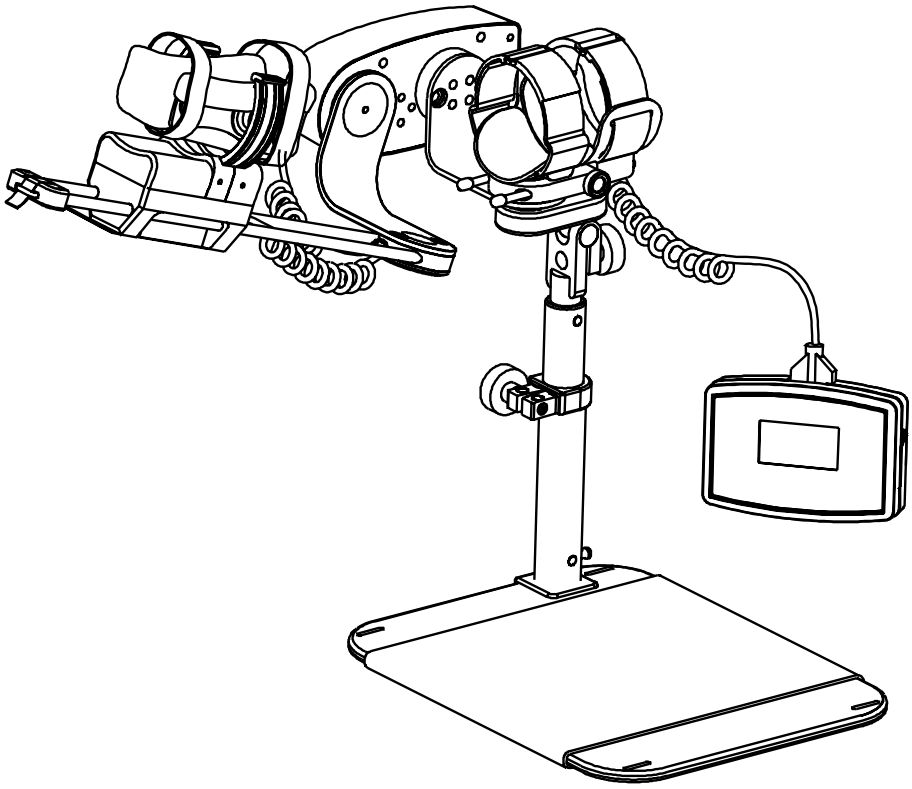
E3 Elbow CPM
Technical & Service Manual



OrthoMotion
AN ORTHOREHAB COMPANY

E3 Elbow CPM Technical & Service Manual

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1.0 General Overview

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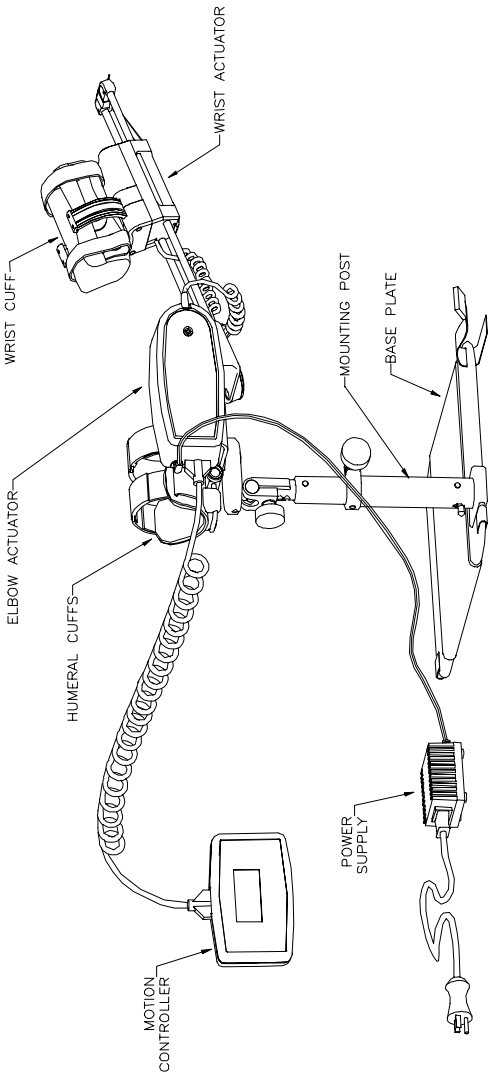


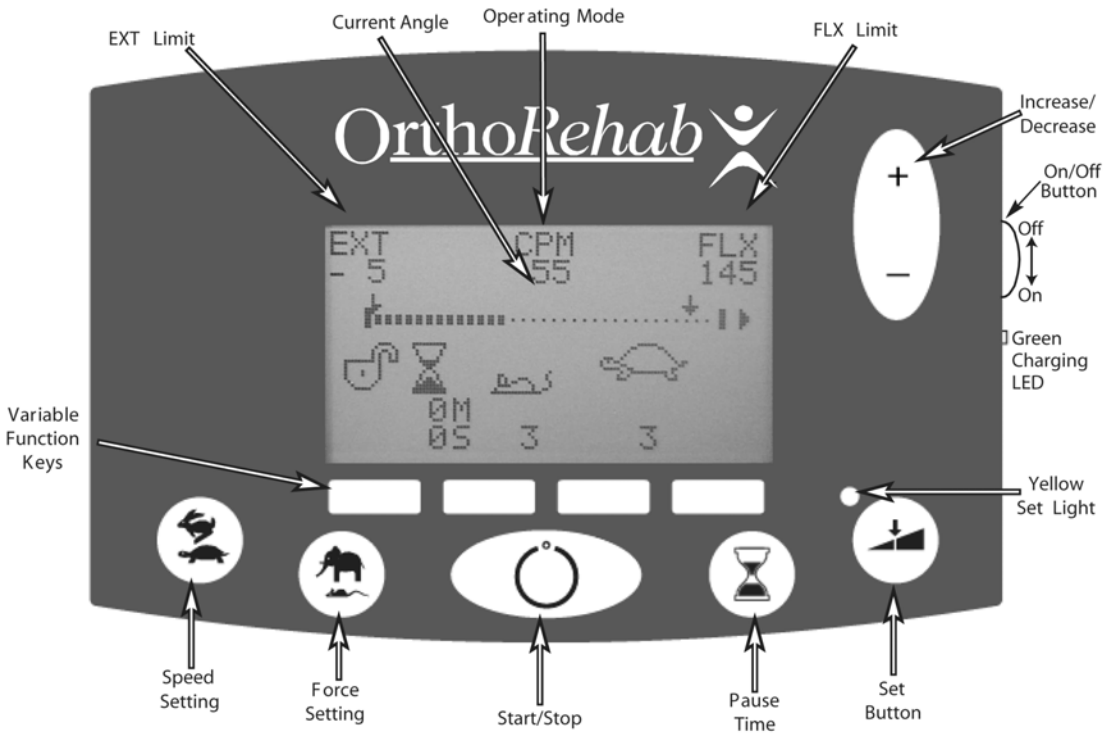
1.2 Introduction

The E3 elbow CPM device is designed to provide Continuous Passive Motion to the elbow, offering Flexion / Extension as well as the option to have pronation and supination to the wrist.

1.3 Specifications and Operating Limits

Specification	**E3 Elbow CPM**
Weight of unit	7.5 Lb. (3.2 Kg.)
Range of Motion Elbow Actuator Wrist Actuator	 -5^{O} to 145^{O} 80^{O} to 80^{O}
Speed Range (elbow)	Approx. 40^{O} / min. to 270^{O} / min.
Force Range (elbow) (Wrist)	3 Lb. to 12 Lb. (13 N to 53 N) 5 in. Lb. to 36 in. Lb. (.5 Nm. to 4.1 Nm.)
Battery Type Life	Lithium Battery 3V. not rechargeable NiMH Battery 7.2V 2Ahr 3.0V - approx. 3 years 7.2V - 2 hours, fully charged, mid range settings
Power Supply	Input: 100 – 240 Vac 50/60 Hz. Output: 12 VDC 1.25A

1.4.1 Programming the Controller



a) Normal Operating Mode

Step 1
Set the power on/off switch to on

Step 2
New Patient Screen. Follow the screen prompts by pressing the button beneath your choice. Press Yes or No
Pressing **Yes** lets you select which mode you want the E3 to run in PSR or CPM mode. The controller will go through each of the setup screens so that new parameters can be set. Selecting **No** will keep the unit in the same mode it was in when it was last switched off.

Step 3
If **New Patient Yes** was selected the device will go to the run mode. The controller will wait until the **Start / Stop** is pressed to activate the actuator(s).

If **New Patient No** was selected the device will Ask if **Warm up** Is required, **Yes** or **No**

Step 4
The device is ready to run.

b) Using the Set Key

To change the Force, ROM, Pause and Speed press the **Set** key.

Step 1
Press the Set key, the yellow LED should light to indicate that the controller is in the setup mode.

Step 2
Press Elbow or Wrist.

Step 3 Elbow
If Elbow was selected then two new option will appear, Flex. or Ext.
In this screen the Speed, Force and Pause can be setup, pressing Exit while in each of these screens will return the controller back to the first screen.
Press Flex. ROM, press the "+" key to increase the ROM or "-" to decrease the ROM. Press Exit to go back to the last screen.
Press Ext. ROM press the "+" key to increase the ROM or "-" to decrease the ROM. Press Exit to go back to the last screen.

Step 3 Wrist
If Wrist was selected then two new option will appear, Pro. or Sup.
In this screen the Speed, Force and Pause can be setup, pressing Exit while in each of these screens will return the controller back to the first screen.
Press Pro. ROM, press the "+" key to increase the ROM or "-" to decrease the ROM. Press Exit to go back to the last screen.
Press Sup. ROM press the "+" key to increase the ROM or "-" to decrease the ROM. Press Exit F4 to go back to the last screen.

Step 4
Once the ROM, Speed, Pause and Force have been set press Exit until the Exit does not show up on the screen over the key. The Set key can now be pressed to return to the run mode. All of the settings are now saved and the unit can be operated or switched off with out loosing the setup.

Note: the software will not allow the angle to approach any closer than 6^{O} of the opposite angle, Flex. can not be less than the Ext. angle plus 6^{O} and Ext. can not be greater than Flex less 6^{O}.
Pro. can not be less than the Sup. angle plus 6^{O} and Sup. can not be greater than Pro less 6^{O}.

c) Hidden Functions

- **Patient Lock Out**

The patient lock limits access to the Start/Stop key only.
To set the Patient Lockout, switch off the controller and then press both the "+ and – " keys and hold them down while switching on the controller (hold the two keys until the first screen comes up). When the controller is locked the lock symbol appears as a closed padlock. To unlock the controller switch the controller off and hold both the "+ and – " keys and hold them down while switching on the controller (hold the two keys until the first screen comes up). When the controller is unlocked the lock symbol appears as an open padlock.

- **Compliance Mode**

To open the compliance mode screens switch off the controller. While pressing the Pause key switch on the controller. Continue holding the Pause key down until the compliance screen appears.

- **Packaging Mode**

The packaging mode activates the two actuators and sets them to 90^{O} for the elbow actuator and the wrist actuator to 0^{O} for easy storage in the carrying case.
To activate the Packaging mode switch off the controller, press the Speed and the Force keys while switching on the controller. Hold the keys down until the packaging screen appears.

1.4.2 PSR Controls and Force Settings (Controller symbol "PSR")

Progressive Stretch Relaxation (PSR) operating mode is available as an option and must be selected during setup from the controller after new patient is selected. In PSR mode the device operates by continually monitoring the force the patient is exerting on the device through the Pro/Supination patient support. In PSR mode the device is preprogrammed to sequentially pause three times for the programmed pause time at the end of every ROM cycle. The first pause occurs when the device senses 80% of the programmed force setting. The second pause occurs when the device senses 90% of the programmed force setting. The third and final pause occurs when the device senses 100% of the programmed force. Once the third pause is complete the device changes direction of travel and begins again at 80% of the programmed force setting. If the force reduces by 5% when stopped at any of the above values the device will drive towards the next level. In PSR mode the device will not exceed the programmed ROM. If the device achieves the programmed ROM before it senses its first sequential pause force threshold the device will reverse direction of travel.
In PSR mode the following controller settings can be adjusted if the relaxation response does not occur before the device reverses direction.

- Range Of Motion
- Pause Time
- Force
- Lock Setting

1.4.3 CPM Controls & Force Settings (Controller symbol “CPM”)

Continuous Passive Motion (CPM) operating mode is the default-operating mode when the device is turned-on. In CPM mode the device operates between the programmed ROM extremes.
Controller symbol “CPM”.
In CPM mode the following controller settings can be adjusted:

- Speed
- Range Of Motion
- Synchronized Motion
- Pause Time
- Force
- Lock Setting

After the controller has been switched on and the Set key has been pressed, force is displayed on the controller by the “mouse/elephant” symbol and is adjustable in five settings. The Force setting determines the amount of load applied to the patient’s limb by the device. The following table illustrates the loads associated with the selected load settings.

Force Settings Table

Range Of Motion	Controller Symbol	Nominal Force
Elbow Flexion & Extension	1	3 Lb. (1.4 kg)
	2	5 Lb. (2.4 kg)
	3	7 Lb. (2.7 kg)
	4	9 Lb. (4.3 kg)
	5	12 Lb. (6.8 kg)
Forearm Pronation & Supination	1	5 in.Lb. (0.5 Nm)
	2	15 in.Lb. (1.5 Nm)
	3	21 in.Lb. (2.3 Nm)
	4	28 in.Lb. (3.1 Nm)
	5	36 in.Lb. (4.1 Nm)

1.4.4 Angle Controls or ROM

ROM is displayed on the controller in degrees and represents the current angle of the device's orthosis during operation and is approximately the same as the patient's limb ROM. ROM is set in CPM operating mode to define the programmed range of motion for each operating cycle. In PSR operating mode the patient's maximum ROM is programmed. See Range Of Motion table for controller symbols.

Range Of Motion Table

Range Of Motion	Controller Symbol	Range in Degrees (°)
Elbow Flexion	FLX	145
Elbow Extension	EXT	-5
Pronation	PRO	80
Supination	SUP	80

Press the Set Key on the controller. The first screen gives the operator the choice of which ROM to adjust, Elbow or Wrist. The "+" key increases the range while the "-" key decreases the range. In Flex. The angle increases as the "+" key is pressed to indicate that the arm will move higher. With Ext. the "+" key decreases the ROM because the arm is to be moved lower, increasing the travel in Ext.

1.4.5 Speed Control

Switch on the controller. Press the Set key. Once the LCD display is in the first screen press the Speed key (rabbit / turtle key). Select the speed required using the "+ / -" keys and then press F4 for Exit. The speed that is selected is for both actuators.

The speed at which the device travels through its range of motion is adjustable from in five steps in CPM operating mode and two steps in PSR operation mode.

CPM Operating Mode Speed Settings Table

Speed Setting	Speed in Degrees Per Minute (°/min.)
1	40
2	90
3	150
4	210
5	270

1.4.6 Minimizing Problems

To minimize problems that could occur with the E3, refer to the following:

- Set the controller up while plugged in to an AC outlet. Though setting up the E3 while on battery power can be done it is preferred to run the E3 on the power adapter as much as possible. It is best to keep the battery fully charged so that the patient can use the device for moving from one location to another for short periods.
- Let the E3 adjust to ambient before running the device. The unit should be given at least one hour after coming in from the heat or cold.
- Make sure that the cable that connects the controller to the elbow actuator is plugged in completely and that the locking clips have snapped into place.

1.5 Power Supply

The power supply that is supplied with the E3 is a universal input device. It can be used in most countries around the world because of its ability to automatically adapt to the line voltages from 100Vac to 240Vac and 50Hz to 60Hz.
The E3 must only be operated with the power supply that comes with the unit.

1.6 Indicator Lights

On the E3 there are two indicator lights. The first is the Setup light located on the front of the controller just below the bottom right corner of the LCD display.
When this light is on it indicates that the controller is in the setup mode.
It switches off when the setup button is pressed a second time.

The second light is located on the right hand side of the controller just below the on/off switch. When on it indicates that the battery is charging. See section 1.14.8.

Though not considered an indicator light the display back light stays on all the time that the power supply is plugged in. The backlight does turn off after a short time when in battery mode. This is to conserve battery life.

1.7 Position Feedback Elbow Potentiometer

The E3 controller continually monitors the signal from the Position Feedback Potentiometer in the elbow actuator. Problems with this signal will cause an error (E02) to be displayed on the LCD and the unit will stop moving.

1.8 Position Feedback Pro/Sup Potentiometer

The E3 controller continually monitors the signal from the Position Feedback Potentiometer in the Pro/Sup actuator. Problems with this signal will cause an error (E03) to be displayed on the LCD and the unit will stop moving.

1.9 Motor Speed Feedback Pro/Sup Actuator

A processor in the Pro/Sup actuator as well as the controller is constantly monitoring the motor speed. The processor in the Pro/Sup actuator is also constantly monitoring the motor direction of travel. The motor speed is checked by a sensor placed under the gearbox drive pulley. The processor measures the pulse count to angular movement ratio to detect angular position/pulse. This feature verifies that every 5 º degrees traveled the expected position of the device is within +/- 5 º. The potentiometer output is compared with the motor encoder output.

If the pulse width produced by the sensor is incorrect or the expected direction of travel is incorrect then the controller produces an error and stops the device. The device will not operate until repaired.

1.10 Load Cell Function

The load cells are mounted on a frame in the Pro/Sup actuator. The load cells indicate any positive or negative loads that are applied vertically or horizontally to the wrist ring in PSR mode. These signals are received by the processor that determines the type and amount of force and torque that is being applied to the load cell frame.

1.11 Safety Features

1.11.1 Reverse On Load Elbow Actuator

This feature electronically monitors the motor current of the specific actuator. If the current surpasses a predetermined limit the device will reverse direction of travel.

See section 1.4.3 CPM Force Settings for reverse on load values.

1.11.2 Reverse On Load Pro/Sup Actuator

This feature electronically monitors the motor current of the specific actuator. If the current surpasses a predetermined limit the device will reverse direction of travel.

See section 1.4.3 CPM Force Settings for reverse on load values.

1.11.3 Error Codes

Error Code 0 – Undetermined

Error Code 1 – Out Of Range

This error includes both the Elbow and Wrist out of range errors. The Out Of Range Error will be set if the device moves beyond its specified limit by 5 degrees or more. This error is generated by the E3 controller, which shuts down the device immediately upon detection.

Error Code 02 – Elbow Potentiometer Not Changing

The processor looks for a potentiometer voltage change when the motor is activated. The E3 controller checks the elbow potentiometer. If the value does not change then the unit stops and the error is displayed.

Error Code 03 – Wrist Potentiometer Not Changing

The processor looks for a potentiometer voltage change when the motor is activated. The E3 controller checks the elbow potentiometer. If the value does not change then the unit stops and the error is displayed.

Error Code 04 – Actuator Switch

This error will check to make sure that the actuator circuit board can be turned on and off by the controller. This is monitored once after power up. The E3 controller then turns on the Actuator switch and makes sure that it goes below 5 volts. If the voltage does not then the device generates an error and shuts down immediately.

Error Code 05 – Start Stop Switch

This is monitored continuously. If the start/stop switch is held low for a short time then an error is flagged and the device shuts down immediately.

Error Code 06 – Undetermined

Error Code 07 – Firmware Checksum

This error is used to monitor for valid firmware during startup. It is only monitored once after startup and shuts down the device immediately if an error is detected.

Error Code 08 – False Data in EEPROM

This error could be generated whenever a byte is stored into the EE memory. (Data is logged, the user stores parameters, etc.) When data is written into EE memory, the E3 controller reads the EE memory back and verifies that it is correct. If the data appears different than that which was written, an error is flagged and the device is shutdown immediately.

Error Code 09 – 10 Undefined

Error Code 11 – No Elbow Encoder

This error has 2 levels of error detection. The first level of detection is provided by the elbow actuator processor. The elbow actuator processor monitors the RPM input on the device. If a pulse is not received within 1.048 seconds of the last pulse, then the elbow actuator processor sets a No encoder flag and transmits this to the E3 controller. If this flag is set for 5 times consecutively then the E3 controller will flag an error and shutdown the device immediately.

Error Code 12 – Reversed Elbow Motor

This error is monitored by the elbow actuator processor. The elbow actuator processor will make sure that the motor is moving in the correct direction of travel and has not been wired in reverse. This check is performed whenever the device is operating and the angular position of the actuator changes. If an error occurs, the elbow actuator processor will flag the E3 controller which will shut down the device immediately.

Error Code 13 – Elbow Angle Position

This error is used to monitor the absolute position of the actuators angular position. If the angular position of the actuator is greater than 4.7Volts or less than 0.5Volts then the elbow actuator processor will shutdown the device and flag the E3 controller. The E3 controller will then display the error immediately.

Error Code 14 – Elbow Encoder Out Of Range

This error is generated by the elbow actuator processor. The elbow actuator processor monitors the correct operation of the Elbow Encoder by making sure that the device receives a set number of pulses for every 5 +/-3 degrees of angular position movement., if the position is not changed with in the set perimeters then the E3 controller is notified and the device is shutdown.

Error Code 15 – Elbow Load Cell 2

This error code is generated by the elbow actuator processor. It is only monitored in PSR mode. This error will be generated if the LC2 value swings too far away from the 2.5V nominal value. The elbow actuator processor will flag an error if the LC2 A/D reading is greater than 4.5Volts or if the LC2 A/D reading is less than 0.5Volts.

