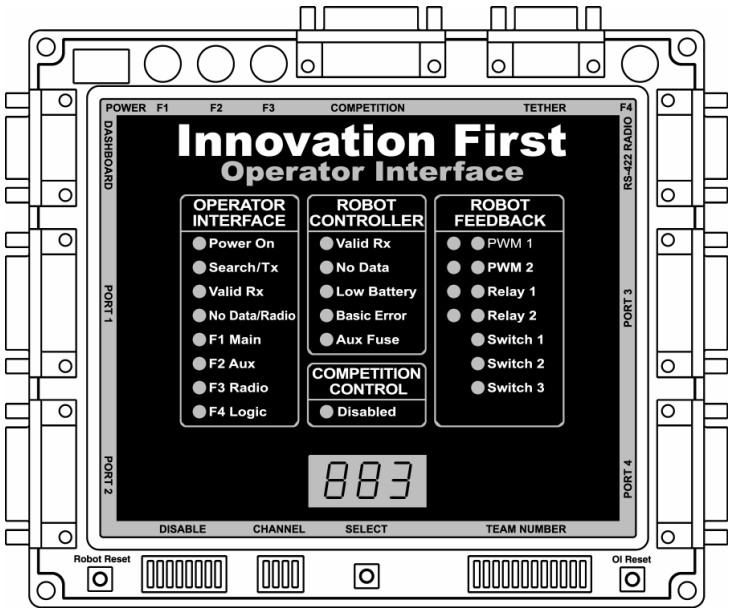
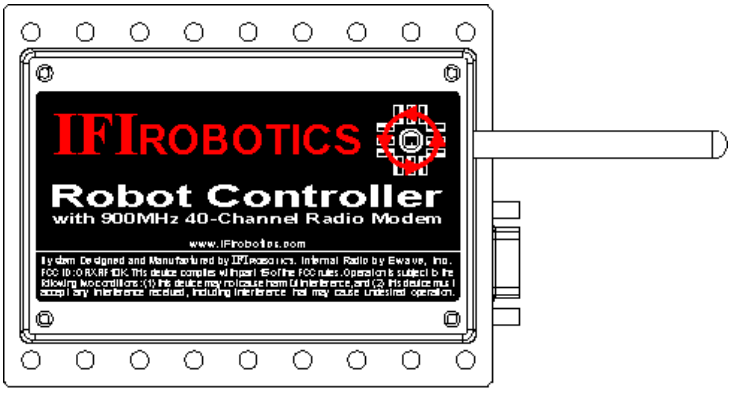


IFI ROBOTICS

Control System Users Manual
Miniature Mini Robot Controller
(ERC/MRC)



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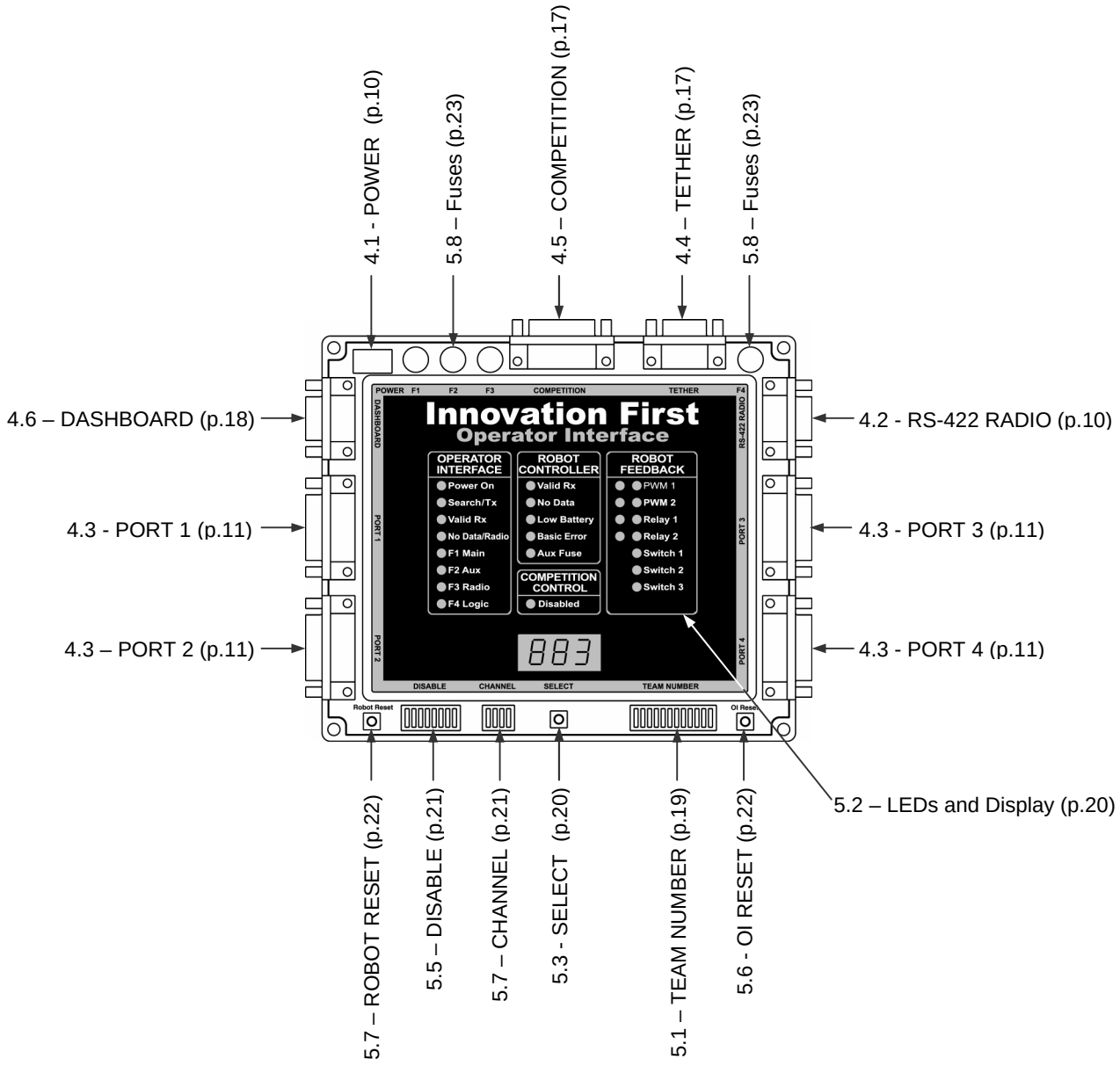


1. Introduction

WARNING: Please read the following sections carefully.
Failure to configure your control system properly could result in personal injury, damage to the control system, or damage to your robot. IFIrobotics will not provide free replacement of control system components damaged due to misuse or miswiring.

In this manual you will find:

- System functional descriptions
- Quick setup guide
- Operator Interface detailed description
- Mini Robot Controller detailed description
- Default code functions
- Basic wiring information

Before proceeding with a discussion of the individual components that make up the control system, it is helpful to understand the overall function of the control system. If, after reading these sections, you have problems configuring the control system, please contact IFIrobotics at 903-454-1978. We will be happy to answer any questions you have.

The heart of the IFIrobotics control system is the Operator Interface and the Robot Controller. The Operator Interface takes input from the robot operators and passes it to the Robot Controller. The Mini Robot Controller takes this information, gathers additional information from sensors on-board the robot, determines how the robot should function, and instructs the robot to perform the functions. The Mini Robot Controller also sends data back to the Operator Interface, giving the robot operators feedback of critical information. Figure 1.1 shows a block diagram illustrating this concept.

The IFIrobotics control system uses a unique "Team Number" identification to ensure safe and reliable human to robot communication. Users enter their team number via dipswitches on both the Operator Interface and the Robot Controller. Both units use this number as a unique identifier, ensuring that all communications received are actually "theirs". Figures 1.2 and 1.3 show a block diagram of the Team Number concept.

The Operator Interface has a "Competition" connector designed specifically for connecting the system to the playing field at competitions. This connection sets the radio to one of 35 competition only channels, provides power, and even starts and stops the robot during matches.

Good luck! We hope you enjoy the new control system!

