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The MPX Series Controller

User's Manual

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1. Introduction

The MPX Series Controller is a microprocessor-based controller designed for controlling motor driven variable transformers. The controller will adjust the output of the variable transformer to maintain the user's desired voltage or current set-points.

See Staco's website for warranty details:

<http://www.stacoenergy.com/support/literature-download-center.html>

2. Installation

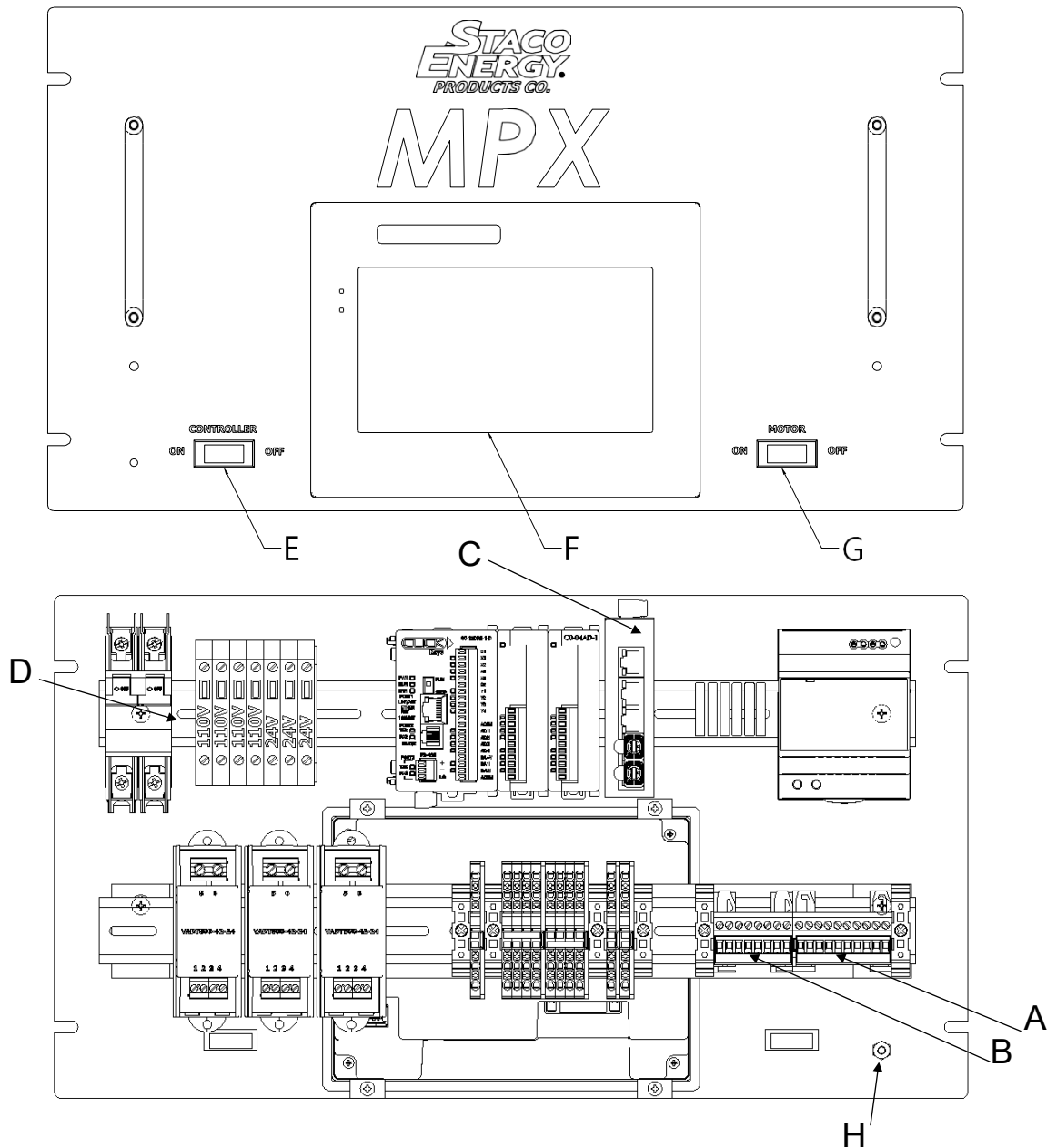


Figure 1 – Layout

A	Output Feedback (TB10)
B	Controller input power & Motor raise/lower signals (TB8)
C	Ethernet Network Switch – connector to remote monitors
D	Fuses and Breakers
E	Controller Power switch
F	LCD touchscreen
G	Motor control power switch
H	Panel Ground $\perp$

2.1 Input Control Power

Connect 120Volt AC input power lines to terminals TB8-1 120 (hot) and TB8-2 C (common) of terminal strip at bottom of panel mounted inside the controller (see **Figure 2**).

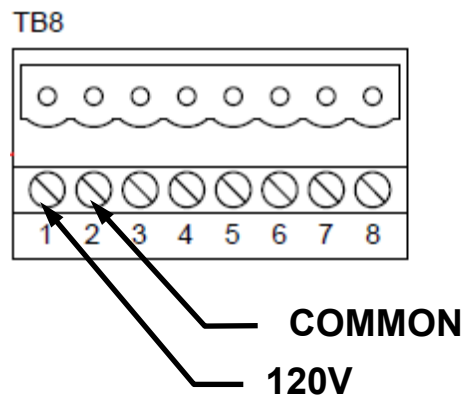


Figure 2 – Input Control Power

2.2 Motor Control

The controller is capable of controlling all STACO's motor driven variable transformers. Connect wiring from controller motor control terminals to the motor controls (see **Figure 3**). For single phase or single motor controls, use phase A terminals.

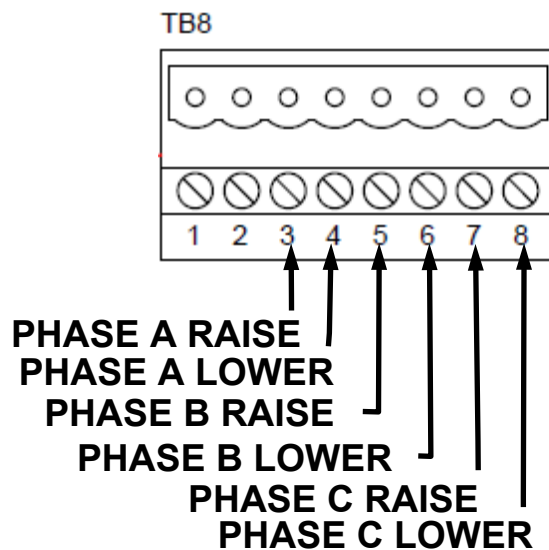


Figure 3 – Motor Control

Terminals	A	B	C
Single Phase*	(3)R: Raise (4)L: Lower	None	None
Three Phase	(3)R: Raise (4)L: Lower	(5)R: Raise (6)L: Lower	(7)R: Raise (8)L: Lower

Table 1– Motor Controls

*Wiring for Single phase or single motor control systems.

