



502- PD- 002- 00

PosiDrive™ Multi-Drive Servo Motor Control

Operation And Service Manual



FORCE CONTROL INDUSTRIES, INC.

WARNING – Read this manual before any installation, maintenance or operation

MANUFACTURES OF MECHANICAL AND ELECTRICAL POWER TRANSMISSION EQUIPMENT

Limited Warranty

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A Return Goods Authorization (RGA) number must be obtained from the factory and clearly marked on the outside of the package before any equipment will be accepted for warranty work. Force Control will pay the shipping costs of returning the owner parts that are covered by warranty.

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Section 1

DESCRIPTION AND OPERATION

Force Control Industries manufactures a variety of complete, pre-engineered, servo systems built around our *PosiDrive* family of Servo Motors and Servo Amplifiers. Some of these systems are designed for general-purpose servo applications. Others are highly customized.

1-1 Scope Of This Manual

PosiDrive Servo Packages are customized to fit specific applications. We add or remove features to suit the job at hand, and the different packages vary widely from one another.

This manual is intended to cover the general features common to most *PosiDrive* Servo Control Packages. It supplements the schematics or other detailed documentation that we provide for each specific system.

This manual does not cover the mechanical components that are sometimes included with a servo package. Mechanical components are documented separately.

1-2 How To Use This Manual

Read the Section(s) that applies to the particular application needed. The general content of each section is described below.

Section #1 contains general descriptive material about servo systems and how they work.

Section #2 contains technical specifications for some of the components used in most *PosiDrive* servo packages.

Section #3 contains general installation tips.

Section #4 discusses the operators' controls in a general way. The physical buttons and switches are usually self-explanatory.

Section #5 describes how to use the HMI touch screen's Main Menu, Run, and Status screens to operate the servo system on a daily basis.

Section #6 describes how to configure the servo system using the Setup Menu on the HMI touch screen.

Sections #7 and 8 both pertain to troubleshooting and maintenance issues.

1-3 General Description

A typical servo package includes one or more servomotors, a control box, operators' station(s), connecting cables, and perhaps mechanical components. *PosiDrive* servomotors feature a brushless design with permanent magnet rotors. We offer a wide variety of speeds, power ratings, and frame sizes. The servomotor needs to be correctly sized to guarantee good performance on your machine. Contact our applications department for assistance.

A *PosiDrive* control box is usually a complete industrial control built in to a NEMA-12 enclosure. The size and complexity of the control depends on the specific application. We offer small control boxes that operate a single servomotor or larger cabinets designed to run multiple servomotors.

In general, the control box houses at least one servo amplifier along with a power supply, fuses, contactors, and other auxiliary equipment. The operators' controls can be located on the door of the main control enclosure, or they can be remote-mounted on a separate console. The operators' console typically includes an industrial touch screen HMI (Human Machine Interface) plus a few other buttons.

The HMI touch screen interface is an important feature of *PosiDrive* control package. The interface is designed to replace the complex and proprietary software usually associated with servo systems, and to eliminate the need for connecting an external laptop computer. You can use the touch screen to easily change the motion of the servomotor and to read out diagnostic information. *PosiDrive* servo packages come with factory default settings stored in the touch screen that you simply download to the servo amplifier. This provides a "plug-and-play" approach for commissioning the servo system on your machine.

Mechanical components are sometimes included with the servo package. These could be off-the-shelf items like couplings or mounting hardware; or they could be custom designed components like special gearboxes or adapter plates.

1-4 Major Components Of A Typical System

Servomotors are specially designed electrical motors that are capable of precisely controlled motion. Servomotors are not intended to run by themselves like ordinary motors; instead they require sophisticated electronic controllers to operate them. These controllers are usually called "Servo Drives" or "Servo Amplifiers".

Figure 1.1 shows the pieces of a typical *PosiDrive* Servomotor and Control Package. All the components working together make a servo system. The elements of the servo system are described below.

- 1. Servomotor** - The purpose of the servo system is to operate a machine in a precisely controlled manner. Servomotors are capable of very accurate movements. *PosiDrive* servomotors are specialized DC motors that have permanent magnet rotors and wound stators. Since there are no windings in the rotor these motors do not have commutators or brushes so they must be "electronically commutated" by the servo amplifier. The brushless design reduces maintenance and improves performance.
- 2. Resolver** – Servo control systems require a feedback signal that tells the controller the machine's position. *PosiDrive* servomotors have built in resolvers that monitor the rotational position of the motor shaft and transmit it to the servo amplifier. This is the most rugged and reliable method of providing the feedback. Resolvers are much more durable than encoders because they do not contain fragile glass disks.
- 3. Servo Amplifier** – (Also called a servo drive). The servo amplifier controls the electrical power fed to the servomotor. By adjusting the amperage, frequency, and phasing of the motor current, the servo amplifier can control the motion of the machine the motor is driving. Meanwhile, the servo amplifier monitors the position and speed of the motor using the feedback signal from the resolver. By comparing the motor's actual position and speed to the desired position and speed, the servo amplifier can correct for any errors as it goes along. This technique, where the servo amplifier constantly checks the movement of the motor and makes corrections, is called closed loop control.
- 4. Motor Choke** – (Also called an AC reactor). The motor choke is only required if the wiring to the motor will be longer than 25 meters (82 feet). The motor choke suppresses high frequency switching noise in the servo amplifiers output waveform. This may reduce vibration in the motor. For long motor leads the choke reduces problems arising from electrical harmonics and reflected voltage waves.
- 5. Motor Cable** – This cable connects the power output stage of the servo amplifier to the stator windings of the servomotor.
- 6. Resolver Cable** – This cable transmits the resolver feedback signal from the servomotor to the servo amplifier.
- 7. Motor Brake** – Servomotors can be equipped with a build-in mechanical brake that is used to lock the motor shaft whenever the motor is not powered. This can keep the machine from drifting when electrical power is turned off. These brakes are usually engaged by a spring and require electrical power to disengage.
- 8. Regeneration Resistor** – (Often referred to as a "braking resistor", or by the slang term "regen resistor"). The regeneration resistor helps the servo amplifier slow down fast moving or massive machinery. Moving machine parts possess kinetic energy because of their mass and velocity. Servomotors convert the kinetic energy into electrical energy as it slows the machine. There is no place in the circuit to store this surplus electrical energy, so it has to be dissipated as heat using a resistor. The servo amplifier has an internal resistor that can be used if the amount of waste heat is not too large. Otherwise an external regeneration resistor must be added to the system.
- 9. Servo Control Box**- (Also called a "control cabinet", a "control enclosure", or a "servo control"). This is a control enclosure with most of the electrical components of the servo system mounted inside it and wired together. It is usually a NEMA-12 type enclosure, which means that dirt and dripping oil or water will not leak in to it.
- 10. CAN Network** – "CAN" stands for "Control Area Network". This is a serial bus system used to network the servo amplifiers. Each servo amplifier connected to the network is called a node and is able to transmit and receive messages from the network. The CAN-bus system was originally developed for use in the automotive industries but has become increasingly popular in industrial, building automation, medical equipment and maritime electronics because of its reliability.
- 11. Touch screen HMI** – "HMI" stands for "Human Machine Interface". This is an LCD graphics display terminal with a touch screen surface. It can be mounted on the servo control box door or they can be installed at a remote location. It provides the operators' controls for the servo system, such as manual index and jog functions. The HMI touch screen is also used for configuring the system, tuning the servo amplifier, monitoring faults, etc.

12. **PLC** – (Programmable Logic Controller). Usually a servo system is part of a larger machine that has many other functions and moving parts. In these cases the servo amplifier will be just one control element within a larger control system. Although

there are many kinds of control systems, PLC based ones are very common. Most *PosiDrive* servo packages are designed to connect to a PLC or other controls of a larger host machine. Some *PosiDrive* servo packages include a PLC of their own.

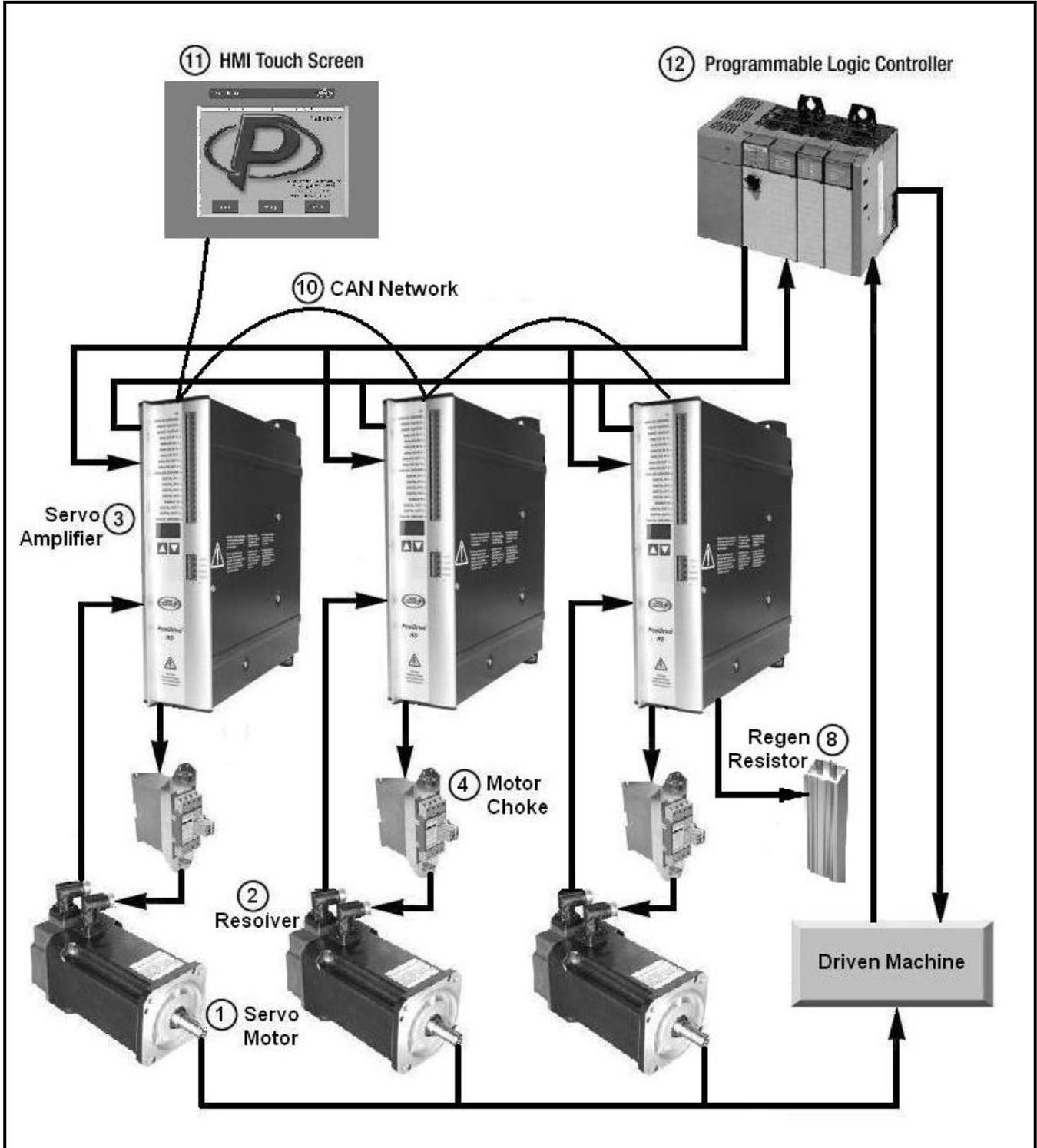


Figure 1.1 – PosiDrive Servo System Diagram

Section 2 SPECIFICATIONS

2-1 Servo Amplifier Specifications

At this time all *PosiDrive* servomotor and control packages utilize our *PosiDrive* Series RS Servo Amplifiers. This family of servo drives is available in six different current ratings and can be operated from 3-Phase voltage supplies between 208VAC and 480VAC nominal.

The two following Tables show some of the more important specifications for the RS Series Servo Amplifiers. Detailed information is available in our manual #502-PD-RS-001 "Installation Manual for *PosiDrive* Series RS Digital Servomotor Control & Amplifier".

Table 2.1 – *PosiDrive* Series RS Servo Amplifier Technical Data

Rated Data	DIM	<i>PosiDrive</i>					
		RS-01	RS-03	RS-06	RS-10	RS-14	RS-20
Rated Supply Voltage	V~ V~	3 x 230V -10%... .480V +10%, 50 Hz 3 x 208V -10%... .480V +10%, 60 Hz					
Rated Installed Load for S1 Operation	KVA	1	2	4	7	10	14
Rated DC Link Voltage	V=	260 TO 675					
Rated Output Current (rms value, ± 3%)	Arms	1.5	3	6	10	14	20
Peak Output Current (max. ca. 5s, ± 3%)	Arms	3	6	12	20	28	40
Clock Frequency of the Output Stage	KHz	8					
Technical Data for Regen Circuit	----	(See Page 19 in Installation Manual #502-PD-RS-001-00)					
Over Voltage Protection Threshold	V	450...900					
Form Factor of the Output Current (at rated data and min. load inductance)	----	1.01					
Bandwidth of Subordinate Current Controller	KHz	> 1.2					
Residual Voltage Drop at Rated Current	V	5					
Quiescent Dissipation, Output Stage Disabled	W	15					
Dissipation at rated current (Incl. Power supply losses, without regen dissipation)	W	30	40	60	90	160	200
Internal Fusing (See Table 2.2 for External Fusing)							
Auxiliary Supply 24V	----	Internal 3.15 AT					
Regen Resistor	----	Internal, Electronic					
Inputs							
Setpoint ½, Resolution 14bit/12bit Common-mode Voltage max. Input Resistance	V	± 10%					
	V	± 10%					
	KW	20					
Digital Inputs	V	Low 0 to 7 / High 12 to 36					
	MA	7					
Digital Outputs, Open Collector	V	Max. 30					
	MA	10					
Ready Output, Relay Contact	V	DC max. 30, AC max. 42					
	MA	500					
Aux. Power Supply, Electrically Isolated without Brake	V	24 (-0%, +15%)					
	A	1					
Aux. Power Supply, Electrically Isolated with Brake (consider voltage loss)	V	24 (-0%, +15%)					
	A	3					
Max. Output Current, Brake	A	2					
Connections							
Control Signals	----	Phoenix Combicon 5.08 / 18 pole, 2.5mm					
Power Signals	----	Power Combicon 7.62 / 4x4 + 1x6-pole, 4mm					
Resolver Input	----	SubD 9 pole (socket)					
Sin-cosine Encoder Input	----	SubD 15 pole (socket)					
PC-interface, CAN	----	SubD 9 pole (plug)					
Encoder Emulation, ROD/SSI	----	SubD 9 pole (plug)					
Mechanical							
Weight	Kg	4			5	7.5	
Height without connectors	mm	275					
Width	mm	70			100	120	
Depth without connectors	mm	265					

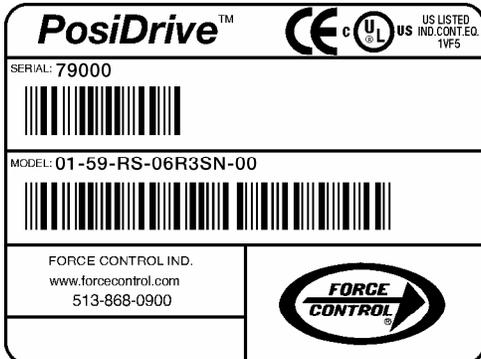
Table 2.2 – PosiDrive Series RS Servo Amplifier External Fusing

Fusible cutouts or similar (Fuse UL time delay)	PosiDrive RS-01/RS-03	PosiDrive RS-06/RS-10	PosiDrive RS-14/RS-20
AC supply FN1/ 2 / 3	6 AT (FRx-R-6)	10 AT (FRx-R-10)	20 AT (FRx-R-20)
24V supply FH ½	Max. 16 AF (FRx-R-16)		
Regen resistor FB ½	4A (FRx-R-4)	6 A (FRx-R-6)	6 AF (FRx-R-6)

(x = S for 480V applications)

