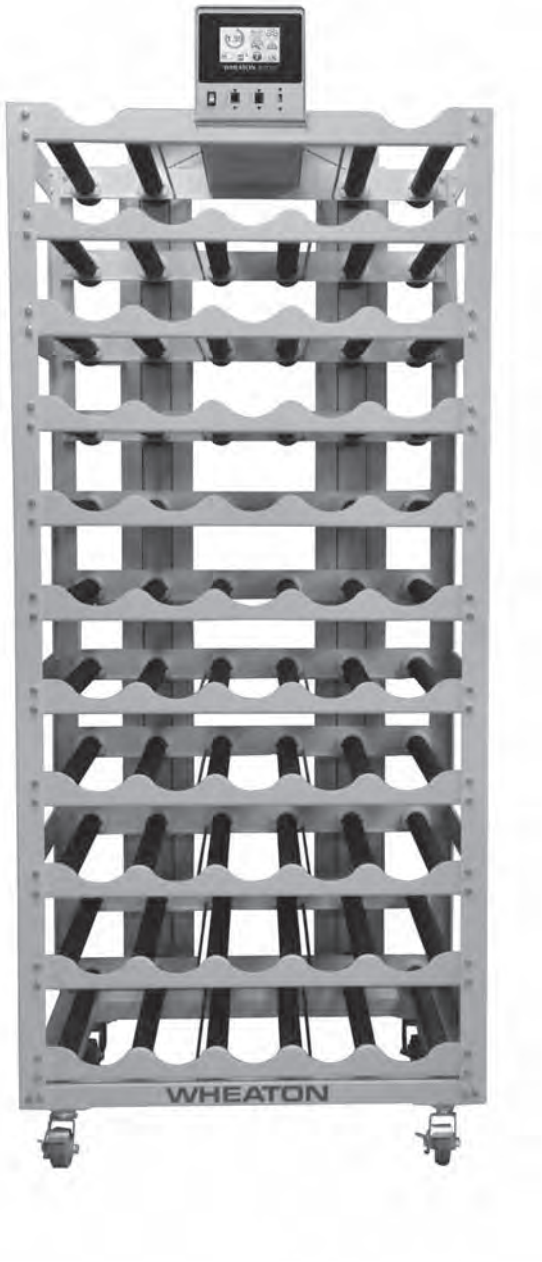
WHEATON® Roller Apparatus

R2P™ 2.0 and the WHEATON Standard Roller
for Adherent Cell Culture Manual

User Manual



General Safety Instructions

Note: Even the safest equipment can cause injury if the user is careless

1. **Know Your Instrument** - read the operating manual carefully. Learn the equipment's application and limitations.
2. **Ground All Equipment** - if electrical, this instrument is equipped with a grounding type plug. The green/yellow conductor in the cord is the grounding wire and should never be connected to a live terminal.
3. **Avoid Dangerous Environment** - electrical instruments designed to process liquids must be operated with extreme caution. If liquid comes in contact with internal electrical components or wires, fire or electrical shock may occur. Adequate surrounding workspace should be provided during use. Do not operate electrical instrumentation in a combustible atmosphere.
4. **Work Surface** - keep well lighted. Be certain the work surface is clean, level and sturdy enough to support the weight of the unit, particularly if it is to be filled with liquid.
5. **Wear Proper Apparel** - do not wear loose clothing, neckties or jewelry that might get caught in moving parts. Non-slip footwear is recommended. Wear protective hair covering to contain long hair.
6. **Wear Safety Goggles** - wear safety goggles at all times. Everyday eyeglasses only have impact resistant lenses, they are not safety glasses.
7. **Don't Overreach** - keep proper footing and balance at all times.
8. **Maintain Instrument with Care** - keep screws tight and unit clean. Check periodically for worn or damaged parts. Inspect the plug and cord before each use. Do not operate this instrument if there are signs of damage.
9. **Avoid Accidental Start Up** - if electrical, always make sure the switch is in the "off" position before plugging instrument into outlet.
10. **Disconnect Instrument** - always disconnect the instrument from the power source before servicing.
11. **Do not block cooling vents if provided**
12. **Do not operate this equipment in any manner not specified in this manual**
13. **Keep the operating manual for the instrument in a safe place near the instrument for quick and easy reference.**
14. **It is recommended that a fire extinguisher always be located in areas where electrical instruments are being used.**

WSP-305

Safety Symbols Used In This Manual

A **WARNING** symbol indicates attention to an operation, which can cause operator injury, improper function of or damage to the equipment and possible problems with the process.

