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## 1. THE ROBOT

### 1.1 Introduction

The Robot section of the 2000 FIRST Robotics Competition Manual provides information about the parts provided in the Kit of Parts at the Kickoff Workshop, information on additional parts that can be used to build the robot, covers power distribution on the robot, gives some wiring examples, and lists the rules covering robot construction. **Please note that documentation for the robot control system is now provided by the manufacturer, Innovation First, and can be found on their web site at [www.innovationfirst.com](http://www.innovationfirst.com).**

### 1.2 Before You Start Building A Robot

Before embarking on the robot design process, it is important to understand that there are certain constraints on the robots which must be observed in order to compete. The reasons for the constraints are many and varied and include making sure that FIRST Robotics Competition events are safe, that all teams have access to the same materials, and that certain good design practices are followed in order to improve reliability and make problem solving and repair easier.

The complete and detailed list of rules governing robot design and construction is included in Appendix A. Below are some important concepts from these rules:

- The materials that may be used to build the robot are limited. There are three sources of materials that may be used; the parts found in the Kit of Parts, parts from Small Parts, Inc., and parts listed in the Additional Hardware List. **Materials which are not from these sources may not be used.** The amount of materials from these sources may be limited by cost or quantity of material. See Appendix B for an inventory list of the Kit of Parts, and Appendix C for the Additional Hardware List. Appendix D contains ordering information for Small Parts, Inc.
- The size of the robot when it starts a match is limited. Once a match starts, the robot may expand.
- The weight of the robot is limited.
- Certain uses of allowed materials are disallowed, primarily for safety reasons.
- All robots must pass inspection before being allowed to compete at each event.
- Once a robot starts competing at an event, certain types of changes to the robot may not be made until after the event is over.

It is very important to become familiar with the rules in Appendix A and read through the allowed materials lists in the following appendices. You should keep in mind the rules of gameplay, listed in the Game section of the manual, and the shipping deadlines listed in the Administrative Details section. By taking the time to read through the rules carefully, you will save time in the long run. Major blocks of time can be wasted rebuilding due to the lack of knowledge about a certain rule at the onset of the design process.

Plan your overall schedule to include simulated competition test runs and give your robot operators as much practice as possible. If you have not built some sort of prototype (motors and wheels mounted on a board running around the floor, pick up mechanisms, etc.) by the end of the 3rd week, you are way behind schedule. If in doubt, consult this manual and the team updates. If these do not answer the questions, call FIRST. It is far better to find out 2

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weeks or even 2 days before you ship your robot that something you wanted to do is against the rules than to find out at the event and have to scramble to re-engineer your robot.

As you progress in the design and build stage, be sure to carefully read all team updates which will be periodically issued on the FIRST web site. In addition to rules updates, corrections, and other important information, team updates contain answers to all questions asked by other teams, which helps to insure that all teams have the same understanding of the rules.

## 1.3. Robot Construction Tips

### 1.3.1 Drill Motors & Drive Assemblies

The drill motors and drive assemblies snap together for convenient handling during assembly of a drill; this motor-drive assembly sub-assembly cannot support normal (side) loads by itself. The gearshift lever on the drive assembly and the gears actuated by it cannot withstand large gear-shifting forces, especially while operating. FIRST recommends using the plastic drill shell to support the motor, drive assembly and shift mechanism, and providing ample speed reduction between the drill and its load.

The drill components were designed for drilling holes and driving screws, not for propelling a heavy robot. Please remember this when designing and operating your robot. Align mechanical power transmission components accurately. If you couple the spindle to another shaft, support the shaft with two bearings and use a suitable flexible coupling. If you mount a gear, pulley, or sprocket to the drive assembly spindle, use the largest pitch diameter possible to minimize side loads resulting from transmitting torque. Note the tradeoff between side loads and available gear ratio. A small pulley on the spindle allows a good gear ratio, but results in excessive side loads. Seriously consider the possible need for two stages of speed reduction between the drill and its load. If the drill shows signs of overloading, such as clutch disengagement, improve your design. When you get out on the playing field, failures will be far more likely than they were during practice. Refer to Appendix H for Motor Specifications.

### 1.3.2 Globe Motor with Drive Assembly

The drive assembly on the Globe Motor provides a 117 to 1 planetary gear redirection. **The output shaft of the drive assembly is not intended to support side loads.** It is required that your robot design incorporate a safe yield to prevent damage to the drive assembly from side loads. Refer to Appendix H for Motor Specifications.

#### NOTE

**The output shaft of the drive assembly is not designed to support side loads. If the output shaft is not properly supported damage to the drive assembly will occur.**

### 1.3.3 Seat, Window, and Van Door Motors

The seat, window, and van door motors contain one worm gear reduction stage and, in the case of the seat motor, a positive temperature coefficient (PTC) thermistor for overload protection. As the seat motor becomes warm from use, the resistance of the PTC device increases, thereby reducing the motor current and output torque. Operation at or near stall continuously will reduce the output torque to near zero until the motor has been allowed to cool. All motors, even those without a PTC device, will lose output power as they heat up. To prevent overheating, take care to couple the output shaft in a manner that does not impose

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large side loads, use an appropriate gear ratio, and minimize the internal friction of the mechanism driven. Refer to Appendix H for Motor Specifications.

## **1.3.4 Mechanical Power Transmission**

One of the most common problems teams have experienced in past competitions is mechanical power transmission failure. Typical torques at the final stage of your propulsion power transmission assembly are large enough to cause serious problems for most conventional means of fixing gears, pulleys, or sprockets to shafts. Set screws almost always fail. Pins offer better torque transmission, but can cost you valuable time if one breaks. Be careful not to use a pin so large that it occupies so much of the original shaft cross-section that the shaft breaks. Consider carefully the use of good clamping-type couplings, even though they may be expensive.

## **1.4 FIRST Policy on Repair and Replacement of Kit Parts**

FIRST has developed the following policies on the repair and replacement of various kit parts.

If you experience a failure in any of the items mentioned below, please review the appropriate documentation to insure that the components are correctly configured. If this does not resolve the problem, you will be instructed to follow the steps outlined below. Please note the differences in procedure based on the component that is determined to be inoperative.

- FIRST has a limited quantity of replacement parts available. If, during examination of components, a failure is determined to be due to misuse or miswiring, in general only one additional unit will be supplied, or the original unit will be repaired only once. FIRST reserves the right to refuse to provide replacements to teams which break the same part over and over.
- Before sending back the item, please fill out the problem report found in Appendix F. This report is to be mailed in with the item.
- Unless otherwise specified, replacement parts shipped from FIRST will be shipped via 2<sup>nd</sup> day air within one business day of receipt of the non-functional part. Teams may opt for overnight shipment at their expense.
- FIRST does not provide “spare” parts to teams. When possible, FIRST will provide teams with information on who to contact to obtain spare kit parts. However, due to the nature of how the Kit of Parts is assembled, there may be some kit parts for which spares are simply not available. Teams wishing to obtain extra parts for use in robot development or to have on hand as backup should utilize regular retail channels or consult the supplier contact information in Appendix G. If contact information for a part supplier is not listed in the supplier contact information, it is because they are not prepared to supply parts directly to teams. **Please do not contact parts suppliers if they are not listed in the supplier contact information.**

## **1.4.1 Innovation First Products**

The following kit parts are Innovation First products:

- Operator Interface
- Robot Controller
- Radio Modems
- Speed Controllers (Victor 883)
- Relay Modules (Spike)
- PWM/relay cables
- 9-pin cables
- 15-pin cables

These units are covered by a product warranty. Please visit the Innovation First web site at [www.innovationfirst.com](http://www.innovationfirst.com) for product support and/or to obtain an RMA #. **Do not contact FIRST for repair or replacement of these items.**

## **1.4.2 Motors and Drive Assemblies**

There are a limited number of replacement motors and drive assemblies available.

If you have a burned out motor or non-functional drive assembly:

1. Fill out a photocopy of the problem report form in Appendix F. Ship the non-functional motor/drive assembly to FIRST. Teams are responsible for the shipping cost.
2. Seriously consider the fact that if a brand new motor or drive assembly failed with the current robot design, a replacement may also fail during a competition event. Carefully evaluate the shock loading of the drive assembly, the interim and overall gear ratios, and the driving techniques used.
3. FIRST will ship a replacement motor to the team via 2nd day UPS shipment within 1 business day of receipt.

### **Note**

**If you modify the drive assembly, and a failure occurs, FIRST will not provide a replacement.**

## **1.4.3 All Other Kit Parts**

1. Fill out a photocopy of the problem report form in Appendix F. Ship the non-functional part to FIRST. Teams are responsible for the shipping cost.
2. FIRST will ship a replacement to the team via 2nd day UPS shipment within 1 business day of receipt.

## 2. ROBOT ELECTRICAL SYSTEMS

### 2.1 Introduction & General Description

#### WARNING

**Please read the following section carefully.** Failure to wire your robot properly could result in personal injury, damage to the control system, or damage to your robot, and could invalidate the control system warranty. **FIRST and/or Innovation First will not provide free replacement of components damaged due to misuse or miswiring. Teams will be required to correct wiring that is not configured according to this section and the control system rules in Appendix A before being allowed to compete.**

This section covers power distribution and wiring rules for the robot and operator controls, and gives examples of how to wire parts included in the kit to the Innovation First control systems. **Please note that control system documentation is now provided by Innovation First and is available on their web site at [www.innovationfirst.com](http://www.innovationfirst.com).**

### 2.2 Wiring the Robot

#### **2.2.1 Power Distribution**

On the robot, electric power from a 12 Vdc sealed-lead-acid (SLA) battery passes through a main fuse and is distributed to the Robot Controller, Relay Modules, muffin fans, and LEDs. Speed Controllers receive power from the battery via a 30A auto-resetting circuit breaker. All other electrical devices receive power from the Robot Controller, Speed Controllers, or Relay Modules as described below.

#### CAUTION

**Do not connect the motors, valves, switches, yaw rate sensor, or potentiometers directly to the battery.**

For safety reasons, the 60A battery fuse supplied in the kit must be wired in series with the +12 Vdc output terminal on the battery, and both terminals on the batteries must be insulated with electrical tape.

#### WARNING

**Be very careful to avoid short circuits!** The 12 Vdc SLA battery can deliver current well in excess of 100 Amps for a sustained period of time (minutes). This level of power can make wires turn red hot and melt through the insulation in a fraction of a second, which can result in serious burns, scars, and/or other injuries. Short circuits can also destroy control system components and could cause the battery to leak highly corrosive acid or even explode. Always make sure the fuse is in series with the battery output. **Please be careful!**

Although not required, it is recommended that power from the battery be distributed via the fuse panels included in the kit. Note that each fuse panel contains 6 fused (via the circuit breakers) outputs connected to one input, and 12 non-fused outputs connected to a second

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input. The fused and non-fused sides are not connected, so that the panel can be used to distribute both 12 Vdc and Ground.

Figure 2.1 shows a schematic for +12 Vdc power distribution using both portions of the fuse panel being used to distribute +12 Vdc. It is assumed that the non-fused portion of a 2<sup>nd</sup> fuse panel will be used to distribute Ground.