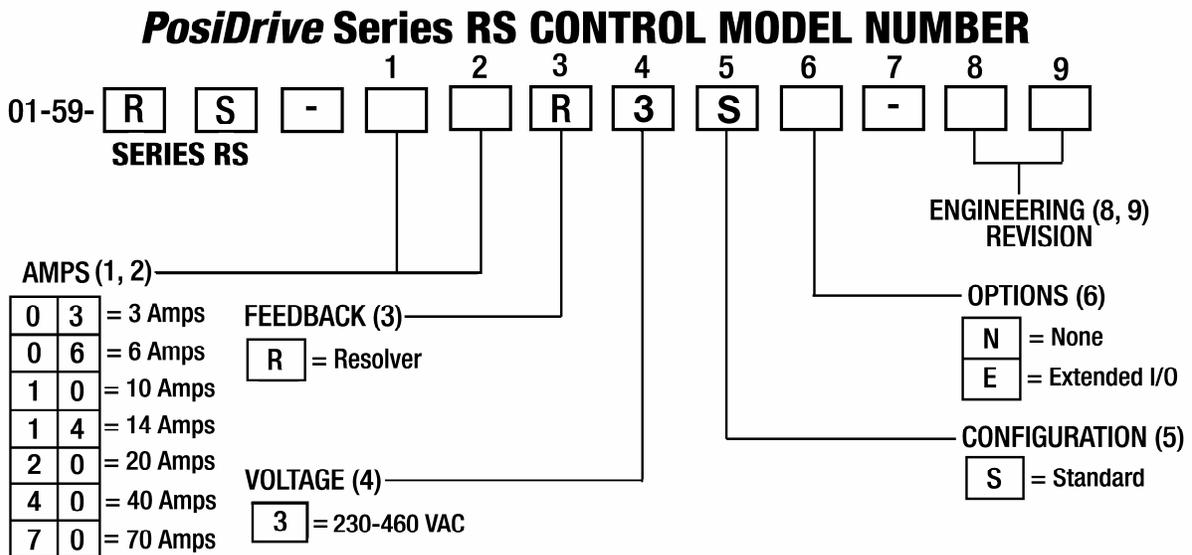
(x = N for 230V applications)

2-2 Servo Amplifier Name Plate & Model Numbers



This Name Plate is located on the Left Hand side of the servo amplifier

Figure 2.1- Servo Amplifier Name Plate



2-3 PosiDrive Servomotor Specifications

At this time all *PosiDrive* Servomotors and control packages utilize our *PosiDrive* Series RA Servomotors. The Tables below show some of the more important specifications for the RA Series Servomotors.

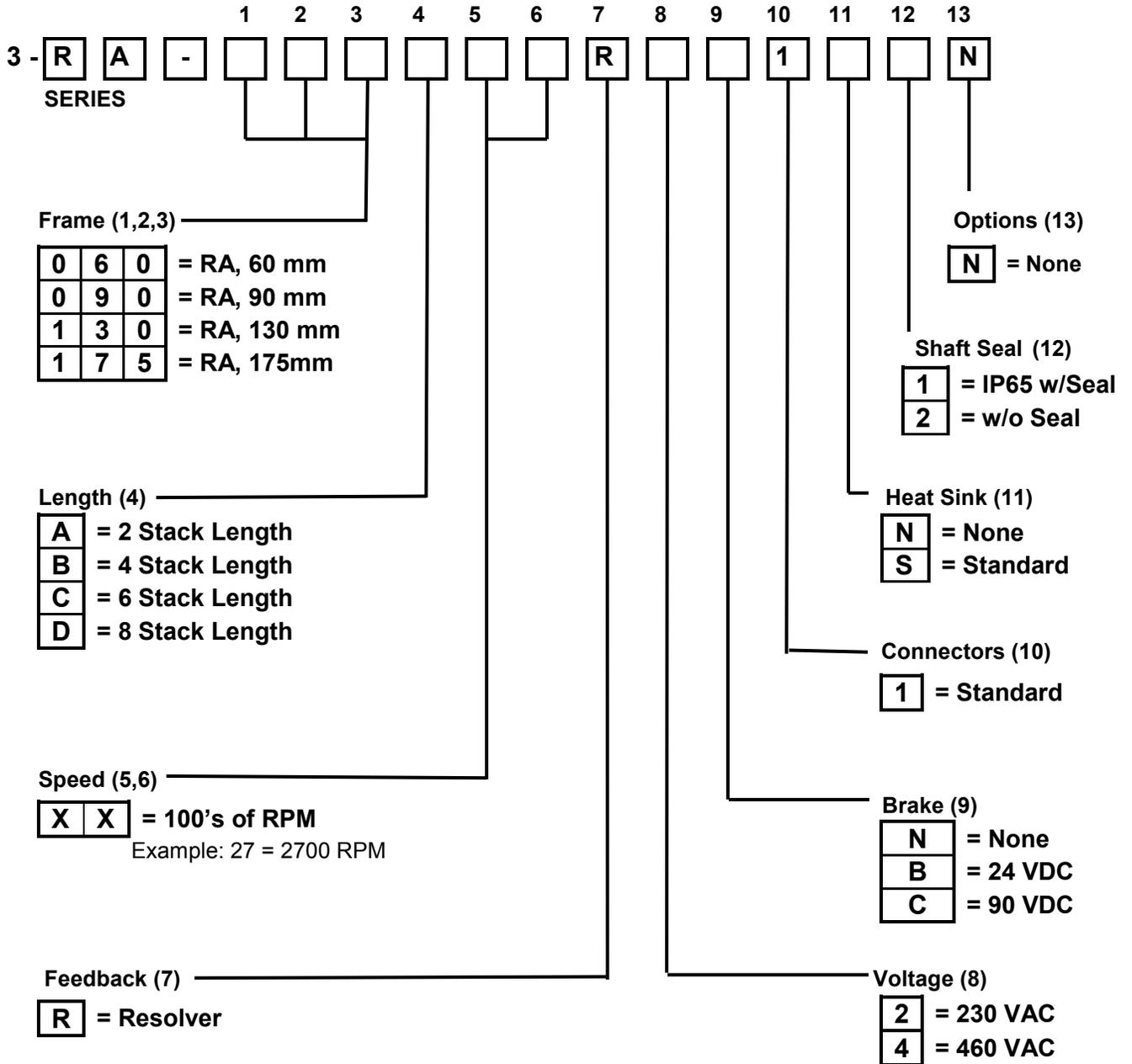
Table 2.3 – 230 Volt Servomotors

Model Number	Frame (mm)	Stack Length	Speed (rpm)	Volts	Continuous Torque lb-ft (N-m)	Peak Torque lb-ft (N-m)	Continuous Power HP (kW)
3-RA-060A60R2x	60	2	6000	230	0.32 (0.44)	0.92 (1.25)	0.31 (0.23)
3-RA-060B60R2x	60	4	6000	230	0.55 (0.74)	1.50 (2.03)	0.50 (0.37)
3-RA-060C60R2x	60	6	6000	230	1.00 (1.35)	2.80 (3.80)	0.90 (0.67)
3-RA-090A45R2x	90	2	4500	230	0.95 (1.29)	1.75 (2.37)	0.79 (0.59)
3-RA-090A60R2x	90	2	6000	230	1.00 (1.36)	2.20 (2.98)	1.02 (0.76)
3-RA-090B30R2x	90	4	3000	230	1.86 (2.52)	3.62 (4.91)	0.95 (0.71)
3-RA-090B60R2x	90	4	6000	230	1.81 (2.45)	3.78 (5.13)	1.80 (1.30)
3-RA-090C25R2x	90	6	2500	230	2.49 (3.50)	4.93 (6.69)	1.10 (0.82)
3-RA-090C46R2x	90	6	4600	230	2.45 (3.32)	4.96 (6.73)	2.00 (1.50)
3-RA-090D15R2x	90	8	1500	230	3.72 (5.04)	8.70 (11.8)	0.95 (0.71)
3-RA-090D30R2x	90	8	3000	230	3.53 (4.79)	7.21 (9.77)	1.70 (1.30)
3-RA-130A24R2x	130	2	2400	230	2.40 (3.30)	4.60 (6.20)	1.10 (0.80)
3-RA-130A40R2x	130	2	4000	230	2.40 (3.30)	5.00 (6.80)	1.6 (1.2)
3-RA-130B24R2x	130	4	2400	230	4.80 (6.50)	9.20 (12.4)	1.9 (1.4)
3-RA-130B40R2x	130	4	4000	230	4.90 (6.60)	9.50 (12.9)	2.5 (1.9)
3-RA-130C23R2x	130	6	2300	230	8.00 (10.9)	17.8 (24.1)	3.0 (2.2)
3-RA-130C40R2x	130	6	4000	230	7.20 (9.70)	13.1 (17.7)	4.2 (3.1)
3-RA-175A22R2x	174	2	2200	230	16.5 (22.3)	35.6 (48.3)	5.2 (3.9)
3-RA-175A33R2x	174	2	3300	230	16.2 (22.0)	41.4 (56.1)	6.2 (4.6)
3-RA-175B20R2x	174	4	2000	230	24.2 (32.8)	41.2 (55.9)	6.3 (4.7)
3-RA-175B30R2x	174	4	3000	230	22.1 (30.0)	56.2 (76.2)	8.0 (6.0)
3-RA-175C20R2x	174	6	2000	230	32.5 (44.0)	85.1 (115)	8.2 (6.1)
3-RA-175C30R2x	174	6	3000	230	32.5 (44.0)	85.1 (115)	9.0 (6.7)

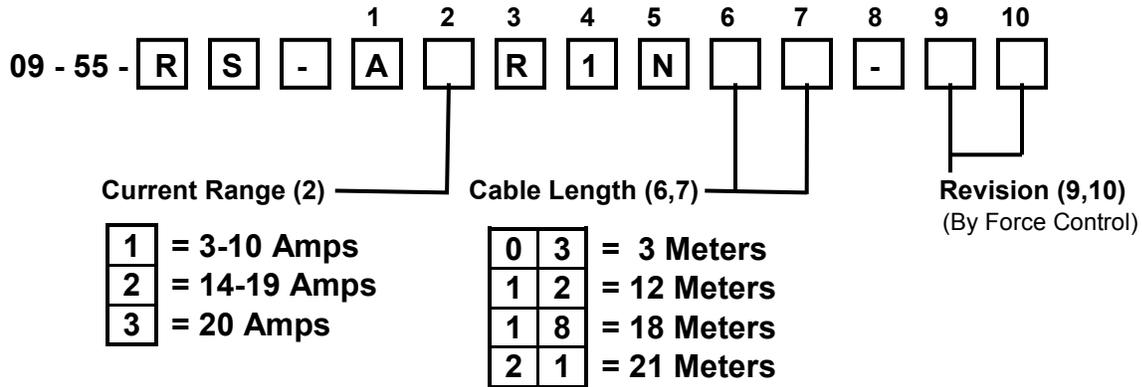
Table 2.4 – 460 Volt Servomotors

Model Number	Frame (mm)	Stack Length	Speed (rpm)	Volts	Continuous Torque lb-ft (N-m)	Peak Torque lb-ft (N-m)	Continuous Power HP (kW)
3-RA-090A60R4x	90	2	6000	460	0.89 (1.21)	2.39 (3.24)	0.91 (0.68)
3-RA-090B60R4x	90	4	6000	460	1.70 (2.31)	5.47 (7.41)	1.65 (1.23)
3-RA-090D30R4x	90	8	3000	460	3.14 (4.26)	13.78 (18.68)	1.21 (0.90)
3-RA-090D50R4x	90	8	5000	460	3.25 (4.41)	13.78 (18.68)	1.59 (1.19)
3-RA-130A40R4x	130	2	4000	460	2.40 (3.30)	7.50 (10.20)	1.60 (1.19)
3-RA-130B23R4x	130	4	2300	460	4.68 (6.30)	16.00 (21.70)	1.90 (1.42)
3-RA-130B40R4x	130	4	4000	460	4.63 (6.30)	16.00 (21.70)	2.90 (2.16)
3-RA-130C27R4x	130	6	2700	460	7.92 (10.70)	33.20 (45.10)	3.20 (2.39)
3-RA-130C36R4x	130	6	3600	460	7.91 (10.70)	33.50 (45.40)	3.90 (2.91)
3-RA-175A24R4x	174	2	2400	460	16.20 (22.00)	45.90 (62.20)	5.16 (3.85)
3-RA-175A30R4x	174	2	3000	460	16.30 (22.10)	45.90 (62.20)	5.60 (4.18)
3-RA-175B22R4x	174	4	2200	460	23.30 (31.60)	66.80 (90.60)	6.95 (5.18)
3-RA-175C23R4x	174	6	2300	460	35.2 (47.70)	106.20(143.90)	9.23 (6.88)

2-4 PosiDrive Servomotor Model Numbers



2-5 PosiDrive Control Cable Set Model Number



NOTE: Use the Model Number above to order a correct Set of Cables. A complete set of Cables includes (1) Servomotor Cable and (1) Resolver Cable as shown in Figure 2.2 below. Cables can only be ordered in 3 meter increments (i.e. 3m, 6m, 9m, 12m, etc).

