and installed at any time.

1.4.8 TTL Control

TTL control of major on/off functions can be accomplished with each DyanaMass. Program selection and channel selection are available on every DynaMass. System control is available only with DM-2XXX versions.

1.5 Electrical Specifications

The DynaMass has the ability to power up to eight mass flow devices manufactured by Vacuum General. Other manufacturers flow devices may be used provided due consideration is given to the power requirements of the devices. Table 1.1 provides the electrical requirements and outputs for the DM-1XXX Series and DM-2XXX Series.

	DM-1XXX	DM-2XXX
Fuse size (slow blow)	3/4 A	1 1/2 A
Flow Device Power Supply Voltages		
Total	2.0 A max	2.0 A max
+15vdc (±3%)	1.4 A max *	1.4 A max *
-15vdc (±3%)	1.4 A max *	1.4 A max *
Set Point Signal	0 - 5vdc proportional to flow	
Flow Input Signal	0 - 5vdc proportional to flow	
Positive Shut Off Signal	+5vdc	
Initial Warm Up Time	30 minutes	

* These are the absolute maximum ratings for the given supply voltage. The total current draw from both supplies simutaneously must not exceed 2.0 A.

1.6 Safety Precautions

The DynaMass should always be disconnected from the AC power source prior to plugging or unplugging any cable that connects to any mass flow device. Failure to do so may cause damage to the DynaMass or mass flow device.

2.1 RF-4 Rack Frame Assembly

The RF-4 rack frame assembly is the basis for the DM-1XXX series of DynaMass. The RF-4 consists of a 19" chassis, power supply module, computer board, a single analog I/O board and all associated internal cables. All modules used with the DM-1XXX series DynaMass attach to the RF-4. The RF-4 rack frame assembly will support a maximum of four mass flow devices.

2.2 RF-8 Rack Frame Assembly

The RF-8 rack frame assembly is the basis for the DM-2XXX series of DynaMass. The RF-8 consists of a 19" chassis, power supply module, computer board, two analog I/O boards and all associated internal cables. All modules used with the DM-2XXX series DynaMass attach to the RF-8. The RF-8 rack frame assembly will support a maximum of eight mass flow devices.

2.3 KM-4 Keyboard Module

The KM-4 keyboard module contains the switches necessary to select MODES, alter values associated with MODES, to step through the channels, select programs and to enable or disable the system. One keyboard module is necessary with every DM-1XXX and DM-2XXX series DynaMass. The KM-4 module is mounted at the far left front side of either rack frame assembly.

The following is a description of the keyboard switches and indicators:

2.3.1 MODE Switch

The MODE switch is used to either select one of the available MODES or to enter the NO MODE condition. The eight available MODES appear on the left side of the keyboard module. LED's are provided to represent each MODE. Pressing the MODE switch causes the topmost LED to illuminate indicating that the FLOW MODE has now been entered. Pressing the MODE switch again now illuminates the next lower LED (the RATIO LED). Pressing the MODE switch when the last LED (OPT 1) is illuminated causes all of the MODE LED's to extinguish. The condition when all MODE LED's are extinguished is termed NO MODE. NO MODE is usually the MODE in which all normal system operations are performed.

NO MODE may also be entered by pressing the MODE and STEP switches simultaneously. This eliminates the need for

repeatedly pressing the MODE switch to enter NO MODE.

2.3.2 STEP Switch

The STEP switch is used to move left to right (and top to bottom using FM-8's) through the channels when one of the eight available MODES is selected.

Initially, when a MODE is entered, a window value at the leftmost channel will begin to flash. The flashing indicates that a MODE value for that channel has been selected and may be altered using the UP and DOWN set switches.

Pressing the STEP switch causes the window value at the next channel to flash. The window value of the previous channel will cease to flash and steadily display the current value.

Note that the STEP switch may also be used in conjunction with the MODE switch to enter the NO MODE condition and store the program.

2.3.3 UP, DOWN SET Switches

Whenever one of the eight modes is selected and a window value is flashing, the flashing value may be altered by pressing the UP or DOWN SET switches.

Pressing the UP SET switch (up pointing triangle) causes the flashing value to increment and pressing the DOWN SET switch (down pointing triangle) causes the flashing value to decrement. Holding down either switch causes the flashing value to continuously change. The speed at which the flashing value changes increases with the length of time that the respective SET switch held down.

2.3.4 PROGRAM Select Switches

The PROGRAM select switches allow the user to select between any one of the four programs (A, B, C or D). Each program switch has a corresponding LED located directly above it which illuminates when the program is selected.

There are four programs available to store four sets of values for each flow device in the system. The programs are labeled A, B, C and D. To change from one program to another, all MODE LEDs must be extinguished (NO MODE must be selected). When NO MODE is entered, the current program may be changed to any other program by pressing the PROGRAM switch for the desired program.

2.3.5 ON/OFF ENABLE Switch

Control of the DynaMass Flow Control System is accomplished by pressing the ON/OFF ENABLE switch. The ENABLE LED located directly above the ENABLE switch illuminates when the system is enabled.

2.3.6 REMOTE LED * See 6.2.5, page 52, and 6.3.3 on page 55.

The REMOTE LED illuminates to indicate that the TTL port has taken over control of the PROGRAM select switches. When illuminated, program selection can only be accomplished via the TTL port. Pressing the PROGRAM select switches on the keyboard module will have no effect.

2.3.7 LOCK LED

The LOCK LED illuminates to indicate that the MODE Value LOCK line at the TTL port has taken over control of the UP and DOWN SET switches. When illuminated, pressing the UP and DOWN SET switches on the keyboard module will have no effect on altering the value selected.

2.3.8 AUTO ZERO LED

The AUTO ZERO LED illuminates to indicate that the DynaMass system is in AUTO ZERO. When not illuminated the system is in MANUAL ZERO. Upon initial power up AUTO ZERO will be entered and the AUTO ZERO LED will be illuminated.

2.4 FM-4 Flow/Ratio Module

The FM-4 is a single channel display and control module designed specifically for use with the DM-1XXX series of DynaMass. One FM-4 module is required for each flow device in the system. The FM-4 modules are mounted left to right on the front panel beginning directly adjacent to the KM-4 module. The FM-4 provides the user with a digital display of the flow device's output, on/off status, Flow or Ratio mode status, device range indication, and a SET window for displaying the values of the mode currently selected for that channel.

2.4.1 ON/OFF Switch

The ON/OFF switch is used to enable or disable a channel in the system. A red LED located directly above the switch is illuminated when the channel is enabled. Pressing the ON/OFF switch toggles the channel status on and off.

2.4.2 FLOW Window

The FLOW window displays the flow output in SCCM or SLM. This window indicates the flow output regardless of the ON/OFF status of the channel.

2.4.3 SET Window

The SET window displays the current value of the Mode selected at the keyboard. This window indicates only when the ON/OFF status of the channel is ON. The SET window value will flash when the channel has been selected using the STEP switch as described above.

2.4.4 MASTER LED

The leftmost decimal point located in the SET window is used as the MASTER channel indicator. The MASTER LED illuminates when its respective channel is the Master channel for ratioing.

2.4.5 FLOW and RATIO LEDs

These LEDs are used to indicate the operating mode of the channel. When the FLOW LED is illuminated, the channel operates independently of all other channels. When the RATIO LED is illuminated, the channel is now set to Ratio to the channel that has been selected as the Master or Ratio Base.

Pressing either UP or DOWN set switch when in the FLOW Mode will illuminate the FLOW LED (as well as adjust the SET POINT value). Pressing either UP or DOWN set switch when in the RATIO Mode will illuminate the RATIO LED (as well as adjust the RATIO value).

2.4.6 SCCM and SLM LEDs

Located directly below the FLOW window is the SCCM and SLM LEDs. These LEDs are set by the user to indicate the full scale range of the channel's associated flow device. These LEDs and the decimal points in the FLOW window are toggled using the UP and DOWN set switches when in the RANGE Mode. Pressing the UP set switch increases the full scale range while pressing the DOWN switch decreases the full scale range.

2.5 FM-8 Flow/Ratio Module

The FM-8 is a two channel display and control module designed specifically for use with the DM-2XXX series of DynaMass. Each FM-8 module is used to monitor and control one or two mass flow devices. A total of four FM-8 modules can be used to allow up to eight channels of flow control. The FM-8 modules are

mounted left to right on the front panel beginning directly adjacent to the KM-4 module.

The FM-8 provides the user with a digital display of each flow device's output or Mode value, on/off status, Flow or Ratio mode status and device range indication.

2.5.1 ON/OFF Switch

Each FM-8 has an ON/OFF switch for each of the two channels. Each ON/OFF switch is used to enable or disable its channel in the system. A red LED located directly above each switch is illuminated when its associated channel is enabled. Pressing the ON/OFF switch toggles the channel status on and off.

2.5.2 Display Windows

There are two display windows on each FM-8 module. The upper display window is used for the first channel and the lower window is used for the second channel. Each window is used for two purposes. In the "No Mode" condition (all Mode LED's extinguished), each window displays its associated flow device output in SCCM or SLM. These windows indicates the flow output regardless of the ON/OFF status of the channel as long as the "No Mode" condition is selected. When any Mode other than "No Mode" is selected, each window displays the value associated with that channel for the selected Mode.

2.5.3 MASTER LED

An LED located beneath and to the left of each window is used as the MASTER channel indicator. The MASTER LED illuminates when its respective channel is selected as the Master channel.

2.6 TM-4 Total Flow Module

The TM-4 totalizer module is used to provide the user with a total flow reading of all ON channels is the system. The TM-4 may also be used as a Master channel to which other channels may be ratioed.

The TM-4 module may be used with the DM-1XXX and DM-2XXX series of DynaMass; however, its use limits the total number of channels that may be used in a system. Only one TM-4 module may be used in a system. The TM-4 module is always located at the rightmost location at the front panel.

2.6.1 ON/OFF Switch

The ON/OFF switch is used to enable or disable the TM-4 module in the system. A red LED located directly above the switch is

illuminated when the channel is enabled. Pressing the ON/OFF switch toggles the channel status on and off.

2.6.2 FLOW Window

The FLOW window displays the accumulated flow outputs in SCCM or SLM generated from the channels that are ON. This window indicates the total system flow output only if the TM-4's ON/OFF switch is ON.

2.6.3 SET Window

The SET window displays the current value of the Mode selected at the keyboard. This window indicates only when the ON/OFF status of the channel is ON.

The SET window value will flash when the channel has been selected using the STEP switch as described above (a mode must be selected). The only Modes available with a TM-4 module are FLOW and RATIO BASE.

2.6.4 MASTER LED

The leftmost decimal point located in the SET window is used as the MASTER channel indicator. The MASTER LED illuminates when its respective channel is selected as the Master channel for ratioing.