A **DANGER** symbol indicates attention to an operation, which could cause electrocution or severe injury or death.

Table of Contents

1.0 Introduction

This service manual provides a detailed description of the inner workings of the R2P Roller Apparatus unit. This manual allows a technician to identify and troubleshoot the individual components that make up the R2P Roller Apparatus. A combination of off the shelf and custom designed components are used in the construction of an R2P Roller Apparatus. Only a qualified technician with sufficient electromechanical experience should attempt to service an R2P Roller Apparatus. This manual is intended to be used as a supplement to the **R2P Roller Apparatus Instruction Manual** as many references are made to figures and diagrams in that manual.

1.1 Safety Considerations

WARNING! Improper grounding can result in electrical shock. In the event of a short circuit, grounding reduces the risk of shock. This instrument must be grounded.

1. This instrument is equipped with a cord having a grounding wire and an appropriate grounding plug. The plug must be used with an outlet that has been installed and grounded in accordance with all local codes and ordinances. The outlet must have the same configuration as the plug. DO NOT USE AN ADAPTER.
2. Do not modify the line cord that has been provided. If it does not fit the available outlet, contact your nearest WSP distributor for the proper line cord for your area.
3. Many of the sensitive electronic components used in the R2P Roller Apparatus are susceptible to Electrostatic Discharge damage (ESD). When attempting to service an R2P Roller Apparatus, make sure that repairs are done in a properly maintained ESD preventative environment.

1.2 Component Identification

Refer to Figure A of the **R2P Roller Apparatus Instruction Manual** for component identification

Power inlet module #3,4,5: Location of the line cord entry and fuse(s) compartment.

Switching Power Supply #7: Supplies 28V DC to the system, automatic sensing and switchover of line voltages from 90-260VAC.

Motor Controller Board #10: Controls the 24V DC brushless motor. Receives an analog speed signal and digital direction signal from the MCU board, and provides motor tach feedback signal back to the MCU board for closed loop control.

Motor #11: Turns all the rollers on the rack via two main belt trains running down the back of the roller rack.

MCU Board #12: Contains an 8 bit CPU which monitors and controls motor speed and direction, roller rotation detection, and serial communications if set up for CART operation.

Power Router Board #8: Directs power to the Motor Controller Board and the MCU Board from either the switching power supply or the optional battery back. Automatically detects power lost and activates battery backup if so equipped, and sends a signal to the MCU board if battery voltage is low.

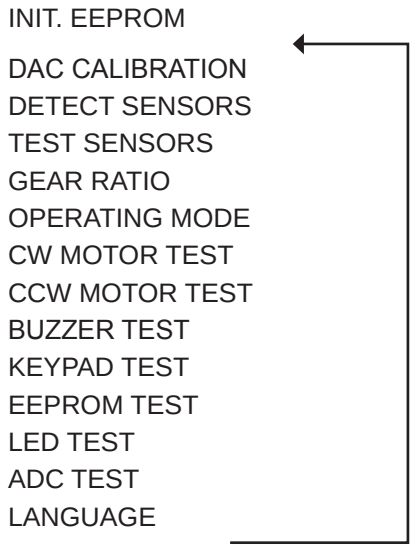
Battery Backup Board #14 (option): Automatically charges discharged batteries and maintains charged batteries at their proper voltage level.

Communications Board #16: Provides serial communications for CART control and dry contact output for fault relay.

2.0 Factory Setup Menu

A hidden menu is used during production to set up and test various functions of the R2P Roller Apparatus. This menu can be accessed by pressing and holding the DOWN arrow key on the front panel keypad while turning the unit on. Menus are selected by pressing the MODE key to the desired choice, and pressing ENTER to start the test. If components are serviced or replaced, or if accessories are added to the R2P Roller Apparatus, the factory setup menu may need to be accessed to set up components.

Factory Setup Screen



INIT EEPROM Initializes the non-volatile RAM on the CPU board. This should be run whenever a CPU board is replaced. (see section 3.2) Clears all stored operation settings, (see R2P Instruction Manual section 6.3) and programs constant values necessary for proper CPU operation.

DAC CALIBRATION The R2P Roller Apparatus CPU board uses a 12-bit digital to analog converter (DAC) to send a 0-5VDC speed signal to the motor controller board. The DAC calibration should be performed whenever a CPU board, motor controller board, (see section 6.2) or a motor is replaced.