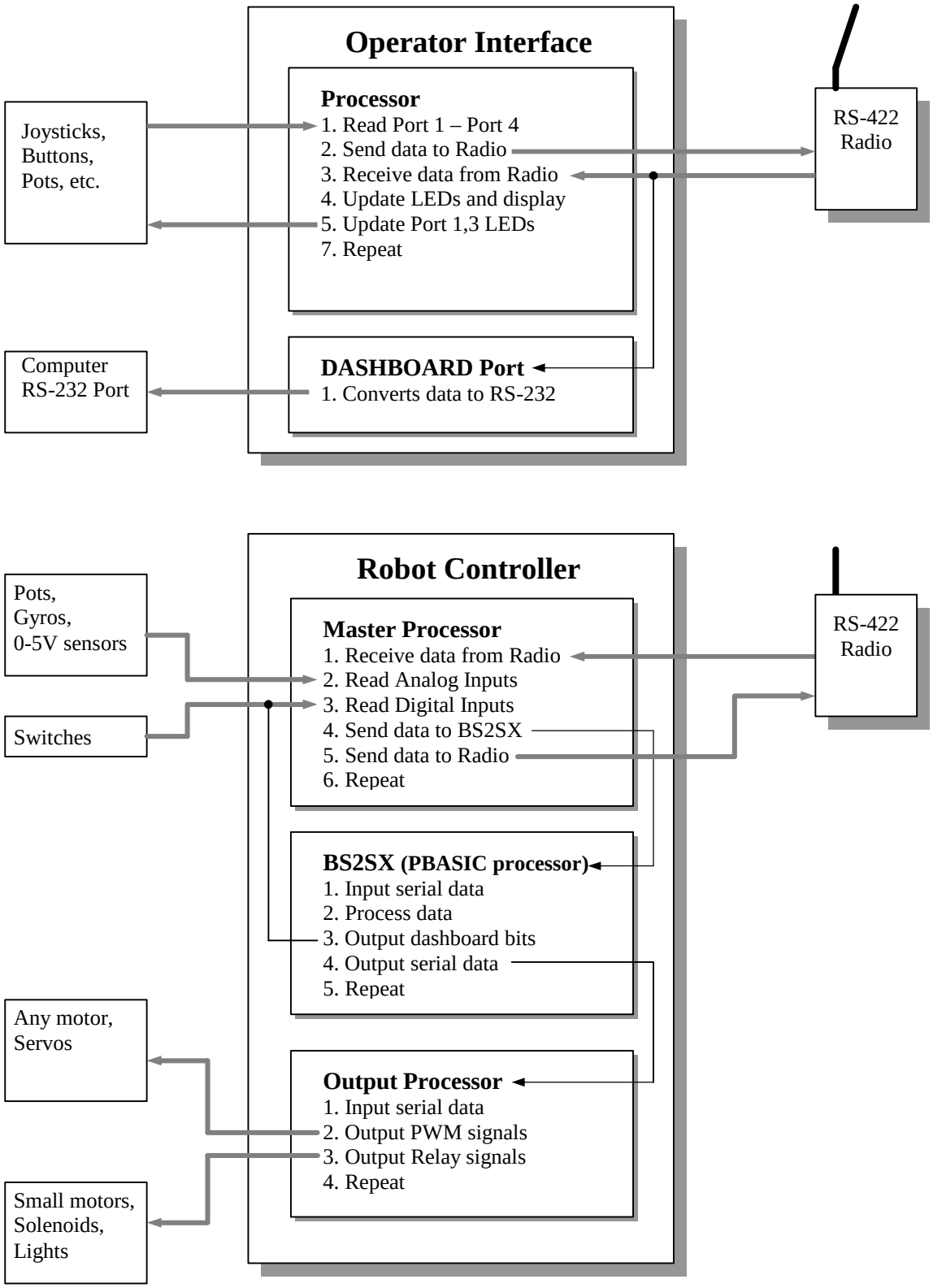


FIGURE 1.1: CONTROL SYSTEM OPERATION DIAGRAM

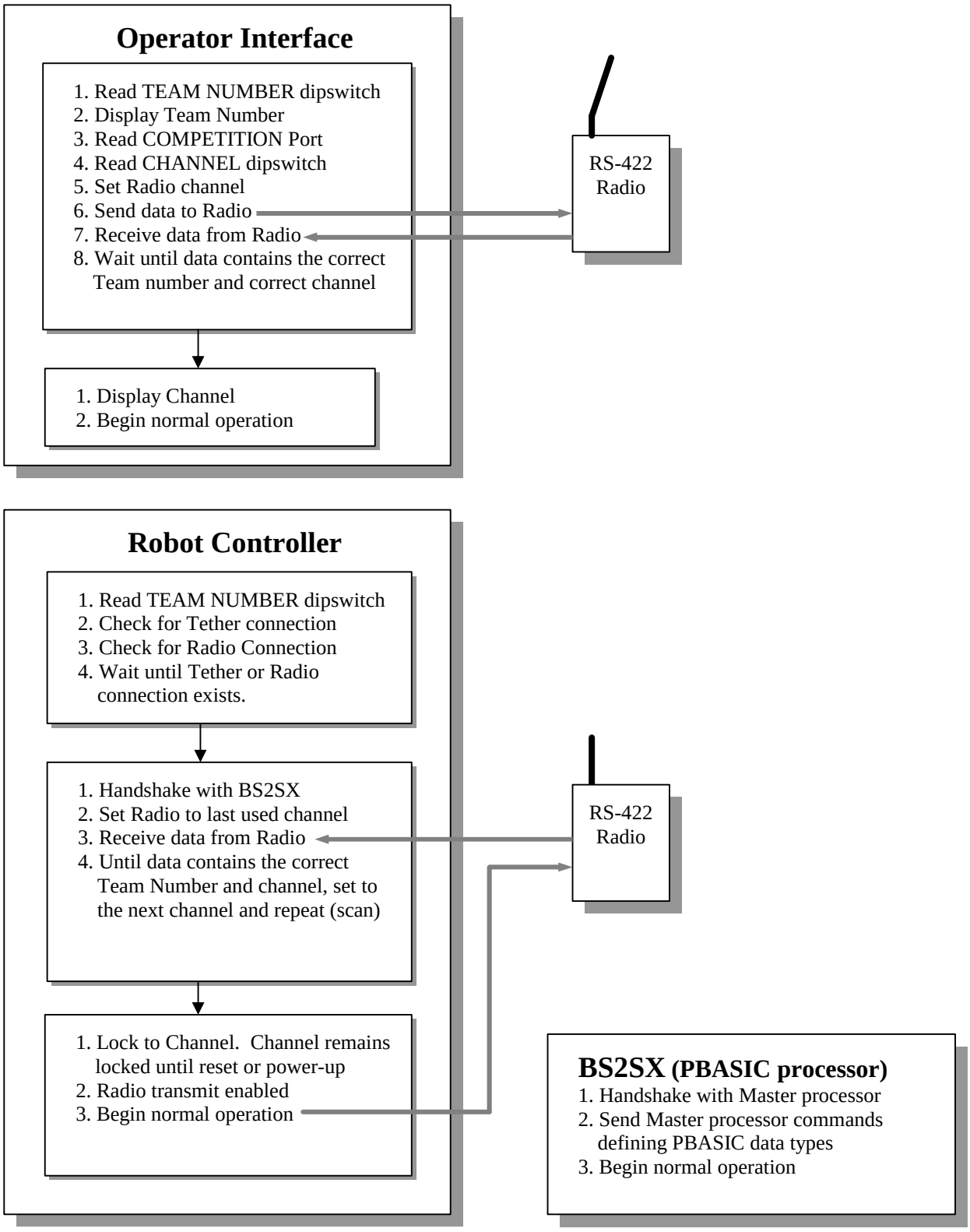


FIGURE 1.2: CONTROL SYSTEM RADIO STARTUP DIAGRAM

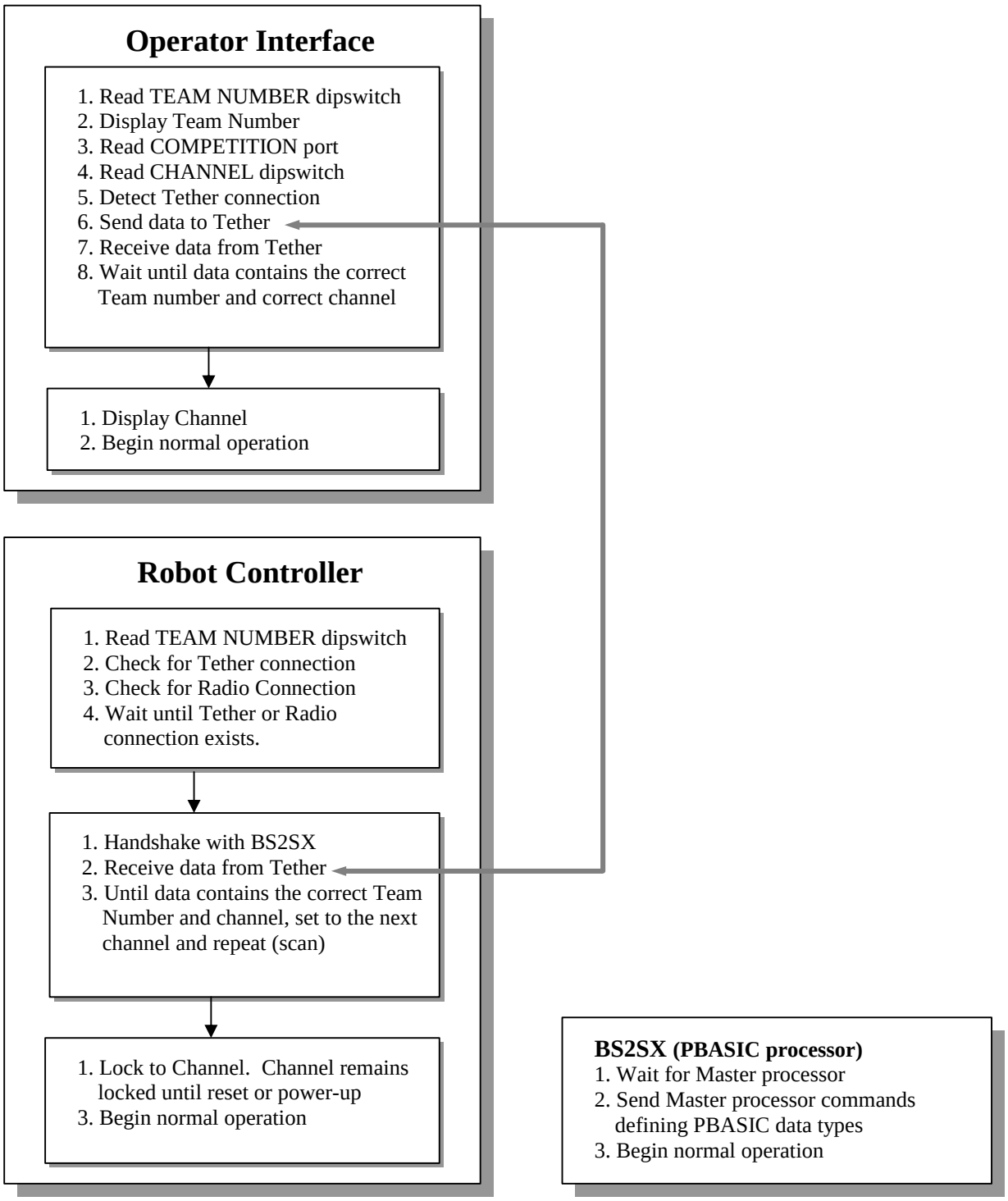


FIGURE 1.3: CONTROL SYSTEM TETHER STARTUP DIAGRAM

Note: Channel scan and lock is performed during tether startup to support radio operation after tether is removed.

2. Quick Setup Guide

This Quick Setup Guide describes the basic cable and switch settings required to begin using the control system. This guide consists of four sections:

- A list of components required for the Quick Setup.
- A pictorial of the basic cabling.
- A brief description of setting the TEAM NUMBER dipswitches.
- An overview of the basic features.

Using the components listed below, make the connections shown in Figure 2.

Robot Control System pieces:

(1) Mini Robot Controller with Motherboard
(1) 7.2V to 12V Power Source

Operator Control System pieces:

(1) Operator Interface
(1) Wall transformer
(1) RS-422 Radio (OI)
(1) DB9 M-F Cable
(2) Joysticks

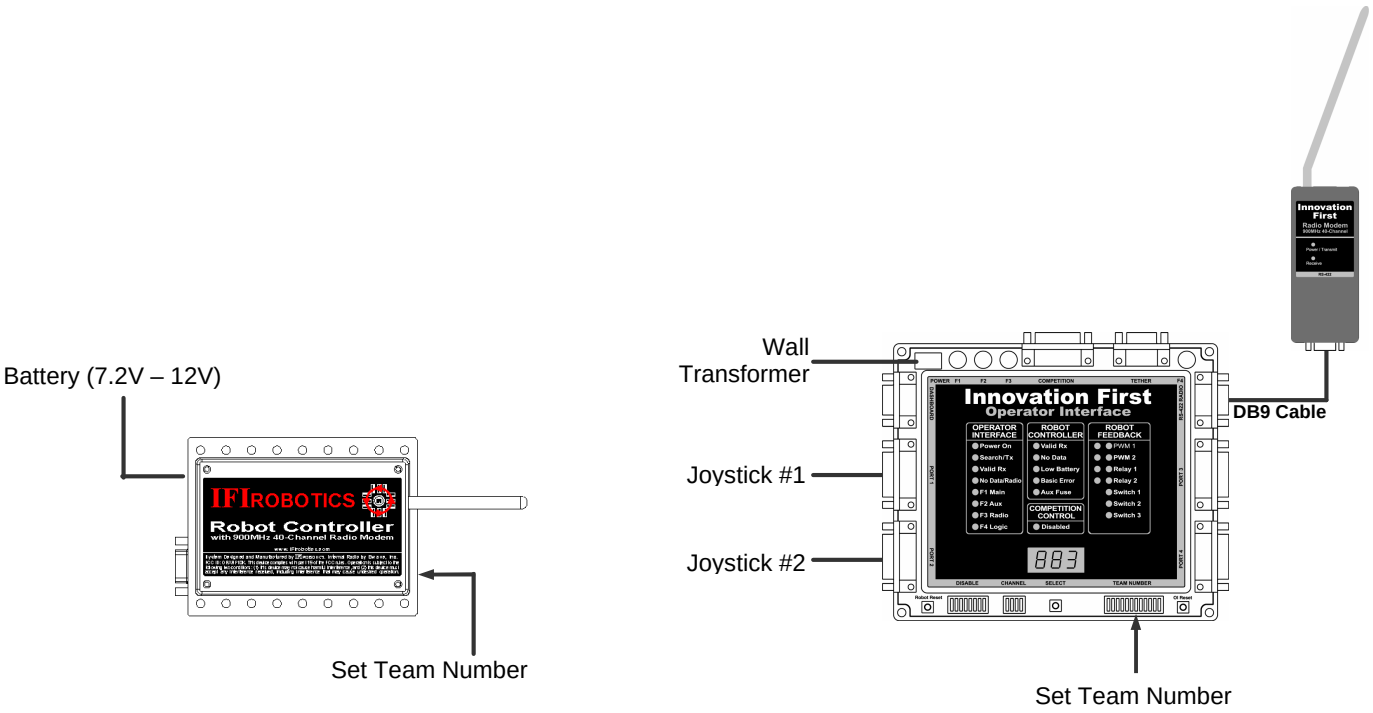


FIGURE 2: CONTROL SYSTEM QUICK SETUP

Team Number Setup

To finish the setup, complete the following instructions.

1. Disconnect power to the Robot Controller.
2. Connect the AC Adaptor to 115V 60Hz power. Plug the AC Adaptor cable into the POWER connector on the Operator Interface (turning it ON).
3. Set Team Number:

   a. Set each of the twelve TEAM NUMBER switches to the Up position. The Operator Interface display should show "000"
   b. Set switch 3 Down and look at the display.
      If the number displayed is greater than your team number, return the switch to Up.
      If the number displayed is less than your team number, leave the switch Down.
      If the number displayed is your team number, go to step 4.
   c. Repeat step b. using the next switch (4, 5, 6 . . .)
4. Copy the "Team Number" switch settings from the Operator Interface to the Robot Controller.
5. Power ON the Robot Controller.
6. After a few seconds, the "Search/TX" and "Valid RX" lights should be flashing on both units, indicating each is transmitting and receiving valid data with the correct team number.
7. The display on the Operator Interface will change to the channel number (c40).

System Feature Overview

The system should be working correctly now. Try the following to see how it works.

1. Pressing the SELECT button on the Operator Interface will change the display between Team Number, Channel, and Robot Voltage.
2. Pressing the ROBOT RESET button on the Operator Interface should cause the "Basic Init Err" light on the Mini Robot Controller to flash, indicating the PBASIC processor is resetting.
3. When the PORT 1 joystick is all the way forward, the "PWM1 Green" light on the Operator interface should be ON, indicating full forward.