2.7 CI-4RS RS-232C Serial Interface Module

The CI-4RS module provides a serial interface for external control from a computer system or dumb terminal. The CI-4RS module plugs in and attaches to the rear panel either the DM-1XXX or DM-2XXX series DynaMass. For further description and installation instructions see Section 4.

3.1 Introduction

Programming the DynaMass can be accomplished using two methods. Programmable values may be entered and stored using the KM-4 Keyboard module or the CI-4RS Serial Interface module.

This section describes the MODES in which programmable values are associated and how the values are entered and stored using the Keyboard module. Section 5 describes programming using the CI-4RS RS-232C commands.

3.1.1 MODES

A MODE is a function which effects the way in which the DynaMass controls the flow devices or communicates using the RS-232C port. There are essentially nine MODES; eight of which have a programmable value for each flow device in the system, and one without programmable values but is used to store values entered in the other MODES.

Seven of the eight programmable MODES store values which give the FLOW setpoint, RATIO percentage, CAL factor, RAMP TIME, device full scale RANGE, RATIO BASE status and ZERO SET offsets for each channel in the system. The eighth MODE stores configuration information for the RS-232C port if installed.

Each of the eight programmable MODES are listed along the left side of the Keyboard module. Adjacent to each listing is a green LED which illuminates when its respective MODE is selected. Only one MODE LED can be illuminated at a time. The MODE switch located at the Keyboard module is used to toggle through the MODES. Pressing the MODE switch allows the user to move through the MODES from top to bottom. As each MODE is selected it's corresponding LED will illuminate.

When the OPT 1 MODE LED is illuminated and the MODE switch is pressed all MODE LEDs will extinguish the DynaMass enters the ninth MODE called NO MODE. Entering NO MODE causes the DynaMass to store any changes made in any MODE for the program currently selected. This storage is accomplished using non-volatile memory. Values are stored permanently this way, but may also be altered and restored at any time. The stored values remain in non-volatile memory even if power to the DynaMass is lost or interrupted.

3.1.2 PROGRAMS

Program A is the program that is selected by default when the

DynaMass is powered up. The LED directly above the A switch at the Keyboard illuminates or flashes to indicate that program A is currently selected. Toggling through the MODES, altering their values and then entering NO MODE will store the new program information in program A.

There are four programs available to store four sets of values for each flow device in the system. The programs are labeled A, B, C and D. To change from one program to another, all MODE LEDs must be extinguished (NO MODE must be selected). When NO MODE is entered, the current program may be changed to any other program by pressing the PROGRAM switch for the desired program.

3.1.3 Common MODES

Three of the MODES have values that will remain constant for the flow device regardless of which program is selected. These MODES: CAL, RANGE and ZERO SET cannot be entered into unless program A is selected. These MODE values can only be altered and displayed when program A is selected, but are used for the remaining programs nevertheless. The OPT 1 MODE, which is used to store RS-232C configuration information, also can only be altered and displayed only when program A is selected.

3.2 MODE Summary

3.2.1 FLOW (Set Point)

The FLOW value is the desired set point in SCCM or SLM (as indicated on the channel module) that the flow device will control to when enabled. The FLOW value has the range of 0-1999 or 0 to 199.9% of the full scale range. The channel's FLOW/RATIO status is also determined in the FLOW Mode. Pressing either UP or DOWN SET switch when a window value is flashing illuminates the FLOW LED for that channel. This configures the channel for independent operation.

To alter a FLOW value or select the channel for independent FLOW:

1. At the Keyboard module, press the MODE switch until the FLOW LED illuminates. The window value at the leftmost channel will begin to flash.
2. Select the desired channel. If the channel window value flashing is not the desired channel, press the STEP switch until the window value of the desired channel is flashing.
3. Press the UP or DOWN SET switches to alter the value as desired. The FLOW value is adjustable from 0 to 1999. A value of 1000 represents the full scale output of the flow device. Pressing either SET switch also illuminates the

FLOW LED and configures the channel for independent operation.

4. Repeat steps 2 and 3 until FLOW values for the remaining channels have been set.

3.2.2 RATIO

The RATIO value is the percentage of the Master channel flow that the select channel will flow. The RATIO value only applies when the channel is in RATIO. The channel's FLOW/RATIO status is also determined in the RATIO Mode. Pressing either UP or DOWN SET switch when a window value is flashing illuminates the RATIO LED for that channel. This configures the channel for ratioing using the channel selected as the Master as a reference.

To alter a RATIO value or select the Channel for RATIO:

1. At the Keyboard module, press the MODE switch until the RATIO LED illuminates. The window value at the leftmost channel will begin to flash.
2. Select the desired channel. If the channel window value flashing is not the desired channel, press the STEP switch until the window value of the desired channel is flashing.
3. Press the UP or DOWN SET switches to alter the value as desired. The RATIO value is adjustable from 0 to 999. A value of 999 represents 99.9 percent. Pressing either SET switch also illuminates the RATIO LED and configures the channel for ratioing.
4. Repeat steps 2 and 3 until RATIO values for the remaining channels have been set.

3.2.3 RAMP TIME

RAMP TIME values are used to linearly ramp the flow of a given channel to the FLOW Set Point value over a selected time period. "Soft Start" is a synonym for RAMP TIME. RAMP TIME values may range from 0 to 30 with each value representing seconds in 1 second increments.

Every channel in each program has its own ramp time value. A ramp time of zero (0) provides the fastest turn on time. Ramp times greater than zero are used to prevent overshoot.

To alter a RAMP TIME value:

1. At the Keyboard module, press the MODE switch until the RAMP TIME LED illuminates. The window value at the leftmost channel will begin to flash.
2. Select the desired channel. If the channel window value flashing is not the desired channel, press the STEP switch until the window value of the desired channel is flashing.
3. Press the UP or DOWN SET switches to alter the value as

desired. The RAMP TIME value is adjustable from 0 to 30. A value of 30 represents 30 seconds.

4. Repeat steps 2 and 3 until RAMP TIME values for the remaining channels have been set.

3.2.4 CAL

CAL is an acronym for Calibration Mode. This mode allows the user to set the calibration factor of the gas used with the corresponding channel. The CAL factor is set only in program "A". The range of the CAL value adjustment is 0.20 to 5.00. The default value is 1.00 which corresponds to air or nitrogen. A chart of commonly used gases and their calibration factors is located in Appendix A.

To alter the CAL value:

1. At the Keyboard module, press the MODE switch until the CAL LED illuminates. The window value at the leftmost channel will begin to flash.
2. Select the desired channel. If the channel window value flashing is not the desired channel, press the STEP switch until the window value of the desired channel is flashing.
3. Press the UP or DOWN SET switches to alter the value as desired. The CAL value is adjustable from 0.20 to 5.00. ~~A value of 30 represents 30 seconds.~~
4. Repeat steps 2 and 3 until CAL values for the remaining channels have been set.

3.2.5 RATIO BASE

The Ratio Base Mode is used to select the channel to be used as the MASTER for ratioing purposes. The MASTER LED will illuminate on the channel selected as the MASTER. The RATIO BASE or MASTER is the channel to which all other ON channels in the RATIO mode ratio against. Channels in RATIO express their flows as a percentage of flow referenced to the Master channel. There may only be ONE MASTER channel per program. Each program (A, B, C and D) may specify any channel as the Master channel.

To select the RATIO BASE or MASTER channel:

1. At the keyboard module, press the MODE switch until the RATIO BASE LED illuminates. All the channels will display three minus signs and the window value in the leftmost channel will begin to flash.
2. Select the desired channel. If the channel window value flashing is not the desired channel, press the STEP switch until the window value of the desired channel is flashing.
3. Press the UP or DOWN SET switch to illuminate the MASTER

LED. Pressing the UP or DOWN SET switch again extinguishes the MASTER LED.

3.2.6 RANGE MODE

Entering the RANGE MODE allows the user to set the decimal points and SCCM or SLM LEDS on the flow modules to reflect the range of the flow device being used. Only one decimal point in the display and only one SCCM or SLM LED will be illuminated at a time.

To alter the RANGE:

1. At the Keyboard module, press the MODE switch until the RANGE LED illuminates. The window value at the leftmost channel will begin to flash.
2. Select the desired channel. If the channel window value flashing is not the desired channel, press the STEP switch until the window value of the desired channel is flashing.
3. Press the UP or DOWN SET switch to select the appropriate range. Pressing either switch will advance the channel to the next highest range. Once the highest range is selected, pressing either switch then restarts the range selection at the lowest range.

3.2.7 ZERO SET MODE

The ZERO SET MODE is used to disable AUTO ZERO and configure the DynaMass for Manual Zero. Offset values for zeroing must manually be entered when in Manual Zero.

3.2.7.1 AUTO ZERO OPERATION

Upon initial powering of the DynaMass, AUTO ZERO is enabled. The AUTO ZERO LED illuminates to indicate that AUTO ZERO is enabled. In AUTO ZERO, the DynaMass automatically computes and applies the necessary offset values to zero each connected flow device. This occurs approximately 90 seconds after the power has been applied or after the ENABLE ON/OFF switch at the Keyboard module has been switched to OFF. Once the 90 second interval has passed, the DynaMass will AUTO ZERO continuously every 5 seconds until the ENABLE ON/OFF switch at the keyboard is switched to ON (the ENABLE LED is illuminated).

The following are the requirements for AUTO ZERO:

- the AUTO ZERO LED is illuminated;
- the ENABLE ON/OFF switch on the Keyboard module is OFF;
- the flow device's output signal in the no flow condition is within + or - 400mv of true zero;
- the 90 second interval has timed out.

If for some reason AUTO ZERO is not desired, the function can be defeated and manual zero adjustment to the flow devices may be performed. Exiting AUTO ZERO puts the DynaMass in Manual Zero.

3.2.7.2 MANUAL ZERO OPERATION

When operating in Manual Zero, the flow device must be zeroed by the user prior to operation. Typically, before operating the flow device, a check of the device's zero should be made. Adjustment, if necessary, should be made to eliminate span errors. If not properly zeroed, the actual flow may be in error by the amount of the device's zero offset from true zero.

To exit AUTO ZERO and enter Manual Zero:

1. At the keyboard module, press the MODE switch until the ZERO SET LED illuminates. The SET window should display offset values, however, none of the windows will flash at this point. AUTO ZERO is still enabled and the values displayed are the offsets generated by AUTO ZERO to zero the flow devices.
2. To exit AUTO ZERO, press the STEP switch. The AUTO ZERO LED will extinguish, and the window value at the leftmost channel will begin to flash.
3. Pressing either UP or DOWN SET switch will now alter the displayed offset value.

When in Manual Zero and in the ZERO SET Mode, the values displayed represent zero offsets. Each digit is equivalent to 5 millivolts. For example, a zero offset value of +15 represents a voltage offset of +75 millivolts.