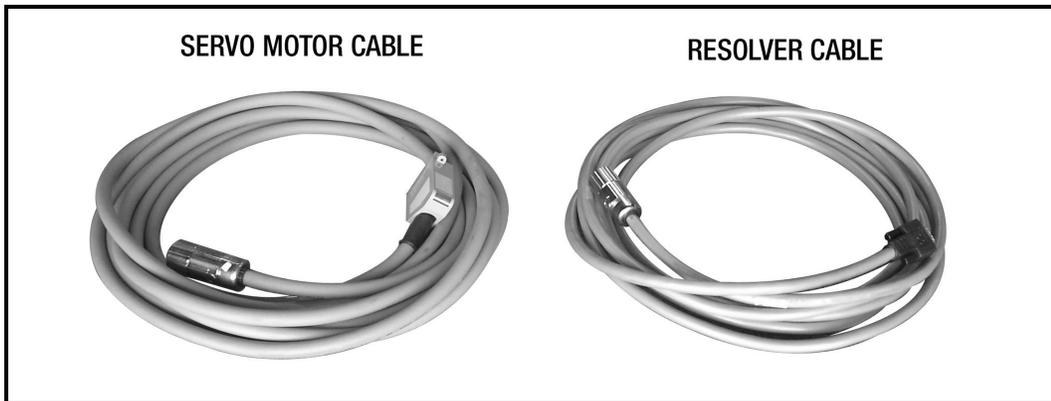


Figure 2.2 – PosiDrive Control Cable Set

2-6 PosiDrive Control Panel Name Plate



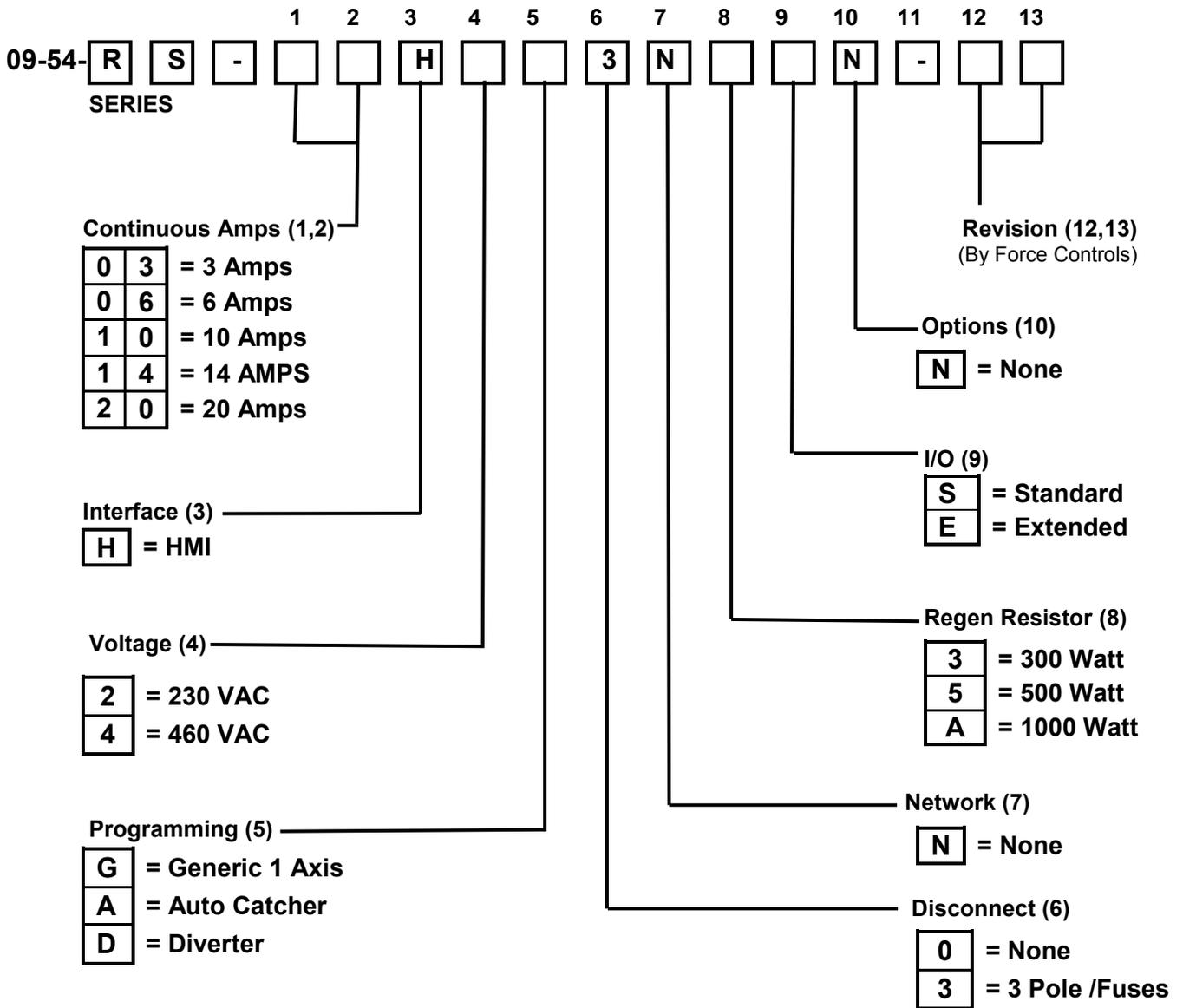
Serial Number

Model Number

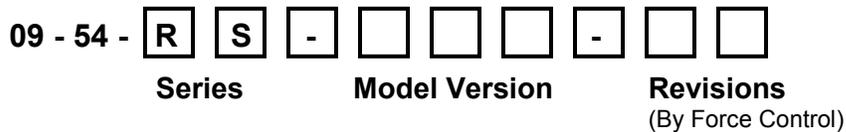
The Name Plate shown is located on the inside of the Control Box. The Model Number System shown in Section 2 – 7 is for Standard Control Panels and the one shown in Section 2 – 8 is for Custom or Special Control Panels.

Figure 2.3 – Control Panel Name Plate

2-7 PosiDrive Control Panel Model Number For Single Drive Units



2-8 PosiDrive Control Panel Model Number For Multi-Drive Or Special Units



Section 3

INSTALLATION

3-1 Receiving And Unpacking Parts

Upon receipt of your *PosiDrive* servo package the following steps should be taken:

1. Inspect all items for possible shipping damage. If you find damage then you should contact the freight carrier immediately and file a claim.
2. Verify that the model numbers and quantities of items received match the purchase order. Contact Force Control Industries if there is a question or problem.

PosiDrive servo packages come in many variations. Most components are usually supplied by Force Control Industries, but can be supplied by the customer instead. Also, some of the components may already be assembled (i.e. servomotor already mounted to a gearbox). A basic checklist follows:

1. Servomotor
2. Servo Control Box
3. Motor Cable – This cable may already be connected to the servo control box.
4. Resolver Cable – This cable may already be connected to the servo control box.
5. Operators' Control Station – The operators' controls might be mounted on the servo control enclosure door or they may be a separate piece.
6. Mechanical Components

3-2 Mounting The Servo Control Box

PosiDrive servo control boxes are usually "Hoffman style" NEMA-12 enclosures. The larger panels will be free standing types. Smaller panels will be wall-mounted types, or supplied with floor stand kits.

1. NEMA-12 Enclosures can be located in indoor factory environments where there may be dust, falling dirt, or dripping, non-corrosive liquids.
2. NEMA-4 Enclosures can be located outdoors where there may be windblown dust and rain, splashing water, hose directed water, and ice formation.
3. NEMA-4X Enclosures can be located in the same sort of places as NEMA-4 enclosures and they are also corrosion resistant.
4. Avoid excessive heat. Operating temperature should be from 32deg to 100deg Fahrenheit. Avoid direct sunlight since it tends to heat the panel.
5. Leave clearance for the regeneration resistor heat sink. If your *PosiDrive* control package is equipped

with an external regeneration resistor then there will probably be a large aluminum heat sink with fins installed on one side of the control box. You should leave 4" for air to circulate around the fins. Avoid putting the heat sink near equipment or materials that could be damaged by heat.

6. Avoid excessive vibration.

7. *PosiDrive* Servo controls are not safe for explosive environments.

8. Maintain a clear workspace in front of the control box. The National Electrical Code requires 3 feet of clear distance in front of the control enclosure as long as there are no exposed live electrical parts behind a maintenance worker when he faces the control box. If the control box is located where a maintenance worker would be between the box and some other hazard, then the clearance should be increased to four feet. See article 110.26 of NEC-2002. (Most *PosiDrive* servo controls use either 230 or 480 VAC, 3-phase).

9. If the operators' controls are on the door of the servo control box, then it will need to be located where your machine operators can easily reach them.

10. Try to locate the servo control box so that the motor cable will be less than 80 feet long.

3-3 Mounting The Servomotor

Please refer to the mechanical documentation for mounting the servomotor.

3-4 Mounting The Home Sensor

Most servo systems have a Home Position Sensor that is used to calibrate the controls to the mechanical position of the machine. This sensor should be located where it will pick up the home (or starting) position of the machine for each cycle by detecting a suitable target. For rotating machinery the target could be on the output shaft of a reducer, or the head shaft of a conveyor. For translating machinery the target might be the slide of a ball screw driven motion. For some applications the home sensor will be factory-installed into a gearbox or similar component.

It will not always be convenient or practical to locate the home sensor at the exact starting position of the machine cycle. For these situations, most *PosiDrive* servo controls provide a Home Offset feature that allows the servo to move away to a pre-programmed home position after finding the physical home sensor.

3-5 Electrical Connections

There are numerous wiring connections to be made, some of which will be completed at our factory before shipping and others that will need to be completed during installation at your facility. Also note that there may be optional items that will not be used in all applications.

IMPORTANT: It is critical that the correct wiring type and wiring paths be followed for maximum performance and a minimum of electrical noise related problems.

Electrical noise is any electrical disturbance that can cause erroneous operation of the control. Transients and line to ground spikes can be generated by load switching, starting of motors, and the actuating of solenoids. The servo amplifier can also be a significant source of electrical noise. Although *PosiDrive* Servo Amplifiers have been tested and conform to a number of EC (European Community) Directives on EMC (Electromagnetic Compatibility), it is still necessary to install them properly to prevent noise-related problems. On the input side, the servo amplifier will produce troublesome electrical harmonics in the power circuits that feed it. On the output side, the cabling from the Servo Amplifier to the motor will be a noise source.

1. Only qualified electricians or engineers should work on the electrical wiring. The power supply for a *PosiDrive* servo control is usually a 240VAC or 480VAC, 3-phase electrical circuit. These voltages can be lethal. Make sure that electrical power is disconnected, locked out, and tagged out per OSHA requirements.

2. The power supply section of the servo amplifier can be damaged if it is connected to an ungrounded or asymmetrically grounded 480 V, three phase power system. The servo amplifier is designed to handle the 277 V (nominal) that is present from line to ground in a 480 Y / 277 V grounded, three or four wire electrical service. The servo amplifier is not able to tolerate the higher line to ground voltages that are present in asymmetrically grounded systems, or that might occur accidentally in an ungrounded system. If your plant's electrical system has this problem then you will need to install a drive isolation transformer with a wye type secondary winding to power the *PosiDrive* Servo System.

If the *PosiDrive* Servo System is to be powered from a 208-240 volt, three phase source, then these grounding issues are not a problem since the highest possible line to ground voltage is 240 volts. Section 7-3 of this manual gives a procedure you can use to run a quick check if you are unsure of how the electrical system is grounded in your plant.

3. The servomotor power cable should be a 600 volt shielded cable with a capacitance of less than 150pF/m. Force Control Industries provides the correct cable as part of a *PosiDrive* servo package. The maximum length for these cables is 100 meters (328 feet). If these cables are longer than 25 meters (82 feet) then a motor choke should be installed in the circuit.

4. The resolver feedback cable should be a twisted-pair shielded cable with a capacitance of less than 120 pF/m. Force Control Industries provides the correct cable as part of a *PosiDrive* servo package. The maximum length for these cables is 100 meters (328 feet). The resolver feedback cable should be routed over a different path than the servo motor power cable so that electrical noise from the power cable will not corrupt the low-level feedback signal. If these cables must run over the same path, then keep them separated as far as possible or run them in separate conduits.

5. The motor power and resolver cables are sheathed with a durable polyurethane insulation. They can be routed over the surface of most machines if there is no danger of mechanical damage from forklifts, cutting torches, etc. Installing the cables in conduit or wireway is obviously a better, but more expensive approach. Take care not to lay cables across sharp edges that will cut into the cable.

6. All high speed or low voltage wiring from encoders, home switch, operators buttons, etc. should be routed away from high voltage cables, AC power lines, or other wiring carrying rapid switching transients. If it is necessary for low voltage wires to cross over high voltage wires, then it is best for them to cross at a 90-degree angle.

7. Wire colors: The usual wire colors for industrial installations in the United States are listed below. Color-coding shows electricians what kind of voltage level to expect on a given wire, making their jobs safer and easier.

- **Green (or Green with Yellow Stripe):** Equipment grounding conductors.
- **Black:** Ungrounded conductors at line voltage (usually 240 or 480VAC).
- **Red:** Ungrounded AC conductors at less than line voltage (120VAC).
- **Blue:** Ungrounded DC control conductors (usually 24VDC or less).
- **Yellow:** Ungrounded conductors and interlock wiring that may remain energized when the main disconnect switch is in the OFF position.
- **White:** Grounded circuit conductors (usually AC neutrals).
- **White with Blue Stripe:** Grounded dc circuit conductors (DC neutrals).

Section 4

GENERAL OPERATION

The operators' controls of most *PosiDrive* Servo Systems are straightforward and self-explanatory. This section covers the physical switches and buttons, but not the touch screen. The touch screen HMI is documented in sections #5 and #6.

Since there are such a variety of *PosiDrive* servo packages this section may describe features that are not included in your particular system.

4-1 Main Disconnect Switch

The main disconnect switch connects the servo control system to its electrical power source. Opening the main disconnect switch shuts off nearly all of the electrical power to the control panel, rendering it safe for qualified electricians to work on.

IMPORTANT: There is a couple of cases where the main disconnect switch will not kill all electrical power in a control panel. The first case occurs where there is an auxiliary power circuit in the panel for lighting, a convenience receptacle for computers, or for a PLC. A circuit like this will usually be a 120VAC circuit, and should be wired with yellow conductors to alert electricians to its presence. The second case occurs when there is interlock wiring entering the control panel from some other machine that has its own power source. Once again, these sorts of circuits should be wired with yellow conductors.

There are only a few *PosiDrive* servo control designs that do not include a main disconnect switch. These exceptions tend to occur where the servo control panel will be part of a larger control system that already has its own main disconnect switch. This is especially true if the host control system provides the power distribution (branch circuit) fusing for multiple servo amplifiers. In these cases the servo control panel will either have a lock on the door, or it will be a type of enclosure that requires tools to open.

There are two general types of disconnect switches: Flange mounted and Door mounted.

Flange Mounted disconnect switches usually have a large operating handle located to the right of the enclosure door. Some two-door enclosures have the handle located on the center post between the two doors. The operating handle swings vertically like a lever. The raised position closes the switch to energize the panel and the lowered position shuts power off. Since the handle is mounted on a flange rather than the door, it is permanently attached to the switch inside the enclosure.

Door Mounted disconnect switches have an operating handle located on the enclosure door. The operating handle rotates clockwise and counterclockwise. Some handles have a long grip; other handles look like a large red knob set into a yellow plastic base. There will be legends on the handle to show which positions are "on" and "off". Some handles will also have a separate "open" position, which releases the door so you can open it. Since the handle is mounted on the door, it must separate from the switch inside the enclosure when the door opens. The switch has a rotating shaft that extends to the back of the handle on the door. When you close the door this shaft must reengage with the handle.

Most disconnect switches are mechanically interlocked with the enclosure door so that the door is locked shut if the disconnect switch is on. This is a safety precaution. Flange mounted disconnect switches nearly always have an override that allows you to open the door while the switch is on. This override will require a tool to operate, usually a screwdriver. Some door mounted disconnect switches are also equipped with a screwdriver override. The main disconnect switch will always have provisions for locking out the electrical power using a pad lock or a safety lockout device. Most disconnect switches can only be locked in the off position, although there are exceptions for control panels that must not be turned off (like fire pumps or traffic lights).

IMPORTANT: Locking the handle of a door mounted disconnect switch does not work since the handle separates from the switch when the door is open. You must open the door and put your safety lockout device directly on the disconnect switch inside the enclosure!

4-2 Emergency Stop Push Button

The Emergency Stop Push Button is intended to stop the machine by shutting off power to the moving parts. As the name suggests, this is a good button to press in an emergency situation. An emergency stop (or "E-Stop") will always be a large, red, mushroom-head push button. Sometimes these buttons will be detented so that they stay pushed in after you press them. In this case you must pull the button back out to reset it. It is common for a machine to have more than one emergency stop push button.

In some control systems, the E-Stop will cause the machine to enter a brief, orderly shutdown sequence before turning off power to the moving parts. If the *PosiDrive* servo control is wired in to a bigger host machine then the E-Stop pushbuttons on the servo control should be wired in to the emergency stop circuits of the host machine.

4-3 Master Stop Push Button

The Master Stop Push Button usually does exactly the same thing as an emergency stop push button. It just has a different name so it will "match" with a nearby "master start" push button. If your *PosiDrive* servo control is meant to be part of a larger host control system, then it probably will not have this button.

4-4 Master Start Push Button

The Master Start Push Button energizes the output control circuits so that a machine will run. You will need to press this button to restart a machine if you have stopped it with an E-Stop button or the master stop button. If your *PosiDrive* Servo Control is meant to be part of a larger host control system, then it probably will not have this button.

4-5 Servo Stop Push Button

The Servo Stop Push Button is intended to stop only the Servomotor by shutting off power to the servo amplifier. A servo stop is usually a large, red, mushroom head push button. These buttons provide a way to kill power to just the mechanism being run by the *PosiDrive* servo control without shutting down the whole machine.

4-6 Servo Enable Selector Switch

The Servo Enable Selector Switch sends a logic signal to the Servo Amplifier telling it to activate its power output stage. You must set the switch to "enable" in order to run the servomotor. If this switch is set to "disable" then the Servomotor will be released so that it can be turned by hand.

IMPORTANT: The servo enable selector switch only sends an electronic signal to the Servo Amplifier. This does not meet the criterion to be considered a safety circuit. DO NOT use the disable function as a means of protecting people from injuries. Instead use servo stop, E- stop, master stop, or the main disconnect switch, as the situation demands.

Section 5 MULTI-DRIVE TOUCH SCREENS HMI

The *Posidrive* Control is equipped with a Multi-Drive Touch Screen HMI (Human Machine Interface). This Intelligent interface is a programmable device so the features will vary depending on your specific application. It is capable of interfacing with a maximum of 8 servo amplifiers using a CAN network for communicating with each servo amplifier. In general, there will be screens that provide operator controls for the following functions.

1. Selecting Pre-programmed Applications.
2. Configuring Motion Parameters.
3. Running the *Posidrive* Servomotor in Manual or Automatic Mode.
4. Monitoring the *Posidrive* Servo Amplifier.
5. Tuning the *Posidrive* Servo Amplifier.