4. When the PORT 1 joystick is all the way back, the "PWM1 Red" light on the Operator interface should be ON, indicating full reverse.
5. Pressing the trigger and thumb buttons on either joystick should light the RELAY 1 and RELAY 2 lights on the Operator Interface.

3. Operator Interface Basics

The Operator Interface's basic function is to collect data from joysticks, buttons, and other input devices controlled by human operator(s). The data is transmitted through a Radio Modem or Tether cable to the Robot Controller. The Operator Interface also receives data transmitted from the Robot Controller, displays the data, and transmits the data out the DASHBOARD port. Refer to Figure 1.1 on page 4 for an overview of the Control System operation.

The Operator Interface inputs data via PORT 1, PORT 2, PORT 3, and PORT 4. These ports are CH Products FlightStick compatible. The ports can also be used with custom control boxes of your own design. The four input ports have a total of 16 digital inputs for switches, 16 analog inputs for potentiometers and sensors, and 8 LED drivers for controlling external indicators.

Three ways to Power the Operator Interface

There are three ways to power the Operator Interface.

- AC Adaptor
- Tether connection to the Robot Controller
- Competition port connection on the competition field

The AC Adaptor power can be used in conjunction with Tether power. Do not use Tether power at the same time as Competition power.

The most common method to power an Operator Interface is with an AC Adaptor. This adaptor converts standard 115V 60Hz wall power to the correct voltage and provides the necessary current. Only use the AC adaptor provided with the system. When the Operator Interface and the Mini Robot Controller are connected via TETHER ports, the Operator Interface will be powered from the robot's 12V battery. Tether power provides a means to power the Operator Interface when 115V 60Hz power is not available. Tether power is useful before or after competition rounds to check your system or collapse your robot. The Operator Interface can also be powered via the COMPETITION port. Competition power will be used at regional and national events, eliminating the need for an AC adaptor on stage.

Reference Documents (available at www.ifiRobotics.com)

Size, weight, and mounting information.....Operator Interface Installation Info.pdf
Frequently asked questions.....Control System FAQ.pdf
Dashboard port data specification.....Dashboard Port Interface Guide.pdf

4. Operator Interface Connections

4.1. POWER

The POWER connection on the Operator Interface is intended to accept DC power from an AC Adaptor. For information on other ways to power the Operator Interface, refer to Section 3.3, Page 9.