2.3 Feedback Signal(s)

The feedback signals are the voltage(s) or current(s) the controller will be regulating. These signals are typically the output of the variable transformer system.

2.3.1 Voltage Feedback Wiring from Output

Connect the feedback voltage(s) to the Feedback Sense locations (see **Figure 4**).

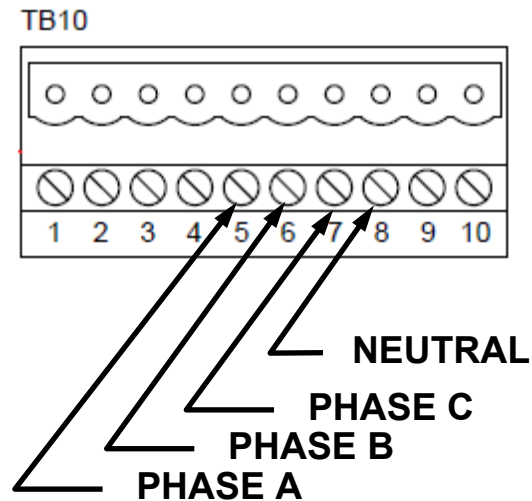


Figure 4 – Voltage Feedback Sense Location

Terminals	A	B	C	N
Single Phase*	(5)Phase A	None	None	(8)Neutral
Three Phase	(5)Phase A	(6)Phase B	(7)Phase C	(8)Neutral

Table 2– Line-Neutral Feedback

Terminals	A	B	C	N
Single Phase*	(5)Phase A	(6)Phase B	None	None
Three Phase	(5)Phase A	(6)Phase B	(7)Phase C	None

Table 3 – Line-Line Feedback

*Wiring for Single phase or single motor control systems.

2.3.2 Current Feedback Wiring from Output

Connect the feedback current(s) to the Feedback Sense locations (see **Figure 5**). The Current feedback must be 4-20mA signal.

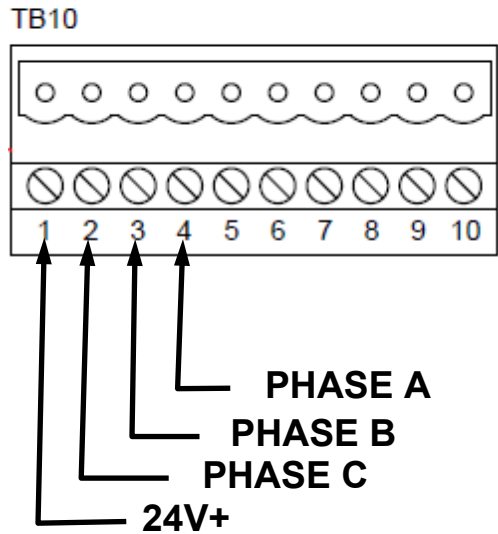


Figure 5 – Current Feedback Sense Location

Terminals	24+	A	B	C
Single Phase*	(1)24V	(4)Phase A	None	None
Three Phase	(1)24V	(4)Phase A	(3)Phase B	(2)Phase C

Table 4 – Current Feedback

*Wiring for Single phase or single motor control systems.

2.4 Remote Target Setpoint controls

The controller can use remote analog signals for setting the Target Set Points. This is enabled from settings via the main screen. If Remote Target is activated, local control of Target Setpoint and Presets are disabled.

Connect a 4-20mA signal to Remote Target terminal (see **Figure 6**).

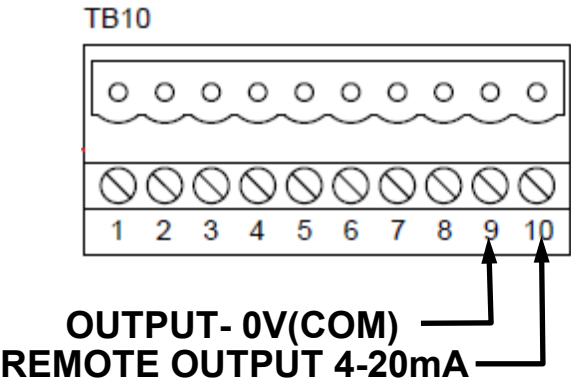
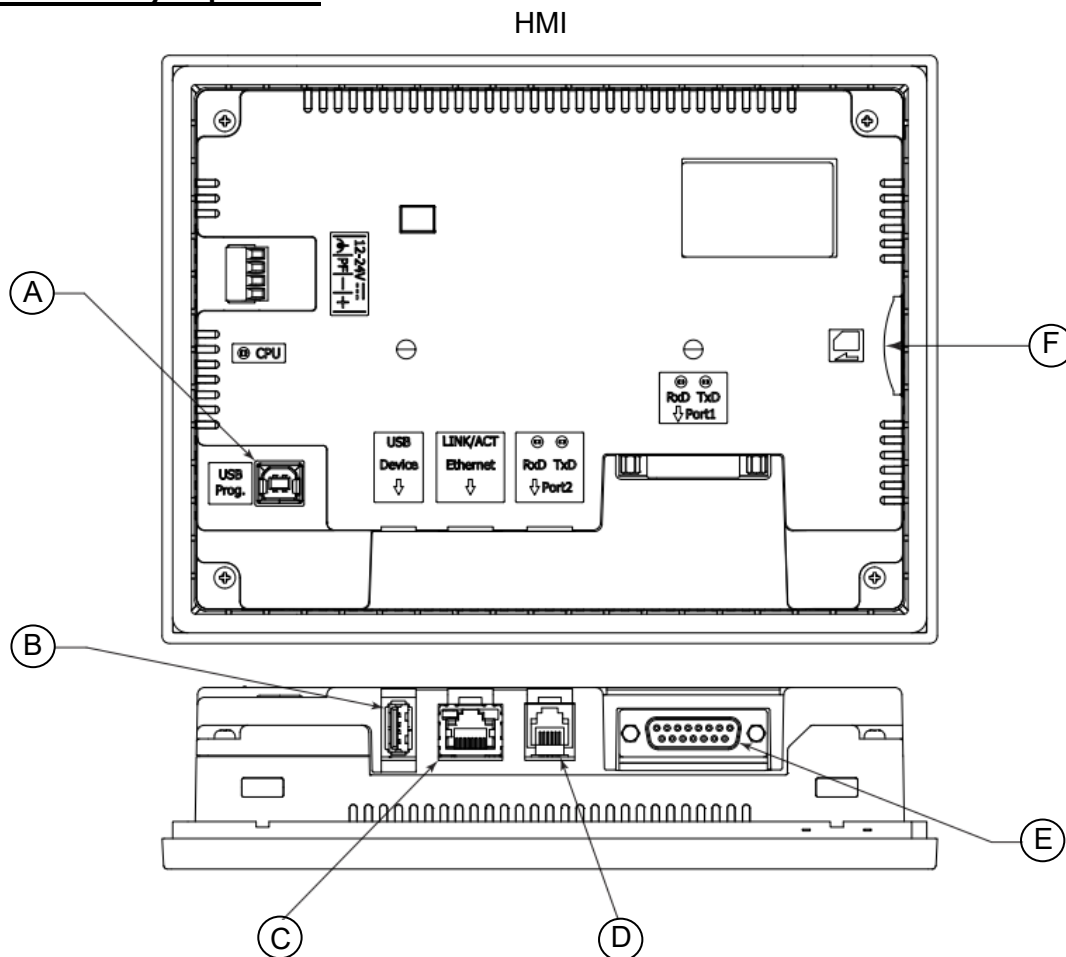
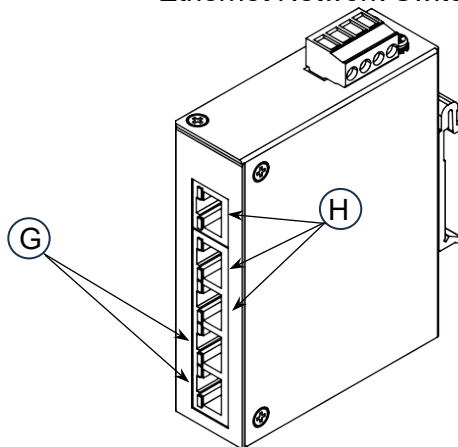


