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3. MULTIPLEX CONTROLLER MODULE

3.1 DESCRIPTION

The Multiplex Controller Module, hereafter referred to as the Controller Module, contains all the control, monitoring, and interface components for the dispensing operations. The Controller Module measures 450.85mm (17 3/4") wide, 488.95mm (19 1/4") deep, 184.15mm (7 1/4") high (feet included) and weighs approximately 11.34kg (25 pounds). The operator indicators, controls, and interface connections are located on the front and rear panels.

A Multiplex system may consist of multiple Controller Modules. With a multiple controller system, one controller will be configured as the “master” and the remaining controllers are “channels”. A system may have a maximum of 8 controllers (including the master) with each controller operating an 8, 10 or 12 pump actuator. (maximum total of 96 pump modules).

As an option, a Multiplex system may be configured with a Multiplex Striper Controller. This configuration limits the number of pump controller modules to 7. With the striper option, the 7 pump controller modules can control a maximum of 84 pump modules. For purposes of compatibility with other IVEK systems, the striper controller is addressed as ‘31’.

3.1.1 Front Panel Indicators (Figure 3.1)

The front panel of the Controller Module contains the system indicators and the main power switch. The following indicators and switch are located on the front panel.

1. Active Indicator
2. Idle Indicator
3. Load Indicator
4. Fault Indicator
5. On/Off Switch

3.1.1.1 Active Indicator (Figure 3.1 Item 1)

This white indicator illuminates while the Multiplex pump is operating.

3.1.1.2 Idle Indicator (Figure 3.1 Item 2)

This white indicator illuminates while the Multiplex pump is not operating.

3.1.1.3 Load Indicator (Figure 3.1 Item 3)

This white indicator illuminates while the Multiplex pump is loading.

3.1.1.4 Fault Indicator (Figure 3.1 Item 4)

This yellow indicator illuminates when a fault has been detected.

3.1.1.5 1/0 Switch (Figure 3.1 Item 5)

This 2-position rocker switch turns controller main power (AC input) “ON” (1) or “OFF” (0).

3.1.2. Rear Panel (Figure 3.2)

The rear panel contains the following:

1. Power Entry Module
2. MOTOR Connector
3. CONTROL POWER Fuse
4. E-STOP Connector
5. CONTROLLER COMMUNICATION Connector(s)
6. RS-232 COMMUNICATION Connector (Master only)
7. CONTROL A and CONTROL B Connectors
8. LOGIC I/O Connector

The RS-232 Communication connector provides a serial communication port (RS-232) for controlling and setting up the Controller Module. The power entry module provides an entry point for power coming into the Controller Module and the main line fuse(s). The pump control connectors (Motor, Control A and Control B) interface to the motor, valves, and sensors on the pump assembly. The emergency stop (E-Stop) enables or disables power to the motor. The Control fuse protects the internal +24V power supply and fan. The controller communication input and output connectors provide Controller Module to Controller Module communications.
The Logic I/O connector provides connections to the customer's PLC.

3.1.2.1 Power Entry Module (Figure 3.2 Item 1)

The power entry module contains a receptacle for a standard IEC power cord, a voltage selector switch and main fuse holder.

CAUTION

Before plugging in the system, insure the line voltage setting appearing in the window agrees with the available line voltage. Damage to the equipment could result if the two voltages do not match.

The design of the power entry module requires that the line cord be disconnected before either the voltage select switch is changed or a line fuse is removed. Perform the following steps if it is necessary to change the setting of the line voltage select switch.

1. Disconnect the line cord at the power entry module and open its cover.

2. Remove the selection cam from the unit and replace it oriented so the desired voltage will appear in the window when the cover is closed.

CAUTION

Rotating the voltage select cam while it is in the module may damage the module.

3. With the voltage select cam in the proper position, close the cover and replace the line cord. If the cover does not completely close, open the cover and slightly reposition the voltage select cam.

3.1.2.2 MOTOR Connector (Figure 3.2 Item 2)

The controller has a 16-pin connector on the rear panel used to connect to the Multiplex motor. The motor provides linear motion for the pump assemblies. This connector provides both power and feedback to and from the motor.

3.1.2.3 CONTROL POWER Fuse (Figure 3.2 Item 3)

A fuse is provided to protect the auxiliary components located inside the controller (24V power supply and fan).

3.1.2.4 E-STOP Connector (Figure 3.2 Item 4)

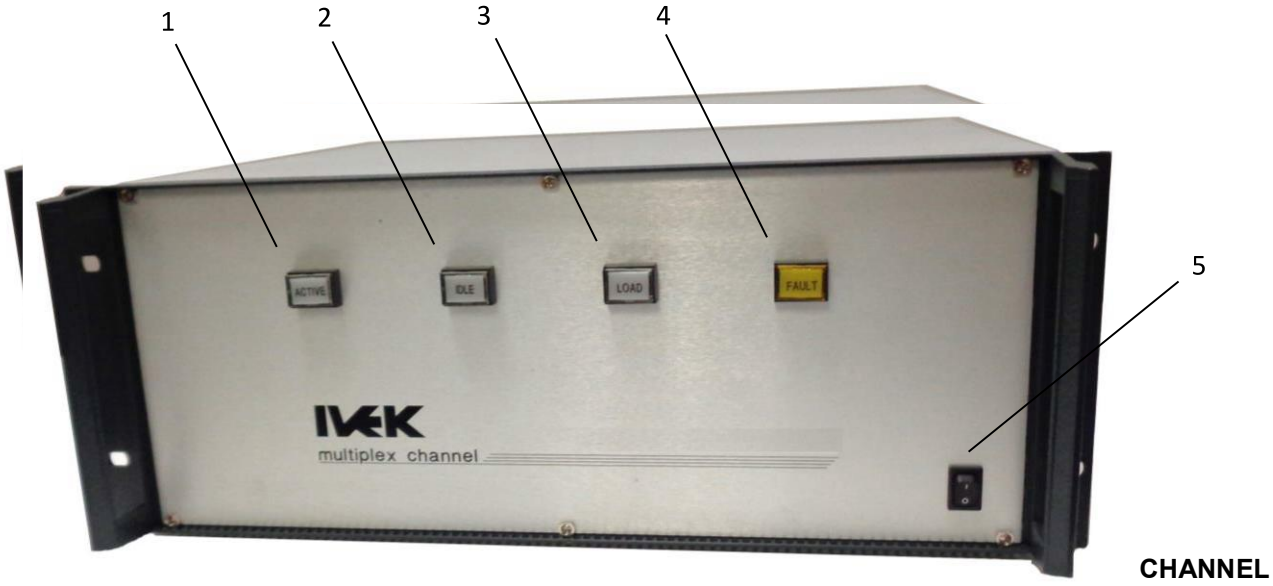
This provides the connection to the emergency stop switch (or switches). The emergency stop switch must be connected in order for the controller to operate. (refer to section 3.2.3)

An E-Stop Connector Kit (Part Number 540108) is supplied with the unit.

3.1.2.5 CONTROLLER COMMUNICATION Connectors (Figure 3.2 Item 5)

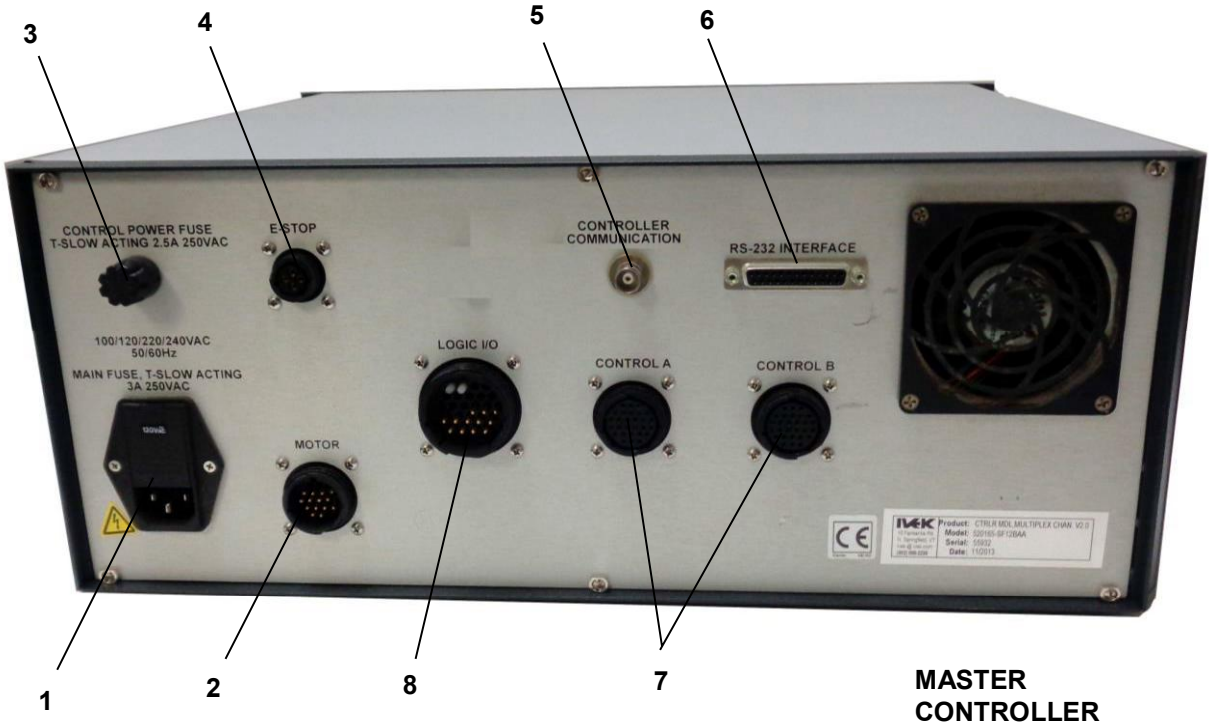
The BNC connectors provide controller-to-controller communications. The first Controller (Master) and last Controller Channel MUST have a 93 Ohm terminating resistor installed on the output connector (terminating resistors are provided with the units). For convenience, the Master has a 93 Ohm terminating resistor installed inside the controller.