Error Code 16 – Elbow Load Cell3

This error code is generated by the elbow actuator processor. It is only monitored in PSR mode. This error will be generated if the LC3 value swings too far away from the 2.5V nominal value. The elbow actuator processor will flag an error if the LC3 A/D reading is greater than 4.5Volts or if the LC3 A/D reading is less than 0.5Volts.

Error Code 17 – 20 Undefined

Error Code 21 – No Wrist Encoder

This error has 2 levels of error detection. The first level of detection is provided by the elbow actuator processor. The Elbow actuator processor monitors the RPM input on the device. If a pulse is not received within 1.048 seconds of the last pulse, then the elbow actuator processor sets a No encoder flag and transmits this to the E3 controller. If this flag is set for 5 times consecutively then the E3 controller will flag an error and shut down the device.

Error Code 22 –Wrist Motor Reversed

This error is monitored by the elbow actuator processor. The elbow actuator processor will make sure that the motor is moving in the correct direction of travel and has not been wired in reverse. This check is performed whenever the device is operating and the angular position of the actuator changes. If an error occurs, the elbow actuator processor will flag the E3 controller which will shut down the device immediately.

Error Code 23 – Wrist Angle Position

This error is used to monitor the absolute position of the actuators angular position. If the angular position of the actuator is greater than 4.7Volts or less than 0.5Volts then the elbow actuator processor will shutdown the device and flag the E3 controller. The E3 controller will then shut down the device immediately.

Error Code 24 – Wrist Encoder Out Of Range

This error is generated by the elbow actuator processor. The elbow actuator processor monitors the correct operation of the Elbow Encoder by making sure that the device receives a set number of pulses for every 5 +/-3 degrees of angular position movement., if the position is not changed with in the set perimeters then the E3 controller is notified and the device is shutdown.

Error Code 25 – Wrist Load Cell1

This error code is generated by the elbow actuator processor. It is only monitored in PSR mode. This error will be generated if the LC1 value swings too far away from the 2.5V nominal value. The elbow actuator processor will flag an error if the LC1 A/D reading is greater than 4.5Volts or if the LC1 A/D reading is less than 0.5Volts.

Error Code 26 – Wrist Load Cell2

This error code is generated by the elbow actuator processor. It is only monitored in PSR mode. This error will be generated if the LC2 value swings too far away from the 2.5V nominal value. The ELBOW ACTUATOR PROCESSOR will flag an error if the LC2 A/D reading is greater than 4.5Volts or if the LC2 A/D reading is less than 0.5Volts.

Error Code 27 – 30 Undefined

Error Code 31 – Elbow Communication Error

If a successful communications packet is not received by the Elbow Actuator within 2 seconds of the last packet, then the elbow actuator processor will shut down the actuator and hang itself in an endless loop. It can only be restarted by switching off the controller and then switching it back on. If the E3 controller receives 10 packets with errors, the device shuts down and displays this error.

Error Code 32 – Wrist Communications Error

If a successful communications packet is not received by the Wrist Actuator within 2 seconds of the last packet, then the elbow actuator processor will shut down the actuator and hang itself in an endless loop. It can only be restarted by switching off the controller and then switching it back on. If the E3 controller receives 10 packets with errors, the device shuts down and displays this error.

Error Code 33 – Both Actuators have Communications Errors

This error occurs if both Error code 31 and Error Code 32 are present on the E3 controller simultaneously.

Error Code 34 – EE Checksum error

The configuration data is stored in the EE memory of the device with a checksum. In the background loop of the E3 controller, the EE data and checksum is constantly monitored to detect any errors. The E3 controller shuts down the device immediately.

Error Code 35 – 39 Undefined

Error Code 40 – Switching Arm

This error is generated by the E3 controller. The actuator type is read from the elbow actuator processor on power up. If the Actuator type changes after power up, the E3 controller generates an error and the device is shutdown immediately.

Error Code 41 – External RAM

The external RAM (0x2400 to 0x4000) is initialized on power up. The RAM is verified in the background loop 64 bytes per loop. The entire external RAM is checked every few mili-seconds. The device shuts down immediately upon detection of an error.

Error Code 42 – RTC Locked

The Real Time Clock is monitored continuously. The routine reads the RTC time and increments a counter if the seconds is the same as the previous time that the RTC was read. If this counter gets to 64, then the error is set and the device shuts down immediately.

1.11.4 Motor Speed Feedback Elbow Actuator

A processor in the elbow actuator as well as the controller is constantly monitoring the motor speed. The processor in the elbow actuator is also constantly monitoring the motor direction of travel. The motor speed is checked by a sensor placed under the gearbox drive pulley. The processor measures the pulse count to angular movement ratio to detect angular position/pulse. This feature verifies that every 5 º degrees traveled the expected position of the device is within +/- 5 º. The potentiometer output is compared with the motor encoder output.

If the pulse width produced by the sensor is incorrect or the expected direction of travel is incorrect then the controller produces an error and stops the device.

1.11.5 Humeral Cuff Position Feedback

The humeral cuff has two micro-switches built in to its base. One part of the base has offset notches cut into it. When the humeral cuff is in the left hand position a distinct binary signal is sent to the controller telling it in which direction the actuators should be driven. When the cuff is moved to the right a different code is sent to the processor. If the cuff is not locked in place a third code is sent causing the controller to stop the device and to display an error message.
Refer to Appendix A for the error code table.

1.11.6 Data Checking System

On startup the controller looks at the firmware and confirms that it has not been corrupted. It does this by counting all of the information on the EPROM and comparing it to the checksum built in to the EPROM. If there is a discrepancy then an E7 error code is displayed on the screen and the unit stops. To fix this a new EPROM must be installed.

1.11.7 Battery Monitoring System

The controller is equipped with a rechargeable battery. Connecting the device's power adapter to the controller or elbow actuator Power receptacles recharges the battery. The device can be operated independently by the batteries for approximately 2 hours depending on battery charge, speed and mass of patient. Approximately 10 hours is required to recharge a fully discharged battery. Battery status is indicated by an LED (light emitting diode) mounted on the side of the controller next to the On / Off switch. A flashing LED indicates normal charging. The charging system is monitored by the controller's processor. If an unsafe charging condition arises the processor will shut the battery charger down and displays an error code E06.

1.12 Suggested Maintenance Schedule

Between Patients:

- If the unit has been out of service for some time, perform a brief battery charge by connecting the device's power supply to either the controller or elbow motor power inputs, and turn the device on for at least one hour before use. A flashing LED below the power switch will indicate normal charging.
- Check the entire unit for any visible evidence of damage, such as bent components, cracked or broken wires, etc.
- Ensure that all knobs and levers are useable and in place.
- Ensure that moving components move freely as required.
- Check the controller display and controls for proper operation
- Check all mechanical pivot and linkage points for smooth operation and secure mechanical connection. Make sure all screws, nuts, bolts, rivets, pivot pins and other fasteners are secure.
- Gently wipe clean all exposed surfaces with a soft cloth dampened with a mild soap solution or alcohol. For stubborn areas, a mild household spray cleaner may be used with a soft cloth. Do not use abrasive or corrosive cleansers.
- To disinfect, wipe exposed surfaces with a 1 to 10 % solution of bleach and water, or other suitable disinfectant. Do not pour cleaning solutions into the machine
- Ensure all labels are present
- Replace the patient Softgoods kit
- Verify that the device operates between set limits for several cycles.

Every 6 months:

- Repeat the above steps as for maintenance between patients
- Verify the basic device calibration by observing the range of motion (ROM) of the device while taking a visual reading using a goniometer at the device's anatomic pivot points. ROM readings should be within +/- 5 degrees of the set parameters. If not, return the device to an authorized service center.

Every 18 months

A full inspection of the device is recommended every 18 months by an authorized service center.

2.0 External Components

The Humeral Support Assembly provides the Mounting peg to attach the E3 CPM device to the Portable Mount. It has pivots at the Locking Mount and the Elbow Actuator to configure the device for Left Hand or Right Hand orientation.
Tools Required: #2 Phillips

2.1 Removal of Humeral Support Assembly E3-005A

See Drawing # E3–005
Remove the four machine screws (109B) securing the Humeral Support Assembly to the Orientation Switch A (Item 42 on E3-005G)
Remove the Lock Button (106A) and the 3/8" (1-cm) spring (107A) from the orientation switch.
Assembly Note: See assembly note on drawing E3-005. Align the curved section of the Humeral Support Arm (132 on E3-005F) with the FLAT section on the Distal Humeral Arm Pivot (146 on E3-005G). Use Loctite 680 on four (4) machine screws (109B).

2.2 Removal of Distal Cuff Assembly E3 – 005B

See Drawing # E3-005A
Remove the three machine screws (123) and lift the Distal Cuff Assembly (122) from the Humeral Support Subassembly (121).
Assembly: Use Loctite 680 on the three machine screws.

2.3 Removal of Humeral Mounting Block Lock Knobs

See Drawing # E3–005D
Remove two white end caps (130) from the Humeral U Rod (128).
Loosen two the Lock Knobs (126) on the Humeral Mounting Block (124).
Slide the Humeral U Rod (128) and the Proximal Cuff Assembly (125) out of the Humeral Mounting Block (24).
Remove the Lock Knobs (126) and Barrel Nuts (127) from the Humeral Mounting Block.
To re-assemble, use Loctite 416 glue or equivalent to secure the two white end caps (130).

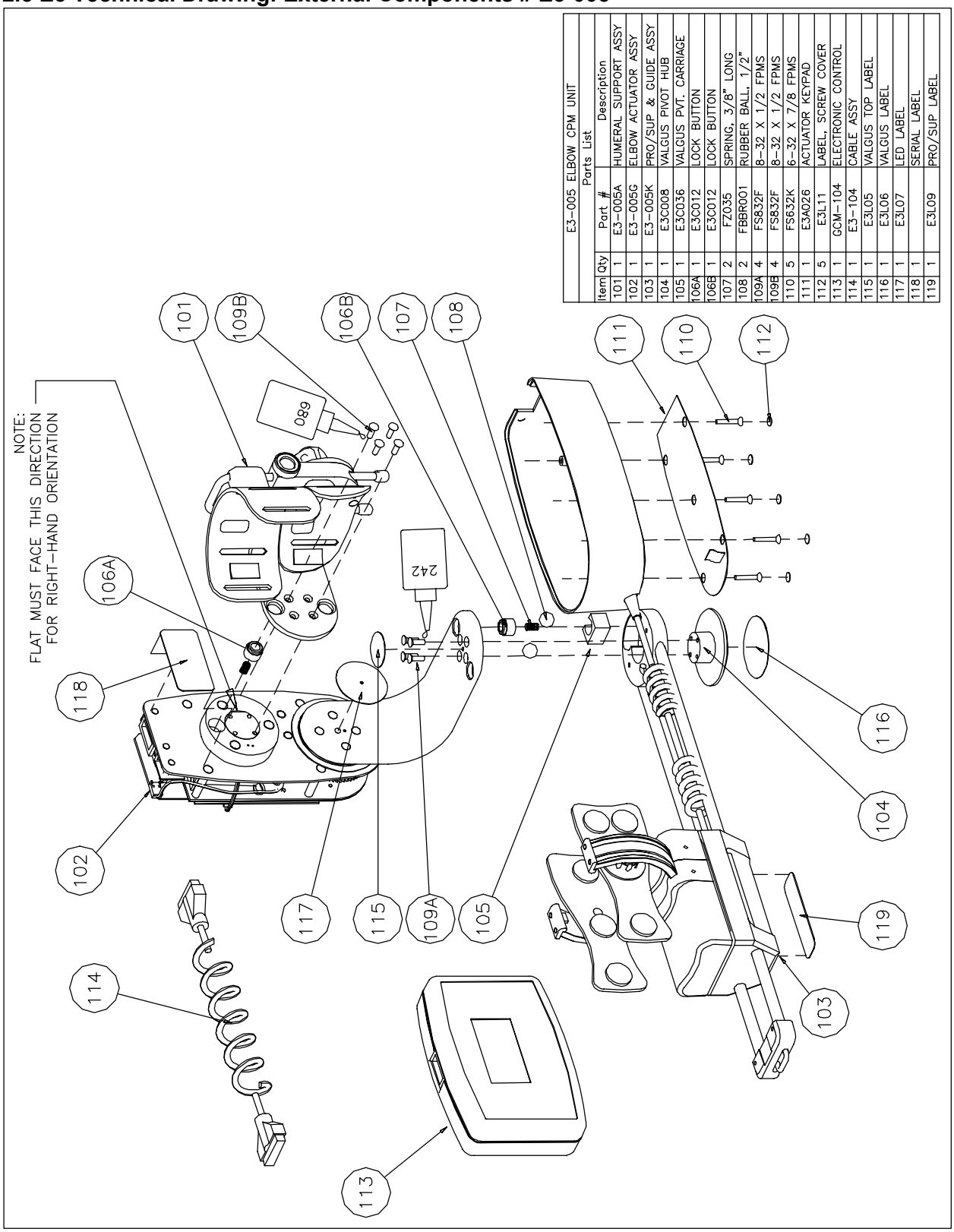
2.4 Disassembly Humeral Support Subassembly

Caution: Two springs and a ball bearing inside.

See Drawing # E3-005F
Remove the four machine screws (138).
Remove the 1-inch (2.5cm) spring (140) and Lock Housing (133).
Remove the Lock Plunger (134) and the one 1/4" (6mm) ball bearing (137) from the Lock Housing (133).
Remove the Humeral Mount Assembly (131) from the Humeral Support Arm (132).
Remove the Lock Button (135) and the 3/8 " (1cm) spring (139) from the Mounting Block

Assembly Note: Use Loctite 242 on the four machine screws (138).
Use one 1/4" ball bearing in the Lock Housing.
Orientation of the Lock Housing is not important.

2.5 E3 Technical Drawing: External Components # E3-005

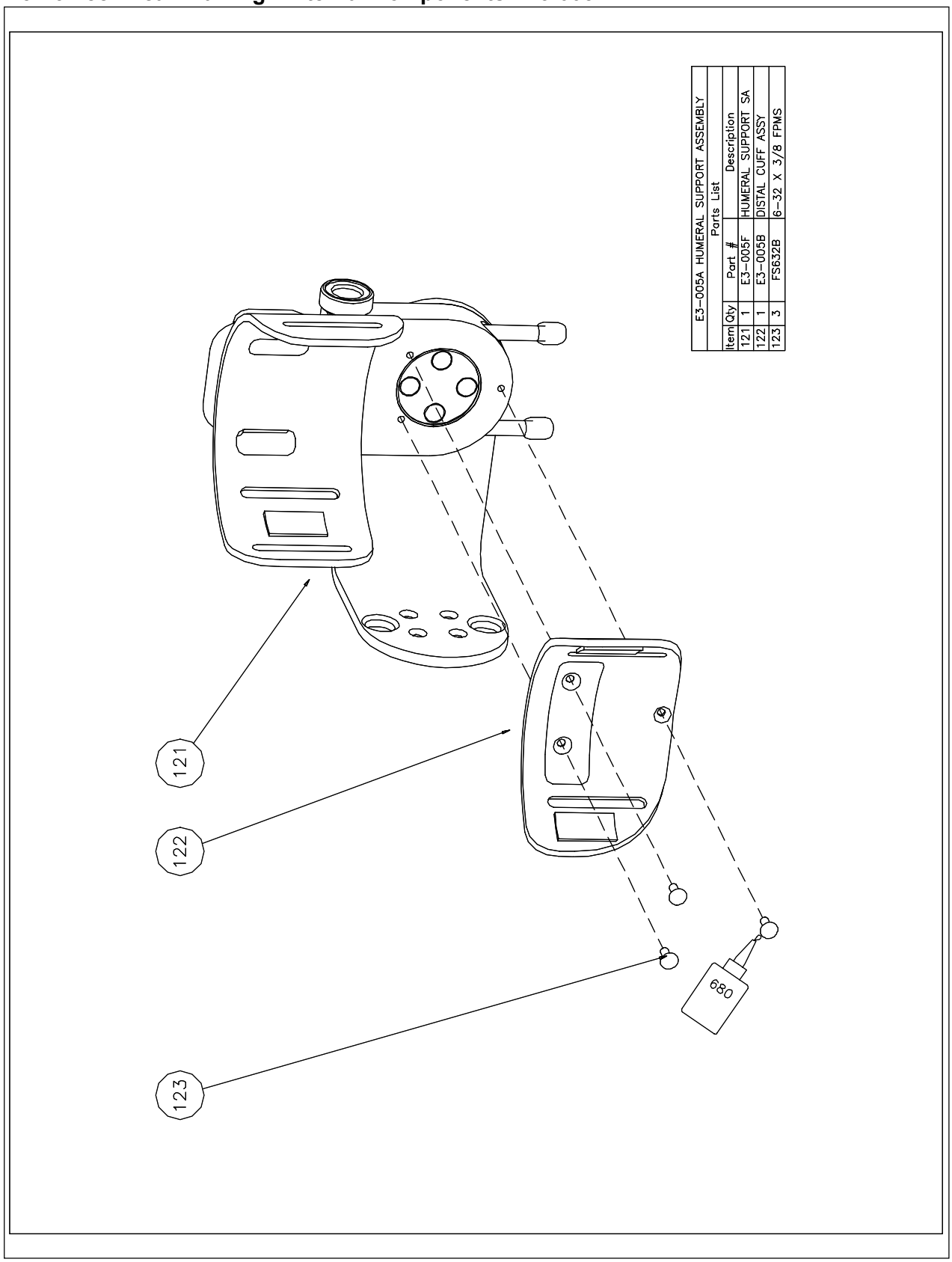


E3-005 ELBOW CPM UNIT

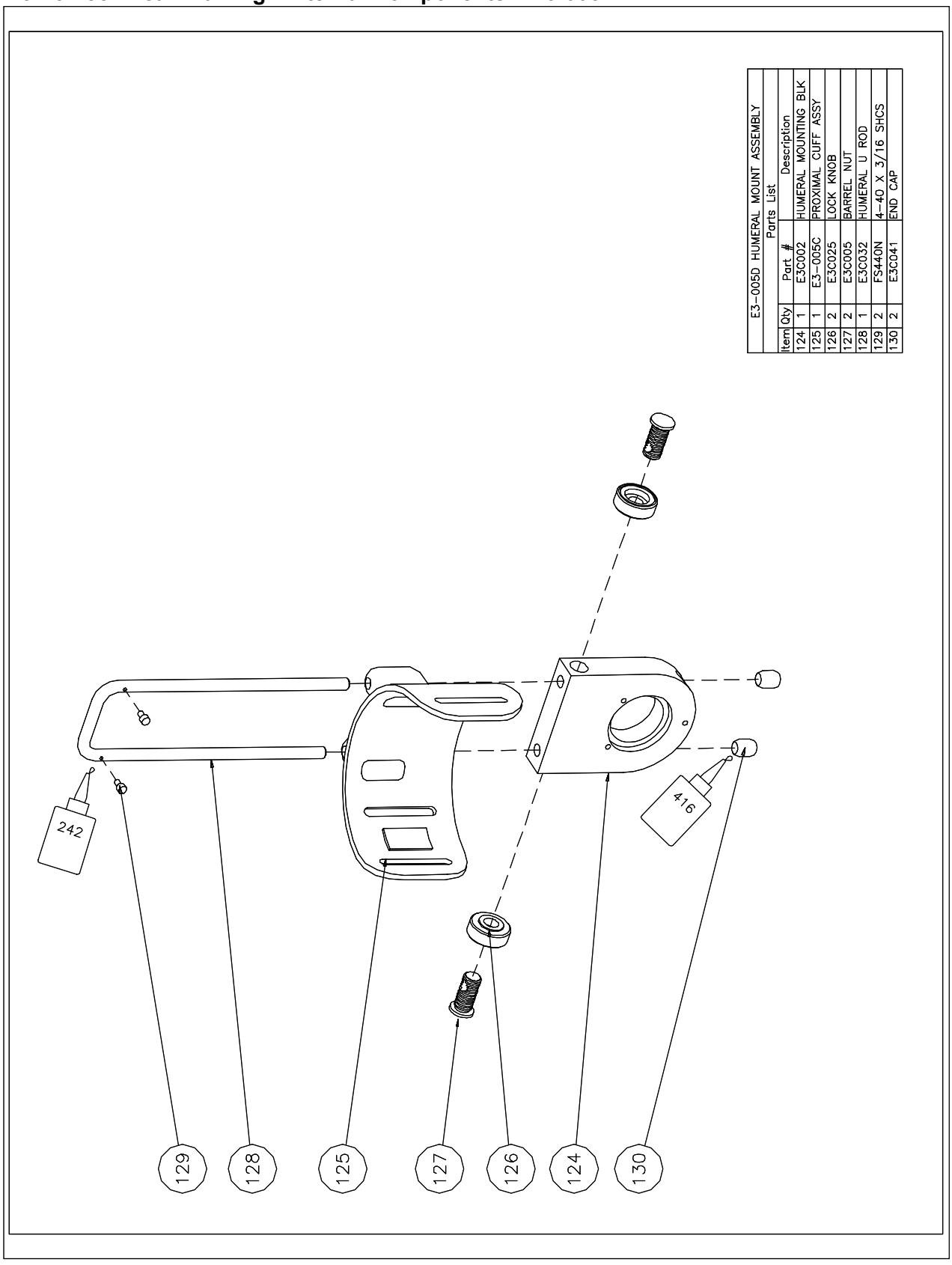
Parts List

Item	Qty	Part #	Description
101	1	E3-005A	HUMERAL SUPPORT ASSY
102	1	E3-005G	ELBOW ACTUATOR ASSY
103	1	E3-005K	PRO/SUP & GUIDE ASSY
104	1	E3C008	VALGUS PIVOT HUB
105	1	E3C036	VALGUS PVT. CARRIAGE
106A	1	E3C012	LOCK BUTTON
106B	1	E3C012	LOCK BUTTON
107	2	FZ035	SPRING, 3/8" LONG
108	2	FBBR001	RUBBER BALL, 1/2"
109A	4	FS832F	8-32 X 1/2 FPMS
109B	4	FS832F	8-32 X 1/2 FPMS
110	5	FS632K	6-32 X 7/8 FPMS
111	1	E3A026	ACTUATOR KEYPAD
112	5	E3L11	LABEL, SCREW COVER
113	1	GCM-104	ELECTRONIC CONTROL
114	1	E3-104	CABLE ASSY
115	1	E3L05	VALGUS TOP LABEL
116	1	E3L06	VALGUS LABEL
117	1	E3L07	LED LABEL
118	1		SERIAL LABEL
119	1	E3L09	PRO/SUP LABEL