Some versions of software allow you to select from different servo applications.

For Example - The Multi-Drive Touch Screen used in the manufacturing lines for roofing shingles can be selected to run Shingle Catchers, Stackers, Flippers, and/or Diverters in any combination (max. of 8).

Because we have integrated the set-up of parameters and tuning functions for our servomotors into the HMI, customers will not need to attach a laptop computer to the servo amplifier during configuration or learn complicated proprietary software to implement their servo application.

The various functions of the HMI Touch Screen can be accessed through a system of Menu Screens beginning with a Main Menu Screen. (See Figures 5.1 and 5.2)

Figure 5.2 shows the first 3-levels of Menu Screens and their functional relationship to each other, showing what screen you will access if you push a certain button.

5-1 Power-Up Messages And Menu Screens

When power is first applied to the HMI several computer-like messages will flash across the screen before the Main Menu Screen appears. They are listed in order here for diagnostic purposes, but in general they can be ignored.

1. BIOS Version Information
2. Memory Check
3. Starting MS DOS
4. Controlware Version
5. Eason Technology WinBuild Version (Loading Application)
6. Setting Files and Drivers Information
7. Force Control and Application
8. Main Menu Screen (See Section 5-2)

5-2 MAIN MENU SCREEN

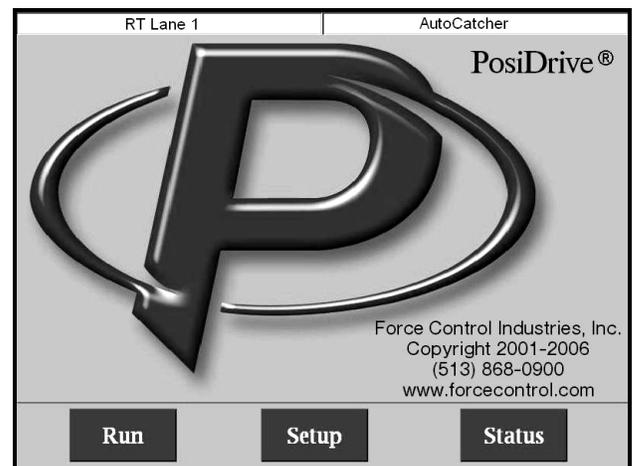


Figure 5.1 – Main Menu Screen

This is the first screen displayed after the HMI completes the **Power-Up Sequence**. It displays the **PosiDrive** logo as well as the Force Control Industries, Inc. contact and copyright information. It will also show the name of the application at the top of the screen. Along the bottom of the screen there are three touch buttons that access different sub-menus.

“Run” Button - This button accesses the **Run Screen**, which provides manual and automatic controls for the servomotor. (See Section 5-3 for more detailed information.)

“Set-Up” Button - This button accesses the **Setup Menu Screen**, which is used to configure the parameters and settings of the servo amplifier. (See Section 5-4 & Section 6 for more detailed information.)

“Status” Button - This button accesses the **Status Screen**, which monitors the servo amplifier. Some of the monitored items include Current Fault, Fault History and Motor Current. (See Section 5-5 for more detailed information.)

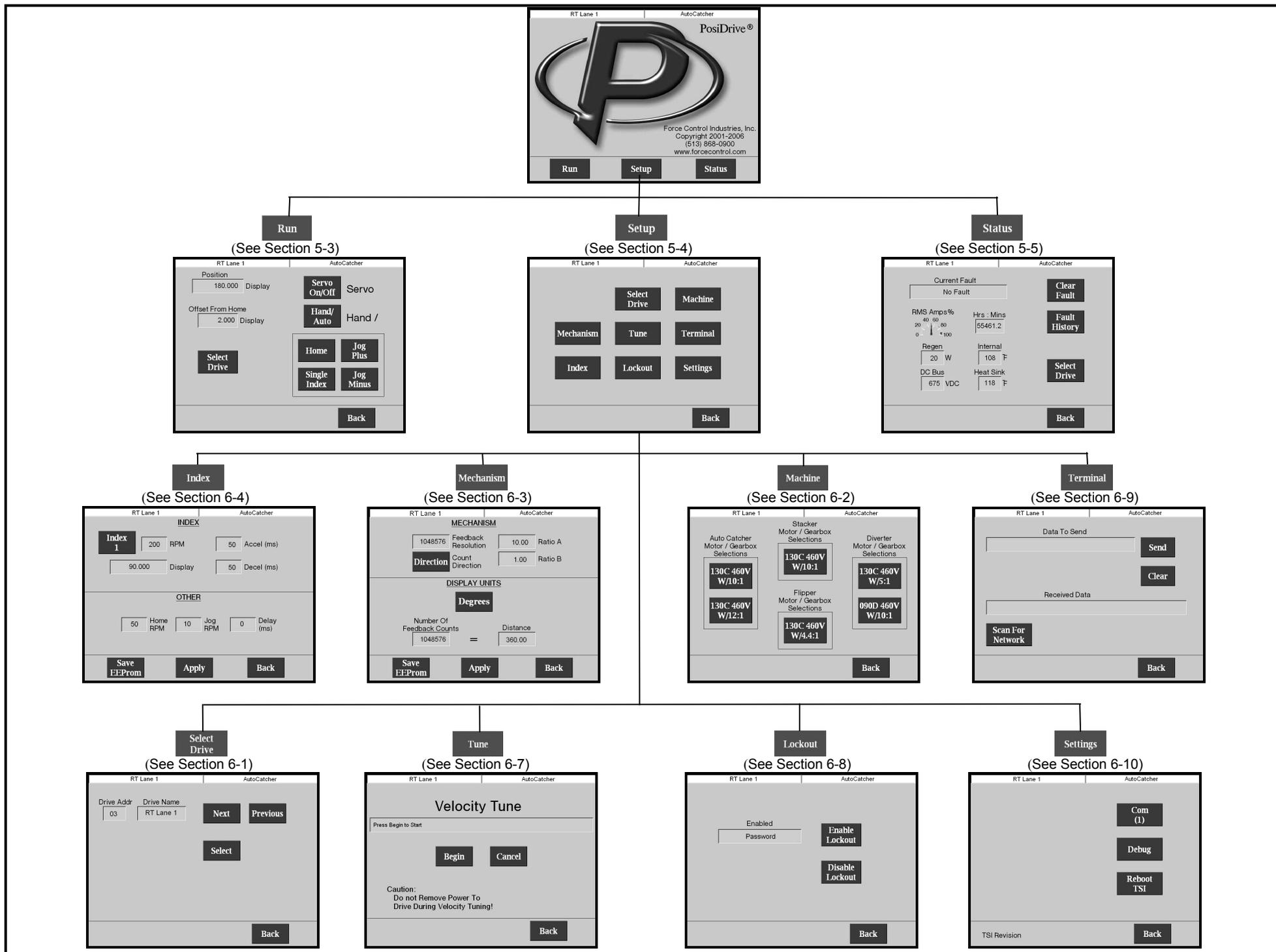


Figure 5.2 – Functional Relationship of Menu Screens

5-3 Run Screen

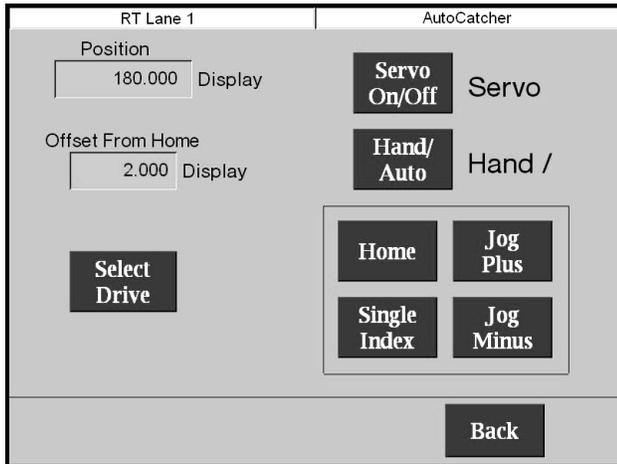


Figure 5.3 – Run Screen

The **Run Screen** allows you to switch between **“Auto” Run Mode** and **“Hand” Run Mode**. It also allows you to turn the **Servomotor “On” or “Off”**. The **Position Display Window** shows the real time position of the servomotor at all times. It can be read in Degrees, Inches, Millimeters or Counts. (See Section 6-3 for changing the **Display Units**.)

Position Display - Shows the real time position of the servomotor.

Servo “On” or “Off” Button - This Button enables or disables the servomotor current loop.

“Select Drive” Button – If there is more than one servo amplifier detected on the CAN network this button allows you to select the different servo amplifiers. (See Section 6-1)

“Back” Button - This button takes you back to the previous screen.

“Hand/Auto” Button - This button switches the **Run Mode** between **“Hand”** or **“Auto”**.

NOTE - When changing from Auto to Hand a **CAUTION Screen** as shown in Figure 5.4 will appear.

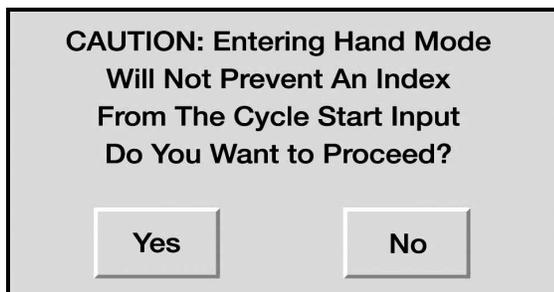


Figure 5.4 - Caution Screen

WARNING - Putting the HMI into **“Hand” Mode** does not prevent the machine’s controller from ordering the servomotor to index. Before placing your hands into the machine, disable the servomotor by pressing the **Servo Off**, **Master Stop** or the **Emergency Stop Push Button**.

Hand Control Window - The appearance of this window changes as you switch from **“Hand”** to **“Auto” Mode**. In **“Auto” Mode** this window will be empty and the legend **“Auto”** will be displayed above the top edge. In **“Hand” Mode** four additional buttons will be displayed inside the window as shown in Figure 5.3.

“Home” Button - Moves the servomotor to the **Home Position**, usually by searching for an external proximity sensor.

“Single Index” Button - Indexes the servomotor one complete index.

“Jog Plus” Button - Jogs the servomotor in the forward direction.

“Jog Minus” Button - Jogs the servomotor in the reverse direction.

NOTES:

1. Holding down either the Jog Plus or the Jog Minus Button will run the servomotor until the button is released.
2. The Jog Speed (RPM) can be manually set in the Setup Menu Screen. (See Section 6-4 for details.)

Other Buttons and Displays - These are for specific applications. **They may not be visible for your application.**

NOTE

In the Example shown in Figure 5.3 the **“Offset From Home”** display window is used for the Auto Catcher applications used in the shingle roofing manufacturing lines. This enables the operator to input an offset from the home position so that the star wheels can be fine tuned for the proper location. When the green display areas is touched a numeric keypad will pop-up to allow the operator to enter a value.

5-4 Setup Menu Screen

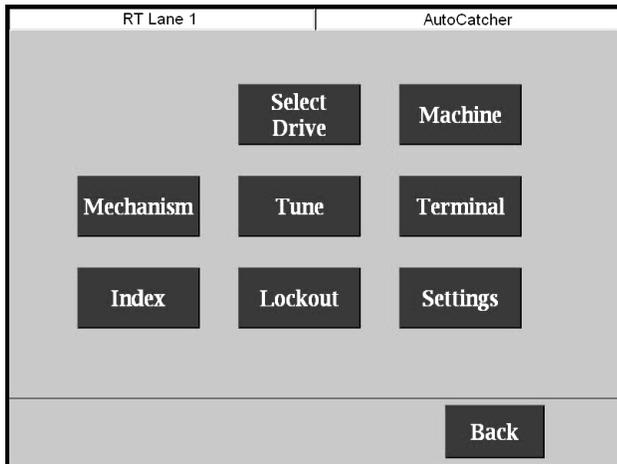


Figure 5.5 – Setup Menu Screen

This **Setup Menu Screen** generally provides eight or nine Touch Screen Buttons that access different Setup and Configuration Screens. These screens allow you to change the parameters and settings that control the motion of the servomotor and the operation of the HMI Display. Some applications will vary from the screen shown in *Figure 5.5*. Pressing the **“Setup” Button** on the **Main Menu Screen** will access this screen.

The **Setup Menu Screen** can be protected with a **Password** if you choose. If the **Password Protection** is active then a **Password Screen** as shown in *Figure 5.6* will pop up when you try to enter the Setup Menu.

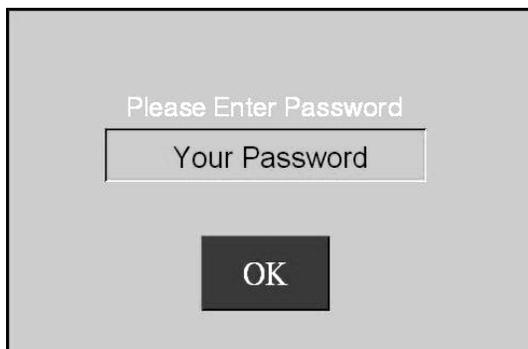


Figure 5.6 – Password Screen

Pressing the **Password Window** will bring up an alpha/numeric keypad that you can use to type in your **Password**. (See *Section 6-8* for details to activate the **Password Protection**.)

“Select Drive” Button – If there is more than one servo amplifier detected on the CAN network this button allows you to select the different servo amplifiers. (See *Section 6-1*)

“Mechanism” Button - This button accesses the Mechanism Screen, which is used to enter gear ratios and set the desired motor rotation direction. It also accesses the Display Units Screen, which is used to set the relationship between the servomotor’s feedback counts and the displayed motion of your machine measured in Degrees, Inches, Millimeters, or Counts. (See *Section 6-3* for more information.)

“Index” Button - This button accesses the Index Screen, which is used to program the index positions that the servomotor will move to when your machine is running. This Index Screen also sets acceleration and deceleration time, jog speed, and the homing speed. (See *Section 6-4* for more information.)

“Tune” Button - This button accesses the Tuning Menu Screen, which is the master screen for functions related to tuning the Servo System. Servo amplifiers need to be tuned before they will run well. Tuning adjusts for the loads and inertia of your particular application. Force Control Industries develops tuning parameters for pre-programmed applications. You can generally use our default parameters, so you may never need this function. (See *Section 6-7* for more information.)

“Lockout” Button - This button activates the Password Screen, which is used to setup **Password Protection** for the Setup Menu. If there is an active Password, the legend on the button will read **“Lockout Enabled”**. If you have not created a Password, the legend will read **“Lockout Disabled”**. (See *Section 6-8* for more information.)

“Machine” Button - This button accesses the Machine Screen, which is used to select the preprogrammed applications for the servo amplifier Settings and downloads the configuration data to the servo amplifier. (See *Section 6-2* for more information.)

“Terminal” Button - This button accesses the Terminal Screen, which allows you to key in command strings and transmits them directly to the servo amplifier. **This screen is intended for service personnel only.** (See *Section 6-9* for more information.)

“Settings” Button - This button accesses the Settings Screen, which allows you to re-boot the HMI and change the COM port setting on the HMI. (See *Section 6-10* for more information.)

“Back” Button - This button returns you to the previous menu. If you have changed any settings that should be stored in the servo amplifier’s EEPROM then a screen will appear that will ask if you want to do so. It is not necessary to save to EEPROM if your settings are experimental or temporary. If you do not save to EEPROM then your new settings will be lost when the servo amplifier loses power.

5-5 Status Screen

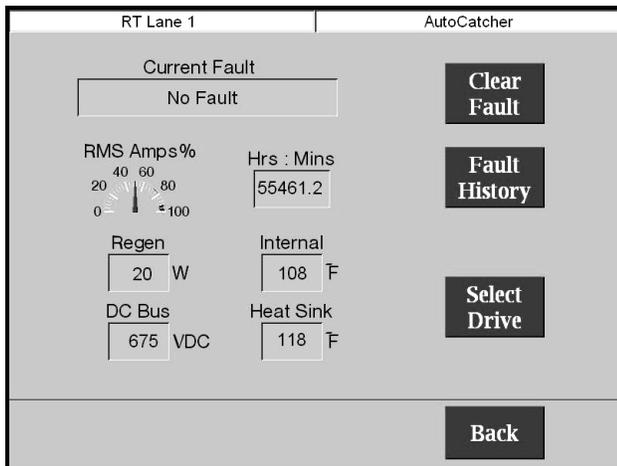


Figure 5.7 – Status Screen

The Status Screen monitors several conditions of the servo amplifier. Pressing the **“Status” Button** on the Main Menu Screen accesses this Status Screen.