MASTER CONTROLLER



CHANNEL CONTROLLER

Figure 3.1 Multiplex Controller Module Front Panels



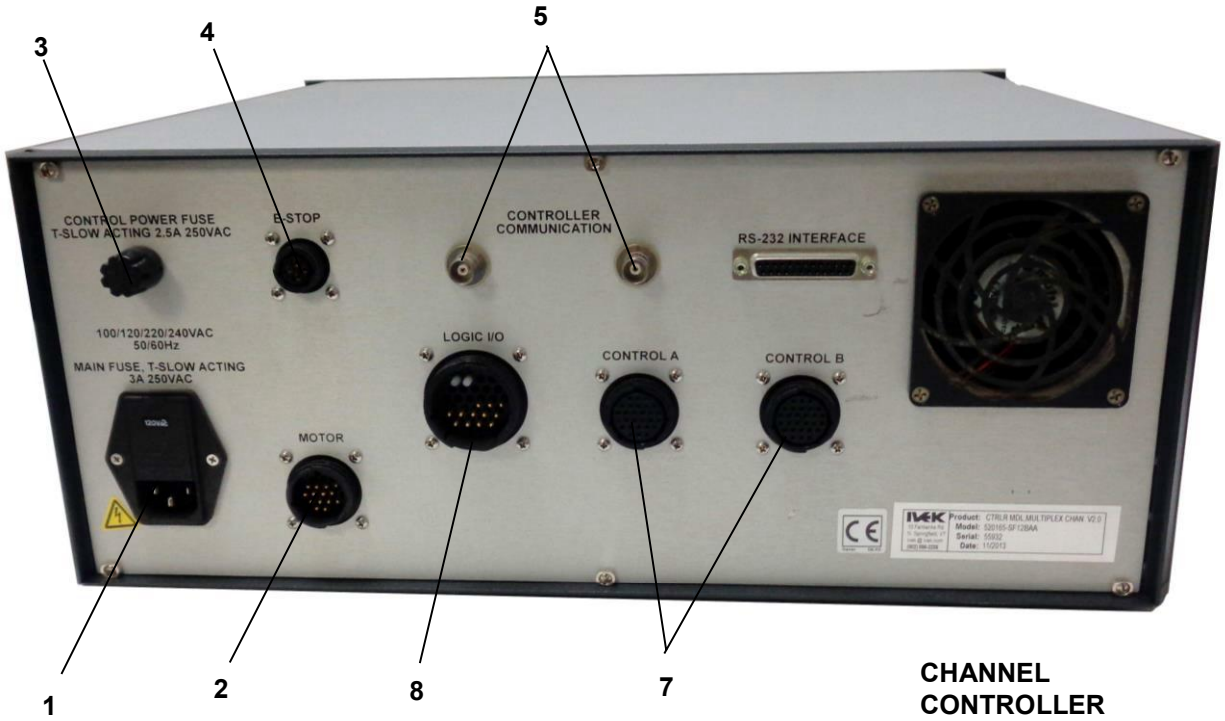


Figure 3.2 Multiplex Controller Module Rear Panels

3.1.2.6 RS-232 COMMUNICATION Connector (Figure 3.2 Item 6)

The Master Controller has a 25 pin “D” subminiature connector wired as described in serial interface section. On Channel Controllers this interface is not used (factory use only).

3.1.2.7 CONTROL A and CONTROL B Connectors (Figure 3.2 Item 7)

The controller has two 28-pin connectors on the rear panel used to control and sense the Multiplex pump assembly valves. The valve actuators are air driven. This connector provides solenoid control and sensor feedback for each value. The Control A connector is used for pump modules 1 through 8 and the linear position sensors. The Control B Connector is used for the remaining Pump Modules and linear position sensor. For system's controlling actuators with eight or less Pump Modules, Control B is not required.

3.1.2.8 Logic I/O Connector (Figure 3.2 Item 8)

The LOGIC I/O connector provides system and channel level control connections to the Customer's PLC.

A PLC Connector Kit (Part Number 540112) is supplied with the unit.

3.2 OPERATION

The Controller Module provides the controls for producing liquid flow via a positive displacement pumping mechanism. The systems utilize solid-state electronics, state-of-the-art motor drives, and precision machined ceramic pump heads. These components combine to provide exceptional accuracy and precision, high reliability, and low maintenance.

IVEK units have custom designed motors and pumps sized to the specific dispensing application to provide the proper torque and speed.

3.2.1 Control

All operational parameters on the Controller Modules are programmed through a single RS-232 interface. Total electronic control allows for effortless, exacting calibration and full accountability of cumulative volumes dispensed. Software contained in the Controller Module allows configuration and operation on a system-wide or individual controller basis.

NOTE

The system does NOT utilize nonvolatile memory. If power is turned Off, all parameters must be re-initialized after power is restored.

3.2.2 Logic I/O Interface

The Logic I/O Interface consists of the PLC Interface and the Independent I/O Interface.

The PLC interface provides communications between the Controller Module and the customer’s PLC. ‘System Trigger Input’, ‘System Ready Out’, ‘System Fault Out’, 'System Load Out' and 'System Load In' signals are communicated to and from the PLC.

The Independent I/O interface provides communications between an individual Controller Module and the customer’s PLC. ‘Channel Trigger Input’, ‘Channel Ready Out’, ‘Channel Fault Out’, 'Channel Load Out' and 'Channel Load In' signals are communicated to and from the PLC.

3.2.2.1 Signal Functions

CAUTION

The Trigger In and Load In signals should only be initiated when the Ready signal is true and the Fault signal is false.

System Trigger In - The 'System Trigger In' signal initiates a cycle. The trigger signal has no effect if the system is Active, in Prime or Agitate mode, is faulted, requires a reference, or requires a load cycle.

Dispense or Dispense MCV Mode - When the Controller Module is properly configured for Dispense or Dispense MCV mode, all controllers are triggered at the transition when a signal is applied to the system trigger. If a controller is disabled, faulted, or requires a reference, that controller is not triggered. If a pump module is disabled, that pump module will remain ported to the inlet.

Meter Mode - When the Controller Module is properly configured for Meter mode, all controllers are triggered as long as a signal is applied to the system trigger (until the pump chambers empty). If a controller is disabled, faulted, or requires a reference, that controller is not triggered. If a pump module is disabled, that pump module will remain ported to the inlet.

System Ready Out - The 'System Ready Out' signal indicates the active/idle state of the Controller Module. All controllers must be 'ready' for this output to be 'true'. This output is false if any controller is not 'ready'. The 'h' command is used to define 'ready' for both the 'system ready' and 'independent ready' outputs.

System Fault Out - The 'System Fault Out' signal indicates that a fault has been detected in the operation. This output is complemented, i.e., the output is true when no fault exists on any controller, and is false when one or more controllers are faulted.

System Load Out - The 'System Load Out' signal indicates that a Controller requires a load cycle. This output is true when no enabled controllers require a load. This output is false if any enabled controller requires a load or is in the process of loading.

System Load In - A signal applied to this input will initiate a load cycle. While idle, operation is initiated at the rising edge of this signal, with any further activities on the signal ignored until the operation is completed.

Channel Trigger In - The 'Channel Trigger In' signal initiates a cycle for an individual controller. A signal applied to this input will trigger the selected controller if the controller has Dispense or Meter mode selected. The controller will not be triggered if it is Active, in Prime or Agitate mode, is faulted, requires a reference, or requires a load cycle.

Channel Ready Out - The 'Channel Ready Out' signal indicates the active/idle state of an individual controller.

Channel Fault Out - The 'Channel Fault Out' signal indicates that a fault has been detected in the operation of the controller. This output is complemented, i.e., the output is true when no fault exists on any controller, and is false when the controller is faulted.

Channel Load Out - The 'Channel Load Out' signal indicates that a channel requires a load cycle. This output is 'false' when any enabled channels require a load or are in process of loading. This output is 'true' if no enabled channel requires a load or is in the process of loading.