DETECT SENSORS Used to detect the number of temperature sensors connected to an R2P Roller Apparatus. This test should also be used if sensors are being added to, or removed from, an R2P Roller Apparatus.

TEST SENSORS Displays, on the front panel LCD screen, the current temperature of each sensor connected to the R2P Roller Apparatus (up to four).

GEAR RATIO Used to set the ratio of the motor gearbox. Ratio setting should be checked if motor is replaced or upgraded to a different speed.

OPERATING MODE Selects between STANDALONE mode or NETWORK CAPABLE mode. If unit is to be used under CART network control, the operating mode should be set to NETWORK CAPABLE.

CW MOTOR TEST Tests the operation of the motor in clockwise direction. Should be performed whenever a CPU board, motor controller board, (see section 6.2) or motor is replaced.

CCW MOTOR TEST Tests the operation of the motor in counter - clockwise direction. Should be performed whenever a CPU board, motor controller board, (see section 6.2) or motor is replaced.

BUZZER TEST Tests the on-board audio alarm for proper operation.

KEYPAD TEST Tests for correct push-button operation of the front panel keypad.

EEPROM TEST Tests for correct operation of the non-volatile RAM on the CPU board. This test is non-destructive to stored data.

LED TEST Turns ON / OFF the front panel LCD backlight.

ADC TEST Used to test the analog to digital converter on the R2P CPU board. NOT USED IN THE R2P ROLLER APPARATUS APPLICATION.

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3.0 CPU Board Diagnostic and Replacement

The R2P Roller Apparatus CPU board monitors and controls operation of the entire unit. The CPU board receives information from the front panel keyboard, belt sensors, temperature sensors, motor speed feedback signals, and remote network communications. It, in turn, processes the information to maintain precise bottle speed control of the R2P unit.

Refer to the **R2P Roller Apparatus Instruction Manual** Figure A item 12, for identification of the CPU board. If a CPU malfunction is suspected, several built-in diagnostic tests (as noted in section 2.0) can help verify operation. These diagnostic tests should also be used if a CPU board is replaced.

3.1 Jumper and Potentiometer Settings

Four jumpers and one potentiometer are used to set parameters and adjust LCD contrast. Refer to figure A in this manual for jumper and potentiometer location on the CPU board.

JP101 **Non volatile RAM security set.** The non-volatile RAM (U104) stores the CPU board setup parameters such as motor calibration, bottle diameter, and unit ID number. Placing a jumper on JP101 allows a section of the non-volatile RAM to be blocked from user access. This feature is not used in the R2P roller apparatus. No jumper should be placed on JP101.

JP102 **Dry Contact Configuration.** This jumper configures the fault condition dry contact output relay (K101). If the jumper is placed on the TOP two pins (NO), the relay will be OPEN in normal condition and CLOSE in fault condition. If the jumper is placed on the LOWER two pins, the relay will be CLOSED in normal condition and OPEN in fault condition.

JP103 **DAC Output Voltage.** The R2P CPU board uses a 12-bit digital to analog converter to output a precision reference voltage to the motor controller board. The full-scale output will be 5.00 VDC, with the jumper removed from JP103, and 10.00 VDC with the jumper installed. The jumper should be REMOVED for the R2P roller apparatus so that the full scale DAC output voltage is 5.00 VDC.

SP104 **Motor Direction.** This jumper sets the motor direction for the R2P Roller Apparatus. SP104 should be solder jumpered to set the correct motor direction for an R2P Roller Apparatus application.

R113 **Display Contrast.** Adjusts the contrast of the front panel LCD display. If the CPU board or the LCD display is replaced in an R2P unit, the display contrast may need to be adjusted. Apply power to the R2P unit and verify the system is working properly. If characters on the front panel LCD display appear faded or are non-existent, adjust R113 to so characters can be read.

3.2 CPU Board Diagnostic Tests

Several built-in diagnostic test programs are available to test for correct operation of the CPU board. Since the CPU board is central to the overall operation of the R2P Roller Apparatus, all tests as outlined in section 2.0 should be performed on a CPU board to ensure proper operation. After performing tests as outlined in this section, proceed to additional tests as outlined in sections 6.0, 7.0 and 11.0

To access the diagnostic tests, follow the instructions in section 2.0, to access the Factory Setup Menu then press the MODE key to select the following menu items:

INIT EEPROM
Initializes the non-volatile RAM on the CPU board. This should be run whenever a CPU board is replaced. Clears all stored operation settings, (see R2P Instruction Manual section 6.3) and programs constant values necessary for proper CPU operation. Press ENTER to start the initialization. The LCD screen will quickly respond with ‘Clearing EEPROM’ and ‘Writing Defaults’.

