

# Roomba 500 Series Service Manual

Published 10<sup>th</sup> September 2007



**Base Robot 3.0 :** *Model 510*

**Base Robot 3.3 :** *Model 530*

**Base Robot 3.4 :** *Model 535, 540*

**Base Robot 3.5 :** *Model 550, 560, 565, 570, 580*



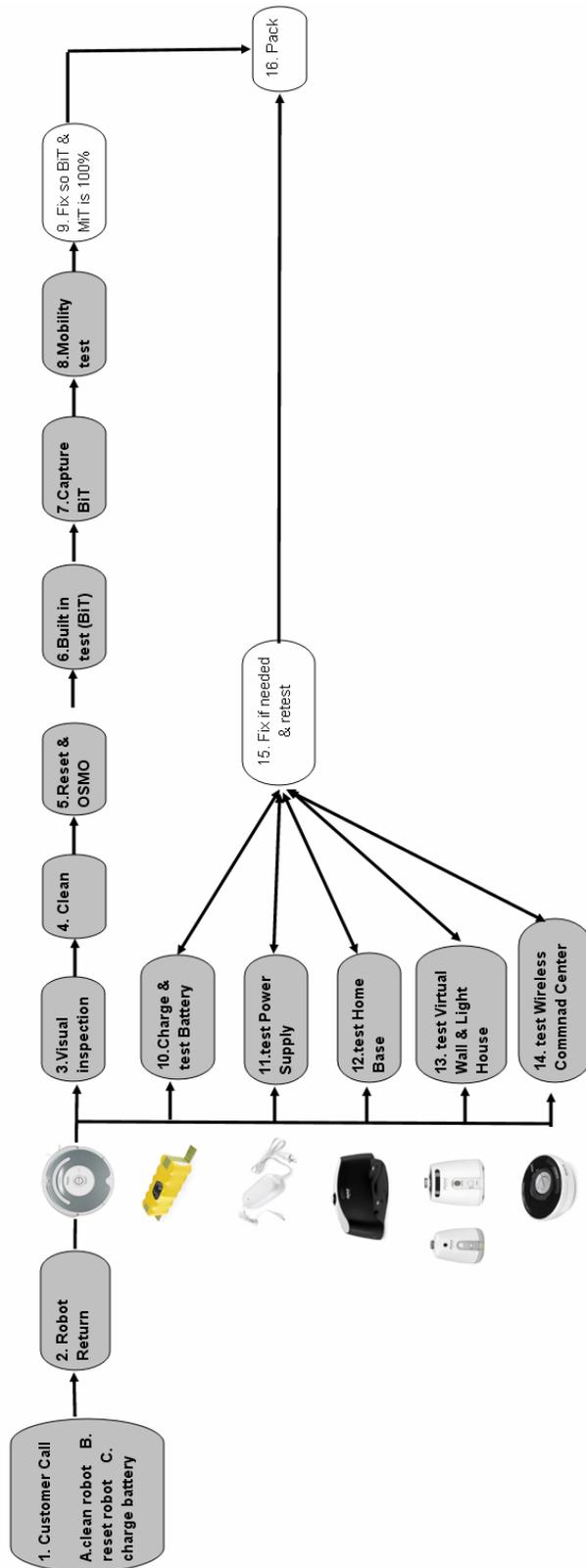
<b><i>Roomba 500 Series Service Process</i></b> .....	<b>4</b>
<b>01: Customer Call</b> .....	<b>5</b>
<b>02: Roomba Return Procedure</b> .....	<b>6</b>
<b>03: Incoming Roomba Inspection</b> .....	<b>6</b>
<b>04: Roomba Cleaning</b> .....	<b>6</b>
<b>05: Roomba Software &amp; Charging Reset</b> .....	<b>7</b>
<b>06: Roomba Diagnostics: Built-in-Test (BiT)</b> .....	<b>7</b>
<b>07: Capture Built-in-Test Data</b> .....	<b>7</b>
<b>08: Roomba Diagnostics: Mobility Test</b> .....	<b>7</b>
<b>09: Fix or Replace Roomba</b> .....	<b>8</b>
<b>10: Test Battery</b> .....	<b>8</b>
<b>11: Test Power Supply</b> .....	<b>8</b>
<b>12: Test Home Base (if applicable)</b> .....	<b>9</b>
<b>13: Test Virtual Wall &amp; Light House (if applicable)</b> .....	<b>9</b>
<b>14: Test Wireless Command Center (if applicable)</b> .....	<b>9</b>
<b>15: Replace Faulty Accessories</b> .....	<b>9</b>
<b>16: Pack &amp; Record the Serial Numbers</b> .....	<b>9</b>
<b>17: Monthly Data Report to iRobot</b> .....	<b>9</b>
<b><i>Roomba 500 Series Vacuuming Robot</i></b> .....	<b>10</b>
<b>Roomba Terminology</b> .....	<b>10</b>
<b>Roomba Features and Compatibility</b> .....	<b>13</b>
<b>Roomba Cleaning Behavior and Technology</b> .....	<b>15</b>
<b>Service Procedure (based on Built-in-Test Failures)</b> .....	<b>17</b>
<b><i>Charging Accessories</i></b> .....	<b>21</b>
<b>Roomba Battery</b> .....	<b>22</b>
<b>Roomba Power Supply</b> .....	<b>23</b>
<b>Roomba Home Base</b> .....	<b>25</b>
<b><i>Roomba Accessories</i></b> .....	<b>27</b>
<b>Roomba Virtual Wall</b> .....	<b>28</b>
<b>Roomba Virtual Wall Light House</b> .....	<b>30</b>
<b>Roomba Wireless Command Center (Base robot 3.4 and 3.5 only)</b> .....	<b>32</b>
<b><i>Roomba 500 Series Errors</i></b> .....	<b>33</b>
<b>Roomba 500 Series Pause Errors(‘uh-oh’ + beeps)</b> .....	<b>33</b>



<b>Roomba 500 Series Behavioral Issues</b> .....	<b>34</b>
<b>Roomba 500 Series Charging Errors</b> .....	<b>39</b>
<b>Appendix A : Roomba 500 Series Built-in-Test Procedure</b> .....	<b>42</b>
AUTO-ADVANCE MODE .....	44
MANUAL-ADVANCE MODE.....	44
BUILT-IN-TEST RESULT .....	44
DATA COLLECTION .....	45
SUMMARY OF ELECTRICAL CONSTANTS .....	46
BUILT-IN-TEST CHART.....	47
ROOMBA BLACK BOX .....	50
<b>Appendix B : Roomba 500 Series Mobility Test Procedure</b> .....	<b>53</b>
MOBILITY TEST PROCEDURE.....	54
MOBILITY TABLE 3 CONSTRUCTION SPECIFICATIONS (IN MM) .....	55
ROBOT RCON TEST .....	56
VIRTUAL WALL TEST .....	57
LIGHT HOUSE TEST.....	57
LIGHT HOUSE TEST.....	58
HOME BASE AND DOCKING TEST .....	59
<b>Appendix C : Module Inspection and Cleaning</b> .....	<b>60</b>
<b>DRIVE WHEEL Module inspection and cleaning</b> .....	<b>60</b>
<b>FRONT WHEEL Module inspection and cleaning</b> .....	<b>60</b>
<b>CLEANING HEAD Module inspection and cleaning</b> .....	<b>61</b>
<b>BUMPER Module inspection and cleaning</b> .....	<b>61</b>
<b>CLIFF SENSOR Module inspection and cleaning</b> .....	<b>61</b>
<b>SIDE BRUSH Module inspection and cleaning</b> .....	<b>62</b>
<b>BRUSH &amp; FLAPPER inspection and cleaning</b> .....	<b>62</b>
<b>VACUUM BIN Module inspection and cleaning</b> .....	<b>63</b>
<b>Appendix D: Roomba Spare Parts Replacement Instructions</b> .....	<b>64</b>
<b>Roomba Spare Parts Replacement (Battery, Side Brush, Cleaning Head and Wheel Modules)</b> .....	<b>65</b>
<b>Roomba Faceplate Replacement</b> .....	<b>69</b>
<b>Roomba Filter Replacement</b> .....	<b>70</b>
<b>Roomba Front Wheel Replacement</b> .....	<b>71</b>
<b>Appendix E: Roomba Software &amp; OSMO</b> .....	<b>71</b>
<b>Appendix F: Battery Test Procedure</b> .....	<b>72</b>
<b>Appendix G: Power Supply Test Procedure</b> .....	<b>73</b>
<b>Appendix H: Home Base Test Procedure</b> .....	<b>73</b>
<b>Appendix I: Roomba Serial Number</b> .....	<b>74</b>
<b>Appendix J: User Interface</b> .....	<b>75</b>
<b>Appendix K: Glossary</b> .....	<b>76</b>



# Roomba 500 Series Service Process

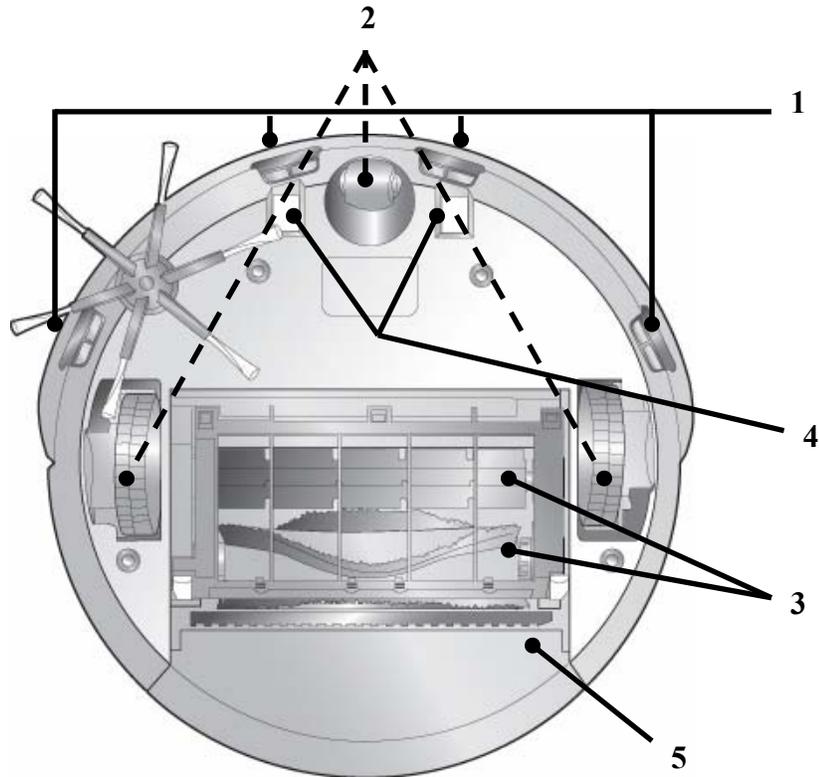


## 01: Customer Call

Depending on the sophistication of the Customer Service Representation at the service centers, Roomba issues can be diagnosed over the phone by guiding a user through a troubleshooting process. At a minimum, iRobot recommends that the customer be asked to perform routine Roomba maintenance steps to resolve the Roomba issue. Only if these steps fail to resolve the issue should a customer send the Roomba to a service center.

### A) Customer should clean Roomba

- i. Clean the cliff sensors under the bumper with a cotton bud. ①
- ii. Remove any hair or obstruction from the three wheels. ②
- iii. Remove any hair or obstruction from the brushes and bearings. ③
- iv. Clean contacts on Roomba and Home Base with alcohol pad (*not all models*). ④
- v. Clean out the vacuum bin and vacuum filter. ⑤



B) If necessary, customer should reset Roomba's charging system by pressing down the Roomba's SPOT and DOCK simultaneously for 10 seconds (this will clear the schedules as well). This can be done when the robot is ON, OFF or CHARGING. When ON the CLEAN button will go dark when the reset is complete.

C) Customer should fully charge the battery.

## **02: Roomba Return Procedure**

If the initial maintenance steps did not solve the issue, a customer should proceed to return the Roomba, battery and all accessories to a service center.

**IMPORTANT** : Before packing and shipping a robot, clear all schedules by resetting the Roomba : Press down the SPOT and DOCK buttons simultaneously for 10 seconds. This can be done when the robot is ON, OFF or CHARGING.

## **03: Incoming Roomba Inspection**

Perform a visual inspection of the Roomba condition. Look for wear and dirt on the chassis, cliff sensors, all wheels, and brushes.	
Manually turn the bristle brush. Does the flexible brush counter rotate?	
Remove the brush guard and check that both yellow brush bearings are present.	
Reinsert all Roomba components and try to recreate the customer complaint by running the robot for a few minutes. If the battery is low, charge the battery first. If during the run, it has an error, record this.	See 'Pause Errors'; 'Behavioral Issues' and 'Charging Error' chapters below

## **04: Roomba Cleaning**

Remove and empty the vacuum bin and vacuum filter.	
Clean the main brush, flexible brush and bearings from hair and dirt.	
Clean drive wheels and front caster.	
Remove and clean under the side brush of hair and dirt.	
Clean the cliff sensors with compressed air or cotton bud.	
Clean the electrical contacts on Roomba and home base with alcohol.	



### **05: Roomba Software & Charging Reset**

Ensure the Roomba has a charged battery and download the latest software, if necessary.	<b><u>Appendix D</u></b>
Reset Roomba's charging system by pressing down the SPOT and DOCK buttons simultaneously for 10 seconds. This can be done when the robot is ON, OFF or CHARGING. This can be done when the robot is ON, OFF or CHARGING. When ON the CLEAN button will go dark when the reset is complete.	

### **06: Roomba Diagnostics: Built-in-Test (BiT)**

It is important that this step only diagnose Roomba failures. For this reason, conduct the BiT with approved accessories (the customer accessories can be tested separately).

Ensure the Roomba has a charged battery in the Roomba.	
If brushes are in bad shape, insert new brushes with bearings.	
Use *approved* Power Supply, Home Base, Virtual Wall and Remote.	
Perform BiT steps. Take note of the button & speaker performance.	<b><u>Appendix A</u></b>

### **07: Capture Built-in-Test Data**

Use "iRobot Factory Test Client Version 1.1" to capture the BiT output. Use "R3BlackBoxReader" program to capture data in the black box	<b><u>Appendix A</u></b>
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### **08: Roomba Diagnostics: Mobility Test**

Perform the Mobility Test.	<b><u>Appendix B</u></b>
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### **09: Fix or Replace Roomba**

Replace parts using Built-in-test Fix and module disassembly procedure.	See “Service Procedure Chapter”  <b><u>Appendix D</u></b>
Re-test the BiT and MT and continue fixing until 100% pass.	<b><u>Appendix A/B</u></b>

### **10: Test Battery**

Fully charge the returned Battery.	
Perform Battery test <ul style="list-style-type: none"><li>○ Battery Voltage should be between 15.5 - 18V.</li><li>○ Battery Voltage drop should be less than 2V.</li></ul>	<b><u>Appendix F</u></b>
When battery PASSES, discharge battery with a Roomba run by pressing DOCK and <u>not</u> having a home base present. The Roomba will run until the battery runs low. The runtime should be at least 60 minutes. If not, replace the battery. (Note : Battery can be discharged at a constant 2.2A until the battery is at 12V. Measure time to discharge.)	