Channel Load In - A signal applied to this input will initiate a load cycle. While idle, operation is initiated at the rising edge of this signal, with any further activities on the signal ignored until the operation is completed.

3.2.2.2 Signal Levels

All signals are optically isolated. The power for all signals is provided by the customer's equipment.

All inputs accept a 24 VDC signal and require 20 mA.

All outputs conduct when the signal is 'true' and do not conduct when the signal is 'false' (see FAULT OUT).

Outputs can switch a signal of up to 24 VDC and 50 mA. The output consists of the emitter and collector connections to an IC opto-isolator.

3.2.2.3 Connections

All connections are through a 24 pin circular plastic connector. The custom wiring connector kit is supplied and includes mating connector, backshell, and crimp pins. The connector has the pin layout as shown in Table 3.1.

3.2.3 Emergency Stop Requirements

The Emergency Stop provides a means of applying and removing air and motor power for the Multiplex Actuator(s) and Multiplex Striper Bed. When energized, the relay interface provides power to the controllers' motor drive electronics and energizes an air dump valve located in the actuator. For convenience, connections to an internal 24 Vdc power source are provided in the connector for energizing the relay.

Table 3.1 Master PLC Pin Configuration

PIN #	SIGNAL		
1	System Trigger In +	13	Channel Trigger In +
2	System Trigger In -	14	Channel Trigger In -
3	System Ready Out +	15	Channel Ready Out +
4	System Ready Out -	16	Channel Ready Out -
5	System Fault Out +	17	Channel Fault Out +
6	System Fault Out -	18	Channel Fault Out -
7	System Load Out +	19	Channel Load Out +
8	System Load Out -	20	Channel Load Out -
9	System Load In +	21	Channel Load In +
10	System Load In -	22	Channel Load In -
11	<<KEY/PLUG>>	23	(Factory Use Only)
12	<<KEY/PLUG>>	24	(Factory Use Only)

3.2.3.1 Instructions

Wire the Emergency Stop switch (customer provided) in series with relay coil(s) and suitable external 24 Volt power source using the Connector Kit. See the sections below for the switch and power source requirements and pinout of the connector. External circuit protection (a series fuse) is required to be provided by the customer if the internal 24 Vdc power source is used to energize the relay coil. Only one 24 VDC power source should be used. Under no circumstance should more than one supply be wired to another supply in parallel. Refer to Figure 3.3.

3.2.3.2 Relay Coil Specification

Nominal Coil Voltage	24 VDC
Nominal Coil Current	0.07 Amps
Nominal Coil Power	1.7 Watts
DC Resistance (± 10%)	350 Ohm
Must Operate Voltage	75% of Coil Voltage (18.0 VDC)
Must Release Voltage	10% of Coil Voltage (2.4 VDC)

3.2.3.3 Connections

PIN	SIGNAL
1	Relay Coil +
2	Relay Coil –
3	+24 Vdc
4	24 V Return

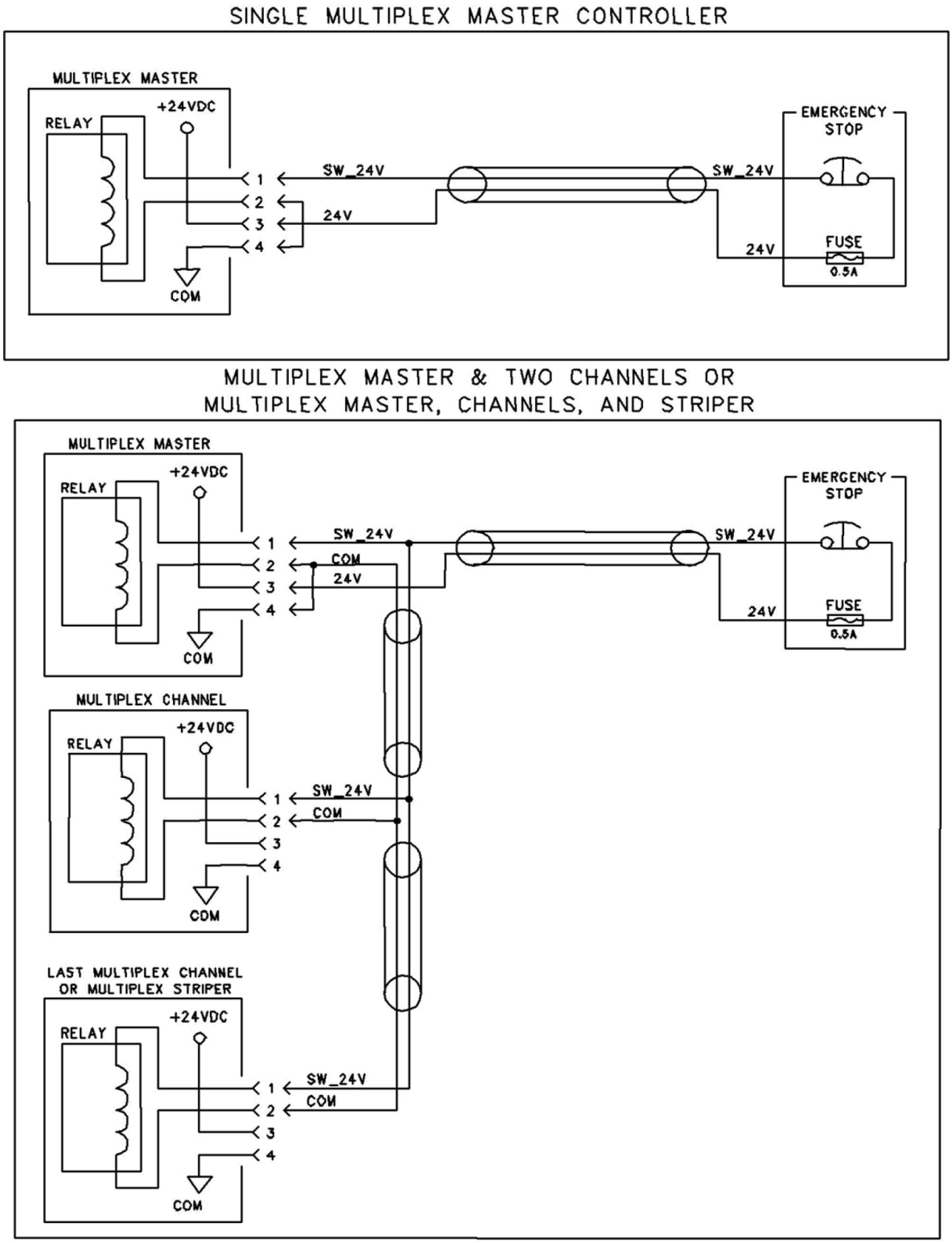


Figure 3.3 Emergency Stop Switch Wiring Diagram

3.2.4 Operating Modes

There are several different modes of operation, which provide the Controller Module with its vast functional flexibility. The operational mode is selected using the 'm' command through the serial interface.

NOTE

Do not initiate operation while the Actuator is in motion. Only send the "b" command when the Actuator is idle.

3.2.4.1 Prime

Prime mode produces a continuous cycle to pump fluid in one direction. Prime mode fills the system with fluid in preparation for actual operation, empties the system of fluid, and flushes the system for cleaning.

The current settings for the fluid direction ('d' command) determines the direction of fluid flow. Pumping cannot be started in this mode using the PLC inputs; only using the begin command ('b') through the serial interface. The pumping will continue until the end command ('e') is issued or up to a maximum time set with the 't' command. The time-out insures a communications problem won't result in the pumps operating indefinitely.

The flow rate for Prime mode is set with the 'u' command. The flow rate for Prime mode is also used during load cycles.

Volume pumped during prime operation does not accumulate on the totalizer (viewed with the 'g' command).

3.2.4.2 Dispense and Dispense MCV

Dispense and Dispense MCV (minimum chamber volume) modes are used to deliver a specific volume of fluid at a specific rate. Dispense MCV will only fill the chamber with the amount of liquid to be dispensed. Dispense fills the entire chamber. The current settings for the liquid direction ('d' command) determines the direction of liquid flow. Pumping can be started with the begin command ('b') using the serial interface, or with PLC inputs. The dispense cycle will continue until the volume set using the 'v' command has been delivered, unless the end command ('e') is issued.

The flow rate for Dispense mode is set with the 'r' command.

The volume for Dispense mode is set with the 'v' command.

Volume pumped during dispense operation accumulates on the totalizer which is viewed with the 'g' command.

NOTE

A Load Command is required anytime the mode is changed to or from Dispense MCV Mode. When recovering from a fault while operating in Dispense MCV mode, after a Reference ("f") is complete, initiate a load cycle ("l".

3.2.4.3 Meter

Meter mode is used to deliver fluid at a specific rate for a period of time determined by PLC input signals or commands through the serial interface. The most accurate and repeatable method to control metering operation uses the PLC inputs. Pumping will start when the trigger signal is present and will stop when the trigger signal is removed or the pump chamber empties. Pumping will also start with the begin command ('b') using the serial interface and stop with the end command ('e'). The current settings for the fluid direction ('d' command) determines the direction of fluid flow.