EEPROM TEST
Tests for correct operation of the non-volatile RAM on the CPU board. This test is non-destructive to stored data. Press START to run the test. The LCD display will respond with:

```
EEPROM TEST
03FF
```

The hexadecimal number, indicating each memory address, will count backwards to zero. Each memory address will be written to, and then read back. If the non-volatile RAM tests correctly, the display will respond with PASSED. Otherwise, the display will indicate:

```
EEPROM TEST
XXXX WR:XX RD:XX
```

The failed memory address will appear with the data written (WR) and the incorrect data read back (RD).

BUZZER TEST
Tests the on-board audio alarm for proper operation. Press ENTER to start the test. Press the UP and DOWN arrow keys to turn ON and OFF the on-board audio alarm.

3.3 CPU Board Voltage Measurements

CAUTION!: Potentially lethal electrical voltages exist inside the R2P control cabinet. Only a qualified technician should attempt to make voltage measurements on running equipment.

Main power for the CPU board enters at J101. J101 is located at the top left-hand corner of the component side of the board.

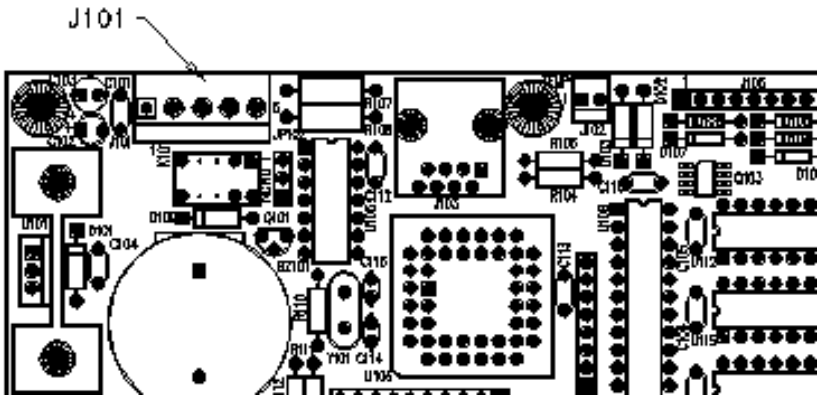

Figure 1: CPU Board Power Connection

Pin 1 is the square pin located on the left side of the connector, and pin 5 is located to the right of the connector.

PIN 1 Logic signal ground. Should read zero volts DC.

PIN 2 Chassis Ground. Should read zero volts DC.

PIN 3 Supply Voltage. In normal operation, this pin should read the supply voltage of 12 VDC. If it does NOT, check to see if the main power switch is ON, and main fuse is installed and good. If battery backup is installed, check to see if the battery backup board is installed properly and batteries are plugged (see section 9.0) No voltage on this pin may indicate a bad wire harness, bad power supply, or bad power router board (see section 8.0).

PINS 4 and 5 These pins function correctly only if the battery backup option is installed. A +5 VDC logic high on pin 4 means that power has failed, and a + 5 VDC logic high on pin 5 means that the battery voltage is low. (**see R2P Instruction Manual section 7.1**)

4.0 LCD Display Replacement

Refer to the **R2P Roller Apparatus Instruction Manual**, Figure A item 18, for identification of the front panel LCD display. Removal of the nylon screws, nuts and standoffs (items 24, 27, and 35) is necessary to unplug the LCD display from the CPU board. Unplug the backlight power cable from the CPU board J109 to complete removal.

To install a new display, plug display back onto the CPU board and secure with the nylon screws, nuts and standoffs. Plug the backlight power cable back into the CPU board J109 to finish replacement. Reconnect the CPU board to the R2P Roller Apparatus and mount the board back into the chassis.

Turn on the unit and watch for characters to appear. If they DO NOT appear, or appear faded, the LCD contrast may need to be adjusted. (see section 3.1)

LCD BACKLIGHT TEST
To access the diagnostic tests, follow the instructions in section 2.0 to access the Factory Setup Menu, then press the MODE key to select the LED TEST. Press ENTER to begin. Press the keypad UP and DOWN arrows to turn ON and OFF the LCD backlight.