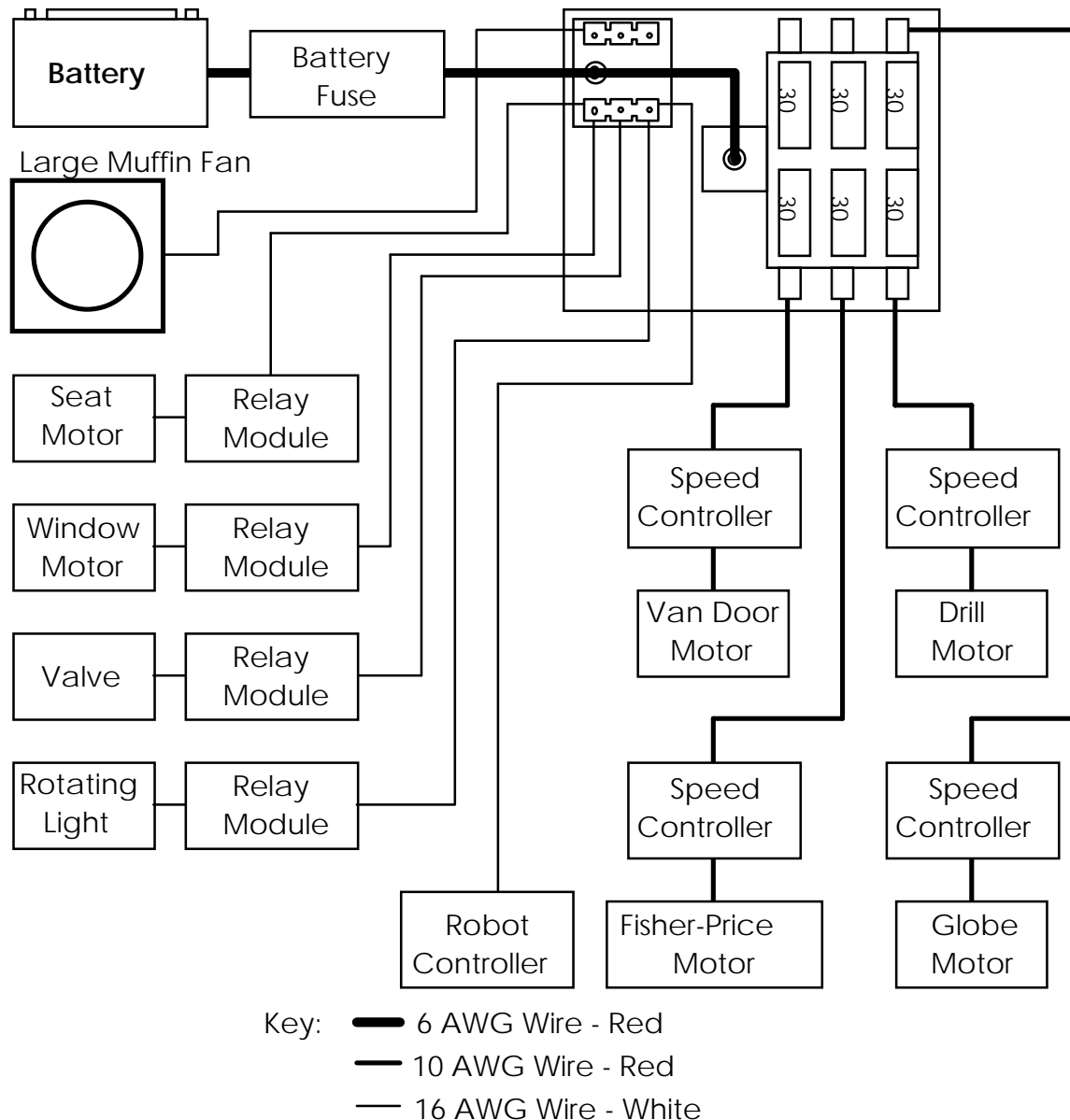


Figure 2.1: +12 Vdc power distribution

Note that Figure 2.1 shows only the +12 Vdc side of the power distribution. The Ground side is similar except for the absence of the circuit breakers, and battery fuse.



## CAUTION

**Be sure to check the wiring on a periodic basis to prevent failures which could harm the control system or cause a robot to stop dead in the middle of a match. Crimp-on connectors that are improperly crimped may work at first, but can fail easily due to the normal operating vibration of a robot. Also, be sure to avoid tension on the wires when components are installed on the robot and never remove a connector by pulling on the wire. Improper or abused connections can result in poor performance, intermittent failures, and/or short circuits.**

In order to minimize mistakes and facilitate diagnosis of any problems, all wires distributing power with a constant polarity (i.e. not an output from a Relay Module or Speed Controller) must be color coded as follows:

- Use Red or White wire for +12 Vdc and +5 Vdc
- Use Black wire for Ground

The wires and cables included in the Kit are intended for specific uses. Table 2.1 shows the minimum wire sizes allowed for hookup of the various control system devices.

Table 2.1: Minimum Wire Size by Device Type

| Device   | Wire Type                |
|--|--------------------------|
| Power distribution from battery to fuse panels   | 6 AWG, red & black       |
| Drill motors, Fisher-Price motors, van door motors, Speed Controllers used with drill, van door, or Fisher-Price motors                                | 10 AWG, red & black      |
| Robot Controller power, Relay Modules, seat motors, window motors, valves, large muffin fan, Speed Controllers used with seat, window, or Globe motors | 16 AWG, 2 conductor      |
| All switches, PWM cables, yaw rate sensors, potentiometers, LEDs, small muffin fans  | 24 AWG, 2 or 3 conductor |

It is acceptable to shorten or lengthen control system cables containing 3 or less wires as needed as long as the following conditions are met:

- Proper insulation and electrical connectors must be used.
- Proper wire type, as specified above, must be used.

This means, for example, that you may use 24 AWG wire to lengthen a PWM/Relay cable, or use 16 AWG wire to lengthen a connector for a seat motor.

Due to their high current requirements, the drill motors, Fisher-Price motors, Globe motors, and van door motors may be driven only by the Speed Controllers. The seat and window motors may be driven by the Speed Controllers or Relay Modules.

Speed Controllers may only power one motor per controller with the exception of the seat motors and window motors. Each Speed Controller may be used to power up to two total

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seat and/or window motors. No other combinations are allowed. No more than one motor may be powered by a single Relay Module.

## CAUTION

**Attempting to drive the drill motors, van door motors, Globe motors, or Fisher-Price motors directly with the Relay Modules could damage the Relay Modules and is therefore prohibited.**

The rotating light and valves may be driven only by the Relay Modules.

The 12 Vdc panel mounted LEDs are intended to be used on the robot as indicator lamps and may be used on Speed Controller or Relay Modules outputs alone or in parallel with a motor, valve, or the rotating light. The LEDs may also be powered directly by the battery (via the 60A fuse).

### 2.2.2 Rotating Light

The rotating light provided in the kit must be powered by a Relay Module such that it turns on when the robot is enabled, and turns off when the robot is disabled. The control system will provide this functionality automatically when a Relay Module is connected to relay output 8 on the Robot Controller and the default program is running. The light must be wired such that the housing is connected to M- and the red power lead is connected to M+ on the Relay Module. This will insure that the housing is connected to Ground and not +12 Vdc.

**When wired properly, the light will rotate CLOCKWISE (when viewed from above).**

*Tip: In order to reduce the potential for short circuits, teams should attempt to electrically isolate the housing of rotating light from the rest of the robot. Try mounting the housing on a non-conductive material, such as wood or polycarbonate sheet, and insure that the mounting bolts, and sides and top of the housing are not in contact with other parts of the robot.*

### 2.2.3 Relay Modules

*Tip: To achieve control of both solenoids on the double solenoid valve and use only one relay module, use the two diodes provided in the kit to route power to one solenoid at a time.*

Figure 2.2 shows the schematic for this arrangement.

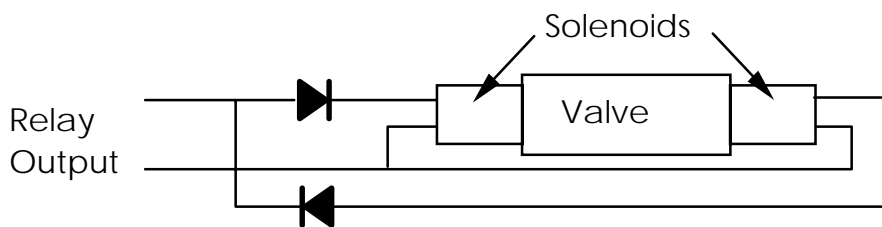


Figure 2.2: Use of Diodes with Double Solenoid Valve

### 2.2.4 Speed Controllers

For the protection of the Speed Controllers, one 30A circuit breaker must be installed in series with each Speed Controller. The circuit breaker must be installed on the input side of the Speed Controller. Do not disable the circuit breaker by connecting its terminals together. Insulate the terminals of this circuit breaker separately so inspectors at the FIRST Robotics Competition can verify correct installation. If a circuit breaker trips during use, you should use a higher gear reduction ratio to reduce current draw. The circuit breakers usually reset in one to three seconds.

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There are two models of the Victor 883 speed controller being used in the 2000 FIRST Robotics Competition. The older models are identified by a red “Victor 883” label, while the newer models have a blue label. There is **no difference in performance** between the old and new models. However, the older models do require the installation of a transorb (included with the speed controllers) across the power input terminals.

*Tip: Teams which purchased spare Victor 883 speed controllers in 1999 should be aware that there is a low cost firmware upgrade available from Innovation First. Teams may use Victor 883 speed controllers purchased in 1999 with or without the firmware upgrade. For more information, consult the Innovation First web site at [www.innovationfirst.com](http://www.innovationfirst.com).*

### **2.2.5 Muffin Fans**

Several 12V muffin fans have been included in the Kit primarily for added protection against overheating of the motors. It is recommended that these fans be installed to direct cooling air over the components that run the hottest. You may provide power to the fans from the 12V power distribution fuse panels directly or use the Relay Modules to switch power to the fans.

#### **CAUTION**

**The muffin fans provided in the kit are not reversible and may be damaged if reverse polarity is applied. Please be careful when wiring the muffin fans.**

### **2.2.6 Sensor Inputs on the Robot Controller**

The exact wiring configuration for sensors connected to the Robot Controller is not specified. Teams may wire these devices, within the rules as described below and according to the documentation supplied by Innovation First, in order to create a custom sensor system on the robot.

Switches should be connected between Ground and the switch input pin of your choice. Potentiometers should be connected with +5 Vdc at one end, Ground at the other end, and the wiper connected to the analog input pin of your choice.

#### **CAUTION**

**Do not connect switches to +5Vdc, it may damage the switches.**

To connect the Yaw Rate Sensor to the Robot Controller, connect +5 Vdc (only use pin 1 - +5Vdc Aux. for this sensor) to the +5 Vdc input on the sensor, connect Ground to Ground, and connect the sensor output to the analog input pin of your choice. Output characteristics of the Yaw Rate Sensor are described in the manufacturers' specification sheets included in Appendix H.

#### **CAUTION**

**Do not connect any voltages greater than +5Vdc to the analog inputs on the Robot Controller. It may damage the Robot Controller.**

Figure 2.3 shows an example of the proper way to connect a limit switch, potentiometer, and yaw rate sensor to the Robot Controller.

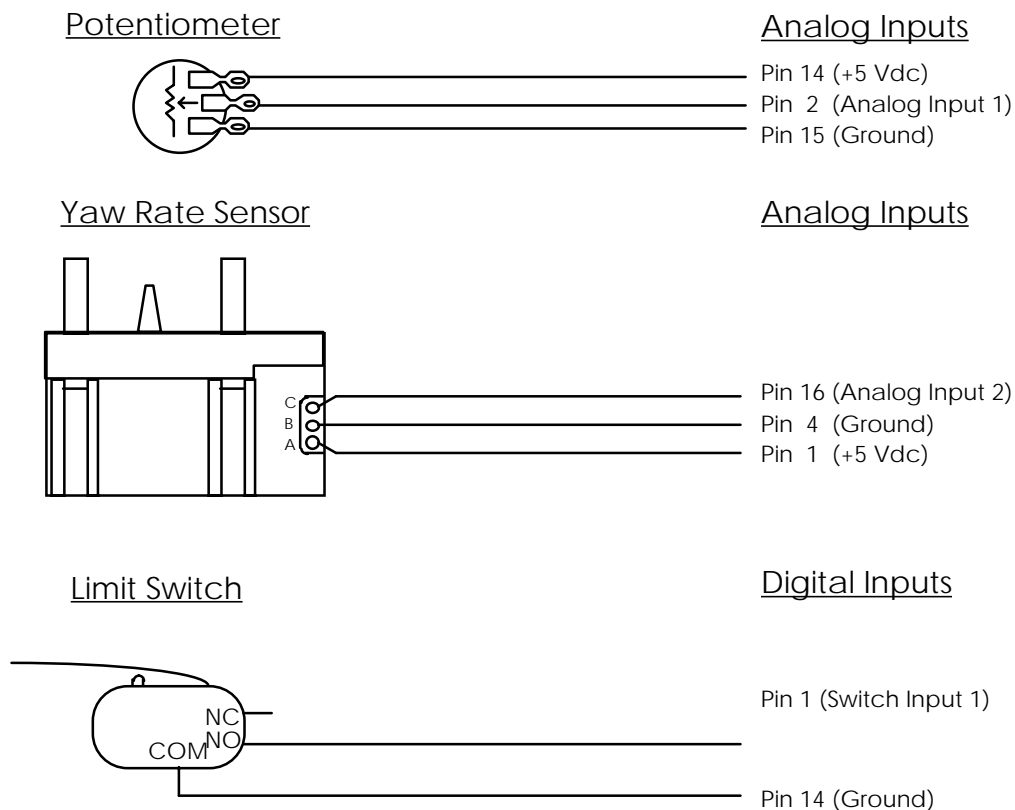


Figure 2.3: Connection Examples for Robot Controller

## 2.3 Wiring the Operator Controls

### 2.3.1 Power Distribution

Power for the Operator Interface can be supplied in 3 different ways.

- The power supply for the Operator Interface may be plugged into the power jack.
- The Robot Controller will provide power to the Operator Interface when they are connected by the tether cable. This disables the radio modems, but is useful in situations where no AC power is available for the power supply.
- Power for the Operator Interface during competition matches will be supplied by a cable that plugs into the Competition port.

Due to the low current used by all devices which interface with the Operator Interface, 24 AWG or larger wire is sufficient for all wiring.

### 2.3.2 Sensor Inputs on the Operator Interface

The exact wiring configuration for the joysticks, switches, potentiometers, LEDs, and yaw rate sensor connected to the Operator Interface is not specified. Teams may wire these devices, within the rules as described below and according to the documentation supplied by Innovation First, in order to create a custom interface for the robot operators.

Although not a requirement, teams may use the black project box as a housing for the switches, potentiometers, LEDs, and yaw rate sensor. When using the project box, wire all components to the 15 pin male connector(s), mount the connector(s) on the project box, and use the 15 pin molded cable(s) to make the connection(s) to the Operator Interface.