The flow rate for metering is set with the 'r' command as in dispense.

Volume pumped during meter operation accumulates on the totalizer that is viewed with the 'g' command.

3.2.4.4 Agitate

Agitate is a unique mode used to prevent fluid from setting in the pumps or pump lines during extended idle times. The current setting for the fluid direction ('d' command) determines the direction of the agitation cycle. Agitate mode cannot be started using the PLC inputs; only using the begin command ('b') through the serial interface. Agitate mode will continue until the end command ('e') is issued.
Agitate mode is a reverse action followed by a sequence of reverse and forward pumping to keep the liquid in the lines and Pump Modules moving. The Isolation Volume ('y1' command) specifies the number of full strokes operated in reverse. The Agitate Volume ('y2' command) specifies the strokes the pump will operate in reverse then forward. The Dwell ('y3' command) specifies the wait time between each reverse and forward cycle. Make sure the Isolation Volume and the Agitate Volume never cause liquid to empty the output tubing.

3.2.4.5 Other Operating Sequences

Load - The load cycle is used to refill the pumping chamber with fluid after dispensing or metering. The piston will valve to the inlet port, fill the pump chamber with fluid, and valve back to the discharge port. Loading can be initiated 'manually' by using the load command ('l') or automatically. The system can be configured to automatically start a load cycle on either of two conditions; empty and every, which is set using the 'a' command.

When the system is configured for 'load empty', a load cycle will start when the pump is idle and the remaining volume in the pump chamber is less than the volume indicated by the 'v' parameter (dispense volume). The 'v' parameter is used for this function during both dispense and meter operation even though the 'v' parameter is not otherwise used during meter operation.

When the system is configured for 'load every', a load cycle will start at the completion of every dispense or meter operation.

The 'a' command is used to configure automatic loading for manual (no automatic loading), empty, or every.

Reference - The controller must complete a reference cycle when power is first applied or when a fault occurs. This is due to the Modules having no sensors that send the absolute linear and rotary locations of the piston at all positions. The piston(s) will first turn to find and verify the rotary home (pump chamber open to inlet), then move linearly to find the linear home references. A reference cycle (initiated with the 'f' command) is required after faults or after power is first applied and before any command resulting in motion of the Module is accepted (b, l etc.). Faults must first be cleared before a reference cycle will start.

NOTE

The system will not operate if a reference command has not been initiated. The system will only return warnings.

Drawback - Drawback is a controlled reverse flow at the end of a dispense to improve volume repeatability when 'stringy' fluids are being dispensed. If no drawback is required, the drawback volume is simply set to "0". When drawback is used, the dispense volume ('v' command) specifies the net fluid dispensed. The actual forward stroke is the sum of the specified dispense volume and the drawback volume. The flow rate during drawback and the dwell (time between the forward and reverse portions of the cycle) are specified in the same command ('w') as the drawback volume. Drawback is valid in Dispense mode only.

NOTE

After priming the fluid system, the first dispense will produce an incorrect volume when drawback is used.

3.2.5 Operating Parameters

Parameters are divided into a number of categories. This section provides a description of each command in the category that best fits its description.

3.2.5.1 Pump Control

The following parameters control the specific operation of the Controller Module. All of the following parameters may be set in the individual controller. The controllers can have the same or different values for each parameter.

Rate for Dispense and Meter Operation - One parameter is used to control the fluid flow rate for both Dispense and Meter mode. ('r' command)

Dispense Volume - While this parameter is used to specify the volume of fluid dispensed during dispense operation, it is also used to determine if a load cycle is required before another dispense or metering cycle can be initiated. ('v' command)

Rate for Prime, Load and Agitate Operation - This parameter is used to control the fluid flow rate for Prime, Load and Agitate operations. ('u' command)

Direction - The direction of the fluid flow is normally forward, but can be reversed to empty fluid back into the supply. ('d' command) Forward produces fluid exiting the outlet port of the Pump Module.

NOTE

Do not send the "d" command while the Actuator is in motion. Only send the "d" command when the actuator is idle.

Drawback - Three parameters are specified with one command to describe drawback operation. These are the drawback volume, the fluid flow rate during drawback, and the dwell (time delay) between the dispense and drawback portions of the cycle. ('w' command)

Auto Load - The pump can be set to automatically begin a load cycle when either the pump is 'empty' or after every dispensing or metering operation. ('a' command)

Keylock - This parameter is used to enable or disable controllers and / or pump modules. ('k' command)

NOTE

Do not send the "k" command while the Actuator is in motion. Only send the "k" command when the actuator is idle.

Time Limit For Prime - In order to prevent a problem if the communications are interrupted during a prime operation, priming is limited to a duration specified by a parameter. ('t' command)

3.2.5.2 Pump Size – Multiplex Series

Pump sizes for the Multiplex Series are as described in Chapter 7.

NOTE

The volume is set in increments and the rates are set in increments per second. Use the chart in Chapter 7 to convert to volume. Multiply the resolution per increment for the Pump Module by the number of increments to obtain the volume.

3.2.5.3 Interface Control

The following parameter controls the interface (PLC) to the Controller Module.

Hardwired Ready Signal - Both the hardwired (PLC) system ready output and the optional controller ready outputs can be configured by the customer. In all cases the output indicates 'busy' during a dispense, but may be configured to be either 'busy' or 'ready' when other conditions exist, such as during a load cycle or if a fault is detected. This parameter may be set in each individual controller. ('h' command)

3.2.6 Status Information

3.2.6.1 General information

Additional information is available which may be used to confirm proper operation of the system.

Totalizer - A totalizer for each controller, which accumulates commanded increments during Dispense and Meter modes, can be read or reset to zero. This is the total increments for the controller, not for individual pump modules within the controller. (see Keylock command) The totalizer stops at a maximum value of 2,000,000,000 increments. The value does not wraparound to 0 so it must be reset. ('g' command)

Ready/Busy - The active or inactive state of each controller can be read. ('q' command)

Volume Remaining - The remaining capacity of the pump chamber (in increments) for each controller can be read. ('s' command)

Software Version - The software version on the master controller and each channel controller can be read. ('z' command)

3.2.6.2 Faults

The response to all commands to a particular controller will include fault or warning information, if applicable. The fault will be indicated until faults are cleared on that particular controller. Warnings will be indicated as long as they apply. A fault present on a controller other than the one addressed by the current command will be indicated, but neither the faulted controller address nor the exact type of fault will be indicated.

A fault is the result of improper operation of the Controller Module being detected.
Warnings indicate an error in the command, or a condition that requires attention before operation can be initiated.

Clear Faults - The clear faults command must be issued prior to any commands which would cause motion in the Controller Module. This command responds with the identity of the fault being cleared and additional information for certain faults. (c command)

NOTE

After a fault is cleared, a reference ('f' command) MUST BE issued to insure proper operation of the controller that was faulted. The controller that was faulted WILL NOT respond to any motion command until the reference command has been completed successfully.

3.2.7 Controller Module Serial Interface Standard Feature

CAUTION

Do not issue a motion command while the actuator is busy (while actuator is in motion). Use the query ('q') Ready / Busy command to determine the actuator Ready / Busy status.

Only commands listed in this manual should be used. All commands must follow the command structure.

The serial interface provides control of all functions available.
The hardware is configured as RS-232 Data Communications Equipment (DCE) standard with the pin configuration shown.

3.2.7.1 Connections (DCE, 25 pin D-sub female)

Pin	Signal	Direction
1	SHLD	Shield not connected
2	TD	Data (command) to IVEK Controller Module
3	RD	Data (response) from IVEK Controller Module
7	GND	

3.2.7.2 Communication Parameters

No hardware signals are currently used for handshaking.

The parameters of the communications interface must be set as follows.

- 9600 BAUD
- 8 BIT
- NO PARITY
- ONE STOP BIT

The maximum response time from the master to host is 750 mSec after the carriage return '<CR>' has been received from the host. It is suggested that the host control attempt a minimum of two (or more) retries before generating a host communication time–out error.

Also, note that an escape '<esc>' will reset the Controllers to a warm restart.

The Multiplex System on power-up or warm-start should take about 10 seconds to initialize and perform built-in power-up diagnostics. During this time, all front panel indicators will be on. At the completion, the IDLE indicator should be on.

3.2.7.3 Command Structure

The command is a string of ASCII characters. The use of the ASCII backspace or rubout characters as a means of entry correction is not supported.

Commands are not directly echoed as they are received. The terminal being utilized to send commands should be setup for half-duplex or local echo mode.

After dispense or metering operation is triggered, the values for that operation are fixed. This allows new parameter values for the following operation to be downloaded before the current operation is complete.

The Controller Module serial interface does not 'broadcast' messages, such as fault conditions, but only responds when it receives a command.

<name> Represents an argument
[ ] Represents an optional argument
, Field delimiter character for numerical arguments.
<CR> End of command represented by ASCII carriage return character (no line feed).