### **11: Test Power Supply**

Test returned Power Supply <ul style="list-style-type: none"><li>○ Shake the unit and make sure there are no loose parts</li><li>○ Connect to wall and ensure DC output is between 21.1-24.0 VDC</li><li>○ Solid green light under load</li><li>○ Measure idle current with AC RMS ammeter to be &lt;18mA</li><li>○ Measure standby power is &lt;0.5W</li></ul>	<b><u>Appendix G</u></b>
[Note: If the power supply light is off or blinking while charging, replace it and make sure the Home Base and Roomba pass all charging tests.]	



### **12: Test Home Base (if applicable)**

Test returned Home Base with an *approved* power supply and robot <ul style="list-style-type: none"><li>○ Clean Home Base (electrical contacts and IR emitter)</li><li>○ Check if power and dock LEDs are solid green when charging</li><li>○ Visually inspect contact springs</li><li>○ Perform Home Base mobility/docking tests</li></ul>	<b><u>Appendix B</u></b> <b><u>Appendix H</u></b>
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### **13: Test Virtual Wall & Light House (if applicable)**

Test returned Virtual Wall with charged batteries <ul style="list-style-type: none"><li>○ Clean Virtual Wall (IR emitter)</li><li>○ Check power light (if blinking then batteries are low)</li><li>○ Perform Virtual Wall mobility tests</li></ul>	<b><u>Appendix B</u></b>
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### **14: Test Wireless Command Center (if applicable)**

Test Wireless Command Center with charged batteries	
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### **15: Replace Faulty Accessories**

Replace faulty accessories	
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### **16: Pack & Record the Serial Numbers**

Pack the robot. If a core robot exchange was necessary, record the new serial number in the service process report	
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### **17: Monthly Data Report to iRobot**

The detailed International Service Process Report should be managed monthly and sent Tonia Giesecke at <a href="mailto:tgiesecke@irobot.com">tgiesecke@irobot.com</a> or Martijn Braam at <a href="mailto:mbraam@irobot.com">mbraam@irobot.com</a> ).	
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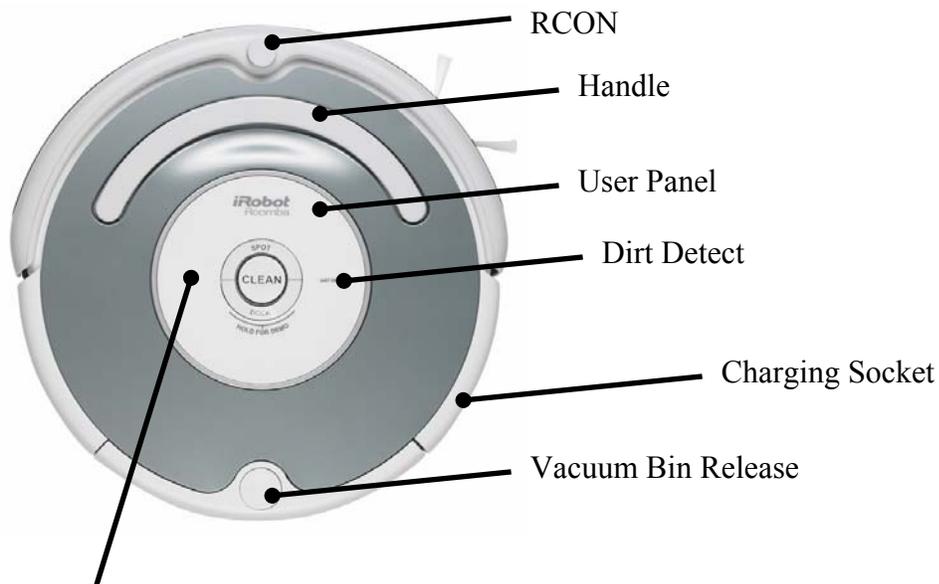
## Roomba 500 Series Vacuuming Robot

The iRobot Roomba 500 series includes the following improvements:

- Better reliability, robustness and product life (R3 core robot has a 500% longer life vs. R2)
- Enhanced mobility system improves room coverage
- Light Houses guide Roomba to clean more rooms
- Larger vacuum bin capacity ( R3 has 117% larger bin capacity vs. R2)
- Better vacuum suction (R3 has 133% greater suction vs. R2)
- Light touch bumper results in a gentler impact (R3 impacts with 50% less force vs. R2)
- Quieter cleaning (R3 has a ~50% lower sound pressure level and a ~75% lower sound intensity level on hardwood floor vs. R2)
- Replaceable squeegee
- Lower standby current drain (R3 takes about 25% longer to discharge its battery than R2)
- Voice tutorial demonstrates Roomba's features to new users
- Anti-tangle technology enables Roomba to extract itself from tassels and cord tangles
- Added binoculars (IR emitters) in Roomba's bumper to improve docking
- Wireless Command Center allows Roomba to be scheduled and directed

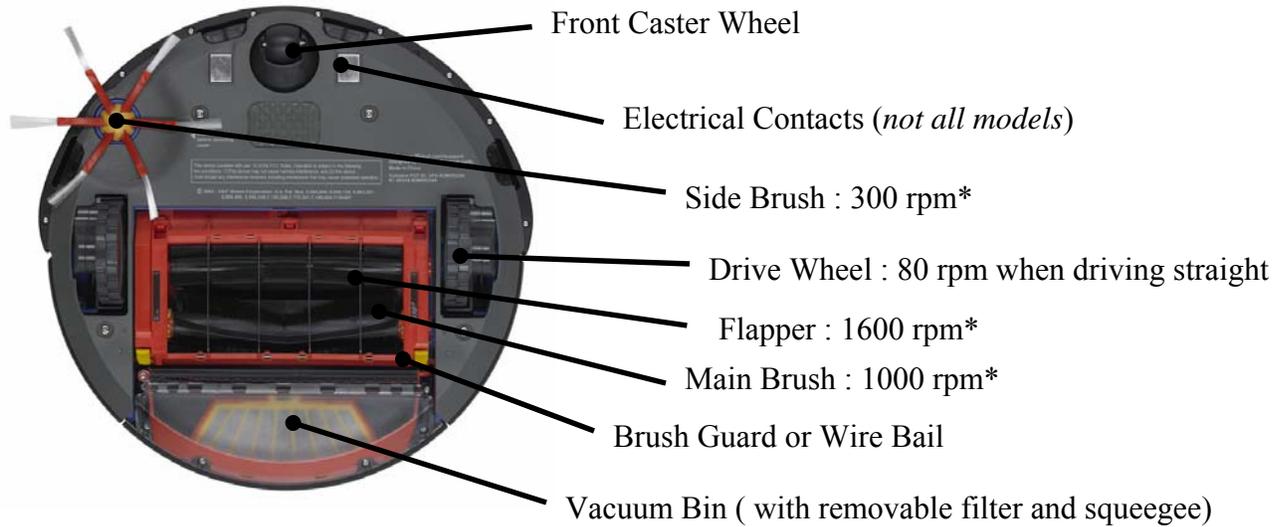
### Roomba Terminology

#### Top View



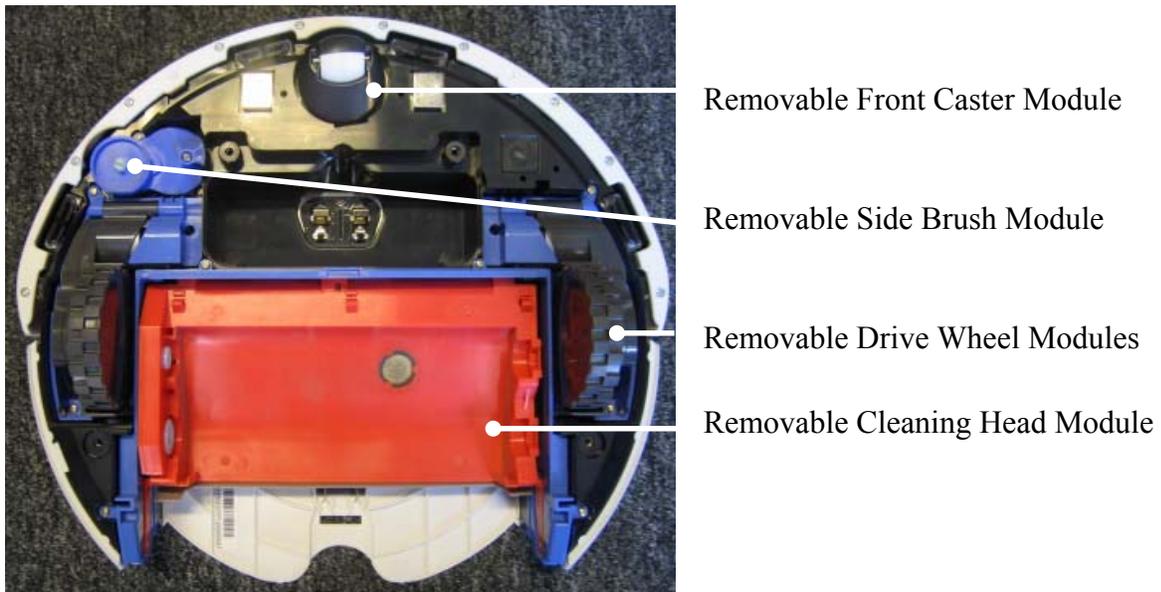
“Check Robot”

## Bottom View



\* rpm is revolutions per minute. These values may vary as battery charge declines

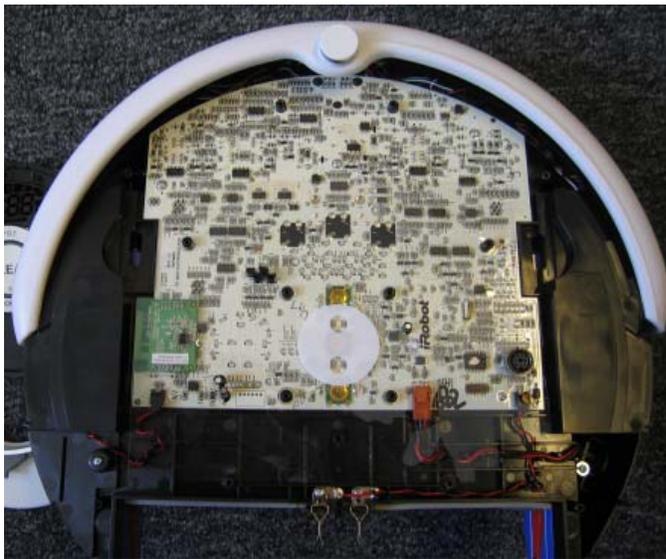
## Bottom View (bottom chassis + battery + brushes + bin removed)



**Top View (front panel removed)**



**Top View (top chassis +user panel removed)**



## Roomba Features and Compatibility

		Base Robot 3.0 <i>Model 510</i>	Base Robot 3.3 <i>Model 530</i>	Base Robot 3.4 <i>Model 535, 540</i>	Base Robot 3.5 <i>Model 550, 560, 565, 570, 580</i>
Virtual Wall compatible?		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Home Base compatible?		<input checked="" type="checkbox"/> (no contacts)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Light House compatible?		<input checked="" type="checkbox"/> (no RF)	<input checked="" type="checkbox"/> (no RF)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
WCC compatible?		<input checked="" type="checkbox"/> (no RF)	<input checked="" type="checkbox"/> (no RF)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Scheduling compatible?		<input checked="" type="checkbox"/> (no RF)	<input checked="" type="checkbox"/> (no RF)	<input checked="" type="checkbox"/> (needs a WCC)	<input checked="" type="checkbox"/> (User Panel has schedule buttons and a display)

The base robots 3.4 and 3.5 uses radio frequency channels\* for wireless connection. The Roomba will scan the channels at the start of a cleaning cycle and choose a channel with the least interference. If during operation the chosen channel becomes very noisy to the point where communications fail, the robot will choose a better channel.

\* Roomba operates on the 2.4GHz US ISM band and has 16 channels spaced at 5MHz intervals, centered from 2405 to 2480 MHz. The system uses direct sequence spectrum technology (DSSS), with O-QPSK modulation. Max conducted power output is a few milliwatts.



### **Sensors on all Base Robots**

- 4 optical infrared (IR) Light-touch sensors
- 4 optical IR cliff sensors
- 1 optical IR stasis
- 1 omni directional IR sensor in RCON
- 2 optical IR bumper switches
- 2 Hall Effect and magnetic encoder wheel encoders
- 2 mechanical switch wheel-drop sensors
- 1 battery-current sensor
- 2 wheel-current sensors
- 1 battery-temp sensor
- 1 battery-voltage sensor
- 1 main-brush current analog sensor
- 1 side-brush current analog sensor
- 1 main-brush pwm (pulse width modulation) truncation sensor
- 1 side-brush pwm truncation sensor
- 1 vacuum pwm truncation sensor
- 1 spot button
- 1 home button
- 1 power button

Total 29

### **Extra Sensors on Base Robot 3.4 and 3.5**

- 2 optical IR binoculars
- 1 dock sensor
- 1 radiofrequency (RF) transceiver
- 1 schedule button
- 1 clock button
- 1 day button
- 1 hour button
- 1 minute button

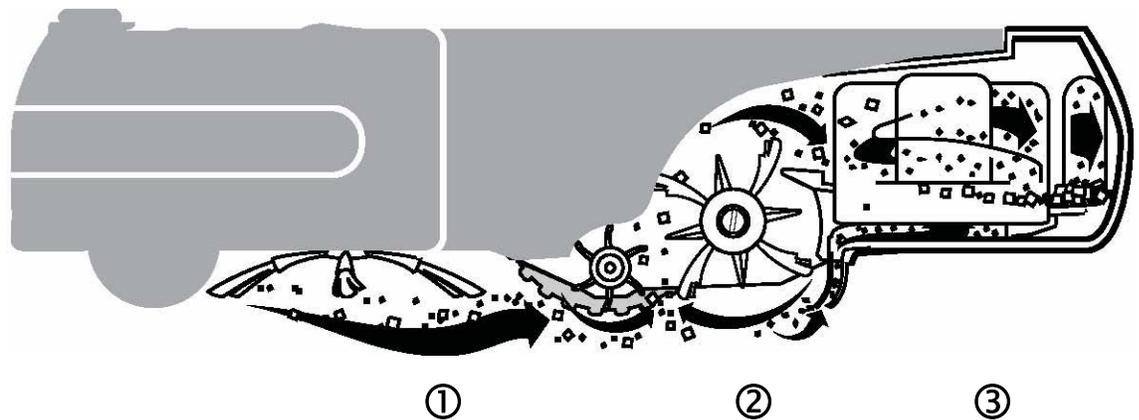
Total 9

## ***Roomba Cleaning Behavior and Technology***

The Roomba (500 Series) has three cleaning modes and will clean based on the cleaning mode you select.