5.0 Keypad Replacement

Refer to the **R2P Roller Apparatus Instruction Manual**, Figure A item 13, for identification of the front panel keypad. Unplug the keypad ribbon cable from the CPU board J105. Remove the CPU board and CPU standoffs to gain access to the nuts that hold the keypad onto the front panel. Remove the nut that holds the keypad ground strap to the front panel, before pulling keypad from the unit.

To replace the keypad, slide the keypad mounting studs through the holes in the front panel and secure the lower mounting studs with nuts and lockwashers. Attach the keypad ground strap to the front panel, and firmly secure with nut and lockwasher. Remount CPU board to unit using standoffs, nuts and lockwashers. Finally, reattach the keypad ribbon cable to the CPU board at J105.

KEYPAD TEST
Tests for the proper key operation. To access the diagnostic tests, follow the instructions in section 2.0 to access the Factory Setup Menu, then press the MODE key to select the KEYPAD TEST. Press ENTER to begin. Press each key on the keypad and watch the LCD display for correct identification of each key. Press ENTER twice to exit the test.

6.0 Motor Controller Replacement and Setup

Refer to the R2P Roller Apparatus Instruction Manual, figure A item 10, for identification of the motor controller board. Carefully mark and unplug the wire harness from the controller board and then remove the nuts and washers (item 33) to pull the controller board from the unit.
To install a new motor controller board, secure board to chassis with nuts and washers, and then carefully plug the wire harness back onto the board.

6.1 Motor Controller Setup and Status Indicator Lights

Three pots on the motor controller board require adjustment before the R2P Roller Apparatus can operate properly. Locate the three pots as per figure 2 below:

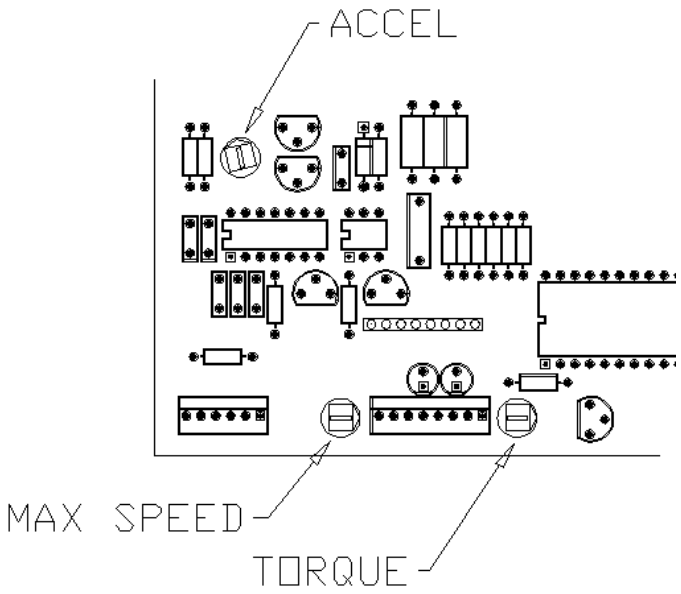

Figure 2: Motor Controller Setup

Both the MAX SPEED (R2) and TORQUE (R4) pots should be turned full clockwise (all the way UP), while the ACCEL (R21) pot should be turned full counterclockwise (all the way DOWN).

On Board Status Indicator Lights

Two LED indicators are located between the MAX SPEED and TORQUE pots on the motor controller board. The GREEN LED indicates that power is properly applied to the board. The RED LED indicates that the board is in overcurrent condition. This is usually an indication of a jammed, shorted, or incorrectly connected motor. Both LEDs unlit indicate that power is not applied to the board.

6.2 Motor Controller Diagnostic Tests

Several built-in diagnostic test programs are available to test for correct operation of the Motor Controller board. To access the diagnostic tests, follow the instructions in section 2.0, to access the Factory Setup Menu then press the MODE key to select the following menu items:

DAC CALIBRATION
The DAC Calibration will calibrate to a speed near the top of the motor speed range, and to a speed near the bottom of the motor speed range. When performing this calibration, the R2P Roller Apparatus should be fully assembled with the motor belted to the pulleys as normal. The motor controller board should be adjusted as described in section 6.1 and Figure 2. To run the calibration:

1. Adjust the motor controller as per the directions in section 6.1 paying particular attention to the setting of the ‘MAX SPEED’ pot R2. (set fully clockwise CW)
2. Press the MODE button until DAC CALIBRATION appears and press ENTER for the upper speed range calibration. Wait for the speed feedback number to stabilize.
3. Press ENTER again to calibrate the lower speed range, and again wait for the speed feedback number to stabilize.