The complete command form is:
[<cntrl>]<cmd>[<value1>[,<value2>[,<value3>]]]<CR>

<cntrl> Controller number
All numerical characters beginning a command are evaluated as the controller number. If omitted, the previous value of the controller remains in effect. The value of zero will broadcast a command to all controllers. Controllers are within the range from 1 to 8 (with the exception of a Multiplex Striper Controller which for compatibility with other IVEK equipment is addressed as 31).

<cmd> Command
The first non-numerical character seen in the command string will be evaluated as the command character. Command characters ARE case sensitive (lower case). If no command is included, (command string only consists of numerical characters), response will only be <CR> indicating unit is ready to accept new command string.

<value1> First numerical parameter
The first numerical character received after the command character begins evaluation of the first numerical parameter. A field delimiter character after the command character and before the first numerical character will be ignored and will not delimit the first parameter to a value of zero. This means a zero character must be used to indicate an argument with value of zero for the first numerical parameter.

<value2> Second numerical parameter
All non-numerical values with the exception of the field delimiter character will be ignored. A null argument will be evaluated as a value of zero (no numerical characters between the field delimiter for the first parameter and a following field delimiter or end of command character).

<value3> Third numerical parameter
All non-numerical values with the exception of the field delimiter character will be ignored. A null argument will be evaluated as a value of zero (no numerical characters between the field delimiter for the second parameter and a following field delimiter or end of command character). All values in the command string which are not required by the command specified will be ignored.

All values in the command string which are not required by the command specified will be ignored. Following are some examples of command strings.

2v890<CR>	Controller 2, command v, one value of 890
0r400<CR>	All controllers, command r, one value of 400
e<CR>	Same controller as previous command, command e
1q<CR>	Controller 1, command q, no values

NOTE

Transmission should stop when an ASCII carriage return character is sent and can resume when the ASCII carriage return of the response is received. The serial interface has a limited receive buffer. Information may be lost if multiple commands are sent one after another without waiting for the ASCII carriage return response.

3.2.7.4 Response String

The response from the Multiplex has a format which is very similar to the command sent with the addition of a 'flag' and value if a fault or warning is active.

<name>	Represents an argument
[ ]	Represents an optional argument
,	Field delimiter character for numerical arguments.
*	Field delimiter character which precedes fault or warning value
<CR>	End of command represented by ASCII carriage return character (no line feed).

[<cntrl>]<cmd>[<value1>[,<value2>[,<value3>]]]<CR>

The description for the response string above follows the structure of the command string previously described.

If a fault or warning exists, the normal value(s) are returned for the command, followed by the fault delimiter (in place of the normal field delimiter) and the fault number to indicate the problem. The fault delimiter and fault number will appear in all responses from that controller until the command to clear faults is sent to the faulted controller. If a command normally returns three values, the fault number will replace the third value. Following are some examples of command strings.

2c<CR>
Command: Controller 2, command
c 2c<CR>
Response: Controller 2, command c, no values other than warnings or first fault (subsequent faults are cleared) are returned by command c.

1m1<CR>
Command: Controller 1, command m, one value of
1 1m1<CR>
Response: Controller 1, command m, one value of 1

u<CR>
Command: Same Controller as previous command (1), command u, no new
value 1u2000<CR>
Response: Controller 1, command u, one value of 2000

u3500<CR>
Command: Same Controller as previous command (1), command u, 1 value of
3500 1u3500<CR>
Response: Controller 1, command u, value of 3500

r0<CR>
Command: Same Controller as previous command (1), command r, 1 value
of 0 1r1000*2
Response: Controller 1, command r, current value is 1000 (unchanged), warning 2 = value no good

3.2.7.5 Broadcasting

A command with a controller address of 0 will be sent to all controllers. A subsequent command which does not indicate a new controller number will also be broadcast to all controllers (previous controller number is retained as in single controller commands). The response from each controller will be sent by the Controller Module (master), with a semicolon separating the responses of different controllers. An ASCII carriage return is sent by the Multiplex at the end of the response from the last controller.

1<cmd><value>;2<cmd><value>;3<cmd><value>; ... ;n<cmd><value><CR>

Examples
0m2<CR>

Command: Sets all controllers to dispense mode
1m2;2m2;3m2<CR>
Response: For a 3 controller system
0v540<CR>

Command: Sets all controllers to a volume of 540
1v540;2v540;3v540;4v540<CR>
Response: For a 4 controller system
0f<CR>

Command: Reference all controllers
1f;2f;3f;4f;5f;6f;7f;8f<CR>
Response: For an 8 controller system

3.2.7.6 Commands

The commands are sent to the controller(s) and can either command one controller or all controllers depending on the code sent. If a 0 is sent as the controller number, all controllers will be affected. If the controller number is sent, (i.e. 1

for controller 1, 2 for controller 2) then only that controller will be affected. The following tables list the commands for the controller(s).

NOTE

Refer to previous description for complete command syntax ("Command Structure")

Controller Commands (Precede command with 0 for all controllers or the individual controller number)

Command	Response	Description
a =>AUTOLOAD		
a	a<value1>	Returns current autoload setting.
a<value1>	a<value1>	Sets the Autoload mode. <value1>: 0 = Manual (default) 1 = Empty 2 = Every
b => BEGIN		
b	b	Initiates a prime, dispense, or meter cycle according to the current 'mode' setting.
c => CLEAR FAULTS		
c	c<value1>	Clears all faults. Error number returned as value1.
d => DIRECTION		
d	d<value1>	Returns current fluid direction setting.
d<value1>	d<value1>	Determines fluid direction. <value1>: 0 = Reverse 1 = Forward (default)

NOTE

Do not send the "d" command while the Actuator is in motion. Only send the "d" command when the actuator is idle.

e => END		
e	e	Stops current pump operation. In Prime mode, will continue until piston chamber is full. In Agitate mode, will continue until fluid is in the original position. In all other modes, motion will stop as soon as possible.
f => REFERENCE		
f	f	References the home position for both the rotary and linear sensors for all enabled controllers and pump modules.

NOTE

Do not send the "f" command while the Actuator is in motion. Doing so may cause damage to the system.

g => TOTALIZER		
g	g<value1>	Returns current value, in pump increments, of the totalizer for dispensing and metering volume. <value1> a decimal value. Maximum: The totalizer will Increment to a maximum value of 2,000,000,000 and stop. The totalizer will not 'wrap around'. The pump will continue to operate without incrementing the totalizer.
h =>HARDWIRED READY SIGNAL		
h	h<value1>	Returns the current configuration for the hardwired ready signals.

h<value1>	h<value1>	Sets the hardwired ready signal configuration. <value1> represents a 3 digit decimal value.

The hardwired ready signals (SYSTEM READY and optional individual CONTROLLER READY) are always false while the pump is active in dispense or metering operation. In addition, the ready signals can be configured to be false during other times by setting appropriate bits in this configuration value. In all other cases, the ready output will be true. Individual configuration information can be determined using binary decoding as follows:

if bit set, SYSTEM

bit	value	READY also false
0	1	Valving
1	2	Priming or Loading
2	4	Load Required
3	8	Any fault true, Ref Required

if bit set, individual Controller

bit	value	READY also false
4	16	Valving
5	32	Priming or Loading
6	64	Load Required
7	128	Any fault true or Ref Required
	136	System or Channel not ready if fault or reference required (default)
	0	Min Value
	255	Max Value

k => KEYLOCK

k	k<value1>	Returns the current setting which inhibits or allows operation of pump modules.
k<value1>	k<value1>	Inhibits or allows operation of a pump module within a controller. <value1>: 0 = Disable all Pumps within controller and the controller. 2^{12}-1 = 4095 Enable all Pumps within controller 255 (Default 8 Channel) 1023 (Default 10 Channel) 4095 (Default 12 Channel) Individual enable / disable functions can be determined using binary coding as follows:

if bit set,	bit	value	Pump Module
	0	1	Enable Pump 1
	1	2	Enable Pump 2
	2	4	Enable Pump 3
	3	8	Enable Pump 4 etc.

NOTE

Do not change the "k" value while the Actuator is in motion. Only send the "k" command when the actuator is idle.

l => LOAD

l	l	Initiates a load cycle.

NOTE

Do not send the "l" command while the Actuator is in motion. Only send the "l" command when the actuator is idle.

m => MODE

m	m<value1>	Returns the current mode.
m<value1>	m<value1>	Sets the operating mode.