- **Clean Mode** : Roomba automatically calculates the room size and adjusts its cleaning time appropriately.
- **Spot Mode**: Roomba will spiral approximately 3 feet in diameter and then spiral back to where it started, intensely cleaning a localized area.
- **Scheduled Cleaning Mode** (*Base Robot 3.4 and 3.5 only*) When a cleaning time is programmed, Roomba enters scheduled cleaning mode. At the specified time, Roomba leaves its Home Base, cleans, and then returns to the Home Base to recharge when it's done.
- **Max Mode**: To recreate a Max mode, run the Roomba by pressing DOCK but do not have a Home Base present. The robot will clean until the battery depletes to 12V.

{Note: When using Roomba with Light Houses, Roomba will clean for a maximum of 35 minutes per room.}



Roomba features a 3-stage cleaning system

1. Spinning Side brush – sweeps along edge of walls and into corners
2. Two counter rotating brushes – sweeps debris into the vacuum bin
3. Vacuum – sucks up dust and small particles which is trapped by a filter



## Normal Cleaning Behavior

In normal cleaning behavior, Roomba switches between several different behaviors:

- Drive – Roomba drives straight
- Spiral – Roomba drives in an outward spiral pattern
- Bounce – Bumper activation makes Roomba back up, turn in place, and drive straight
- Wall follow – Roomba follows along a wall

When first started, Roomba goes into spiral mode (if the ‘clean’ button is held twice after the robot is ON, it will drive straight and skip the spiral mode). When the bumper is activated for the first time, Roomba goes into wall follow mode. Thereafter, when the bumper is activated Roomba will normally do a bounce, but will revert to wall-follow mode after a number of bumper activations.

There are other behaviors that react to specific situations

- Cliff avoid – Roomba backs up and turns whenever its cliff sensor detects a cliff
- RCON avoid – Roomba turns whenever the RCON sensor detects an infrared beam
- Bump follow – Roomba follows a wall with its bumper
- Panic spin – Roomba will spin in place when the front wheel is stuck (stasis not triggered) or when Roomba moves straight for 6 meters without triggering its bumper or cliff sensors.
- Wedge Escape – Roomba will turn forwards and backwards in attempt to dislodge itself.
- Dirt Detect – when dirt is detected it will concentrate its cleaning in a specific area
- Light Touch – Roomba will sense objects in front of it and slow down. It does not work well with thin or black objects.
- Power Save - Roomba will switch off after 5 minutes if switched ON and not in use.

There is special control of brush and drive motors:

- Anti Tassel – The main brush and side brush will reverse direction so as to remove the thread wrapped around the brush.
- Undocking - The brushes and vacuum are deactivated when Roomba undocks. Then it will turn and first turn on the vacuum and next the brushes.

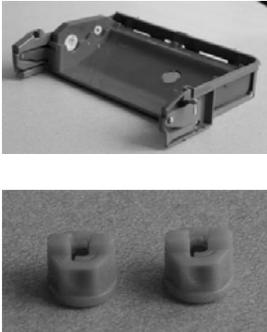
## **Service Procedure (based on Built-in-Test Failures)**

Every Roomba that is serviced is required to undergo a Built-in-Test (BiT) which will then dictate how to best service the Roomba. A Roomba needs to pass the BiT before being returned to a customer.

The following process is based on failed BiT steps or specific symptoms. Basic troubleshooting steps are detailed but as a last resort, a replacement part is suggested.

#	Description	Spare Part
0	<p><b>Roomba BiT 0 – PANEL LEDS/BUTTONS/SPEAKER</b>            Roomba Spare Part : Service or Core Robot Replacement</p>	
2	<p><b>Roomba BiT 2 – BUMPERS</b>            Trouble shooting : Toggle the bumper and retest            Roomba Spare Part : Service or Core Robot Replacement</p>	
3-4	<p><b>Roomba BiT 3 to 4 – OUTER + INNER CLIFF SENSORS</b>            Troubleshooting : Has the side brush stalled and obstructing the cliff sensor? Wipe all cliff sensor windows.            Roomba Spare Part : Service or Core Robot Replacement</p>	

<p><b>5-7</b></p>	<p><b>Roomba BiT 5 to 7 – LIGHT TOUCH BUMPERS</b>          Troubleshooting : Clean front window along bumper. Do not use a black obstacle during test.          Roomba Spare Part : Service or Core Robot Replacement</p>	
<p><b>8</b></p>	<p><b>Roomba BiT 8 – WHEEL DROP SENSOR</b>          Troubleshooting : Toggle wheels.          Roomba Spare Part : Drive Wheel Replacement</p>	
<p><b>9</b></p>	<p><b>Roomba BiT 9 – RCON RECEIVER</b>          Troubleshooting : Clean RCON with a cloth.          Roomba Spare Part : Service or Core Robot Replacement</p>	
<p><b>10</b></p>	<p><b>Roomba BiT 10 – FRONT DIRECTIONAL IR RECEIVERS</b>  <i>(Base robot 3.4 and 3.5 only)</i>          Troubleshooting : Clean front bumper windows          Roomba Spare Part : Service or Core Robot Replacement</p>	
<p><b>11</b></p>	<p><b>Roomba BiT 11 – BATTERY SENSORS</b>          Trouble shooting : Tighten bottom cover.          Roomba Spare Part : Battery Replacement</p>	
<p><b>12-14</b></p>	<p><b>Roomba BiT 12 to 14 – LEFT &amp; RIGHT WHEEL &amp; ENCODERS</b>          Trouble shooting : Clean wheels from dirt and hair.          Roomba Spare Part : Drive Wheel Replacement</p>	

<p><b>15</b></p>	<p><b>Roomba BiT 15 – STASIS</b>          Trouble shooting : Remove front caster module. Clean optical stasis window in chassis. Clean white/black wheel if dirty.          Roomba Spare Part : Front Caster and Wheel Replacement</p>	
<p><b>16</b></p>	<p><b>Roomba BiT 16 – MAIN BRUSH</b>          Troubleshooting: Redo test with new brush and flapper. Ensure motor and pulley string of module is functioning.          Roomba Spare Part : Cleaning Head, Brush, Flapper Drive and Bearing Replacement</p>	
<p><b>17</b></p>	<p><b>Roomba BiT 17 – DEBRIS SENSOR</b>          Troubleshooting: Clean debris sensor          Roomba Spare Part : Cleaning Head Replacement</p>	
<p><b>18</b></p>	<p><b>Roomba BiT 18 – VACUUM</b>          Troubleshooting: Empty vacuum bin and inspect filter for holes.          Roomba Spare Part : Vacuum Bin Replacement</p>	

<p><b>19</b></p>	<p><b>Roomba BiT 19 – SIDE BRUSH</b> Troubleshooting: Remove side brush and clean side brush from hair and dirt. Inspect side brush axle. Roomba Spare Part : Side Brush Module Replacement</p>	 
<p><b>20-26</b></p>	<p><b>Roomba BiT 20 to 26 – CHARGING</b> Troubleshooting: Clean robot and Home Base contacts is necessary Roomba Spare Part : Service or Core Robot Replacement</p>	

## **Charging Accessories**



**Battery**



**Power Supply**

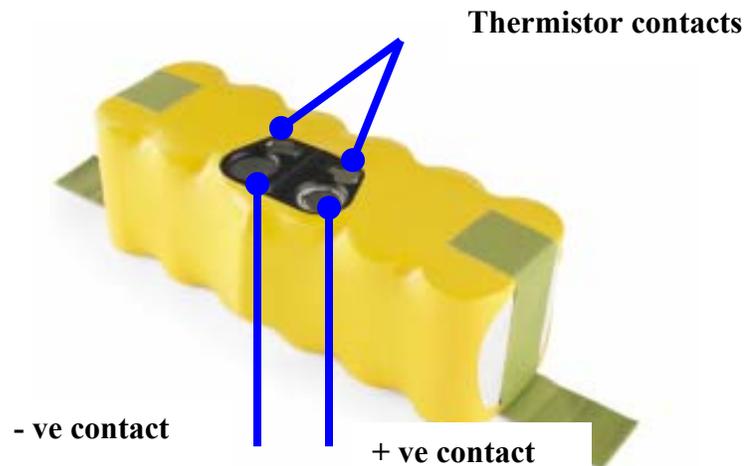


**Home Base**

## Roomba Battery

Roomba is powered by a soft pack rechargeable NiMH (nickel metal hydride) battery made up of 12 cells. The battery can only be accessed by removing the bottom plate of the Roomba. A fully charged battery has a voltage between 15.5 and 18 V. The battery also has a thermistor and it relies on the change of resistance to measure battery temperature.

Roomba will clean until the battery voltage is 12V under load after which it will stop if not already on the home base for charging.



- **Normal battery charge** : A normal charge (indicated by a slow pulsing CLEAN button) takes up to 3 hours.
- **Recovery battery charge** : A recovery charge is automatically detected by the robot (indicated by rapid flashing CLEAN button) and takes 16 hours and should not be disrupted. This is activated if the battery voltage is under 10.8 V.
- **Charging/Battery reset** : A robot charging system can be reset by holding down the SPOT and DOCK buttons together for 10 seconds . This will also erase all schedules. It is easiest to reset when robot is ON as the CLEAN light will go dark when the reset is complete.

## **General Battery Maintenance Tips**

- Keep the battery charging at all times unless in use.
- Occasionally reset the charging system in the Roomba. Reset Roomba's charging system by pressing down the SPOT and DOCK buttons simultaneously for 10 seconds. This can be done when the robot is ON, OFF or CHARGING. This can be done when the robot is ON, OFF or CHARGING. When ON the CLEAN button will go dark when the reset is complete.
- It is also recommended at times to run down the battery and then charge it fully. To deplete the battery, press DOCK and allow robot to clean without a Home Base present. The Roomba will clean until the battery runs flat. Then give the battery a full charge.



## Roomba Power Supply

Roomba's are charged by either a Universal (100-240V) or Domestic (120V) Power Supply. The Power Supply steps the voltage down to 22.5VDC and 1.25A. A solid green LED light on the Power Supply is an indication that it is plugged in and operating properly.



## Roomba 500 Series Charging Algorithm Overview

### High level sequence

1. **Check charging FETs** – If FETs fail then charging is aborted
2. **Pre-charge cooling** { 0mA } - Runs until battery temperature is less than 50°C, or an end of charge condition is true. Sets the charging state to NORMAL or RECOVERY based on the battery voltage.
3. **Charging** - Runs until an end of charge condition is true, in one of the following modes:
  - a. **Normal** { 1250mA } – for initial battery voltage greater than 10.8V .
  - b. **Recovery** { 300mA } - for initial battery voltage less than 10.8V .
4. **Post-charge cooling** { 0mA } - Runs until battery temperature is less than 35°C, or 2hrs passes. Sets charging state to WAITING/TRICKLE.
5. **Trickle** { 50mA } - Runs indefinitely. If the temperature goes above 42°C, trickle turns off until the temperature drops below 40°C, then re-enables.

### End of charge conditions

Charging is terminated as soon as one of these conditions is true. These conditions are tested in variable times during charging.

- **Voltage Dip** : Voltage dips more than a 30 mV from the maximum voltage.
- **Temperature Slope** : Temperature increases by more than 0.5°C per minute.
- **Coulombs Max** : If battery level is more than 2 times the nominal capacity.



- **Normal Charge Timeout** : 9 hours maximum in normal charge mode.
- **Recovery Charge Timeout** : 16 hours maximum in recovery charge mode.
- **Temperature Max** : Battery temperature exceeds 60° C for at least 1 minute.
- **Voltage Max** : Pack voltage exceeds 21.6V for at least 1 minute.
- **Previous end-of-charge** : If a battery has been discharged by less than 150mAH since the last complete charge.

### Charging LEDs

- **Normal and Recovery Mode** : The power LED pulses orange as long as the robot is in the normal (slow pulse) or recovery (fast pulse) charging state. Note that this does not necessarily mean that current is actually flowing into the battery. If the robot's hardware is damaged such that no current can flow into the battery, the LED pulses orange until an end-of-charge condition is detected, such as the 9 hour timeout.
- **Waiting/Trickle Mode** : The power LED is solid green when the robot is doing post-charge cooling and trickle charging.

### **Power Supply Troubleshooting**

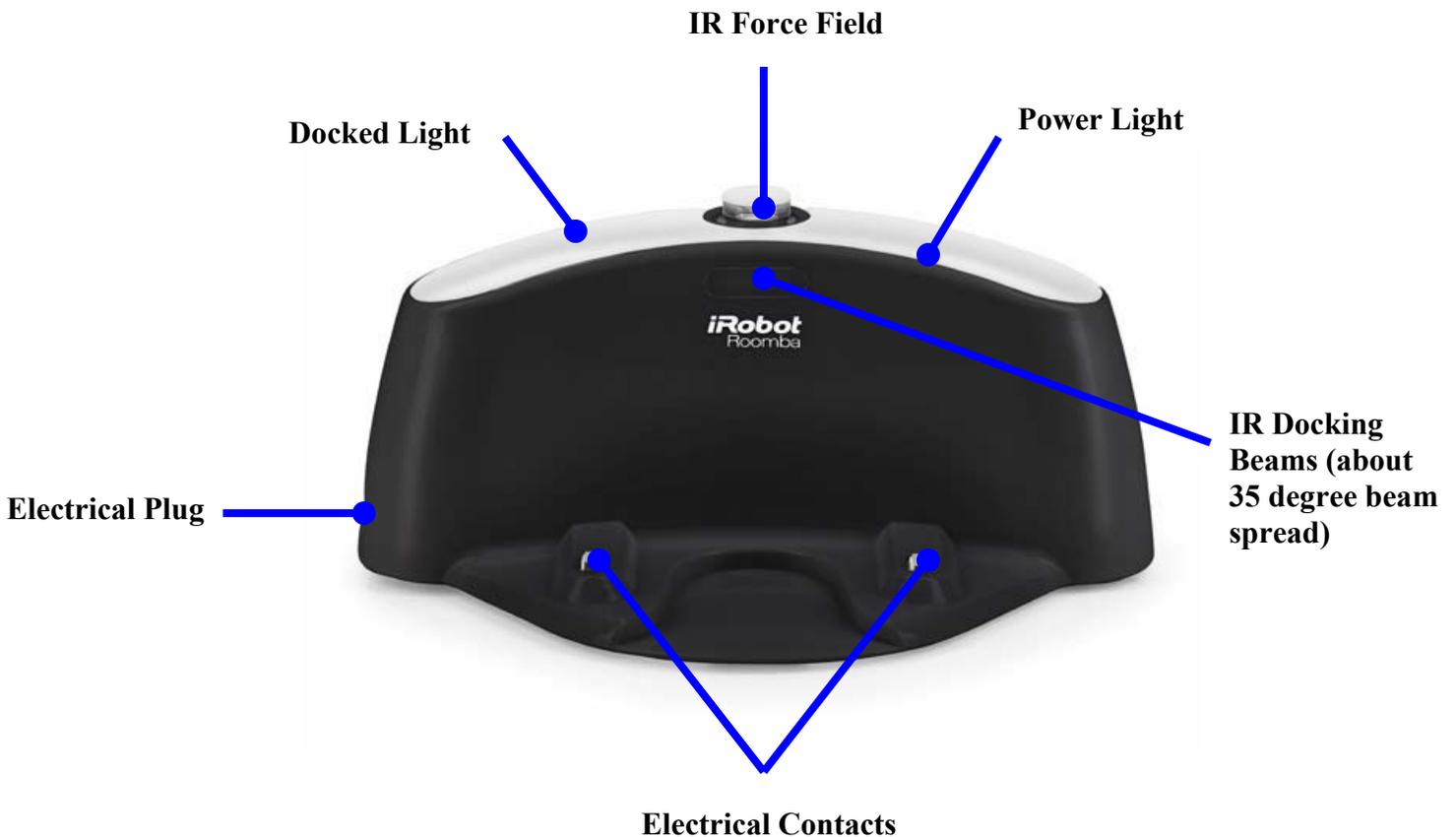
- Is the Power Supply LED solid green while charging? If not try another wall socket.
- If the power light is off or flashing, replace the Power Supply and test the Roomba and Home Base for charging errors.