Press ENTER to finish calibration.

CW MOTOR TEST
Tests the motor controller for correct operation of the motor in the clockwise direction. Press ENTER to start the test. Use the UP and DOWN arrow keys on the front panel keypad to increase or decrease the DAC output voltage to the motor controller board.

CW MOTOR TEST	
DAC 105	150 RPM

Observe the DAC output and Motor speed on the front panel LCD display, and watch the motor shaft for movement in the correct direction.

CCW MOTOR TEST
Tests the motor controller for correct operation of the motor in the counterclockwise direction. Follow instructions above for CW MOTOR TEST.

7.0 Motor Replacement

Motor Diagnostic Tests

When replacing a motor in a R2P Roller Apparatus unit, several built-in diagnostic test programs can be accessed to test for correct operation of the motor. All tests used in replacing the motor controller board, as outlined in section 6.2 should be performed when replacing a motor. In addition, the motor gear ratio diagnostic should be run when a motor is replaced. The motor gear ratio diagnostic should be run first, before the diagnostics in section 6.2 are run. When performing these diagnostics, the R2P Roller Apparatus should be fully assembled with the motor belted to the pulleys as normal. The motor controller board should be adjusted as described in section 6.1 and Figure 2. To access the diagnostic tests, follow the instructions in section 2.0, to access the Factory Setup Menu then press the MODE key to select the following menu items:

GEAR RATIO
Before starting, read the builder's sticker on the motor to find the motor gearbox ratio. Press ENTER to start the GEAR RATIO diagnostic. Use the UP and DOWN arrows on the front panel keypad to select the proper gear ratio and then press ENTER.

Proceed in performing diagnostic tests as outlined in section 6.2 to complete the motor replacement.

8.0 Power Route Board Troubleshooting and Replacement

Refer to the **R2P Roller Apparatus Instruction Manual**, Figure A item 8, for identification of the power route board. Carefully mark and unplug the wire harnesses from the board, and then remove the nuts and washers to pull the power route board from the unit. If the optional battery backup board is installed, remove the battery backup board first. Carefully pull the battery backup board from it's mating connector with the power route board. Remove the four threaded standoffs to gain access to the power route board.

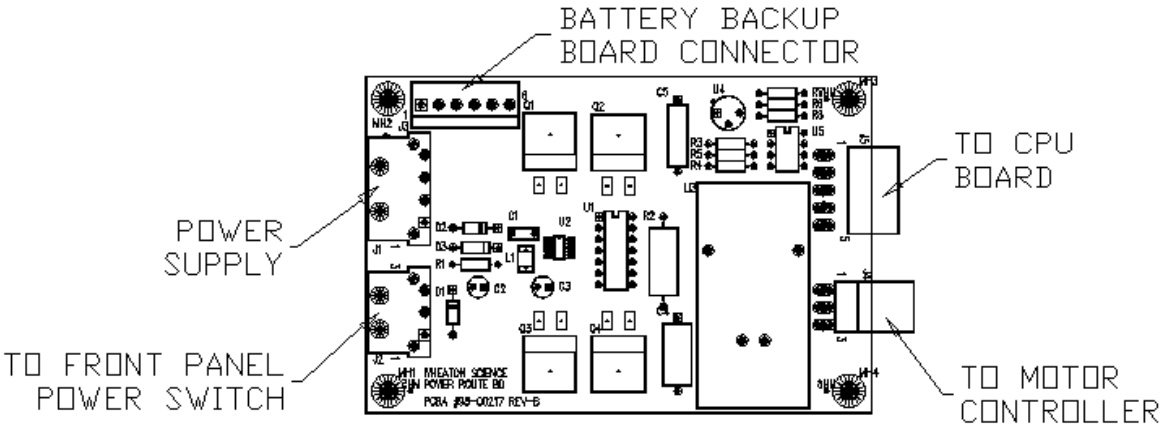

Figure 3: Power Route Board Connections

The power route board, routes power from the power supply to the motor controller board, CPU board and the (optional) battery backup board. If primary power fails, and the battery backup option is installed, the power route board uses solid-state switches to route power from the battery backup board. Several pinout voltages are available to confirm correct operation of the power route board.

CAUTION!: Potentially lethal electrical voltages exist inside the R2P control cabinet. Only a qualified technician should attempt to make voltage measurements on running equipment.