Figure 6 – Remote 4-20mA control

2.5 Ports and Memory Expansion



Ethernet Network Switch



A	USB Port – Type B 2.0 High Speed Max 15 ft. long (Not Applicable)
B	USB Port – Type A 2.0 High Speed Max 15 ft. long (USB Device Options)
C	Ethernet 10/100 Base-T (Not Available/Used)
D	Port 2 (Not Applicable)
E	Port 1 - 15 PIN (Not Applicable)
F	SD Card Slot – Max 2GB(SD) 32GB (SDHC)
G	Ethernet 10/100 Base-T (Not Available/Used)
H	Ethernet 10/100 Base-T (Available, Remote Access)

2.5.1 Ethernet Port

The MPX Series Controller comes with an Ethernet switch that can be used in several ways: for programming the panel (downloading a project), for PLC communication, and for the advanced features, such as sending e-mail, web server, FTP access, and allowing users to access and control the panel remotely. The Ethernet connector is an RJ-45 Module jack. Staco uses Ethernet to communicate between controller, PLC and Network Switch. To connect via Ethernet, plug directly into Network Switch.

Ethernet 10/100 Base-T
PLC Communications,
Programming/Download

Pin	Signal	Pin	Signal
1	TD+	5	do not use
2	TD-	6	RD-
3	RD+	7	N.C.
4	do not use	8	N.C.

Link Status LED (Green)	
On	Ethernet Linked
Off	No Ethernet Comm.
Blinking Green	Comm. Activity

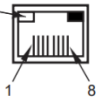


Table 4– Ethernet Pin Assignments

2.5.2 USB Type A Port

The MPX Series Controller comes with a USB Type A port that can be used to connect various USB devices to the panel, such as keyboards, barcode scanners, card scanners, etc. MPX can log data to the USB pen drive as well as restore projects to the panel from the pen drive. You can also back up project files and panel firmware.

USB Port - Type A
USB Device Options

Pin	Signal
1	Vbus
2	D-
3	D+
4	GND
SHELL	Shield



Table 5– USB Type A Pin Assignments

2.5.3 SD Slot

The MPX Series Controller comes with a SD card that can be used to store different types of numeric and text data from the MPX touch panel. Numeric data from Line Trend Graph and PID Faceplate Trend Graph objects may be stored. Text data from Lookup Text and Multi-state Text Indicator objects can also be stored. Memory Devices should be formatted according to the following guidelines to ensure best performance and integrity of logged data. If replacing the current SD card, the new SD card must be formatted using the SD formatter provided by the SD Association at www.sdcard.org using the standard allocation unit size for best performance.

Item		Capacity	Supported Resolution	Supported
USB Memory Device		up to 2GB	FAT	Yes
		4GB to 32GB	FAT 32	Yes
		64GB or larger	exFAT	Yes
SD Card	Type			
	SD	up to 2GB	FAT	Yes
	SDHC	4GB to 32GB	FAT 32	Yes
	SDXC	32GB or larger	exFAT	4" - 7" - No 10" - 22" - Yes

Table 6 – Memory Device Guidelines

*** Data will not be logged unless memory device installed, you will receive an error message**

3. HMI Screen

The LCD provides for local display of the System output and access to the target set point(s).