## **Roomba Home Base**

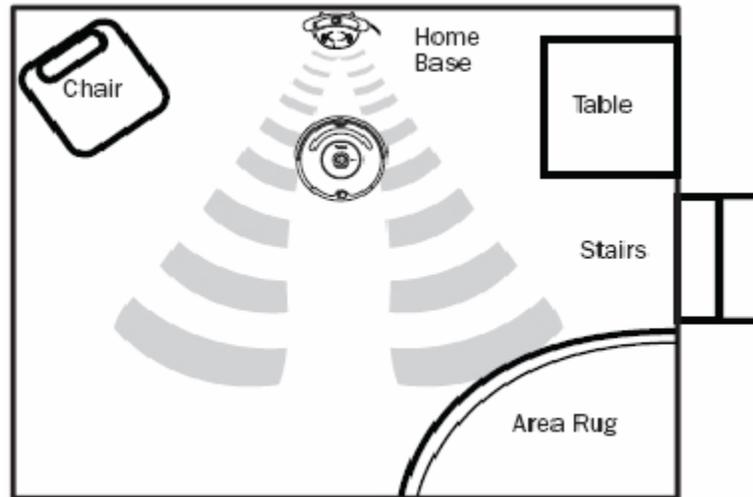
The Roomba Home Base is a self-charging station where the Roomba (through a sophisticated infrared tracking mechanism) can drive back to at the end of a clean cycle or when its battery is low. After docking itself, the Roomba will recharge its battery. The charging sequence takes about 3 hours in a normal charge and 16 hours in a recovery mode.

The power light on the Home Base indicates that it is plugged in and operating properly. This light must be on and solid green for Roomba to charge. The docked light on the Home Base indicates that Roomba is successfully docked and charging.





Roomba needs to find the infrared signal of the Home Base in order to return so it is necessary to always keep the Home Base plugged in. The Home Base should be placed on a hard level surface and in an area where Roomba has a clear path to return to the Home Base at the end of a cleaning cycle. If Roomba is unable to dock on its first attempt, it will try again until it successfully docks.



## Manual Docking

To manually test the ability of the Roomba to dock successfully on the Home Base:

1. Verify that the Home Base is plugged in and that the power light is on.
2. Place the Home Base in a relatively open and flat area without any obstacles.
3. Remove any Virtual Walls closer than 2.5 meters from the Home Base.
4. Place Roomba about 1.5 meters in front of the Home Base and press DOCK. Roomba should drive back to the Home Base and it may take a few attempts.
5. Once the Roomba is on the Home Base verify the two green lights on the Home Base are lit and solid.
6. If not, clean the electrical contacts under the Roomba and on the Home Base and repeat these instructions.

## Home Base Troubleshooting

- The power light and charging light on the Home Base must be on and solid green while charging. If not, check the connection and the Power Supply. Also ensure the electrical contacts are clean. [Note: If flashing replace the Home Base and test Power Supply and Roomba for charging problems]
- Inspect the integrity of the electrical spring contacts
- Wipe the top Home Base IR lens from dust
- Perform the Home Base Mobility test (see Appendix B).



## Roomba Accessories



**Virtual Wall**



**Light House**



**Wireless  
Command Center**

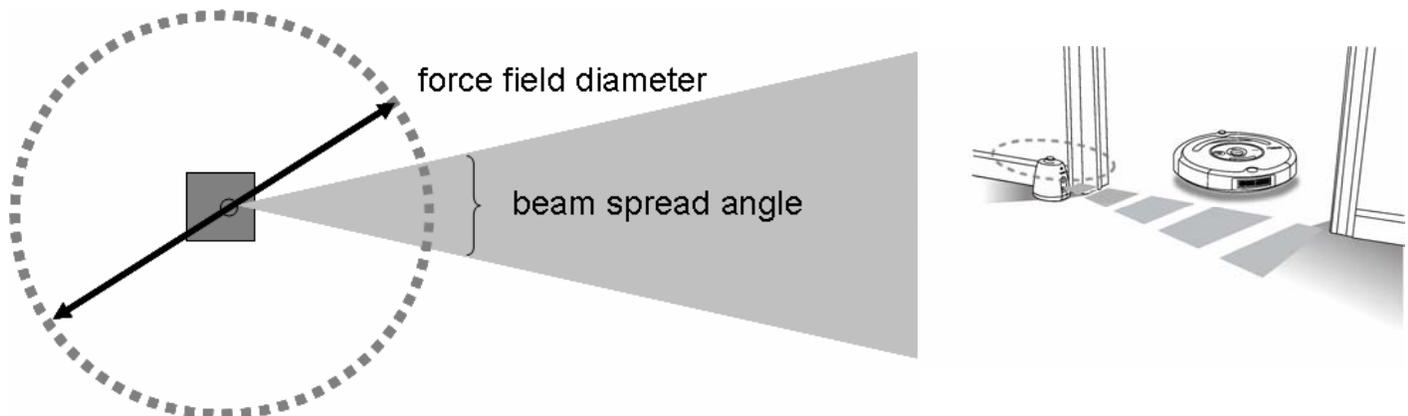
## Roomba Virtual Wall

The Roomba Virtual Walls create an invisible barrier that Roomba will not cross. The Virtual Walls can be set to block an area ranging from 0 to 2.4 meters long. Light Houses turn off automatically after 2 hours.



The Virtual Wall beam is triangular shaped. A small halo prevents Roomba from bumping into the Virtual Wall and a larger cone-shaped section blocks off areas of your home where you don't want Roomba to go.

Top view of Virtual Wall : ~30 degrees beam spread angle





## Virtual Wall Troubleshooting

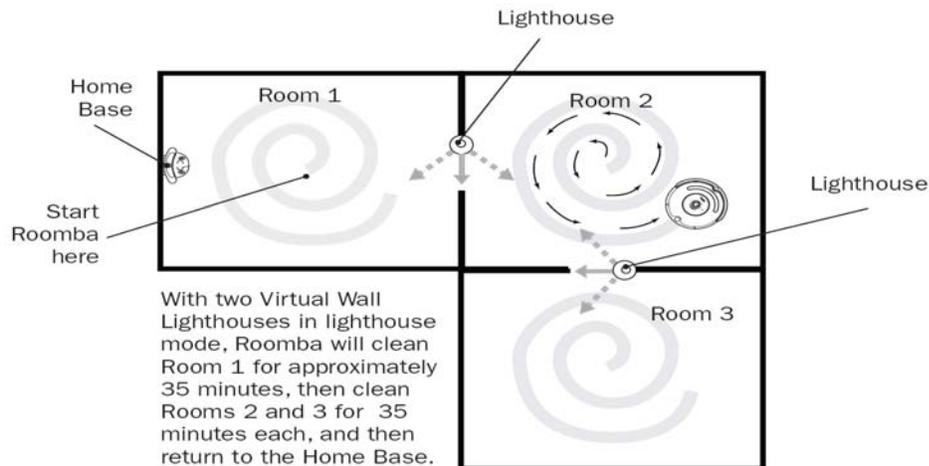
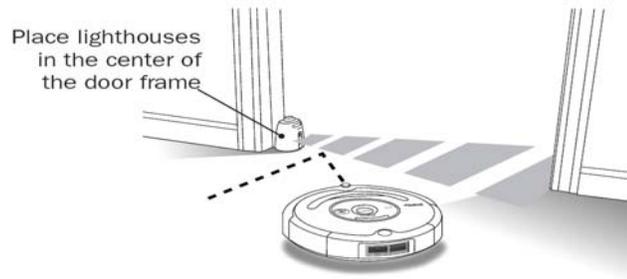
- If the Virtual Wall is turned on but the battery status light is off or flashing, the batteries are low. Check the batteries and the virtual battery door. When replacing batteries wait 5 seconds between removal and insertion for a full reset. Also, choosing a higher range in Virtual Wall than necessary will drain the battery faster.
- If Roomba goes through the beam, wipe Roomba's RCON and the infrared field emitter on the Virtual Wall and retest mobility through the beam.
- Perform the Virtual Wall Mobility test (Appendix B).

## Roomba Virtual Wall Light House

Light Houses help Roomba navigate around a home, helps Roomba find the Home Base, and allow Roomba to clean one room before starting the next. There is a mode selector to choose either Virtual Wall or Light House mode. In either mode, the Light House will automatically turn ON when the Roomba is on and within radiofrequency range (~15 meters). The Light House will turn OFF when Roomba is OFF or out of range. Light Houses indicate that their battery is low by flashing the power light repeatedly.



- In Virtual Wall mode, a virtual ‘wall’ is set up and is continuously on when the robot is close by. Choosing a higher range in Virtual Wall mode will drain the battery faster.
- In Light House mode, a virtual ‘door’ is set up between rooms which stays closed for up to 35 minutes before opening and allowing the Roomba to pass into the next room.
- Light House and Robot pairing : Light Houses need to be paired up with its Roomba and this occurs every time batteries are inserted into the Light House. Pairing occurs during the first cleaning run when the Roomba and Light House get within IR distance (~0.5 m). This pairing is important so that Light Houses are not controlled by other Roombas within RF range (~15 m).
- Light House Placement : Place Light Houses in the doorway between two rooms. Roomba will clean the room it starts in, navigate to the next room, and then clean the second room. When Roomba has completed cleaning, it will use the Light Houses to navigate back to the Home Base. With 2 Light Houses as shown below, Roomba will sequentially clean room 1, 2 and 3 for approximately 35 minutes each before returning to the Home Base.



## Light House Troubleshooting



- Complaint : Customer gets a new Service Roomba (models 535 and above) and the old Light Houses stop working properly. Solution : Have the customer remove all the Light House batteries and reinsert them (flushes Light House memory). Background : When a customer first uses their new Roomba, all new Light house within RF range will turn on. Then, as Roomba cleans for the first time it will get within infrared distance of the Light House and share its identifier # with the Light House. Result is that they are 'paired' and each Light House can only be controlled by its specific Roomba. Therefore, when a new strange service robot comes into the picture it is necessary to flush the Light House memory so it can be paired anew.
- The user can confuse the Roomba by moving the lighthouse to another room during a clean cycle. Then issues come up when the Roomba actually wants to find the dock at the end of the clean cycle and it enters the wrong room. Another issue is when the user manually docks the Roomba to abort a clean cycle and the Roomba ignores the dock and even bumps into it because it thinks it is in another room. Solution : If accessories have been moved, turn robot OFF and then ON again. Also, have users not move accessories once a cycle has started.



### **Roomba Wireless Command Center (Base robot 3.4 and 3.5 only)**

The Wireless Command Center allows a user to remotely turn the Roomba on or off, be directed and scheduled. To schedule a Roomba to clean, use the buttons on the Wireless Command Center as if they were on the robot user panel itself.



### **Wireless Command Center Troubleshooting**

The WCC should work normally at distances of about 30 feet. However, depending on the environment this will vary. In open areas it may be more and when environment cluttered with interfering objects (especially metallic) it will be reduced.

Prior to using a new Wireless Command Center (WCC) with Roomba, it needs to be paired to the Roomba.

- Remove WCC batteries
- Reinstall WCC batteries while holding down the left drive button.
- Continue holding the left drive button for 3 seconds or until the days of the week lights flash in a sequence from Saturday to Sunday.
- Install WCC battery door.
- Hold the WCC close to the robot you want to pair it with. It should stop scrolling.
- When the Roomba responds to the WCC, press and hold the DAY and MINUTE buttons for 2 seconds until the WCC lights flash and the Roomba beeps once quickly.
- They are now paired. From now on, when the WCC is powered on, lights will sequence from Sunday to Saturday until the robot is under control.

## Roomba 500 Series Errors

### Roomba 500 Series Pause Errors('uh-oh' + beeps)

When a Roomba experiences an error it will stop cleaning and emit an error. A pause error will always have an “uh-oh” followed by beeps and perhaps even a voice message. The beep errors can be replayed by hitting the bumper. The voice message can be replayed when a button is pressed.

<b>'Uh-Oh'</b> 	<b>Voice Message*</b> 	<b>What it means</b> 	<b>What to do</b> 
<b>+1-beep</b>	<ul style="list-style-type: none"> <li>▪ <i>Please inspect and Clean Roomba's Left Wheel</i></li> <li>▪ <i>Please inspect and Clean Roomba's Right Wheel</i></li> <li>▪ <i>Please inspect and Clean Roomba's Wheels</i></li> </ul>	<b>wheel-drop error</b> Roomba's wheel has dropped below body of robot	See <b>Appendix C</b> : Inspect and Clean Wheel modules.
<b>+2-beeps</b>	<ul style="list-style-type: none"> <li>▪ <i>Please remove and clean Roomba's Brushes</i></li> </ul>	<b>main-brush-stall</b> Main brushes cannot turn	See <b>Appendix C</b> : Inspect and Clean Cleaning Head Module.
<b>+5-beeps</b>		<b>drive-stall</b> One or both wheels cannot turn	See <b>Appendix C</b> : Inspect and Clean Wheel modules.
<b>+6-beeps</b>	<ul style="list-style-type: none"> <li>▪ <i>Please inspect and clean Roomba's cliff sensors</i></li> </ul>	<b>constant-cliff</b> Roomba sees a constant cliff	Go to “Cliff Issues” below
<b>+7-beeps</b>		<b>wheel-drop-rate</b> Roomba has excessive wheel drop errors	See <b>Appendix C</b> : Inspect and Clean Wheel modules.
<b>+8-beeps</b>		<b>stasis-stuck</b> Roomba's front wheel cannot turn	See <b>Appendix C</b> : Inspect and Clean Front Wheel.
<b>+9-beeps</b>		<b>Constant Bump</b> Roomba's bumper is stuck	See <b>Appendix C</b> : Inspect and Clean

			Bumper
+11-beeps		<b>no-bump</b> Roomba's bumper is not registering obstacles after four straight runs of 6 meters	This might occur in a large room such as a gymnasium. Try using a virtual wall to contain Roomba.
+12-beeps		<b>cliff-sensors-failed</b> Cliff sensor failure	Go to "Cliff Issues" below

\*NOTE: Error code beeps will **not** always be accompanied by a voice message. Press bumper to access beep codes and use this whenever troubleshooting!