Warning: Only use the AC Adaptor AD48-0901500DU provided with the system. The use of any other AC Adaptor may damage the Operator Interface and will void the warranty. Additional AC Adaptors are available from IFIrobotics at www.ifiRobotics.com.

4.2. RS-422 Radio

The RS-422 RADIO port is intended to connect to the IFIrobotics RS-422 Radio Modem only. This port uses RS-422, instead of RS-232, to minimize noise interference in the communication link.

Caution: Do not connect any other equipment to this port.

There are two different Radio Modems provided with the system. Be sure to connect the Operator Interface to the Radio Modem that has a chrome antenna and is marked "Operator Interface." Use a DB9 Male-Female Pin-to-Pin cable (maximum length 6 ft.) to connect the Operator Interface to a RS-422 Radio.

The chrome antenna on the "Operator Interface" Radio Modem does not extend.

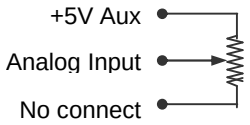
4.3. Operator Interface Ports 1, 2, 3, and 4

The Operator Interface Port's 1, 2, 3, and 4 are intended to provide user input. All four ports are designed to be joystick compatible. Each port can be split with a Y-Cable, allowing two joysticks to be connected to one port. Custom user input boxes can also be connected to one or more of these ports.

Joysticks
These ports are 100% CH Products FlightStick compatible. Other joysticks may be used (except during FIRST competitions), however, the joystick pinouts must be checked to ensure compatibility. The DISABLE dipswitch on the Operator Interface allows the joystick buttons to be disabled on PORT 1 and PORT 3.

Joystick Y-Cables
Y-Cables may be used to connect two joysticks to one port. This allows more functions on a custom user input box (see Figure 4.3.3). Refer to our web site (www.ifiRobotics.com) for details on making a Joystick Y-Cable.

Analog Inputs (see pinouts on pages 13-16)
Each port provides four analog inputs. These inputs are typically connected to joysticks and potentiometers, providing an analog input ranging from 0 to 254 that is transmitted to the Robot Controller. In the event that an analog input is less than 0.05V, a value of 127 will be generated. This ensures that when a joystick is unplugged, the output will not go full reverse. Each port provides +5V Aux, used for wiring to potentiometers or other sensors. The wiring diagram for a potentiometer is shown below. Always use 100k? potentiometers.



Digital Inputs (see pinouts on pages 13-16)
Each port provides four unique digital inputs. PORT 2 provides access to the same digital inputs as PORT 3, allowing access to 8 digital inputs from PORT 2. PORT 4 provides access to the same digital inputs as PORT 1, allowing access to 8 digital inputs from PORT 4. To utilize these inputs, wire buttons or switches between the desired digital signal pin and any ground pin.
Do not connect switches to 5V. Do not use lighted switches.

LED Drivers (see pinouts on pages 13-16)
PORT 1 and PORT 3 each provide four LED output drivers. These LED drivers allow the connection of external LEDs that duplicate the function of the top eight Robot Feedback LEDs on the Operator Interface. The LED drivers provide 5V that is current limited to 10mA. Connect the LED's anode to the desired LED drive pin. Connect the LED's cathode to any ground pins.

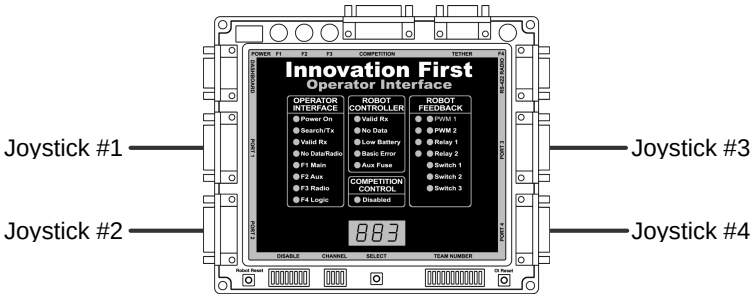


Figure 4.3.1: Operator Interface with Four Joysticks

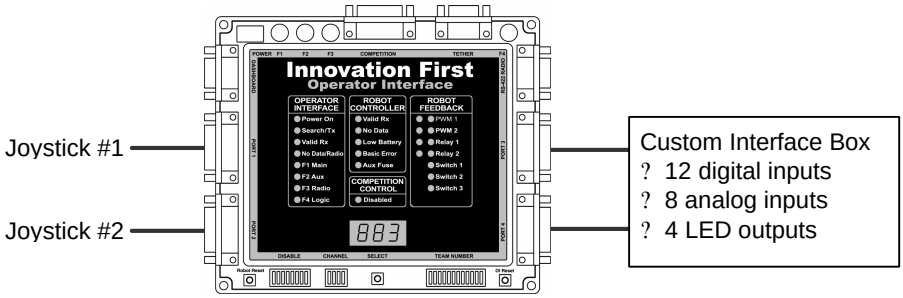


Figure 4.3.2: Operator Interface with Two Joysticks and a User Box

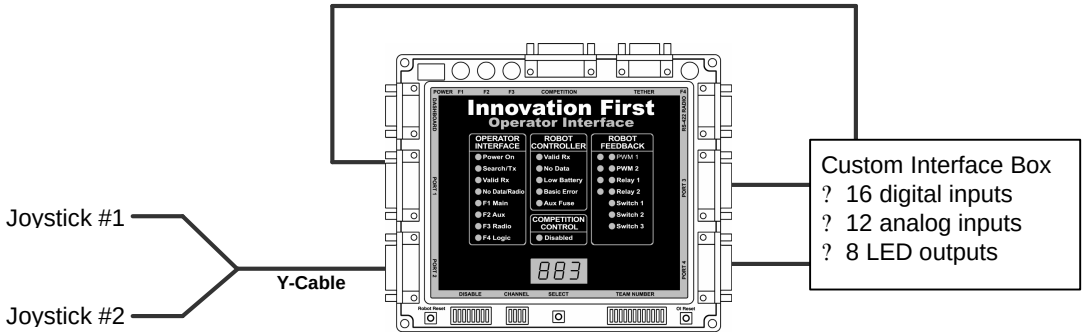


Figure 4.3.3:
Operator Interface with Two Y-Cable Joysticks and a User Box

Table 4.3.1: Port 1 Pinout and Software Function

		Default PBASIC Code Information [1]			Disable
Pin	Function	Variable type	Variable Name	Code Function	Dipswitch
3	X-Axis	Analog (byte)	p1_X	RC PWM5	
6	Y-Axis	Analog (byte)	p1_Y	RC PWM1	
13	Wheel	Analog (byte)	p1_wheel	RC PWM9	
11	Aux Analog	Analog (byte)	p1_aux		
2	Joystick Trigger Switch	Digital (bit)	p1_sw_trig	RC Relay 1 Forward	SW01 [5]
7	Joystick Thumb Switch	Digital (bit)	p1_sw_top	RC Relay 1 Reverse	SW02 [5]
10	Aux Switch1	Digital (bit)	p1_sw_aux1	Relay 5 Forward	SW03 [5]
14	Aux Switch2	Digital (bit)	p1_sw_aux2	Relay 5 Reverse	SW04 [5]
15	Robot Feedback LED driver [2]	Output (bit)	out8	OI Feedback LED - PWM1 Green	
8	Robot Feedback LED driver [2]	Output (bit)	out9	OI Feedback LED - PWM1 Red	
9	Robot Feedback LED driver [2]	Output (bit)	out10	OI Feedback LED - PWM2 Green	
5	Robot Feedback LED driver [2]	Output (bit)	out11	OI Feedback LED - PWM2 Red	
1	+5V Aux (Fuse F2) [3,4]				
4	Ground				
12	Ground				

Notes:
RC refers to the Robot Controller
OI refers to the Operator Interface

[1] Software functions listed are for Default Code only. These functions and variable names may be changed for user programs.
[2] LED drivers provide 5V at 10mA
[3] +5V Aux is to be used for potentiometers in Joysticks and custom I/O boxes.
[4] Do not use +5V Aux for lamps or LEDs.
[5] The DISABLE dipswitch on the Operator Interface

Table 4.3.2: Port 2 Pinout and Software Function

		Default PBASIC Code Information [1]		
Pin	Function	Variable type	Variable Name	Code Function
3	X-Axis	Analog (byte)	p2_X	RC PWM6
6	Y-Axis	Analog (byte)	p2_Y	RC PWM2
13	Wheel	Analog (byte)	p2_wheel	RC PWM10
11	Aux Analog	Analog (byte)	p2_aux	
2	Joystick Trigger Switch	Digital (bit)	p2_sw_trig	RC Relay 2 Forward
7	Joystick Thumb Switch	Digital (bit)	p2_sw_top	RC Relay 2 Reverse
10	Aux Switch1	Digital (bit)	p2_sw_aux1	
14	Aux Switch2	Digital (bit)	p2_sw_aux2	
5	same as OI Port 3 Joystick Trigger Switch	Digital (bit)	p3_sw_trig	RC Relay 3 Forward
8	same as OI Port 3 Joystick Thumb Switch	Digital (bit)	p3_sw_top	RC Relay 3 Reverse
9	same as OI Port 3 Aux Switch1	Digital (bit)	p3_sw_aux1	RC Relay 6 Forward
15	same as OI Port 3 Aux Switch2	Digital (bit)	p3_sw_aux2	RC Relay 6 Reverse
1	+5V Aux (Fuse F2) [2,3]			
4	Ground			
12	Ground			

Notes:
RC refers to the Robot Controller
OI refers to the Operator Interface

[1] Software functions listed are for Default Code only. These functions and variable names may be changed for user programs.
[2] +5V Aux is to be used for potentiometers in Joysticks and custom I/O boxes.
[3] Do not use +5V Aux for lamps or LEDs.