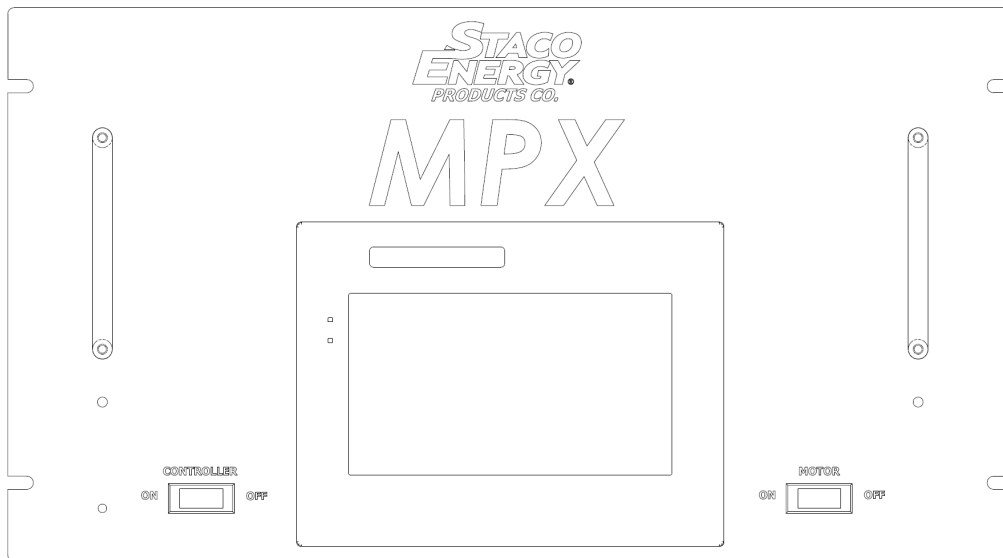


Figure 7 –Front panel

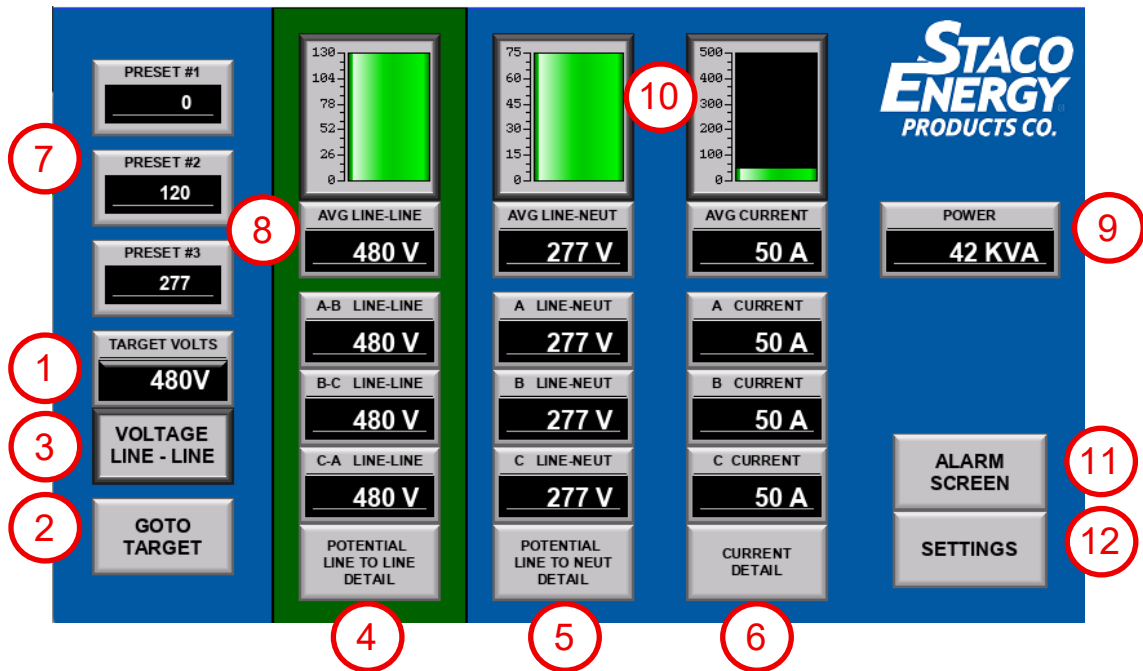
3.2 Main Title Screen

The main screen to access either Control Screen or Service menus. Service Menu is password protected for Staco Technicians to access during Setup and Troubleshooting.



3.3 Control Screen

Control Screen will display Line-Line Voltage(s), Line-Neutral voltage(s), and Current Target setting (optional). If the system is configured with output Current sense, the output current(s) Power will be displayed.



1. **Target Volts:** The setpoint voltage the controller will try to keep the output at. This can be set by the button on the control screen and the button in settings (see section 3.5 Settings Screen). It will open a numeric entry pad (see **Figure 8**). Only amounts that are greater than or equal to the minimum and less than or equal to the maximum will be accepted. These are limits are established in settings (see 3.5 Settings Screen).

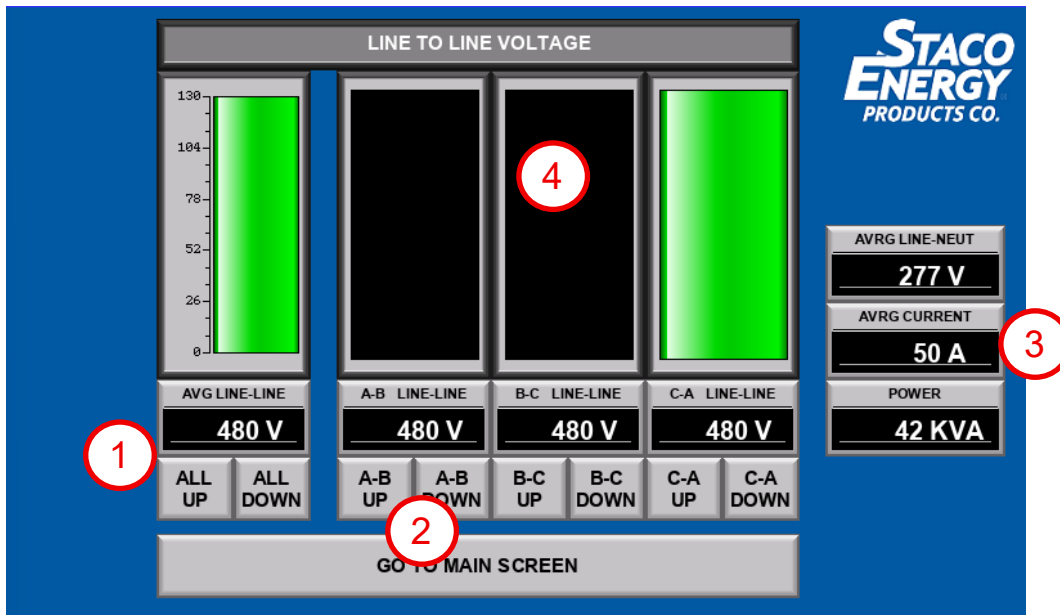
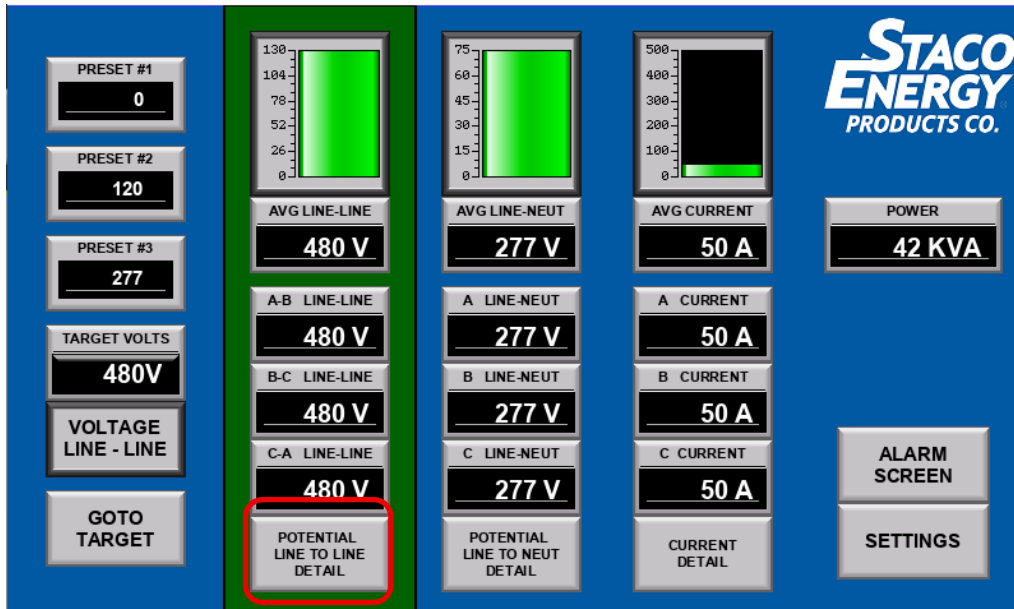
TARGET VOLTS					
Current	0	7	8	9	ESC
Minimum	0	4	5	6	BS
Maximum	0	1	2	3	CLR
		+/-	0	.	ENT