“Current Fault” Display - Shows a Fault Code if the servo amplifier is faulted, otherwise it displays “no errors”. (See Section 7 for a list of Fault Codes.)

“RMS Amps %” Display - Shows the current as a percentage of the full load current of the servo amplifier. The servo amplifier will fault at 105% current.

“Internal” Display - Shows the internal temperature of the servo amplifier in Degrees Fahrenheit.

“Regen” Display - Shows the electrical power currently being dissipated in the Regeneration Resistor in Watts.

“Hrs : Mins.” Display - Shows the total time that the servo amplifier has been powered up in Hours and Minutes.

“Heat Sink” Display - Shows the temperature of the servo amplifier’s Heat Sink in degrees Fahrenheit.

“Bus” display - Shows the servo amplifier’s DC Bus Voltage.

“Clear Fault” Button - This button sends a fault reset command to the servo amplifier.

“Fault History” Button - This button accesses the **Fault History** Screen, which displays up to ten prior faults along with time stamps. (See Figure 5.7)

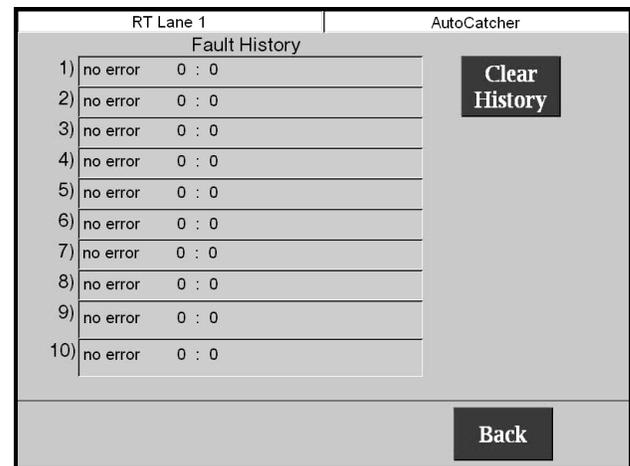


Figure 5.7 – Fault History

Fault History Screen

The Fault History Screen has two Touch Buttons on it. There is a **“Clear History”** Button that resets the Historical Faults to **“No Errors”**. The other one is a **“Back”** Button that returns you to the Status Screen.

Section 6 SERVO SET-UP USING HMI SET-UP SCREENS

6-1 Select Drive Screen

The **Select Drive Screen** is used to select which servo amplifier (drive) you wish to communicate with the HMI. Since this is a Multi-Drive HMI there is usually a CAN network linking it to a number of drives. Each drive must be programmed with its own unique address. The drive that is connected directly to the HMI must have the highest address number. This will designate it as the master drive and all the other drives connected to it as slaves. For example if there are three drives connected to the HMI, the drive directly connected to the HMI would have an address of "03". The next drive in line would have an address of "02" and the last would have an address of "01". A maximum of 8 servo amplifiers can be addressed or connected on the CAN network.

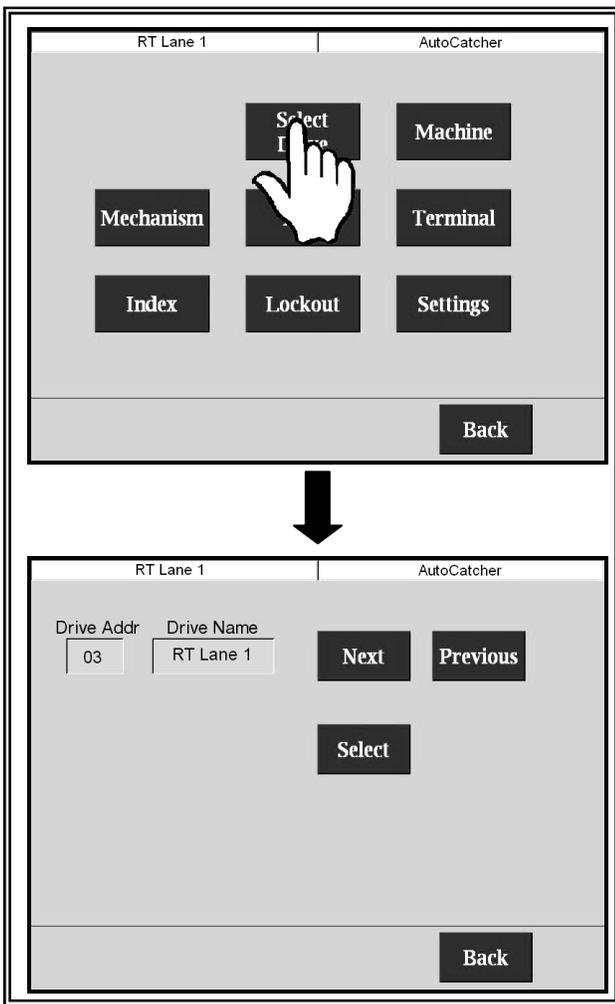


Figure 6.1 – Select Drive Screen

“INFO:” Screen -- If there is a problem with the network communications or there is only one drive connected to the HMI a screen will pop up warning you. The condition must be corrected before continuing (See Figure 6.2).



Figure 6.2 -- INFO Screen

“Next” & “Previous” Button -- These buttons are used to scroll through the drives that are detected by the HMI. You will see the **“Drive Addr”** and **“Drive Name”** change each time the buttons are pushed.

“Select” Button -- This button is used to select the drive you wish to communicate with that is being displayed in the **“Drive Addr”** and **“Drive Name”** windows.

NOTES

1. The name of the current drive that the HMI is communicating with is displayed in the yellow top left header above all the screens. Once you have selected a different drive with the **“Select” Button** you will see this header change to reflect the drive name that was selected.
2. Each drive can be given a unique name to customize the HMI to the specific application and to make drive identification easier. Touching the green header in the upper left hand side where the name is displayed will pop up an alpha/numeric keypad (See Figure 6.3). Use the keypad to type in the desired name and press the **Enter** key. The pop up will disappear and the **“Drive Name”** window will be updated.

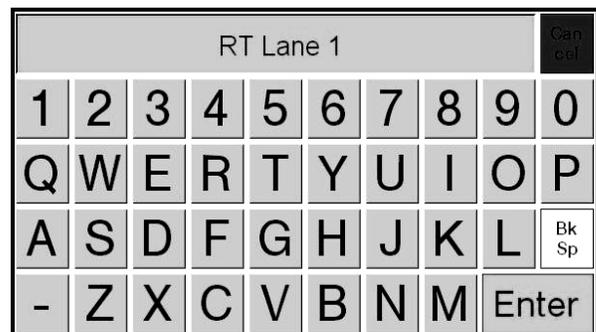


Figure 6.3 -- Alpha/Numeric Keypad

6-2 Machine Screen

The **Machine Screen** is used to program the servo amplifier with the pre-programmed applications for the PosiDrive Control Package. It loads the values for the particular motor that is being used so the system will be tuned. It programs the servo amplifier with the motion task as well as default parameters for the indexes, acc. time, and dec. time. Once the servo amplifiers have been programmed the parameters stay with the servo amplifier and they will operate independently from the HMI. *Figure 6.4* below shows the various applications available for the Shingle Roofing Manufacturing lines. These include shingle Catchers, Stackers, Flippers, and Diverters.

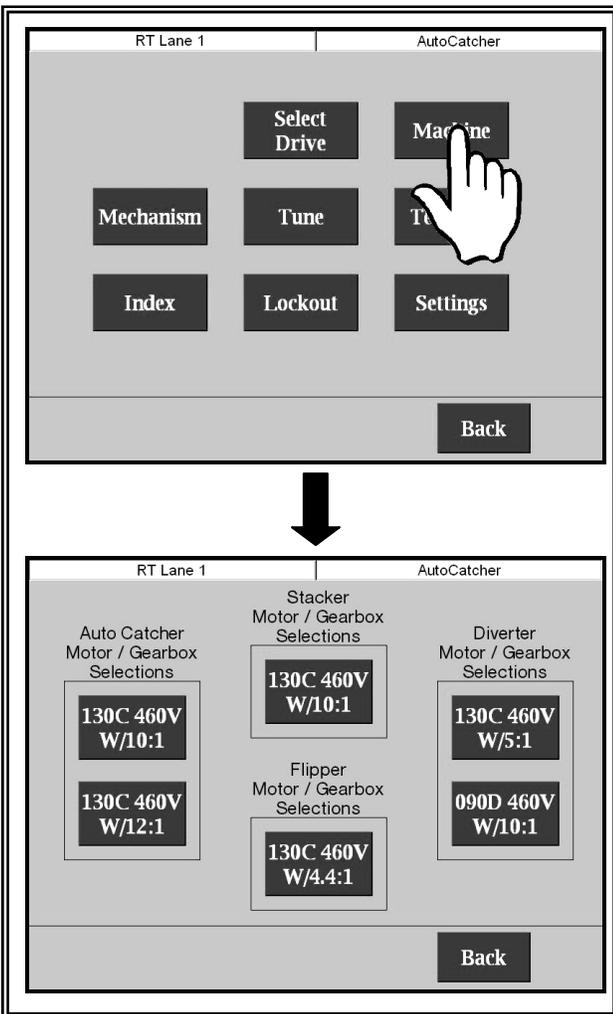


Figure 6.4 – Machine Screen

Pressing an **Application Button** begins the process of configuring the servo amplifier to run a particular piece of equipment.

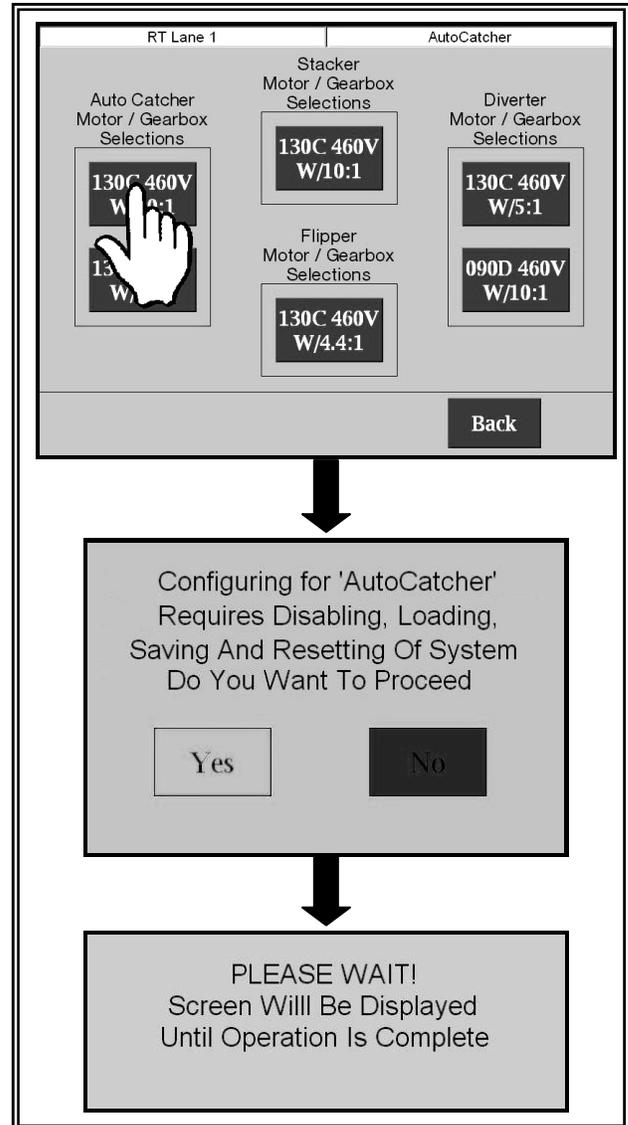


Figure 6.5 – Saving Pre-Programmed Applications

The **Warning Screen** informs you that the servo amplifier will need to be Disabled and Reset. It has **"Yes"** and **"No"** buttons that allow you to continue the operation or else abort. Pressing the **"Yes"** button transmits the new parameters to the servo amplifier. A **"Please Wait"** screen will be displayed for a few moments during this process. When the operation is finished you will be returned to the Machine Screen and the Servo system will be ready to run your application.

NOTE: After the servo amplifier has been programmed the application name will appear on the right hand side of the yellow header located above the screens. This can't be changed.

6-3 Mechanism Screen

The **Mechanism Screen** is used for two functions. The first is called the **Mechanism** that is used to set the relationship between the servomotor's speed in RPM and the displayed motion of your machine measured in RPM. You do this by entering the gear ratio of any gearboxes that are a part of your application. You also use this screen to set the desired motor rotation direction. For most applications Force Control Industries will have pre-program default settings for this screen.

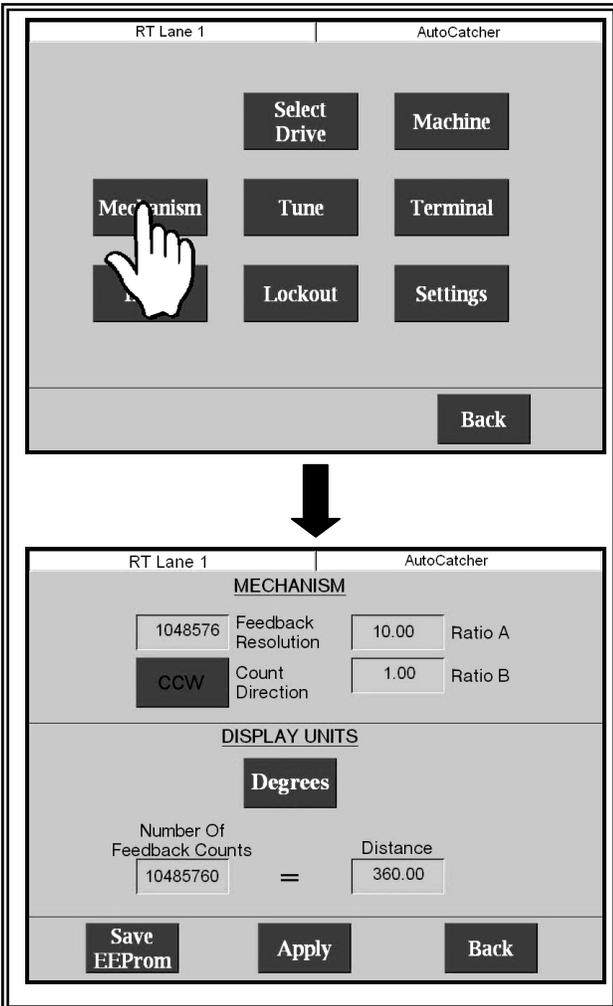


Figure 6.6 -- Mechanism Screen

“Feedback Resolution” Parameter – Set this parameter to the appropriate feedback resolution for your servomotor and servo amplifier. For *PosiDrive* Servomotors and Servo Amplifiers, the feedback resolution is usually 1,048,576 counts per revolution (2 to the 20th power). Touching the **“Feedback Resolution”** box will pop up a Numeric Keypad that you use to enter the desired value. (See Figure 6.7)

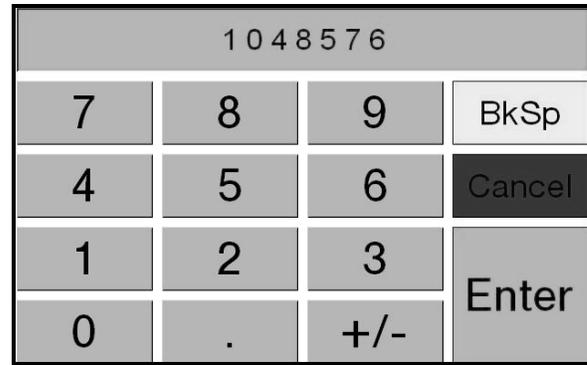


Figure 6.7 – Numeric Keypad

“Ratio A” Parameter – Set this parameter in conjunction with the **“Ratio B”** parameter described below to show the gear ratio of your application. This parameter corresponds to the number of turns the input shaft makes in relation to the output shaft. In the case of a 20:1 gear reducer **“Ratio A”** would be set to 20. Touching the **“Ratio A”** box will pop up a numeric keypad that you use to enter the desired value. (See Figure 6.7)

“Ratio B” Parameter – Set this parameter in conjunction with the **“Ratio A”** parameter described above to show the gear ratio of your application. This parameter corresponds to the number of turns the output shaft makes in relation to the input shaft. In the case of a 20:1 gear reducer **“Ratio B”** would be set to 1. Touching the **“Ratio B”** box will pop up a numeric keypad that you use to enter the desired value. (See Figure 6.7)

“Count Direction” Button – This button toggles the direction of the motor's rotation. The legend shown on the button will indicate which direction is selected by showing either **“CW”** or **“CCW”**. These shaft directions are designated for an observer looking at the shaft end of the motor. When you press the **Count Direction** button a warning screen will pop up to inform you that the servo amplifier will need to be **Disabled and Reset**. The warning screen has **“Yes”** and **“No”** buttons that allow you to apply your change or else abort. Pressing the **“Yes”** button transmits the new direction parameter to the servo amplifier. A **“Please Wait”** screen will pop up for a few moments during this process. When the operation is finished you will be returned to the mechanism screen. (See Figure 6.8)

It is not possible to process a direction change if there are other parameter changes that have not been saved to the servo amplifier's EEPROM. See *Section 6 - 5* for more details on saving parameters. If you attempt to change the rotation direction when there are other unsaved parameter changes then a warning screen will pop up to notify you of the problem.