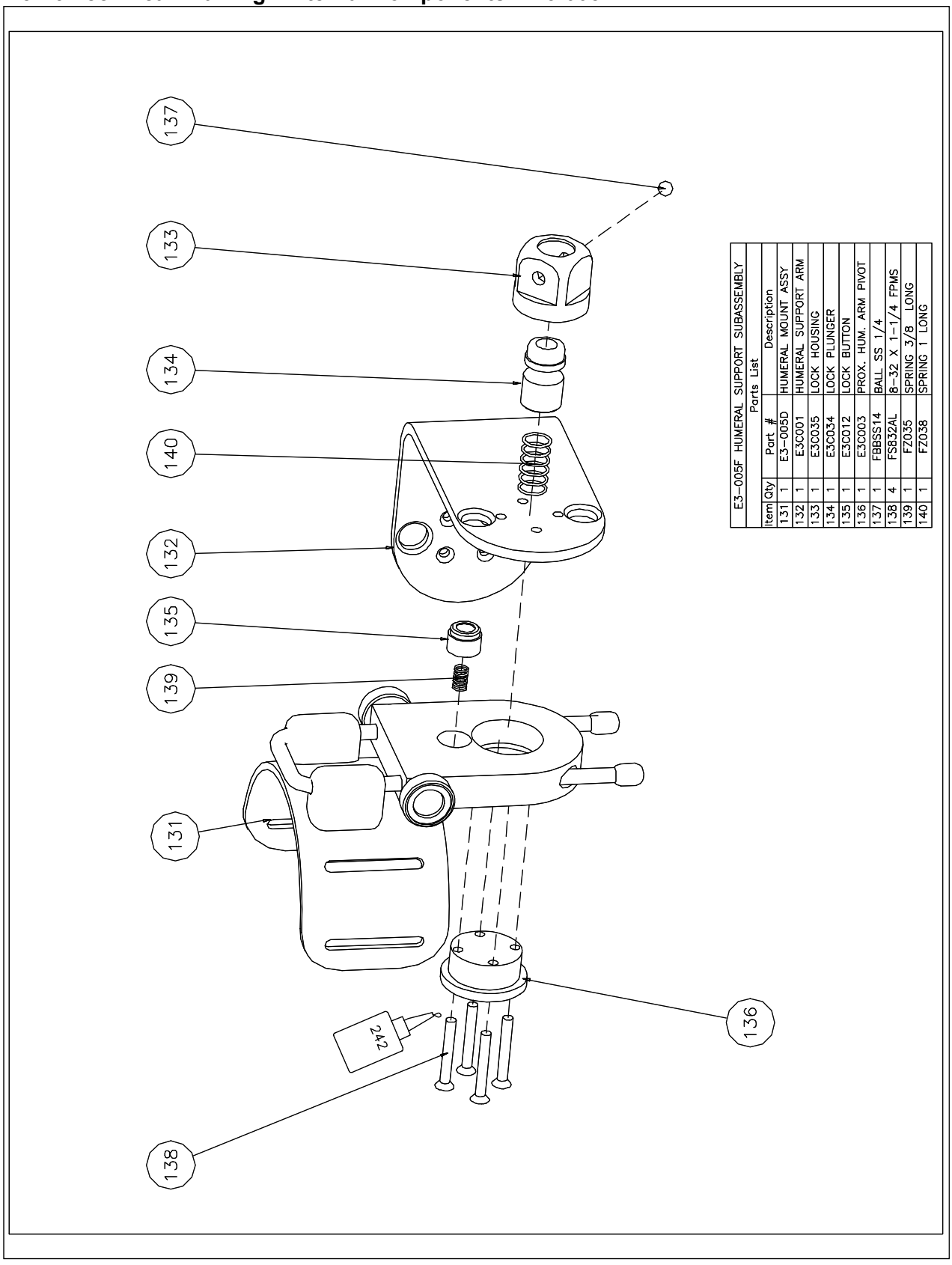
2.5 E3 Technical Drawing: External Components #E3-005A



2.5 E3 Technical Drawing: External Components # E3-005D



2.5 E3 Technical Drawing: External Components # E3-005F



E3-005F HUMERAL SUPPORT SUBASSEMBLY

Parts List

Item	Qty	Part #	Description
131	1	E3-005D	HUMERAL MOUNT ASSY
132	1	E3C001	HUMERAL SUPPORT ARM
133	1	E3C035	LOCK HOUSING
134	1	E3C034	LOCK PLUNGER
135	1	E3C012	LOCK BUTTON
136	1	E3C003	PROX. HUM. ARM PIVOT
137	1	FBBSS14	BALL SS 1/4
138	4	FSB32AL	8-32 X 1-1/4 FPMS
139	1	FZ035	SPRING 3/8 LONG
140	1	FZ038	SPRING 1 LONG

3.0 Controller Disassembly

3.1 Introduction

The Electronic Controller contains the Main PCB Assembly and Battery pack. The Main PCB assembly is composed of 3 circuit boards. The Main PCB and the Display PCB are soldered together at the connector. The Regulator Board plugs into the Main PCB. It contains the Memory Battery and regulates the 5V supply for the main board. The life of the memory battery is conservatively estimated at three years. The 7.2 V NiMh Battery will provide power to operate the unit for approximately 2 hours.

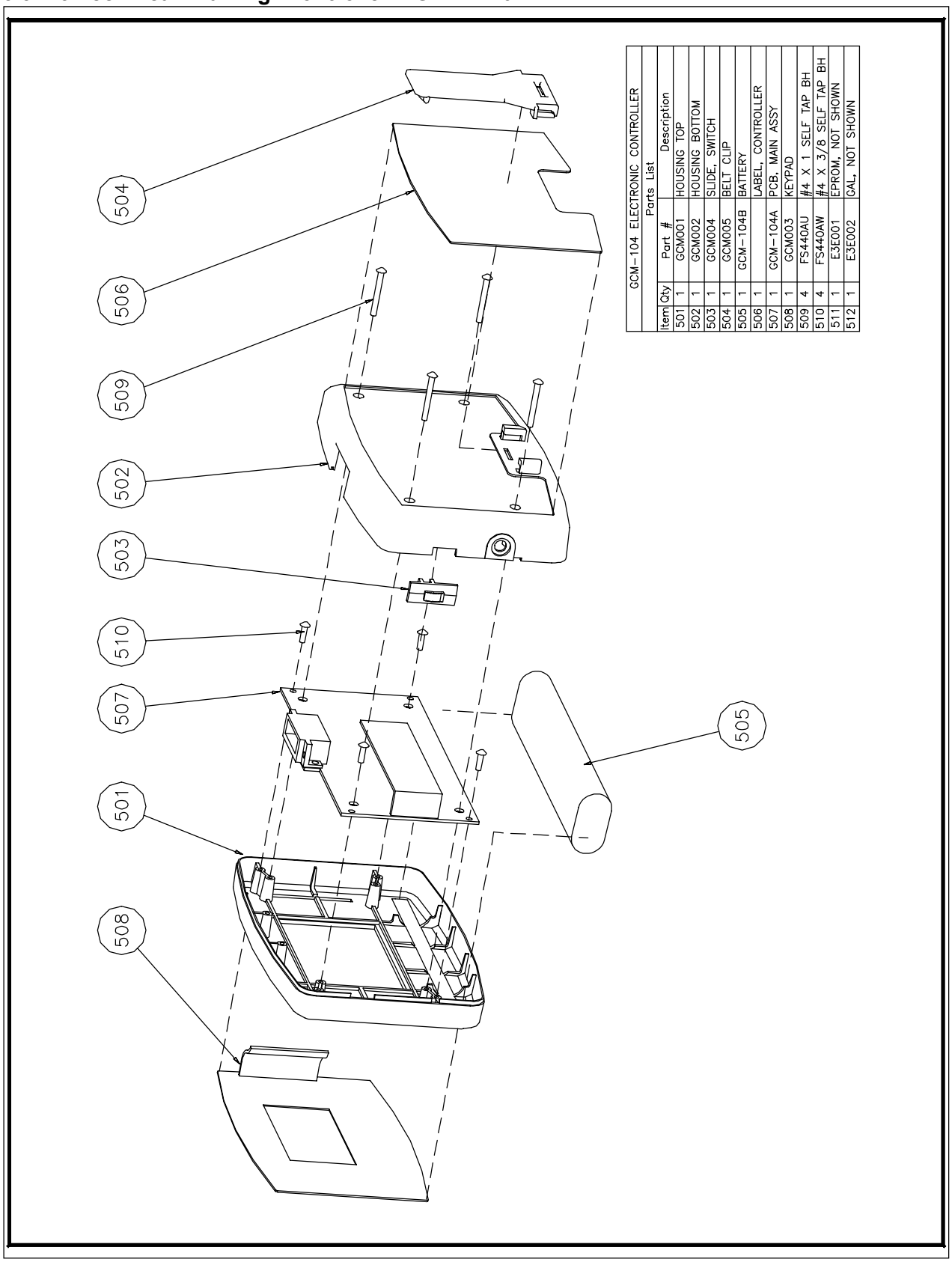
Caution: This CPM device contains components that can be damaged by Electrostatic Discharge. Only qualified personnel should only attempt repairs.
All precautions for protecting static sensitive devices must be followed.
Caution: Cable and Connector Inside.
Tools Required: #2 Phillips

3.2 Disassembly of the Controller

See Drawing # GCM – 104
Lift the four corners of the Controller Instruction Label to access the four housing screws. Remove the four screws (509) (FS440AU 1“ self tap BH).
Lift the Battery (505) and unplug it from the PCB assembly.
Remove the Switch Actuator Glide (503) from the power switch.
Lift the Main PCB assembly (507) away from the Top Housing (50l).
Use **Caution** to avoid damaging the Key Pad (508) and the keypad cable.
Unplug the interconnect cable from the Main PCB Assembly.

Lift the small Regulator PCB away from the Main PCB connector. The battery holder is secured to the microprocessor by double-sided adhesive foam tape.
The Keypad (508) has an adhesive coating on the back to secure it to the Top Housing (501) and to the LCD display.

3.3 E3 Technical Drawing: Controller # GCM – 104



GCM-104 ELECTRONIC CONTROLLER

Parts List

Item	Qty	Part #	Description
501	1	GCM001	HOUSING TOP
502	1	GCM002	HOUSING BOTTOM
503	1	GCM004	SLIDE, SWITCH
504	1	GCM005	BELT CLIP
505	1	GCM-104B	BATTERY
506	1		LABEL, CONTROLLER
507	1	GCM-104A	PCB, MAIN ASSY
508	1	GCM003	KEYPAD
509	4	FS440AU	#4 X 1 SELF TAP BH
510	4	FS440AW	#4 X 3/8 SELF TAP BH
511	1	E3E001	EPROM, NOT SHOWN
512	1	E3E002	GAL, NOT SHOWN

4.0 ELBOW ACTUATOR

4.1 Introduction

The Elbow Actuator provides mounting point for the CPM device to the base, the Arm Cuffs and the Drive Motor to move the Elbow. This actuator also provides the connection point for the Motion Controller Cable and the Power Supply.

4.2 Removal of the Drive Arm from the Elbow Actuator & Circuit Board

Caution: This CPM device contains components that can be damaged by Electrostatic Discharge. Only qualified personnel should only attempt repairs. All precautions for protecting static sensitive devices must be followed.
Tools Required: #2 Phillips

Remove the Targeting Label (Item 117 on E3 –005) from the Drive Arm.

See Drawing # E3 – 005G
Remove the four machine screws (151)(FS632H ½" FPMS) from the Drive Arm (143)
Remove the Drive Arm (143) and Washer (145) from the Elbow Actuator

Assembly Note: The Drive Pin in the Drive Arm (143) must enter the "U" shaped slot in the Cam on the Pot shaft. Line it up by looking through the holein the drive arm. The Pot Shaft Cam can not be removed from the Pot shaft.

Caution – When lifting the housing cover there is a cable and connector inside.

See Drawing # E3-005
Remove the five Screw Cover Labels (112) from the Label (111) to access the screws.
Remove the five machine screws (110)(FS632K 7/8"FPMS) securing the cover to the actuator.
Remove the 10-pin connector from the PCB.

See Drawing # E3–005G
Remove the Connectors for the Pot, Orientation Switch and Motor from the PCB.
Remove the three machine screws (154)(FS440AD 3/8" Binding) with #4 nylon washers (152) securing the PCB.
Lift the PCB and remove the three #4 nylon spacers (153) from the PCB insulator (148).
Remove the PCB insulator (148).
Leave the main PCB connected to the Controller Cable Connector PCB.

4.3 Remove Base Plate Sub Assembly

See Drawing # E3A–005
Remove the four machine screws (211)(FS832F ½"FPMS) and the four machine screws (210)(FS632B 3/8"FPMS) from the Top Plate (202)
Lift the Top Plate (202)

See Drawing # E3A – 005B
Remove the four machine screws (219)(FS632D ¼" FPMS) securing the Bevel Gear Assembly.
Remove the Bevel Gear Subassembly (215) with the Spur Gear and the Bevel Gear Bushing (216).

Assembly Note: The offset hole in the Bushing (216) must line up with the threaded hole in the centre of the Base Plate (212). Use Loctite 242 on machine screws (218).

4.4 Removal of the Spur Gear

See Drawing # E3A – 005
Lift the Spur Gear (204) from the top plate (202).
Remove the Bushing #1 (205) and Bushing #2 (203) from the Spur Gear.

See Drawing # E3 – 005G
Remove the three screws (150)(FS 832R ¾") from the Orientation Switch Assembly (142).
Remove the Distal Humeral Arm Pivot (146) from the Switch Assembly (142).

Assembly note: Insert the Pivot (146) with the FLAT side aligned with the Micro-switches in the Switch Assembly (142) to prevent the switches from breaking.

4.5 Removal of Drive Belt

See Drawing # EA3-005D
Remove the Drive Belt (226).

4.6 Disassembly of the Motor / Gearbox / Motor Speed Sensor

Tools required: 1/16" Allen wrench, #1 Phillips screwdriver.

See Drawing # E3A – 005
Remove the four machine screws (210) (FS632B 3/8") and lift the Motor Gearbox assembly from the top plate.

See Drawing # EA3-005D
Remove the set screw (224)(FS632Q 5/16").
Remove the gearbox (221) from the Elbow Motor Plate Assembly (222).
Remove the two screws (225)(FS632B 3/8 FPMS). Assemble with Loctite 242.
Remove the Motor assembly (223) from the Elbow Motor Plate Assembly (222).

Assembly Note: Install the Gearbox so that the one hole that is in line with the long side of the gearbox support is in line with the screw hole in the white Delrin gear head insert. Install the set screw (224). Assemble with Loctite 680.

4.7 Removal of the Position Sensing Potentiometer

Caution: Do not remove the Pot Mount Assembly E3A-005C unless it is required. It will be necessary to re-calibrate the Position Sensing Potentiometer if this is done.

See Drawing # E3A–005B
Remove the four machine screws (220)(FS632ZA).
Remove the Silicone Sealant securing the Pot Assembly to the Base Plate (212).
Remove the Pot Mount Assembly (213) from the Base Plate (212).
Assembly Note: The Pot Shaft Cam can not be removed from the Pot shaft nor can the pot be removed from the pot housing.

4.8 Calibration of Position Sensing Potentiometer

Tools required: Spirit or Bubble Level, 1/16th Allen Wrench

Elbow Actuator:
The objective of this procedure is to position the Drive Arm in the 90^{O} degree position and then adjust the Potentiometer (Pot) to indicate 90^{O} on the LCD Screen.

See Drawing # E3A-005B
Remove the Drive Assembly Cover (161) on drawing E3-005K if this has not already been done. Make sure all connectors are connected, drive arm must also be attached.
Remove any silicone sealant that may be holding the Pot to the Base Plate (212).
Use the Spirit Level to locate a work area that is LEVEL.
Place the Actuator so the bottom flat edge of the Base Plate (212) is on this level work area.

See Drawing # E3-005G
Plug in the hand controller and power supply. Turn it on and go to the run screen.
Run the device until the flat surface of the Drive Arm Assembly (143) is at the top of the Actuator.
Place the Spirit level on the flat surface of the Drive Arm Assembly (143) and use the controller to adjust the Arm until it is level.
Loosen the set screw in the side of the Pot Mount Assembly (213) on drawing E3A-005B and rotate the Pot until the LCD Screen indicates that the Arm is at 90^{O} degrees. Retighten the set screws, do not over tighten.

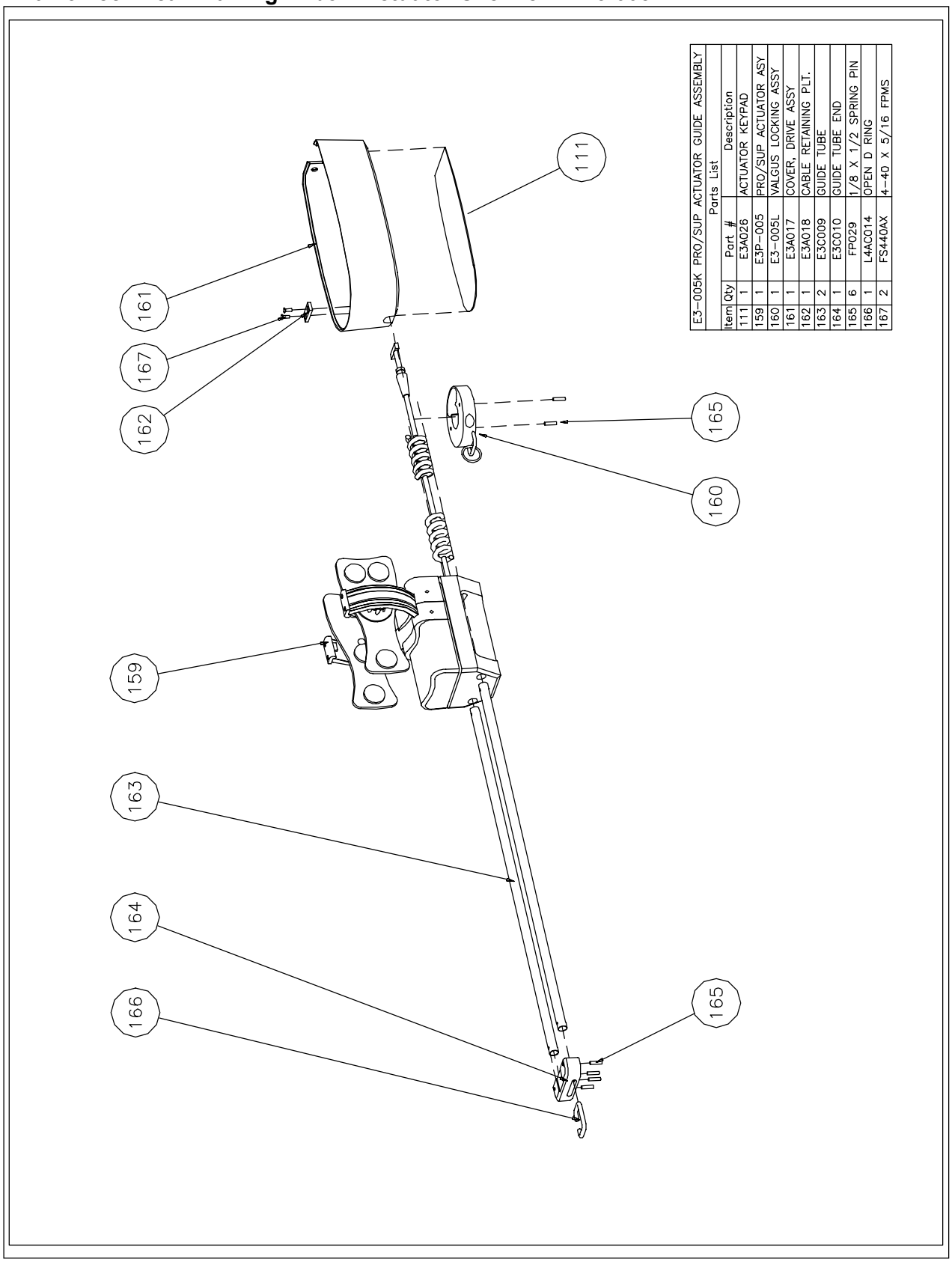
4.9 Valgus Pivot

The Valgus Pivot has a locking button to configure the device for Left Hand or Right Hand Orientation. The two rubber balls permit a small amount of movement that corresponds to the actual movement of the patient's elbow as it moves through its normal Range of Motion.
Tools Required: #2 Phillips