Figure 8 – Target Volts Entry Pad

2. **GOTO Target:** when active (green), controller will regulate output to Target Volts setpoint.
3. **Voltage:** Displays whether the Target is set for Line-Neutral Voltage(s), Line-Line Voltage(s), or current(s). Selected option is also highlighted dark green, light green when go to target is activated. This can be changed in settings (see section 3.5 Settings Screen).
4. **Line-Line:** Displays RMS Line-Line voltages of each phase-phase voltage.
5. **Line-Neutral:** Displays RMS Line-Neutral voltages of each phase voltage.
6. **Current:** If output current sense is activated, displays RMS of each phase current.
7. **Presets (#1/2/3):** Presets to quickly select pre-determined Target values. The presets are established in settings (see section 3.5 Settings Screen).
8. **Averages:** Displays RMS Average of all phases for Line-Line, Line-Neutral, and Current(optional). This display can be turned on/off in settings (see section 3.5 Settings Screen).
9. **Power:** If output current sense is activated, displays calculated overall output power.
10. **Bar Graph Display:** Visual representation of Averages all phases for Line-Line, Line-Neutral, and Current(optional).
11. **Alarm Screen:** See section 3.6 Alarms
12. **Settings:** See section 3.5 Settings Screen

3.4 Manual Raise/Lower

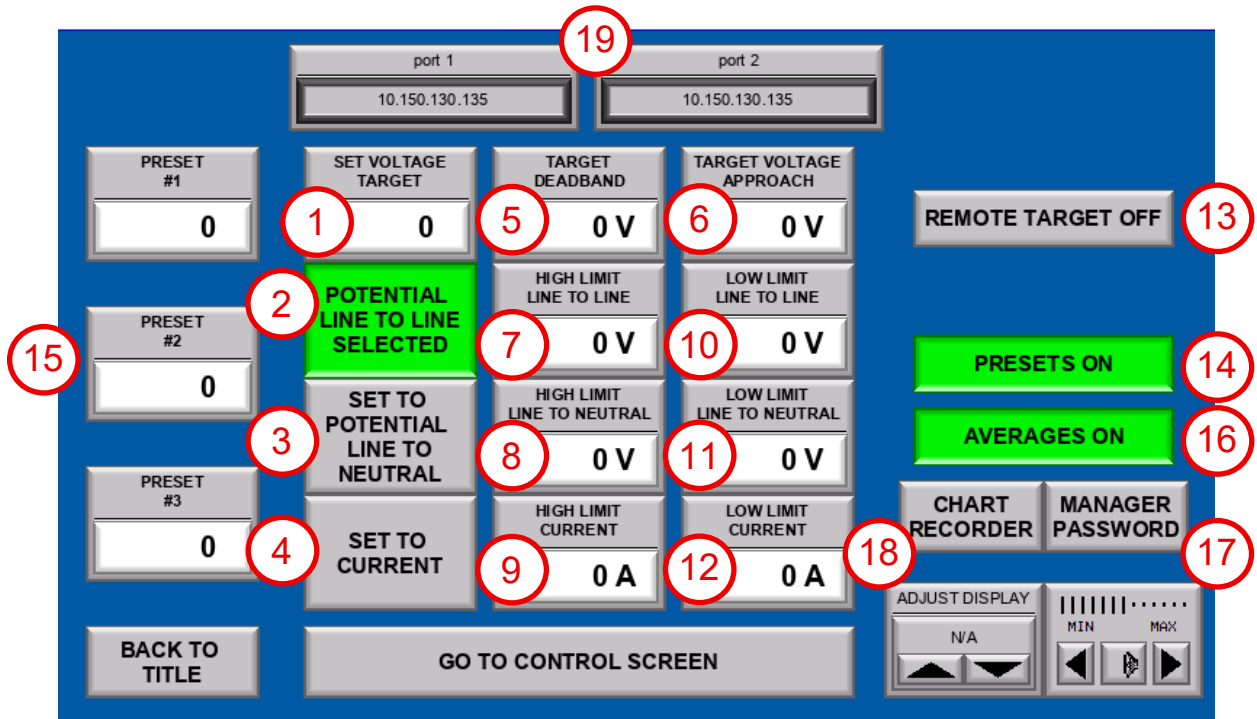
When GOTO Target is not Active, selecting Detail button at bottom of readings will open menu page to manually raise or lower output.