## Roomba 500 Series Behavioral Issues

### Cliff issues

Customer observations 	<ul style="list-style-type: none"> <li>▪ "Inspect and clean Roomba's Cliff Sensors"</li> <li>▪ "Uh-Oh" + 6 beeps (constant cliff)</li> <li>▪ "Uh-Oh" + 12 beeps (cliff sensors failed)</li> <li>▪ Roomba backs away from a carpet transition</li> <li>▪ Roomba backs up for no apparent reason</li> <li>▪ Roomba falls down stairs or stops at top of stairs</li> </ul>
Most common causes: 	<ul style="list-style-type: none"> <li>▪ Roomba was started on an uneven surface.</li> <li>▪ Roomba encountered a step and its cliffs activated.</li> <li>▪ Robot got stuck on a dark obstacle or high pile carpet that has obstructed its cliff sensors (6-beep error code). This is unavoidable in certain situations, so use virtual walls to confine Roomba to desired areas.</li> <li>▪ Roomba's side brush has stalled and is obstructing an outer cliff sensor</li> </ul>
Troubleshooting: 	<ul style="list-style-type: none"> <li>• CLIFF SENSOR Module inspection and cleaning (Appendix C).</li> <li>• Replace core robot if all fixes fail.</li> </ul>

### Bumper issues

Customer observations 	<ul style="list-style-type: none"> <li>▪ Roomba backs up for no apparent reason.</li> <li>▪ "Uh-Oh" + 9 beeps (bumper stuck error)</li> <li>▪ Robot drives too slow (light touch bumper always on)</li> <li>▪ Robot contacts objects too hard (light touch bumper does not activate)</li> <li>▪ The light touch bumper will not slow the robot down for all objects</li> </ul>
Troubleshooting:	<ul style="list-style-type: none"> <li>• Light touch bumper does no work for thin objects or dark objects</li> <li>• BUMPER Module inspection and cleaning (Appendix C).</li> </ul>

	<ul style="list-style-type: none"> <li>• Replace core robot if all fixes fail.</li> </ul>
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## Drive Wheel Module issue

<p>Customer observations</p> 	<ul style="list-style-type: none"> <li>▪ “Please inspect and clean Roomba’s wheel”</li> <li>▪ “Uh-Oh” + 1 beep (wheel drop error)</li> <li>▪ “Uh-Oh” + 5 beeps (drive stall error)</li> <li>▪ “Uh-Oh” + 7 beeps (wheel drop rate error)</li> <li>▪ Robot spins around in circles – circle dance</li> <li>▪ Roomba wiggles or rocks from side to side</li> </ul>
<p>Most common causes:</p> 	<ul style="list-style-type: none"> <li>▪ Roomba was started on an uneven surface or got stuck on an obstacle during the cleaning cycle.</li> </ul>
<p>Troubleshooting:</p> 	<ul style="list-style-type: none"> <li>• Pick Roomba up and set back on ground</li> <li>• DRIVE WHEEL Module inspection and cleaning (Appendix C).</li> <li>• Replace drive wheel modules if fixes fail.</li> </ul>

## Circle Dance (Drive Wheel Module Problem)

<p>Customer observations</p> 	<ul style="list-style-type: none"> <li>▪ Erratic spinning and arching</li> <li>▪ Extended circling around one wheel</li> <li>▪ Circling interspersed with wiggling or rocking behavior</li> <li>▪ Forward and/or backward circling</li> <li>▪ Circling at slow, normal or rapid speed</li> </ul>
<p>Most common causes:</p> 	<ul style="list-style-type: none"> <li>▪ Dirt has infiltrated the wheel encoder or a drive belt has failed.</li> </ul>
<p>Troubleshooting:</p> 	<ul style="list-style-type: none"> <li>• In MOST cases, the robot’s software will recognize and correct the behavior within minutes. If the battery was recently reset, the robot may act erratic again at startup until the software has a chance to correct the condition.</li> <li>• If the Robot does not resume normal driving behavior within the first couple minutes of runtime, go to DRIVE WHEEL Module inspection and cleaning (Appendix C). If cleaning wheel modules does not correct the problem, both wheel modules may need to be replaced.</li> <li>• Replace drive wheel modules if fixes fail.</li> </ul>

## Front Wheel Module issues

Customer observations	<ul style="list-style-type: none"> <li>▪ “Remove and clean Roomba’s front wheel”</li> <li>▪ “Uh-Oh” followed by 8 beeps (stasis stuck error)</li> </ul>
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	<ul style="list-style-type: none"> <li>▪ Roomba’s front wheel is squeaking or dragging.</li> <li>▪ Frequent panic spins (Roomba abruptly changes course with a rapid spin in either direction).</li> </ul>
<p>Most common causes:</p> 	<ul style="list-style-type: none"> <li>▪ Front wheel is clogged and cannot spin.</li> </ul>
<p>Troubleshooting:</p> 	<ul style="list-style-type: none"> <li>• FRONT WHEEL Module inspection and cleaning (Appendix C).</li> <li>• Replace front caster wheel module if fixes fail.</li> </ul>

## Main Brushes are thumping

<p>Customer observations</p> 	<ul style="list-style-type: none"> <li>▪ Roomba’s brushes thump (approximately once per second) on all floor types.</li> </ul>
<p>Most common causes:</p> 	<ul style="list-style-type: none"> <li>▪ The cleaning head module has entered anti-tassel behavior. The main brushes alternate between forward and reverse direction in order to escape from carpet tassels or wires.</li> </ul>
<p>Troubleshooting:</p> 	<ul style="list-style-type: none"> <li>• If thumping is heard when no carpet tassels or wires are present, clean brushes.</li> <li>• BRUSH and FLAPPER inspection and cleaning (Appendix C).</li> <li>• Replace cleaning head module if fixes fail.</li> </ul>

## Side Brush Module

<p>Customer observations</p> 	<ul style="list-style-type: none"> <li>▪ “Please clean Roomba’s Side Brush”</li> <li>▪ Side brush does not spin or is intermittent.</li> </ul>
<p>Most common causes:</p> 	<ul style="list-style-type: none"> <li>▪ Something is tangled around the side brush.</li> </ul>
<p>Troubleshooting:</p> 	<ul style="list-style-type: none"> <li>• SIDE BRUSH Module inspection and cleaning (Appendix C).</li> </ul>
<p>Customer observations</p> 	<ul style="list-style-type: none"> <li>▪ Side brush spins backwards.</li> </ul>

<p>Most common causes:</p> 	<ul style="list-style-type: none"> <li>▪ The side brush module has entered anti-tassel behavior. The side brush may spin slowly or briefly spin backwards in order to escape from carpet tassels or wires. The robot may occasionally enter this behavior on thick or high-pile carpets. This is normal.</li> </ul>
<p>Troubleshooting:</p> 	<ul style="list-style-type: none"> <li>• If this behavior is observed on hard floor surfaces or when no tassels or wires are present, try cleaning SIDE BRUSH Module (Appendix C).</li> </ul>

## Cleaning Head Module

<p>Customer observations</p> 	<ul style="list-style-type: none"> <li>▪ “Please inspect and clean Roomba’s Cleaning Head Module”</li> <li>▪ “Uh-Oh” followed by 2 beeps (main brush stall error)</li> <li>▪ Main brushes do not spin</li> <li>▪ Roomba is not picking anything up in vacuum bin</li> <li>▪ Roomba’s brushes thump (approximately once per second) on all floor types.</li> </ul>
<p>Most common causes:</p> 	<ul style="list-style-type: none"> <li>▪ Something is stuck in the main brushes.</li> </ul>
<p>Troubleshooting:</p> 	<ul style="list-style-type: none"> <li>• CLEANING HEAD Module inspection and cleaning (Appendix C).</li> <li>• BRUSH &amp; FLAPPER inspection and cleaning (Appendix C).</li> </ul>

## Vacuum Bin issues

<p>Customer observations</p> 	<ul style="list-style-type: none"> <li>▪ Vacuum isn’t working.</li> <li>▪ Debris isn’t collecting on filter (visible through clear compartment of vacuum bin.)</li> <li>▪ Rear squeegee fell out.</li> </ul>
<p>Most common causes:</p> 	<ul style="list-style-type: none"> <li>▪ Something is stuck in the main brushes.</li> </ul>
<p>Troubleshooting:</p> 	<ul style="list-style-type: none"> <li>• VACUUM BIN Module inspection and cleaning (Appendix C).</li> </ul>

## Home Base issues

<p>Customer observations</p> 	<ul style="list-style-type: none"> <li>▪ Robot does not successfully return to Home Base.</li> </ul>
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<p>Most common causes:</p> 	<ul style="list-style-type: none"> <li>• Home Base placement is not appropriate</li> <li>• Electrical contacts on Home Base or Robot are dirty</li> </ul>
<p>Troubleshooting:</p> 	<ul style="list-style-type: none"> <li>• Make sure Light Houses are set to “Light House” mode rather than “Virtual Wall” mode.</li> <li>• Check for proper Home Base and Light House placement as described in the owner’s manual.</li> <li>• If problem is not resolved, follow the steps outlined in the “Charging issues” section below.</li> </ul>

## Wireless Command Center

<p>Customer observations</p> 	<ul style="list-style-type: none"> <li>▪ Wireless Command Center (WCC) has poor range.</li> </ul>
<p>Most common causes:</p> 	<ul style="list-style-type: none"> <li>▪ WCC is not paired with Roomba.</li> </ul>
<p>Troubleshooting:</p> 	<ul style="list-style-type: none"> <li>• Follow WCC troubleshooting guide in main document which describes ‘pairing’ process described in manual.</li> </ul>

## Roomba 500 Series Charging Errors

CLEAN/POWER light flashes orange and  blinks every 2 seconds for a number of times indicated below. For charging errors that do not produce error codes, see Battery and Runtime issues.

# of Robot Blinks 	Robot Display <i>Not all models</i>	Robot Says	What it means 	What to do 
<b>1 blink</b> (when charging)	-	-	<b>Battery not connected.</b> This occurs when the Power Supply is available, but the battery thermistor is not connected.	<ol style="list-style-type: none"> <li>1. Is battery pull tab removed?</li> <li>2. Remove bottom cover, remove battery and make sure there is nothing obstructing contacts.</li> <li>3. Re-install battery and securely tighten all 4 bottom cover screws. (Tighten the two screws up front near the battery first.)</li> <li>4. If problem persists, replace Battery.</li> </ol>
<b>2 blinks</b>	Err2	<b>Charging Error 2</b>	<b>Battery overcurrent.</b> This occurs when the current is over 1250 mA.	<ol style="list-style-type: none"> <li>1. Replace Robot + Power Supply.</li> </ol>
<b>3 blinks</b>	Err3	<b>Charging Error 3</b>	<b>Charging FET Failed.</b> The occurs when the FET test fails at the beginning of the charge cycle.	<ol style="list-style-type: none"> <li>1. Replace Robot + Power Supply.</li> </ol>
<b>5 blinks</b>	Err5	<b>Charging Error 5</b>	<p><b>Power Supply Failed / Overheated</b> or <b>Roomba lost connection on Home Base</b></p> <p>This occurs when the full charging current is below 400 mA for more than 30 minutes.</p>	<ol style="list-style-type: none"> <li>1. Hold down SPOT and DOCK for 10 seconds to reset Roomba.</li> <li>2. Unplug Power Supply from wall and allow it to cool for 2 min.</li> <li>3. Ensure charging is not being done in a warm environment.</li> <li>4. Wipe dust off the Home Base charging contacts and the Roomba contacts (use finger or eraser to wipe).</li> <li>5. Move Home Base to a hard, flat surface to ensure good contact with Roomba.</li> <li>6. Replace Power Supply if problem persists.</li> </ol>

<b>6 blinks</b>	<b>Err6</b>	<b>Charging Error 6</b>	<b>Battery overheated.</b> This occurs when the battery temperature is over 75°C for 1 second.	<ol style="list-style-type: none"><li>1. Move charging setup to a cooler environment and make sure there is no object on top of robot.</li><li>2. If problem persists, replace Battery and Robot.</li></ol>
<b>7 blinks</b>	<b>Err7</b>	<b>Charging Error 7</b>	<b>Battery not Cooling.</b> This occurs when the battery doesn't cool within 4 hours. Most likely the battery thermistor is shorted.	<ol style="list-style-type: none"><li>1. Replace Battery.</li><li>2. If problem persists, replace Robot.</li></ol>

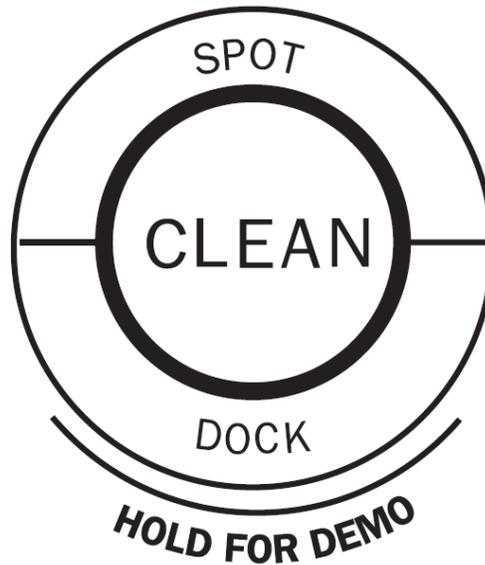
## Battery and Runtime issues

<p>Customer observations</p> 	<ul style="list-style-type: none"> <li>▪ Short battery runtime.</li> <li>▪ Robot doesn't charge on Home Base.</li> <li>▪ Robot does not turn on.</li> <li>▪ Power supply light blinks or goes out.</li> </ul>
<p>Most common causes:</p> 	
<p>Troubleshooting:</p> 	<ul style="list-style-type: none"> <li>• If charging error blinks, consult charge error table.</li> <li>• Verify all four bottom cover screws are securely tightened.</li> <li>• Hold down the "SPOT" and "DOCK/DEMO" buttons for 10 seconds to reset Roomba.</li> <li>• Wipe dust off the two charging contacts on the bottom of the robot AND the two charging contacts on the Home Base with finger or pencil eraser.</li> <li>• Plug Power Supply into working wall outlet             <ul style="list-style-type: none"> <li>○ If the green light does not turn on replace Power Supply</li> </ul> </li> <li>• Plug Power Supply directly into Roomba             <ul style="list-style-type: none"> <li>○ If green light on the Power Supply goes out or starts blinking replace Robot, Home Base, and Power Supply</li> <li>○ If "CLEAN/POWER" light on Robot does not start pulsing (it is ok if light is dim), replace Robot, Home Base, and Power Supply</li> </ul> </li> <li>• Unplug Power Supply from Roomba and plug Power Supply directly into Home Base             <ul style="list-style-type: none"> <li>○ If "Power" light on Home Base does not come on, replace Home Base</li> </ul> </li> <li>• Place Robot on Home Base             <ul style="list-style-type: none"> <li>○ If "Docked" light on Home Base does not come on wiggle robot for a better connection or move Home Base to a different floor surface (hard surfaces work best)                 <ul style="list-style-type: none"> <li>▪ Replace Robot and Home Base if Home Base's "Docked" light still does not turn on</li> </ul> </li> </ul> </li> <li>• Charge battery for 16 hours             <ul style="list-style-type: none"> <li>○ If runtime does not improve replace Battery. If problem persists then replace Robot, Home Base and Power Supply</li> </ul> </li> </ul>



## Appendix A : Roomba 500 Series Built-in-Test Procedure

Start with Roomba powered OFF by pressing the CLEAN button for a few seconds.