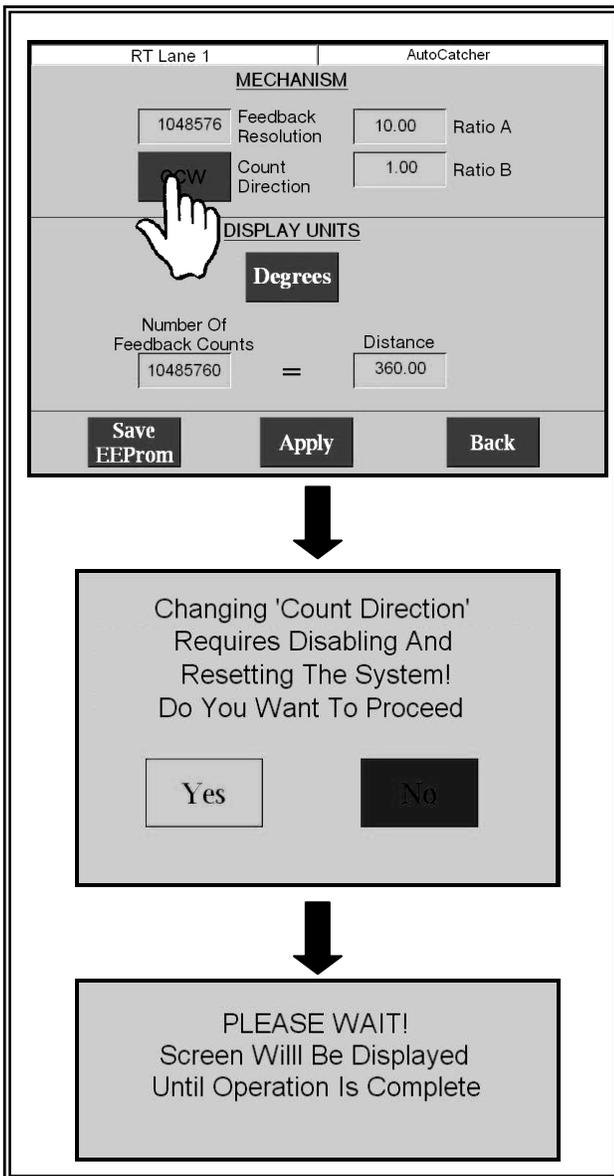


Figure 6.8 -- Changing The Count Direction

The second function of the **Mechanism Screen** is called **Display Units** which is used to set the relationship between the servomotor's feedback counts and the displayed motion of your machine measured in degrees, inches, millimeters, or counts. For most applications Force Control Industries will have pre-program default settings for this screen.

“Units” Button – This button steps through four different units of measurement: Degrees; Inches; Millimeters; and Counts. The legend shown on the button will change each time you press it. The units should be set for the most convenient way of displaying the movement of the servomotor. For linear motions, set the units to inches or millimeters. For rotary motions, set the units to degrees.

“Number of Feedback Counts” Parameter – Set this in conjunction with the “Distance” parameter described below. Feedback counts track the rotation

of the servomotor. Touching the Feedback Count box will pop up a numeric keypad that you use to enter the desired value. If you selected Counts for the Units then this parameter is not used.

“Distance” Parameter – Set this in conjunction with the “Feedback Counts” parameter described above. The Distance parameter describes the motion of your machine in terms of the units you selected with the **Units** button. Touching the **Distance** box will pop up a numeric keypad that you use to enter the desired value. If you selected Counts for the Units then this parameter is not used.

The digital servo amplifier converts feedback signals from the servomotor's resolver in to a “feedback count” which shows the motor's position. For *PosiDrive* Servomotors and Servo Amplifiers, the feedback resolution is usually 1,048,576 counts per revolution (2 to the 20th power). Based on the mechanics of your application there will be a fixed relationship between the feedback counts for the motor and the resulting motion of your machine. You have to calculate this relationship and then enter your results into the Feedback Counts and Distance parameters. By setting the correct ratio between these two parameters you will be able to order motion and read the results using convenient display units rather than having to work with huge numbers of “counts”. See the following Examples.

IMPORTANT: The direction of motor rotation can be reversed using the “Count Direction” button described previously. Do not try to reverse the motor by entering negative numbers in the Feedback Counts or Distance parameters.

Example #1:

Shingle Catcher: The servomotor drives a pair of “starwheels” on a roof shingle manufacturing line “catcher”. (Shingles coming off the end of the line stack up between two starwheels in the catcher and are then dropped vertically by rotating the starwheels). The mechanism includes a gear reducer with a 10:1 gear ratio. You might decide to use one complete revolution of the starwheels as your machine motion “distance”. One revolution equals 360 degrees, so you would set the units parameter to “degrees” using the Units button and enter 360 for the Distance Parameter. Next you will need to calculate the number of Feedback counts that equal a 360 degree turn of the star-wheel. Since the gear box has a 10:1 gear ratio the servomotor must make 10 complete revolutions to turn the starwheels 360 degrees. Ten complete revolutions will produce 10 x 1,048,576 or 10,485,760 feedback counts. Set the Feedback Counts parameter to 10485760.

The result of these settings is that the HMI will communicate in terms of degrees rather than

counts. If you want to flip the starwheels half a turn, then you order them to index 180 degrees and let the digital servo amplifier take care of computing the 5,242,880 required counts. (See section 6-4 for details on setting up index movements).

Example #2:

Shingle Catcher: It was not critical to pick 360 degrees for the Distance Parameter in Example #1. Other Distance Parameter settings will work provided you compute the corresponding feedback count correctly. Most starwheels rotate 90 degrees when they index, so it would be reasonable to enter 90 degrees for the Distance parameter and units. In this case the Feedback Counts parameter should be set to 2,621,440 based on **Calculation "A"** shown below.

Calculation "A"

Feed Back Count Parameter

$$= (\text{Motor Resolver Count}) \times (\text{Gear Ratio}) \times (\text{Distance Parameter})$$

$$= \left(\frac{1,048,576 \text{ Counts}}{360^\circ (\text{Motor})} \right) \left(\frac{10 (\text{Motor})}{1 (\text{Starwheel})} \right) (90^\circ (\text{Starwheel}))$$

$$= 2,621,440 \text{ Counts}$$

Example #3

Linear Slide: The servomotor drives a ball screw with a 16 millimeter pitch. You could select millimeters for the units and set the distance parameter to 1 millimeter. In this case the Feedback Counts parameter should be set to 65,536 based on **Calculation "B"** shown below.

Calculation "B"

Feed Back Count Parameter

$$= (\text{Motor Resolver Count}) \times \left(\frac{1}{\text{Ball Scr Pitch}} \right) \times (\text{Distance Parameter})$$

$$= \left(\frac{1,048,576 \text{ Counts}}{\text{Revolution}} \right) \left(\frac{1 \text{ Revolution}}{16 \text{ mm}} \right) (1 \text{ mm})$$

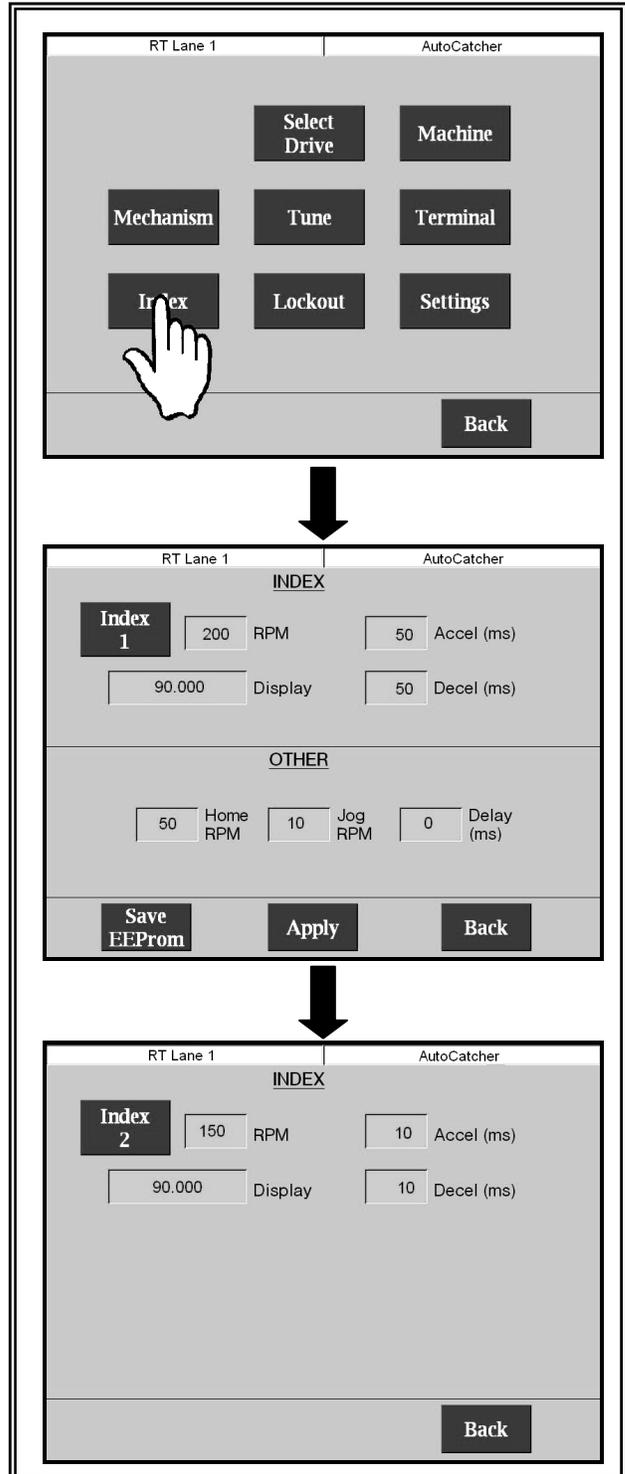
$$= 65,536 \text{ Counts}$$

"Apply" Button – This button downloads your parameter changes to the servo amplifier. This button will only be available if you have changed the parameters; otherwise the **"Apply"** legend on the button will be hidden. See section 6-5 for more details.

"Save EEPROM" Button – This button saves your parameter changes to the servo amplifier's permanent EEPROM memory so that they will not be lost if the amplifier loses power. This button will only be available after you have "applied" parameters changes using the **"Apply"** button, otherwise the "Save EEPROM" legend on the button will be hidden. **NOTE:** The servo amplifier will be **Disabled** during this operation. (See Section 6-6 for more details).

6-4 Index Screen

The Index Screen is used to program the index positions that the servomotor will move to when your machine is running. This screen also sets acceleration time, jog speed, and the homing speed. For most applications Force Control Industries will have pre-programmed default settings for this screen. Access this screen by pressing the **Index Button** on the Setup Menu.



6.9 -- Index Screen

NOTE - If the parameters in the Display Units Screen and the Mechanism Screen (See Section 6-3) are setup correctly, then the index parameters on this screen will be referenced to the actual motion of your machine.

Example: The final driven segment of your servo system is a rotating shaft. There is a 10:1 gear reducer between the servomotor and the shaft. Entering a 90° index on this screen will program the motor to turn 2-1/2 revolutions (900°) so that the output shaft will turn 90°.

"Index" Button – This button selects which index will be displayed on the Index Screen. For applications with only a Single programmed index position, this button will not be present. For applications with multiple programmed index positions, the legend on the button will indicate which index position is being displayed by showing a number beneath the word **"Index"**. Each time you press the button the index number will increase by one so that you step through all the available index screens. The **RPM, Degrees, Accel ms** and **Decel ms** parameters all have unique settings for each programmed index, so they will be updated with the appropriate values as you step through the Index Screens. The **Home RPM, Jog RPM** and **Delay ms** parameters are only displayed with **Index 1**; for other Index numbers they are not required.

"RPM" Parameter – This parameter sets the speed of the selected index movement in revolutions per minute. This speed is scaled to match your application using the parameters on the Mechanism Screen (See section 6-3). A separate RPM parameter is entered for each index move.

"Position" Parameter – This parameter sets the target position of the selected index movement. On the example screens shown in *Figure 6.9* this parameter is labeled **"Degrees"**. In general the label will depend on which display units have been selected: degrees; inches; millimeters; or counts (See Section 6-3). This position is scaled to match your application using the parameters on the Display Units Screen. A separate position parameter is entered for each index move.

"Accel ms" Parameter – This parameter sets the acceleration time for the selected index movement in milliseconds. While indexing, the servomotor will accelerate from zero to full speed in as many milliseconds that have been set in this parameter. A separate acceleration parameter is entered for each index.

"Decel ms" Parameter – This parameter sets the deceleration time for the selected index movement in milliseconds. A separate deceleration parameter is entered for each index move.

"Home RPM" Parameter – This parameter sets the servomotor's speed during a homing operation. While homing, the servomotor should turn slowly as it seeks the home sensor. This parameter is only shown on the first index screen.

"Jog RPM" Parameter – This parameter sets the servomotor's speed for jogging. This parameter is only shown on the first index screen. The servomotor can be jogged manually using buttons on the Run Screen. (See Section 5-3.)

"Delay mS" Parameter – This parameter sets a delay time in milliseconds. After receiving a "cycle start" command, the servo amplifier will wait for the delay time before it begins indexing the servomotor. The cycle start command is a physical signal that is wired to the servo amplifier's digital input #1. (See *schematics for details*.) This parameter is only shown on the first index screen.

"Apply" Button – This button downloads your parameter changes to the servo amplifier. This button will only be available if you have changed the parameters; otherwise the **"Apply"** legend on the button will be hidden. (See section 6-5 for more details.)

"Save EEPROM" Button – This button saves your parameter changes to the servo amplifier's permanent **EEProm** memory so that they will not be lost if the amplifier loses power. This button will only be available after you have "applied" parameters changes using the **"Apply"** button, otherwise the **"Save EEPROM"** legend on the button will be hidden. **NOTE:** The servo amplifier will be **Disabled** during this operation. (See Section 6-6 for more details.)

"Back" Button – This button returns you to the Setup Menu.

6-5 Applying Parameters

Several of the screens that are accessed from the Setup Menu have an **"Apply" Button**. This button is used to download parameter changes to the servo amplifier. Changing parameter settings on the HMI screens has no effect on the motion of the servomotor until you apply your changes using this button. It is important to note that saving parameter changes permanently in to the servo amplifier's EEPROM Memory is a separate process that uses a different button (See Section 6-6).

HINT - You can apply parameter changes while the servo system continues to run. This allows you to make **"On the Fly"** Adjustments without shutting your machine down.