Power Route Board Connector Functions

Connector	Pin No.	Function	Notes
Power Supply (J1)	1	Input from power supply 24-28VDC	
	2	Power Fail Input from Power Supply +5V TTL signal HIGH when power supply is active	TTL Signal goes low when power supply loses AC input voltage
	3	GROUND	
	4	GROUND	
Front Panel Power Switch (J2)	1	Battery Backup Voltage Switched +24V nominal from batteries	Voltage present only if battery pack is installed and plugged into charger board.
	2	NO CONNECTION	
	3	Battery Backup Voltage Switched +24V nominal to power route board	Same as ‘1’
Power Router Board Connector (J3)	1	Battery Voltage Output nominal 24V	Output present only if battery pack is plugged into charger.

Connector	Pin No.	Function	Notes
Power Router Board Connector (J3)	2	TTL level charge control signal. Logic LOW when primary power is on and OK	Charge control signal goes HIGH when primary power is lost and main front panel switch is ON
	3	TTL level charge control signal. Logic HIGH when primary power is on and OK	Signal goes LOW when primary power is lost, battery pack is plugged in, and main power switch is ON
	4	TTL level charge control signal. Same function as '3'	Same function as '3'
	5	Power Supply Voltage +24VDC	0 Volts when in Battery Backup mode
	6	GROUND	
Motor Controller Power (J4)	1	+24V nominal to motor controller board	Main power to motor controller board
	2	GROUND	
	3	GROUND	
CPU Board (J5)	1	TTL logic Battery Low Signal normally low, goes high (+5V) when battery voltage falls below 21.19 volts	Only Active if battery backup option is installed
	2	TTL logic Power Fail Signal normally low, goes high (+5V) when power fails	Only Active if battery backup is installed. Also used to turn on/ off power MOSFET bank to route battery power to system
	3	+12VDC Main Power for CPU Board	
	4	CHASSIS GROUND	
	5	SIGNAL GROUND	

9.0 Battery Backup Board Diagnostic and Replacement

Refer to the **R2P Roller Apparatus Instruction Manual**, Figure A item 14, for identification of the battery backup board. The battery backup board automatically charges two (2) 12V 12ah sealed lead acid batteries. The backup board electronics monitor charging activity and automatically shuts off when charging is complete. The on board relay switches the battery pack connections from parallel (charging) to serial (discharging) when primary power is lost.

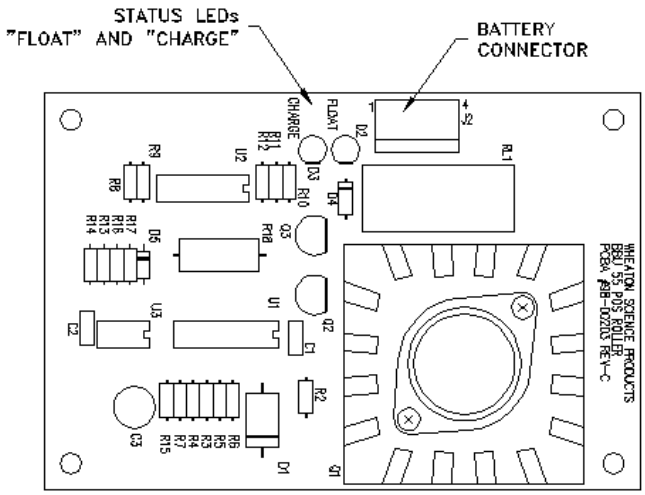

Figure 4: Battery Backup Board

9.1 LED Status Indicators

Two LED status indicators are on the battery backup board. The ‘charge’ (yellow) indicates when the backup board is charging batteries. As the current tapers and the charging completes its cycle, the lights will switch from yellow to green (float), indicating the main charging is done. The backup board will then apply a low current maintenance voltage on the batteries, to maintain peak capacity. If batteries are discharged by normal use, the yellow light will indicate again and the charging cycle will restart.

9.2 Battery Connector Pinouts

Batteries are hooked up to the backup board, J2, in the following manner.

Pin No.	Function
1	Battery 1 + (POSITIVE RED)
2	Battery 1 - (NEGATIVE BROWN)
3	Battery 2 + (POSITIVE ORANGE)
4	Battery 2 – (NEGATIVE BLACK)

10.0 Rotation Alarm Diagnostic

Two magnetic sensors, located at the top of the R2P Roller Apparatus, monitor the belt train for roller movement. The CPU board, taking into account bottle speed and motor gear ratio, calculates the time required for the roller shafts to make one revolution. If the CPU doesn’t detect an electrical pulse from either of the magnetic sensors in two roller shaft revolutions, it will set an alarm condition.