Table 4.3.3: Port 3 Pinout and Software Function

		Default PBASIC Code Information [1]			Disable
Pin	Function	Variable type	Variable Name	Code Function	Dipswitch
3	X-Axis	Analog (byte)	p3_X	RC PWM7	
6	Y-Axis	Analog (byte)	p3_Y	RC PWM3	
13	Wheel	Analog (byte)	p3_wheel	RC PWM11	
11	Aux Analog	Analog (byte)	p3_aux		
2	Joystick Trigger Switch	Digital (bit)	p3_sw_trig	Relay 3 Forward	SW05 [5]
7	Joystick Thumb Switch	Digital (bit)	p3_sw_top	Relay 3 Reverse	SW06 [5]
10	Aux Switch1	Digital (bit)	p3_sw_aux1	Relay 6 Forward	SW07 [5]
14	Aux Switch2	Digital (bit)	p3_sw_aux2	Relay 6 Reverse	SW08 [5]
15	Robot Feedback LED driver [2]	Output (bit)	out13	OI Feedback LED - Relay1 Green	
8	Robot Feedback LED driver [2]	Output (bit)	out12	OI Feedback LED - Relay1 Red	
9	Robot Feedback LED driver [2]	Output (bit)	out15	OI Feedback LED - Relay2 Green	
5	Robot Feedback LED driver [2]	Output (bit)	out14	OI Feedback LED - Relay2 Red	
1	+5V Aux (Fuse F2) [3,4]				
4	Ground				
12	Ground				

Notes:

RC refers to the Robot Controller
OI refers to the Operator Interface

[1] Software functions listed are for Default Code only. These functions and variable names may be changed for user programs.
[2] LED drivers provide 5V at 10mA
[3] +5V Aux is to be used for potentiometers in Joysticks and custom I/O boxes.
[4] Do not use +5V Aux for lamps or LEDs.
[5] The DISABLE dipswitch on the Operator Interface

Table 4.3.4: Port 4 Pinout and Software Function

		Default PBASIC Code Information [1]		
Pin	Function	Variable type	Variable Name	Code Function
3	X-Axis	Analog (byte)	p4_X	RC PWM8
6	Y-Axis	Analog (byte)	p4_Y	RC PWM4
13	Wheel	Analog (byte)	p4_wheel	RC PWM12
11	Aux Analog	Analog (byte)	p4_aux	
2	Joystick Trigger Switch	Digital (bit)	p4_sw_trig	Relay 4 Forward
7	Joystick Thumb Switch	Digital (bit)	p4_sw_top	Relay 4 Reverse
10	Aux Switch1	Digital (bit)	p4_sw_aux1	Relay 7 Forward
14	Aux Switch2	Digital (bit)	p4_sw_aux2	Relay 7 Reverse
5	same as OI Port 1 Joystick Trigger Switch	Digital (bit)	p1_sw_trig	RC Relay 1 Forward
8	same as OI Port 1 Joystick Thumb Switch	Digital (bit)	p1_sw_top	RC Relay 1 Reverse
9	same as OI Port 1 Aux Switch1	Digital (bit)	p1_sw_aux1	Relay 5 Forward
15	same as OI Port 1 Aux Switch2	Digital (bit)	p1_sw_aux2	Relay 5 Reverse
1	+5V Aux (Fuse F2) [2,3]			
4	Ground			
12	Ground			

Notes:
RC refers to the Robot Controller
OI refers to the Operator Interface

[1] Software functions listed are for Default Code only. These functions and variable names may be changed for user programs.
[2] +5V Aux is to be used for potentiometers in Joysticks and custom I/O boxes.
[3] Do not use +5V Aux for lamps or LEDs.

4.4. Tether

The TETHER port is intended to connect the Operator Interface to the Robot Controller. The TETHER port passes the same data as the radios, allowing full functionality without the use of radios. A tether connection can be made with or without Radio Modems connected. The system will always use tether if it is available, however you will see no change in the status indicators on the Radio Modems. Both the Operator Interface and the Mini Robot Controller will automatically detect a tether connection and switch to tether without requiring power OFF or a reset.

A tether connection also provides power to the Operator Interface from the Robot Controllers 12V battery. Tether power provides a means to power the Operator Interface when 115V 60Hz power is not available. Tether power is useful before or after competition rounds to check your system or collapse your robot.

Caution: This port is not intended to interface with a computer.

Use a DB9 Male-Female Pin-to-Pin cable (maximum length 25 ft.) to connect the Operator Interface to the Robot Controller.

4.5. Competition

The COMPETITION port is intended to allow control of your Operator Interface by competition organizers. Competition organizers can use the Competition port to access additional channels, provide power, and disable robot control for starting and stopping matches.

An adaptor cable can be connected to the Competition port allowing the 'disable robot' feature to be used anytime. This adaptor connector is not provided with the system. Details on making a disable adaptor cable are provided later in this section.

The COMPETITION port is also used to provide teams access to four additional radio channels. All Operator Interfaces default to channel 40. Access to channels 4, 13, 22, and 31 can be achieved by connecting an adapter connector to the COMPETITION port. The adaptor connector is not provided with the system. Details on making a channel access adaptor connector are provided later in this section. Refer to Section 5.4 on page 21 for information on selecting additional channels once the channel access adaptor is installed.

Access to channels other than 40 will be restricted at events. Do not make the channel access jumper internal to the Operator Interface. This jumper connection is intended to be externally visible. Internal channel access jumper will be detected when you connect to the stage.

WARNING: The COMPETITION port has pins that connect directly to the Operator Interface microprocessor. Incorrect wiring may damage the unit and will void the warranty. This damage may not be apparent until connecting to the stage at competition. Use caution and double check you're wiring prior to making a connection. Always use a backshell to protect the connector's pins from ESD discharge.

Competition Port Adapter

A Competition port adaptor can provide access to four additional channels and/or provide access to the Disable feature. To build this adaptor, you will need wire and the following:
(1) DB15 Male solder pot connector
(1) DB15 backshell
(1) ON/OFF switch

Connect pin 12 to pin 15 to provide additional channel access. Connect pins 6 and pin 8 to the appropriate pins of an ON/OFF switch. Be sure that no other pins are shorted.

Table 4.5: COMPETITION Port Pinout

Pin	Function
12	Channel access
15	Ground
6	Disable
8	Ground

WARNING: The COMPETITION port has pins that connect directly to the Operator Interface microprocessor. Incorrect wiring may damage the unit and will void the warranty. This damage may not be apparent until connecting to the stage at competition. Use caution and double check your wiring prior to making a connection. Always use a backshell to protect the connector's pins from ESD discharge.

4.6. Dashboard

The DASHBOARD port is intended to allow the Operator Interface to transfer data to a computer for enhanced robot feedback. The DASHBOARD port is a transmit only interface. The data transmitted out the DASHBOARD port is the same data that is received by the Operator Interface from the Robot Controller.

IFIrobotics provides a Windows? compatible Dashboard Viewer program for viewing this data on a PC. IFIrobotics does not provide support for the Dashboard Viewer software or release the source code. Custom programs may be written to make use of this data.

Connect the DASHBOARD port to the RS-232 serial port of a computer using a DB9 Male-Female Pin-to-Pin cable (maximum length 6 ft.).

Refer to the Dashboard Port Data Specification available at www.ifiRobotics.com.

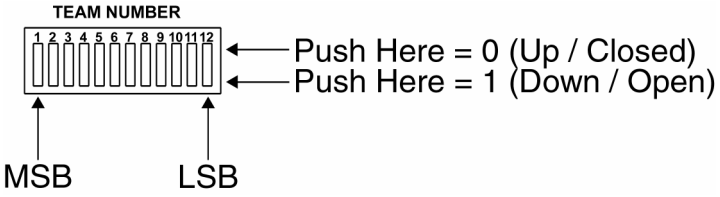
5. Using the Operator Interface

5.1. Setting the Team Number

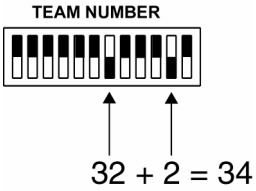
A quick method of setting the Team Number without using binary is described in the Quick Setup Guide on page 38.

Setting the Team Number on the Operator Interface requires changing the TEAM NUMBER dipswitch settings. The Team Number is set by changing the switches to match the binary equivalent of your Team Number. The Operator Interface will update the Team Number on the 3-digit display while you change the TEAM NUMBER dipswitch. You may have to press the SELECT button several times until the Team Number is shown. The Team Number is displayed as three numbers only, no decimal place or letters. Any Team Number greater than 999 will be displayed as "- - -".