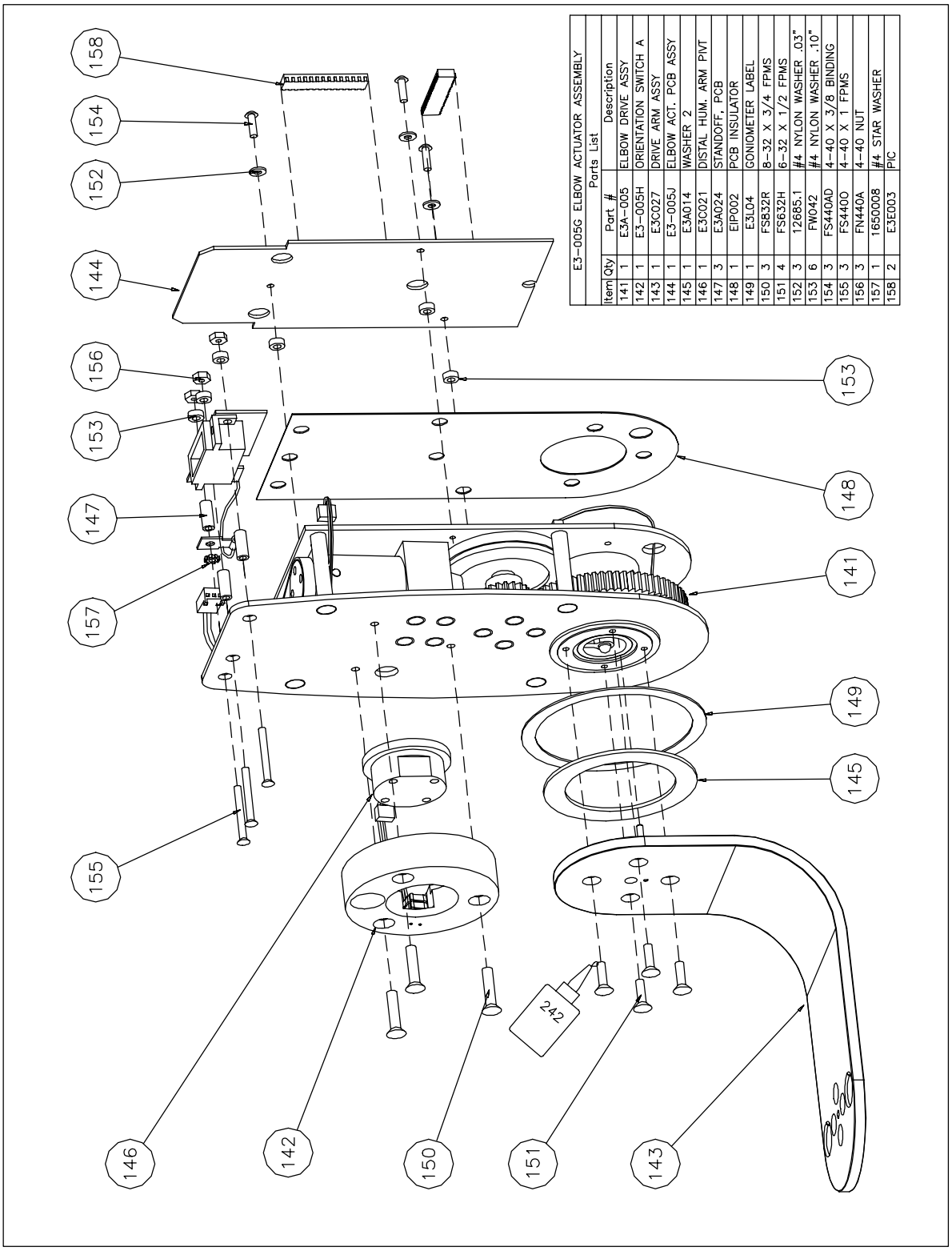
See Drawing # E3–005
Remove the Valgus Pivot Top Label (115)
Remove the four machine screws (109A)(FS832F ½") and remove the Curved Drive Arm.
Remove the Lock Button (106), the Spring 3/8" (1cm) (107), the two ½ "(1.3cm) rubber balls (108), the Valgus Pivot Carriage (105) and the Valgus Pivot Hub (104) with label.
Assembly: Use Loctite 242 on 4 screws (109A).

See Drawing # E3-005K
Caution: The Pro-Sup Actuator Assembly (159) E3P-005 does not need to be removed from the two Guide Tubes (163) unless the tubes or the Actuator Bottom Cover are damaged. To release the Actuator Assembly (159) from the tubes, push out the two spring pins (165) from the metal Guide Tube End (164).

4.10 E3 Technical Drawing: Elbow Actuator Overview # E3-005K



4.10 E3 Technical Drawing: Elbow Actuator Overview # E3-005G



E3-005G ELBOW ACTUATOR ASSEMBLY
Parts List

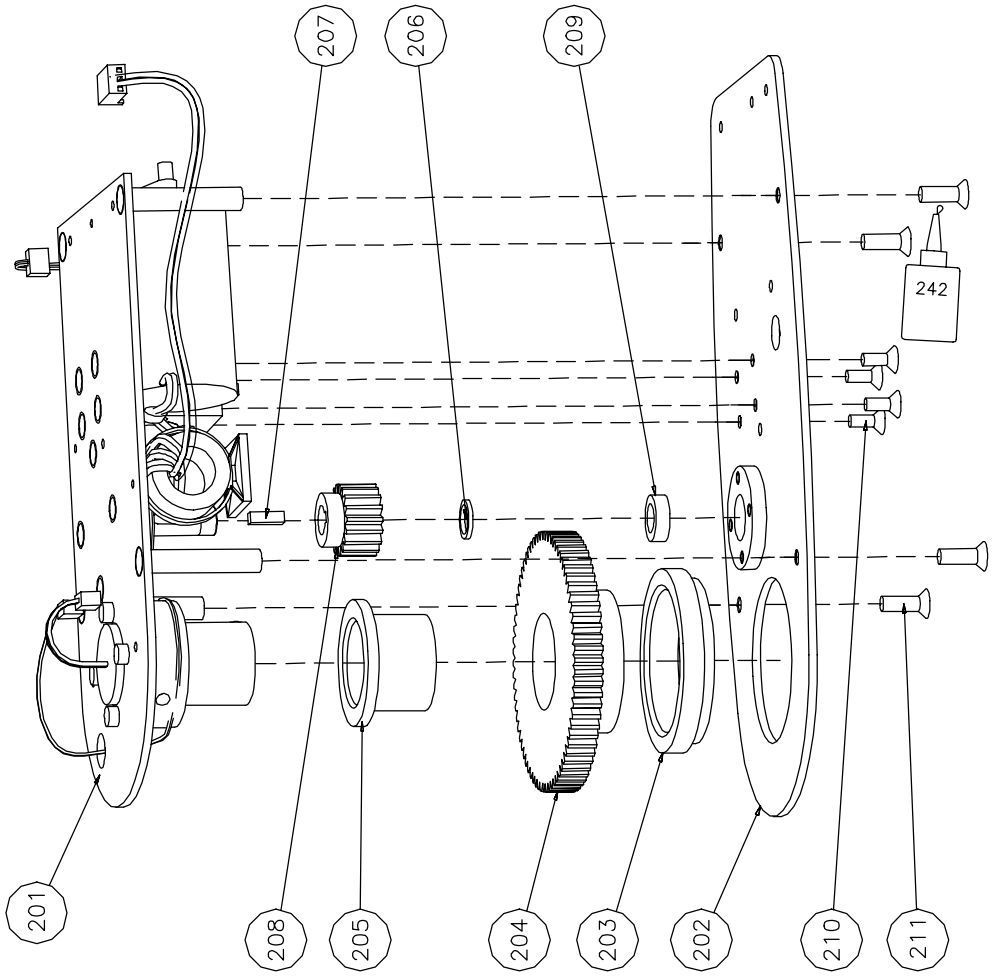
Item	Qty	Part #	Description
141	1	E3A-005	ELBOW DRIVE ASSY
142	1	E3-005H	ORIENTATION SWITCH A
143	1	E3C027	DRIVE ARM ASSY
144	1	E3-005J	ELBOW ACT. PCB ASSY
145	1	E3A014	WASHER 2
146	1	E3C021	DISTAL HUM. ARM PIVT
147	3	E3A024	STANDOFF, PCB
148	1	EIP002	PCB INSULATOR
149	1	E3L04	GONIOMETER LABEL
150	3	FSB32R	8-32 X 3/4 FPMS
151	4	FS632H	6-32 X 1/2 FPMS
152	3	12685.1	#4 NYLON WASHER .03"
153	6	FW042	#4 NYLON WASHER .10"
154	3	FS440AD	4-40 X 3/8 BINDING
155	3	FS440O	4-40 X 1 FPMS
156	3	FN440A	4-40 NUT
157	1	1650008	#4 STAR WASHER
158	2	E3E003	PIC

4.10 E3 Technical Drawing: Elbow Actuator Overview # E3A-005

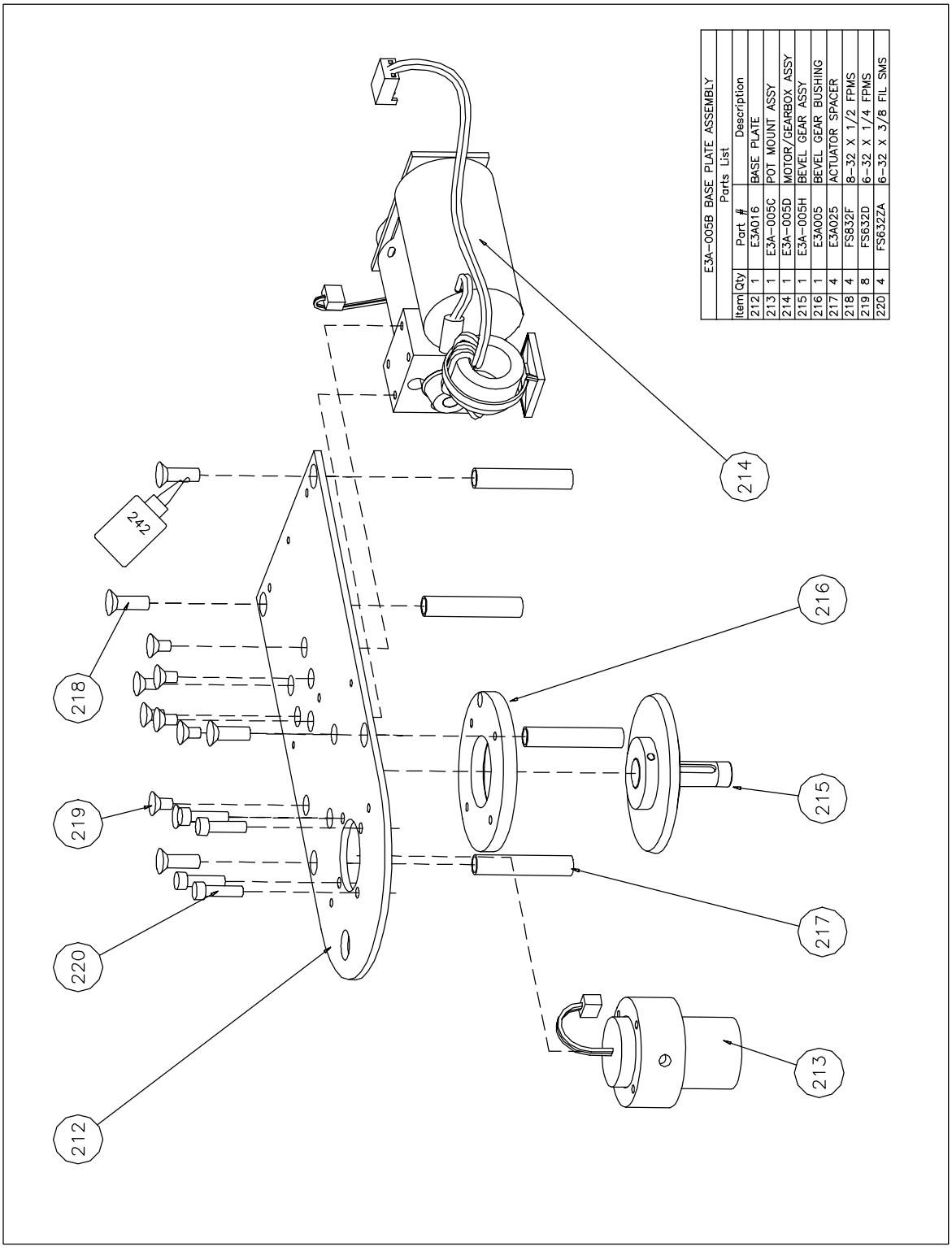
E3A-005 ELBOW DRIVE ASSEMBLY

Parts List

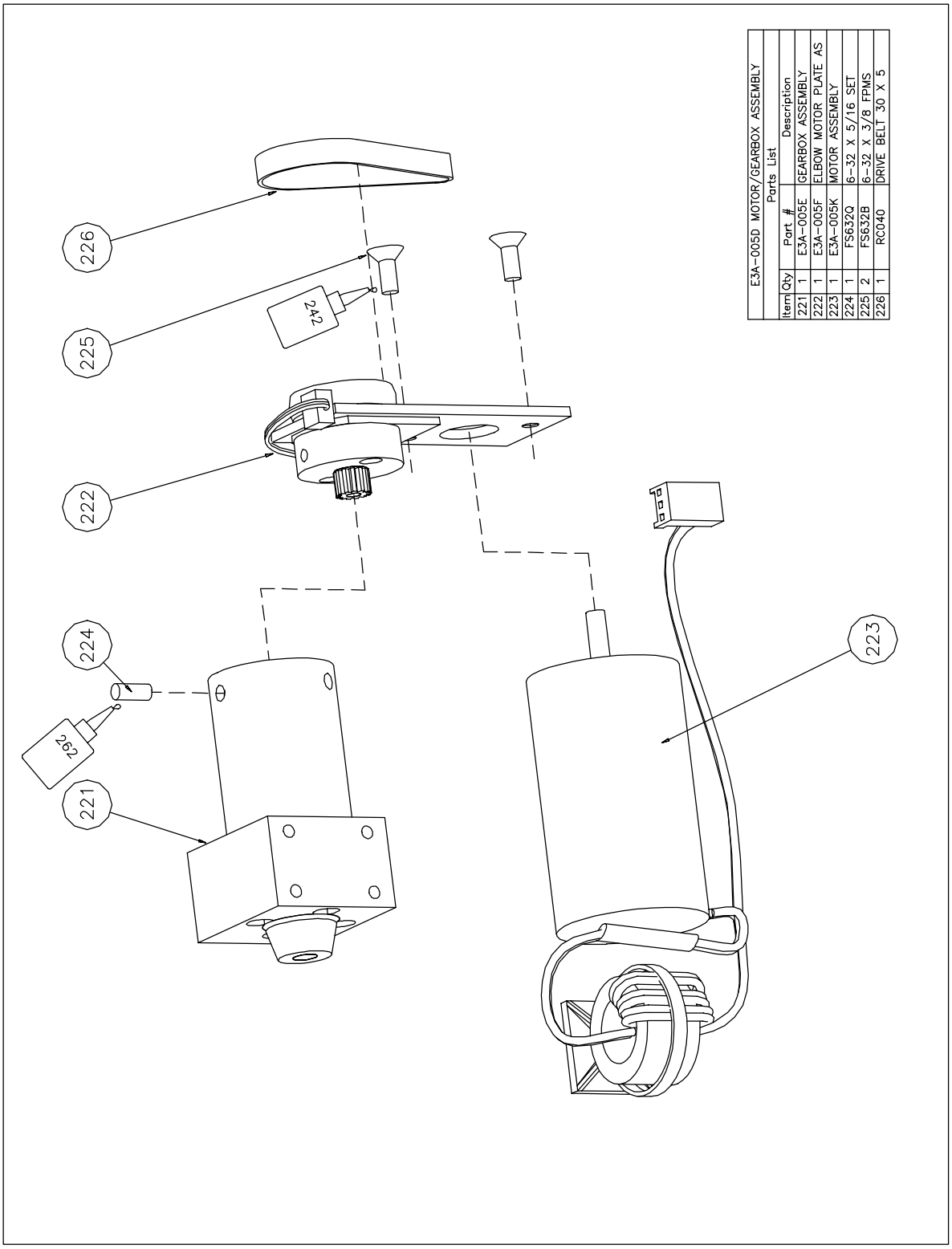
Item	Qty	Part #	Description
201	1	E3A-005B	BASE PLATE ASSY
202	1	E3A-005A	TOP PLATE ASSY
203	1	E3A013	BUSHING 2
204	1	E3A021	SPUR GEAR MACHINED
205	1	E3A011	BUSHING 1
206	1	E3A008	WASHER 1
207	1	E3A007	KEY
208	1	FG022	GEAR SPUR 1-18
209	1	E3A027	OILITE BUSHING
210	4	FS632B	6-32 X 3/8 FPMS
211	4	FS832F	8-32 X 1/2 FPMS



4.10 E3 Technical Drawing: Elbow Actuator Overview # E3A-005B



4.10 E3 Technical Drawing: Elbow Actuator Overview # E3A-005D



5.0 Pro/Sup (Wrist) Actuator

5.1 Introduction

The Pro/sup Actuator provides the Pronation and Supination movement to the Elbow. It contains the Load Cell Frame and the electronics to support the Progressive Stretch Relaxation feature of this CPM Device.
Use extreme **Caution** with the Load Cell Frame and Wires.
Caution: Never adjust the variable resistors on the Load Cell PCB.
Caution: This CPM device contains components that can be damaged by Electrostatic Discharge. Only qualified personnel should only attempt repairs. All precautions for protecting static sensitive devices must be followed.
Tools Required: #2 Phillips screwdriver, 2.5 mm Allen Wrench, 5/64 " Allen Wrench, 1/16" Allen Wrench

5.2 Wrist Support Assembly E3P-005C

See Drawing # E3P-005A
Using a 1/16" Allen Wrench, unscrew the two belt tension screws (329)(FS832AE ½" set screw).
Remove the two screws (327) and the Belt holder (320) on the side of the Wrist Support Assembly to be replaced.

See Drawing # E3P-005B
Remove the two screws (335)(FS440 ½") under the belt.
Install the replacement Wrist Support Assembly.
Assembly: Use Loctite 242 on the two screws.

Refer to Section 5.10 for Wrist Ring Drive Belt Tension Adjustment Procedure.

Caution: Do not proceed with 5.3 to 5.9 unless required. It will be necessary to Adjust the Drive Belt Tension and to re-calibrate the Position Sensing Potentiometer after completing these procedures.

5.3 Pro/Sup Actuator Housing E3P-005A
Caution – Cable and Connector is fastened to the housing.

See Drawing # E3P-005
Remove the label from the bottom cover (302).
Remove the four machine screws (306)(FS832B 3/8") from the bottom cover to release the Drive Assembly (301).
Remove the connector for cable (305) from the PCB assembly.

5.4 Wrist Drive Ring Belt

Disassembly

See Drawing # E3P-005A
Remove the two machine screws (330) (FS832AM 2½"FSMS) to release the top pro/sup cover (319).
Using a 1/16 " Allen wrench loosen the two Drive Belt Tension Adjust set screws (329) (FS832AE ½") until they are almost at the top of hole.
Remove the two machine screws (328)(FS832R ¾") securing the load cell assembly (308) to the Proximal Ring Guide (315) and remove the Proximal Ring Guide.
Remove the two belt idlers (318), the Belt Idler Shaft (316) and the floating Belt Idler Shaft (317).
Remove the Pot Shaft Assembly (311).
Remove the four machine screws (327)(FS256A ¼") from the two belt holders (320) and remove the belt (321).

Reassembly

Locate the Slots for the Floating Idler Shaft (317) in the Distal (314) and Proximal (315) Ring Guides. Place the new belt between the Drive Ring (312) and Belt Holder (320). Allow five (5) teeth to extend past the Belt Holder and tighten the two screws (327). Install the shaft (316) with Idler wheel (318) and the Pot Shaft Assembly (311). Route the drive belt around the drive gear on the motor assembly (309) and between the pot shaft assembly (311) and the Idler wheel (318). Install the tensioning idler wheel (318) with the floating shaft (317). Install the Proximal Ring Guide (315) and the two screws (330) with Loctite 680. Pull the belt to apply some tension and secure to the Drive Ring with the remaining Belt Holder and the two machine screws (327). Install the two machine screws (328) with Loctite 680.

Refer to Section 5.10 for Wrist Ring Drive Belt Tension Adjustment Procedure and Section 5.9 to re-calibrate the Position Sensing Potentiometer.

5.5 Pro/Sup Motor Replacement E3P-005J

See Drawing # E3P-005G
Remove the motor power plug from the socket on the PCB.
Remove the Drive Belt (346).
Remove the two screws (344) (FSM2E M2X4FSMS).
Install the new motor assembly (E3P – 005J).
Replace the two screws (344). Do not over tighten.
Plug the motor into the socket on the PCB.

5.6 Gearbox Assembly Replacement E3P-005M

Method one:
Tools required: 2.5 mm Allen Wrench and #2 Phillips screwdriver.

See Drawing # E3P-005A
Caution: Use great care to avoid damaging the strain gauges inside and outside the Load Cell Frame. Use a short Allen Wrench or ball-end Allen Wrench to remove the two screws (325)(FSM3F M3X8SHCS). Remove the motor gearbox assembly (309).
With a 2.5 mm Allen Wrench, remove the two screws (325) (FSM3F M3X8SHCS) and remove the motor gearbox assembly (2).