To exit Manual Zero and enter AUTO ZERO:

1. At the Keyboard module in the NO MODE condition, press the MODE switch until the ZERO SET LED illuminates. The AUTO ZERO LED will illuminate indicating that AUTO ZERO has been entered.

3.2.8 OPT 1 MODE

The OPT 1 MODE provides a means for configuring the CI-4RS RS-232C Serial Interface Module data format and duplex mode. Additionally OPT 1 is used to determine the output transmission speed for automatic flow reporting using the CI-4RS module and for displaying error messages which may occur in the system. If the DynaMass system does not have the CI-4RS module, the OPT 1 values have no effect on the operation of the system.

To properly transmit and receive information using the CI-4RS

module, the data format value and duplex mode value must correspond to the configuration settings of the interfacing device. Values improperly set may cause communications problems between the two devices.

3.2.8.1 DATA FORMAT VALUE

The data format value is displayed in the flashing window of the leftmost channel when in the OPT 1 Mode. This value represents the way in which the data string is transmitted between the DynaMass and the interfacing device. The number of data bits in the data word, the number of following stop bits and whether parity is odd, even or not used are all combined and represented by the data format value. Table III-1 lists the possible data format values and their descriptions.

Value	Data Format	Parity	Stop Bits
000	7 bits	Even	2 Stop
001	7 bits	Odd	2 Stop
002	7 bits	Even	1 Stop
003	7 bits	Odd	2 Stop
004	8 bits	None	2 Stop
005	8 bits	None	1 Stop
006	8 bits	Even	1 Stop
007	8 bits	Odd	1 Stop

Table 3.1
RS-232C Data Format Values

To alter the data format value:

1. At the Keyboard module, press the MODE switch until the OPT 1 LED illuminates. The window value at the leftmost channel will begin to flash.
2. Select the appropriate data format value from Table 3.1.
3. Press the UP or DOWN SET switch to alter the value as desired.

3.2.8.2 DATA TRANSMISSION SPEED

The DynaMass has the ability to automatically transmit the flow values of all channels whenever the ENABLE switch on the Keyboard module is ON (LED illuminated). The data transmission speed refers to the rate at which this automatic transmission occurs. Transmission rates may vary from 0 to 10 seconds in 0.3 second increments. A data transmission speed of 0 stops the flow values from being transmitted. A value of 30 represents approximately a 10 second delay between

transmissions.

The data transmission speed is displayed in the window of the second leftmost channel when in the OPT 1 Mode.

To alter the data transmission speed value:

1. At the Keyboard module, press the MODE switch until the OPT 1 LED illuminates. The window value at the leftmost channel will begin to flash.
2. Press the STEP switch once. The window value at the second leftmost channel will begin to flash.
3. Press the UP or DOWN SET switch to alter the value as desired. The data transmission value is adjustable between 0 and 30. Each digit represents approximately 0.3 seconds.

3.2.8.3 DUPLEX FORMAT

The duplex format determines the way in which ASCII characters are transmited and received between the DynaMass and the interfacing device. Two formats are available with the DynaMass, half and full duplex.

In the half duplex format the interfacing device sends characters to the DynaMass without immediately knowing if the DynaMass actually received them. In the half duplex format the DynaMass will only receive characters as they are sent and respond the the command string when a carriage return completes the string of characters. The interfacing device has no way of verifying that the characters were actually received.

In the full duplex format the interfacing device sends characters to the DynaMass and the DynaMass echos the characters back as they are received. Every character entered is transmitted back to the interfacing device to indicate that it has been received. In this way the interfacing device is given a form of verification that the characters have been received.

The duplex format value is displayed in the window of the third leftmost channel when in the OPT 1 Mode. The duplex format value is used to represent the duplex format selected One of two values can be used, a value of 0 represents half duplex and a value of 1 represents full duplex.

To enter or alter the duplex format value:

1. At the Keyboard module, press the MODE switch until the OPT 1 LED illuminates. The window value at the leftmost

channel will begin to flash.

2. Press the STEP switch twice. The window value at the third leftmost channel will begin to flash.
3. Press the UP or DOWN SET switch to alter the value as desired. The duplex format value can only be 0 or 1. A value of zero represents half duplex and a value of one represents full duplex.

3.2.8.4 Error Messages

The error messages that occur during system operation or programming appear in the channel four window when in the OPT 1 Mode. The last system error message can be viewed by selecting the OPT 1 Mode. Additionally the OPT 1 cchannel four value can be extracted using the OPT 1 RS-232C command described in section 5.4.8. The OPT 1 channel four value can also be altered similarly to the other window values in the OPT 1 Mode. This is necessary when using RS-232C commands to read error messages so the same error message is not repeatedly read.

4.1 Description

All DynaMass systems (DM-1xxx and DM-2xxx Series) have an optional RS-232C interface module available. This module, the CI-4RS, allows serial communication between the DynaMass and a host computer or terminal.

The DynaMass may be ordered from the factory with the CI-4RS installed or the user may order and install the interface when convenient. This section covers the installation of the CI-4RS and the programming format used for serial communication. The last digit in the DynaMass model number indicates the presence or absence of the CI-4RS interface. A "1" indicates that it exists; a "0" indicates that it does not.

4.2 Installation

The CI-4RS RS-232C Interface Module inserts and attaches to the rear panel of the DynaMass. Located adjacent to the power supply module in the center of the rear panel, the CI-4RS is held in place by four retaining screws externally and a nylon standoff internally. Two internal cables are used to provide power and computer bus connections.

The interface is factory set for a 9600 baud rate and wired electrically for handshaking using the RTS and CTS lines. Both may be reconfigured by the user as necessary. Additional baud rates available are 1200, 2400 and 4800. The interface may be used with three wires and no handshaking.

Installation of the CI-4RS is a simple process requiring only a medium size phillips screwdriver and a regular one. The baud rate should be changed if necessary prior to installation. The baud rate is factory set at 9600 baud.

1. Configure the baud rate if necessary.
2. Remove the seven top cover retaining screws and washers.
3. Remove the top cover.
4. Expose the CI-4RS slot by removing the cover plate on the rear panel located next to the power supply module.
5. Insert the CI-4RS module into the slot and attach the PCB to the nylon standoff at the center of the DynaMass.
6. Attach the CI-4RS module to the rear panel with the cover plate retaining screws.
7. Connect the three wire polarized power cable from the

power supply board to the CI-4RS.

8. Connect the computer bus cable from the analog input/output board to the CI-4RS.
9. Reattach the top cover to the DynaMass.
10. The RS-232C interface is now ready to be used. Configure the OPT 1 values as necessary. See Section 3.2.8, OPT 1 MODE.

4.3 Baud Rate Configuration

The CI-4RS RS-232C Interface Module can be configured for the following baud rates: 300, 1200, 4800 and 9600 baud. The factory preset is 9600 baud. Should a different rate be desired, the desired baud rate may be selected by reconfiguring the S702 jumper on the CI-4RS module., (on older CI-4RS modules, the jumper is located at J704 vice S702.)

To reconfigure the baud rate:

1. Insure that power is disconnected from the DynaMass.
2. Remove the top cover.
3. Locate the jumper and configure as shown in Figure 4.1 below for the desired baud rate.
4. Reinstall the top cover.

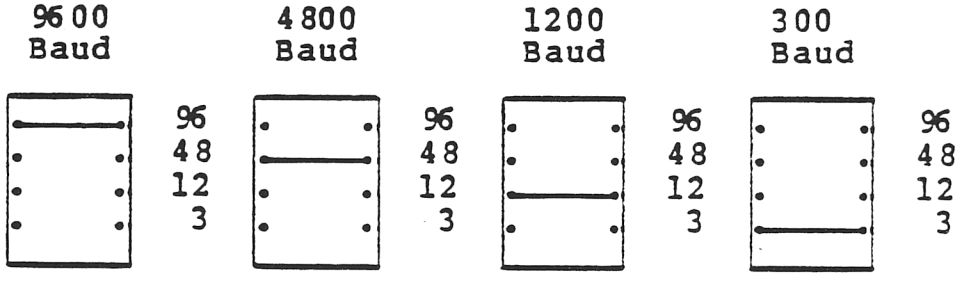


Figure 4.1
Baud Rate Jumper Configurations

Data Format

The CI-4RS can be configured to accept and transmit a variety of data formats. The data format consists of the length of the data string, the number of stop bits in the string and the parity, either odd, even or none.

The data string format is programmable using the OPT 1 Mode. Table 3.1 lists the available data string formats and their respective values for programming. For further information on programming the OPT 1 Mode, refer to Section 3.2.8, OPT 1 Mode

or Section 5, RS-232C Programming.

The connections between the computer or terminal and the DynaMass should be configured as follows:

- The RXD line from the DynaMass should be connected to the TXD line of the computer or terminal.
- The TXD line from the DynaMass should be connected to the RXD line of the computer or terminal.
- The CTS line from the DynaMass should be connected to the RTS line of the computer or terminal.
- The RTS line from the DynaMass should be connected to the CTS line of the computer or terminal.
- Grounds should be tied together.

Pin #	Description
2	RXD (receive data)
3	TXD (transmit data)
5	RTS (Request to Send)
4	CTS (Clear to Send)
8	DCD (Data Carrier Detect)
20	DTR (Data Transmit Ready)
7	Ground

Table 4.1
RS-232C Port Pin Descriptions

5.1 Introduction

This section provides the user with the proper syntax for using RS-232C commands. These commands, the majority of which are covered in Section 3, are used to remotely operate, program and query the DynaMass. Beginning with version L software (see the configuration sticker on the right side panel of the DynaMass for the software version) all front panel commands are also available using the RS-232C interface. The version L software also includes additional commands available only by using the RS-232C interface. All available RS-232C commands are included in this section.

5.2 Command Line Notation

The following is a description of the notation used for all command strings in this section.

[ ]	Items that appear between the brackets must be included in the command string. The brackets, however, are not included in any command string.
S	Items that appear in **bold** lettering must be specifically included in the command string.
|	Items that are separated by this symbol indicate that one or the other of the items must be selected for use in the command string.
<CR>	This is the symbol used to represent the ASCII value for a carriage return. Whenever encountered, this symbol should be replaced with the ASCII value for a carriage return.
.	Periods are arbitrarily used as delimiters in all examples in this section. Other delimiters may also be used if desired.
value	Items that appear in lower case indicate that a selection between two or more values must be made.
D	Items that appear in upper case indicate that the must be entered as shown if used in the command string.

5.3 Command String Template

All RS-232C commands are transmitted and received as a string of ASCII characters terminated by a carriage return. The command string template is used for all commands issued to the DynaMass.

Command String Template

[command].[channel character].[action character|value]<CR>

The command string consists of the [command], a delimiter, a [channel character], another delimiter, the [action character] or [value] string to be entered and a carriage return.

delimiters

The delimiters can be any of the following ASCII characters:

! " # $ % & ' ( ) * + , - . /

The period "." is arbitrarily used as the delimiter in all examples in this manual. See Appendix C for a listing of characters and their ASCII values used in this manual.