The diagram below shows the location of the Most Significant Bit (MSB) and the Least Significant Bit (LSB).



The following diagram is an example of setting the Team Number to 34.



5.2. Operator Interface Indicators

Table 5.2.1: Operator Interface LEDs - Operator Interface Section

Power ON	Solid	Input power is ON from AC Adaptor, Tether, or Competition port.
Search/TX	Blink	Transmitting data packets to Radio Modem.
Valid RX	Blink	Receiving data packets with correct Team Number and Channel Number.
No Data/Radio	Blink	No data packets received or bad data packets received.
No Data/Radio	Solid	Radio Modem not found. Check modem and cables.
F1 Main	Solid	Fuse F1 blown. Replace with correct value (see Section 5.9 on page 23).
F2 Aux	Solid	Fuse F2 blown. Replace with correct value (see Section 5.9 on page 23).
F3 Radio	Solid	Fuse F3 blown. Replace with correct value (see Section 5.9 on page 23).
F4 Logic	Solid	Fuse F4 blown. Replace with correct value (see Section 5.9 on page 23).

Table 5.2.2: Operator Interface LEDs – Mini Robot Controller Section

Indicator	Status	
Valid RX	Blink	The Mini Robot Controller is receiving good data packets.
No Data	Blink/Solid	The Mini Robot Controller is receiving bad data/no data.
Low Battery	Blink	Low battery voltage detected. Replace or recharge battery soon. Low Battery will remain blinking if the voltage ever drops below 9.0V. The Low Battery Blink threshold is user definable in the PBASIC code.
Low Battery	Solid	Low battery voltage detected. Replace or recharge battery now. Low Battery will remain solid if the voltage ever drops below 8V.
Basic Error	Solid	The Mini Robot Controller has either a PBASIC Initialization error or a PBASIC run error.
Aux Fuse	Solid	The Aux fuse on the Mini Robot Controller is blown. Replace with correct value (see Section 8.4 on page 29).

The COMPETITION CONTROL Disabled light on the Operator Interface indicates that the entire Control System has been disabled via the Competition port (see Section 4.5 on page 17). When the Disabled light is ON, the Robot Controller's PWM and RELAY outputs are disabled. The following functions are still active when the Control System is disabled:

- Operator Interface inputs (joystick, buttons, etc.) are transmitted to the Robot Controller.
- PBASIC code is executing.
- PBASIC input, including Operator Interface inputs and local inputs (switches, pots, etc) are read in.
- PBASIC output commands are still sent, but ignored by the output processor.
- Mini Robot Controller feedback is transmitted to the Operator Interface.

The ROBOT FEEDBACK lights on the Operator Interface represent data transmitted from the Mini Robot Controller to the Operator Interface. The upper eight lights (PWM1, PWM2, Relay 1, and Relay 2) are user definable in the PBASIC code (see Section 9 on page 30). The Default PBASIC Code provided with the Mini Robot Controller utilizes these lights to display the status of PWM 1, PWM 2, Relay 1, and Relay 2 respectfully.

The Switch 1, 2, and 3 indicators represent the status of the Robot Controller's digital inputs 1, 2, and 3. These are not PBASIC software programmable.

5.3. SELECT Button and the 3-Digit Display

The SELECT button is used to change the 3-digit display. Pressing SELECT will cycle the display between Team Number, Channel, and Robot Voltage. The data displayed can be distinguished by the format used.

Team Number display	000
Channel display	c40
Robot Voltage display	12.0

The display of team number will show "- - -" if the team number selected with the TEAM NUMBER dipswitch is greater than 999.

5.4. CHANNEL Dipswitch

The CHANNEL dipswitch located on the Operator Interface is used to select a channel for both the Operator Interface and the Robot Controller. The Operator Interface reads the CHANNEL dipswitch on power-up or after pressing the OI RESET button. Access to channels 4, 13, 22, and 31 can be achieved by connecting an adapter connector (see Section 4.5 on page 17) to the COMPETITION port and setting the CHANNEL dipswitch according to Table 5.4. The Operator Interface will default to channel 40 independent of the dipswitch setting if a competition port adapter is not detected.

The Mini Robot Controller sets channels by scanning for the Operator Interface with the same Team Number (see Figure 1.2 on page 5). The Mini Robot Controller will only scan channels on power-up or after pressing the RESET button located on the Robot Controller.

Table 5.4: CHANNEL Dipswitch Settings

2	3	4	Channel
ON	ON	ON	04
ON	ON	OFF	13
ON	OFF	ON	22
ON	OFF	OFF	31
OFF	OFF	OFF	40

Steps for changing channels:

1. Make sure a COMPETITION port adapter is installed.
2. Make sure both units are set to the same Team Number.
3. Set the CHANNEL dipswitch to the desired channel.
4. Press OI RESET on the Operator Interface.
5. Press RESET on the Robot Controller.
   Note: ROBOT RESET on the Operator Interface will not work for this.
6. After a few seconds, the "Search/TX" and "Valid RX" lights should be flashing on both units, indicating each is transmitting and receiving good data with the correct team number and channel.

5.5. DISABLE dipswitch

The DISABLE dipswitch is used to disable buttons on joysticks connected to PORT 1 and PORT 3. Only PORT 1 and PORT 3 have joystick digital inputs that are available on another port. This disable feature is useful when a custom button box uses the same digital input as a joystick. A button on a joystick can be disabled so only the button on the box is functional. The tables below list the buttons that can be disabled.

Table 5.5.1: Disable Switches for Port 1

Port 1		DISABLE switches for Port 1	Port 4	
Pin	Button		Pin	Button
2	Joystick Trigger Switch	SW01	5	same input as OI Port 1 Joystick Trigger Switch
7	Joystick Thumb Switch	SW02	8	same input as OI Port 1 Joystick Thumb Switch
10	Aux Switch1	SW03	9	same input as OI Port 1 Aux Switch1
14	Aux Switch2	SW04	15	same input as OI Port 1 Aux Switch2

Table 5.5.2: Disable Switches for Port 3

Port 3		DISABLE switches for Port 3	Port 2	
Pin	Button		Pin	Button
2	Joystick Trigger Switch	SW05	5	same input as OI Port 1 Joystick Trigger Switch
7	Joystick Thumb Switch	SW06	8	same input as OI Port 1 Joystick Thumb Switch
10	Aux Switch1	SW07	9	same input as OI Port 1 Aux Switch1
14	Aux Switch2	SW08	15	same input as OI Port 1 Aux Switch2

5.6. OI Reset

The OI RESET button performs a complete hardware reset of the Operator Interface. The following are the most common uses for the OI RESET button:

- Pressing OI RESET after the CHANNEL dipswitch is changed will initiate a radio channel change.
- Pressing OI RESET is required after connecting a radio to initialize the radio.

When in doubt, pressing OI RESET won't hurt.

5.7. Robot Reset

The ROBOT RESET button is intended to allow remote reset of the Robot Controller's BS2SX PBASIC processor. The most common use for the ROBOT RESET button is to restart the BS2SX processor in case of a programming error. The ROBOT RESET button can also be used to reset the BS2SX after a new program has been downloaded.

The ROBOT RESET button on the Operator Interface only resets the BS2SX and not the entire Robot Controller. Pressing RESET (if present) on the Mini Robot Controller or power cycling the Mini Robot Controller are the only ways to reset the entire Robot Controller.

5.8. Fuses F1, F2, F3, F4

The four fuses on the Operator Interface are intended to protect the circuitry from a short circuit. In the unlikely event that a fuse blows, a light on the front panel will indicate the fuse that failed. The most likely cause of a blown fuse is improper wiring. Prior to replacing the fuse, check your wiring for shorts or incorrect pin connections.

Be sure to only replace the fuse with the appropriate value, slow blow, TR-5 style fuse. Replacement fuses are available at the IFIrobotics website or from electronics vendors. If the replacement fuses continue to blow and you have thoroughly checked your wiring, contact IFIrobotics for further assistance (see Section 10 on page 33).

Fuse	Protects	Value	Type
F1	Main	2.0 – 3.0 Amps	Slow Blow
F2	Aux	1.0 – 1.5 Amps	Slow Blow
F3	Radio	.50 - .75 Amps	Slow Blow
F4	Logic	.50 - .75 Amps	Slow Blow

6. Mini Robot Controller Basics

The Mini Robot Controller receives information from the Operator Interface, gathers additional information from sensors on-board the robot, determines how the robot should function, and instructs the robot perform the functions. The Mini Robot Controller also sends data back to the Operator Interface, giving the robot operators feedback of critical information. Figure 1.1 shows a block diagram illustrating this concept.

The Mini Robot Controller gathers on-board sensor data via the ANALOG INPUTS and DIGITAL INPUTS connectors. There are 8 digital inputs and 4 analog inputs. Switches of various types may be connected to the digital inputs. Sensors that provide a 0-5V output, such as potentiometers and gyros (yaw rate sensors) may be connected to the analog inputs.