Method two:
See Drawing # E3P-005A
Observe the six Strain Gauges with wires attached to the Load Cell frame. Ensure that the sprocket on the gearbox shaft and the tools do not damage the strain gauges and wires.
Remove one Drive Belt Holder (320) and remove the Drive Belt (321).
Remove the four machine screws (328)(FS832R) and separate the Drive Ring Assembly (312) including the Ring Guides (314) and (315) from the Load Cell Assembly (308) and Gearbox Support (313).

See Drawing # E3P – 005A
Caution: Use great care to avoid damaging the strain gauges inside and outside the Load Cell Frame.
With a 2.5 mm Allen Wrench, remove the two screws (325) (FSM3F M3X8SHCS) and remove the motor gearbox assembly (309).

See Drawing # E3P-005G
With a 1/16” Allen wrench, remove the set screw (345)(FS632Q 5/16”)
Remove the gearbox (343) from the Pro/Sup Motor Plate Assembly (341).

Assembly Notes

See Drawing # E3P-005G
Locate and mark the only one of the three (3) holes in the side of the gearbox that is in line with one of the four (4) mounting holes on the front of the gearbox. See Drawing # diagram on drawing. Place the Motor Mounting Plate (341) inside the gearbox and insert the set screw (345) through the marked hole into the Delrin Insert.
Assembly: Use Loctite 680 on the set screw (345).

5.7 Motor Plate Replacement E3P-005H

The Motor Plate assembly contains the Optical Sensor. This assembly is not serviceable. Note routing of Motor and Optical Sensor cables before disassembly.

Remove motor as described in Section 5.5 and the Gear Box as described in Section 5.6. Follow assembly instructions.

5.8 Pot and Wire Assembly E3P-005F

See Drawing # E3P-005E
Loosen the two set screws (339)(FS25CP 3/32") and remove the gear (337).
Loosen the set screw (340)(FS440K ¼") and unscrew the pot and wire assembly from the Pot Support (336).

Re-assemble with new pot and wire assembly and calibrate the actuator. See Drawing # E3P-005A.

5.9 Calibration of Position Sensing Potentiometer

Tools required: Spirit or Bubble Level, 0.05" Allen Wrench

Pro/Sup Actuator:
The objective of this procedure is to position the Drive Ring Assembly in the Zero degree position and adjust the Potentiometer (Pot) to indicate 90^{O} on the LCD Screen.

See Drawing # E3P-005B
Remove the Bottom Cover (302) on drawing E3P-005 if this has not already been done.
Use the Spirit Level to locate a work area that is LEVEL.
Place the Actuator so the Load Cell Assembly (308) is on this level work area. Plug in the controller, switch on and go to the run screen.
Place the Spirit level on the two ends of the Drive Ring Assembly (312) and use the controller to adjust the level is horizontal.
See Drawing # E3P-005E
Loosen the set screw (340) in the side of the Pot Support (336) and adjust the position of the Pot until the LCD Screen indicates the Arm is at 90^{O}. Do not over tighten the set screw.

5.10 Wrist Ring Drive Belt Tension Adjustment

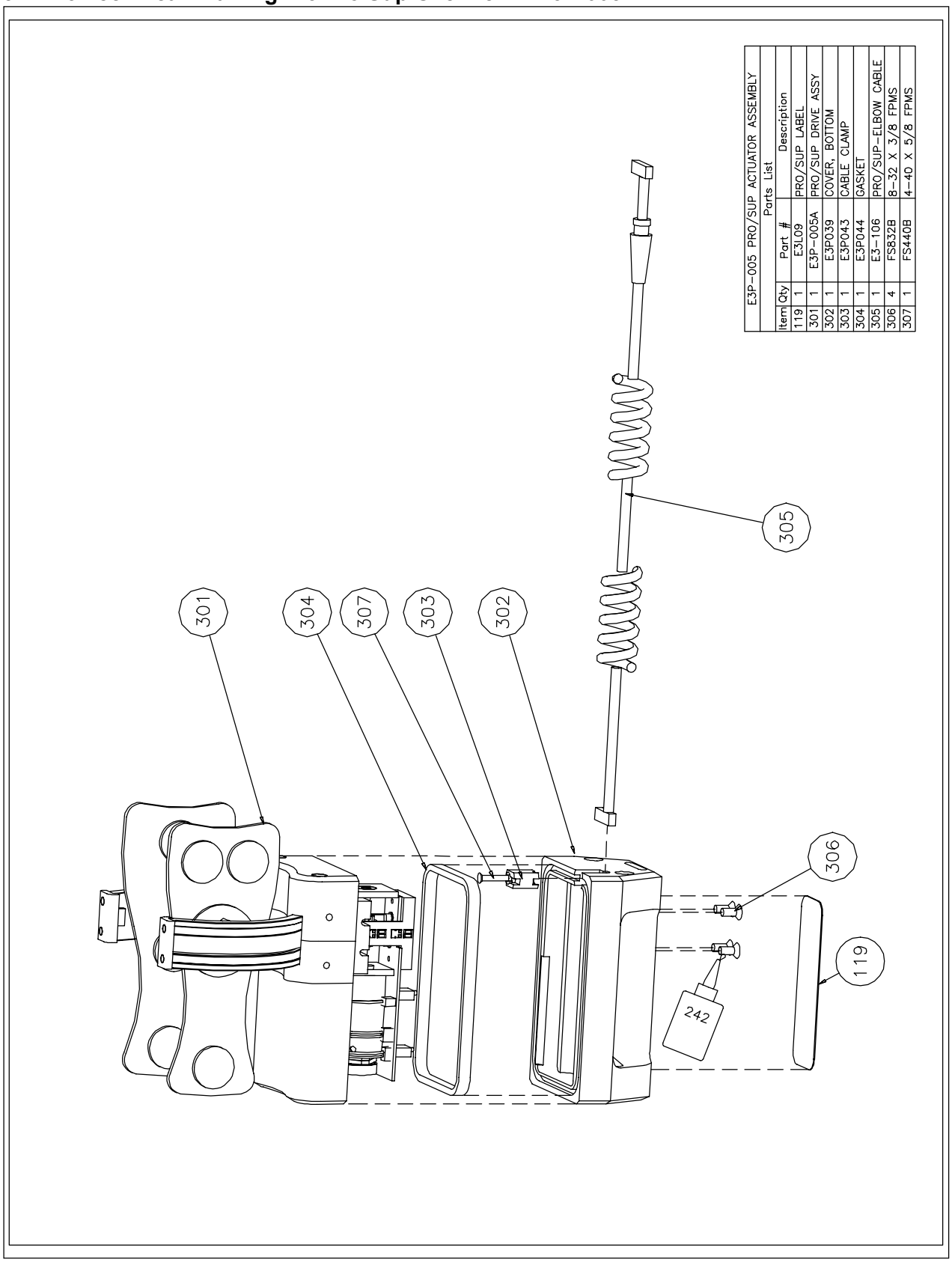
This procedure is done after the device has been assembled and is operational.

Turn on the controller. Set for New Patient and CPM mode. Adjust the Pro/Sup Actuator Force or Reverse on Load setting to the maximum. Tighten each of the two set screws (329) (in drawing E3P-005A) ALTERNATELY by one or two turns each time. When resistance is felt, run the device and apply pressure to the Drive Ring to activate the Reverse on Load feature and cause the actuator to change direction. If the sprocket on the Gearbox Shaft jumps over the teeth on the Drive Belt, continue tightening the set screws using the procedure described above until the Drive Ring reverses direction when pressure is applied.

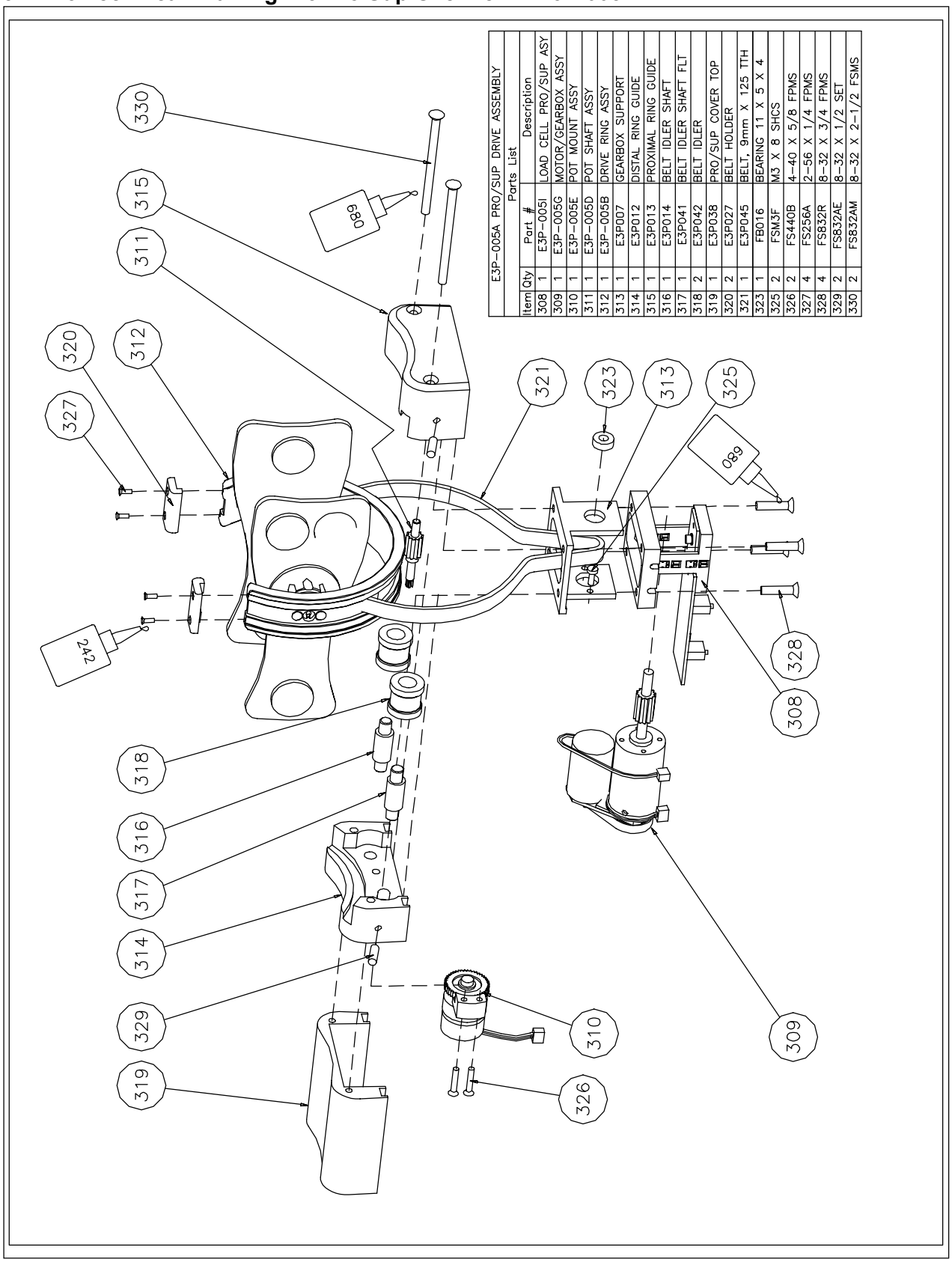
5.11 Removal of the Load Cell Assembly

Do not replace or make adjustments to the load cell assembly without prior training and calibration jigs.
Remove the two machine screws (328)(FS832R ¾") securing the load cell assembly (308) to the Proximal Ring Guide (315) and remove the Proximal Ring Guide.
Use a short Allen Wrench or ball-end Allen Wrench to remove the two screws (325)(FSM3F M3X8SHCS). Remove the motor gearbox assembly (309).
Remove the Load Cell from the Gearbox Support(313).
Install the two machine screws (328) with Loctite 680.

5.12 E3 Technical Drawing: E3 Pro/Sup Overview # E3P-005



5.12 E3 Technical Drawing: E3 Pro/Sup Overview # E3P-005A

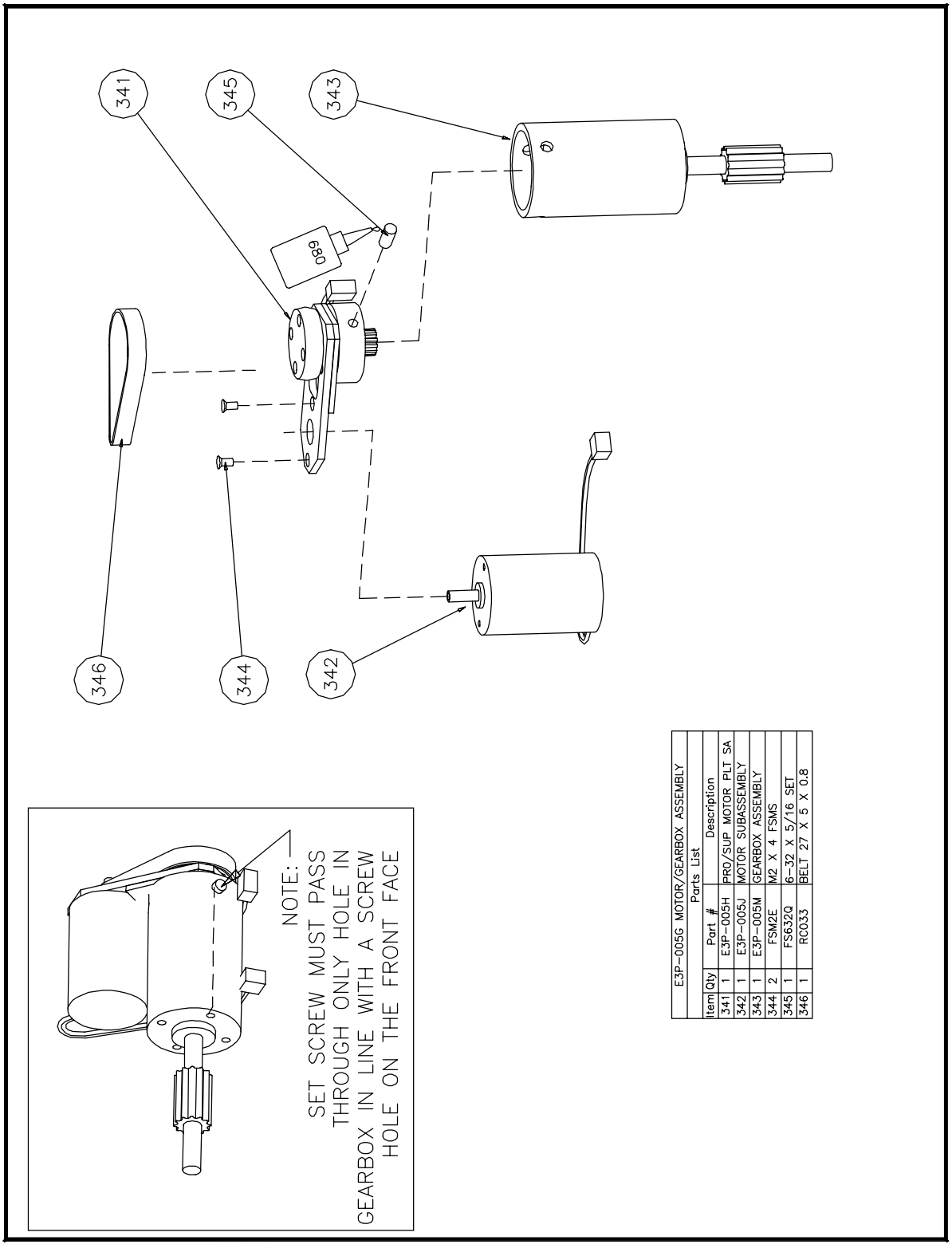


E3P-005A PRO/SUP DRIVE ASSEMBLY

Parts List

Item	Qty	Part #	Description
308	1	E3P-005I	LOAD CELL PRO/SUP ASY
309	1	E3P-005G	MOTOR/GEARBOX ASSY
310	1	E3P-005E	POT MOUNT ASSY
311	1	E3P-005D	POT SHAFT ASSY
312	1	E3P-005B	DRIVE RING ASSY
313	1	E3P007	GEARBOX SUPPORT
314	1	E3P012	DISTAL RING GUIDE
315	1	E3P013	PROXIMAL RING GUIDE
316	1	E3P014	BELT IDLER SHAFT
317	1	E3P041	BELT IDLER SHAFT FLT
318	2	E3P042	BELT IDLER
319	1	E3P038	PRO/SUP COVER TOP
320	2	E3P027	BELT HOLDER
321	1	E3P045	BELT, 9mm X 125 TTH
323	1	FB016	BEARING 11 X 5 X 4
325	2	FSM3F	M3 X 8 SHCS
326	2	FS440B	4-40 X 5/8 FPMS
327	4	FS256A	2-56 X 1/4 FPMS
328	4	FS832R	8-32 X 3/4 FPMS
329	2	FS832AE	8-32 X 1/2 SET
330	2	FS832AM	8-32 X 2-1/2 FSMS

5.12 E3 Technical Drawing: E3 Pro/Sup Overview # E3P-005G

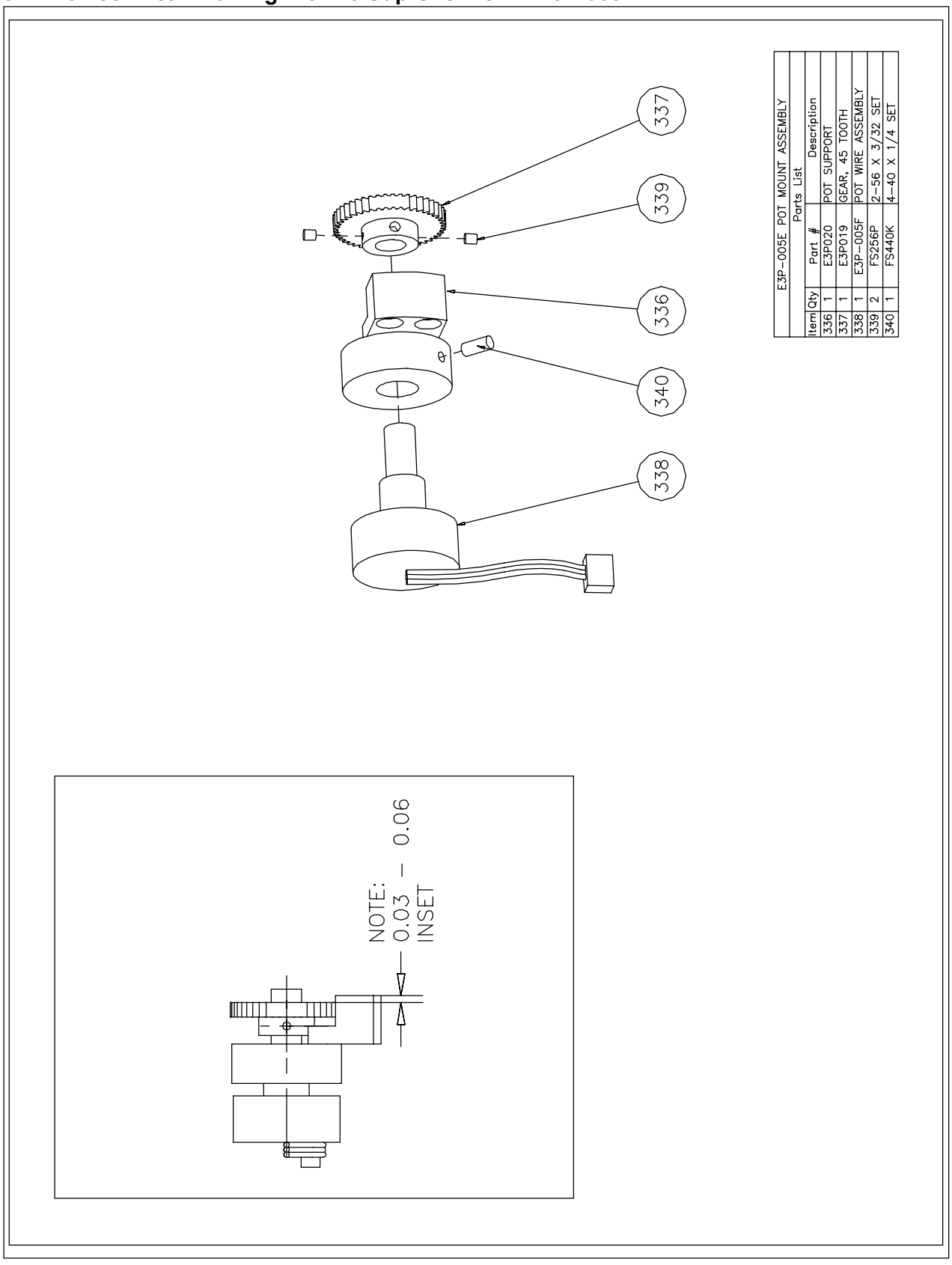


E3P-005G MOTOR/GEARBOX ASSEMBLY

Parts List

Item	Qty	Part #	Description
341	1	E3P-005H	PRO/SUP MOTOR PLT SA
342	1	E3P-005J	MOTOR SUBASSEMBLY
343	1	E3P-005M	GEARBOX ASSEMBLY
344	2	FSM2E	M2 X 4 FSMS
345	1	FS632Q	6-32 X 5/16 SET
346	1	RC033	BELT 27 X 5 X 0.8