[command]

The [command] represents the command Mode in which the operation is to be performed. The following table lists the available commands and their respective command Modes.

Command	Command Mode
S	FLOW (Set Point)
R	RATIO
C	CAL
T	RAMP TIME
B	RATIO BASE
H	RANGE
I	ZERO SET
O	OPT 1
A	Report Flow
P	Program Select
E	Enable
V	Vacuum General Mode

Table 4.1
Available RS-232C Commands

[channel character]

The [channel character] determines which channel or channels the command will effect. The character value represents the channel number in the system and can be any value between 1 and 8 depending on the number of available channels in the system. To include all channels in the system the "*" is sometimes used as the [channel character]. Some commands only allow the "*" character to be used as the [channel character].

[action character|value]

The last part of the command string is the [action character] or [value] string to be input. The [action character] is limited to one of two choices, the character "D" or "?". The [value] can be a single character or a string of up to four characters.

The [action character] "D" is used to indicate that a query of a currently programmed value is required. Whenever a "D" is input as the [action character] in a command string, the DynaMass will output the current value(s) programmed in memory for the command Mode and channel or channels selected. The "?" character is used only in the Program Select Mode to query about which program is currently selected.

The [value] is numeric and may consist of one to four characters. The available values range from 0 to 1999 depending on the command Mode selected. [value] characters are entered without decimal points and negatives are not allowed.

<CR>

The carriage return symbol terminates the end of every command string. This symbol is used to represent the ASCII value for a carriage return.

5.4 Command Summary

5.4.1 FLOW (Set Point)

Purpose:

To initiate a command to query or alter the FLOW (set point) value for the currently selected program.

Syntax:

S.[channel character].[D|value]<CR>

Remarks:

[channel character]

The [channel character] determines which channel or channels the command will effect. The character value represents the channel number in the system and can be any value between 1 and 8 depending on the number of available channels in the system. To include all channels in the system the "*" is used as the [channel character].

[D|value]

A choice must be made as to whether a action is to be performed or if a new [value] is to be entered.

The only action character permitted is the query character "D". This character causes the DynaMass to output the current FLOW (set point) value or values programmed for the channel or channels as indicated by the [channel character].

The [value] may be a one, two, three or four character numeric string in the range of 0 to 1999. Decimal points and negative signs are not allowed. A [value] of 1000 represents full scale of the flow device.

<CR>

The carriage return symbol terminates the end of every command string. This symbol is used to represent the ASCII value for a carriage return. The DynaMass must receive a carriage return to begin processing the command string.

Examples:

1. Sending the following ASCII characters:

   S.3.500<CR>

   alters the channel three FLOW (set point) value to 50.0 percent of full scale.

2. Sending the following ASCII characters:

   S.*.1000<CR>

   alters the FLOW (set point) values for all channels to 100.0 percent of full scale.

3. Sending the following ASCII characters:

   S.*.D<CR>

   queries the DynaMass for all FLOW (set point) values for the currently selected program. The DynaMass will respond by transmitting the FLOW (set point) values for all channels in the currently selected program. The number of values transmitted will correspond to the number of channels in the system.

   1000 1000 1000 1000 (four channel system)

5.4.2 RATIO

Purpose:

To initiate a command to query or alter the RATIO value for the currently selected program.

Syntax:

R.[channel character].[D|value]<CR>

Remarks:

[channel character]

The [channel character] determines which channel or channels the command will effect. The character value represents the channel number in the system and can be any value between 1 and 8 depending on the number of available channels in the system. To include all channels in the system the "*" is used as the [channel character].

[D|value]

A choice must be made as to whether a action is to be performed or if a new [value] is to be entered.

The only action character permitted is the query character "D". This character causes the DynaMass to output the current RATIO value or values programmed for the channel or channels as indicated by the [channel character].

The [value] may be a one, two, three or four character numeric string in the range of 0 to 1000. Decimal points and negative signs are not allowed. A [value] of 500 represents a ratio percentage of 50 percent.

<CR>

The carriage return symbol terminates the end of every command string. This symbol is used to represent the ASCII value for a carriage return. The DynaMass must receive a carriage return to begin processing the command string.

Examples:

1. Sending the following ASCII characters:

   R.3.500<CR>

   alters the channel three RATIO value to 50.0 percent.
2. Sending the following ASCII characters:

   R.*.999<CR>

   alters the RATIO values for all channels to 99.9 percent.

3. Sending the following ASCII characters:

   R.*.D<CR>

   queries the DynaMass for all RATIO values for the currently selected program. The DynaMass will respond by transmitting the RATIO values for all channels in the currently selected program. The number of values transmitted will correspond to the number of channels in the system.

   999 999 999 999 (four channel system)

5.4.3 CAL (Calibration Factor)

Purpose:

To initiate a command to query or alter the CAL (calibration factor) value for the currently selected program.

Syntax:

C.[channel character].[D|value]<CR>

Remarks:

[channel character]

The [channel character] determines which channel or channels the command will effect. The character value represents the channel number in the system and can be any value between 1 and 8 depending on the number of available channels in the system. To include all channels in the system the "*" is used as the [channel character].

[D|value]

A choice must be made as to whether a action is to be performed or if a new [value] is to be entered.

The only action character permitted is the query character "D". This character causes the DynaMass to output the current CAL value or values programmed for the channel or channels as indicated by the [channel character].

The [value] may be a one, two or three character numeric string in the range of 20 to 500. Decimal points and negative signs are not allowed. A [value] of 100 represents a calibration factor of 1.00. See Appendix A for a listing gases and their calibration factors.

<CR>

The carriage return symbol terminates the end of every command string. This symbol is used to represent the ASCII value for a carriage return. The DynaMass must receive a carriage return to begin processing the command string.

Examples:

1. Sending the following ASCII characters:

   C.3.145<CR>

   alters the channel three CAL value to 1.45.

2. Sending the following ASCII characters:

   C.*.100<CR>

   alters the CAL values for all channels to 1.00.

3. Sending the following ASCII characters:

   C.*.D<CR>

   queries the DynaMass for all CAL values for the currently selected program. The DynaMass will respond by transmitting the CAL values for all channels in the currently selected program. The number of values transmitted will correspond to the number of channels in the system.

   01.00 01.00 01.00 01.00 (four channel system)

5.4.4 RAMP TIME

Purpose:

To initiate a command to query or alter the RAMP TIME value for the currently selected program.

Syntax:

T.[channel character].[D|value]<CR>

Remarks:

[channel character]

The [channel character] determines which channel or channels the command will effect. The character value represents the channel number in the system and can be any value between 1 and 8 depending on the number of available channels in the system. To include all channels in the system the "*" is used as the [channel character].

[D|value]

A choice must be made as to whether a action is to be performed or if a new [value] is to be entered.

The only action character permitted is the query character "D". This character causes the DynaMass to output the current RAMP TIME value or values programmed for the channel or channels as indicated by the [channel character].

The [value] may be a one or two character numeric string in the range of 0 to 30. Decimal points and negative signs are not allowed. A [value] of 30 represents a ramp time of 30 seconds.

<CR>

The carriage return symbol terminates the end of every command string. This symbol is used to represent the ASCII value for a carriage return. The DynaMass must receive a carriage return to begin processing the command string.

Examples:

1. Sending the following ASCII characters:

   T.3.10<CR>

   alters the channel three RAMP TIME value to 10 seconds.

2. Sending the following ASCII characters:

   T.*.30<CR>

   alters the RAMP TIME values for all channels to 30 seconds.

3. Sending the following ASCII characters:

   T.*.D<CR>

   queries the DynaMass for all RAMP TIME values for the currently selected program. The DynaMass will respond by transmitting the RAMP TIME values for all channels in the currently selected program. The number of values transmitted will correspond to the number of channels in the system.

   0030 0030 0030 0030 (four channel system)

5.4.5 RATIO BASE (MASTER)

Purpose:

To initiate a command to query the RATIO BASE (MASTER) status or set a channel as the RATIO BASE (MASTER).

Syntax:

B.*.[D|channel character]<CR>

Remarks:

[D|channel character]

A choice must be made as to whether a query is to be performed or a channel selected as the RATIO BASE (MASTER).

The character "D" is used to query the current program for the channel selected as the RATIO BASE (MASTER) (MASTER). The DynaMass will respond with an output indicating which channel is currently selected.

The [channel character] determines which channel the command will effect. Only one channel may be selected as the RATIO BASE (MASTER) per program. The character value represents the channel number in the system and can be any value between 1 and 8 depending on the number of available channels in the system.

<CR>

The carriage return symbol terminates the end of every command string. This symbol is used to represent the ASCII value for a carriage return. The DynaMass must receive a carriage return to begin processing the command string.

Examples:

1. Sending the following ASCII characters:

   B.*.3<CR>

   selects channel three as the RATIO BASE (MASTER). If the duplex mode is set for extended echo, the DynaMass will respond by transmitting the new RATIO BASE (MASTER) values for the currently selected program. The last digit in each value represents the channel selected as the RATIO BASE (MASTER). The number of values transmitted will correspond to the number of channels in the system.

0003 0003 0003 0003 (four channel system)

2. Sending the following ASCII characters:

B.*.D<CR>

queries the DynaMass for the RATIO BASE (MASTER) channel for the currently selected program. The DynaMass will respond by transmitting the RATIO BASE (MASTER) values for the currently selected program. The number of values transmitted will correspond to the number of channels in the system.

0003 0003 0003 0003 (four channel system)

5.4.6 RANGE

Purpose:

To initiate a command to query or alter the RANGE value for the currently selected program.

Syntax:

H.[channel character].[D|value]<CR>

Remarks:

[channel character]

The [channel character] determines which channel or channels the command will effect. The character value represents the channel number in the system and can be any value between 1 and 8 depending on the number of available channels in the system. To include all channels in the system the "*" is used as the [channel character].

[D|value]

A choice must be made as to whether a action is to be performed or if a new [value] is to be entered.

The only action character permitted is the query character "D". This character causes the DynaMass to output the current RANGE value or values programmed for the channel or channels as indicated by the [channel character].

The [value] may only be a single numeric character in the range of 0 to 7. Decimal points and negative signs are not allowed. Table V-1 lists the possible RANGE values.

VALUE	FULL SCALE RANGE
0	1 SCCM
1	10 SCCM
2	100 SCCM
3	1000 SCCM
4	1 SLM
5	10 SLM
6	100 SLM
7	1000 SLM

Table V-1
RANGE VALUES

<CR>

The carriage return symbol terminates the end of every command string. This symbol is used to represent the ASCII value for a carriage return. The DynaMass must receive a carriage return to begin processing the command string.