The **Apply** button will only be available if you have changed a parameter. When there are no changes pending the **"Apply"** legend on the button will be hidden and the button will not operate.

When you press the **Apply** button a **Warning Screen** will pop up. The warning screen reminds you that applying the new parameters will change the motion of the Servo Motor. It also reminds you to save your changes to EEPROM if you want them to be permanent. (See *Figure 6.10*)

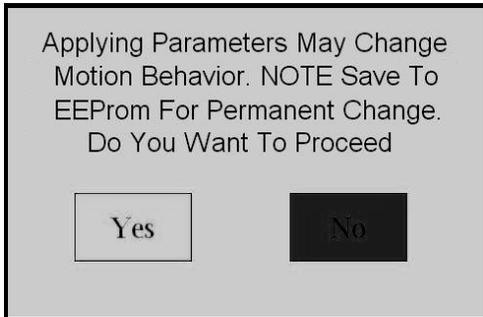


Figure 6.10 -- Applying Parameters

The warning screen has **"Yes"** and **"No"** buttons that allow you to apply your changes or else abort. Pressing the **"Yes"** button transmits the new parameters to the Servo Amplifier. A **"Please Wait"** screen will pop up for a few moments during this process. When the operation is finished you will be returned to the parameter screen you started from.

6-6 Saving Parameters To EEPROM

Several of the screens that are accessed from the Setup Menu have a **"Save EEPROM"** Button. This button is used to save changed parameters in the servo amplifier's permanent memory. If you do not save your changes to EEPROM then they will be lost when you shut off power to the servo amplifier

The **Save EEPROM** button will only be available if you have **"Applied"** a change using the **Apply** button. (See *Section 6-5.*) When there are no changes pending the **"Save EEPROM"** legend on the button will be hidden and the button will not operate.

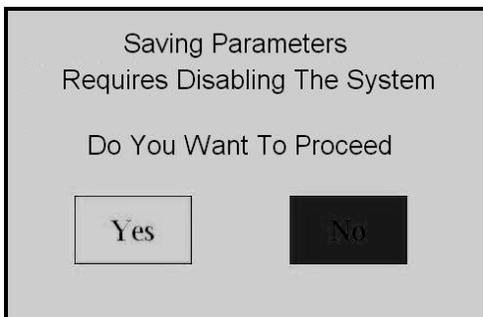
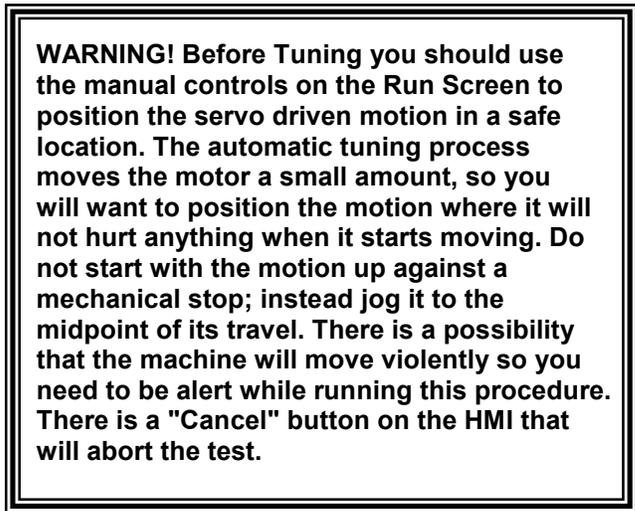


Figure 6.11 -- Saving Parameters to EEPROM

When you press the **Save EEPROM** button a **Warning Screen** will pop up. (See *Figure 6.11*) The warning screen notifies you that the Save operation requires the temporary disabling of the system. The warning screen has **"Yes"** and **"No"** buttons that allow you to save your changes or else abort. Pressing the **"Yes"** button disables the servo amplifier and then saves the parameters to permanent memory. A **"Please Wait"** screen will pop up for a few moments during this process. When the operation is finished you will be returned to the parameter screen you started from.

6-7 Velocity Tune Screen



The **Velocity Tune Screen** is used to invoke an automatic tuning sequence and to monitor the results. Tuning adjusts for the loads and inertia of your particular application. Force Control Industries develops tuning parameters for pre-programmed applications. You can generally use our default parameters, so you may never need this function. Access this screen by pressing the **Tune** button on the **Setup Menu Screen**.

When you activate the automatic tuning process, the servo amplifier drives the servomotor to make a series of very short moves back and forth. In addition to oscillating, the machine will also vibrate. The frequency of the vibration will increase in steps over the course of about a minute as the amplifier "test drives" the motor. At the end of the test the display will show a "Done" message plus a "GV" value, and a "GVTN" value. The GV value is the proportional gain of the velocity loop. The GVTN value is the integration time constant.

It may be useful to record the GV and GVTN values. If they were to change drastically it would indicate a change in the dynamics of your machine.

In some cases the servomotor will vibrate violently at the beginning of the tuning procedure but will quiet down quickly. This happens as soon as the servo amplifier takes its first data point, and starts to adapt to the mechanical load.

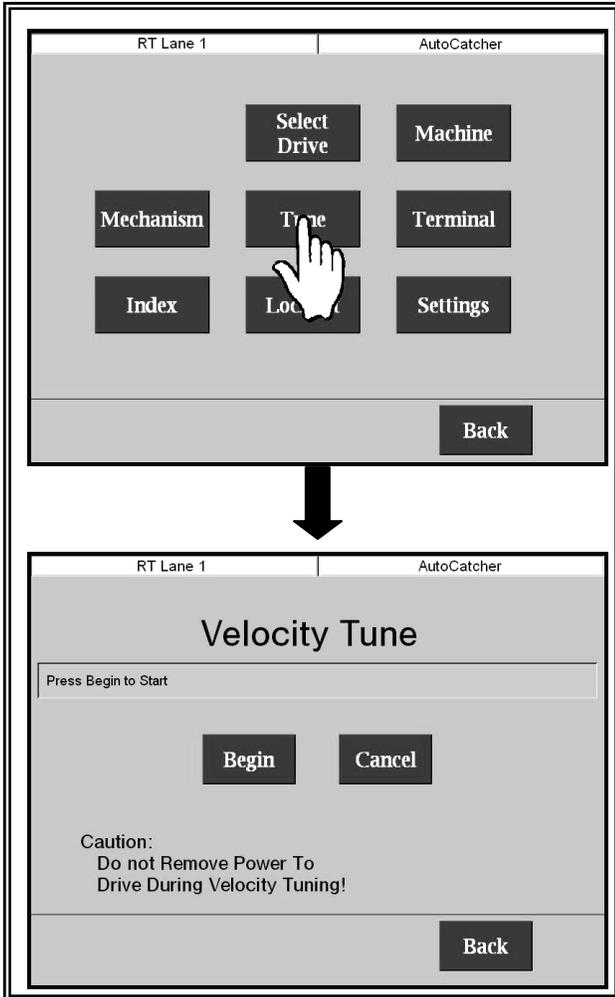


Figure 6.12 -- Velocity Tune Screen

"Begin" Button – This button will start the automatic tuning sequence. The legend in this button changes to **"Wait"** while the test is running. Be ready to hit the **Cancel** button if the machine starts to vibrate too badly or "runs away".

Caution! Do Not remove power to the servo amplifier during velocity tuning!

"Cancel" Button – This button aborts the velocity tuning sequence. Normally this button is blank; the **"Cancel"** legend only appears after you have started a test with the **Begin** button.

"Back" Button – This button returns you to the Setup Menu Screen.

6-8 Password Entry Screen

The Password Entry Screen is used to set up password protection for the Setup Menu. Access this screen by pressing the **"Lockout" Button** on the setup menu.

"Password" Window – This window displays the password if one has been entered. Pressing the **Password Window** will bring up an alpha/numeric keypad. Use the keypad to type in a password and then press the **Enter** Button. The password can use any character that is on the keypad, including spaces, and can be of almost any reasonable length. *(The Password Window can display 13 characters. You can enter longer Passwords but they will scroll out of the window.)*

The **"Cancel" Button** will return you to the Password Screen without keeping the new entry. The **"BKSP" Button** backspaces and deletes the last letter you typed in. The **"Enter" Button** returns you to the Password Screen and displays your new password in the password window. *(See Figure 6.13)*

"Enable Lockout" Button – This button activates the password shown in the password window. Pressing this button causes the legend **"Enabled"** to appear above the password window. **Important** - Be sure to press the **"Enable Lockout" Button** after changing the password. You can change the password while it is enabled, but the new password does not take effect until you press the **Enable Lockout Button**. If you fail to do this before you exit the password screen then the previous password will still be the valid one, even though the new password was displayed in the password window.

"Disable Lockout" Button – This button deactivates the password feature and clears the password window.

"Back" Button – This button returns you to the Setup Menu.

The new password will take effect once you exit the Setup Menu and return to the Main Menu.

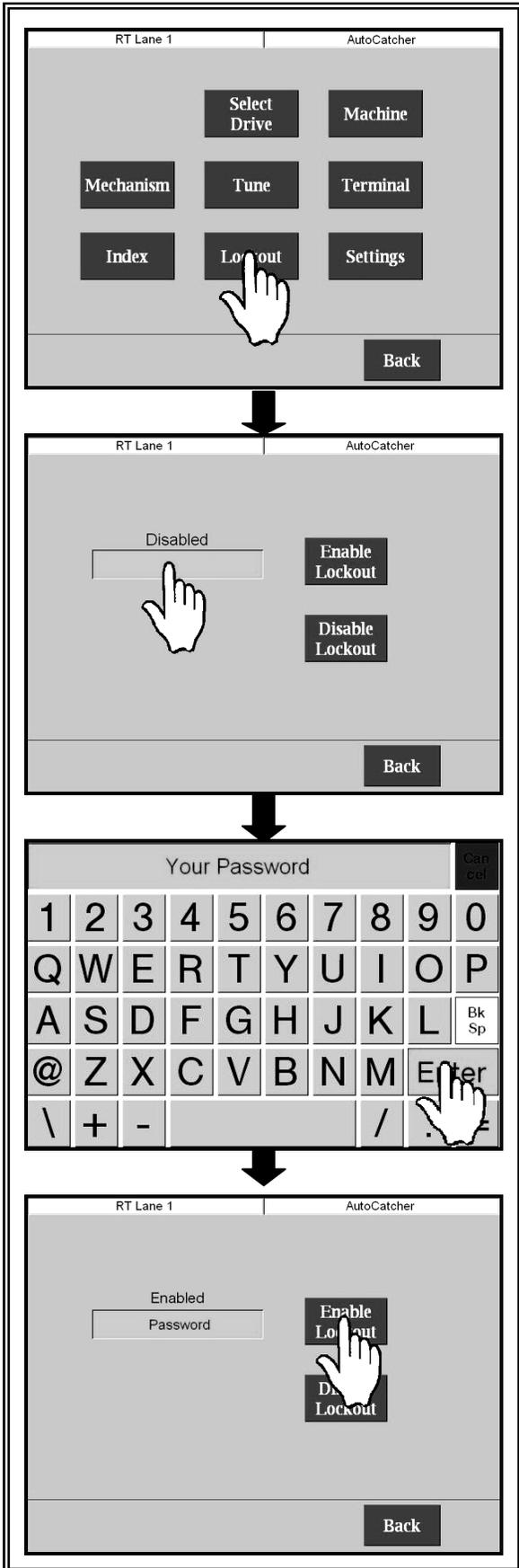


Figure 6.13 – Lockout Screen

Once **Password Protection** is activated it will be necessary to enter the password in order to access the Setup Menu from the Main Menu. When you press the **"Setup" Button** on the Main Menu; a Password Screen, as shown in *Figure 6.14* will pop up. Pressing the green Password Window on this screen will bring up the same Alpha/Numeric keypad that was described earlier. Use the keypad to enter the password and press the **"Enter" Button**. Pressing **"Enter"** returns you to the Password Screen, where you then press the **"OK" Button**. If the password you typed in is correct, the Setup Menu will be displayed. If your password is not valid then the message **"Password Error"** will flash across the top of the screen, and you will be returned to the Main Menu.

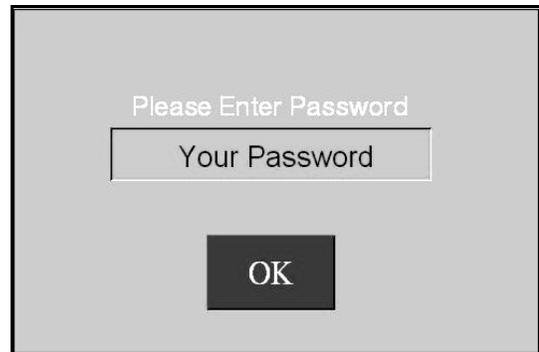


Figure 6.14 – Password Screen

6-9 Terminal Screen

The **Terminal Screen** allows you to key in command strings and transmit them directly to the servo amplifier. This screen is intended for service personnel only. Access this screen by pressing the **"Terminal" Button** on the setup menu screen.

The *PosiDrive* Servo Amplifier and the HMI display communicate over a CAN Network cable, which is plugged in to connector-X6 on the servo amplifier. Parameters, commands, and data are exchanged over this network link using an instruction set of over 350 different variable/command codes.

The program running in the *PosiDrive* HMI handles all of this behind the scenes. However, it is possible to enter these commands "by hand" on the terminal screen.

"Data To Send" Window – This window is used to enter command codes. Pressing the box will bring up the standard alpha/numeric keypad, which you use to type in the desired command. Pressing the **"Enter" Button** on the keypad returns you to the Terminal Screen. (See section 6-8 Password Entry Screen for a more complete description of the keypad).

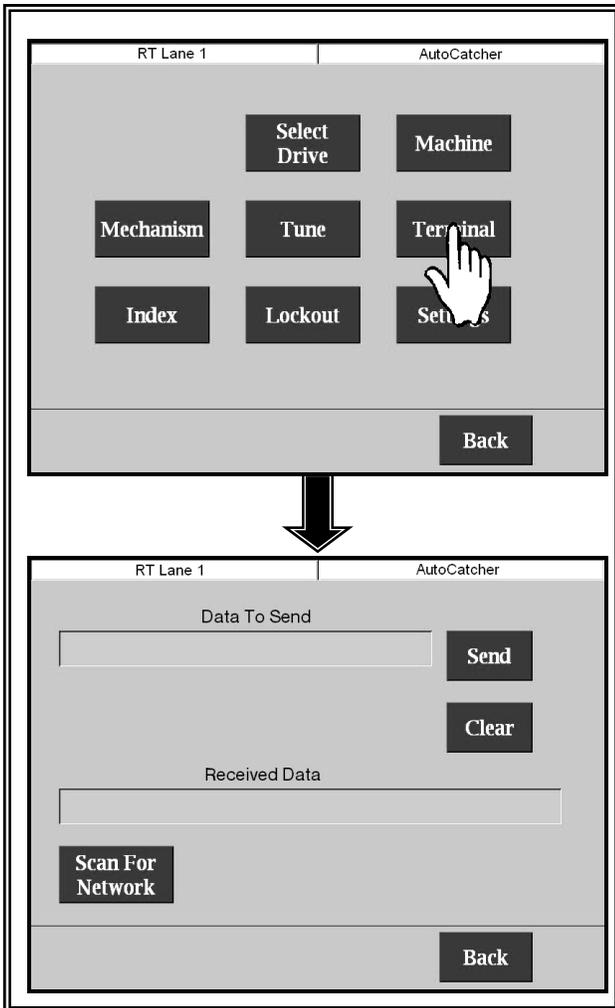


Figure 6.15 – Terminal Screen

"Received Data" Display – This display shows data that is returned from the servo amplifier in response to commands you issue from the "Data To Send" window.

"Send" Button – This button transmits commands displayed in the **"Data To Send"** window to the servo amplifier.

"Clear" Button – This button clears commands out of the **"Data To Send"** window.

"Back" Button – This button returns you to the Setup Menu.

6-10 SETTINGS SCREEN

The **Settings Screen** allows you to reboot the HMI, and change the COM port of the HMI screen. This screen may have additional, application specific, buttons that are not shown or described here. They will be described in supplemental documents. Access this screen by pressing the **"Settings" Button** on the Setup Menu Screen.