To enter :	Perform these Key Sequences:
<b>Auto-advance Built-in-Test</b>	Hold CLEAN and DOCK and pulse SPOT 3 times. Release buttons
<b>Manual-advance Built-in-Test</b>	Hold CLEAN and DOCK and pulse SPOT 6 times. Release buttons
<b>Auto-advance Mobility Test</b>	Hold CLEAN and DOCK and pulse SPOT 9 times. Release buttons
<b>Manual-advance Mobility Test</b>	Hold CLEAN and DOCK and pulse SPOT 12 times. Release buttons
<b>Display + beep software date code</b>	Hold CLEAN and SPOT and pulse DOCK 6 times. Release buttons
<b>Enter voice tutorial</b>	Turn robot on by pressing CLEAN. Hold DOCK for 3 seconds
<b>Power OFF and reboot Roomba (will erase schedule too)</b>	Hold SPOT and DOCK at least 10 seconds (15 is safe)

Put Roomba into Built-in-Test mode (BIT):



- Power Roomba OFF by pressing the CLEAN button for a few seconds.
- For **AUTO-ADVANCE** mode hold down the CLEAN and DOCK buttons and press the SPOT button 3 times. Release buttons.
- For **MANUAL-ADVANCE** mode: hold down the CLEAN and DOCK buttons and press the SPOT button 6 times. Release buttons.
- Wait for the Built-in-Test sound.

Note :

- To get out of BIT once in it, hold down DOCK and SPOT for 10 seconds.
- To advance a step press DOCK and to go back a step press SPOT.

**BUILT-IN-TEST 0** tests the user panel LEDs.

- For base robot assembly 3.5 check that
  - a. DIRT ALERT flashes at beginning
  - b. SPOT and DOCK are toggling
  - c. SCHEDULE and CLOCK are toggling
  - d. CHECK ROBOT is on
  - e. The clock display is toggling through the 7 segments including the semi colon :
  - f. AM and PM are toggling
- For base robot assembly 3.3 and 3.4 check that :
  - a. SPOT and DOCK are toggling
  - b. CHECK ROBOT is on

Note : Even in AUTO-ADVANCE mode, you must advance to Test 1 by pressing the DOCK button.

In the BUILT-IN-TEST (all test numbers except 0):

1. Each TEST NUMBER has multiple SUB-TESTS.
  - The SPOT, CLEAN and DIAGNOSTIC LEDs indicate when the sensors are activated.
  - Current measurements are taken in 0.5 second readings. During current readings, ALL LEDS ARE OFF.
  - The DIRT ALERT LED will blink to indicate that the test is advancing to the next test number. During a test, the DIRT ALERT will indicate the step number by a pattern of long and short blinks where one long flash is equal to five short blinks. For example, test 12 is indicated by long-long-short-short.
  - The robot will BEEP when advancing to the next Built in Test number. Test numbers are indicated by a pattern of long and short beeps, where one long beep is equal to five short beeps. For example, test 11 is indicated by long-long-short.



## **AUTO-ADVANCE MODE**

This is designed to be used on the assembly line. In this mode, the robot internally decides PASS/FAIL for each test number. The test advances automatically so each sensor or actuator is tested only once.

In AUTO-ADVANCE mode:

- Activate the sensors for each sub-test in order as described in the chart below.
- When all sub-tests in a test number have PASSED, the Built in Test will AUTO-ADVANCE to the next test number.
- If a test does not pass, you can press the DOCK button to MANUALLY ADVANCE to the next test number to continue the Built-in-Test.
- The test number checks may check multiple conditions other than those which turn on the LEDs. Therefore the test number may FAIL even though the sensors that turn on the LEDs seem to be working. In particular, the CURRENT DRAW of each actuator must be within acceptable limits for the test to pass.

The CLEAN LED will be RED until all sub-tests in a test number are passed, then it will turn GREEN for a moment before advancing to the next test number.

## **MANUAL-ADVANCE MODE**

This is designed to be used for debugging particular sensors or actuators. In this mode, the robot DOES NOT decide PASS/FAIL for each test number. The test does not automatically advance, so sensors or actuators can be tested as many times as necessary.

In MANUAL-ADVANCE mode:

- Use the DOCK button to MANUALLY ADVANCE to the next Built-in-Test number.
- Use the SPOT button to go back to the previous Built-in-Test number.
- The CLEAN LED will always be GREEN.
- There is no pass or fail. If you advance past the last test number, the test number will wrap around to the first test.

## **BUILT-IN-TEST RESULT**

When you get to the last test number, either by AUTO or MANUAL- ADVANCE:

1. If all tests PASSED, the CLEAN LED will BLINK FAST GREEN.
2. The robot can be powered off using the power button and will operate NORMALLY.
3. A serial cable and translation circuit can be used to connect the Roomba to a PC. Pressing the CLEAN button will cause the Roomba to transmit a summary of the test results through the serial port. These can be logged to a file. {Note : if using HyperTerminal, then select 115200 Bits and 'none' for Flow Control.}

If any test FAILED:

1. The CLEAN LED will BLINK FAST RED.



2. The robot CANNOT be powered off and will not respond to any buttons until the BATTERY IS REMOVED (do not do this unless the procedure calls for it).

## DATA COLLECTION

In both manual and automatic advance modes, data can be collected by connecting a serial cable under the face plate to the computer. {Note : if using HyperTerminal, then select 115200 Bits and 'none' for Flow Control.}

Cable connected during test : When executing the BIT in automatic mode, when the last step is completed, the Roomba will transmit a summary of the test results. If the operator presses the CLEAN button again, the Roomba will transmit the summary again.

Cable connected after test : This allows the BIT to be completed without being encumbered by a serial cable. When the test is completed, pass or fail, the cable can be connected and the data downloaded by pressing CLEAN.

Example output :

```
SUMMARY: START
SUMMARY: DATE-TAG 2007-06-20-0411-L
SUMMARY: BOOTLOADER-ID 0000 01BB
SUMMARY: BOARD-ASSEMBLY 3.4
SUMMARY: BOARD-REVISION 0
SUMMARY: FACTORY-TEST PASS
SUMMARY: flash version: 2
SUMMARY: flash info crc passed: 1
SUMMARY: (user-button-day?) disabled
SUMMARY: (user-button-hour?) disabled
SUMMARY: (user-button-minute?) disabled
SUMMARY: (user-button-scheduling?) disabled
SUMMARY: (user-button-clock?) disabled
SUMMARY: (bump-left?) PASS
SUMMARY: (bump-right?) PASS
SUMMARY: (cliff-left?) PASS
SUMMARY: (cliff-right?) PASS
SUMMARY: (cliff-front-left?) PASS
SUMMARY: (cliff-front-right?) PASS
SUMMARY: (and (lt-bumper-left?) (not (bump?))) PASS
SUMMARY: (and (lt-bumper-right?) (not (bump?))) PASS
SUMMARY: (and (lt-bumper-front-left?) (not (bump?))) PASS
SUMMARY: (and (lt-bumper-front-right?) (not (bump?))) PASS
SUMMARY: (and (lt-bumper-center-left?) (not (bump?))) PASS
SUMMARY: (and (lt-bumper-center-right?) (not (bump?))) P
SUMMARY: (wheel-drop-left?) PASS
SUMMARY: (wheel-drop-right?) PASS
SUMMARY: (rcon?) PASS
SUMMARY: (valid-code-in-channel? dir-left) PASS
SUMMARY: (valid-code-in-channel? dir-right) PASS
SUMMARY: (battery-voltage-ok?) PASS
SUMMARY: (battery-temperature-ok?) PASS
SUMMARY: (baseline-current-ok?) PASS mA -242 min -300 max -14 mV 16059 degrees-C 37
```



SUMMARY: (left-wheel-stall?) PASS  
 SUMMARY: (drive-speed-ok? left forward) PASS  
 SUMMARY: (drive-speed-ok? right stopped) PASS  
 SUMMARY: (left-drive-current-ok?) PASS mA -86 min -150 max -75 mV 16031 degrees-C 37  
 SUMMARY: (left-drive-stall-current-ok?) PASS mA -804 min -850 max -700 mV 15919 degrees-C 37  
 SUMMARY: (right-wheel-stall?) PASS  
 SUMMARY: (drive-speed-ok? right forward) PASS  
 SUMMARY: (drive-speed-ok? left stopped) PASS  
 SUMMARY: (right-drive-current-ok?) PASS mA -90 min -150 max -75 mV 16031 degrees-C 37  
 SUMMARY: (right-drive-stall-current-ok?) PASS mA -788 min -850 max -700 mV 15919 degrees-C 37  
 SUMMARY: (drive-speed-ok? left reverse) PASS  
 SUMMARY: (drive-speed-ok? right reverse) PASS  
 SUMMARY: (stasis-strong-signal?) PASS  
 SUMMARY: (main-brush-motor-stall?) PASS  
 SUMMARY: (main-brush-current-ok?) PASS mA -283 min -500 max -200 mV 15947degrees-C 37  
 SUMMARY: (main-brush-stall-current-ok?) PASS mA -1338 min -1400 max -1250 mV 15892 degrees-C 37  
 SUMMARY: (debris-right?) PASS  
 SUMMARY: (vacuum-current-ok?) PASS mA -143 min -230 max -50 mV 15947 degrees-C 37  
 SUMMARY: (side-brush-motor-stall?)  
 SUMMARY: (side-brush-current-ok?) PASS mA -95 min -120 max -30 mV 16031 degrees-C 37  
 SUMMARY: (side-brush-stall-current-ok?) PASS mA -456 min -550 max -400 mV 15975 degrees-C 37  
 SUMMARY: (int-charger-available?) PASS  
 SUMMARY: (int-charging-recovery-current-ok?) PASS mA 281 min 250 max 350 mV 16253 degrees-C 37  
 SUMMARY: (int-charging-current-ok?) PASS mA 1206 min 1000 max 1400 mV 16560 degrees-C 37  
 SUMMARY: (int-charging-trickle-current-ok?) PASS mA 58 min 40 max 70 mV 16170 degrees-C 37  
 SUMMARY: (int-charging-watchdog-current-ok?) PASS mA 0 min -20 max 20 mV 16142 degrees-C 37  
 SUMMARY: (ext-charger-available?) PASS  
 SUMMARY: (ext-charging-recovery-current-ok?) PASS mA 278 min 250 max 350 mV 16253 degrees-C 37  
 SUMMARY: (ext-charging-current-ok?) PASS mA 1162 min 1000 max 1400 mV 16532 degrees-C 37  
 SUMMARY: (ext-charging-trickle-current-ok?) PASS mA 60 min 40 max 70 mV 16170 degrees-C 37  
 SUMMARY: (bootloader-ok?) PASS  
 SUMMARY: (bbox-test-write-succeeded?) PASS  
 SUMMARY: (rf-system-functioning?) PASS  
 SUMMARY: (flash-file-system-ok?) PASS  
 SUMMARY: (calibration-data-stored?) disabled  
 SUMMARY: (factory-test-data-saved?) PASS  
 SUMMARY: END

## SUMMARY OF ELECTRICAL CONSTANTS

Description	Min	Max	Units	Sensor
baseline battery current	-300	-14	mA	battery
left / right drive current	-150	-75	mA	wheel motor
left / right stall current	-850	-700	mA	wheel motor
main brush run current	-500	-200	mA	main brush
main brush stall current	-1400	-1250	mA	main brush
vacuum current	-230	-50	mA	battery
side brush run current	-120	-30	mA	side brush
side brush stall current	-550	-440	mA	side brush
Internal/external charging recovery current	250	350	mA	battery
Internal/external charging current	1000	1400	mA	battery
Internal/external charging trickle current	40	70	mA	battery



## BUILT-IN-TEST CHART

The following chart describes how to use each built-in-test number. To PASS the built-in-test in AUTO-ADVANCE mode, the user must perform the actions EXACTLY AS DESCRIBED.

	Test Name	Tester Action	Robot Action	Spot LED	Dock LED	Check Robot LED
0	Panel LEDs	Check correct flashing of LEDs. Press CLEAN to advance to the first test.				
1	Buttons (skipped if no buttons)	Press and release DAY, then HOUR, then MINUTE, then SCHEDULE and finally CLOCK.		Day, Minute, Clock button is pressed.	Hour or Schedule button pressed.	
2	Bumpers	Press and release left bumper. Press and release right bumper.		Left bumper pressed.	Right bumper pressed.	
3	Outer Cliff Sensors	Briefly lift robot's left side to simulate cliff-left. Briefly lift robot's right side to simulate cliff-right.		Cliff-left detected.	Cliff-right detected.	
4	Inner Cliff Sensors	Briefly lift robot's left side to simulate cliff-front-left. Briefly lift robot's right side to simulate cliff-front-right.		Cliff-front-left detected.	Cliff-front-right detected.	
5	Outer Light touch Sensors	Briefly put your hand in front of the left light touch sensor to simulate a wall. Then do the same for the right left touch sensor.		Left light-touch detected	Right light-touch detected	
6	Front Light-touch sensors	Briefly put your hand in front of the front-left light touch sensor to simulate a wall. Then do the same for the front-right left touch sensor.		Front left light-touch detected	Front right light-touch detected	

7	Center Light-touch sensors	Briefly put your hand in front of the center-left light touch sensor to simulate a wall. Then do the same for the center-right light touch sensor.		Center left light-touch detected	Center right light-touch detected	
8	Wheel Drop	Briefly lift robot to cause a wheel drop on left wheel, then right wheel. Briefly simulate a wall.		Wheel drop left detected.	Wheel drop right detected.	
9	RCON IR Receiver	Point a virtual wall (or home base) at the RCON IR receiver. Then point virtual wall away or turn it off.		Virtual-wall signal at RCON IR receiver.		
10*	Front directional IR receivers	Briefly point a virtual wall (or home base) at the front left directional IR receiver. Briefly point a virtual wall (or home base) at the front right directional IR receiver.		Virtual-wall signal at front left directional IR receiver.	Virtual-wall signal at front right directional IR receiver.	
11	Battery Sensors	No user action.		Battery voltage between 12 and 18 V.	Thermistor present.	Baseline current OK
12	Left Wheel	Make sure wheels are in the air and unobstructed. Wait until DOCK is on solid. Then briefly stall left wheel until SPOT is on solid.	Left wheel turns in forward direction	Left wheel overcurrent stall.	Left motor current and encoder speed OK.	
13	Right Wheel	Make sure wheels are in the air and unobstructed. Wait until DOCK is on solid. Then briefly stall left wheel until SPOT is on solid.	Right wheel turns in forward direction.	Right wheel overcurrent stall.	Right motor current and encoder speed OK.	
14	Wheel Encoders	Make sure wheels are in the air and unobstructed.	Drive wheels turn in backward direction.	Left wheel encoder signal.	Right wheel encoder signal.	Motor current and encoder speed OK.