The Mini Robot Controller takes the collected data from both the Operator Interface and the on-board sensors and then forwards it to the PBASIC program processor. The program takes the data, determines what to do with the outputs to make the robot behave as desired, and sets the PWM and Relay outputs to the appropriate states. The Mini Robot Controller comes with a default program that will handle most robot control needs. If more sophisticated control of the robot is desired, then a custom program can be written.

PBASIC default source code is available at www.ifiRobotics.com.
Programming tools and manuals are available at www.parallaxinc.com.

The Mini Robot Controller has 8 PWM outputs and 4 RELAY outputs. The PWM outputs are used to drive Victor 883 speed controllers and servos. The most common use of these outputs is to control a variable speed motor. The PWM outputs will also control most industry standard servos. The Relay outputs are used to drive Spike bi-directional relay modules. The most common use of these outputs, when connected to a Spike, is to drive small motors in Forward, Reverse or Off. The Relay outputs, in conjunction with a Spike, can also be use to turn On or Off solenoids, pumps, and lights.

Reference Documents (available at www.ifiRobotics.com)

Size and mounting information.....Mini Robot Controller Installation Info.pdf
Frequently asked questions.....Control System FAQ.pdf
2000 Default Code listing.....2000 Default Code.pdf

7. Mini Robot Controller Connections

7.1. Power

The Mini Robot Controller accepts power from a 7.2V to 12V battery. The current draw for the Mini Robot Controller is typically between 0.75A to 1.5A. The maximum voltage allowable input is 15.0V. Exceeding the 15.0V limit will damage internal voltage regulators and will void the warranty. The minimum required voltage is 6.2V.

The Mini Robot Controller is internally protected from reverse polarity.

Refer to the appropriate Motherboard Users Manual for power wiring information.

7.2. Radio

The Mini Robot Controller uses a custom 900MHz internal radio designed to communicate with the Operator Interface radio modem.

7.3. Tether

Refer to the TETHER port section for the Operator Interface on page 17 for tether instructions.

Refer to the appropriate Motherboard Users Manual for TETHER connection information.

7.4. Program

The PROGRAM port on the Mini Robot Controller's Motherboard is used to change the PBASIC program. This port is intended to connect to a PC's serial port. Use a DB9 Male-Female Pin-to-Pin cable (maximum length 25 ft.) to connect the PROGRAM port to a PC serial port.

Refer to Section 9 on page 30 for programming details.

Refer to the appropriate Motherboard Users Manual for PROGRAM connection information.

7.5. PWM Outputs

The PWM outputs are used to drive Victor 883 speed controllers and servos. The most common use of these outputs is to control a variable speed motor from a joystick axis connected to the Operator Interface. The PWM outputs will control most industry standard servos and speed controllers. Each of the eight outputs generates a unique Pulse Width Modulated (PWM) signal corresponding to a specific output of the PBASIC program. Custom PBASIC software can be used to control the PWM outputs as desired (see Section 9 on page 30).

Use a PWM/Relay extension cable to connect a speed controller or servo to one of the PWM output ports. Be sure to connect the cable so the black wire is on the indicated side. A Y-cable can be used on any PWM output to drive two like devices at the same time. You can connect up to three Victor 883 speed controllers to one PWM port. Do not use a PWM Signal Driver in conjunction with the Robot Controller.

Refer to the appropriate Motherboard Users Manual for PWM connection information.

Table 7.5 below shows which of the PWM outputs are controlled by joysticks on the Operator Interface. This table is only valid for default code. These functions and variable names may be changed for user programs.

Table 7.5: PWM Output Map (Default Code Only)

PWM Output	PBASIC Variable	Output Controlled by
PWM1	p1_y	Port 1 joystick Y-axis
PWM2	p2_y	Port 2 joystick Y-axis
PWM3	p3_y	Port 3 joystick Y-axis
PWM4	p4_y	Port 4 joystick Y-axis
PWM5	p1_x	Port 1 joystick X-axis
PWM6	p2_x	Port 2 joystick X-axis
PWM7	p3_x	Port 3 joystick X-axis
PWM8	p4_x	Port 4 joystick X-axis

Note: The Mini Robot Controller digital inputs are configured by the default code to act as limit switches for PWMs 3, 4, 9-12. Refer to Section 7.8 on page 28 for more details.

7.6. Relay Outputs

The Relay outputs are used to drive Spike bi-directional relay modules. The most common use of these outputs, when connected to a Spike, is to drive small motors in Forward, Reverse or Off. The Relay outputs, in conjunction with a Spike, can also be use to turn On or Off solenoids, pumps, and lights from a joystick button on the Operator Interface. Each of the four ports generates two binary signals corresponding to a specific output of the PBASIC program. Custom PBASIC software can be used to control the Relay outputs as desired (see Section 9 on page 30).

Refer to the Spike Users Manual (available at www.ifiRobotics.com) for detailed instructions on wiring to motors, solenoids, pumps, and lights.

Use a PWM/Relay extension cable to connect a Spike to one of the Relay outputs. Be sure to connect the cable so the black wire is on the indicated side. Each Relay output can be used with a Y-cable to drive two Spikes from the same output.

Refer to the appropriate Motherboard Users Manual for Relay connection information.

Table 7.6 below shows which of the Relay outputs are controlled by joysticks connected to the Operator Interface. This table is only valid for default code. These functions and variable names may be changed for user programs. Refer to the 2000 User Default code available at www.ifiRobotics.com.

Table 7.6: Relay Output Map (Default Code Only)

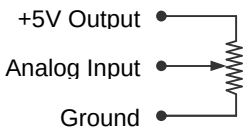
Relay	Operator Interface Connector	Operator Interface Control Switch	Pin	PBASIC Variable
Relay 1 Forward	OI Port 1	Joystick Trigger Switch	2	p1_sw_trig
Relay 1 Reverse	OI Port 1	Joystick Thumb Switch	7	p1_sw_top
Relay 2 Forward	OI Port 2	Joystick Trigger Switch	2	p2_sw_trig
Relay 2 Reverse	OI Port 2	Joystick Thumb Switch	7	p2_sw_top
Relay 3 Forward	OI Port 3	Joystick Trigger Switch	2	p3_sw_trig
Relay 3 Reverse	OI Port 3	Joystick Thumb Switch	7	p3_sw_top
Relay 4 Forward	OI Port 4	Joystick Trigger Switch	2	p4_sw_trig
Relay 4 Reverse	OI Port 4	Joystick Thumb Switch	7	p4_sw_top

Note: The Mini Robot Controller digital inputs are configured by the default code to act as limit switches for Relay 1 and Relay 2. Refer to Section 7.8 on page 28 for more details.

7.7. Analog Inputs

The analog inputs on the Mini Robot Controller can be used to measure various conditions on the robot and trigger automatic responses by the control program. There are four analog inputs available on the ANALOG INPUT port. Potentiometers and gyros (yaw rate sensors) may be connected to the analog inputs. For wiring 0-5V sensors, refer to the sensor manufacturer's data sheet.

Potentiometers should be wired per the diagram below. Always use 100k? potentiometers.



Refer to the appropriate Motherboard Users Manual for ANALOG connection information.

Table 7.7: Analog Inputs and Software Function

Pin	Function	PBASIC Variable
AN1	Analog 1	sensor1
AN2	Analog 2	sensor2
AN3	Analog 3	sensor3
AN4	Analog 4	sensor4

7.8. Digital Inputs

The digital inputs on the Mini Robot Controller can be used to monitor various conditions on the robot and trigger automatic responses by the control program. There are eight digital inputs available on the Motherboard. Various switches may be connected to the digital inputs. Wire switches between the desired digital signal pin and the ground pin. Switches may be wired individually, in parallel or in series.

Refer to the appropriate Motherboard Users Manual for DIGITAL connection information.

Table 7.8: Digital Inputs and Software Function

Switch	Function	PBASIC Variable	PBASIC Default Code Function
SW1	Switch 1	rc_sw1	Relay 1 won't go Forward if rc_sw1 is ON
SW2	Switch 2	rc_sw2	Relay 1 won't go Reverse if rc_sw2 is ON
SW3	Switch 3	rc_sw3	Relay 2 won't go Forward if rc_sw3 is ON
SW4	Switch 4	rc_sw4	Relay 2 won't go Reverse if rc_sw4 is ON
SW5	Switch 5	rc_sw5	PWM 3 won't go Forward if rc_sw5 is ON
SW6	Switch 6	rc_sw6	PWM 3 won't go Reverse if rc_sw6 is ON
SW7	Switch 7	rc_sw7	PWM 4 won't go Forward if rc_sw7 is ON
SW8	Switch 8	rc_sw8	PWM 4 won't go Reverse if rc_sw8 is ON

8. Using the Robot Controller

8.1. Setting the TEAM NUMBER

A quick method of setting the Team Number without using binary is described in the Quick Setup Guide on page 7.

Setting the Team Number on the Mini Robot Controller Motherboard is best accomplished by first setting the Team Number on the Operator Interface (see Section 5.1 on page 19), then copying the switch setting to the Robot Controllers TEAM NUMBER dipswitch.

8.2. Mini Robot Controller Indicators

Refer to the appropriate Motherboard Users Manual for Indicator information.