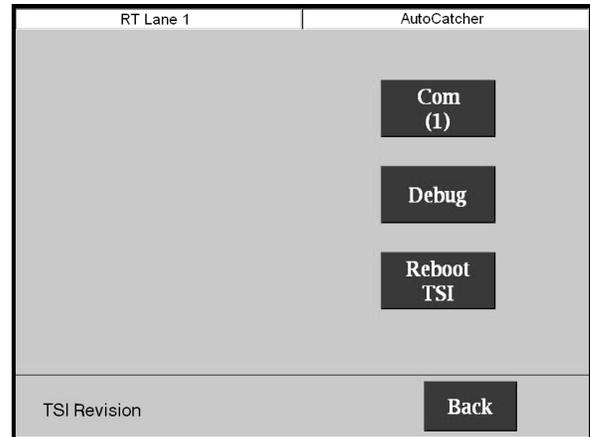


Figure 6.16 – Setting Screen

"COM" Button – This button allows you to change the communication port on the HMI that is used to communicate with the servo amplifiers between the two serial COM ports 1 & 2. If the COM is changed make sure that the serial cable is plugged into the appropriate connector located on the bottom of the HMI screen.

"Debug On/Off" Button – This button is intended for service personnel only. The legend on this button toggles between **"Debug OFF"** and **"Debug ON"** to indicate if Debug mode is active or not. You should leave the Debug mode **Off**. (See section 6-11 for more information on the "Debug" mode.)

"Reboot HMI" Button – This button reboots the HMI display.

"Back" Button – This button returns you to the Setup Menu.

6-11 Debug Mode

The **Debug Mode** allows Force Control Industries engineers to bench test applications using different servomotors, amplifiers, and electrical supplies than the real application will require. **Debug Mode** is activated using the **Debug Button** on the Settings Screen (See Section 6-11). You should leave **Debug Mode "OFF"**.

Setting the **Debug Mode "On"** prevents the HMI from downloading several of the usual pre-programmed parameters in to the servo amplifier when the "Application" buttons on the Machine Screen are pressed (See Section 6-2).

Pressing the Debug button toggles the status of the Debug mode between **"OFF"** and **"ON"**. If Debug mode is on, then the message **"DEBUG MODE"** displayed near the bottom of the Main Menu Screen.

Section 7 TROUBLE SHOOTING

7-1 Servo Amplifier Fault Codes

When a *PosiDrive* Series RS Servo Amplifier is faulted it will display an error code. These error codes can be read from the two digits, 7 segment LED display on the front of the servo amplifier. Error codes are also transmitted to the touch screen HMI and displayed on the Status Screen (See section 5-5). Table 7.1 shows the fault codes and their

explanations. When any of these faults occur, the output stage of the servo amplifier will be switched off and the contacts of the ready output will open. Shutting down the output stage removes power from the servomotor, causing it to loose torque. If the motor is equipped with a built in brake, then the brake will be engaged since the drive will drop the 24VDC power that releases the brake.

Table 7.1 – Servo Amplifier Fault Codes

DISPLAY FAULT CODE	HMI FAULT MESSAGE	EXPLANATION
F01*	ERR 1 heat sink temperature !!!	The heat sink temperature is too high. The limit is factory set to 80°C.
F02*	ERR 2 overvoltage !!!	Overvoltage in the DC-link circuit. The limit depends on the supply voltage
F03*	ERR 3 following error !!!	The following error is to large.
F04	ERR 4 feedback !!!	Resolver cable break, short-circuit, or short to ground.
F05*	ERR 5 undervoltage !!!	Undervoltage in the DC-link. The default limit setting is 100V.
F06	ERR 6 motor temperature !!!	The motor temperature is too high, or the temperature sensor is faulty. The default limit setting is 145°C.
F07	ERR 7 v_fault (int.supply) !!!	Internal auxiliary voltage not OK.
F08*	ERR 8 overspeed !!!	The motor is running away or the speed is higher than permitted.
F09	ERR 9 EEPROM !!!	EEPROM Checksum error.
F10	ERR 10 Flash-EPROM !!!	Flash-EPROM Checksum error.
F11	ERR 11 brake !!!	Brake cable break, short-circuit, or short to ground.
F12	ERR 12 motor phase !!!	Motor phase missing (cable break or similar).
F13*	ERR 13 internal temperature !!!	Internal temperature is too high.
F14	ERR 14 output stage !!!	Fault in the power output stage.
F15	ERR 15 I ² t max. !!!	I ² t max. value exceeded.
F16*	ERR 16 mains BTB/RTO !!!	Two or three supply phases missing.
F17	ERR 17 A/D converter !!!	Error in the analog-digital conversion.
F18	ERR 18 regen !!!	Regeneration circuit faulty or incorrect setting.
F19*	ERR 19 mains phase !!!	A supply phase is missing. (Can be switched off for 1-phase operation).
F20	ERR 20 Slot error !!!	Hardware error on the expansion card.
F21	ERR 21 Handling error !!!	Software error on the expansion card.
F22	ERR 22 Short circuit to earth !!!	40/70 amp types only: Short circuit to earth.
F23	ERR 23 CAN bus off !!!	CAN bus total communication error.
F24	ERR 24 Warning !!!	Warning display as error.
F25	ERR 25 Commutation error !!!	Commutation error. (Run-away of the motor)
F26	ERR 26 Limit switch !!!	Homing error (Hardware limit switch reached)
F27	ERR 27 AS-Option !!!	Operating error for AS-option.
F28	ERR 28 reserved !!!	Reserved

* - These error messages can be cancelled by the remote reset without the drive performing a coldstart. The non-asterisk Error Messages will coldstart the drive.

Table 7.1 – Servo Amplifier Fault Codes (Continued)

F29	ERR 29 Sercos !!!	Sercos error.
F30	ERR 30 Emerg. Stop Timeout!!!	Emerg. Stop Timeout.
F31	ERR 31 wrong Firmware-version!!!	Wrong Firmware Version.
F32	ERR 32 system fault!!!	System software not responding correctly.

7-2 Servo Amplifier Warning Codes

When a *PosiDrive Series RS Servo Amplifier* experiences a fault that is not severe enough to warrant a total shut down, it will display a warning code. These warning codes can be read from the two digits, 7 segment LED display on the front of the servo amplifier. Error codes are not transmitted to

the touch screen HMI at this time. Table 7.2 shows the warning codes and their explanations.

Some of these faults do trigger a controlled shutdown of the drive (as opposed to total shutdown). During a controlled shutdown the motor and load are stopped using the emergency deceleration ramp.

Table 7.2 – Servo Amplifier Warning Codes

WARNING CODE	NAME	EXPLANATION
n01	I ² t	I ² t threshold exceeded
n02	Regen power	Preset regen power reached
n03*	FError	Exceeded preset following error window
n04*	Node guarding	Response monitoring (fieldbus) is active
n05	Mains phase missing	Supply phase missing
n06*	Sw limit-switch 1	Passed software limit-switch 1
n07*	Sw limit-switch 2	Passed software limit-switch 2
n08	Motion task error	A faulty motion task was started
n09	No reference point	No reference point set at start of task
n10*	PSTOP	PSTOP limit-switch activated
n11*	NSTOP	NSTOP limit-switch activated
n12	Default values	Only HIPERFACE®: motor default values were loaded
n13*	Expansion card	Expansion card not functioning correctly
n14	SinCos	SinCos commutation is not determined
n15-n31	Reserved	Reserved
n32	Firmware beta version	The firmware is a not released beta version

* - These warning messages lead to a controlled shutdown of the drive.
(Braking with an emergency ramp.)

7-3 Checking 480V 3-Phase System Grounding

As was explained in **Section 3-5**, *PosiDrive Servo Amplifiers* can be damaged if they are connected to ungrounded or asymmetrically grounded 480VAC three-phase power. The following **Test Procedure** described on page 32 will allow you to run a quick check if you are unsure of how the power is set up in your factory. This procedure is somewhat dangerous since it involves testing live, 480 volt circuits. It should only be carried out by a qualified electrician or engineer. A qualified electrician should also be

able to confirm the results of this test procedure by inspecting the electrical service equipment that powers your plant.

Figure 7.1 on the next page shows schematics of the various Acceptable 3-Phase Electrical Systems. The right hand column also shows how to connect an Isolation Transformer to protect the drives if your power system is ungrounded or asymmetrically grounded.

A. Connecting to Different 3-Phase Systems Schematics

In *Figure 7.1* you will find all possible connection variations to different Electrical Networks

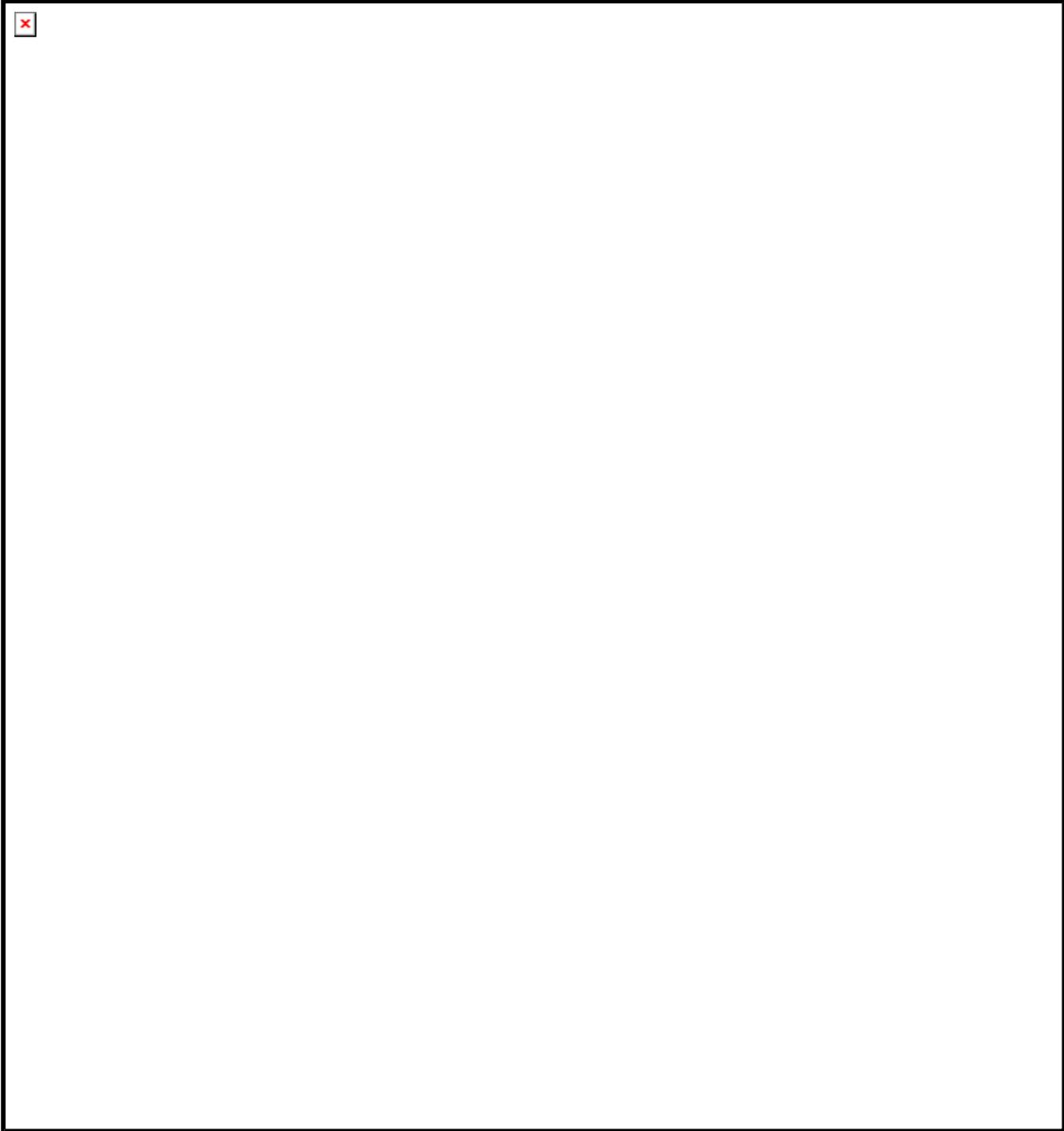


Figure 7.1 – Connecting to Different 3-Phase Systems Schematics

B. Test Procedure For Checking 480 Volt 3-Phase System Grounding

Sometimes you can tell how a factory power circuit is grounded by measuring the line voltages using both a DVM (digital voltmeter) and a "Wiggy" type solenoid voltage tester. The trick is that the Wiggy will not respond to small leakage currents from line to ground in an ungrounded system, while the DVM will. With grounded systems the two meters will generally agree with each other for all the readings. With ungrounded systems the Wiggy will sometimes find little or no voltage on a wire where the DVM does.

There are confounding factors that can make these tests harder to interpret. One is the presence of connected loads in your factory that create a partial ground reference in an ungrounded system.

1. Measure the line to line voltages using either meter. All three of them should be close to 480VAC. Then measure the line to ground voltages for all three legs using both meters and compare your results to the following examples.

2. If both meters measure 277VAC from line to ground for all three legs, then the system is probably a 480Y/277, three or four-wire circuit. This is a good power supply for the *PosiDrive* servo system.

3. If both meters measure 240VAC from line to ground for two of the legs and about 415VAC on the remaining leg, then your power system is probably delta connected with one phase center-tapped. A drive isolation transformer will be necessary to power the servo system so that the high voltage of the 415VAC "wild leg" will not fry the power supply circuits of the servo amplifier.

4. If both meters measure 480VAC from line to ground for two of the legs and zero volts on the remaining leg, then your power system is either a wye or delta connected circuit with one of the "corners" grounded. You will need to use a drive isolation transformer to power the servo system.

5. If the DVM measures voltage from line to ground for all three legs, but the Wiggy does not find voltage then the power system is ungrounded. The DVM, with its high impedance MOSFET inputs, is responding to small leakage currents that can flow through or around the insulation somewhere in the system. The Wiggy has low input impedance and takes more power to operate than the leakage paths can provide. Some times the voltage readings taken by the DVM will be balance at 277VAC, but it would not be surprising if some were higher and some lower than 277. If you leave the DVM attached to one of the legs and then connect the Wiggy from line to ground on one of the other legs you may see the voltage on the DVM shoot up to 480VAC. You will need to use a drive isolation transformer to power the servo system.

6. If both meters agree on the voltages from line to ground but the voltages are not balanced then the system may be an ungrounded one that is picking up a stray ground reference from one of the other connected loads. This is not a good situation and you should get it fixed. In the mean time you will need to use a drive isolation transformer to power the servo system.

Section 8 ORDERING REPAIR PARTS

8-1 FACTORY REPAIR SERVICE

Repair Service is offered by Force Control Industries, Inc. at the factory.

Contact Force Control Industries, Inc. for authorization and shipping instruction before returning a control unit for this service. Force Control cannot be responsible for units returned to the factory without prior notice and authorization.

Care must be given to the packing of returned control units. Always protect the control cabinet by attaching to a skid. Also make sure that any external cables are tied down to the skid. Shipment damage always delays repairs. It is usually impossible to recover damage costs from the carrier. When possible, describe the problem experienced on your shipping papers.

Return to: **Force Control Industries, Inc.**
3660 Dixie Highway
Fairfield, Ohio 45014

Phone: (513) 868-0900

Fax: (513) 868-2105

E-Mail: info@forcecontrol.com

Web: www.forcecontrol.com

8-2 ORDERING REPLACEMENT PARTS

When ordering replacement parts, please specify all of the following information:

- 1 . *PosiDrive* Control Panel Model Number (On the Name Plate.)
- 2 . *PosiDrive* Control Panel Serial Number (On the Name Plate.)
3. Part Reference Number, Part Name and Quantity.
(From the Panel Layout, Bill of Material and Schematic furnished with your *PosiDrive* Control Panel)
4. Complete Shipping Information.

Failure to include information for items 1 through 4 will only delay your parts order. Unless another method is specified for item 6, parts weighing less than 150 Lbs. will be shipped United Parcel Service. Parts weighing more than 150 Lbs. will be shipped Motor Freight. Air freight and other transportation services are available but only if specified on your order.

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