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The +12 Vdc LEDs may be connected between +5Vdc and Ground or between an LED output and Ground to serve as a visual indicator to the robot operators. This can be helpful during a competition match when a robot operator may not have a good view of the Operator Interface.

Switches must be connected between a switch input and Ground. **Lighted switches may not be used with the Operator Interface unless the light is disabled.**

## NOTE

**Do not connect switches to +5Vdc.**

The yaw rate sensor must be connected to +5 Vdc, Ground, and an analog input. Potentiometers must be connected to +5 Vdc and an analog input. Due to the special nature of the analog inputs on the Operator Interface, connecting potentiometers to Ground is optional but not recommended. See the Innovation First documentation for more information.

Figure 2.4 shows an example of the proper way to connect a switch, potentiometer, LED, and yaw rate sensor to the Operator Interface.

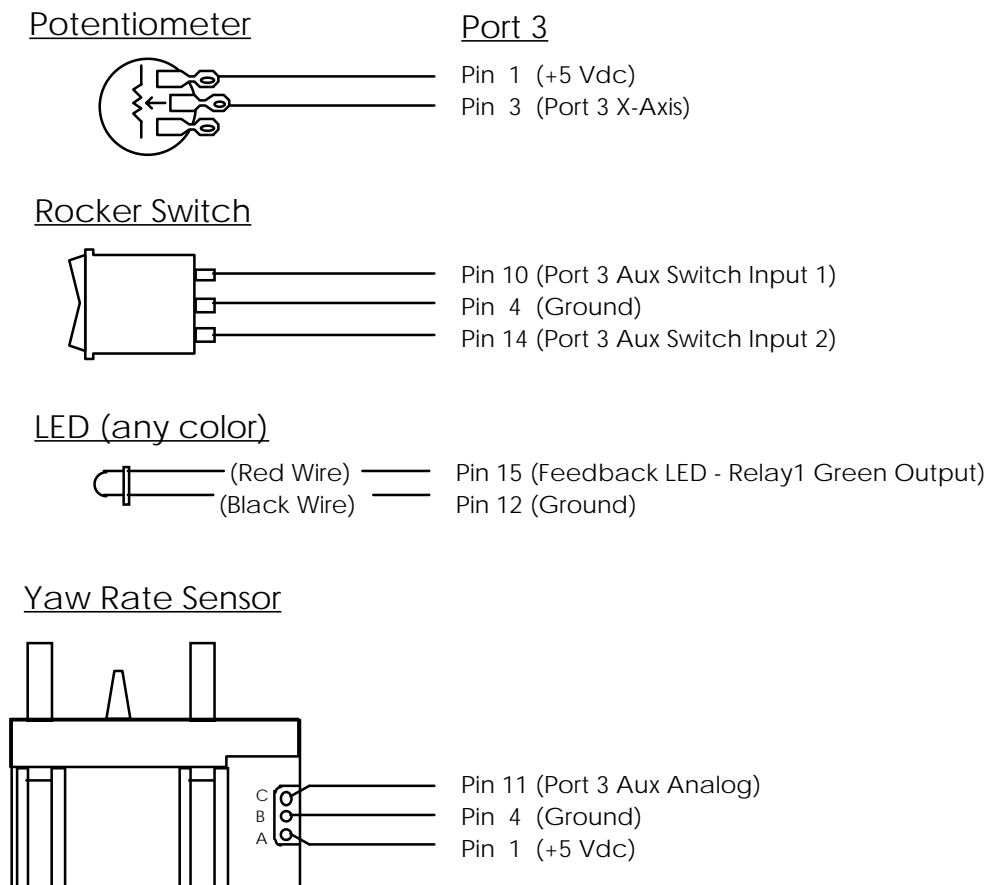


Figure 2.4: Connection Examples for Operator Interface

## 2.3.3 Dashboard Port

Teams are permitted to connect a portable computing device (Laptop computer, Palm Pilot, etc.) to the RS232 output of the Dashboard Port for the purpose of displaying feedback from the robot while competing in FIRST Robotics Competition matches. **Please note that AC**

**power will not be available at the playing fields, so these devices will have to run on internal batteries.** Innovation First may or may not make pre-written software for such a purpose available, and may or may not choose to document the data protocol or provide software source code. Teams assume all risk associated with use of this data. For more information, consult the Innovation First web site at [www.innovationfirst.com](http://www.innovationfirst.com).

## 2.4 Batteries and Chargers

Teams are responsible for managing the power consumption of their robot and for ensuring that their batteries are sufficiently charged to compete in each two minute match. This means that teams must charge their batteries at their pit stations at each FIRST Robotics Competition event.

For instructions on charging the batteries, please refer to the battery charger documentation included in the Kit.

### WARNING

**A warm battery should be allowed to cool before charging. Please do not attempt to cool a battery by immersing it in ice, water, or snow. A battery that has been left out in cold weather must be allowed to reach room temperature before charging. Failure to do so will cause serious damage to the battery, which may leak toxic liquid as a result.**

**Be careful to avoid shorting the batteries. Short-circuit current exceeds 100A and can cause fire, serious injury, and leakage of toxic materials.**

If you have a battery that you know to be damaged, please do not put it in the trash. Return the damaged battery to FIRST so that it can be recycled properly.

It is estimated that each SLA battery can store sufficient energy to power a robot for at least 5 two minute matches. Thus, it should not be necessary to swap batteries after each match.

Due to the short delay between matches upon reaching the elimination match on the final day of each FIRST Robotics Competition event, FIRST will provide a freshly charged battery to each remaining competitor at each level of finals. For example, a team making it all the way to the finals would receive a freshly charged battery at the start of the quarter-finals, a second freshly charged battery at the start of the semi-finals, and a third freshly charged battery at the start of the finals.

To connect the battery to the rest of the control system, FIRST recommends using ring terminal contacts and the red Anderson Power Products connector.

When connecting the battery, be very careful to observe the proper polarity in order to prevent damage to control system components.

During any FIRST Robotics Competition event, the robots may only be powered by a single 12 Vdc SLA battery supplied by FIRST. These batteries may only be charged through the normal operation of the battery charger provided by FIRST.

## APPENDIX A: ROBOT RULES

### M Machine Design & Operation Rules

- M1. The energy used by the robots in the FIRST Robotics Competition must come solely from:
1. Electrical energy derived from the onboard battery
  2. Storage achieved by deformation of springs or latex tubing
  3. Compressed air stored in the pressure tank (the pressure tank may be charged prior to the start of a match, but only by SMC Pneumatics)
  4. A change in the altitude of the device's center of gravity.
- M2. Robots must sit, unconstrained, inside a 36"x30" rectangular footprint and be no more than 60" high at the start of a match. The weight of the robot, including battery, bumper, and control system, may not exceed 130.0 pounds.

**Size ≤ 36" long dimension x 30" short dimension x 60" high; Weight ≤ 130.0 pounds**

*Tip: Keep in mind that these are maximum dimensions. It is recommended that robots be designed for slightly smaller dimensions and weights in order to allow a degree of tolerance for oversized/overweight mechanisms and differences in measurement between the team and the official inspection. Many teams have discovered the hard way that reducing size and/or weight while preserving functionality is no easy task after the robot has been constructed. Also, many shippers such as UPS will not ship packages as large as a full robot. Many teams have found it helpful to make ease of disassembly and reassembly one of their design goals.*

M3. In order to help lessen the severity of impacts that robots may experience while competing, teams may add a “bumper” around the perimeter of the robot as long as it meets the following conditions:

- The bumper is allowed to extend out from the maximum starting dimensions of the robot by up to 6” on all sides (not top or bottom).
- The bumper may be up to 6” tall and must be vertically centered at 6.5” above the bottom of the robot. If the material inside the bumper is likely to sag, be sure to design it so that it sags within the 6” height limit.
- Materials used for the bumper are not considered with respect to the robot materials limits.
- The bumper may only be designed to serve as an energy absorbing device or to interact with balls on the playing field, and must be mounted to a static portion of the robot. **The bumper may not be mounted on robot mechanisms which move, such as an arm or wheel.**
- A hard backing for the bumper may be fabricated from up to  $\frac{3}{4}$ ” thick wood, and mounted to the robot by bolts with recessed heads.
- The outer face of the hard backing must be covered with an energy absorbing material which does not come loose during a match. For example, a heavy duty nylon covering over foam rubber or packing foam.
- The bumper must be designed to be removed quickly. This will facilitate robot inspection and will be necessary at some event sites where robots must pass through doors just wide enough to pass a 30” wide robot.

Figure 2.5 shows an example cross-section of a bumper.

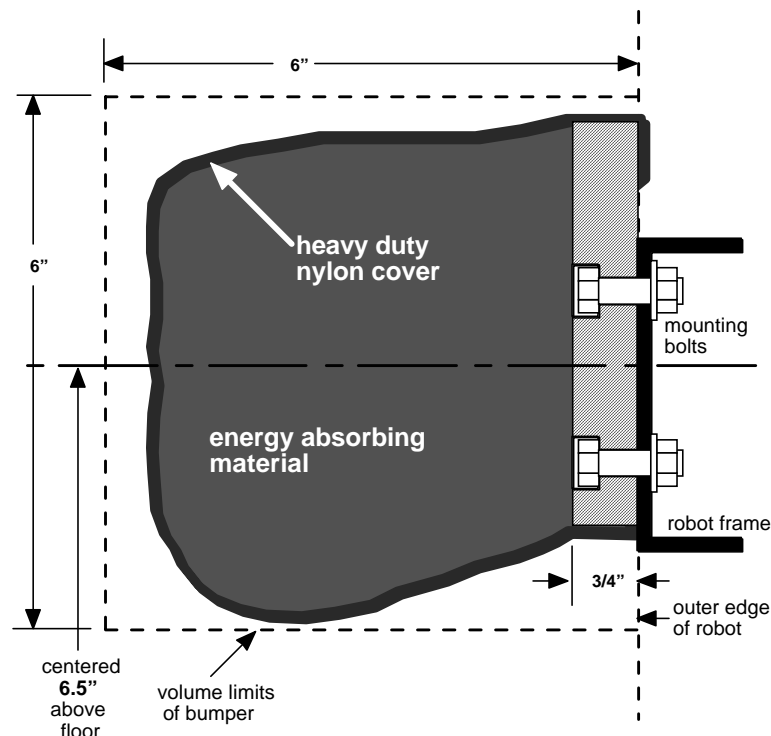


Figure 2.5 - Example of Bumper Cross Section



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- M4. All robots will be inspected, weighed, and measured during the practice day at each FIRST Robotics Competition event. The robot must pass inspection before competing in any competition matches. Teams may be re-inspected at anytime during an event at FIRST's discretion. If modifications to your robot are necessary to comply with the Robot Rules, they must be completed before the robot will be allowed to compete in further competition matches. If a team wishes to have their robot re-inspected to insure rules compliance, they may ask FIRST officials to do so. If you suspect that another team's robot is in violation of the robot rules, please approach FIRST officials and we will review the robot in question. This is an area where "Gracious Professionalism" is very important.
- M5. **Teams are expected to design and build robots to withstand vigorous interaction with other robots.**
- M6. Until the controls are enabled at the beginning of each match, robots and any appendages, or extensions (excluding the bumper) must remain unconstrained within the 36"x30"x60" starting size. Once a match begins, robots may extend beyond that limit under their own power.
- M7. Robots must be designed to operate by reacting against the surface of the playing field, the innermost face of the 4x4 field border, the ramp, the horizontal bar connecting the goals, the balls, the other robots, and the air. Robots should not be designed to react off of the top face of the 4x4 field border, other parts of the field border, or the goals. If your robot inadvertently drives on the top of the 4x4 field border, you won't be penalized unless the playing field is damaged.
- M8. **Robots must display their team company and school names and/or logos. The judges, referees, and announcers must be able to easily identify them by name. In addition, team numbers must be displayed on at least two opposite sides (180 degrees apart) of the robot. Numbers should be at least 5 inches high and clearly visible from a distance of not less than 50 feet.**
- M9. Robots must use the rotating light provided in the kit to display alliance color (red or blue). The light must be mounted on the robot such that the alliance color is visible in at least 4 locations 90 degrees apart around the sides of the robot from a distance of at least 50 feet. The light should be mounted to allow easy changeover of the colored lens before matches. See **Rule C26 for wiring information.**

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M10. “Non-functional” decorations may be added to robots under the following conditions:

- Decorations must not cause the weight or initial size requirements for the robot to be exceeded.
- Decorations must not affect the outcome of the match. For example, flashing lights are OK as long as they do not blind opponents or cause confusion about the alliance color of the robot.
- Any decorations which involve broadcasting a signal to/from the robot, such as remote cameras, must be cleared with FIRST prior to use.
- Decorations may draw power from the control system (batteries or Relay Modules) as long as they do not affect the operation of other control system components.
- Non-functional decorations do not count against the \$425 SPI limit or Additional Hardware List.
- Decals are considered non-functional decorations.