Example:

1. Sending the following ASCII characters:

   H.3.2<CR>

   alters the channel three RANGE to 100 SCCM.

5.4.7 ZERO SET

Purpose:

To initiate a command to exit AUTO ZERO, enter AUTO ZERO or to set or query ZERO SET offset values.

Syntax:

I.[channel character].[D|value]<CR>

Remarks:

[channel character]

The [channel character] determines which channel or channels the command will effect. The character value represents the channel number in the system and can be any value between 1 and 8 depending on the number of available channels in the system. To include all channels in the system the "*" is used as the [channel character].

[D|value]

A choice must be made as to whether a action is to be performed or if a new [value] is to be entered.

The only action character permitted is the query character "D". This character causes the DynaMass to output the current ZERO SET value or values programmed for the channel or channels as indicated by the [channel character].

The [value] may be a two or three character numeric string in the range of 29 to 226. Decimal points and negative signs are not allowed.

The ZERO SET value is used to exit AUTO ZERO and to offset the displayed value up to $\pm$99 counts. A [value] of 128 is used as the offset base for zeroing purposes. The [value] 128 corresponds to an offset of 0 (zero) counts at the display. Entering a [value] of 128 for any channel commands the DynaMass to enter AUTO ZERO and generates an offset value of 0 (zero) for all channels. All channels must simultaneously be in either AUTO ZERO or Manual Zero but never both. Therefore, commanding one channel into AUTO ZERO for example causes all channels to enter AUTO ZERO.

Entering a [value] other than 128 for any channel commands the DynaMass to exit AUTO ZERO and to enter an offset to the displayed value. ZERO SET values greater than 128 offset the displayed values in a negative direction and values less than 128 offset the displayed values in a

positive direction. A ZERO SET [value] of 29 is the lowest [value] allowed and generates a display offset of +99 counts. A ZERO SET [value] of 226 is the highest [value] allowed and generates a display offset of -99 counts.

<CR>

The carriage return symbol terminates the end of every command string. This symbol is used to represent the ASCII value for a carriage return. The DynaMass must receive a carriage return to begin processing the command string.

Examples:

1. Sending the following ASCII characters:

   I.3.100<CR>

   causes the DynaMass to exit AUTO ZERO and applies a positive offset of 27 counts to the channel three display.

2. Sending the following ASCII characters:

   I.*.128<CR>

   commands the DynaMass to enter AUTO ZERO.

3. Sending the following ASCII characters:

   I.*.D<CR>

   queries the DynaMass for all ZERO SET offset values. The DynaMass will respond by transmitting the ZERO SET values for all channels in the currently selected program. The number of values transmitted will correspond to the number of channels in the system.

   0128 0128 0128 0128 (four channel system)

   These values represent a 0 (zero) offset for all channels. A value of 128 corresponds to an offset value of 0 counts.

5.4.8 OPT 1

Purpose:

To initiate a command to query or alter the OPT 1 values for the DynaMass system or to read the last error message.

Syntax:

O.[channel character].[D|value]<CR>

Remarks:

[channel character]

The [channel character] determines which channel or channels the command will effect. The character value represents the channel number in the system and can be any value between 1 and 4. To include all channels in the system the "*" is used as the [channel character]. [channel character] values above 4 are not used in OPT 1 . The OPT 1 display windows are different from most other Modes in that they each serve a specific purpose. For a complete explanation of OPT 1 windows and their respective values see Section 3.2.8, OPT 1 Mode.

[D|value]

A choice must be made as to whether a action is to be performed or if a new [value] is to be entered.

The only action character permitted is the query character "D". This character causes the DynaMass to output the current ZERO SET value or values programmed for the channel or channels as indicated by the [channel character].

The [value] may be a one or two character numeric string in the range of 0 to 30 depending on the channel selected. Decimal points and negative signs are not allowed. For a complete explanation of OPT 1 windows and their respective values see Section III OPT 1 Mode.

<CR>

The carriage return symbol terminates the end of every command string. This symbol is used to represent the ASCII value for a carriage return. The DynaMass must receive a carriage return to begin processing the command string.

Examples:

1. Sending the following ASCII characters:

   O.1.5<CR>

   alters the channel one OPT 1 value to 7.

2. Sending the following ASCII characters:

   O.*.D<CR>

   queries the DynaMass for all OPT 1 values. The DynaMass will respond by transmitting the OPT 1 values for all channels. The number of values transmitted will correspond to the number of channels in the system.

   0005 0001 0001 0000 (four channel system)

5.4.9 Flow Report

Purpose:

To initiate a command to query one or all channels for current flow output information.

Syntax:

A.[channel character].D<CR>

Remarks:

[channel character]

The [channel character] determines which channel or channels the command will effect. The character value represents the channel number in the system and can be any value between 1 and 8 depending on the number of available channels in the system. To include all channels in the system the "*" is used as the [channel character].

D

The only action character permitted is the query character "D". This character causes the DynaMass to output the current flow output value or values for the channel or channels as indicated by the [channel character].

<CR>

The carriage return symbol terminates the end of every command string. This symbol is used to represent the ASCII value for a carriage return. The DynaMass must receive a carriage return to begin processing the command string.

Examples:

1. Sending the following ASCII characters:

   A.3.D<CR>

   commands the DynaMass to transmit the current flow output value for channel three. The DynaMass will respond by transmitting the flow output value for channel three.

   An example of this output might be

   0100

2. Sending the following ASCII characters:

   A.*.D<CR>

   commands the DynaMass to transmit the current flow output values for all channels in the system. The DynaMass will respond by transmitting the current flow output values for all channels. The number of values transmitted will correspond to the number of channels in the system.

   An example of this output might be

   1000 1001 0925 0050 (four channel system)

5.4.10 Enable

Purpose:

To initiate a command to enable or disable a channel from the system, configure channel status for FLOW or RATIO, query the channel status or to enable or disable the system.

Syntax:

E.[channel character].[D|value]<CR>

Remarks:

[channel character]

The [channel character] determines which channel or channels the command will effect. The [channel character] is also used to select the system when used with this command. The character value represents the channel number in the system and can be any value between 1 and 8 depending on the number of available channels in the system. The "*" character is used to select the system ENABLE when used in conjunction with a [value] as the last character in the command string. The "*" character is also used to select all channels when used in conjunction with a "D" character as the last character in the command string.

[value]

A choice must be made as to whether a action is to be performed or if a new [value] is to be entered.

The only action character permitted is the query character "D". This character causes the DynaMass to output the current channel status which includes ON/OFF status and FLOW/RATIO status. Queries may address an individual channel or all channels in the system.

The [value] may only be a one character numeric string in the range of 0 to 2. Decimal points and negative signs are not allowed. The [value] range depends upon the whether a channel or the system is being addressed.

When addressing a channel, the [value] has a range of 0 to 2 and will only effect the ON/OFF and FLOW/RATIO status of one channel at a time. A [value] of 0 commands the DynaMass to turn the channel off and leaves the current FLOW/RATIO status alone. A [value] of 1 commands the DynaMass to turn the selected channel on and set the FLOW/RATIO status to FLOW. A [value] of 2 commands the DynaMass to turn the channel on and set the FLOW/RATIO

status to RATIO.

When addressing the system, the [value] has a range of 0 to 1 and only effects the ENABLE status of the system. A [value] of 0 turns the ENABLE off and a [value] of 1 turns the ENABLE on.

<CR>

The carriage return symbol terminates the end of every command string. This symbol is used to represent the ASCII value for a carriage return. The DynaMass must receive a carriage return to begin processing the command string.

Examples:

1. Sending the following ASCII characters:

   E.3.1<CR>

   turns channel three on and sets the FLOW/RATIO status to FLOW.

2. Sending the following ASCII characters:

   E.1.2<CR>

   turns channel one on and sets the FLOW/RATIO status to RATIO.

3. Sending the following ASCII characters:

   E.1.0<CR>

   turns channel three off and does not effect the FLOW/RATIO status of the channel.

4. Sending the following ASCII characters:

   E.*.1<CR>

   turns the system ENABLE on.

5. Sending the following ASCII characters:

   E.*.D<CR>

   commands the DynaMass to transmit the status for all channels in the system. The DynaMass will respond by transmitting the current status values for all channels. The number of values transmitted will correspond to the

number of channels in the system.

An example of the output might be

0000 0001 0001 0002 (four channel system)

The output indicates that channel one is off, channels two and three are on and set to FLOW and channel four is on and set to RATIO.

5.4.11 Program

Purpose:

To initiate a command to select a program, to query which program is currently selected or to save any Mode value changes to the currently active program.

Syntax:

P.*.[?|S|value]<CR>

Remarks:

[?|S|value]

A choice must be made as to whether a action is to be performed or if a new [value] is to be entered.

The action characters permitted are the "?" and the "S" characters. The "?" character is used to query the DynaMass for the program that is currently active. The "S" character is used to save any changes made to the currently active program.

The [value] may only be a one digit alphabetical character in the range of A to D. The characters correspond to the available programs in the DynaMass system.

<CR>

The carriage return symbol terminates the end of every command string. This symbol is used to represent the ASCII value for a carriage return. The DynaMass must receive a carriage return to begin processing the command string.

Examples:

1. Sending the following ASCII characters:

   P.*.C<CR>

   commands the DynaMass to select program C as the active program.

2. Sending the following ASCII characters:

   P.*.?<CR>

   queries the DynaMass for the currently active program. The DynaMass will respond by transmitting the current program value.

An example of the output might be

D

indicating that program D is the currently active program.

3. Sending the following ASCII characters:

P.*.S<CR>

commands the DynaMass to save any changes made to the currently active program to the currently active program.

5.5 Error Messages

Error messages are displayed in the fourth channel window when in the OPT 1 Mode. The value stored can be read at any time using a RS-232C command. This command is described in the section 3.2.8, OPT 1 Mode and 5.4.8, OPT 1 programming.

6.1 TTL Port Locations

A TTL port is included as standard equipment with each DM-1XXX and DM-2XXX Series of DynaMass. One TTL port resides on each Input/Output board included with each DynaMass. The DM-1XXX Series contains one I/O board and the DM-2XXX Series contains two. The I/O boards have five connectors that protrude from the rear panel of the DynaMass. Four connectors are 9 pin "D" type and are used to connect the flow devices to the DynaMass. The fifth connector is a 15 pin "D" type and is used as the TTL port. TTL Port 1 is located just to the right of the center and to the bottom of the rear panel. Included with each DM-2XXX Series an additional port, TTL Port 2, is located directly above TTL Port 1.

6.2 Common TTL Functions

The following is a description of the common TTL functions available with all versions of DynaMass. All references to the TTL Port 1 refer to the only port available with the DM-1XXX Series and the lower port on the DM-2XXX Series.