<value1>:
1 = Prime (default)
2 = Dispense
3 = Meter
6 = Agitate
7 = Dispense MCV

q => READY/BUSY

q q<value1> Indicates Ready/Busy status.
<value1> is 0 for Ready and not zero for Busy. Individual operational information can be determined using binary decoding as follows:

bit	value	active if bit set
0	1	Any Motion
1	2	Dispense or Meter
2	4	Prime
3	8	Load
4	16	Valve
5	32	Reference
6	64	Drawback

r =>DISPENSE RATE

r r<value1> Returns the current dispense and metering flow rate in increments per second.

r<value1> r<value1> Sets the dispense and metering flow rate in increments per second. represents a 6 digit decimal value.
Maximum: 150000
Minimum: 1
20000 (default)

s=> STATUS INFORMATION

s s<value1> Returns the volume remaining in the pumps (units are increments)
<value1>: volume remaining

s10 s10,<value2> Returns the post trigger delay before pump motion starts.

s10,<value2> s10,<value2> Sets the post trigger delay before pump motion starts. Value of zero will start pump motion when trigger is received.
<value2>
Delay in milliseconds.
Maximum: 500
Minimum: 0 (default)

s11 s11,<value2> Returns the valve dwell before sensing valve motion.

s11,<value2> s11,<value2> Sets the valve dwell before sensing valve motion.
<value2>
Delay in tens-of-milliseconds.
Maximum: 200 (2.0 seconds)
Minimum: 0
Default: 10

s20 s20,<value2> Returns motor torque reduction multiplier.

s20,<value2> s20,<value2> Sets the motor torque reduction multiplier.
Maximum: 100 (default)
Minimum: 60

s21 s21,<value2> Returns the current reference rate in increments per second.

s21,<value2> s21,<value2> Sets the rate used for referencing the linear (piston displacement) axis in increments per second. <value 2> represents a six digit value
Maximum: 20000 (default)
Minimum: 500

s1002 s1002,<value2> Returns the encoded valve fault identified. See the "k" command for encoding.

t => TIME LIMIT FOR PRIME

t t<value1> Returns current limit on prime cycle in seconds.

t<value1>	t<value1>	Sets the limit on prime cycle in seconds. Small values of 't' will allow at least one pump cycle. <value1> Represents a 4 digit decimal value. Maximum: 9999 Minimum: 1 Default: 20

u => PRIME RATE

u	u<value1>	Returns the current prime and load flow rate in increments per second.
u<value1>	u<value1>	Sets the prime and load rate in increments per second. <value1> Represents a 6 digit decimal value. Maximum: 150000 Minimum: 1 Default: 40000

v => DISPENSE VOLUME

v	v<value1>	Returns the current dispense volume in increments.
v<value1>	v<value1>	Sets the dispense volume in increments. A volume of zero will not allow the unit to be triggered while in dispense mode. <value1> represents a 5 digit decimal value. Maximum: 40000 Minimum: 0 Default: 10000

w => DRAWBACK

w1	w1,<value2>	Returns the drawback volume in increments.
w1,<value2>	w1,<value2>	Sets the drawback volume in increments. <value2> represents a 5 digit decimal value Maximum 40000 Minimum 0 (default)
w2	w2,<value2>	Returns the drawback rate in increments per second.
w2,<value2>	w2,<value2>	Sets the drawback rate in increments per second. <value2> represents a 6 digit decimal value Maximum 150000 Minimum 1 Default: 20000
w3	w3,<value2>	Returns the drawback dwell in tens-of-milliseconds.
w3,<value2>	w3,<value2>	Sets the drawback dwell in tens of-milliseconds. <value2> represents a 3 digit decimal value Maximum 255 Minimum 0 (default)

NOTE

The DISPENSE VOLUME setting PLUS the DRAWBACK (v<value1> + w1,<value1>) setting must be less than the maximum Volume of 40000.

y => AGITATE

y1	y1,<value2>	Returns the agitate isolation volume in full pump strokes.
y1,<value2>	y1,<value2>	Sets the agitate isolation volume in full strokes. <value2> represents a 3 digit decimal value Maximum 100 Minimum 0 (default)
y2	y2,<value2>	Returns the agitate strokes in full pump stokes.
y2,<value2>	y2,<value2>	Sets the agitate strokes in full pump strokes. <value2> represents a 3 digit decimal value Maximum 100 Minimum 1 (default)

y3	y3,<value2>	Returns the agitate dwell in tens of-milliseconds.
y3,<value2>	y3,<value2>	Sets the agitate dwell in tens-of-milliseconds. <value2> represents a 3 digit decimal value Maximum 999 Minimum 0 (default)

z => SOFTWARE VERSION

z	z<value1>	Returns the software version. Software version information includes the Multiplex family or group and date code (revision code). The versions include:
	PMBdddyy	For striper bed
	PMCdddyy	For custom systems
	PMDdddyy	For SF series W/O Touchscreen
	PMEdddyy	For LF series W/O Touchscreen
	PMFdddyy	Reserved
	PMGdddyy	For SF series W Touchscreen
	PMHdddyy	For LF series W Touchscreen
	PMJdddyy	Reserved

The revision code is 'ddd' the day of the year and 'yy' the last two digits of the year.

3.2.7.7 Warnings

Warnings indicate problems in the command received, or a state of the Controller Module which prohibits immediate operation. An asterisk (*) precedes warnings in responses. An appropriate command (other than ‘clear faults’) may be required to operate the pump.

1 Command Not Valid
Response to any unrecognized command.
2 Value Not Valid
Response to any out of range value.
3 Load Required
Pump is empty or remaining volume is less than the current dispense volume.
4 Reference Required
Pump needs to locate linear and rotary reference position. Reference cycle, using ‘f’ command, must be completed before continuing.
5 (not used)
Warning number reserved for consistency with functions of other controllers.
6 (not used)
Warning number reserved for consistency with functions of other controllers.
7 Controller Not Installed
No response from controller with that address.
8 (not used)
Warning number reserved for consistency with functions of other controllers.
9 Controller/Pump Not Enabled
Specific controller or pump triggered with ‘begin’ or ‘load’ commands but all pumps disabled (k=0).
10 E-Stop, Guard
Emergency Stop or Guard switch (if installed).
11 (not used)
Warning number reserved for consistency with functions of other controllers.
15 (not used)
Warning number reserved for consistency with functions of other controllers.
16 (not used)
Warning number reserved for consistency with functions of other controllers.

3.2.7.8 Faults

Faults are a result of the system detecting improper operation of the Controller Module or Pump. All fault numbers will be greater than or equal to 1000. An asterisk (*) precedes warnings in responses. The 'clear faults' command must be used before any subsequent operation of the affected controller is performed.

1000 Fault On Other Controller
An unspecified fault has been detected on another controller. This error will not appear if a warning or fault condition exists in the controller for the command (won't replace warning or fault information from command's controller to indicate fault elsewhere). This error will not appear in a broadcast response.

1001 Linear Sensor Fault
"Home" position sensor for linear motion was not detected. Clear faults using 'c' command and re-reference using 'f' command.

1002 Rotary Sensor Fault
"Home" position sensor for rotary motion was not detected. Clear faults using 'c' command and re-reference using 'f' command.

1003 (not used)
Error number reserved for consistency with functions of other controllers.

1004 (not used)
Error number reserved for consistency with functions of other controllers.

1010 Control Cable Fault
Control cable either not connected or incorrectly connected.

3.2.7.9 Command Summary

The command summary section is almost identical to the Command section except it has been abbreviated into two pages. This will allow for copying to create a single front-and-back reference sheet.

Controller Commands Summary

(Precede command with 0 for all controllers or the individual controller number)

Command	Response	Description
a<value1>	a<value1>	Sets the Autoload mode. <value1>: 0 = Manual (default) 1 = Empty 2 = Every
b	b	Initiates a pump cycle.
c	c<value1>	Clears all faults
d<value1>	d<value1>	Determines fluid direction. <value1>: 0 = Reverse 1 = Forward (default)
e	e	Stops current pump operation.
f	f	Sets the piston in the reference location.
g	g<value1>	Returns the total number of increments of the totalizer (send 0 to reset)
h<value1>	h<value1>	Sets configuration for the hardwired ready signals if bit set, SYSTEM READY also false bit value 0 1 Valving 1 2 Priming or Loading 2 4 Load Required 3 8 Any Fault True or Ref Required if bit set, individual CONTROLLER bit value READY also false 4 16 Valving 5 32 Priming or Loading 6 64 Load Required 7 128 Any Fault True or Ref Required 136 System or Channel not ready if fault or reference required (default)
k<value1>	k<value1>	Inhibits or allows operation of a pump module within a controller (binary coded). <value1>: 0 = Disable all Pumps within controller 255 (Default 8 Channel) 1023 (Default 10 Channel) 4095 (Default 12 Channel)
l	l	Initiates a load cycle.
m<value1>	m<value1>	Sets operating mode. <value1>: 1 = Prime (default) 2 = Dispense 3 = Meter 6 = Agitate 7 = Dispense MCV
q	q<value1>	Returns the Ready / Busy status. <value1>: 0 = Ready not 0 = Busy
r<value1>	r<value1>	Sets the dispense and metering flow rate in increments per second. <value1> represents a 6 digit decimal value. Maximum: 150000 Minimum: 1 20000 (default)
s	s<value1>	Returns the volume remaining in the pumps (units are increments). <value1>: volume remaining
s10,<value2>	s10,<value2>	Sets the post trigger delay before pump motion starts. Value of zero will start pump motion when trigger is received. <value2> Delay in milliseconds. Maximum: 500 Minimum: 0 (default)
s11,<value2>	s11,<value2>	Sets the valve dwell before sensing valve motion. <value2> Delay in tens-of-milliseconds. Maximum: 200 (2.0 seconds) Minimum: 0 10 (default)
s20, <value 2>	s20,<value2>	Sets the motor torque reduction multiplier. Maximum: 100 (default) Minimum: 60