M11. Robots must be designed to be operated by the wireless programmable control system.

M12. Gaining traction by using adhesives or by damaging the surface of the playing field or the balls is not allowed. Using Velcro to adhere to the carpet has the potential to damage the carpet and is therefore prohibited.

M13. During robot inspection, all mechanisms that will be used on the robot at the event must be present on the robot. However, it is acceptable for a robot to play matches with a subset of the mechanisms that were present during inspection. Mechanisms which were present during the inspection may be added, removed, or reconfigured between matches. Also, the control system may be reprogrammed between matches.

M14. No substitute robots are permitted; however, “functionally identical” replacement parts are allowed. “Functionally identical” implies a part that is of the same geometry, materials, etc. and not an improved design.

M15. Only items listed under the PNEUMATICS section of the Kit list may be used to store, generate, or transmit compressed air or vacuum, with the following exceptions:

- Suction cups may be fabricated from legal Kit parts, as defined in rule K1 below.
- Pneumatic fittings from Small Parts, Inc. may be used.
- Tubing may be compressed in order to block the flow of air.
- Tubing may not be compressed in order to generate compressed air or vacuum.

**Custom-made pneumatic fittings, air cylinders, pumps, air accumulators, and so forth are not allowed, even if they are created from components included in the Kits. Also, valves, syringes, tubing, and so forth from SPI or outside sources may not be used for pneumatics.**

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M16. Pneumatic components supplied in the Kit (pressure tank, regulator, cylinders, valves, fittings, tubing, etc.) may not be modified except as follows:

- Tubing may be cut.
- The wiring for the valves and pressure switches may be modified as necessary to interface with the rest of the control system.
- The pressure switch may be calibrated by the normal operation of the adjustment screw.

Mounting and connecting pneumatics components using the pre-existing threads, mounting brackets, etc. is not considered a modification of the components.

M17. All mechanisms on the robot should be fabricated/assembled by the 2000 team and not be reused from previous year's robots.

M18. Mechanisms which present a risk of entanglement may be disallowed by the referees.

M19. The motors in the kit may **not** be modified except as follows: It is acceptable to modify the mounting brackets and/or other structural parts of the motors (output shaft, housing, etc.) as long as the electrical system is not modified and the integral mechanical system of the moving parts (bearings, bushings, worm gear output stages, etc.) is not changed or removed. The gearboxes for the Fisher-Price and Drill motors are not considered "integral" and may be separated from the motors. FIRST will not provide replacement for parts which fail due to modification.

## C Control System Rules

C1. The control system is provided to allow wireless control of the robots. The Operator Interface, Robot Controller, Servos, Speed Controllers, Relay Modules, Radio Modems, Batteries, Battery Charger, Power Supply, 9 pin cables, circuit breakers, fuse, and joysticks may not be tampered with, modified or adjusted in any way, with the following exceptions:

- The dip switches on the Operator Interface and Robot Controller may be set as appropriate.
- The program select jumper on the Robot Controller may be set as appropriate.
- The user programmable code in the Robot Controller may be customized.
- The Speed Controllers may be calibrated as described in owner's manuals.

**Tampering includes drilling, cutting, machining, gluing, rewiring, etc. All items listed in Rule C1 must be mounted without alteration.**

C2. The Radio Modem connected to the Operator Interface must be able to reach the mounting bracket on the operator stations. Be sure to leave sufficient slack in the 9 pin cable.

C3. The black project box is intended to serve as a mounting point for the rocker switches, pushbutton switches, and potentiometers used by the robot operators, and to enclose the associated wiring. You may modify the project box in any manner to accommodate your needs.

C4. **The wire supplied in the Kit may be used to conduct electricity. Additional wire may be used as long as it meets the gauge and insulation color requirements as described in Section 2.**

## THE 2000 FIRST ROBOTICS COMPETITION MANUAL

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- C5. Electrical devices may only be wired as described in Section 2 and/or the Robot Rules.
- C6. Six gauge wire must be used to connect the battery to the fuse panels (or equivalent).
- C7. Ten gauge or larger diameter wire must be used for connections to and from the Speed Controllers if they are used with the drill, Fisher-Price, or van door motors.
- C8. Sixteen gauge or larger diameter wire must be used to connect Globe, seat, or window lift motors to the Speed Controllers, from the Fuse Panels (or equivalent) to the Robot Controller, for the large muffin fan, and for any connections to and from the Relay Modules.
- C9. Twenty-four gauge or larger diameter wire must be used for connecting sensors (switches, potentiometers, yaw rate sensor) to inputs, for extending the PWM cables, for the small muffin fans, or for wiring the LEDs.
- C10. **Relay Modules may not power more than one device per output.** The double-solenoid valve is considered one device, if a pair of diodes is used to route power to only one solenoid at a time. Also, the 12 Vdc LEDs may be wired in parallel with other output devices connected to the Relay Modules.
- C11. **Only the Robot Controller, Relay Modules, 12 Vdc LEDs, and muffin fans may be connected directly to the fused battery outputs.**
- C12. The drill motors, Fisher-Price motors, Globe motors, and van door motors may be powered only by the Speed Controllers.  
**Do not connect the drill motors, Fisher-Price motors, Globe motors, or van door motors to the Relay Modules.**
- C13. No more than one drill motor, Fisher-Price motor, Globe motor, or van door motor may be powered by each Speed Controller.
- C14. The seat motors, window lift motors, and 12 Vdc LEDs may be powered by the Speed Controllers or the Relay Modules. A maximum of two of these types of motors may be powered by each Speed Controller.
- C15. One 30A circuit breaker (provided in the Kit) must be installed in series with each Speed Controller on the +12 Vdc input. All circuit breakers must be accessible for inspection at each FIRST Robotics Competition event.
- C16. The battery fuse (provided in the Kit) must be installed in series with the positive terminal of the battery, such that all battery output flows through this fuse before being distributed to any electrical component on the robot. This fuse must be accessible for inspection at each FIRST Robotics Competition event.
- C17. Do not connect 12 Vdc power, relay, Speed Controller, or PWM outputs to the analog or switch inputs on the Robot Controller.
- C18. All sensors used on the robot must be connected directly to the analog or switch inputs on the Robot Controller, and may not be wired in series with the motors. It is acceptable to wire switches in series or parallel.
- C19. If the control system is damaged due to improper wiring or misuse, Innovation First will charge for repair or replacement of the affected items.
- C20. During each competition match, your robot may only be powered by one of the two batteries provided by FIRST.

## THE 2000 FIRST ROBOTICS COMPETITION MANUAL

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- C21. When recharging Kit batteries, you may only use the charger provided by FIRST.
- C22. All wires distributing power with a constant polarity (i.e. not a Relay Module or Speed Controller output) must be color coded as follows:
- Use Red or White wire for +12 Vdc and +5 Vdc connections.
  - Use Black wire for Ground connections.
- C23. **Teams are responsible for any software bugs introduced into the Robot Controller's control program when using a custom program.**
- C24. Position the Robot Controller within your robot so that its LED's may be seen during operation in a match. This will greatly facilitate analysis in case of problems and will be beneficial to you and field personnel during the FIRST Robotics Competition.
- C25. Position the 12 Vdc battery within your robot so that it is accessible and may be easily changed out between matches. The terminals on the battery must be insulated with electrical tape to reduce the risk of short circuits.
- C26. The rotating light provided in the kit must be powered by a Relay Module such that it turns on when the robot is enabled, and turns off when the robot is disabled. The control system will provide this functionality automatically when a Relay Module is connected to relay output 8 on the Robot Controller and the default program is running. The light must be wired such that the housing is connected to M- and the red power lead is connected to M+ on the Relay Module. This will insure that the housing is grounded and not at +12 Vdc. **When wired properly, the light will rotate CLOCKWISE (when viewed from above). See Rule M9 for mounting information.**
- C27. The team number settings on the Robot Controller and Operator Interface must be set to the team number assigned by FIRST to the team.
- C28. Each Speed Controller with a red "Victor 883" label must have the transorb included with the speed controller installed across the power input terminals. Speed Controllers with blue "Victor 883" labels do not require an external transorb.

## K Kit Materials Usage & Limitations

- K1. Each robot must be constructed exclusively from materials provided in the Kit of Parts ("the Kit") supplied by FIRST, with the following additions and exceptions:
- Material available from outside sources, as explained below.
  - The Kit containers, part packaging, and any documentation in the Kit container may not be used to build the device.
  - Adhesive tape may not be used except as an electrical insulator.
  - Lubricants may not be used except to reduce friction within your own robot.

### *Outside Sources - Small Parts, Inc. Catalog*

- Each team receives a SPARK (Small Parts Addition to Robotics Kits) certificate representing an account with a \$425 credit balance. This account will be debited for the actual purchases you make, meaning you get up to \$425 worth of parts for free. You may go beyond this dollar limitation for prototyping or to purchase spare parts, but your team is responsible for paying the balance on the account. See Appendix D for more details on accounting and ordering.
- Up to \$425 worth of materials purchased from Small Parts, Inc. (SPI) may appear on your final robot. **Items which appear in the Additional Hardware List do not count against the \$425 SPI limit.** When your robot is inspected at a competition, you will be asked to verify that you have not used more than \$425 worth of materials from SPI on your robot. Be prepared to show documentation to support this requirement, e.g. a bill of materials and purchase prices.
- It has been brought to our attention that the actual prices of components purchased from Small Parts, Inc. may not match the prices printed in the catalog. Please use the catalog prices when calculating the cost of robot components from SPI for compliance with the \$425 limit.
- If you use only a portion of what you buy from Small Parts, you may prorate the dollar amount used to the smallest quantity listed for purchase in the catalog. For example, if you buy 5' of rod which could have been purchased by the foot, but end up using only 6", you may calculate the amount used as the purchase price for one foot (the minimum amount that you could have purchased in order to build your robot).

### *Outside Sources - Additional Hardware List*

- **Materials on the Additional Hardware List may be obtained from any supplier and are not limited by cost, but may be limited by quantity.** A specific list of materials and maximum quantities/dimensions is provided in Appendix C.
- If an item on the Additional Hardware List is available from Small Parts, Inc. (SPI), then it may be purchased from SPI without being counted against the \$425 limit on SPI parts used on the robot. However, any amount of the item purchased from SPI above and beyond the quantity allowed in the Additional Hardware List will count against the \$425 limit on SPI parts used on the robot.

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- K2. Many of the materials in the Kit are raw materials. They are intended to be used for manufacturing structural or mechanical parts for your robot.
- K3. As denoted in the Additional Hardware List there is no restriction on the total quantity or source of sprockets/pulleys/gears and chain/belt that can appear on your robot. Each team may purchase from an outside source sprockets, gears and/or pulleys and additional chain and/or belt, with the following condition:
- These components must be "commercially available," strictly *off-the-shelf* only. No custom or special orders.
- K4. For safety reasons, you may not fabricate your own springs. However, it is acceptable to elastically deform and relax materials not designated as springs as long as the rate at which the energy is released does not exceed the rate at which the energy was stored. This is intended to allow reasonable use of the elastic properties of materials without creating unsafe conditions caused by sudden the release of stored energy in materials not designed to act as springs. Materials which are designated as springs include: All items listed in the Springs section of the Kit List, and compression, tension, torsion, constant force, Latex tubing, and washer springs available from Small Parts, Inc. You may not modify or plug a pneumatic actuator in any way to use it as a spring.
- K5. A limited number of replacement parts will be made available by FIRST upon justified request.
- K6. Teams may replace lost or damaged Kit materials only with identical components of the same material, dimensions and treatment.
- K7. Materials in the Kit may not be changed chemically with the following exceptions:
- rope ends may be singed to prevent loose ends or to bind them together
  - resin and hardener may be mixed to produce epoxy.
  - metal may be heat treated
  - metal may be anodized to improve appearance
- The melting and recasting of materials, such as a block of aluminum, is allowed as long as the basic alloy or chemical composition is not changed. Note however, that other rules restrict which parts may and may not be modified. For example, the motors and pneumatic cylinders in the kit may not be melted and recast.
- K8. The mailing tube provided in the Kit is considered packaging material and may not be used on the robot.
- K9. Although SPI can special order parts in sizes other than those listed in the catalog, special ordered parts may not be used on the robot unless the catalog specifically mentions, on the same page as a given type of parts, that sizes other than those listed are available. One of the reasons for using the SPI catalog is to insure all teams have equal access to parts. Allowing a team to use a part others did not know was available would be unfair.
- K10. The robot may not contain more than one of the batteries provided in the kit during a match.