5.12 E3 Technical Drawing: E3 Pro/Sup Overview # E3P-005E

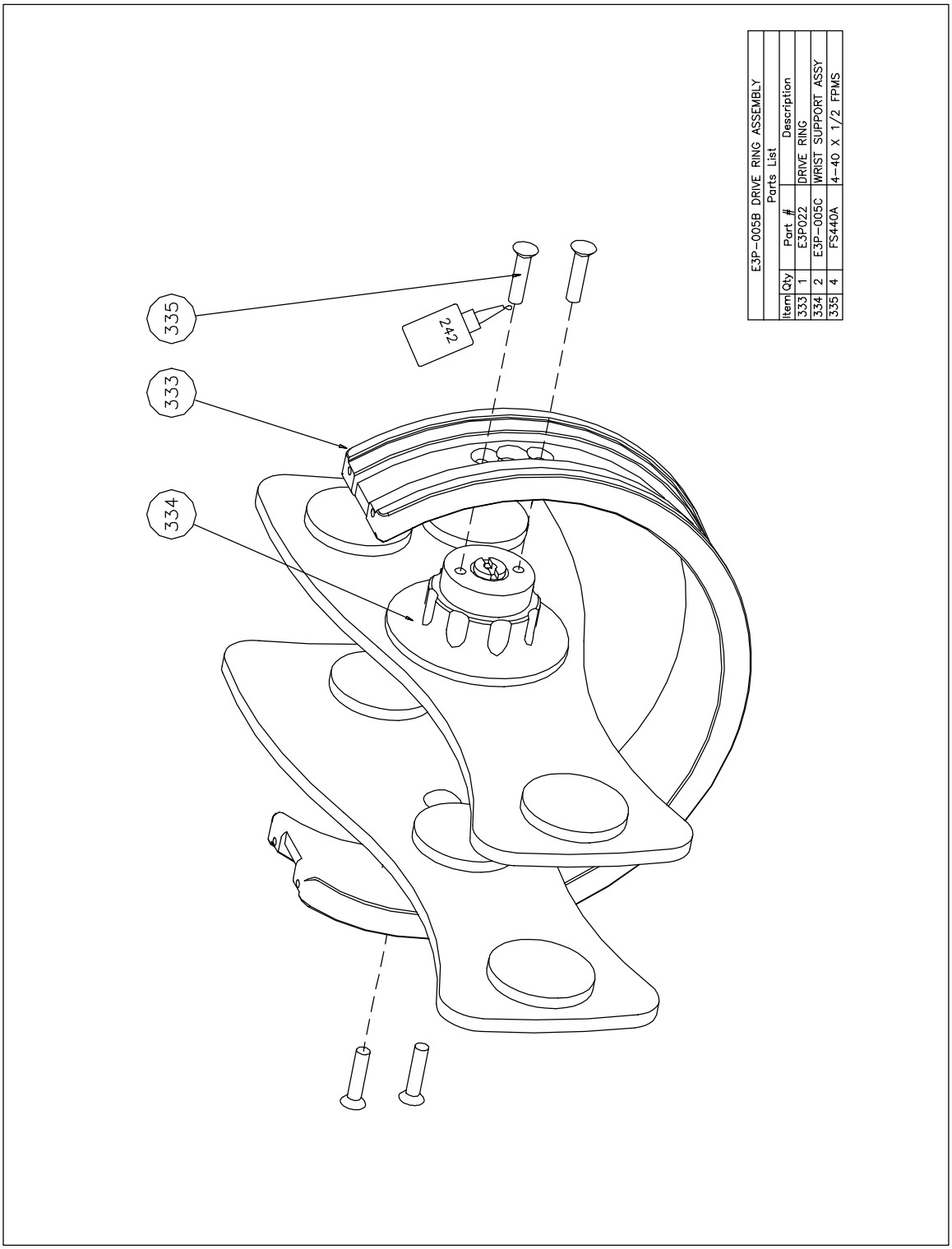


E3P-005E POT MOUNT ASSEMBLY

Parts List

Item	Qty	Part #	Description
336	1	E3P020	POT SUPPORT
337	1	E3P019	GEAR, 45 TOOTH
338	1	E3P-005F	POT WIRE ASSEMBLY
339	2	FS256P	2-56 X 3/32 SET
340	1	FS440K	4-40 X 1/4 SET

5.12 E3 Technical Drawing: E3 Pro/Sup Overview # E3P-005B



6.0 Cable Replacement

6.1 Removal of the Controller Cable

The Controller Cable connects the Motion Controller to the two actuators. The Controller Cable has plugs at both ends for easy replacement. Squeeze the Locking Tabs together and lift the connector from the device.

6.2 Removal of the Pro/Sup – Elbow Cable:

The Pro/Sup – Elbow Cable connects the Elbow Actuator to the Pro/Sup Actuator. It is a coiled Cable with a straight section in the centre.
Tools Required: #1 Phillips

See Drawing # E3P – 005
Lift one end of the Gasket (304) and remove screw (307)(FS 440B 5/8 FPMS) and the Cable Clamp (303).
Lift the Pro/Sup – Elbow Cable (305) from the Bottom Cover (302)

See Drawing # E3 – 005 K
Pull the Pro/Sup – Elbow cable through the Split Ring attached to the Glider Bar attached to the Valgus Locking Assembly (160).
Remove the two screws (167)(FS440AX 5/16 FPMS) securing the Cable Retaining Plate (162).
Remove the Cable (with strain relief) from the Drive Assembly Cover (161).

6.3 Assembly Notes:

Insert the end of the Cable without a strain relief through the Split Ring on the Glider Bar attached to the Valgus Locking Assembly (160).
Pull the Cable through until the straight section at the centre of the Cable reaches the Split Ring. Insert the end of the Cable (305) with the strain relief into the hole in the Drive Assembly Cover (161).
Place the cable between the two pins and install the two screws (167) and the Cable Retaining Plate (162).

Place the end of the cable without the strain relief into the Bottom Cover (302). Adjust the position until 5 to 5.5 inches, (13-14 cm) extend into the channel in the Bottom Cover. (302). Install screw (307), cable clamp (303) and gasket (304).
Assemble the two actuators.

7.0 Chair/Bed Mounting Assembly (E3-105)

7.1 Introduction

The Chair/Bed Mount is comprised of a Butt Plate with straps, a Mounting Post Assembly and the Mounting Angle Clamp Assembly
The Mounting Post Assembly can be flipped to the opposite side of the Butt Plate to change from Left to Right Hand Orientation of the CPM device.
Velcro secures the Base Plate Straps (605) to the Butt Plate (603).
The Mounting Post Assembly (601) is attached to the Butt Plate (603) by a 1/8 " elastic rope part number RC035.
Tools Required: #2 Phillips

7.2 Mounting Angle Clamp Assembly E3-105H

See Drawing # E3 –105
Remove the two screws (604)(FS632B 3/8 " FPMS) and lift the Mounting Angle Clamp Assembly (602) from the Inner Tube Assembly.

7.3 Tube Clamp Assembly E3-105D

See Drawing # E3-105B
Remove the screw (610) from the Post Clamp Assembly (608) and remove the White Delrin Post Clamp Assembly (608) with the Telescope Pad (609).

Reassembly: Make sure the telescope pad fits between the post clamp and the inner tube.

7.4 Base Tube Assembly E3-105F

See drawing # E3-105F.
Tools required: #3 Phillips screwdriver, #2 Phillips screwdriver, Pliers, Hammer, ¼" Rod minimum 2" long.

Unscrew the Plunger Handle (615) with the pliers. Remove the two screws (618)(FS632B 3/8 " FPMS).
Remove the Base Plate Bracket (612) and Tube Mount (613) from the Base Tube (611).
Compress the Spring (619) by lifting the Plunger (614). When the tip of the Plunger rises above the Base Plate Bracket (612), remove the Plunger and Spring from the Tube Mount.

7.5 Elastic Rope Replacement

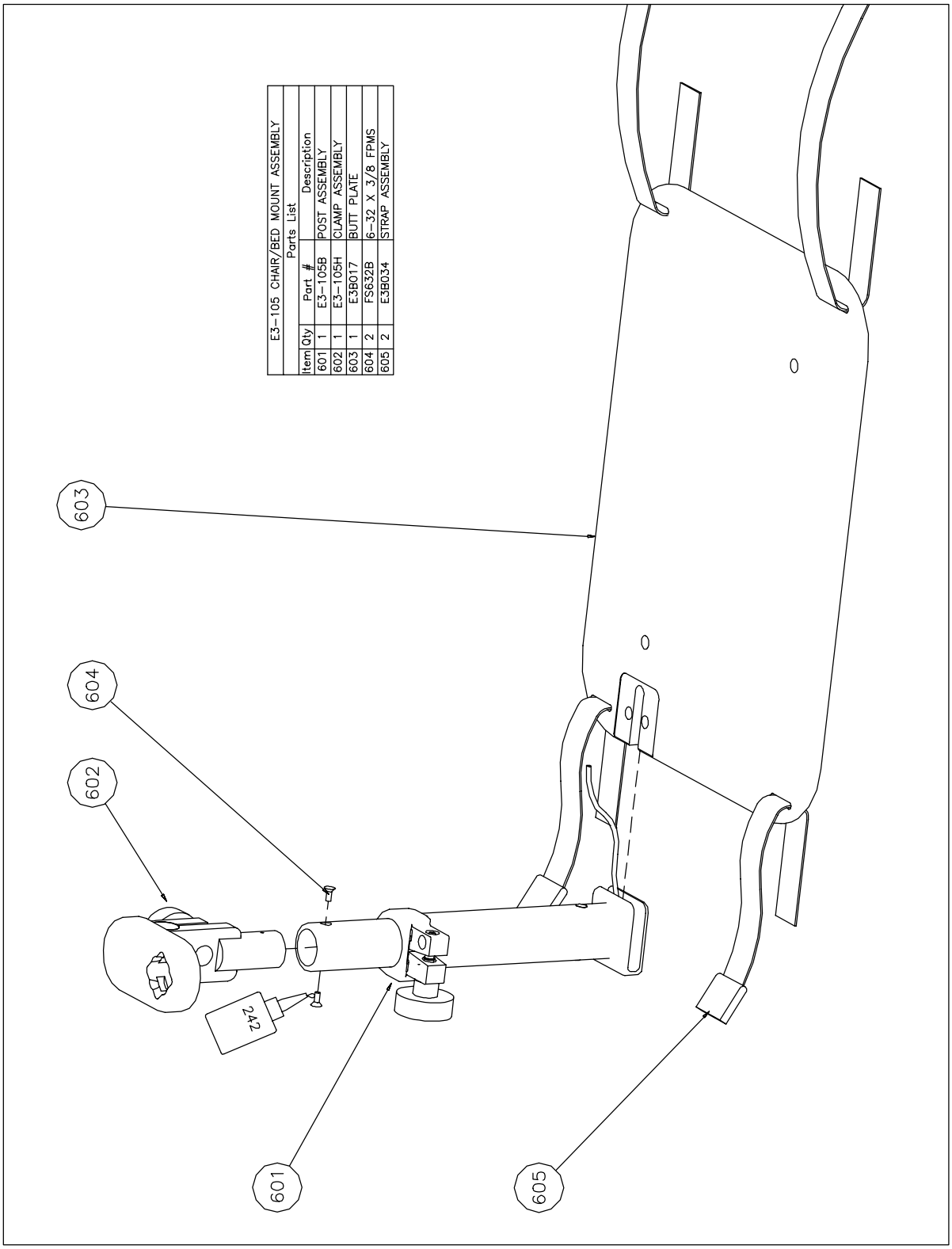
Remove the Screw (617)(FS1420B 1" FPMS) from the Base Plate Bracket.
Separate the Tube Mount (613) from the Base Plate Bracket (612) to remove and replace the Elastic Rope (620).
Method one:
Using the Hammer and the ¼" Rod, push the Spring Pin (616)(1/4 x 1"), with the Tube Mount attached, through the Base Plate Bracket (612).
Method two:
Use a screwdriver to remove the screw (616B) from the Base Plate Bracket (612) and release the Tube Mount (613).
Remove the Elastic Rope.

7.6 Assembly Notes:

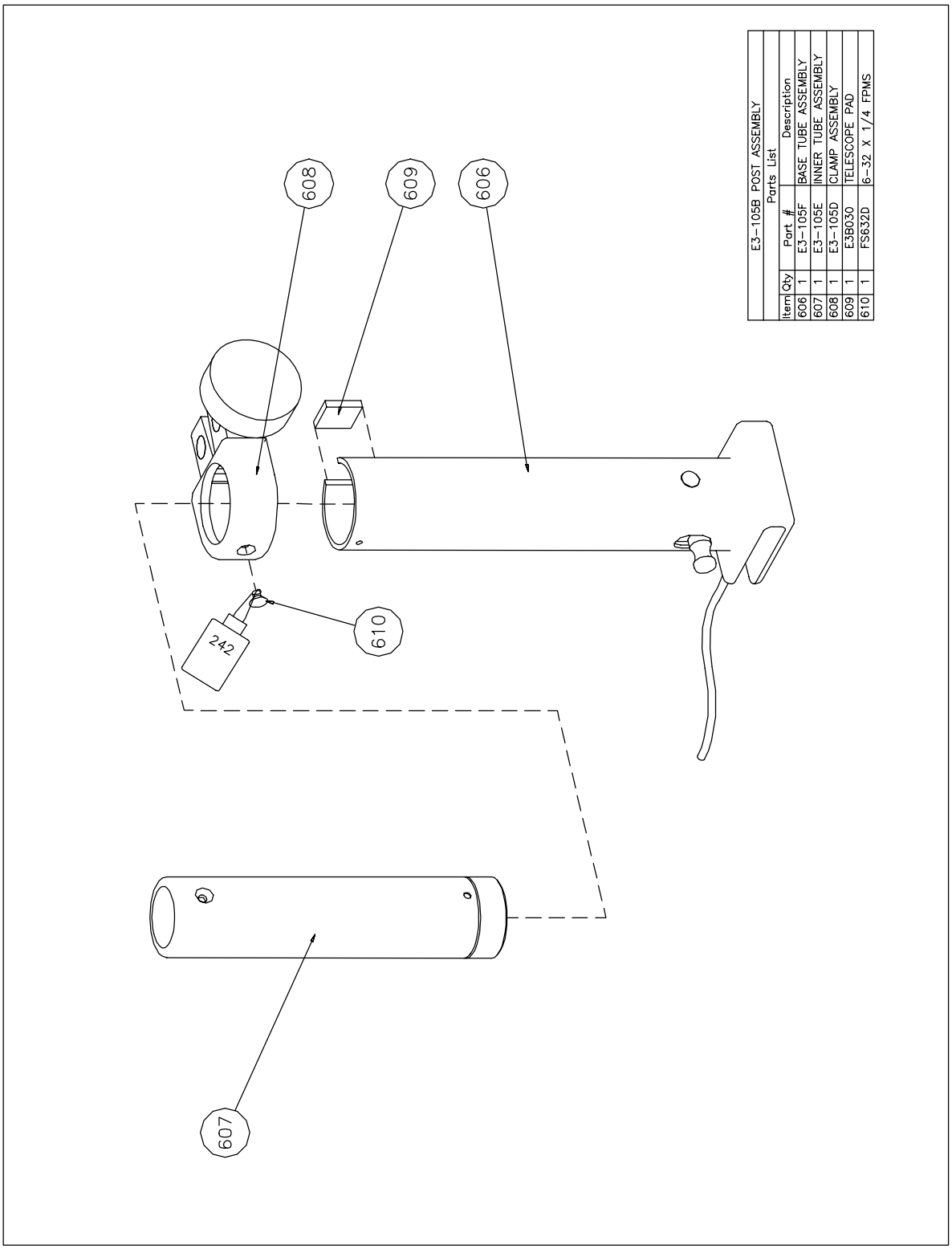
Tie a knot in the Elastic Rope and pull it through the Base Plate Bracket. Use Loctite 242 on the screw (617), the two screws (611) and the Plunger Handle (615).

Once the Mounting Post has been reassembled, feed the Elastic Rope through the slot and hole in the Butt Plate. Engage the Mounting Post with the Butt Plate and tie a knot in the end of the Elastic Rope.

7.7 E3 Technical Drawing: Mounting Plate # E3-105



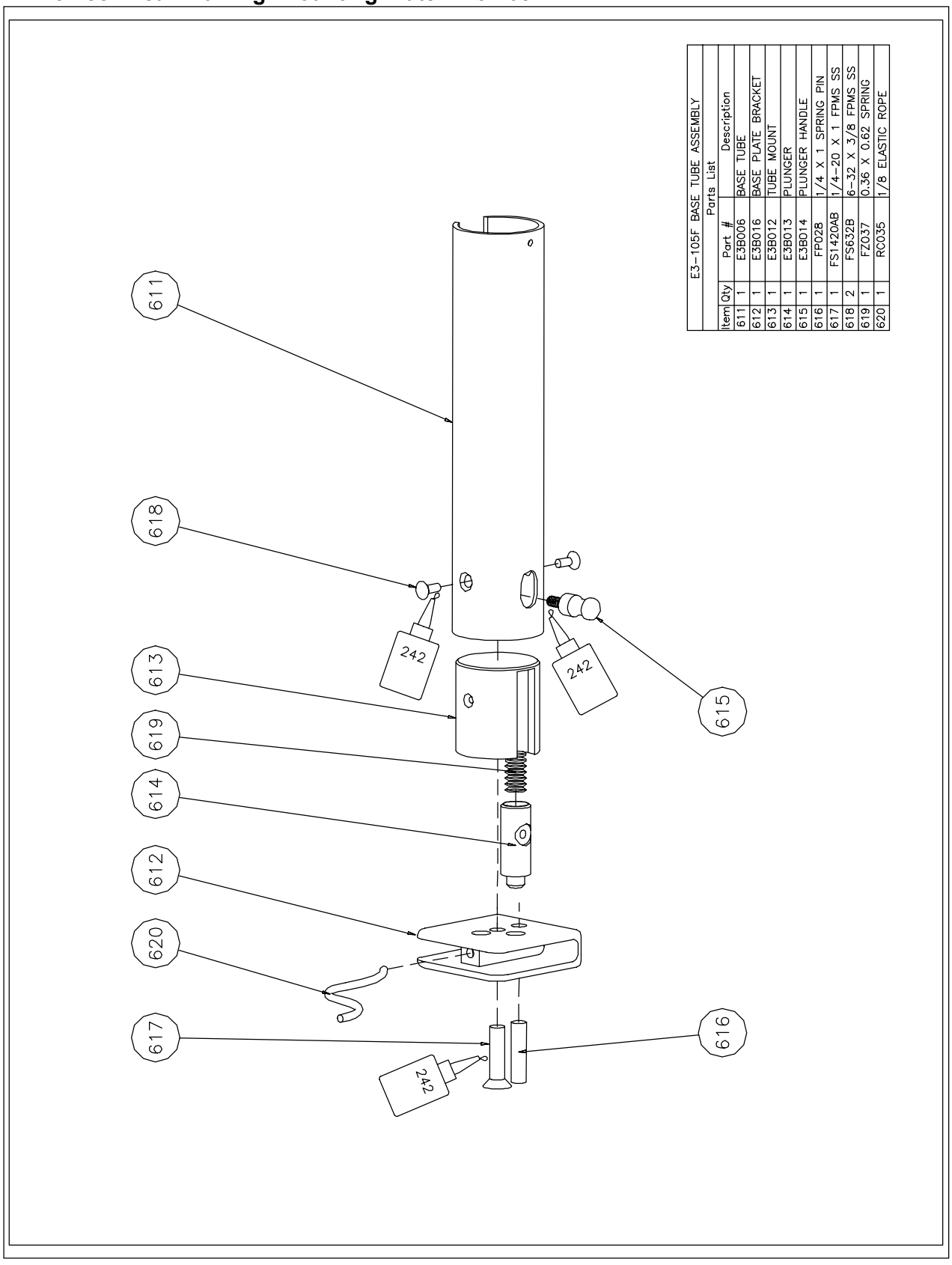
7.7 E3 Technical Drawing: Mounting Plate # E3-105B



E3-105B POST ASSEMBLY
Parts List

Item	Qty	Part #	Description
606	1	E3-105F	BASE TUBE ASSEMBLY
607	1	E3-105E	INNER TUBE ASSEMBLY
608	1	E3-105D	CLAMP ASSEMBLY
609	1	E3B030	TELESCOPE PAD
610	1	FS632D	6-32 X 1/4 FPMS

7.7 E3 Technical Drawing: Mounting Plate # E3-105F



E3-105F BASE TUBE ASSEMBLY

Parts List

Item	Qty	Part #	Description
611	1	E3B006	BASE TUBE
612	1	E3B016	BASE PLATE BRACKET
613	1	E3B012	TUBE MOUNT
614	1	E3B013	PLUNGER
615	1	E3B014	PLUNGER HANDLE
616	1	FP02B	1/4 X 1 SPRING PIN
617	1	FS1420AB	1/4-20 X 1 FPMS SS
618	2	FS632B	6-32 X 3/8 FPMS SS
619	1	FZ037	0.36 X 0.62 SPRING
620	1	RC035	1/8 ELASTIC ROPE

8.0 Soft Goods

Applying soft good kit:

The soft goods are applied with the white side against the patient's skin. The material is will breathe, wick perspiration away, and keep the patient's arm from sliding during treatment.