8.3. Power Cycle or Reset

Power Cycling involves removing power from the Mini Robot Controller and then re-connecting power after a few seconds. Some Mini Robot Controller Motherboards will have a reset button. Some Mini Robot Controller Motherboards have a power switch. Power cycling the Mini Robot Controller and pressing the RESET button both have the same result. Power Cycling or Resetting performs a complete hardware reset of the Robot Controller, including the Master, Slave, and BS2SX PBASIC processors.

The following are the most common uses for Power Cycling or pressing RESET:

- Restart the BS2SX processor in case of a PBASIC programming error.
- Restart the Mini Robot Controller after a new program has been downloaded to the BS2SX.
- Restart the Mini Robot Controller after the CHANNEL dipswitch on the Operator Interface is changed, to initiate a radio channel scan.

Note: The ROBOT RESET button on the Operator Interface does not perform the same function as Power Cycling or pressing RESET on the Robot Controller. ROBOT RESET on the Operator Interface only resets the BS2SX and not the entire Robot Controller.

When in doubt, Power Cycling or pressing RESET won't hurt.

8.4. Fuse

Refer to the Motherboard Users Manual for information on the fuse.

9. Programming the Robot Controller

The Mini Robot Controller is supplied with a "Default" program in order to help get the robot up and running quickly. The functionality of the default control program is described below. If more sophisticated control of the robot is desired, then a custom program, known as the 'user' program, must be written. In order to facilitate the creation of a user program, source code for the default program is provided. Various default programs are available at www.ifiRobotics.com.

Program Language

All programs running on the Mini Robot Controller must be written in PBASIC, a dialect of the BASIC programming language. This language was selected because it is fairly easy to learn, use, and debug in a short period of time. With the exception of the source code for the default program, the programming utility and manuals can be obtained via the Internet from Parallax, Inc. at www.parallaxinc.com.

Write Protect Jumper

A Write Protect Jumper on the Mini Robot Controller Motherboard is used to protect the PBASIC memory from being overwritten inadvertently. Install a jumper across the two pins to allow programming. Remove the jumper to write protect the PBASIC memory.

The Mini Robot Controller programming steps are as follows:

1. Power ON the Robot Controller.
2. Connect a DB9 Male-Female Pin-to-Pin cable (maximum length 25 ft.) to connect the PROGRAM port on the Mini Robot Controller to PC serial port. Some Mini Robot Controller Motherboards require jumper pins to be set to enable the Program Port. See the Motherboard Users Manual for more information.
3. Ensure the Write Protect jumper is installed on the Motherboard.
4. Run Parallax, Inc. BASIC Stamp Version 1.091 beta or higher.
5. Load the desired program.
6. Press CTRL-R to download the program.
7. Power cycle (or press RESET) on the Robot Controller.

Successful Programming: Basic Run Indicator

After programming the Robot Controller, after the Mini Robot Controller is communicating with a Operator Interface, and after power cycling (or pressing RESET) on the Robot Controller, you should see the BASIC RUN light flashing. This BASIC RUN light indicates that the new program is running. The PBASIC program controls this light.

Programming Problem: Basic Run Error Indicator

If after programming and power cycling (or Resetting) the Robot Controller, the BASIC RUN ERR light is ON, then the basic code has no output. This means that the code is not running properly. Check for errors in the code. The BASIC RUN ERR light is controlled by the Output microprocessor.

Programming Problem: Basic Init Error Indicator

If after programming and reseting the Robot Controller, the BASIC INIT ERR light is ON, then the basic code did not properly initialize the data packet structure with the master microprocessor. Check the initialization part of the code for errors. A common mistake is having a different number of variables in the SERIN command, as compared to the requested data setup in the "Set the Initialization constants you want to read" section of the code. The BASIC INIT ERR light is controlled by the Master microprocessor.

Table 9.1: PWM Output vs. Default Program vs. Input

Code Function	Variable Name	Variable Type	Connector	Pin	Function
PWM 1	p1_Y	Byte	OI Port 1	6	Y-Axis
PWM 2	p2_Y	Byte	OI Port 2	6	Y-Axis
PWM 3	p3_Y	Byte	OI Port 3	6	Y-Axis
PWM 3 Rev only if rc_sw5 is ON	rc_sw5	Bit	RC Digital Inputs	4	Switch 5
PWM 3 Fwd only if rc_sw6 is ON	rc_sw6	Bit	RC Digital Inputs	5	Switch 6
PWM 4	p4_Y	Byte	OI Port 4	6	Y-Axis
PWM 4 Rev only if rc_sw7 is ON	rc_sw7	Bit	RC Digital Inputs	18	Switch 7
PWM 4 Fwd only if rc_sw8 is ON	rc_sw8	Bit	RC Digital Inputs	19	Switch 8
PWM 5	p1_X	Byte	OI Port 1	3	X-Axis
PWM 6	p2_X	Byte	OI Port 2	3	X-Axis
PWM 7	p3_X	Byte	OI Port 3	3	X-Axis
PWM 8	p4_X	Byte	OI Port 4	3	X-Axis

Notes:

"RC" refers to the Robot Controller.

"OI" refers to the Operator Interface.

"ON" indicates a switch that is grounded (closed).

Table 9.2: Relay Output vs. Default Program vs. Input

Code Function	Variable Name	Variable Type	Connector	Pin	Function
Relay 1 Forward	p1_sw_trig	Bit	Port 1	2	Joystick Trigger Switch
Relay 1 Forward	p1_sw_trig	Bit	Port 4	5	Same as OI Port 1 Joystick Trigger
Relay 1 Rev only if rc_sw1 is ON	rc_sw1	Bit	RC Digital Inputs	1	Switch 1
Relay 1 Reverse	p1_sw_top	Bit	Port 1	7	Joystick Thumb Switch
Relay 1 Reverse	p1_sw_top	Bit	Port 4	8	Same as OI Port 1 Joystick Thumb
Relay 1 Fwd only if rc_sw2 is ON	rc_sw2	Bit	RC Digital Inputs	2	Switch 2
Relay 2 Forward	p2_sw_trig	Bit	Port 2	2	Joystick Trigger Switch
Relay 2 Rev only if rc_sw3 is ON	rc_sw3	Bit	RC Digital Inputs	15	Switch 3
Relay 2 Reverse	p2_sw_top	Bit	Port 2	7	Joystick Thumb Switch
Relay 2 Fwd only if rc_sw4 is ON	rc_sw4	Bit	RC Digital Inputs	16	Switch 4
Relay 3 Forward	p3_sw_trig	Bit	Port 3	2	Joystick Trigger Switch
Relay 3 Forward	p3_sw_trig	Bit	Port 2	5	Same as OI Port 3 Joystick Trigger
Relay 3 Reverse	p3_sw_top	Bit	Port 3	7	Joystick Thumb Switch
Relay 3 Reverse	p3_sw_top	Bit	Port 2	8	Same as OI Port 3 Joystick Thumb
Relay 4 Forward	p4_sw_trig	Bit	Port 4	2	Joystick Trigger Switch
Relay 4 Reverse	p4_sw_top	Bit	Port 4	7	Joystick Thumb Switch

Notes:
"RC" refers to the Robot Controller.
"OI" refers to the Operator Interface.
"ON" indicates a switch that is grounded (closed).

Table 9.3: Robot Feedback Default Program

Code Function	Variable Name	Variable Type	Connector	Pin	Function
OI Feedback LED - PWM1 Green	out8	Bit (out)	Port 1	15	Robot Feedback LED driver
OI Feedback LED - PWM1 Red	out9	Bit (out)	Port 1	8	Robot Feedback LED driver
OI Feedback LED - PWM2 Green	out10	Bit (out)	Port 1	9	Robot Feedback LED driver
OI Feedback LED - PWM2 Red	out11	Bit (out)	Port 1	5	Robot Feedback LED driver
OI Feedback LED - Relay1 Red	out12	Bit (out)	Port 3	8	Robot Feedback LED driver
OI Feedback LED - Relay1 Green	out13	Bit (out)	Port 3	15	Robot Feedback LED driver
OI Feedback LED - Relay2 Red	out14	Bit (out)	Port 3	5	Robot Feedback LED driver
OI Feedback LED - Relay2 Green	out15	Bit (out)	Port 3	9	Robot Feedback LED driver

Notes:
"OI" refers to the Operator Interface.

10. Contacting IFIrobotics

IFIrobotics website: www.ifiRobotics.com
IFIrobotics e-mail: info@ifiRobotics.com
Technical Support Hotline: 903 454-1978

Documentation
Documentation for all IFIrobotics products is available on our web site. This includes data sheets, installation information, users guides, and Frequently Asked Questions.

Ordering
Orders should be made via our secure on-line web site.
Our site accepts VISA, MasterCard, and American Express.
Purchase Orders (POs) will not be accepted.

Technical Support
Please refer to the Frequently Asked Questions (FAQ) on our website for help diagnosing control system problems. Refer any unanswered questions to the Technical Support Hotline.

Technical support hours are 9:00 to 5:00 M-F (central standard time). IFIrobotics will attempt to provide phone support outside normal business hours as much as possible .

Return Policy
Discuss all return issues with technical support before returning items. The return policy and shipping instructions are available on the website.

Warranty Policy
Refer to our website.