1. **Avg:** This will send raise/lower commands to all motors. This will allow all phases to raise or lower at same rate.
2. **Phase:** This allows users to raise or lower phases individually. Only available for systems with Independent Phase Control (IPC)
3. **Metering:** This will display averages of all phases for reference. If current option is not active, Avg Current & Power display will not be displayed.
4. **Bar Graph Display:** Visual representation of average as well as individual phases.

3.5 Settings Screen

The settings screen allows users to adjust parameters of the controller. This may be a password protected via Manager Password (see section 3.7 Manager Password). If password is active a pop-up will appear before the page is opened.



1. **Set Target:** Set the value to control and regulate output. This cannot be set outside the High & Low Limit settings. (7-12 Below)
2. **Set to Potential Line to Line:** This sets the Target to Line-Line Voltage.
3. **Set to Potential Line to Neutral:** This sets the Target to Line-Neutral Voltage.
4. **Set to Current:** This sets the Target to Current. This is only available if output current sense option is activated.
5. **Target Deadband:** Range (+/-) around the setpoint in which no control actions are taken. It means that small deviations are not detected by the controller. The deadband reduces unnecessary wear and adjustments on the relays. This increases the stability and longevity of the system. Range 0-10.
6. **Target Approach:** Range (+/-) that controls transition form for motor speed to pulse control. This value is used to help prevent over/under shooting the output target. Range 0-100.
7. **High Limit Line-Line:** The maximum Line-Line value Target can be set.
8. **High Limit Line-Neutral:** The maximum Line-Neutral value Target can be set.
9. **High Limit Current:** The maximum Current value Target can be set. This is only available if output current sense option is activated.
10. **Low Limit Line-Line:** The minimum Line-Line value Target can be set.
11. **Low Limit Line-Neutral:** The minimum Line-Neutral value Target can be set
12. **Low Limit Current:** The minimum Current value Target can be set. This is only available if output current sense option is activated.
13. **Remote Target:** When activated user can control Target setpoint via 4-20mA signal generator. See 2.4 Remote Target Setpoint controls for wiring.
14. **Presets On:** If activated presets will be available for user.
15. **Presets:** Up to three (3) preset Target values can be programmed.
16. **Averages On:** When activated user will see averages displayed on main screen.
17. **Manager Password:** When activated user will be prompted to enter a password for settings and manual adjustment of phases. See section 3.7 Manager Password.

18. **Chart Recorder:** Is a graphic display of output readings. MPX controller will support data logging to SD cards or USB memory devices. Data is logged every 5 minutes and saved First In First Out to memory device. See section 2.5.3 SD Slot. *** Data will not be logged unless memory device installed, you will receive an error message**

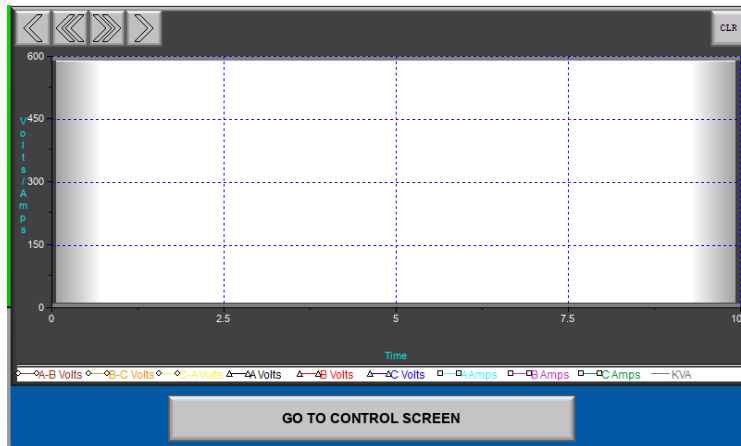


Figure 9 – Chart Recorder

19. **IP Address:** Ethernet IP addresses of Serial Communication Ports.

Note:

1. If use attempts to set Target value outside High or Low Limit settings, the Target will automatically change to Limit value.
2. If output voltage rises above High Limit setting, the High Voltage alarm will activate.
3. If output voltage drops below Low Limit setting, the Low Voltage alarm will activate.
4. High and Low Line-Line Limit range is 0-778V.
5. High and Low Line-Neutral Limit range is 0-450V

3.6 Alarms

Alarm Summary screen displays log of all alarms. Alarms are used to notify operators of critical situations that may arise during a process. The Alarm screen allows operator interaction with alarms that have occurred and allows operators to view, confirm, or clear the alarms. The log includes Alarm type and date/time stamp when alarm is activated and deactivated.

[illegible]

Figure 10 – Alarm Summary

Alarm	Description
Phase A Above High Limit	Phase A output voltage is above the High Voltage limit setting
Phase B Above High Limit	Phase B output voltage is above the High Voltage limit setting
Phase C Above High Limit	Phase C output voltage is above the High Voltage limit setting
Phase A Below Low Limit	Phase A output voltage is below the Low Voltage limit setting
Phase B Below Low Limit	Phase B output voltage is below the Low Voltage limit setting
Phase C Below Low Limit	Phase C output voltage is below the Low Voltage limit setting
Motor Fail (default 10 sec)	Motor has failed to move after Motor Fail timer setting

Table 5 – Alarm Possibilities

3.7 Manager Password

The MPX unit offers password protection and may be activated via the settings screen. The Manager Password screen (see **Figure 11**) has a button to turn the password on/off. Turning the password on will prevent users from accessing Settings and Manual Raise/Lower Screens. A pop-up will appear requiring password before the screen can be accessed.

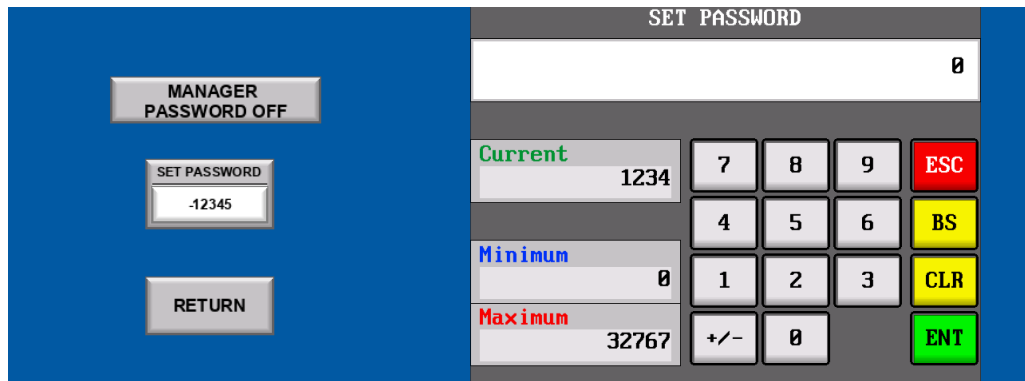


Figure 11 – Manager Password

5. Remote HMI Access

With remote access, you can remotely monitor and control screen operations of the MPX HMI as if touching the screen itself, test and troubleshoot the project, view, zoom, print, and save screen captures of active screens.