## APPENDIX B: KIT OF PARTS

### 2000 FIRST Robotics Competition Kit Parts

#### Bearings

| Part Name/Description                   | Dimensions                     | Location                     | Qty /Kit | Product Supplier       |
|---|--------------------------------|------------------------------|----------|------------------------|
| Pillow Block                            | 1/2"                           | Gray Container - Bearing Bag | 2        | The Torrington Company |
| Radial Ball Bearing With Spherical O.D. | 1/2" I.D., Self Locking Collar | Gray Container - Bearing Bag | 4        | The Torrington Company |
| Roller Clutch                           | 3/8" I.D.                      | Gray Container - Bearing Bag | 2        | The Torrington Company |
| Single Row Radial Flanged Ball Bearing  | 1/4" I.D.                      | Gray Container - Bearing Bag | 4        | The Torrington Company |
| Single Row Radial Flanged Ball Bearing  | 3/8" I.D.                      | Gray Container - Bearing Bag | 4        | The Torrington Company |
| Two Bolt Self Aligning Flange           | Fits 1/2" Bearing              | Gray Container - Bearing Bag | 8        | The Torrington Company |

#### Control System

| Part Name/Description           | Dimensions                       | Location                          | Qty /Kit | Product Supplier        |
|---------------------------------|----------------------------------|-----------------------------------|----------|-------------------------|
| 1 Conductor Wire                | 10', #6 AWG, Black               | Gray Container - Loose            | 1        | BICC General            |
| 1 Conductor Wire                | 10', #6 AWG, Red                 | Gray Container - Loose            | 1        | Pioneer Packard         |
| 1 Conductor Wire                | 35', #10 AWG, Black              | Gray Container - Loose            | 1        | BICC General            |
| 1 Conductor Wire                | 35', #10 AWG, Red                | Gray Container - Loose            | 1        | BICC General            |
| 15 Pin Molded Cable             | DB15 pin M-F, 6 feet             | Green Container - Loose           | 2        | Innovation First        |
| 15 Pin Solder Cup Connector     | DB15 Male                        | Green Container - Electronics Bag | 2        | AMP Foundation          |
| 2 Conductor Jacketed Wire       | 30', #24 AWG                     | Gray Container - Loose            | 1        | BICC General            |
| 2 Conductor Jacketed Wire       | 35', #16 AWG                     | Gray Container - Loose            | 1        | BICC General            |
| 25 Pin Solder Cup Connector     | DB25 Male                        | Green Container - Electronics Bag | 2        | AMP Foundation          |
| 3 Conductor Shielded Wire       | 30', #24 AWG                     | Gray Container - Loose            | 1        | BICC General            |
| 9 Pin Cable                     | DB9 Male to Female, 6', Shielded | Green Container - Loose           | 4        | Innovation First        |
| Anderson Power Products Catalog | Catalog                          | Green Container - Loose           | 1        | Anderson Power Products |
| Battery                         | 12 volt                          | Green Container - Loose           | 2        | Exide                   |
| Battery Charger                 | Sealed Lead Acid Battery, 4 amp  | Green Container - Loose           | 1        | Xenotronix              |
| Battery Fuse                    | 60 A, Maxi-Fuse                  | Green Container - Electronics Bag | 1        | Bussmann                |

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|                               |                                      |                                   |    |                                  |
|-------------------------------|--------------------------------------|-----------------------------------|----|----------------------------------|
| Battery Fuse Holder           | Maxi-Fuse, 6 AWG leads               | Green Container - Electronics Bag | 1  | Bussmann                         |
| Circuit Breaker For Motors    | 30 amp, 12 volt, Auto-Resetting      | Green Container - Electronics Bag | 12 | Snap-Action, Inc.                |
| Connector for Seat Motor      | 2 pin, 16 AWG x 12" cable            | Green Container - Loose           | 2  | Delphi Packard Electric Systems  |
| Connector for Window Motor    | 2 pin, 16 AWG x 12" cable            | Green Container - Loose           | 2  | Delphi Packard Electric Systems  |
| Connector for Yaw Rate Sensor | 3 pin, 24 AWG x 12" cable            | Green Container - Loose           | 1  | Delphi Packard Electric Systems  |
| Diode                         | Max:1 Amp, 50V (peak rev.)           | Green Container - Electronics Bag | 2  | Brevan                           |
| Flightstick Joystick          | 7" Cable with Male DB15              | Green Container - Loose           | 2  | CH Products                      |
| Fuse Panel                    | ATC, 6 fuseable, 12 unfused          | Green Container - Electronics Bag | 2  | Bussmann                         |
| Heat Shrink Tubing            | 1/2"Ø x 6", Black, 2:1 Shrink Ratio  | Green Container - Electronics Bag | 1  | Brevan                           |
| Heat Shrink Tubing            | 1/4"Ø x 6", Black, 2:1 Shrink Ratio  | Green Container - Electronics Bag | 1  | Brevan                           |
| Heat Shrink Tubing            | 1/8"Ø x 6", Black, 2:1 Shrink Ratio  | Green Container - Electronics Bag | 1  | Brevan                           |
| Heat Shrink Tubing            | 3/16"Ø x 6", Black, 2:1 Shrink Ratio | Green Container - Electronics Bag | 1  | Brevan                           |
| Heat Shrink Tubing            | 3/4"Ø x 6", Black, 2:1 Shrink Ratio  | Green Container - Electronics Bag | 1  | Brevan                           |
| Heat Shrink Tubing            | 3/8"Ø x 6", Black, 2:1 Shrink Ratio  | Green Container - Electronics Bag | 1  | Brevan                           |
| Knob for Potentiometer        | 1" Hexagon, Fits 1/4" Shaft          | Green Container - Electronics Bag | 2  | Radio Shack                      |
| LED, Panel Mount              | Amber, 12V                           | Green Container - Electronics Bag | 4  | Chicago Miniature Lamp, Inc.     |
| LED, Panel Mount              | Green, 12V                           | Green Container - Electronics Bag | 4  | Chicago Miniature Lamp, Inc.     |
| LED, Panel Mount              | Red, 12V                             | Green Container - Electronics Bag | 4  | Chicago Miniature Lamp, Inc.     |
| Limit Switch                  |                                      | Green Container - Electronics Bag | 10 | Honeywell - Microswitch Division |
| Momentary Rocker Switch       |                                      | Green Container - Electronics Bag | 4  | Honeywell - Microswitch Division |
| Muffin Fan                    | 12 Vdc                               | Gray Container - Loose            | 1  | EBM Industries                   |
| Muffin Fan (Tiny)             | 12 Vdc                               | Green Container - Electronics Bag | 3  | EBM Industries                   |
| Operator Interface            |                                      | Green Container - Loose           | 1  | Innovation First                 |

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|                                     |                                 |                                   |    |                                  |
|-------------------------------------|---------------------------------|-----------------------------------|----|----------------------------------|
| Plastic Shield for 25 Pin Connector | fits DB25 Connector             | Green Container - Electronics Bag | 2  | AMP Foundation                   |
| Potentiometer                       | 100K $\Omega$ , Linear          | Green Container - Electronics Bag | 6  | Bourns, Inc.                     |
| Power Supply for Operator Interface | 9 Vdc                           | Green Container - Loose           | 1  | Innovation First                 |
| Project Box                         | Black                           | Gray Container - Loose            | 1  | Serpac                           |
| PWM/Relay Cable                     | Hitec/JR-style, 36" Long        | Green Container - Electronics Bag | 8  | Innovation First                 |
| PWM/Relay Y Cable                   | Hitec/JR-style, 24" Long        | Green Container - Electronics Bag | 2  | Innovation First                 |
| Quick-Disconnect Power Connector    | #6 AWG Red/Black Wire           | Green Container - Loose           | 2  | Anderson Power Products          |
| Radio Modem for Operator Interface  | RS-422, 9 pin F, metal antenna  | Green Container - Loose           | 1  | Innovation First                 |
| Radio Modem for Robot Controller    | RS-422, 9 pin F, rubber antenna | Green Container - Loose           | 1  | Innovation First                 |
| Reed Switch                         | Normally Open, Magnet Activated | Green Container - Electronics Bag | 4  | CP Clare                         |
| Relay Module (Spike)                | 12V, 20A Max                    | Green Container - Loose           | 4  | Innovation First                 |
| Ring Connector                      | # 10-12 Awg, #6 lug             | Kick Off Check Out -              | 20 | Thomas & Betts Corp.             |
| Ring Connector                      | # 14-16 Awg, #6 lug             | Kick Off Check Out -              | 10 | Thomas & Betts Corp.             |
| Ring Connector                      | # 22-26 Awg, #6 lug             | Kick Off Check Out -              | 8  | Thomas & Betts Corp.             |
| Ring Connector                      | # 6 Awg                         | Kick Off Check Out -              | 10 | Thomas & Betts Corp.             |
| Robot Controller                    |                                 | Green Container - Loose           | 1  | Innovation First                 |
| Rocker Switch Cover                 | Any Color                       | Green Container - Electronics Bag | 3  | Honeywell - Microswitch Division |
| Servo                               | 42 oz. in. Peak, 0.19 s/60°     | Green Container - Electronics Bag | 2  | Hitec RCD, Inc.                  |
| Spade Connector                     | Female, 12-10 AWG, Yellow       | Green Container - Electronics Bag | 10 | Thomas & Betts Corp.             |
| Spade Connector                     | Female, 16-14 AWG, Blue         | Green Container - Electronics Bag | 10 | Thomas & Betts Corp.             |
| Spade Connector                     | Female, 22-18 AWG, Red          | Green Container - Electronics Bag | 10 | Thomas & Betts Corp.             |
| Spade Connector                     | Male, 12-10 AWG, Yellow         | Green Container - Electronics Bag | 10 | Thomas & Betts Corp.             |
| Spade Connector                     | Male, 16-14 AWG, Blue           | Green Container - Electronics Bag | 10 | Thomas & Betts Corp.             |

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|                               |                                    |                                   |    |                       |
|-------------------------------|------------------------------------|-----------------------------------|----|-----------------------|
| Spade Connector               | Male, 22-18 AWG, Red               | Green Container - Electronics Bag | 10 | Thomas & Betts Corp.  |
| Speed Controller (Victor 883) |                                    | Green Container - Loose           | 4  | Innovation First      |
| Tri-lens Revolving Light      | Light w/ red and blue domes        | Green Container - Loose           | 1  | North American Signal |
| Wire Nut                      | Wire Nut for Wire Sizes #18-10 AWG | Green Container - Electronics Bag | 10 | Thomas & Betts Corp.  |
| Yaw Rate Sensor               |                                    | Gray Container - Loose            | 1  | BEI Systron Donner    |

### Documentation

| Part Name/Description                      | Dimensions | Location                       | Qty /Kit | Product Supplier        |
|--|------------|--------------------------------|----------|-------------------------|
| BASIC Stamp Programming Disk               | CD-ROM     | Packaged with Innovation First | 1        | Parallax, Inc.          |
| BASIC Stamp Programming Manual             |            | Green Container - Loose        | 1        | Parallax, Inc.          |
| Kee Klamp Pipe Fitting Catalog             |            | Gray Container - Loose         | 1        | Kee Industrial Products |
| Pneumatic Training Manual CD               |            | Vendor will drop ship to teams | 1        | SMC Pneumatics, Inc.    |
| Small Parts Catalog                        |            | Green Container - Loose        | 6        | Small Parts, Inc.       |
| The 2000 FIRST Robotics Competition Manual |            | Kick Off                       | 1        | FIRST                   |

### Fasteners

| Part Name/Description                        | Dimensions                    | Location                          | Qty /Kit | Product Supplier              |
|--|-------------------------------|-----------------------------------|----------|-------------------------------|
| 5 Minute Epoxy Gel                           | Resealable 1 oz. Dual Syringe | Gray Container - Loose            | 1        | Kaman Industrial Technologies |
| Cable Tie                                    | 7" x 0.09"                    | Green Container - Electronics Bag | 12       | Thomas & Betts Corp.          |
| Cable Tie Mounting Base                      | Self-Adhesive, #8 Holes       | Green Container - Electronics Bag | 10       | Thomas & Betts Corp.          |
| Drill Housing Screws                         | #4 x 3/4, Pan Head - Phillips | Green Container - Drill Bag       | 10       | Fastenal Company              |
| Drill Motor Mounting Flange Fastening Screws | M4 x 6mm, Button Head 19      | Green Container - Drill Bag       | 4        | Fastenal Company              |
| Helical Plastic Wire Wrap                    | 1/2" Ø x 24"                  | Gray Container - Hardware Bag     | 1        | Tyton Hellermann              |
| Helical Plastic Wire Wrap                    | 1/4" Ø x 24"                  | Gray Container - Hardware Bag     | 1        | Tyton Hellermann              |
| Polyethylene grommet                         | 1/16" x 24"                   | Gray Container - Hardware Bag     | 1        | Tyton Hellermann              |
| Polyethylene grommet                         | 3/8" x 24"                    | Gray Container - Hardware Bag     | 1        | Tyton Hellermann              |
| Velcro 1" Hook & Loop Tape                   | 36" Length, Adhesive Backing  | Gray Container - Velcro Bag       | 1        | Velcro USA, Inc.              |