6.2.1 Fail Safe Lock

Fail Safe Lock is used to inhibit the ENABLE switch at the KM-4 Keyboard module. This function can be used as a safety feature to inhibit the DynaMass system from controlling the gas channels.

When Fail Safe Lock is active, an error message E.02 will be displayed at the channel one display. The DynaMass system will remain inhibited until Fail Safe Lock is deactivated. Pressing the ENABLE switch while Fail Safe Lock is active will have no effect.

Fail Safe Lock is activated by disconnecting pin #11 (Fail Safe Lock) from pin #6 (ground) at TTL Port 1. Fail Safe Lock is deactivated by connecting pin #11 (Fail Safe Lock) to pin #6 (ground) at TTL Port 1.

For users who do not wish to utilize TTL Port 1, a TTL "plug" is provided to defeat the Fail Safe Lock function. This "plug" connects directly into TTL Port 1 and contains the jumper necessary to tie pin #11 to pin #6.

6.2.2 Program Lock and Selection

Program Lock allows the user to disable the PROGRAM select switches at the KM-4 Keyboard module and to enable program selection using the TTL port. Program Selection is used in conjunction with Program Lock to select between one of four available programs.

When Program Lock is active, the PROGRAM select switches at the KM-4 module are disabled. Pressing any PROGRAM select switch (A, B, C or D) will cause the error message E.12 to be displayed at the channel one display. RS-232C commands which attempt to change programs while Program Lock is active are ignored.

Program Lock is activated by connecting pin #13 (Program Lock/Select Enable) to pin #6 (ground) at TTL Port 1. Program Lock is deactivated by disconnecting pin #13 (Program Lock/Select Enable) from pin #6 (ground) at TTL Port 1.

Program selection using the TTL port is available only when Program Lock is active. Program selection is accomplished by configuring two control pins (pin #8 and pin #15) in one of four possible configurations as shown in Table 6.1 below.

Desired Program	pin #8	pin #15
A	connected to pin #6	connected to pin #6
B	connected to pin #6	no connection
C	no connection	connected to pin #6
D	no connection	no connection

Table 6.1
TTL Port 1 Program Selection Configurations

Deactivating Program Lock returns program control to the PROGRAM SELECT switches at the Keyboard module. The program last selected using the TTL port will remain as the currently active program when Program Lock is deactivated.

6.2.3 MODE Value LOCK

MODE Value LOCK inhibits the use of the UP or DOWN SET switches at the Keyboard module protecting all MODE values stored in memory from alteration. The RS-232C Serial Interface port, however, may be used to alter MODE values even when MODE Value LOCK is active.

When Mode Value LOCK is active, the lock led at the Keyboard module will illuminate and the UP and Down SET switches are disabled. Pressing either UP or DOWN SET switch will cause the error message E.11 to be displayed at the channel one display.

MODE Value LOCK is activated by connecting pin #4 (MODE Value LOCK) to pin #6 (ground) at TTL Port 1. MODE Value LOCK is deactivated by disconnecting pin #4 (MODE Value LOCK) from pin #6 (ground) at TTL Port 1.

6.2.4 Polarity Control 1

Polarity Control 1 provides a way of setting the active state of the Channel Select lines for channels one thru four. Polarity Control 1 must be connected to either ground or +5vdc to allow the Channel Select lines to function properly.

Internal resistors are used to connect the Polarity Control 1 line to the Channel Enable lines. These connections configure the Channel Enable active logic levels to be the logic level connected to Polarity Control.

If pin #7 (+5vdc) is connected to pin #14 (Polarity Control 1), the active state of each Channel Enable line is +5vdc. This means that for the channels to be ON, the respective Channel Enable lines must be connected to pin #7 (+5vdc) or not connected to any other pin. To turn each channel OFF, the Channel Enable lines must be connected to pin #6 (ground).

If pin #6 (ground) is connected to pin #14 (Polarity Control 1), the active state of each Channel Enable line is ground. This means that for the channels to be ON, the respective Channel Enable lines must be connected to pin #6 (ground) or not connected to any other pin. To turn each channel OFF, the Channel Enable lines must be connected to pin #7 (+5vdc).

6.2.5 Channel Lock 1 and Channel Selection

Channel Lock 1 allows the user to disable the ON/OFF switches located at the FM-4 or FM-8 Flow/Ratio modules for channels one thru four and to enable channel selection using TTL Port 1. Channel selection is used in conjunction with Channel Lock 1 to determine the ON/OFF status of channels one thru four.

When Channel Lock 1 is active, the ON/OFF switch located at each Flow/Ratio module for channels one thru four is disabled and the REMOTE LED at the Keyboard module will illuminate. Pressing any Flow/Ratio module ON/OFF switch for channels one thru four will have no effect.

Channel Lock 1 is activated by connecting pin #5 (Channel Lock 1/Select Enable) to pin #6 (ground) at TTL Port 1. To deactivate Channel Lock 1 pin #5 (Channel Lock 1/Select Enable) must be disconnected from pin #6 (ground).

Channel selection using the TTL Port 1 for channels one thru four is available only when Channel Lock 1 is active. The channels are in the ON state when the Channel Enable lines are not connected (left open or floating) to any other pins. To turn a channel OFF, the Channel Enable pin for the desired channel must be connected to either pin #6 (ground) or pin #7 (+5vdc) depending on Polarity Control 1. If Polarity Control 1 is connected to pin #7 (+5vdc), then to turn a channel OFF, the Channel Enable line for the desired channel must be connected to pin #6 (ground). If Polarity Control 1 is connected to pin #6 (ground), then to turn a channel OFF, the Channel Enable line for the desired channel must be connected to pin #7 (+5vdc).

Pin #	Description	Active State
1	Channel Three Enable	Depends on Polarity Control 1
2	Channel Two Enable	Depends on Polarity Control 1
3	Channel One Enable	Depends on Polarity Control 1
4	MODE Value LOCK	Connected to pin #6 (ground)
5	Channel Lock 1/ Select Enable	Connected to pin #6 (ground)
6	Ground	
7	+5vdc (20mA maximum)	
8	Program Select	See Table 6.1
9	Channel Four Enable	Depends on Polarity Control 1
10		
11	Fail Safe Lock	Open - no connection
12	Chassis Ground	
13	Program Lock/ Select Enable	Connected to pin #6 (ground)
14	Polarity Control 1	See text - Polarity Control 1
15	Program Select	See Table 6.1

Table 6.2
TTL Port 1 Pin Descriptions
All DM-1XXX Series and Lower Port for All DM-2XXX Series

6.3 Additional DM-2XXX Series TTL Functions

The following is a description of additional TTL functions available with the DM-2XX Series of DynaMass. These functions are available using a second Input/Output board installed in the DM-2XXX. These functions are not available on the DM-1XXX Series. This second TTL port is located above TTL Port 1 and is designated TTL Port 2.

6.3.1 System ENABLE Lock/System ENABLE

System ENABLE Lock provides the user with the ability to control and lock the ON/OFF ENABLE status of the entire DynaMass system using TTL Port 2. System ENABLE allows selection, when System ENABLE Lock is active, for the DynaMass system to be either enabled or disabled.

When System ENABLE Lock is active, the ENABLE switch at the Keyboard module is inhibited and the system's ENABLE ON/OFF status is controlled by the System ENABLE line. Pressing the ENABLE switch at the keyboard module will have no effect.

System ENABLE can only be used when System ENABLE Lock is active. System ENABLE Lock is active when pin #11 (System ENABLE Lock) is connected to pin #6 (ground) at TTL Port 2. System ENABLE may then be activated by connecting pin #10 (System ENABLE) to pin #6 (ground) at TTL Port 2.

When System ENABLE is not active and System ENABLE Lock is active, the ENABLE status at the Keyboard module will be locked in OFF. When System ENABLE is active and System ENABLE Lock is active, the ENABLE status at the Keyboard module will be locked in ON.

6.3.2 Polarity Control 2

Polarity Control 2 provides a way of setting the active state of the Channel Select lines for channels five thru eight. Polarity Control 2 must be connected to either ground or +5vdc to allow the Channel Select lines to function properly.

Internal resistors are used to connect the Polarity Control 2 line to the Channel Enable lines. These connections configure the Channel Enable active logic levels to be the logic level connected to Polarity Control.

If pin #7 (+5vdc) is connected to pin #14 (Polarity Control 2), the active state of each Channel Enable line is +5vdc. This means that for the channels to be ON, the respective Channel Enable lines must be connected to pin #7 (+5vdc) or not

connected to any other pin. To turn each channel OFF, the Channel Enable lines must be connected to pin #6 (ground).

If pin #6 (ground) is connected to pin #14 (Polarity Control 2), the active state of each Channel Enable line is ground. This means that for the channels to be ON, the respective Channel Enable lines must be connected to pin #6 (ground) or not connected to any other pin. To turn each channel OFF, the Channel Enable lines must be connected to pin #7 (+5vdc).

6.3.3 Channel Lock 2 and Channel Selection

Channel Lock 2 allows the user to disable the ON/OFF switches located at the FM-8 Flow/Ratio modules for channels five thru eight and to enable channel selection using TTL Port 2. Channel selection is used in conjunction with Channel Lock 2 to determine the ON/OFF status of channels five thru eight.

When Channel Lock 2 is active, the ON/OFF switch located at each Flow/Ratio module for channels five thru eight is disabled and the REMOTE LED at the Keyboard module will illuminate. Pressing any Flow/Ratio module ON/OFF switch for channels five thru eight will have no effect.

Channel Lock 2 is activated by connecting pin #5 (Channel Lock 2/Select Enable) to pin #6 (ground) at TTL Port 2. To deactivate Channel Lock 2 pin #5 (Channel Lock 2/Select Enable) must be disconnected from pin #6 (ground).

Channel selection using the TTL Port 2 for channels five thru eight is available only when Channel Lock 2 is active. The channels are in the ON state when the Channel Enable lines are not connected (left open or floating) to any other pins. To turn a channel OFF, the Channel Enable pin for the desired channel must be connected to either pin #6 (ground) or pin #7 (+5vdc) depending on the state of Polarity Control 2. If Polarity Control 2 is connected to pin #7 (+5vdc), then to turn a channel OFF, the Channel Enable line for the desired channel must be connected to pin #6 (ground). If Polarity Control 2 is connected to pin #6 (ground), then to turn a channel OFF, the Channel Enable line for the desired channel must be connected to pin #7 (+5vdc).

Pin #	Description	Active State
1	Channel Seven Enable	Depends on Polarity Control 2
2	Channel Six Enable	Depends on Polarity Control 2
3	Channel Five Enable	Depends on Polarity Control 2
4		
5	Channel Lock 2/ Select Enable	Connected to pin #6 (ground)
6	Ground	
7	+5vdc (20mA maximum)	
8		
9	Channel Eight Enable	Depends on Polarity Control 2
10	System ENABLE	Connected to pin #6 (ground)
11	System ENABLE Lock	Connected to pin #6 (ground)
12	Chassis Ground	
13		
14	Polarity Control 2	See text - Polarity Control 2
15		

Table 6.3
TTL Port 2 Pin Descriptions
DM-2XXX Series DynaMass Only

Displayed Message : E.01

Cause: An attempt has been made to alter a Mode value while the ENABLE LED at the Keyboard module is illuminated.