15	Stasis	Turn the front caster.		Stasis signal (caster rotation switch).		
16	Main Brush	Make sure brush is unobstructed. Wait until DOCK is on and solid and brush is turning forward. Then briefly stall the main brush until DOCK and SPOT are on and solid	Main brush turns in backwards then turns forwards.	Brush overcurrent stall.	Brush current OK	
17	Debris	Briefly place robot in debris pile on left side. Briefly place robot in debris pile on right side.	Main brush turns on.	Debris detected	Debris detected	
18	Vacuum	No user action.	Vacuum turns on.	Vacuum current OK.		
19	Side Brush	Make sure side brush is unobstructed. Wait until DOCK is on and side brush is turning counterclockwise. Then briefly stall the side brush motor until DOCK and SPOT are on and solid.	Side brush turns clockwise, then turns counterclockwise.	Side brush stall.	Brush current OK	
20	Plug-in Charger Precharge	Plug in the plug-in Power Supply.		Plug-in charger available.	Recovery current OK	
21	Plug-in Charger On	No user action.		Plug-in charger available.	Charging current OK	
22	Plug-in Charger Trickle	No user action.		Plug-in charger available.	Trickle current OK	
23	Charger Watchdog	No user action.		Plug-in charger available.	Baseline current OK	
24*	Dock / Wall-Mount Charger Precharge	Remove the plug-in Power Supply. Place Robot in Home Base.		Dock / Wall-Mount charger available.	Recovery current OK	
25*	Dock / Wall-Mount Charger On	No user action.		Dock / Wall-Mount charger available.	Charging current OK	



26*	Dock / Wall-Mount Charger Trickle	No user action.		Dock / Wall-Mount charger available.	Trickle current OK	
27	Bootloader	No user action.				
28	Black-box variables	No user action.				
29*	Verify RF	No user action.		RF Post passed		
30	Audio flash check	No user action.				
31	Cliff Calibration	No user action.				
32	Save Factory Test	No user action.				
33	Complete					

\* skipped for Base Robot 3.0 as it does not have electrical contacts nor directional IR beams

## ROOMBA BLACK BOX

Every Roomba has a black box that is an onboard data logging processor. This processor is not erased when the robot is reset. This data may be valuable if one wants to know the total cleaning time in the robot's life (mission runtime) or how long it has been charging on the Home base (total-hours-on-dock)

To access the black box Information you will need the serial port cable between the robot and computer and the software called "R3blackboxreader.exe"

1. Connect the serial port cable to Com 1. If battery is low, have the power supply connected to Roomba.
2. Run the "R3blackboxreader.exe"
3. Select "Black Box" tab and press "Check"
4. Press Copy
5. Open a separate Excel sheet and paste the data.



Passing values for BIT summary	Model 3.5 & 3.4	Model 3.3	Model 3
bit-summary-0-15	65504	64512	64512
bit-summary-16-31	65023	65023	61951
bit-summary-32-47	48111	48111	48111
bit-summary-48-63	65275	65275	16123
bit-summary-64-79	111	79	76

**Example Black Box output :**

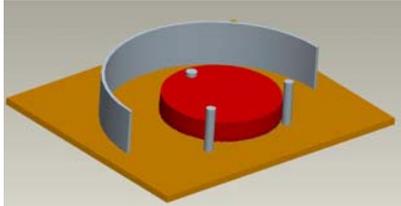
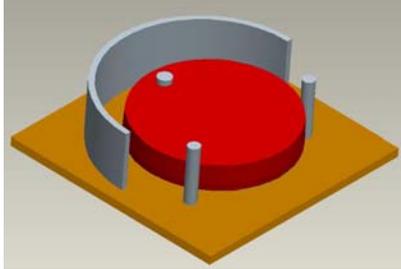
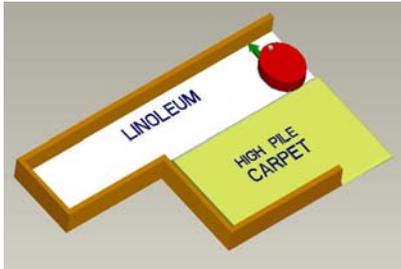
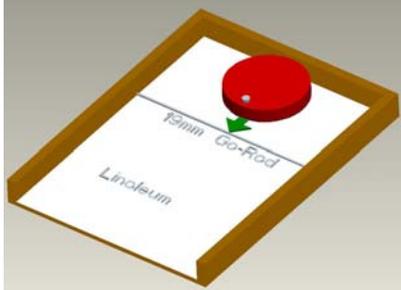
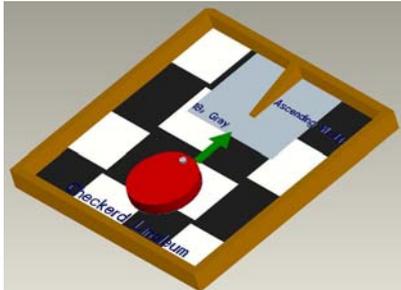
run-time-hours	26
run-time-minutes	6
factory-test-passed?	1
bit-summary-0-15	65504
bit-summary-16-31	65023
bit-summary-32-47	48111
bit-summary-48-63	65275
bit-summary-64-79	111
bb-right-motor-current	-134
bb-left-motor-current	-95
bb-main-brush-motor-current	-363
bb-side-brush-motor-current	-98
bb-right-motor-current-stalled	-785
bb-left-motor-current-stalled	-773
bb-main-brush-motor-current-stalled	-1306
bb-side-brush-motor-current-stalled	-467
n-charging-fet-failures	0
n-charging-successes-post-failure	2
n-pwm-failures	5
n-charger-watchdog-failures	32
n-ddb-rgens	1
avg-charge-time-minutes	88
total-hours-on-dock	23
total-hours-direct-charge	0
avg-time-on-doc	88
avg-time-direct-charge	0
n-charger-availables	8
est-battery-capacity	9720
n-batt-overtmps	2
n-bumper-clicks-low	2411
n-bumper-clicks-high	0
n-clean-clicks	58
n-spot-clicks	3
n-home-clicks	16
n-wheel-drops	66
n-dock-detects	140
n-cliffs	73
n-panics	10



avg-mission-minutes	13
n-incomplete-missions	2
n-complete-missions	3
last-state-0	11
last-state-1	3
last-state-2	2
last-state-3	1
last-state-4	3
last-state-5	2
last-state-6	1
last-state-7	0
last-state-8	10
last-state-9	1
last-pause-id-0	1
last-pause-id-1	6
last-pause-id-2	1
last-pause-id-3	6
last-pause-id-4	1
last-pause-id-5	6
last-pause-id-6	1
last-pause-id-7	6
last-pause-id-8	1
last-pause-id-9	6
max-discharge-temp-avg	606
max-charge-temp-avg	803
n-no-current-errors	0
n-app-exceptions	0
charging-bbox-unused-5	0
charging-bbox-unused-6	0
charging-bbox-unused-7	0
charging-bbox-unused-8	0
charging-bbox-unused-9	0
charging-bbox-unused-10	0
last-panic-id-0	13
last-panic-id-1	9
last-panic-id-2	13
last-panic-id-3	15
last-panic-id-4	9
mission-runtime-minutes	53
mission-runtime-hours	1
voice-demo-listen-count	2
n-clean-cycles-in-open-loop	0
calib-validation	0
cliff-adjustments	0
[Bumper-Clicks]	2411
[max-discharge-temp-avg-Degrees-C]	41
[max-charge-temp-avg-Degrees-C]	61
[est-battery-capacity-mAh]	2700

## Appendix B : Roomba 500 Series Mobility Test Procedure

The Mobility Test procedure for tests the robot's mobility and sensors across 5 different test floors, of which service centers need only conduct Test Floor 3.

Test Floor #	Tests Performed	Floor/Fixture
Test Floor 1	<ul style="list-style-type: none"> <li>○ light-touch-max-distance</li> </ul>	
Test Floor 2	<ul style="list-style-type: none"> <li>○ light-touch-min-distance</li> </ul>	
<input checked="" type="checkbox"/> Test Floor 3	<ul style="list-style-type: none"> <li>○ wall-follow-encoder-check;</li> <li>○ wall-follow- on tile;</li> <li>○ corner-orbit;</li> <li>○ tile and carpet (50: 50);</li> <li>○ light-touch-front;</li> <li>○ wall-follow-on carpet;</li> <li>○ cliff-avoid- on carpet</li> </ul>	
Test Floor 4	<ul style="list-style-type: none"> <li>○ go-rod,</li> <li>○ cliff-avoid-on tile</li> </ul>	
Test Floor 5	<ul style="list-style-type: none"> <li>○ ascending-wedge</li> </ul>	



For **AUTO-ADVANCE** mode:

- Power Roomba OFF by pressing the CLEAN button for a few seconds.
- Hold CLEAN and DOCK and pulse SPOT 9 times → Auto-advance Mobility Test (AMT)

When the AMT is paused, the numeric display will show “NEXT” (in Scheduler models)

When the AMT is prevented from running due to a failed BIT, the numeric display will show “BIT”

For **MANUAL-ADVANCE** mode: \*RECOMMENDED MODE\*

- Power Roomba OFF by pressing the CLEAN button for a few seconds.
- Hold CLEAN and DOCK and pulse SPOT 12 times → Manual-advance Mobility Test

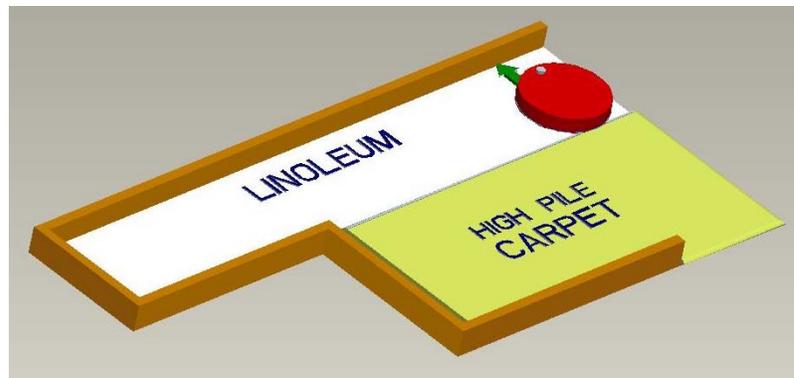
The main difference is that manual mode test does NOT stop when it fails. Manual mode test will run regardless of whether the BIT has passed. Also, you may skip forward only (not backward) at any point before or during the test by pressing the DOCK button. You will hear beeps and see the Sun-Thu lights (in Scheduler models) to indicate which test it is in.

### **DATA RETRIEVAL :**

- Connect robot to a serial terminal after the test is finished and tap the bumper to receive a summary.

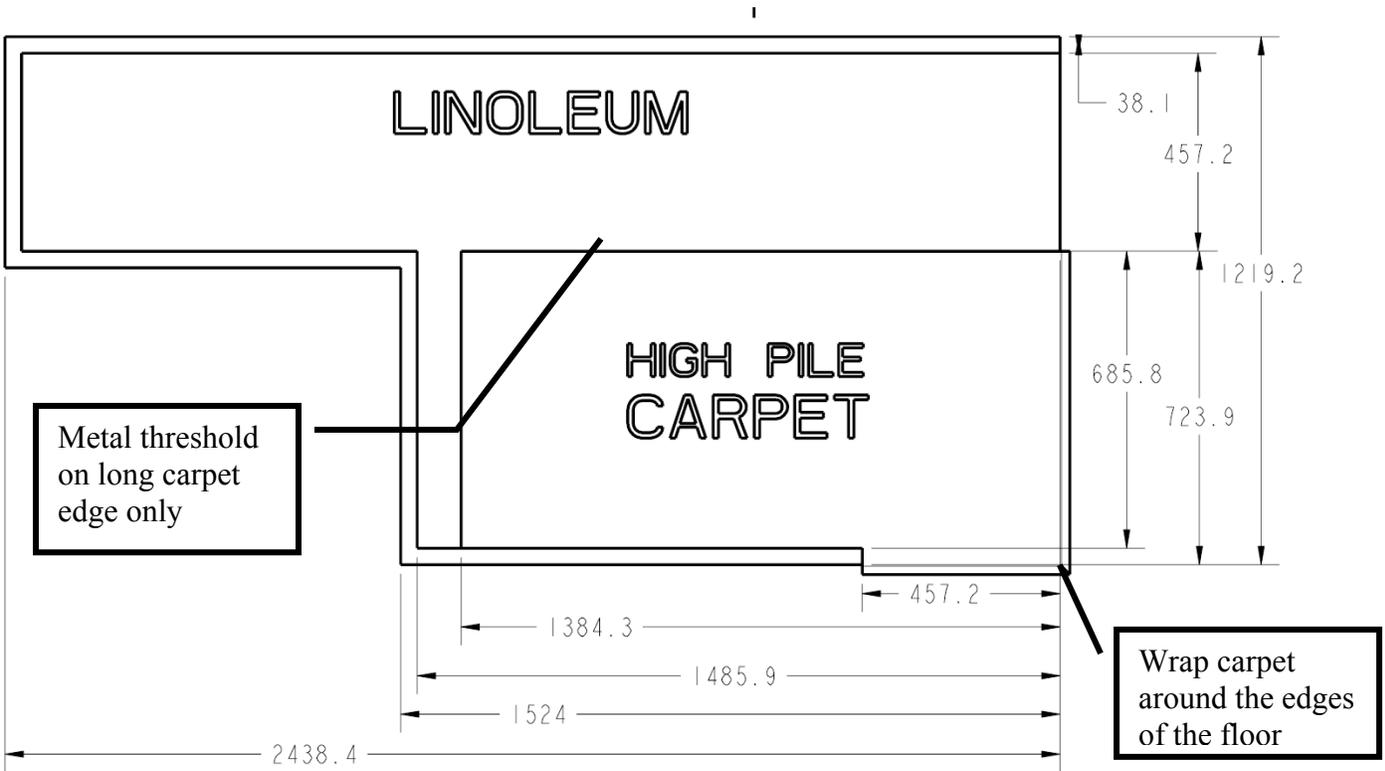
## **MOBILITY TEST PROCEDURE**

**Test Floor 3** – (TUE is lit on Scheduler display)



- Place the robot facing the long linoleum wall as shown above.
- Press CLEAN until it is in test 3 or 3 beeps or TUE is on the display
- Verify that robot completes test and stops at the carpeted cliff, sing 3 high pitched beeps, and display a blinking orange light and the word “NEXT” on the numeric display if robot passes this step of test. If robot does not pass every test it will keep driving around until either the tests are passed or the 60 second time limit expires.