Command	Response	Description
s21, <value 2>	s21,<value2>	Sets the rate used for referencing the linear (piston displacement) axis in increments per second. <value 2> represents a 6 digit decimal value. Maximum: 2000 (default) Minimum: 500
s1002	s1002,<value2>	Returns the encoded valve fault identified. See the "k" command for encoding.
t<value1>	t<value1>	Sets the limit on prime cycle in seconds. Value of zero will allow priming for less than one second. <value1> represents a 4 digit decimal value. Maximum: 9999 Minimum: 1 20 (default)
u<value1>	u<value1>	Sets the prime and load rate in increments per second. <value1> represents a 6 digit decimal value. Maximum: 150000 Minimum: 1 40000 (default)
v<value1>	v<value1>	Sets the dispense volume in increments. A volume of zero will not allow the unit to be triggered while in dispense mode. <value1> represents a 5 digit decimal value. Maximum: 40000 Minimum: 0 10000 (default)
w1,<value2>	w1,<value2>	Sets the drawback volume in increments. <value2> represents a 5 digit decimal value Maximum 40000 Minimum 0 (default)
w2,<value2>	w2,<value2>	Sets the drawback rate in increments per second. <value2> represents a 6 digit decimal value Maximum 150000 Minimum 1 20000 (default)
w3,<value2>	w3,<value2>	Sets the drawback dwell in tens-of-milliseconds. <value2> represents a 3 digit decimal value Maximum 255 Minimum 0 (default)
y1,<value2>	y1,<value2>	Sets the agitate isolation volume in full strokes. <value2> represents a 3 digit decimal value Maximum 100 Minimum 0 (default)
y2,<value2>	y2,<value2>	Sets the agitate strokes in full pump strokes. <value2> represents a 3 digit decimal value Maximum 100 Minimum 1 (default)
y3,<value2>	y3,<value2>	Sets the agitate dwell in tens-of-milliseconds. <value2> represents a 3 digit decimal value Maximum 999 Minimum 0 (default)
z	z<value1>,	Returns the software version

WARNINGS

1	Command Not Valid
2	Value Not Valid
3	Load Required
4	Reference Required
5	(not used)
6	(not used)
7	Controller Not Installed
8	(not used)
9	Controller / Pump Not Enabled
10	E-Stop, Guard
11	(not used)
15	(not used)
16	(not used)

FAULTS

1000	Fault On Other Controller
1001	Linear Sensor Fault
1002	Rotary Sensor Fault
1003	(not used)
1004	(not used)
1010	Control Cable Fault

3.2.8 Typical Command Sequence

Following are typical command sequences for operating the system. Your sequence may vary depending on your application.

3.2.8.1 Prime Sequence

Typical sequence for Priming a system. Example is for a two-controller system. This procedure can also be used for cleaning and emptying the system of fluid.

	COMMAND	RESPONSE	OUTCOME
1.	0q<CR>	1q0*4;2q0*4	Query Actuator Ready/Busy. Actuators require reference (*4 warning)
2.	0f<CR>	1f*4;2f*4	Initiate reference . Actuator reference required warning, *4, present until the Actuator references successfully.
3.	0q<CR>	1q0;2q0<CR>	Actuator ready, no warnings or faults.
4.	0d1<CR>	1d1:2d1<CR>	Sets the direction to forward.
5.	0m1<CR>	1m1:2m1<CR>	Sets to Prime Mode.
6.	0t120<CR>	1t120;2t120<CR>	Sets the prime cycle to 120 seconds
7.	0u4000<CR>	1u4000;2u4000<CR>	Sets Prime/Load rate to 4000 increments/sec. The Priming procedure fills the inlet tubing, pump head chamber, outlet tubing and nozzle with liquid.
8.	1k2241	1k2241<CR>	Enable controller 1, pump modules 1, 7,8 and 12 2241 decimal=100011000001 binary
9.	1b<CR>	1b<CR>	Begins Prime mode for controller 1, pump modules 1, 7, 8, and 12.
10.	1e<CR>	1e<CR>	Ends Prime mode (early if required) for controller number 1. The procedure is complete when there are no air bubbles remaining in the inlet tubing, pump head chamber, outlet tubing and nozzle. Prime the second controller in the same manner.
11.	2b<CR>	2b<CR>	Begins Prime mode in controller number 2, all pump modules (default).
12.	2e<CR>	2e<CR>	Ends Prime mode (early if required) for controller number 2. It is recommended that operators be able to individually start and stop the controllers during prime operation. This allows them to efficiently clear bubbles from each fluid line.

3.2.8.2. Dispense Sequence

Typical sequence for Dispensing. Example is for a two-controller system. The system must be Primed prior to dispensing.

	COMMAND	RESPONSE	OUTCOME
1.	0a1<CR>	1a1;2a1<CR>	Sets to load on empty.
2.	0d1<CR>	1d1;2d1<CR>	Sets the direction for forward.
3.	1k2730<CR>	1k2730<CR>	Enable controller 1, all even pump modules 2730 decimal = 101010101010 binary
4.	2k1365<CR>	2k1365<CR>	Enable controller 2, all odd pump modules 1365 decimal = 010101010101 binary
5.	0r60000<CR>	1r60000;2r60000<CR>	Sets the Dispense / Meter Rate to 60,000 increments/sec.
6.	1v15000<CR>	1v15000<CR>	Sets the dispense volume for controller 1 to 15,000 incre ments.
7.	2v30000<CR>	2v30000<CR>	Sets the dispense volume for controller 2 to 30,000 incre ments.
8.	0m2<CR>	1m2;2m2<CR>	Sets all controllers to Dispense mode. For initiation of a dispensing cycle, a 24V input trigger is necessary or receipt of the ‘b’ command.

3.2.8.3 Pump Reference Sequence

Typical sequence for referencing a system. A reference is required every time the unit is powered or after a system fault. The example is for a two-controller system.

	COMMAND	RESPONSE	OUTCOME
1.	0q<CR>	1q0*4;2q0*4<CR>	Query pumps on power-up (or after fault clear).
2.	1f<CR>	1f*4<CR>	Start the reference sequence for controller number 1.
3.	1q<CR>	1q33*4<CR>	Controller is busy, reference in progress. The query can be repeated until the controller has completed the reference successfully. The reference sequence is processor time intensive. The repeated polling frequency should be as slow as the application allows and should not be less than the maximum response time.
4.	1q<CR>	1q0<CR>	The controller has completed the reference sequence successfully. The system is ready to use. An unsuccessful completion would result in a response of the form "2q0*<fault code>". This would require a clear error "1c" and the reference sequence to be retried. A second attempt resulting in a fault would require operator action to correct the fault condition.
5.	2f<CR>	2f*4<CR>	Start the reference sequence for controller number 2.
6.	2q<CR>	2q33*4<CR>	Controller is busy, reference in progress. The query can be repeated until the controller has completed the reference successfully. The reference sequence is processor time intensive. The repeated polling frequency should be as slow as the application allows and should not be less than the maximum response time.
7.	2q<CR>	2q0<CR>	The controller has completed the reference sequence successfully. The system is ready to use. An unsuccessful completion would result in a response of the form "2q0*<fault code>". This would require a clear error "1c" and the reference sequence to be retried. A second attempt resulting in a fault would require operator action to correct the fault condition.

3.2.8.4 Pump Fault Recovery Sequence

If, during the process of operation, the system encounters a fault it will report the fault in the response string. An example is given for a two-pump controller system with a fault on controller 1. The fault occurred while the pumps were dispensing.

	COMMAND	RESPONSE	OUTCOME
1.	0q<CR>	1q0*1001;2q3<CR>	Controller 1 has a linear sensor fault. Controller 2 is still dispensing.
2.	1c<CR>	1c*1001<CR>	Clear the fault on controller 1.
3.	1q<CR>	1q0*4<CR>	Fault cleared, reference required.
4.	1f<CR>	1f*4<CR>	Start the reference sequence for controller number 1.
5.	1q<CR>	1q33*4<CR>	Controller is busy, reference in progress. The query can be repeated until the controller has completed the reference successfully. The reference sequence is processor time intensive. The repeated polling frequency should be as slow as the application allows and should not be less than the maximum response time.
6.	1q<CR>	1q0<CR>	The controller has completed the reference sequence successfully. The system is ready to use. An unsuccessful completion would result in a response of the form "2q0*<fault code>". This would require a clear error "1c" and the reference sequence to be retried. A second attempt resulting in a fault would require operator action to correct the fault condition.

3.2.8.5 Polling Pump Sequence

The system should be queried prior to commands for priming, dispensing, metering, loading or referencing. This is used to insure the system has completed the sequence successfully before issuing another command that would cause pump motion. The system will ignore pump motion commands (i.e. “b”, “f”, “l”) until the system is ready. Value commands may be changed while the pump is busy.