Remarks: Only FLOW and RATIO Mode values may be altered while the system is enabled (ENABLE LED is illuminated). All other Mode values may only be altered while the system is disabled (ENABLE LED extinguished).

Solution: Press the ENABLE switch at the Keyboard module to disable the system, the ENABLE LED will extinguish. When the ENABLE LED is extinguished any Mode value selected may be altered.

Displayed Message: E.02

Cause: The Fail Safe Lock pin on the TTL port connector has been disconnected from circuit ground enabling Fail Safe Lock.

Remarks: The Fail Safe Lock pin provides a means for externally disabling the system. This pin must be connected to circuit ground to allow the system to enable. On systems where the TTL port is not used, a TTL "plug" is installed to ground the Fail Safe Lock pin. See Section VI for more information on the Fail Safe Lock pin.

Solution: Connect the Fail Safe Lock pin on the TTL port connector to the circuit ground pin or insert the TTL "plug" supplied with the DynaMass into the TTL port connector.

Displayed Message: E.03

Cause: The selected "MASTER" channel has a range that is less than any channel set to RATIO.

Remarks: The channel selected as the "MASTER" must have a larger full scale range than any channel set to ratio against it.

Solution: The full scale range of the channel selected as the "MASTER" must be changed or another channel with a suitable range must be selected as the "MASTER" or

channels with smaller full scale ranges set to RATIO must be used.

Displayed Message: E.04

Cause: The channel selected as the "MASTER" channel is also set to RATIO. A channel cannot be set to ratio against itself.

Remarks: The channel selected as the "MASTER" must be set to FLOW.

Solution: Deselect the channel as the "MASTER" or set the channel to FLOW.

Displayed Message: E.05

Cause: The FLOW value of the "MASTER" channel is so large that the ratioing channel exceeds it's full scale range.

- or -

The channel set to RATIO has a RATIO value that is too large causing the channel to exceed it's full scale range.

Remarks: This error message occurs to warn the user that the percentages required cannot be delivered due to the differences in the ranges of the affected devices.

Displayed Message: E.06

Cause: The channel has been set to RATIO without a "MASTER" channel selected.

Remarks: This error message typically occurs when configuring the system for ratioing. The error message is a reminder that a "MASTER" channel needs to be selected. Upon selection of a "MASTER" channel the error message will no longer be displayed.

Solution: Select a "MASTER" channel for ratioing or turn off the channels set to RATIO or reset the channels set to RATIO to FLOW.

Displayed Message: E.07

Cause: The channel set to RATIO is less than one hundredth the full scale range of the "MASTER" channel.

Remarks: For accurate ratioing results the full scale range of any ratioing channel may not be less than one hundredth the full scale range of the "MASTER" channel.

Solution: A channel with a full scale range greater than one hundredth the full scale range of the "MASTER" must be used or the channel must be set to FLOW.

Displayed Message: E.08

Cause: When the Totalizer module (TM-4) is selected as the "MASTER" channel, the sum of the "on" channel set to RATIO do not equal 100 percent.

Remarks: If the sum of the RATIO values for all "on" channels set to RATIO are not equal to 100 percent, then the Total FLOW (Set Point) value will not be achieved.

Solution: Increase the RATIO value of any of the "on" channels set to RATIO until the RATIO values add up to 100 percent.

Displayed Message: E.09

Cause: The ENABLE switch at the Keyboard module has been pressed within five seconds of applying power to the DynaMass.

Remarks: The DynaMass requires five seconds to initialize the system and electrically settle. The system is not ready (nor are the flow devices) for flow control before at least five seconds after applying power. The flow devices typically should be allowed a substantially longer warm up period before operating.

Solution: Simply waiting until five seconds have elapsed from when power was applied.

Displayed Message: E.11

Cause: An attempt has been made to alter a Mode value while the TTL Parameter LOCK is active.

Remarks: When the Parameter LOCK is active the LOCK LED at the Keyboard module will illuminate and the UP and DOWN SET switches are defeated. Pressing the UP or DOWN SET switches will have no effect in altering the flashing Mode value and the error message will

display briefly to indicate such.

Solution: The TTL Parameter Lock must be deactivated to alter Mode values at the Keyboard module.

Displayed Message: E.12

Cause: An attempt has been made to change a program while Program Lock at the TTL port is active.

Remarks: When the TTL Program Lock is active the PROGRAM select switches (A, B, C and D) at the KM-4 Keyboard module are defeated. Pressing any PROGRAM select switch will have no effect and the error message will display briefly to indicate such.

Solution: The TTL Program Lock function must be deactivated to select programs at the Keyboard module.

Displayed Message: E.31

Cause: Unrecognized command character used in the RS-232C command string.

Displayed Message: E.32

Cause: Illegal delimiter used in the RS-232C command string.

Displayed Message: E.33

Cause: Unrecognized [channel character] used in the RS-232C command string.

Displayed Message: E.34

Cause: Unrecognized action character or [value] used in the RS-232C command string.

Displayed Message: E.37

Cause: RS-232C character buffer underflow.

Displayed Message: E.38

Cause: RS-232C character buffer overflow.

Displayed Message: E.41

Cause: The zero offset voltage generated from the flow device is less than -400 millivolts from true zero.

Remarks: The DynaMass cannot AUTO ZERO when the zero offset error is less than -400 millivolts. This exceeds the AUTO ZERO range and indicates that the flow device should be zeroed before use with the DynaMass.

Solution: The zero offset must be adjusted at the flow device so it not less than -400 millivolts.

Displayed Message: E.42

Cause: The zero offset voltage generated from the flow device is greater than +400 millivolts from true zero.

Remarks: The DynaMass cannot AUTO ZERO when the zero offset error is greater than +600 millivolts. This exceeds the AUTO ZERO range and indicates that the flow device should be zeroed before use with the DynaMass.

Solution: The zero offset must be adjusted at the flow device so it not greater than +400 millivolts.

Displayed Message: E.54

Cause: Autocal value out of range.

Displayed Message: E.55

Cause: Calibration value out of range (absolute value greater than 31).

Displayed Message: E.57

Cause: Autocal attempted during program storage.

Appendix A Gas Calibration Factors

The following list of calibration factor values are to be used when programming the DynaMass in the CAL Mode. These are the only gases for which known calibration factor values exist at this time.

Gas	Symbol	CAL Value
Acetylene	C_2H_2	0.58
Air	----	1.00
Allene (Propadiene)	C_3H_4	0.43
Ammonia	NH_3	0.73
Argon	Ar	1.45
Arsine	AsH_3	0.67
Boron Trichloride	BCl_3	0.41
Boron Trifluoride	BF_3	0.51
Bromine	Br_2	0.81
Bromine Pentafluoride	BrF_5	0.26
Bromine Trifluoride	BrF_3	0.38
Bromotrifluoromethane (Freon - 13B)	$CBrF_3$	0.37
1, 3 - Butadiene	C_4H_6	0.32
Butane	C_4H_{10}	0.26
1 - Butene	C_4H_8	0.30
2 - Butene CIS/TRANS	C_4H_8	0.32/0.29
Carbon Dioxide	CO_2	0.74
Carbon Disulfide	CS_2	0.60
Carbon Monoxide	CO	0.31
Carbon Tetrachloride	CCl_4	0.42
Carbon Tetrafluoride (Freon - 14)	CF_4	0.42
Carbonyl Fluoride	COF_2	0.54
Carbonyl Sulfide	COS	0.66
Chlorine	Cl_2	0.86
Chlorine Trifluoride	ClF_3	0.40
Chlorodifluoromethane (Freon - 22)	$CHClF_2$	0.46
Chloropentafluoroethane (Freon - 115)	C_2ClF_5	0.24
Chlorotrifluoromethane (Freon - 13)	$CClF_3$	0.38
Cyanogen	C_2N_2	0.61
Cyanogen Chloride	ClCN	0.61
Cyclopropane	C_3H_6	0.46
Deuterium	D_2	1.00
Diborane	B_2H_6	0.44
Dibromodifluoromethane	CBr_2F_2	0.19
Dichlorodifluoromethane (Freon - 12)	CCl_2F_2	0.35
Dichlorofluoromethane (Freon - 21)	$CHCl_2F$	0.42
Dichloromethylsilane	$(CH_3)_2SiCl_2$	0.25
Dichlorosilane	SiH_2Cl_2	0.40
1, 2 - Dichlorotetrafluoroethane (Freon-114)	$C_2Cl_2F_4$	0.22
1, 1 - Difluoroethylene (Freon-1132A)	$C_2H_2F_2$	0.43

Dimethylamine	$(CH_3)_2NH$	0.37
Dimethyl Ether	$(CH_3)_2O$	0.39
2.2 - Dimethylpropane	C_5H_{12}	0.22
Ethane	C_2H_6	0.50
Ethanol	C_2H_6O	0.39
Ethyl Acetylene	C_4H_6	0.32
Ethyl Chloride	C_2H_5Cl	0.39
Ethylene	C_2H_4	0.60
Ethylene Oxide	C_2H_4O	0.52
Fluorine	F_2	0.98
Fluoroform (Freon - 23)	CHF_3	0.50
Freon - 11	CCl_3F	0.33
Freon - 12	CCl_2F_2	0.35
Freon - 13	$CClF_3$	0.38
Freon - 13 B_1	$CBrF_3$	0.37
Freon - 14	CF_4	0.42
Freon - 21	$CHCl_2F$	0.42
Freon - 22	$CHClF_2$	0.46
Freon - 23	CHF_3	0.50
Freon - 113	CCl_3FCClF_2	0.20
Freon - 114	$C_2Cl_2F_4$	0.22
Freon - 115	C_2ClF_5	0.24
Freon - 116	F_3CCF_3	0.24
Freon - C318	C_4F_8	0.17
Freon - 1132A	$C_2H_2F_2$	0.43
Germane	GeH_4	0.57
Germanium Tetrachloride	$GeCl_4$	0.27
Helium	He	1.45
Hexafluoroethane (Freon - 116)	F_3CCF_3	0.24
Hexane	C_6H_{14}	0.18
Hydrogen	H_2	1.01
Hydrogen Bromide	HBr	1.00
Hydrogen Chloride	HCl	1.00
Hydrogen Cyanide	HCN	0.76
Hydrogen Fluoride	HF	1.00
Hydrogen Iodide	HI	1.00
Hydrogen Selenide	H_2Se	0.79
Hydrogen Sulfide	H_2S	0.80
Iodine Pentafluoride	IF_5	0.25
Isobutane	$CH(CH_3)_3$	0.27
Isobutylene	C_4H_8	0.29
Krypton	Kr	1.45
Methane	CH_4	0.72
Methanol	CH_3OH	0.58
Methyl Acetylene	C_3H_4	0.43
Methyl Bromide	CH_3Br	0.58
Methyl Chloride	CH_3Cl	0.63
Methyl Fluoride	CH_3F	0.56
Methyl Mercaptan	CH_3SH	0.52
Methyl Trichlorosilane	$(CH_3)SiCl_3$	0.25
Molybdenum Hexafluoride	MoF_6	0.21
Monoethylamine	$C_2H_5NH_2$	0.35