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|                              |                           |                             |    |                  |
|------------------------------|---------------------------|-----------------------------|----|------------------|
| Velcro 1" One Wrap Tape      | 24" Lengths, Black        | Gray Container - Velcro Bag | 1  | Velcro USA, Inc. |
| Velcro 18" One Wrap grip tie | 1"x18" grip tie, lemon    | Gray Container - Velcro Bag | 2  | Velcro USA, Inc. |
| Velcro 5/8" One Wrap Tape    | 24" Lengths, Black        | Gray Container - Velcro Bag | 1  | Velcro USA, Inc. |
| Velcro 8" One Wrap grip tie  | 1"x8" grip tie, Cranberry | Gray Container - Velcro Bag | 10 | Velcro USA, Inc. |
| Velcro grip tie              | 6"x 1"                    | Gray Container - Velcro Bag | 2  | Tyton Hellermann |
| Velcro Sticky Back Coins     | 5/8" Ø x 36" (48 sets)    | Gray Container - Velcro Bag | 1  | Velcro USA, Inc. |

### Field Components

| Part Name/Description | Dimensions                         | Location                | Qty /Kit | Product Supplier |
|-----------------------|------------------------------------|-------------------------|----------|------------------|
| Ball                  | 13" Ø yellow ball, w/ plastic plug | Green Container - Loose | 1        | Sport Fun        |

### Misc Hardware

| Part Name/Description                                 | Dimensions                        | Location                          | Qty /Kit | Product Supplier                     |
|---|-----------------------------------|-----------------------------------|----------|--------------------------------------|
| Caster, W/ Bolt Hole Mount                            | 165 Pounds, swivel                | Gray Container - Loose            | 2        | WT Hight company                     |
| Channel For Tape Drive                                | 28" Long                          | Gray Container - Loose            | 4        | Delphi Interior and Lighting Systems |
| Double Magnet Cabinet Catch                           |                                   | Gray Container - Hardware Bag     | 1        | Stanley Hardware                     |
| Drill Housing Cover                                   | W/ Shift Lever                    | Green Container - Drill Bag       | 2        | S-B Power Tool                       |
| Flange Nut for Seat Positioning Unit                  | M6 x 1.0 Pitch                    | Gray Container - Seat Positioning | 8        | Lear Corporation                     |
| Flat Washers  | 1/4" I.D., 7/8" O.D.              | Gray Container - Hardware Bag     | 4        | Fastenal Company                     |
| Flexible Shaft Coupling                               | Black                             | Gray Container - Seat Positioning | 2        | DEKA                                 |
| Folding Table Brace                                   | 9-1/2" Brass plated               | Gray Container - Hardware Bag     | 1        | Stanley Hardware                     |
| Gate Latch  | Steel/Zinc Plated                 | Gray Container - Hardware Bag     | 1        | Stanley Hardware                     |
| Hex Head Bolt for Seat Positioning Unit               | M6 x 1.0 Pitch x 30mm             | Gray Container - Seat Positioning | 4        | Lear Corporation                     |
| Hex Nuts  | 1/4" I.D., 20 Pitch Coarse Thread | Gray Container - Hardware Bag     | 8        | Fastenal Company                     |
| Horiz. Act. (L) for Seat Positioning Unit, Left Hand  | Natural Color                     | Gray Container - Seat Positioning | 1        | Lear Corporation                     |
| Horiz. Act. (R) for Seat Positioning Unit, Right Hand | Black and Natural Color           | Gray Container - Seat Positioning | 1        | Lear Corporation                     |
| Lower Channel for Seat Positioning Unit               | 2.25" x 17" Channel               | Gray Container - Loose            | 1        | Lear Corporation                     |

# THE 2000 FIRST ROBOTICS COMPETITION MANUAL

## 2000 FIRST Robotics Competition Kit Parts

|   |   |                                   |   |                                      |
|---|---|-----------------------------------|---|--------------------------------------|
| Magnet                                  | 1/4-20 Plastic Thread                       | Gray Container - Hardware Bag     | 2 | Honeywell - Microswitch Division     |
| Pivot                                   | 5/16" Ø                                     | Gray Container - Hardware Bag     | 2 | Stanley Hardware                     |
| Roller Guide                            | 7/8" Ø x 1/4" Wheel                         | Gray Container - Hardware Bag     | 2 | Stanley Hardware                     |
| Screen Door Holder                      | Zinc-Plated                                 | Gray Container - Hardware Bag     | 1 | Stanley Hardware                     |
| Upper Channel for Seat Positioning Unit | 1.3125" x 9.875" Channel with Gear          | Gray Container - Seat Positioning | 2 | Lear Corporation                     |
| Wheelchair Wheel                        | 6" Ø, 5/16" I.D. Bearings, 1-1/2" Wide      | Gray Container - Loose            | 2 | Skyway Recreation Products           |
| Wheelchair Wheel                        | 8" Ø, 5/16" I.D. Bearings, 1-1/2" Wide      | Gray Container - Loose            | 2 | Skyway Recreation Products           |
| Window Lift Bracket, Left Hand          | Color Natural                               | Gray Container - Window Lift      | 1 | Delphi Interior and Lighting Systems |
| Window Lift Bracket, Right Hand         | Color Natural                               | Gray Container - Window Lift      | 1 | Delphi Interior and Lighting Systems |
| Window Lift Gear                        | Use with Window Tape, Window Lift Mechanism | Gray Container - Window Lift      | 2 | Delphi Interior and Lighting Systems |
| Window Lift Guide Drive                 | Use with Guide, Channel, Window Tape        | Gray Container - Window Lift      | 8 | Delphi Interior and Lighting Systems |
| Window Lift Guide, Left Hand            | Attach to Triangular Mount, Window Lift     | Gray Container - Window Lift      | 1 | Delphi Interior and Lighting Systems |
| Window Lift Guide, Right Hand           | Attach to Triangular Mount, Window Lift     | Gray Container - Window Lift      | 1 | Delphi Interior and Lighting Systems |
| Window Lift Mechanism Tape              | 16' Length                                  | Gray Container - Window Lift      | 1 | Dymetrol Company, Inc.               |
| Window Lift Triangular Mount            | White, Window Lift Mechanism                | Gray Container - Window Lift      | 2 | St. Clair Plastics Company           |

### Motors & Pumps

| Part Name/Description           | Dimensions                      | Location                    | Qty /Kit | Product Supplier       |
|---------------------------------|---------------------------------|-----------------------------|----------|------------------------|
| Drill Drive Assembly            | 225 in. lbs Maximum Torque      | Green Container - Drill Bag | 2        | S-B Power Tool Company |
| Drill Housing                   | T-Handle Style Grip, Left/Right | Green Container - Loose     | 2        | S-B Power Tool         |
| Drill Motor                     | 12 Vdc                          | Green Container - Drill Bag | 2        | S-B Power Tool         |
| Fisher-Price 10 Web Jeep Driver | Black                           | Gray Container - Loose      | 2        | Fisher-Price, Inc.     |
| Fisher-Price Axle               | 7/16" Ø x 26"                   | Gray Container - Loose      | 1        | Fisher-Price, Inc.     |
| Fisher-Price Motor/Gearbox      | two 12 Vdc motors, switches     | Gray Container - Loose      | 1        | Fisher-Price, Inc.     |
| Globe Motor with Drive Assembly | 12Vdc                           | Gray Container - Loose      | 2        | Globe Motors           |

# THE 2000 FIRST ROBOTICS COMPETITION MANUAL

## 2000 FIRST Robotics Competition Kit Parts

|                          |  |                              |   |                                      |
|--------------------------|--|------------------------------|---|--------------------------------------|
| Seat Motor               | 12 Vdc                                 | Gray Container - Loose       | 2 | Delphi Automotive                    |
| Van Door Motor - Tiagene | 12 Vdc, 75 RPM                         | Gray Container - Loose       | 2 | Delphi Interior and Lighting Systems |
| Window Motor, Left Hand  | 12 Vdc, 12 Tooth Pinion, 16 pitch stub | Gray Container - Window Lift | 1 | ITT Automotive                       |
| Window Motor, Right Hand | 12 Vdc, 12 Tooth Pinion, 16 pitch stub | Gray Container - Window Lift | 1 | ITT Automotive                       |

### Other

| Part Name/Description               | Dimensions                     | Location                       | Qty /Kit | Product Supplier |
|-------------------------------------|--------------------------------|--------------------------------|----------|------------------|
| Carpet Sample                       | 12" x 12", 20 oz., Closed Loop | Gray Container - Loose         | 1        | FIRST            |
| Co-Polymer Gutter Guard             | 6" x 24"                       | Gray Container - Loose         | 1        | Home Depot       |
| Folding Table Leg Brace, Left Hand  | Heavy Duty Leg Brace           | Gray Container - Loose         | 1        | Stanley Hardware |
| Folding Table Leg Brace, Right Hand | Heavy Duty Leg Brace           | Gray Container - Loose         | 1        | Stanley Hardware |
| Pneumatics Bag                      |                                | Vendor will drop ship to teams | 1        | SMC              |

### Rods & Shafts

| Part Name/Description | Dimensions                           | Location                          | Qty /Kit | Product Supplier             |
|-----------------------|--------------------------------------|-----------------------------------|----------|------------------------------|
| Aluminum Rod          | 1/2" Ø x 24"                         | Gray Container - Tube             | 2        | Cohen Steel Supply Inc.      |
| Delrin (Acetal) Rod   | 1/4" Ø x 20"                         | Gray Container - Tube             | 1        | Plastic Supply               |
| Drill Rod             | 1/2" Ø x 18"                         | Gray Container - Tube             | 2        | Cohen Steel Supply Inc.      |
| Drill Rod             | 1/4" Ø x 18"                         | Gray Container - Tube             | 2        | Cohen Steel Supply Inc.      |
| Drill Rod             | 3/8" Ø x 18"                         | Gray Container - Tube             | 2        | Cohen Steel Supply Inc.      |
| Drill Rod             | 5/16" Ø x 18"                        | Gray Container - Tube             | 2        | Cohen Steel Supply Inc.      |
| Flexible Motor Shaft  | 13.5" Long, Fits Seat Motor          | Gray Container - Seat Positioning | 2        | Grand Rapids Controls        |
| LDPE Rod              | 1" Ø x 24"                           | Gray Container - Loose            | 1        | Plastic Supply Inc.          |
| Lead Screw            | 12" Long                             | Gray Container - Loose            | 1        | Kerk Motion Products, Inc.   |
| Threaded Rod          | 1/4" Ø x 18", 20 Pitch Coarse Thread | Gray Container - Tube             | 1        | McMaster-Carr Supply Company |

### Sheets & Boards

| Part Name/Description | Dimensions      | Location               | Qty /Kit | Product Supplier        |
|-----------------------|-----------------|------------------------|----------|-------------------------|
| Aluminum Plate        | 1/4" x 3" x 12" | Gray Container - Loose | 1        | Cohen Steel Supply Inc. |

# THE 2000 FIRST ROBOTICS COMPETITION MANUAL

## 2000 FIRST Robotics Competition Kit Parts

|            |              |                        |   |                |
|------------|--------------|------------------------|---|----------------|
| HDPE Block | 1" x 2" x 6" | Gray Container - Loose | 1 | Plastic Supply |
|------------|--------------|------------------------|---|----------------|

### Springs

| <u>Part Name/Description</u>       | <u>Dimensions</u>                              | <u>Location</u>               | <u>Qty /Kit</u> | <u>Product Supplier</u>   |
|------------------------------------|--|-------------------------------|-----------------|---------------------------|
| Compression Spring                 | 0.600" O.D. x 3.5" Long x 0.059" Wire Diameter | Gray Container - Hardware Bag | 2               | Associated Spring Raymond |
| Constant Force Spring, Extra Small | 0.34" I.D.                                     | Gray Container - Hardware Bag | 2               | Associated Spring Raymond |
| Constant Force Spring, Large       | 1.02" I.D.                                     | Gray Container - Hardware Bag | 2               | Associated Spring Raymond |
| Constant Force Spring, Medium      | 0.59" I.D.                                     | Gray Container - Hardware Bag | 2               | Associated Spring Raymond |
| Constant Force Spring, Small       | 0.51" I.D.                                     | Gray Container - Hardware Bag | 2               | Associated Spring Raymond |
| Extension Spring                   | 0.650" O.D. x 2.000" Long                      | Gray Container - Hardware Bag | 2               | Associated Spring Raymond |
| Latex Tubing                       | 1/4" I.D., 3/8" O.D., 5'                       | Gray Container - Loose        | 1               | Gulf South Medical Supply |
| Snugger                            | Spring With Plastic Guide                      | Gray Container - Hardware Bag | 2               | Stanley Hardware          |
| Spring Loaded Hinge/brass          | 4" x 4", 30 in/lb Maximum                      | Gray Container - Hardware Bag | 1               | Stanley Hardware          |
| Spring Loaded Hinge/gray           | 4" x 4", 30 in/lb Maximum                      | Gray Container - Hardware Bag | 1               | Stanley Hardware          |
| Torsion Spring, Left Hand          | 270 Degrees, 0.664" Dia , 0.054" Wire Diameter | Gray Container - Hardware Bag | 2               | Associated Spring Raymond |
| Torsion Spring, Right Hand         | 270 Degrees, 0.664" Dia , 0.054" Wire Diameter | Gray Container - Hardware Bag | 2               | Associated Spring Raymond |