There are two methods of polling, either with a broadcast command or a command for each controller. The broadcasting is restricted to the pump controllers and will not be sent or reported from a striper bed controllers. An example is given for a two controller system.

Refer to the Ready / Busy Command (‘q’) for description of the returned value. A returned value of ‘0’ indicates ready, a value not equal to ‘0’ is busy.

Broadcast

	COMMAND	RESPONSE	OUTCOME
1.	0q<CR>	1q0;2q0<CR>	Both controllers ready.
2.	0q<CR>	1q3;2q5<CR>	Both controllers busy. Controller 1 is dispensing or metering. Controller 2 is priming.
3.	0q<CR>	1q0;2q9<CR>	Controller one is ready. Controller 2 is busy loading.

Broadcast with Striper Controller

	COMMAND	RESPONSE	OUTCOME
1.	0q<CR>	1q0;2q0<CR>	Both pump Controllers ready.
2.	31q<CR>	31q5<CR>	Striper Controller referencing.
3.	0q<CR>	1q3;2q5<CR>	Both controllers busy. Controller 1 is dispensing or metering. Controller 2 is priming.
4.	31q<CR>	31q0<CR>	Striper Controller is ready.
5.	0q<CR>	1q0;2q9<CR>	Controller one is ready. Controller 2 is busy loading.
6.	31q<CR>	31q3<CR>	Striper Controller Striping.

Sequencing through each Controller

	COMMAND	RESPONSE	OUTCOME
1.	1q<CR>	1q0<CR>	Pump Controller 1 ready.
2.	2q<CR>	2q0<CR>	Pump Controller 2 ready.
3.	31q<CR>	31q5<CR>	Striper Controller referencing.
4.	1q<CR>	1q3<CR>	Controller 1 is busy dispensing or metering.
5.	2q<CR>	2q5<CR>	Controller 2 is busy priming.
6.	31q<CR>	31q0<CR>	Striper Controller is ready.
7.	1q<CR>	1q0<CR>	Controller 1 is ready.
8.	2q<CR>	2q0<CR>	Controller 2 is ready.
9.	31q<CR>	31q0<CR>	Striper Controller Striping.
10.	1q<CR>	1q3<CR>	Controller 1 is busy dispensing or metering.
11.	2q<CR>	2q3<CR>	Controller 2 is busy dispensing or metering.
12.	31q<CR>	31q3<CR>	Striper Controller is busy striping.

3.3 INSTALLATION

General operating practices provide the best guidelines for locating the components of the system. The Controller Module should be located for ease of use during all phases of operation and maintenance.

The Controller Module enclosure is provided as a tabletop piece of equipment (standard).

A 19” rack-mount version is available as an option. The 19” rack-mount version must be supported from the bottom of the enclosure, NOT the front mounting holes. The front mounting holes are provided to prevent the enclosure from accidentally moving in and out of the rack.

The controller communication output connector on the last Controller Module connected MUST have a 93 Ohm terminating resistor installed. The terminating resistor is provided with the equipment and is installed at the factory. The factory installs the terminating resistor on the expected last controller, that is, the controller with the highest number address. The Master has the terminating resistor installed internal to the controller.

3.4 OPTIONS

IVEK Corporation offers a variety of options to best meet the customers' needs. Following is a list and description of available options for the Controller Module.

3.4.1 Linear Striper with Multiplex

A Multiplex system may be configured with a Multiplex Striper Controller. A system with a Multiplex Striper Controller may have a maximum of 7 pump controller modules (maximum total of 84 pump modules).

3.5 MAINTENANCE

No periodic maintenance is required on the Controller Module, beyond standard practices for electronic equipment.

3.5.1 Assembly/Disassembly Procedures

The Controller Module contains the following replaceable parts.

- Main Power Fuse(s)
- Control Power Fuse

3.5.1.1 Main Power Fuse

The main power fuse located in the Power Entry Module on the rear panel is replaceable. Replace the fuse with the same type and value as supplied with the unit.

Disassembly

1. Remove the power cord.
2. Using a small flat blade screwdriver, open the power entry module's cover.
3. Slide the fuse tray out and remove the fuse.

Assembly

1. Install the new fuse into the fuse tray and slide the tray in. The arrow on the fuse holder should point to the right.
2. Close the power entry module's cover.
3. Connect the power cord.

3.5.1.2 Control Power Fuse

The control power fuse located on the rear panel is replaceable. Replace the fuse with the same type and value as supplied with the unit.

Disassembly

1. Remove the power cord.
2. Turn the fuse holder counterclockwise. Remove the fuse.

Assembly

1. Install the new fuse into fuse holder
2. Insert holder turning clockwise.
3. Connect the power cord.

3.6 PROBLEM GUIDE

Table 3.2 contains a list of possible problems, causes and solutions for the Controller Module.

WARNING

Hazardous voltages exist inside the Controller Module. Under no circumstances should the Controller Module be opened. There are no user serviceable parts inside the Controller Module. Any unauthorized access to the inside will void the warranty.

3.7 SPECIFICATIONS

The Logic I/O is intended to be connected directly to a customer's PLC, if present. The connections provided allow the customer to wire the inputs and outputs as sinking or sourcing depending on the PLC configuration.

IVEK Logic I/O Input Signal
Requirements: 24 VDC @ 20 mA

IVEK Logic I/O Output Signal Requirements:
Can switch a maximum of 24 VDC @ 50mA

Input Power Requirements:
Refer to the Title Page section of this manual.

3.8 MODEL NUMBER

The model number provides important information about the specifics of your Controller Module. Refer to this number when calling IVEK Technical support. The model number for your Controller Module is located in the Title Page section of this manual.

Master	**520164 -**	**##**	**##**	**#**	**#**	**#**	**#**
Channel	**520165 -**	**##**	**##**	**#**		**#**	**#**

Pump Size

LF - Large Frame
SF - Small Frame

Number of Channels

01 - 1 Channel
02 - 2 Channels
03 - 3 Channels
04 - 4 Channels
05 - 5 Channels
06 - 6 Channels
07 - 7 Channels
08 - 8 Channels
09 - 9 Channels
10 - 10 Channels
11 - 11 Channels
12 - 12 Channels

Logic Interface

A – PLC
B – PLC With Load I/O

Parameter Interface (Master Only)

A - RS 232

Enclosure Style

D - Enclosure W/Front Handles, 19"Rack, Style B
E - Enclosure W/Front Handles, Style B
F - Enclosure W/Trim, Style B

Line Cord and Agency Approval

A - US Cord, CE
B - Intl Cord, CE

3.9 ILLUSTRATED PARTS BREAKDOWN

The illustrated parts breakdown (Figure 3.4) contains the information required for identifying and ordering replacement parts.

Table 3.2 Common Operational Problems And Solutions

PROBLEM	PROBABLE CAUSE	POSSIBLE SOLUTION
No power, nothing works.	AC power may be absent or inadequate. Unit not plugged in. Fuse is blown.	Ensure AC power cord is plugged into a properly grounded three-prong outlet capable of supplying the voltage listed in the Title Page section of this manual. Unplug main power cord from outlet. Remove fuse from rear panel fuse holder. Test fuse conductivity. Install good fuse in rear panel fuse holder.
Power is on, Controller Module accepts trigger, piston fails to move and Actuator Module makes a sound. * This condition does not harm the system.	A Pump Module or motor malfunction can cause this problem.	Turn off Controller Module power. Remove Pump Module(s) from Actuator Module. Turn on Controller Module and try again. If the motor operates correctly, the pump(s) may need to be cleaned or serviced.
Power is on, Controller Module accepts a trigger, (ACTIVE indicator illuminates), piston fails to move, and Actuator Module is silent.	Channel fuse is blown. A motor malfunction can cause this problem.	Unplug main power cord from outlet. Remove fuse from fuse holder. Test fuse conductivity. Replace if necessary. Turn off Controller Module power. Check to ensure Actuator Module is properly connected to Controller Module. Turn on Controller Module and try again. If the motor operates incorrectly, servicing may be necessary to the motor or the controller. Return complete Controller, Actuator and Pump Modules to IVEK Corporation for repair.
Controller Module power on and operational, but will not activate Actuator.	I/O Cable E-Stop active or no E-Stop connected. No air supply.	Check connection of cable between Controller Module and Actuator Module. Inspect and repair faulty cable. Reset E-Stop switch and/or connect E-Stop cable. Verify air supply is connected and is pressurized.
After pressing a button, expected results don't occur.	Slow response time.	Wait longer before pressing another button.
The Ready/Busy display is not as expected.	Slow response time.	Wait longer before pressing another button. **If none of the above solves the problem, contact IVEK technical support for assistance.**

INDEX NO.	PART NUMBER	DESCRIPTION	UNITS PER ASSY
		Multiplex Controller Module	**1**
1	520164	Ctrlr Mdl, Multiplex Master Ver 2.0	1
2	520165	Ctrlr Mdl, Multiplex Channel Ver 2.0	1-7

Figure 3.4 Multiplex Controller Module (Sheet 1 of 1)