5.1 Panel Pass Through

The MPX HMI client panel is configured to display the data collected from each MPX connected through a server panel. When the client panel is configured, the server panels will pass through data to the client via ethernet. The information seen on the client panel is identical to the server panel, they operate simultaneously.

5.2 Remote HMI from PC

With a Web browser on any PC, remote users can operate and monitor a local MPX HMI system from anywhere on the Internet or on a local network. You can use an Ethernet cable to go to the network switch from your PC. Use any connected PC with a browser to request screen captures and retrieve log files via IP address.

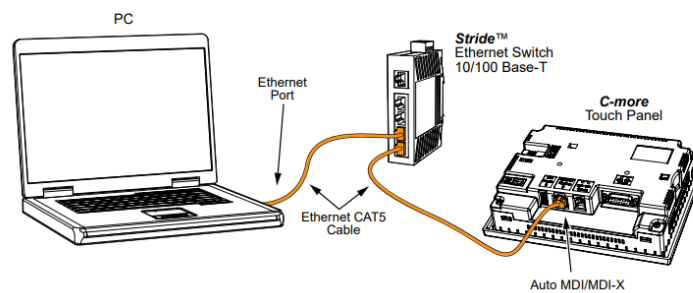


Figure 12 – HMI to PC via Web Server

6. Modbus Communication

Modbus TCP and EtherNet/IP are two of the leading industrial protocols in the US and are widely used in a range of industries. MPX controllers come with Modbus TCP and EtherNet/IP protocols standard so they can be installed in existing networks with no problem. Connect via Ethernet to Modbus TCP/IP Little Endian Byte Swap protocols.

READ/WRITE						
Address	Data Type	Modbus Address	Function Code	Nickname	Initial Value	Retentive
C1	BIT	16385	FC=01,05,15	HMI_Setpoint_LL	0	Yes
C2	BIT	16386	FC=01,05,15	HMI_Setpoint_LN	0	Yes
C3	BIT	16387	FC=01,05,15	HMI_Setpoint_Current	0	Yes
C4	BIT	16388	FC=01,05,15	HMI_Goto_Target	0	Yes
C5	BIT	16389	FC=01,05,15	HMI_Raise_All	0	Yes
C6	BIT	16390	FC=01,05,15	HMI_Raise_A	0	Yes
C7	BIT	16391	FC=01,05,15	HMI_Raise_B	0	Yes
C8	BIT	16392	FC=01,05,15	HMI_Raise_C	0	Yes
C9	BIT	16393	FC=01,05,15	HMI_Lower_All	0	Yes
C10	BIT	16394	FC=01,05,15	HMI_Lower_A	0	Yes
C11	BIT	16395	FC=01,05,15	HMI_Lower_B	0	Yes
C12	BIT	16396	FC=01,05,15	HMI_Lower_C	0	Yes
C14	BIT	16398	FC=01,05,15	HMI_Raise_AB	0	Yes
C15	BIT	16399	FC=01,05,15	HMI_Raise_BC	0	Yes
C16	BIT	16400	FC=01,05,15	HMI_Raise_CA	0	Yes
C17	BIT	16401	FC=01,05,15	HMI_Lower_AB	0	Yes
C18	BIT	16402	FC=01,05,15	HMI_Lower_BC	0	Yes
C19	BIT	16403	FC=01,05,15	HMI_Lower_CA	0	Yes
C24	BIT	16408	FC=01,05,15	HMI_Presets	0	Yes
C25	BIT	16409	FC=01,05,15	HMI_Preset_1_Select	0	Yes
C26	BIT	16410	FC=01,05,15	HMI_Preset_2_Select	0	Yes
C27	BIT	16411	FC=01,05,15	HMI_Preset_3_Select	0	Yes
C32	BIT	16416	FC=01,05,15	HMI_RemoteTarget	1	Yes
DF42	FLOAT	428755	FC=03,06,16	HMI_Current_HL	0	Yes
DF43	FLOAT	428757	FC=03,06,16	HMI_Current_LL	0	Yes
DF46	FLOAT	428763	FC=03,06,16	HMI_Volt_LL_HL	0	Yes
DF47	FLOAT	428765	FC=03,06,16	HMI_Volt_LL_LL	0	Yes
DF48	FLOAT	428767	FC=03,06,16	HMI_Volt_LN_HL	0	Yes
DF49	FLOAT	428769	FC=03,06,16	HMI_Volt_LN_LL	0	Yes
DF68	FLOAT	428807	FC=03,06,16	HMI_Deadband	0	Yes
DF69	FLOAT	428809	FC=03,06,16	HMI_Voltage_Approach	0	Yes
DF70	FLOAT	428811	FC=03,06,16	HMI_Voltage_SP	0	Yes
DF71	FLOAT	428813	FC=03,06,16	HMI_Amp_SP	0	Yes
DF80	FLOAT	428831	FC=03,06,16	HMI_Amp_Approach	0	Yes
DF81	FLOAT	428833	FC=03,06,16	Preset_1	0	Yes
DF82	FLOAT	428835	FC=03,06,16	Preset_2	0	Yes
DF83	FLOAT	428837	FC=03,06,16	Preset_3	0	Yes
DF167	FLOAT	429005	FC=03,06,16	Remote4	0	Yes
DF168	FLOAT	429007	FC=03,06,16	Remote20	0	Yes