### Sprockets & Pulleys

| <u>Part Name/Description</u> | <u>Dimensions</u>    | <u>Location</u>               | <u>Qty /Kit</u> | <u>Product Supplier</u> |
|------------------------------|----------------------|-------------------------------|-----------------|-------------------------|
| Pulley With Fixed Eye        | 1" Ø, For 5/16" Rope | Gray Container - Hardware Bag | 3               | Stanley Hardware        |



**APPENDIX C: ADDITIONAL HARDWARE LIST****Control System**

|                                  |  |
|----------------------------------|--|
| CH Products Flightstick Joystick | Up to 2                                      |
| DB15 female solder cup connector | Up to 8                                      |
| DB15 M-F Cable                   | 6' Length, Up to 2                           |
| DB15 male solder cup connector   | Up to 4                                      |
| Electrical Tape                  | Any amount when used as an insulator         |
| Heat Shrink Tubing               | Any amount, Any Ø                            |
| Hood for 15 pin connector        | Thermoplastic, Up to 12                      |
| Insulated Crimp-on Connectors    | Spade, Butt, Ring & Bullet , Any amount/size |
| Permanent Magnet                 | Any amount                                   |
| PWM/Relay Cable                  | JR-style, Any Amount                         |
| PWM/Relay Y Cable                | JR-style, Any Amount                         |
| Relay Module (Spike)             | Any amount - when used per rules             |
| Speed Controller (Victor 883 )   | Any amount - when used with motor            |
| Wire                             | Proper gauge, color & insulated              |
| Wire Nuts                        | Any amount                                   |

**Fasteners**

|                                     |                           |
|-------------------------------------|---------------------------|
| Fasteners, Washers, Nuts, Adhesives | Any amount - Joining ONLY |
| Hose Clamps                         | Any Ø, Any amount         |

|                               |                             |
|-------------------------------|-----------------------------|
| Joining Plates for Extrusions | Any amount, Any size        |
| Rubber Band, Large            | 3-1/2" x 1/4" wide, Up to 5 |
| Rubber Band, Small            | 3-1/2" x 1/8" wide, Up to 5 |

## Rods & Shafts

|                               |                             |
|-------------------------------|-----------------------------|
| Copper Water Pipe             | Any length, 1/2" Ø          |
| Electrical Conduit Pipe (EMT) | Any length, 1/2" - 3/4" Ø   |
| Flexible Conduit (ENT)        | Any length, 1/2" Ø PVC      |
| Pins - linkage or hinge       | Any amount                  |
| Schedule 40 PVC Pipe          | Any length, 1/2" - 1 1/2" Ø |
| Shaft Couplings               | Any size, Up to 10          |
| Wooden Closet Rod             | Any length, up to 1 1/4" Ø  |

## Rope, Belts, & Chain

|                    |                           |
|--------------------|---------------------------|
| Chain/Belt         | Any length                |
| Nylon Braided Rope | Any length, up to 5/16" Ø |
| Steel Cable        | Any length, up to 1/8" Ø  |

## Sheets & Boards

|                |                              |
|----------------|------------------------------|
| 1/2" Plywood   | 1 sheet 4'x8'                |
| 1/4" Plywood   | 1 sheet 4'x8'                |
| Aluminum Plate | Any length, Up to 1/4" thick |

|                      |                              |
|----------------------|------------------------------|
| HDPE Block           | 1 Piece 1" x 12" x 12"       |
| Pine Board           | Any length, 3/4" x 3-1/2"    |
| Poly carbonate Sheet | Any amount, Up to 3/8" thick |
| Steel Plate          | Any amount, Up to 1/4" thick |

## Sprockets & Pulleys

|                              |                      |
|------------------------------|----------------------|
| Sprockets, Gears and Pulleys | Any size, Any amount |
|------------------------------|----------------------|

## Structural

|                     |                                     |
|---------------------|-------------------------------------|
| Aluminum Angle      | Any length, Up to 2"x2"x 1/4" thick |
| Extruded Aluminum   | Any length, Up to 2"x3"             |
| Extruded Fiberglass | Any length, Up to 3"x3"             |
| Fiberglass          | Any amount, Up to 1/8" thick        |
| Resin + Hardener    | As needed for fiberglass            |
| Steel Angle         | Any length, Up to 2"x2"x 1/4" thick |

## Wheels

|                           |                                 |
|---------------------------|---------------------------------|
| Skyway Wheelchair Wheel   | 5"-8" Ø, Up to 6 non-pneumatic  |
| W.T. Hight Caster, Swivel | Any amount, part #31CD30X8812MM |



**APPENDIX D: SMALL PARTS, INC. ORDERING  
INFORMATION**



**SMALL  
PARTS  
INC.**

Toll-Free Fax: 877-573-9273

Web Site: [www.smallparts.com/first](http://www.smallparts.com/first)

E-mail: [first@smallparts.com](mailto:first@smallparts.com)

Tel: 305-825-7961

## **ORDERING GUIDELINES**

**FIRST – Robotics Competition 2000**

**SMALL PARTS, INC.** is your team's major source for the additional material and parts needed to design, prototype and build your final robot. This year in addition to your team's \$425.00 SPARK Account, **SMALL PARTS, INC.** will contribute these two additional start-up kits containing:

**Aluminum Kit:** (4) 1" x 1/8" x 72" Aluminum Angles  
(1) 1-1/2" x 1/8" x 72" Aluminum Angle

**Drive Components Kit:** 10' No. 35, 3/8" Pitch Roller Chain  
(4) 10-tooth Steel Roller Chain Sprockets  
(10) Connecting Links  
(5) Roller Links

### **REGISTERING**

**By Fax:** Fill out the Registration Form (next page) and send it **Toll-Free** to 877-573-9273  
**By Internet:** Go to [www.smallparts.com/first](http://www.smallparts.com/first) and follow the instructions.

When we receive your registration we will ship your two start-up kits immediately with no shipping charge. Once registered you may immediately order other materials from the **SMALL PARTS** Catalog as described below.

### **ORDERING** (*Your team must register before ordering.*)

We encourage teams to place their orders via Fax or the Internet. This allows us to enter your order directly from a hard copy and immediately contact you if any problems are found. Please make sure you fill out all sections of the Order Form. Any section not completely filled out may delay the processing and shipping of your order.

It is not necessary to specify to **SPI**, at the time you order, which materials you will be using in your final robot. All purchases by your team will be placed in your team's account. Your **SPARK** credit will be deducted from your account and reflected on your invoice.

### **SHIPPING** (*Shipping charges apply to all orders and will appear on your invoice.*)

All orders will be shipped within 24 hours ARO (after receipt of order). We will make every effort to ship orders placed before noon (your time zone) that same day. Our standard method of shipping for the competition will be via FedEx with 2-Day guaranteed delivery, unless you request an alternate method. 2-Day is guaranteed delivery on the second business day after pickup from **SPI**.

**Please plan accordingly.** Placing orders late in the week may require additional charges to assure delivery by the weekend. Shipping charges will be applied as follows:

Shipping weights under 20 lbs .....\$6.00 shipping charge.  
Shipping weights in excess of 20 lbs .....Current FedEx rate.  
Overnight Shipping .....Current FedEx rate.  
Saturday Delivery .....Overnight shipping charge + \$10.00.  
Other Carrier .....Actual charges per your direction.

### **BACK ORDERS**

**SPI** has increased its product stocking levels for the competition. However, sometimes the demand exceeds our on-hand quantity. Should a part be temporarily out-of-stock, **SPI** will make every effort to supply your item in a timely manner.

### **RETURNS**

Returns must be made within 30 days of receipt. For full credit, products must be returned in their original unopened individual packages. Please call Customer Service at 305-557-7955 to obtain an RMA number. Be sure to have your packing slip(s) available when you call, since you must provide the packing slip number(s) for the material to be returned. Returns may be subject to a 15% restocking fee.

### **HOLIDAY SCHEDULE**

**SPI** will be closed for the following National Holidays:

Monday, January 17, 2000 . . . . Martin Luther King Day  
Monday, February 21, 2000 . . . . Presidents' Day



Sponsor of the  
Woodie Flowers Award

**"Chance favors the  
prepared mind."**

Louis Pasteur



**FIRST**  
*Robotics Competition*

# SPARK

SMALL PARTS ADDITION TO ROBOTICS KIT

## **FIRST** *Robotics Competition 2000*

**\$425.00** (Four Hundred Twenty Five Dollars) presented to Team No. \_\_\_\_\_

We are happy to contribute this vital **SPARK** towards successful completion of your robot.

By **extending** the kit of materials to include items from our catalog, we offer you choices from hundreds of devices, components and materials. We hope this will make it easier for you to create innovative and reliable machines.

In the spirit of helping to "level the field" for all teams, **FIRST** provides a kit but limits the additions which can be made to the kit of parts in your robot. The most versatile kit **addition** is the **\$425 of SMALL PARTS** we offer you free of charge. Please note that the **\$425** "level playing field" amount applies only to the **SMALL PARTS** items which are used in your machine.

You may purchase unlimited additional items from the **SMALL PARTS** catalog as you need them.

Read complete rules and regulations in the manual for **FIRST** — Robotics Competition 2000

***Best of luck to your team!***



**SMALL  
PARTS  
INC.**

Toll-Free Fax: 877-573-9273

Tel: 305-825-7961

E-mail: [first@smallparts.com](mailto:first@smallparts.com)

Web Site: [www.smallparts.com/first](http://www.smallparts.com/first)

## REGISTRATION FORM

**FIRST** – Robotics Competition 2000

Team No.: \_\_\_\_\_ Date: \_\_\_\_\_

Team Name: \_\_\_\_\_

Corporate Sponsor: \_\_\_\_\_

### Contact Person: *(Individual responsible for team purchasing records.)*

Name: \_\_\_\_\_ Title: \_\_\_\_\_

Address: \_\_\_\_\_

City: \_\_\_\_\_ State: \_\_\_\_\_ Zip: \_\_\_\_\_

Phone: ( ) \_\_\_\_\_ Fax: ( ) \_\_\_\_\_ E-mail: \_\_\_\_\_

24-hour emergency phone number for problem resolution: \_\_\_\_\_

### Other team members who can order:

Name: \_\_\_\_\_ Affiliation: \_\_\_\_\_

Name: \_\_\_\_\_ Affiliation: \_\_\_\_\_

Name: \_\_\_\_\_ Affiliation: \_\_\_\_\_

Name: \_\_\_\_\_ Affiliation: \_\_\_\_\_

Name: \_\_\_\_\_ Affiliation: \_\_\_\_\_

### Billing Information: *(For charges outside the SPARK credit)*

Name: \_\_\_\_\_ Title: \_\_\_\_\_

Address: \_\_\_\_\_

City: \_\_\_\_\_ State: \_\_\_\_\_ Zip: \_\_\_\_\_

Phone: ( ) \_\_\_\_\_ Fax: ( ) \_\_\_\_\_ E-mail: \_\_\_\_\_

Use Purchase Order No.: \_\_\_\_\_

CREDIT CARD INFORMATION ☐ AMEX ☐ VISA ☐ MASTERCARD Expiration Date: \_\_\_\_\_

Card No.: \_\_\_\_\_ Cardholder Name: \_\_\_\_\_

Billing Address: \_\_\_\_\_

City: \_\_\_\_\_ State: \_\_\_\_\_ Zip: \_\_\_\_\_

### Shipping Address: *(All packages will be shipped to this address unless an alternative is given with the order.)*

Name: \_\_\_\_\_ Title: \_\_\_\_\_

Address: \_\_\_\_\_

City: \_\_\_\_\_ State: \_\_\_\_\_ Zip: \_\_\_\_\_

Phone: ( ) \_\_\_\_\_ Fax: ( ) \_\_\_\_\_ E-mail: \_\_\_\_\_

FEDEX Account No. (if applicable): \_\_\_\_\_



# FAX ORDER FORM



**SMALL  
PARTS  
INC.**

Toll-Free Fax: 877-573-9273

Tel: 305-825-7961

Web Site: [www.smallparts.com/first](http://www.smallparts.com/first)

E-mail: [first@smallparts.com](mailto:first@smallparts.com)



**FIRST – Robotics Competition 2000**

Team No. \_\_\_\_\_

Team Name \_\_\_\_\_

Corporate Sponsor \_\_\_\_\_

Date: \_\_\_\_\_ Ref. No.: \_\_\_\_\_

Your Name: \_\_\_\_\_

E-mail: \_\_\_\_\_

Phone: \_\_\_\_\_ Fax: \_\_\_\_\_

## PAYMENT METHOD

☐ From Allotment (If this order exceeds allotment, please bill as indicated)

☐ Blanket P.O. No. \_\_\_\_\_ ☐ Credit Card

## SHIPPING METHOD

FEDEX ☐ 2-Day ☐ Priority ☐ Saturday Delivery (Priority Only)