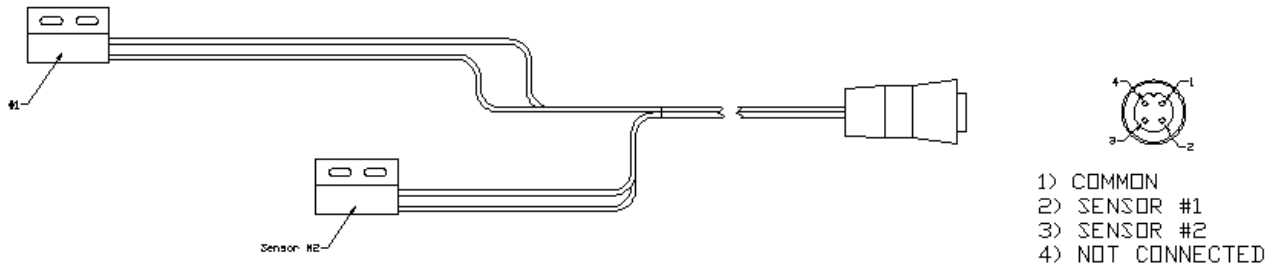

Figure 5: Rotation Alarm Cable

Use a small magnet and an ohmmeter to test the Rotation Alarm cable. Connect an ohmmeter to pins 1 and 2. Pass a magnet over the face of sensor 1, the longer of the two sensor wire sets. Zero ohms indicates a presence of a magnet and infinite ohms indicates an absence of a magnet. An incorrect reading may mean an open or shorted cable. Use the same procedure to test for sensor 2, connecting the ohmmeter to pins 1 and 3.

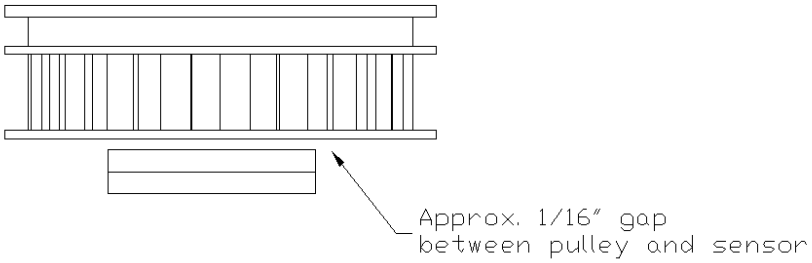

Figure 6: Sensor Spacing

Proper spacing between the magnetic belt sensor and pulley face should be maintained for correct operation. An approximate 1/16” gap should be maintained between the pulley and sensor.

11.0 Temperature Sensor Setup and Troubleshooting

Up to four (4) solid state temperature sensors can be connected to the R2P Roller Apparatus to monitor incubator temperature. The solid state sensors have no adjustment and require no calibration. Refer to this section if sensors are added, removed, or if sensor problems are expected.

11.1 Sensor Setup

Refer to section 2.0 and access the **Factory Setup Menu**. Make sure the temperature sensor cable is connected to the rear of the unit, and then press the front panel MODE key until the **DETECT SENSORS** menu appears then press ENTER. The front panel display should respond with:

DETECT SENSORS ‘X’ Sensors Found

Where ‘X’ is the number of sensors on the sensor cable. If this number does not match the actual number of sensors, recheck the cable for damage and proper connection to the R2P unit.

11.2 Sensor Location

If a multiple sensor cable has been factory installed on the R2P Roller Apparatus, the bottom most sensor on the rack is sensor #1, and the highest number sensor is at the top of the rack. Sensors, whether factory or field installed, can be numbered in any order that the user desires. Press the MODE key until the LOCATE SENSORS appears, then press ENTER. The front panel display should respond with:

Heat Up Sensor 1

Apply heat to sensor #1. The unit will beep when it recognizes the heated sensor. Continue applying heat to sensors until all sensors have been accounted for. If a four-sensor cable is used, only sensors #1-#3 need to be located, as the unit will automatically figure out that the last unheated sensor is #4. Similarly, if 3 sensors are used, only sensors 1 and 2 need to be located. **Skip the Sensor Location step if the unit uses only one sensor.**

11.3 Testing Sensor Operation

Press the MODE key until the **TEST SENSORS** appears then press ENTER. Refer to the **R2P Roller Apparatus instruction manual**, section 11.0 for identification of measured sensor temperatures on the front panel display.