READ ONLY						
DF50	FLOAT	428771	FC=03,06,16	PhaseA_Current	0	Yes
DF51	FLOAT	428773	FC=03,06,16	PhaseB_Current	0	Yes
DF52	FLOAT	428775	FC=03,06,16	PhaseC_Current	0	Yes
DF53	FLOAT	428777	FC=03,06,16	Wired LL Phase A_B	0	Yes
DF54	FLOAT	428779	FC=03,06,16	Wired LL Phase B_C	0	Yes
DF55	FLOAT	428781	FC=03,06,16	Wired LL Phase C_A	0	Yes
DF56	FLOAT	428783	FC=03,06,16	Wired LL Phase A	0	Yes
DF57	FLOAT	428785	FC=03,06,16	Wired LL Phase B	0	Yes
DF58	FLOAT	428787	FC=03,06,16	Wired LL Phase C	0	Yes
DF59	FLOAT	428789	FC=03,06,16	AvgCurrent	0	Yes
DF60	FLOAT	428791	FC=03,06,16	AvgLL	0	Yes
DF61	FLOAT	428793	FC=03,06,16	AvgLN	0	Yes
DF62	FLOAT	428795	FC=03,06,16	VoltAmps	0	Yes
DF143	FLOAT	428957	FC=03,06,16	Wired LN Phase A	0	Yes
DF144	FLOAT	428959	FC=03,06,16	Wired LN Phase B	0	Yes
DF145	FLOAT	428961	FC=03,06,16	Wired LN Phase C	0	Yes
DF146	FLOAT	428963	FC=03,06,16	Wired LN Phase A_B	0	Yes
DF147	FLOAT	428965	FC=03,06,16	Wired LN Phase B_C	0	Yes
DF148	FLOAT	428967	FC=03,06,16	Wired LN Phase C_A	0	Yes

Appendix A – Theory of Operation

The controller utilizes solid state relays to control motor raise or lower movement. Each motor being controlled has (1) raise relay and (1) lower relay. When the relay is closed, power is connected from controller to motor.

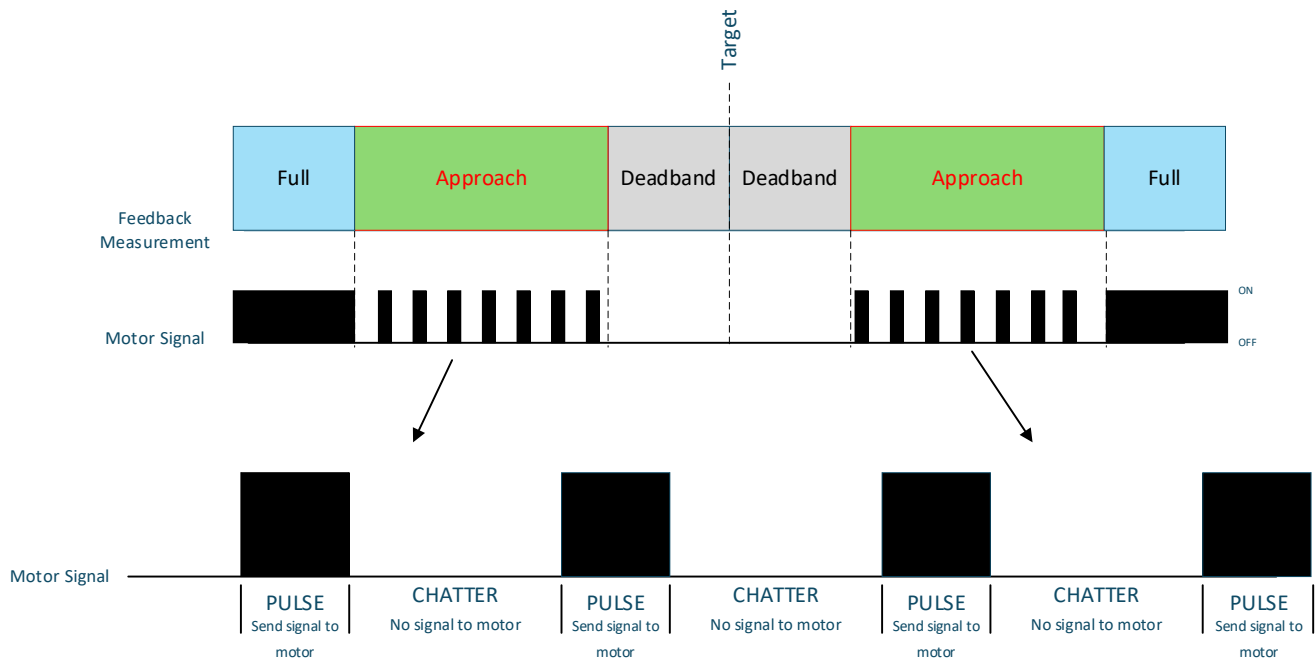


Figure 13 – Theory of Operation

Appendix B – Feedback Measurement Zones

When “GOTO Target” is activated the feedback measurement is in 1 of 3 zones:

1. The **Full zone** - the controller will continuously close the raise/lower relay.
2. The **Approach zone** - the controller will cycle the raise/lower relays based on the Pulse and Chatter timer settings and Approach range.
 - Pulse width timer - amount of time signal is active. (In Service Menu)
 - Chatter width timer – amount of time signal is inactive. (In Service Menu)
 - Approach range is +/- when to start pulsing to prevent over/under shoot based on Target Approach setting.
3. The **Deadband zone** - the raise/lower relays will stay open. Deadband range is based Target Deadband setting.

Appendix C – Target Filtering

The MPX unit is programmed with an Exponential Moving Average (EMA) Low Pass High Pass Filter. This is only accessible through the Service Menu. The following expression is applied to the output:

Raw Weight (α):

Alpha = 1 provides the unfiltered signal
Alpha = 0 causes the filtered value to always be zero
Hence, Alpha must be 0.1 - 0.9. Decreasing the alpha factor increases signal smoothing but also increases response time, which could cause a delay.

Sample rate: How many times per second a signal is sampled. The range is 1Hz to 20Hz or 1000ms to 50ms. * Chatter time should be 2-3 times the sample rate.

Appendix D – Setup Screen and Calibration

The System Setup Screen can be accessed at any time by pressing the extreme upper left corner of the panel display area for 3 seconds as shown below.



Figure 14 – Accessing the System Setup Screen

3.1.1 Information

The information tabs display details about the HMI hardware, firmware, features enabled, memory status, Ethernet port settings, panel errors and license information.

3.1.2 Settings

The Settings menu allow adjustments to be made to the internal clock, touch screen calibration, Ethernet port settings, display brightness and enabling or disabling other options.

3.1.3 Test Menu

The Test menu is used to test the touch screen, audio outputs, serial and Ethernet PLC connections, display colors and pixels and User LEDs.

3.1.1 Memory

The Memory menu is used to Backup and Restore the panel firmware and project, clear the panel memory or reset the HMI to a factory default state.

*** DO NOT Clear Project Memory or Factory Reset, will cause a loss of all programming and abilities**