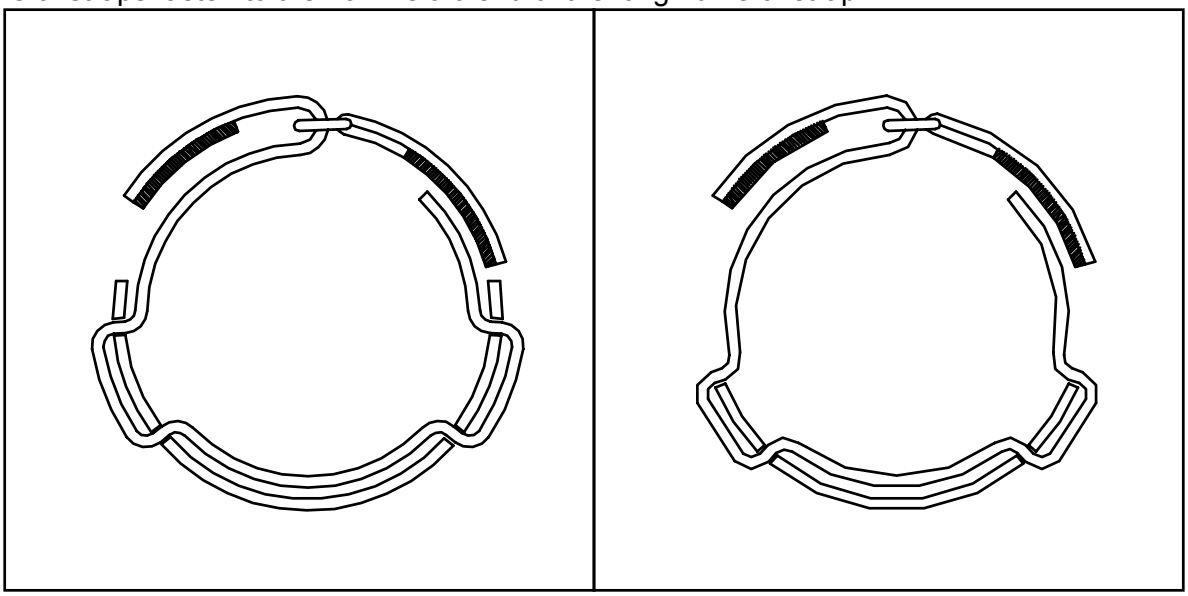
8.1 Wrist Inserts (Optional)

If your patient has narrow wrists, the wrist clamp plates may not close enough to secure their wrist and you may need to use the optional wrist inserts. To apply the wrist inserts, simply match the hook and loop fastener on the wrist clamp plates and press them into position. The E3 is shipped from the factory with the wrist inserts in the case, not attached to the wrist clamp plates.

Wrist Pad
Place the pockets of the wrist pad over the wrist clamp plates, white side up. Wrap the pad's straps around the wrist clamp plates. Thread the pad's straps through the rings of the wrist straps so that the wrist straps close around the wrist lamp plates and the pad's straps close back on themselves.

8.2 Humeral Straps

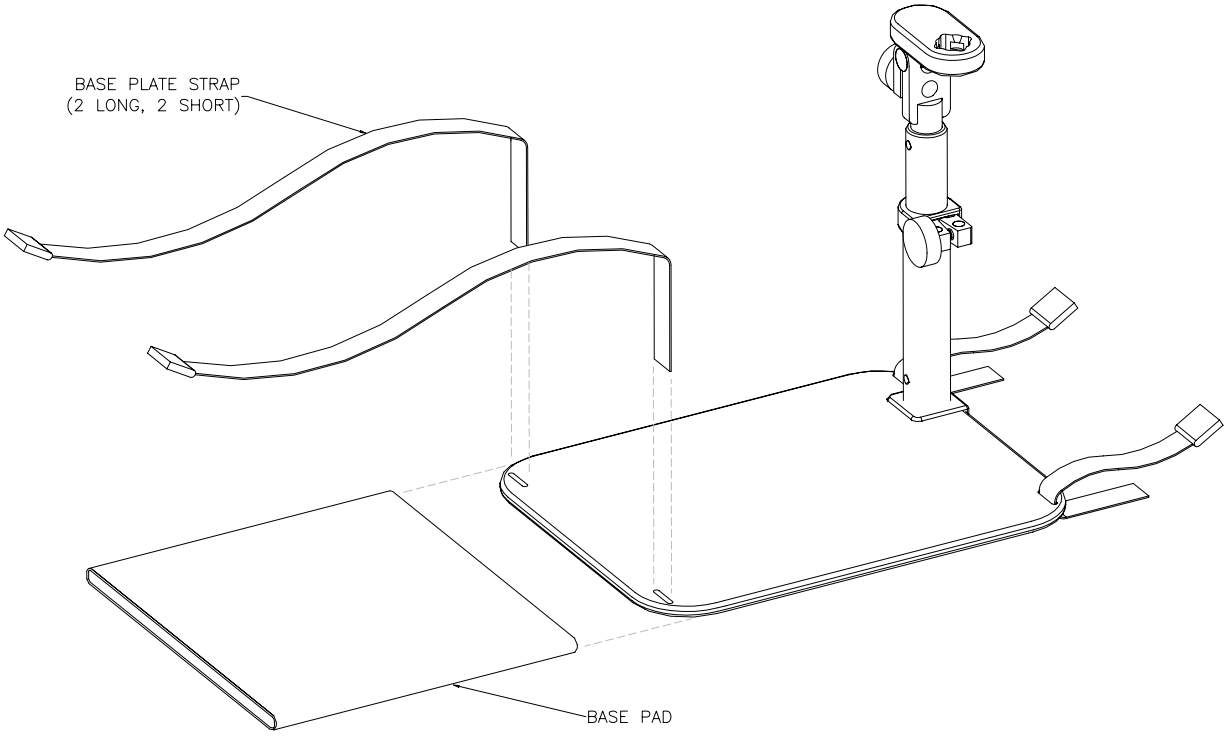
Thread the straps through the cuffs, as shown below. Pass the Velcro ends of the long humeral straps through the rings of the short humeral straps so that the long straps close on themselves. The short humeral straps fasten to the non-Velcro end of the long humeral strap.



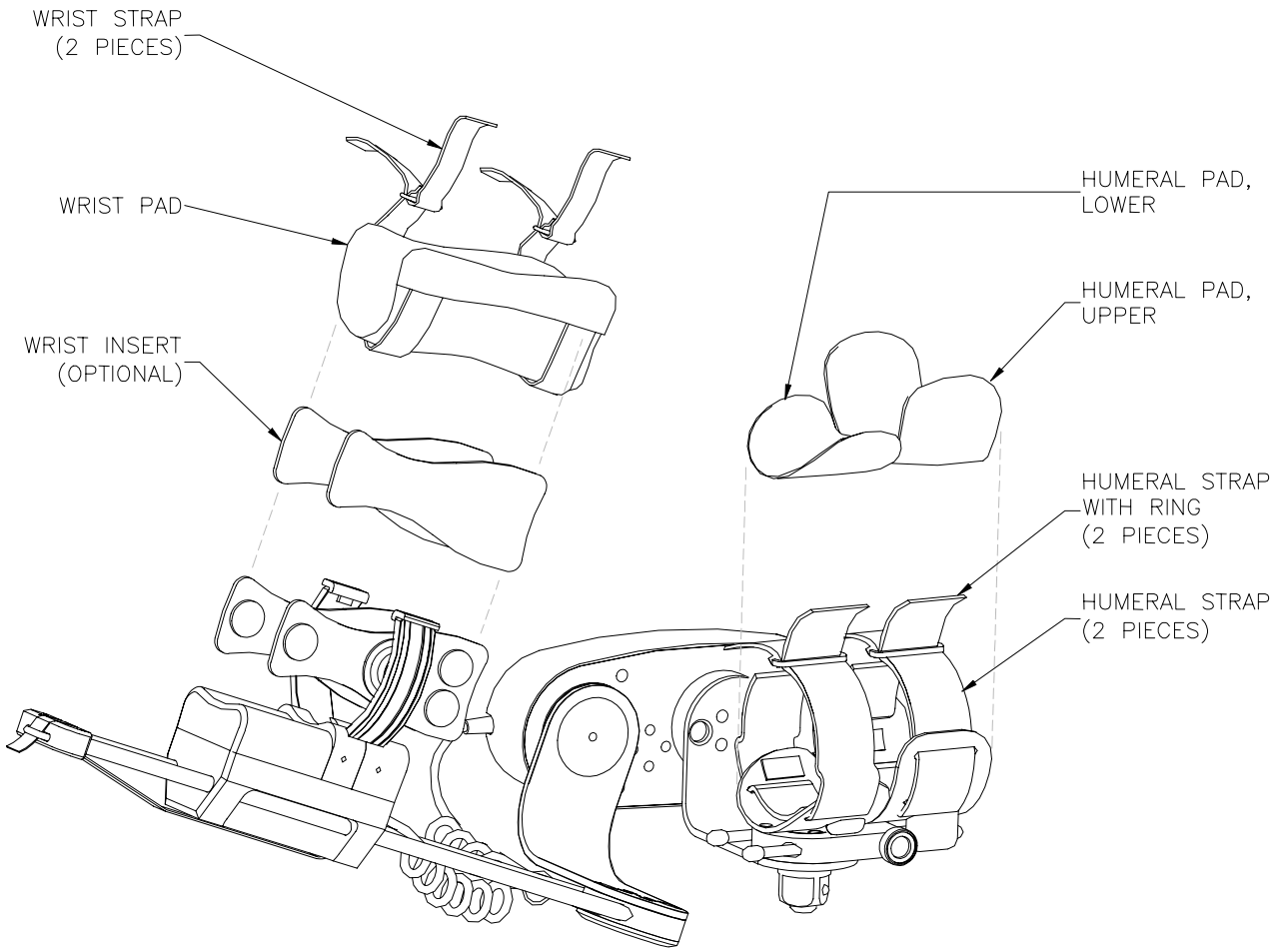
UPPER HUMERAL CUFF LOWER HUMERAL CUFF

Humeral Pads
Attach the upper and lower humeral pads to the upper and lower humeral cuffs by aligning them and pressing them into position.

8.3 Technical Drawing: Base Plate



8.4 Technical Drawing: Soft Goods



9.0 Packaging

To put the E3 into the packaging position the controller must be switched off.
Press and hold the Speed and Force keys while switching on the controller.
The display will ask “Packaging Position?” Choose “Y” for Yes or “N” for No.
If “Y” is selected then the controller will drive elbow actuator to 90^{O} and the pro/sup actuator to 0^{O} then the display the “New Patient?” screen.
If “N” is selected then the controller will return to the run mode and wait for the Start/Stop key to be pressed.

Appendix A

E3 Elbow CPM Troubleshooting Table

Error	Fault/Problem Description	Possible Conditions	Solutions
E0	low voltage	battery discharged	plug into power supply
E01	out of range	drive arm incorrectly assembled	remove and reassemble drive arm
E02	elbow potentiometer	pot not changing	check elbow pot wires and connections
		no motor power	check elbow motor connections
		faulty elbow actuator PCB	replace elbow actuator PCB E3-005J
	(elbow drive slows down)	dirty optical sensor	dust sensor with clean canned air; retest
		faulty optical sensor	check connections; replace E3A-005F if necessary
E03	wrist potentiometer	pot not changing	check pro/sup pot wires and connections
		pro/sup drive stalled	loosen pro/sup drive cover screws FS832AM 1/4 turn and retest
	(pro/sup drive slows down)	dirty optical sensor	dust sensor with clean canned air; retest
		faulty optical sensor	check connections; replace E3P-005H if necessary
E04	actuator switch	faulty elbow actuator PCB	replace elbow actuator PCB E3-005J
E05	start/stop key	keeping start/stop key pressed	turn power off and on
		faulty controller key pad	replace controller key pad
E06	charger	faulty controller PCB	replace controller board GCM-104A
E07	checksum	faulty EPROM	open controller and replace EPROM
E08	false data in eeprom	faulty controller PCB	replace controller board GCM-104A
E11	elbow no encoder	dirty optical sensor	dust sensor with clean canned air; retest
		faulty optical sensor	check connections; replace E3A-005F if necessary
		drive belt slipping/off/broken	check drive belt RC040
E12	elbow reversed motor	motor wires reversed	check elbow motor connections
		elbow pot black/red wires reversed	check elbow pot wiring
E13	elbow angle position	pot out of range, disconnected, or damaged	check elbow pot wires and connections
E14	elbow encoder out of range	break in drive train between pulley and drive arm	check gearbox pinion and pulley pinion
E15	elbow load cell 1	overloading pro/sup	remove excess load from drive ring; restart
		faulty load cell or load cell deformed	*replace load cell assembly E3P-005I; recalibrate
E16	elbow load cell 2	overloading pro/sup or load cell not calibrated	remove excess load from drive ring; restart
		faulty load cell or load cell deformed	*replace load cell assembly E3P-005I; recalibrate
E21	wrist no encoder	dirty optical sensor	dust sensor with clean canned air; retest
		faulty optical sensor	check connections; replace E3P-005H if necessary
		drive belt slipping/off/broken	check drive belt RC033
E22	wrist reversed motor	motor wires reversed	check pro/sup motor connections
		drive belt skips backwards	tighten belt tensioning set screws FS832AE 1/4 turn each and retest
E23	wrist angle position	pot out of range, disconnected, or damaged	check pro/sup pot wires and connections
		pro/sup cable disconnected	ensure cable E3-106 is connected

		pro/sup cable faulty	replace cable E3-106
E24	wrist encoder out of range	break in drive train between pulley and drive ring	check gearbox pinion and pulley pinion
E25	wrist load cell 1	overloading pro/sup	remove excess load from drive ring; restart
		faulty load cell	*replace load cell assembly E3P-005I; recalibrate
E26	wrist load cell 2	overloading pro/sup	remove excess load from drive ring; restart
		faulty load cell	*replace load cell assembly E3P-005I; recalibrate
E31	communication, elbow	communication cable disconnected	ensure E3-104 cable connection
		communication cable faulty	replace cable E3-104
		no PIC	ensure elbow PIC properly installed
		unplugging power cord while "on"	turn power off and on
E32	communication, wrist	communication cable disconnected	ensure E3-104 cable connection
		communication cable faulty	replace cable E3-104
		no PIC	check wrist PIC properly installed
		unplugging power cord while "on"	turn power off and on
E33	communication, elbow and wrist	communication cable disconnected	ensure E3-104 cable connection
		communication cable faulty	replace cable E3-104
		no PICs	check elbow and wrist PICs properly installed
		unplugging power cord while "on"	turn power off and on
E34	EE checksum error	electronics not initialized	turn power off and on
E40	orientation switch	rotating humeral support while "on"	turn power off and on
		faulty switch or connections	check switch and connections
E41	external RAM	faulty controller PCB	replace controller board GCM-104A
E42	RTC locked	no voltage	plug into power supply
NA	controller display blank on power up and both LEDs off	no power from AC adaptor and battery too low	plug into power supply
		fuse(s) burnt (overloading or jamming the motor can blow the fuse)	replace controller board GCM-104A; *replace fuse(s)
		fuse(s) burnt due to filter board fault	replace filter board
NA	controller display blank on power up, backlight and yellow "SET" LED are blinking	one of the controller ICs is not inserted, inserted incorrectly, or faulty	check controller ICs; change controller board assy GCM-104A
NA	controller display blank on power up, only green LED on	Regulator board not plugged into controller board or faulty	open controller and reconnect the regulator board
NA	unit cannot run from battery; green LED is always lit (never blinks) and unit is "ON" (recheck after 10min if LED is still lit)	faulty or disconnected battery	check battery connections; replace battery if necessary

NA	battery icon displayed and green LED always OFF when AC adaptor pluged in	power supply disconnected, power supply or power cable faulty, fuse(s) burnt	check power cable, power supply, replace controller board GCM-104A; *replace fuse(s)

*repair must be performed at an authorized service centre

Appendix B

Glossary of Terminology and Abbreviations

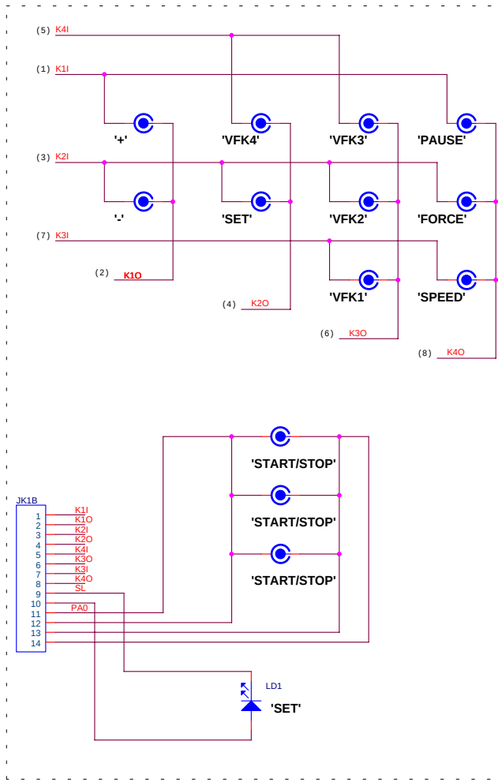
Abbreviations	Terminology
"-"	To decrease
"+"	To increase
Bat.	Battery
CAL	Calibrate
CPM	Continuous Passive Motion
EFOR	Elbow actuator force
EMC	Elbow motor current
EPOT	Elbow potentiometer
Ext.	Extension, to extend or straighten out
Flex.	Flexion, to bend
Force	The a mount of pressure applied to the limb
LC 1 to 3	Load cell 1 through 3
Pause	To stop for a set amount of time
Pro.	Pronation, to rotate inward
PSR	Progressive Stretch and Relaxation
ROL	Reverse on load
ROM	Range of motion, length of travel
Spd.	Speed, measured in number of degrees per minute traveled
Sup.	Supination, to rotate outward
VACT	The voltage of the elbow actuator circuit board
VBAT	Battery voltage

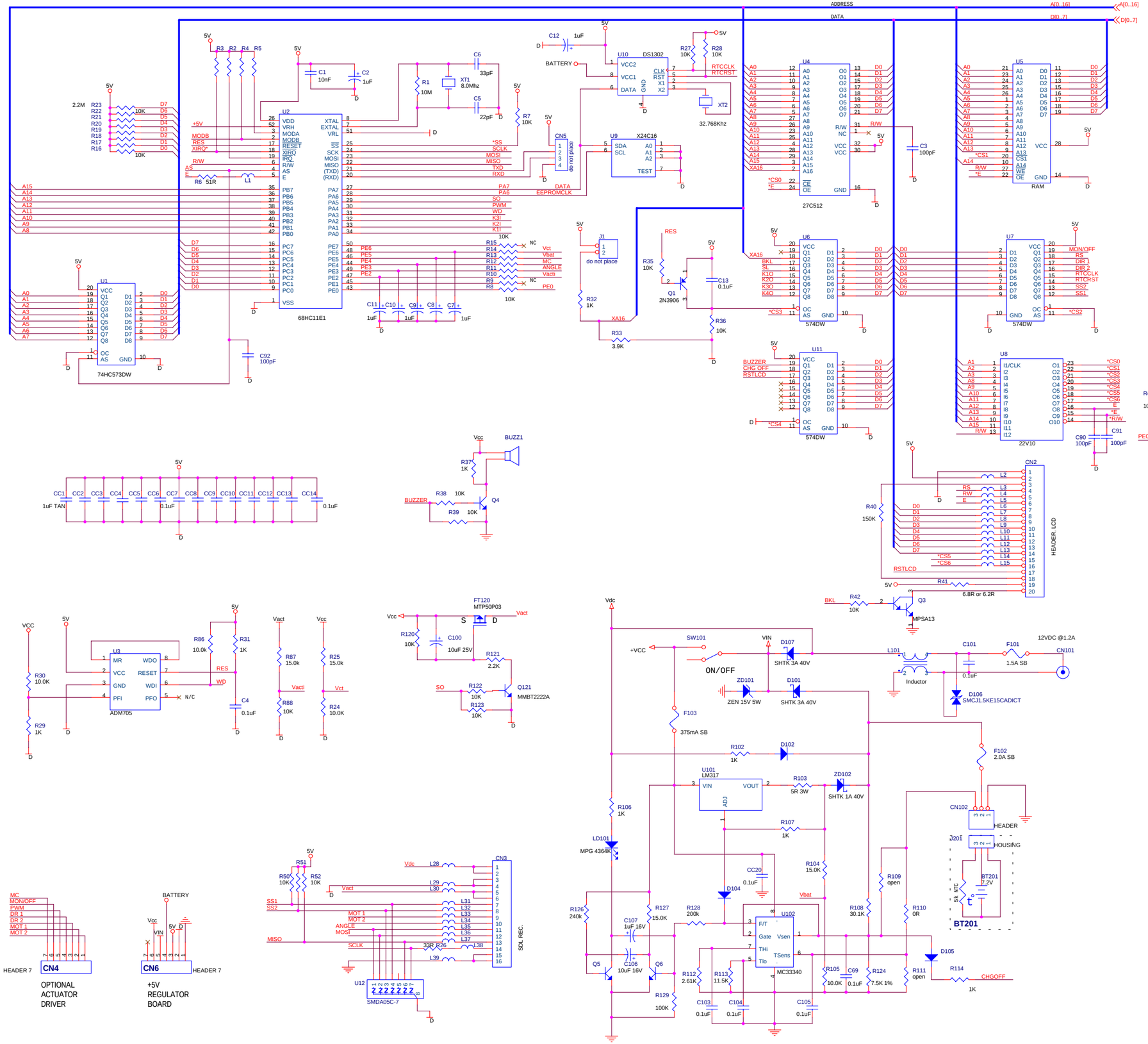
Appendix C

E3 Electronic Schematics

ADDRESS
DATA
A[0..16]
D[0..7]

Keypad





REV:	DESCRIPTION:	DATE:	CHG BY:	APPROVED:
A3	R23 corrected to 2.2M, new table	14NOV02	G. D.	
A2	R41 added option of using 6.8R or 6.2R	09OCT02	G. D.	
A1	Vdc (D7[A], L28 changed from Vin to Vdc, R23 changed to 2.2M, Add R26.	23JUL02	G. D.	