Monomethylamine	CH_3NH_2	0.45
Neon	Ne	1.46
Nitric Oxide	NO	0.99
Nitrogen	N_2	1.00
Nitrogen Dioxide	NO_2	0.74
Nitrogen Trifluoride	NF_3	0.48
Nitrosyl Chloride	NOCl	0.61
Nitrous Oxide	N_2O	0.71
Octafluorocyclobutane (Freon - C318)	C_4F_8	0.17
Oxygen	O_2	1.00
Oxygen Difluoride	OF_2	0.63
Pentaborane	B_5H_9	0.26
Pentane	C_5H_{12}	0.21
Perchloryl Fluoride	ClO_3F	0.39
Perfluoropropane	C_3F_8	0.17
Phosgene	$COCl_2$	0.44
Phosphine	PH_3	0.76
Phosphorus Pentafluoride	PH_5	0.30
Propane	C_3H_8	0.36
Propylene	C_3H_6	0.41
Silane	SiH_4	0.60
Silicon Tetrachloride	$SiCl_4$	0.28
Silicon Tetrafluoride	SiF_4	0.35
Sulfur Dioxide	SO_2	0.69
Sulfur Hexafluoride	SF_6	0.26
Sulfuryl Fluoride	SO_2F_2	0.39
Tetrafluorohydrazine	N_2F_4	0.32
Trichlorofluoromethane (Freon - 11)	CCl_3F	0.33
Trichlorosilane	$SiHCl_3$	0.33
1, 1, 2 - Trichloro - 1, 2, 2 Trifluoroethane (Freon - 113)	CCl_2FCClF_{22}	0.20
Triisobutyl Aluminum	$(C_4H_9)_3Al$	0.06
Trimethylamine	$(CH_3)_3N$	0.28
Tungsten Hexafluoride	WF_6	0.25
Uranium Hexafluoride	UF_6	0.20
Vinyl Bromide	CH_2CHBr	0.46
Vinyl Chloride	CH_2CHCl	0.48
Xenon	Xe	1.32

B.1 Flow Device Connectors

The flow device connectors are located at the rear panel of the DynaMass. The connectors are standard 9 pin "D" type and the pin outs are identical for each channel in the system. DM-1XXX devices have four connectors and DM-2XXX devices have eight.

Pin #	Description
1	Positive Shut Off Signal (Active hi)
2	0 - 5vdc Set Point Signal Out
3	Power Ground
4	0 - 5vdc Flow Input Signal
5	Chassis Ground
6	+15vdc (see Section 1.5)
7	Input Signal Common
8	Power Ground
9	-15vdc (see Section 1.5)

Table B.1
Flow Device Connector Pin Descriptions

B.2 TTL Port Connectors

Pin #	Description	Active State
1	Channel Three Enable	Depends on Polarity Control 1
2	Channel Two Enable	Depends on Polarity Control 1
3	Channel One Enable	Depends on Polarity Control 1
4	MODE Value LOCK	Connected to pin #6 (ground)
5	Channel Lock 1/ Select Enable	Connected to pin #6 (ground)
6	Ground	
7	+5vdc (20mA maximum)	
8	Program Select	See Table 6.1
9	Channel Four Enable	Depends on Polarity Control 1
10		
11	Fail Safe Lock	Open - no connection
12	Chassis Ground	
13	Program Lock/ Select Enable	Connected to pin #6 (ground)
14	Polarity Control 1	See text - Polarity Control 1
15	Program Select	See Table 6.1

Table B.2
TTL Port 1 Pin Descriptions
All DM-1XXX Series and Lower Port for All DM-2XXX Series

Pin #	Description	Active State
1	Channel Seven Enable	Depends on Polarity Control 2
2	Channel Six Enable	Depends on Polarity Control 2
3	Channel Five Enable	Depends on Polarity Control 2
4		
5	Channel Lock 2/ Select Enable	Connected to pin #6 (ground)
6	Ground	
7	+5vdc (20mA maximum)	
8		
9	Channel Eight Enable	Depends on Polarity Control 2
10	System ENABLE	Connected to pin #6 (ground)
11	System ENABLE Lock	Connected to pin #6 (ground)
12	Chassis Ground	
13		
14	Polarity Control 2	See text - Polarity Control 2
15		

Table B.3
TTL Port 2 Pin Descriptions
DM-2XXX Series DynaMass Only

B.3 RS-232C Port Connector

Pin #	Description
2	RXD (receive data)
3	TXD (transmit data)
5	RTS (Request to Send)
4	CTS (Clear to Send)
8	DCD (Data Carrier Detect)
20	DTR (Data Transmit Ready)
7	Ground

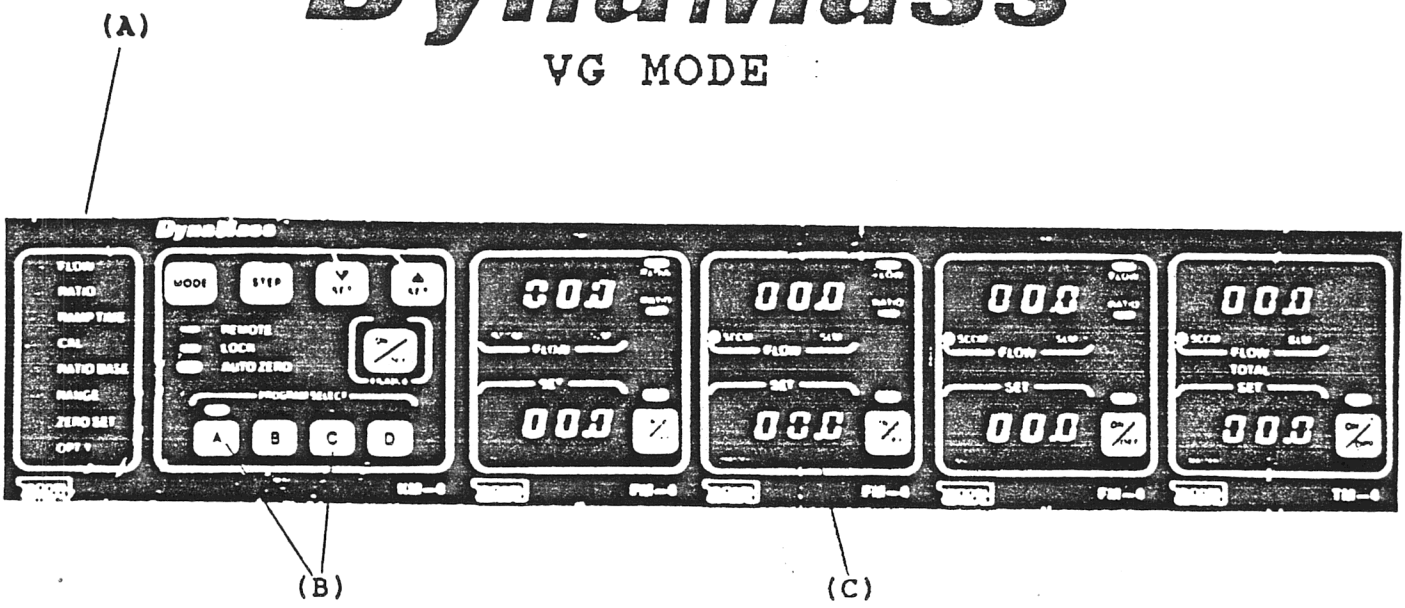
Table B.4
RS-232C Port Pin Descriptions

DM-2401
S/N 815630392

KM-4 FM-8 FM-8 BP-4 BP-4

DynaMass™

VG MODE



To deactivate: This mode will take the Dynamass (software rev. "N") out of VG mode. To be used when using non VG MFC's.

1. Dynamass must be on and in RUN MODE. (All MODE LED's should be off) See letter 'A'.
2. To deactivate press PROGRAM SELECT keys 'A' and 'C' simultaneously.
3. To check, put Dynamass in OPT 1 mode. See letter 'A'. Window 4 (See letter 'C') will display all zeros when in non VG mode, all 1's when in VG mode.

NOTE: Above procedures are for Dynamass with software revision "N". Previous revision of software powered up unit in non VG mode. To activate VG mode for these revision press PROGRAM SELECT keys 'A' and 'D'. To check use step 3 above

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Reading non-decade ranges on the Dynamass Flow Display

The Dynamass was designed to monitor and control mass flow controllers within decade ranges. There have been an increasing number of applications requiring mass flow devices in ranges between standard decade ranges. The Dynamass was incorrectly believed incapable of reading these non-decade ranges directly. It is, in fact, very easy to apply the appropriate correction factor to the Dynamass to control non-decade ranged mass flow devices (Typically called a Mass Flow Controller or MFC).

The Dynamass uses a Gas Calibration Factor (GCF) to correct for the slight differences between the gas being measured and the nearest safe calibration gas. By multiplying the GCF by a Range Correction Factor, the Dynamass will gain the ability to control and correctly display the flow units in the proper scale for a non-decade range.

For each channel of the Dynamass connected to a non-decade MFC, follow these simple steps.

1. At the keyboard module, press the MODE switch until the RANGE LED illuminates. The window value at channel 1 (the leftmost channel) will begin to flash with the current range for channel 1.

2. Select the desired channel by pressing the STEP button until the flashing channel has moved to the channel you want.

3. Use the SET switches (with the up and down arrows) to select the closest decade range that is larger then the non-decade range of the MFC attached to this channel. For example, a 50 sccm MFC would work best with a channel set to 100 sccm.

4. Once the range has been set to the nearest decade range, press the MODE switch until the CAL light is illuminated. The window value at channel 1 will begin to flash with the old value of the GCF for channel 1.

5. Again, repeat step 2 to move the flashing channel indicator to the desired channel.

6. Use the SET switches to enter the corrected GCF. The corrected GCF is obtained by multiplying the original GCF for the gas by the decade channel range and dividing by the new non-decade range. For example, a 50 sccm MFC connected to a 100 sccm channel would have a corrected GCF of twice the original value.

7. Finally, cycle the mode lights into the no-mode condition (when no mode lights are illuminated) twice to ensure that the channel setups are written into the non-volatile memory for the currently active PROGRAM.

This is Backward

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