FEDEX Account No. (If needed) \_\_\_\_\_

## CREDIT CARD INFORMATION

☐ AMEX ☐ VISA ☐ MASTERCARD Expiration Date: \_\_\_\_\_

Card No.: \_\_\_\_\_

Cardholder Name: \_\_\_\_\_

Billing Address: \_\_\_\_\_

City: \_\_\_\_\_ State: \_\_\_\_\_ ZIP: \_\_\_\_\_

## USE THIS ALTERNATE SHIPPING ADDRESS

Attention: \_\_\_\_\_

Address: \_\_\_\_\_

City: \_\_\_\_\_ State: \_\_\_\_\_ ZIP: \_\_\_\_\_

Phone: \_\_\_\_\_ Fax: \_\_\_\_\_

## USE THIS ALTERNATE BILLING ADDRESS

Attention: \_\_\_\_\_

Address: \_\_\_\_\_

City: \_\_\_\_\_ State: \_\_\_\_\_ ZIP: \_\_\_\_\_

Phone: \_\_\_\_\_ Fax: \_\_\_\_\_

| ITEM | QTY. | PART No. | DESCRIPTION | UNIT PRICE | TOTAL |
|------|------|----------|-------------|------------|-------|
| 1    |      |          |             |            |       |
| 2    |      |          |             |            |       |
| 3    |      |          |             |            |       |
| 4    |      |          |             |            |       |
| 5    |      |          |             |            |       |
| 6    |      |          |             |            |       |
| 7    |      |          |             |            |       |
| 8    |      |          |             |            |       |
| 9    |      |          |             |            |       |
| 10   |      |          |             |            |       |
| 11   |      |          |             |            |       |
| 12   |      |          |             |            |       |
| 13   |      |          |             |            |       |
| 14   |      |          |             |            |       |
| 15   |      |          |             |            |       |
| 16   |      |          |             |            |       |
| 17   |      |          |             |            |       |
| 18   |      |          |             |            |       |
|      |      |          |             | TOTAL      |       |

# THE 2000 FIRST ROBOTICS COMPETITION MANUAL

## APPENDIX E: KEE KLAMP ORDERING INFORMATION

### PURCHASE ORDER FORM – FIRST Competitors – SPECIAL PRICING

Kee Industrial Products, Inc  
100 Stradtman Street, Buffalo, NY 14206 - Fax: (716) 896-5696

### Kee Klamp® Pipe Fittings

|   |  |                    |       |                  |              |         |
|---|--|--------------------|-------|------------------|--------------|---------|
| Team #  |  | Corporate Sponsor: |       |                  |              |         |
| Phone:  |  | Fax:               |       | Ship To Address: |              |         |
| PAYMENT METHOD: Master Card / Visa (CIRCLE ONE) |  |                    |       | City:            | State        | Zip     |
| CARD NO.  |  | Exp. Date          | Attn: |                  |              |         |
| Card Holder Name:                               |  |                    |       | Phone :          |              |         |
| Signature:                                      |  |                    |       | SHIPPING METHOD: |              |         |
| PLEASE FAX COMPLETED FORM TO (716) 896-5696     |  |                    |       | RPS/UPS Ground   | UPS Next Day | Two Day |

Any questions, please call (800) 851-5181

PLEASE NOTE—NO RETURNS OR REFUNDS

| Description              |  | NET             |       |
|--------------------------|--|-----------------|-------|
| Kee Klamp Goal           | All Kee Klamp Fittings Required for one Goal               | <u>\$195.89</u> |       |
| Bill of Materials        | Note: Please specify Quantity ( 2 goals per playing field) |                 |       |
| <b>Kee Klamp Fitting</b> |  |                 |       |
| KK 10-7                  | Kee Klamp Tee  | 8               | 5.04  |
| KK 15-7                  | Kee Klamp Elbow  | 6               | 6.16  |
| KK 26-7                  | Kee Klamp Two Socket Cross                                 | 6               | 6.86  |
| KK 35-7                  | Kee Klamp Side Outlet Tee                                  | 1               | 10.09 |
| KK C51-7                 | Kee Klamp Double Swivel Socket                             | 2               | 15.57 |
| KK C58-7                 | Kee Klamp Swivel Flange                                    | 2               | 9.45  |
| KK 61-7                  | Kee Klamp Flange   | 1               | 5.62  |
| KK 62-7                  | Kee Klamp Railing Flange                                   | 1               | 8.06  |
| KK 77-7                  | Kee Klamp Plastic Plug                                     | 4               | .91   |

| Description       |   | NET             |       |
|-------------------|---|-----------------|-------|
| Kee Klamp Border  | All Kee Klamp Fittings Required for the complete Border and Driver Stations | <u>\$692.52</u> |       |
| Bill of Materials |   |                 |       |
| Kee Klamp Fitting |   |                 |       |
| KK 14-7           | Kee Klamp Straight Coupling   | 4               | 5.75  |
| KK 15-7           | Kee Klamp Elbow   | 6               | 6.16  |
| KK 19-7           | Kee Klamp Adj. Side Outlet Tee  | 4               | 13.82 |
| KK 26-7           | Kee Klamp Two Socket Cross  | 14              | 6.86  |
| KK 35-7           | Kee Klamp Side Outlet Tee   | 2               | 10.09 |
| KK M50-7          | Kee Klamp Male Single Socket Member   | 16              | 4.10  |
| KK M58            | Kee Klamp Male Base Plate   | 8               | 4.46  |
| KK 61-7           | Kee Klamp Flange  | 20              | 5.62  |
| KK 70-7           | Kee Klamp Rail Support  | 36              | 6.72  |
| KK 77-7           | Kee Klamp Plastic Plug  | 6               | .91   |

Effective: January 1, 2000 Terms: Only Master Card/Visa Accepted F.O.B. Buffalo, NY Warehouse

\* SPECIAL PRICING FOR FIRST ROBOTICS COMPETITION ONLY

ALL ORDERS MUST BE TAGGED OR IDENTIFIED AS: "FIRST COMPETITION"



## APPENDIX F: PROBLEM REPORT FORM

### PROBLEM REPORT PROCEDURE

On occasion, your team may experience difficulty with a part supplied by FIRST. If you do, please follow these procedures:

**1. Try to solve the problem yourself.**

(Refer to the Robot section of the manual referring to the Policy on Repair and Replacement of Kit Parts.)

**2. Contact our engineers or Innovation First, as appropriate.**

(They may be able to give advice and save you shipping costs, time, and money.)

If the part is supported by FIRST, then follow steps 3-5 below. If the part is supported by Innovation First, visit the Innovation First web site at [www.innovationfirst.com](http://www.innovationfirst.com) for instructions on returning the part.

**3. Fill out the Problem Report Form completely:**

- Team Number
- Reported Defect (Explain the problem fully)
- Name
- Date Sent
- Phone Number (Where we can reach you during the day)
- Special Attention (Any special handling, timing, etc.)

**4. Carefully package the item(s) and enclose the filled out Problem Report Form.**

**5. Label the package and it send to:**

FIRST

Attn: FRC Part Return

200 Bedford Street

Manchester, NH 03101

We have a one business day turnaround policy on replacement. We try very hard to send a replacement item within one day after we receive the non-functional unit.

# THE 2000 FIRST ROBOTICS COMPETITION MANUAL

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## PROBLEM REPORT FORM

Team Number: \_\_\_\_\_

Program: FIRST Robotics Competition

Reported Defect(s) (You may use a separate sheet to explain):

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Name: \_\_\_\_\_

Date: \_\_\_\_\_

Phone Number: \_\_\_\_\_

Special Attention:

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## **APPENDIX G - SUPPLIER CONTACT INFORMATION**

|  |   |
|--|---|
| AMP Incorporated<br>P.O. Box 3608<br>Harrisburg, PA 17105-3608<br>Phone: 717-592-4869<br>Fax: 717-592-3043   | Associated Spring Raymond<br>Customer Service<br>P.O. Box 586<br>1705 Indianwood Circle<br>Maumee, OH 43537-0586<br>Phone: 1-800-458-0867                           |
| Autodesk, Inc.<br>Ms. Laura London<br>Education Department<br>111 McInnis Parkway<br>San Rafael, CA 94903<br>Phone: 415-507-6411<br>Fax: 415-507-6113  | Brevan Electronics<br>Mr. Stewart Schuster<br>6 Continental Blvd.<br>Merrimack, NH 03054<br>Phone: 603-429-1900<br>Fax: 603-429-1001                                |
| CH Products<br>970 Park Center Drive<br>Vista , CA 92083<br>Phone: 760-598-2518<br>Fax: 760-598-2524<br>Web: www.chproducts.com                        | CP Clare Corporation<br>For reed switches contact:<br>Newark Electronics<br>59 Composite Way<br>Lowell, MA 01851<br>Phone: 800-463-9275<br>Web: www.newark.com      |
| EBM Industries, Inc.<br>100 Hyde Road<br>Farmington, CT 06034<br>Phone: 860-674-1515<br>Fax: 860-674-8536<br>Email: sales@ebm.com<br>Web: www.ebm.com  | Hitec RCD Servos<br>12115 Paine St.<br>Poway CA 92064<br>Phone : 858-748-6948<br>Web: www.hitecrcd.com  |
| Honeywell - Microswitch Division<br>11 West Spring Street<br>A2-140<br>Freeport, IL 61032<br>Phone: 815-235-6616                                       | Innovation First, Inc.<br>8910 F. Wesley St.<br>Greenville, TX 75401<br>Phone: 903-454-1978<br>Web: www.innovationfirst.com<br><b>NO PHONE ORDERS WILL BE TAKEN</b> |
| Kee Industrial Products/Green Sales Co.<br>P.O. Box 6186<br>Nashua, NH 03063-6186<br>Phone: 800-851-5181<br>Fax: 603-880-0962<br>Web: www.keeklamp.com | McMaster-Carr Supply Co.<br>473 Ridge Rd.<br>P.O. Box 317<br>Dayton, NJ 08810<br>Phone: 732-329-3200<br>Fax: 732-329-3772<br>Web: www.mcmaster.com                  |

## THE 2000 FIRST ROBOTICS COMPETITION MANUAL

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|---|--|
| <p>Parallax, Inc.<br/>3805 Atherton Road<br/>Suite 102<br/>Rocklin, CA 957657<br/>Phone: 888-512-1024<br/>Fax: 916-624-8003<br/>Web: www.parallaxinc.com</p>                                  | <p>S-B Power Tool Company<br/>20 Truman Drive South<br/>Edison, NJ 08817<br/>Phone: 732-572-5009<br/>Fax: 908-572-9587</p>   |
| <p>SERPAC<br/>619 Commercial Ave.<br/>Covina, CA 91723<br/>Phone: 626-331-0517<br/>Fax: 626-331-8584</p>  | <p>Skyway Recreation Products<br/>4451 Caterpillar Road<br/>Redding, CA 96003<br/>Phone: 800-332-3357<br/>Fax: 530-243-5104<br/>Email: sales@skywaywheels.com<br/>Web: www.skywaytuffwheels.com</p>  |
| <p>SMC Pneumatics Inc.<br/>Zero Centennial Drive<br/>Peabody, MA 01960<br/>Phone: 978-326-3600<br/>Fax: 978-326-3700</p>  | <p>Small Parts, Inc.<br/>13980 NW 58th Court<br/>Miami Lakes, FL 33014<br/>Phone: 305-820-9371<br/>Fax: 800-423-9009<br/>Web: www.smallparts.com</p>   |
| <p>Sport Fun, Inc.<br/>Mr. Dave Jackson<br/>4621 Sperry Street<br/>P.O. Box 39150<br/>Los Angeles, CA 900039-0150<br/>Phone: 800-423-2597<br/>Fax: 818-502-0399<br/>Web: www.sportfun.com</p> | <p>S.S. Mills, Inc.<br/>P.O. Box 1568<br/>Customer Service<br/>Dalton, GA 30722<br/>Phone: 800-241-4013<br/>Fax: 706-277-3677</p>  |
| <p>Stanley Hardware Division<br/>P.O. Box 1308 [H]<br/>New Britain, CT 06050<br/>Phone: 860-827-5691<br/>Fax: 860-827-5694</p>  | <p>Thomas &amp; Betts<br/>Electrical Components Division<br/>8155 T &amp; B Blvd.<br/>Memphis, TN 38125<br/>Phone: 901-682-8221 or 800-888-0211<br/>Fax: 800-888-0790</p>  |
| <p>Torrington Bearings<br/>For additional bearings call<br/>Motion Industries, Inc.<br/>P.O. Box 1097<br/>Earth City, MO 63043-0097<br/>Phone: 314-770-2600<br/>Fax: 314-770-2272</p>         | <p>TytonHellermann<br/>7930 N. Faulkner Rd.<br/>P.O. Box 245017<br/>Milwaukee, WI 53224<br/>Phone: 800-537-1512 or 414-355-1130<br/>Fax: 800-848-9866 or 414-355-7341<br/>Email: ksweet@tytonhellermann.com<br/>Web: www.tytonhellermann.com</p> |
| <p>Velcro USA, Inc.<br/>406 Brown Avenue #1<br/>P.O. Box 5218<br/>Manchester, NH 03103<br/>Phone: 603-669-4892<br/>Fax: 603-669-8991</p>  | <p>W.T Hight Company<br/>225 Corporate way<br/>Medford, MA 02155<br/>Phone: 800-445-4082 or 781-396-2268<br/>Fax: 781-396-0542<br/>Web: www.weroll.com</p>   |

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