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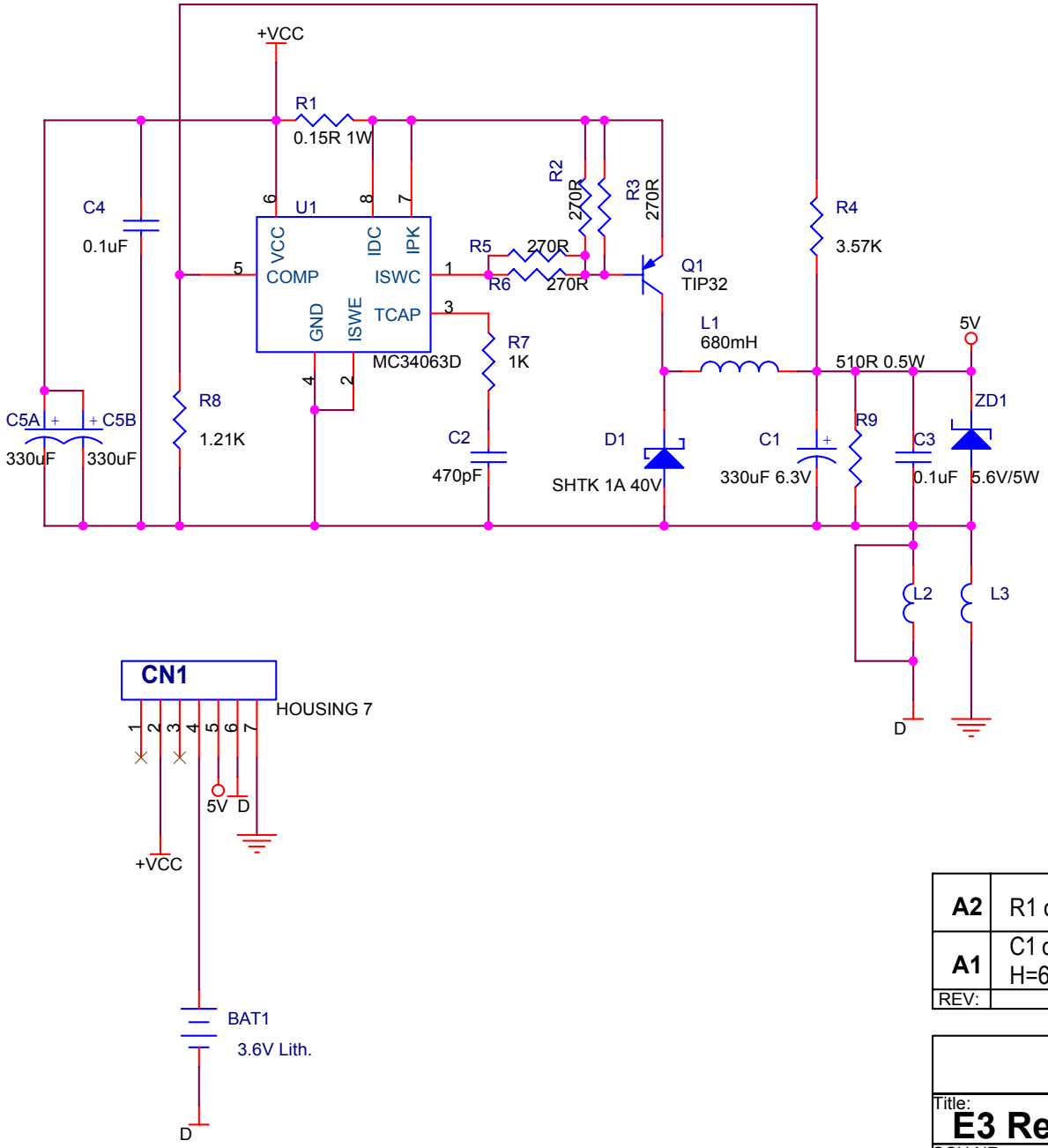
Title: **E3 Hand Controller**

SCH NR: 980001		File: 980001A3.PDF	
Drawn: G.Debkowski	Date: 10SEP02	SIZE: Custom	REV: A3
Checked: G.Debkowski	Date: 11NOV02	SCALE: N/A	SHEET: 1 OF 1

SOURCE FILE: OrCad, 980001xx.DSN



Source file OrCad,
980002xx.DSN

REV:	DESCRIPTION:	DATE:	CHG BY:	APPROVED:
A2	R1 changed to 1W, change table	11NOV02	G. D.	
A1	C1 changed to 330uF 6.3V H=6.2mm Low Impedance	20AUG02	G. D.	

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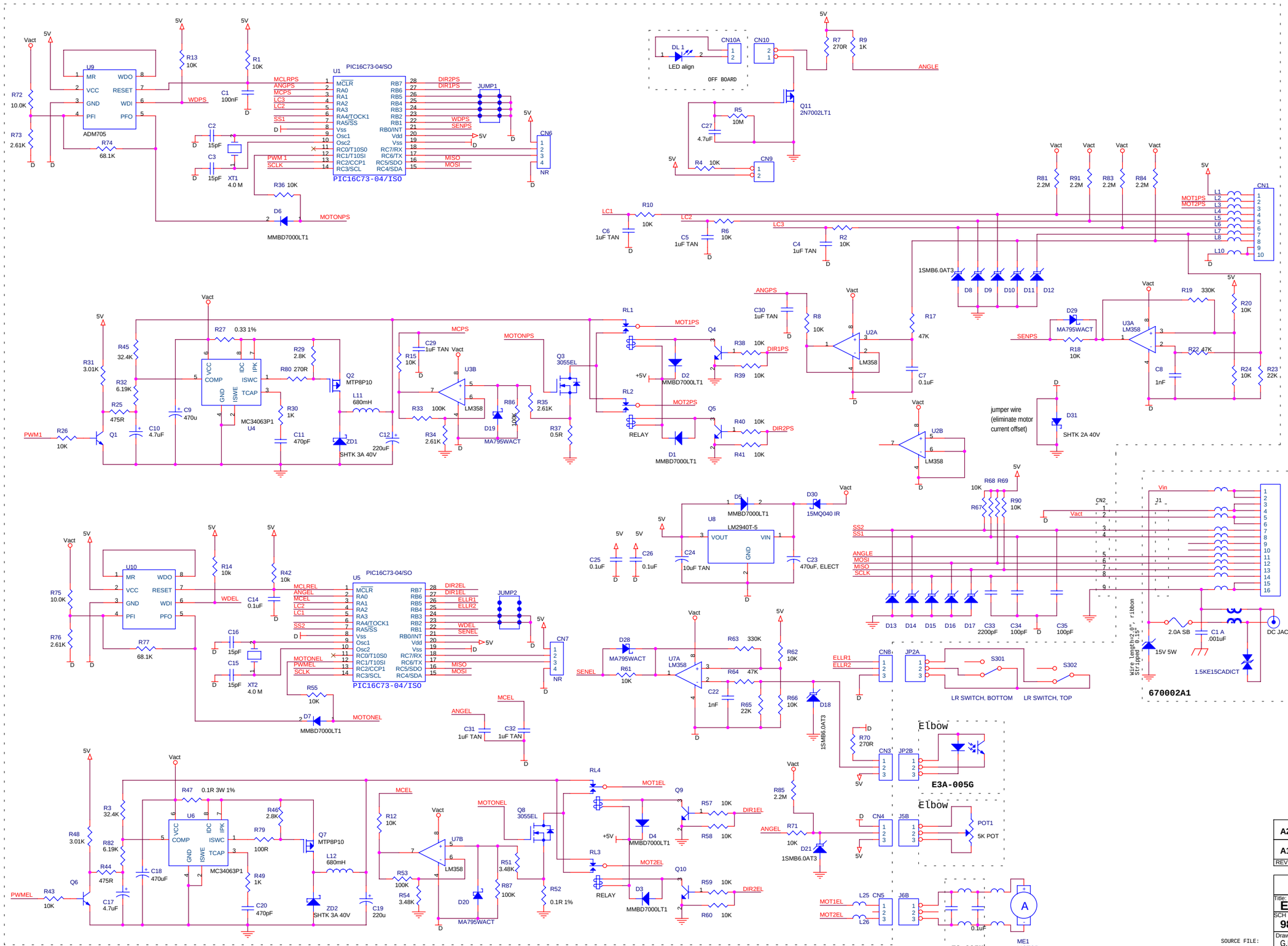
Title: **E3 Regulator Board**

SCH NR: **980002**		File: **980002A2.PDF**	
Drawn: **G.Debkowski**	Date: **06AUG02**	SIZE: **A**	REV: **A2**
Checked: **G.Debkowski**	Date: **11NOV02**	SCALE: **N/A**	SHEET: **1** OF **1**



REV:	DESCRIPTION:	DATE:	CHG BY:	APPROVED:
A2	Table changed	11NOV02	G. D.	
A1	production release, R19,63 changed to 330k, C33 to 2200pF	21AUG02	G. D.	

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Title: **E3 Main Actuator Board**

SCH NR: **980003**		File: 980003A2.PDF	
Drawn: G.Debkowski	Date: 10AUG02	SIZE: **Custom**	REV: **A2**
Checked: G.Debkowski	Date: 11NOV02	SCALE: **N/A**	SHEET: **1** OF **1**

SOURCE FILE:
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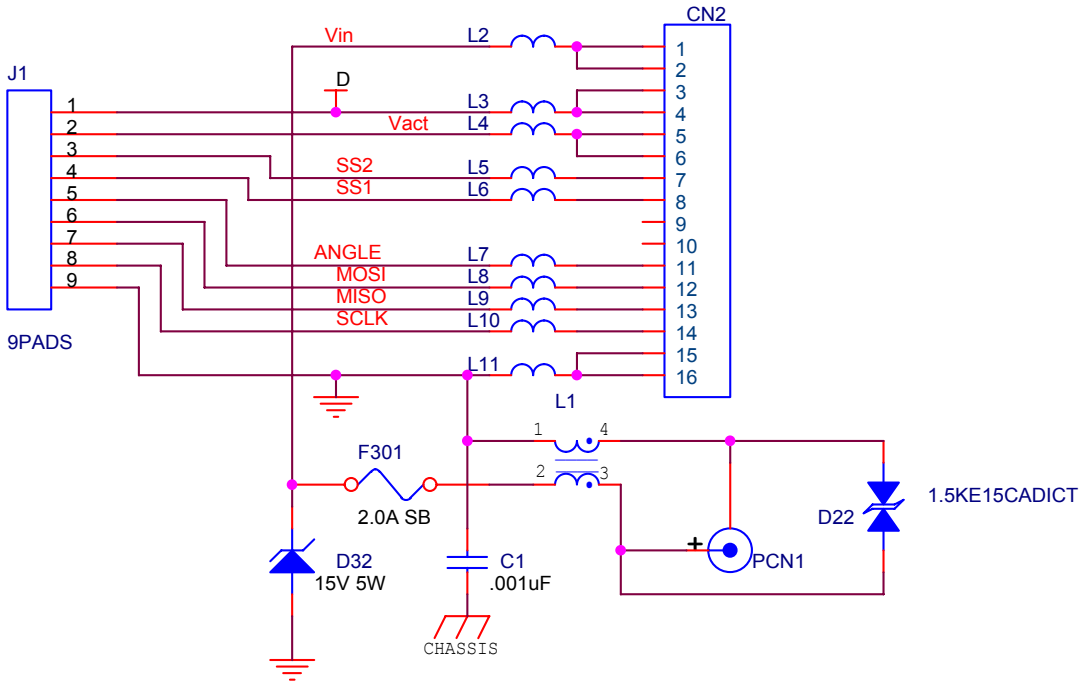
980003xx.DSN



REV:	DESCRIPTION:	DATE:	CHG BY:	APPROVED:
A2	Table changed	11NOV02	G. D.	
A1	Initial Release, L10 to 2.7k@100MHz	20AUG02	G. D.	

OrthoMotion Inc.
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Title: **E3 Connector Board**

SCH NR: **980004**		File: **980004A2.PDF**	
Drawn: **G.Debkowski**	Date: **06AUG02**	SIZE: **A**	REV: **A2**
Checked: **G.Debkowski**	Date: **11NOV02**	SCALE: **N/A**	SHEET: **1** OF **1**

Source File:
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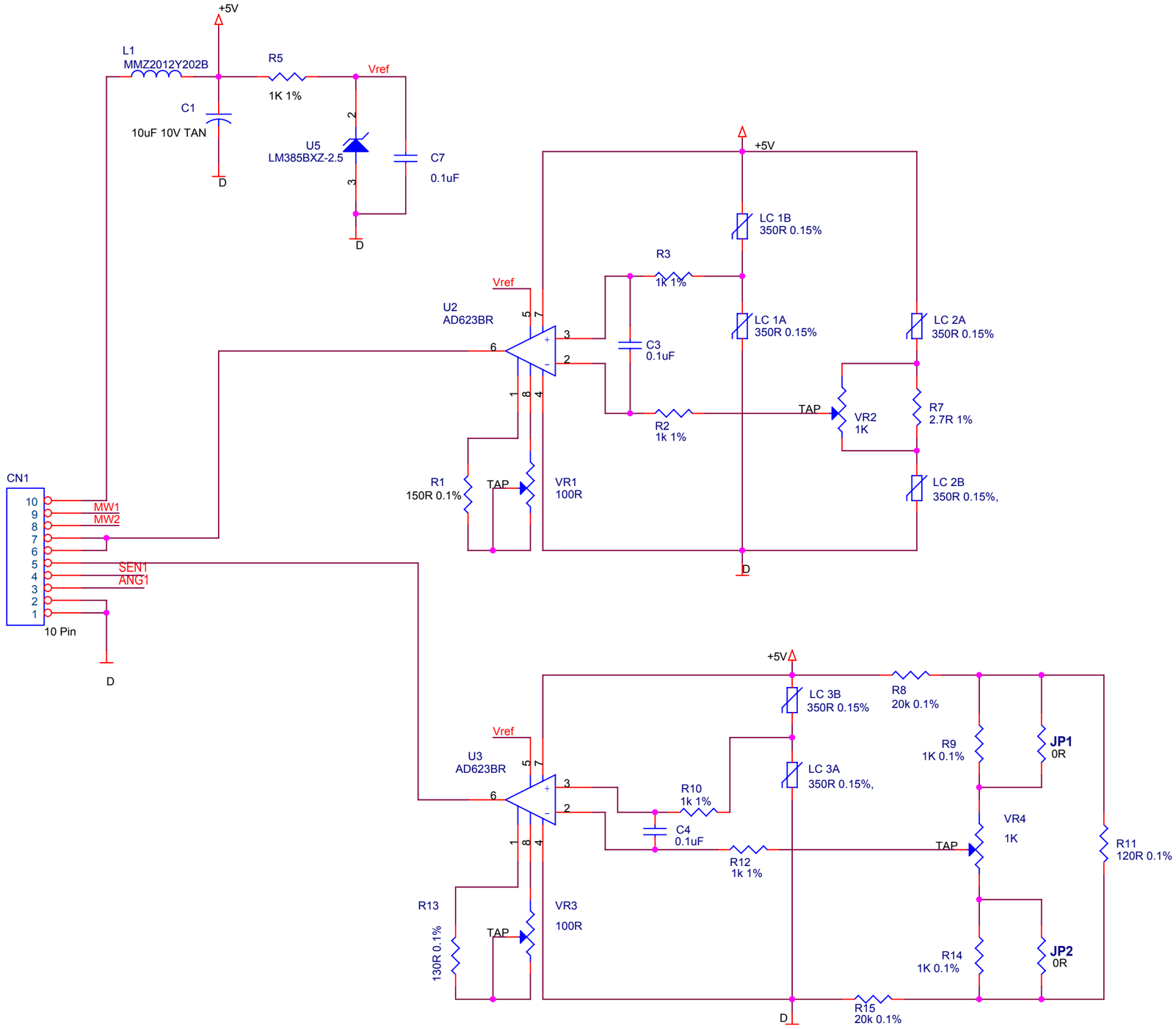

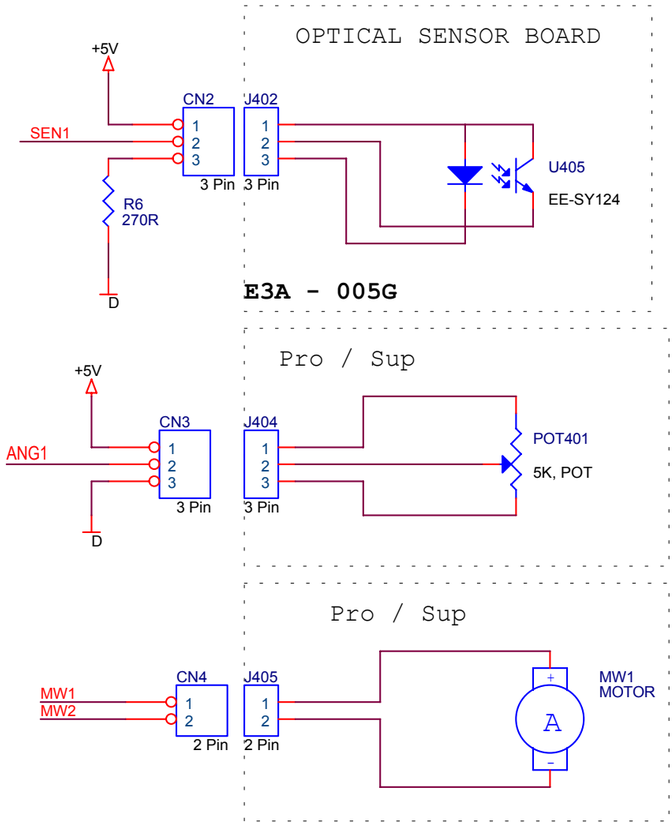

REV:	DESCRIPTION:	DATE:	CHG BY:	APPROVED:
B2	Table changed	14NOV02	G. D.	
B1	R1 (150R 0.1%), R13 (130R 0.1%)	02OCT02	G. D.	
A2	R1 (240R 0.1%), R13 (220R 0.1%), R7 (2.7R 1%)	02AUG02	G. D.	
A1	Op-Amp module removed	02JUL02	G. D.	

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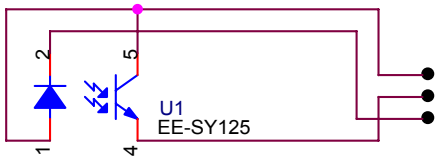
Title: **E3 ProSup Board**

SCH NR: **980005**		File: **980005B2.PDF**	
Drawn: **G.Debkowski**	Date: **06AUG02**	SIZE: **B**	REV: **B2**
Checked: **G.Debkowski**	Date: **11NOV02**	SCALE: **N/A**	SHEET: **1** OF **1**

SOURCE FILE: OrCad, 980005A2.DSN



NOTE:
E3PCB01 is used in the following assemblies:
E3A - 005G
E3P - 005N

REV:	DESCRIPTION:	DATE:	CHG BY:	APPROVED:
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A1	Initial Release	20AUG02	G. D.	

OrthoMotion Inc.
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Title: **E3 Optical Sensor**

SCH NR: **980006**		File: **980006A2.PDF**	
Drawn: **G.Debkowski**	Date: **06AUG02**	SIZE: **A**	REV: **A2**
Checked: **G.Debkowski**	Date: **11NOV02**	SCALE: **N/A**	SHEET: **1** OF **1**

SOURCE FILE:
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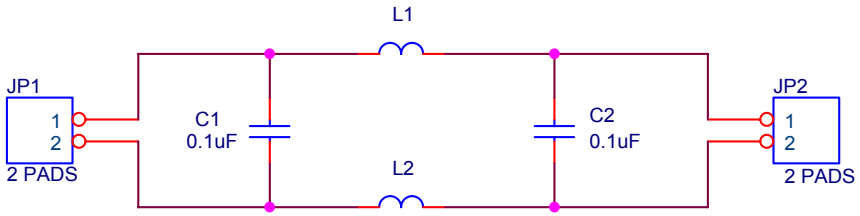

REV:	DESCRIPTION:	DATE:	CHG BY:	APPROVED:
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A1	Initial Release	21AUG02	G. D.	

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Title: **E3 Motor Filter Board**

SCH NR: **980007**		File: **980007A2.PDF**	
Drawn: **G.Debkowski**	Date: **06AUG02**	SIZE: **A**	REV: **A2**
Checked: **G.Debkowski**	Date: **14NOV02**	SCALE: **N/A**	SHEET: **1** OF **1**

SOURCE FILE:
OrCad, 980007xx.DSN

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1-800-225-1814

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Ontario, L1W 2Y5 Canada
1-905-420-3303 Fax 1-905-420-3970

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901 Dillingham Road, Pickering, Ontario L1W 2Y5 Canada
Intl. Tel: 1-905-420-3303 Fax: 1-905-420-3970

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