## MOBILITY TABLE 3 CONSTRUCTION SPECIFICATIONS (IN MM)

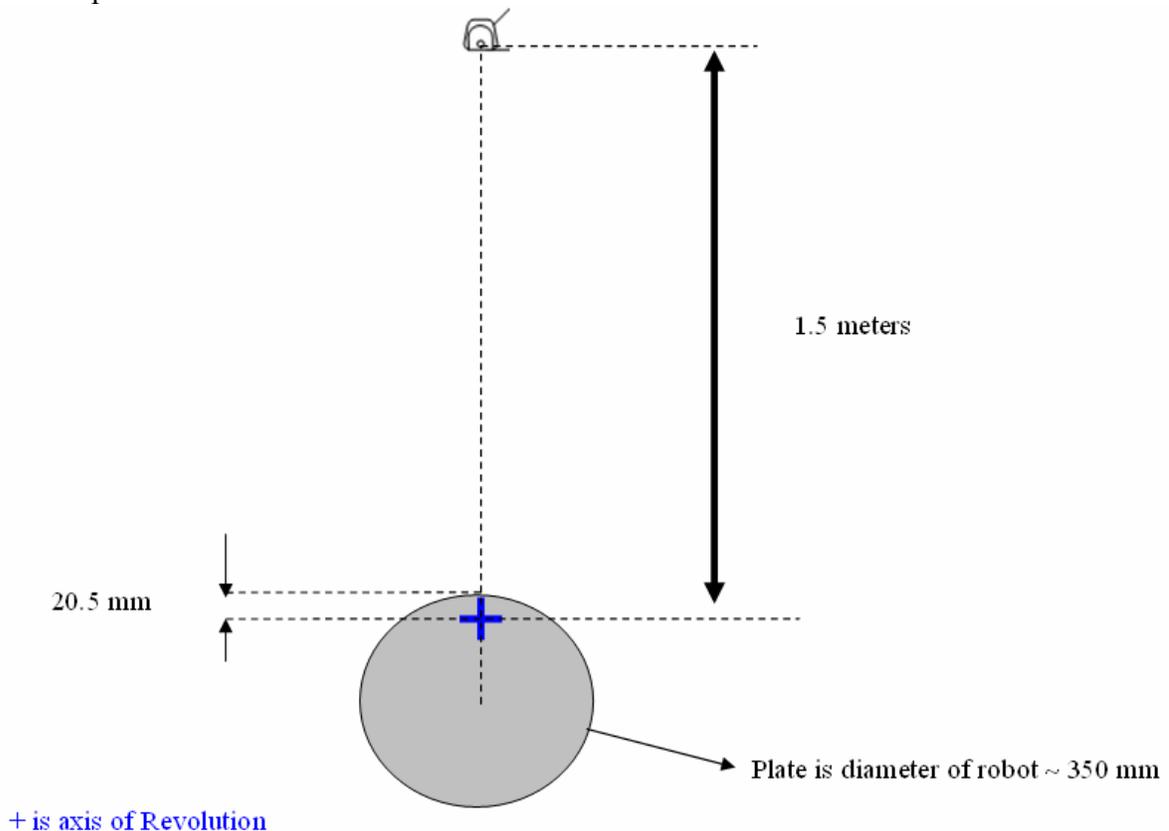


## ROBOT RCON TEST

The procedures for this test are

1. Build a fixture which can rotate around robot's RCON lens as shown below
2. Put a Virtual Wall (VW) 1.5 m away from robot's RCON lens.
3. Put robot into Built-in-Test #9.
4. Turn on the VW and set it at medium power (1 - 2 m).
5. Verify that the SPOT light on the robot is lit.
6. Slow turn the fixture and verify that the SPOT light is on all the time.
7. Set the VW at lowest power (0 – 0.9m), and put it 2.4 m away.
8. Verify that the SPOT light on the robot is not lit at any angle.
9. Set the VW back to medium power.
10. Put robot into Built-in-Test #10 and let the robot face the VW (*only base robots 3.4 and 3.5*).
11. Verify that both SPOT and DOCK lights are both on.
12. Turn off the VW. Test is complete

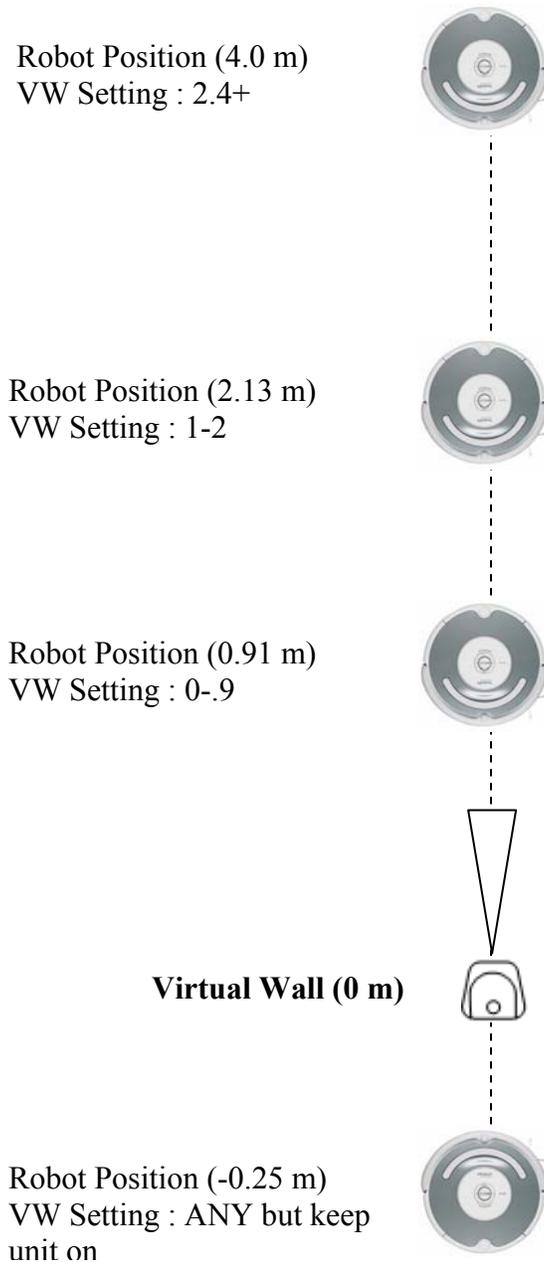
Fixture Setup: :



## VIRTUAL WALL TEST

The procedures for this test are

1. Put the robot in Built-in-Test # 9.
2. Turn Virtual Wall (VW) on (make sure the VW is not pulsing or off). If in doubt you can verify that the VW emitters are on using IR viewer or a digital camera.
3. Place the Roomba in the below distances from the VW. Distance is measured from VW RCON to Roomba RCON. The settings of the VW should be set at 0-.9 / S/M/L depending settings shown on the left hand side.
4. Verify that the Roomba's SPOT button is lit for all 4 positions.

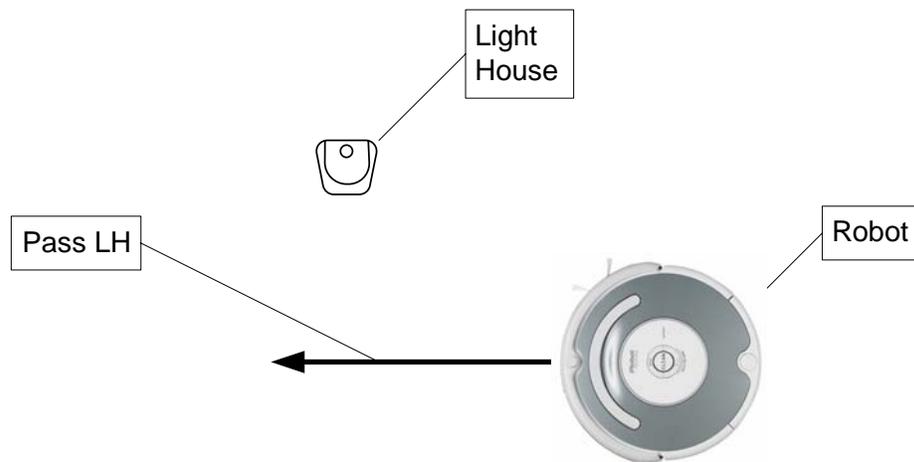


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## LIGHT HOUSE TEST

The procedures for this test are

1. Put batteries in the Light House. Make sure for each new robot, the battery should be removed and reinstalled.
2. Start a robot near the Light House and verify that the LED light on top of the Light House will go green.
3. Verify that the Light House gate and omni emitters are on using IR viewer or a digital camera.

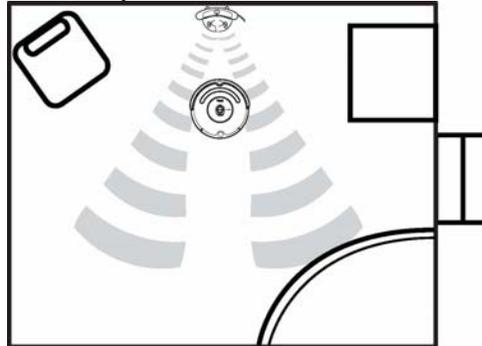


## HOME BASE AND DOCKING TEST

The procedures for this test are

### DOCKING / NAVIGATION BEAM TEST :

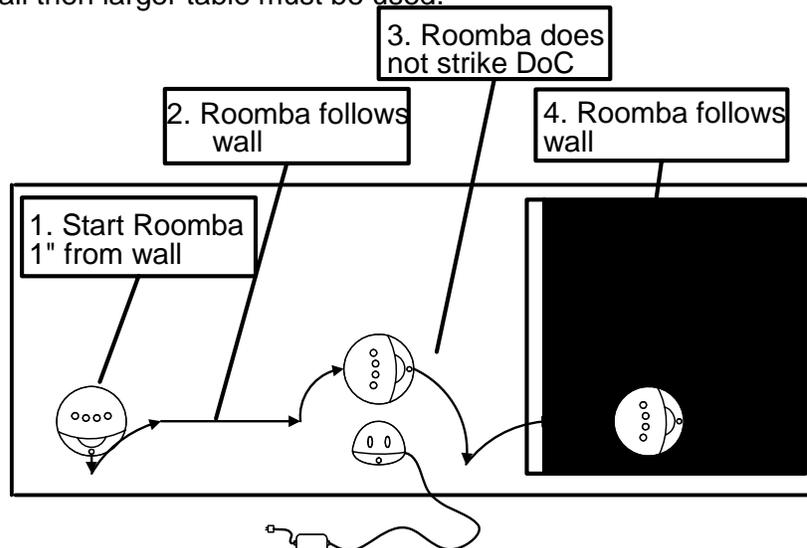
1. Place the Home Base on the floor, plugged in.
2. Place the robot in front of the Home Base about 1.5 m away, within the expected beams.
3. Turn robot on with CLEAN
4. Press DOCK on the robot.
5. Verify that the robot autonomously finds the Home Base and starts charges (red light pulsing).



### FORCE FIELD AVOID TEST :

1. Place the Home Base on the table and plug in power.
2. Start the test robot by pressing “CLEAN” and having it face a wall.
3. The robot will attempt to start a spiral, strike the wall, and then follow the wall (right to left).
4. Verify that robot will deflect and not touch any part of Home Base when it encounters the force field. The robot must make it all the way around the Home Base. Note that if robot strikes opposite wall of the test table during test, a larger table may be needed. For the time being, it is suggested that the deflection radius is about 30 inches.

Note: If Roomba strikes opposite wall then larger table must be used.

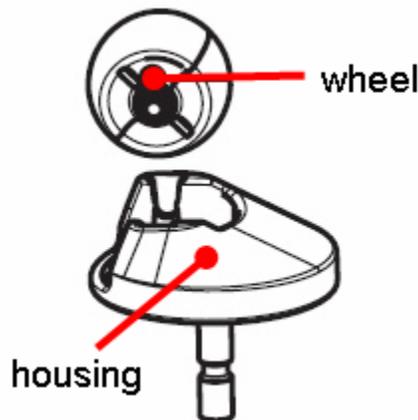


## Appendix C : Module Inspection and Cleaning

### *DRIVE WHEEL Module inspection and cleaning*

- Check the wheels for obstructions.
- Push the wheels up and down several times and shake out any loose debris that may be trapped in the wheel well.
- Make sure the wheels turn freely.
  - If there is uneven resistance between the wheels, hold down Roomba's SPOT and DOCK buttons for 10 seconds to reset the robot and try again.
- Check tires for wear and tear.
  - If tire treads are no longer visible, or if large tears are present, replace wheel modules.
- If wheel module problems persist on flat surfaces when there are no obstacles present, replace wheel modules.

### *FRONT WHEEL Module inspection and cleaning*



- Flip robot over and hold wheel and pull out the entire front wheel module.
- Look in chassis hole and clear away any fuzz or debris that is blocking the two sensors located under the front wheel module.
- Remove wheel from housing and clear any hair wrapped around axle.
- If necessary, slide axle out of wheel and wipe axle clean.
- If white half of wheel is dirty, wash wheel and wipe clean.
- Reinsert wheel into wheel housing and drop module back into Roomba
- Do not forget to reinstall wheel - it is possible for Roomba to run without it! Grasp housing with both hands and firmly press wheel into housing until both sides of axle snap into place.



## ***CLEANING HEAD Module inspection and cleaning***

- Check if main brushes are spinning by running the robot with the vacuum bin removed.
- Remove Brushes and clean them if dirty.
- Make sure both yellow main brush caps are installed correctly.
  - If not, send replacement brush caps.
- Make sure the main brush and the flapper brush each have a yellow bearing installed correctly.
  - If not, send replacement bearings.
- Check the square ends of both brushes.
  - If the square end of either brush is rounded, check the corresponding square recess in the cleaning head module.
    - If the either brush is rounded, send replacement brushes.
    - If the either square recess is rounded, replace cleaning head module.
- If brushes still do not spin after cleaning, or if error alert persists, replace cleaning head module.

## ***BUMPER Module inspection and cleaning***

- Gently tap both sides of bumper several times to shake out any debris that might be causing the bumper to stick. Try cleaning around bumper with compressed air, if available.
- If problem persists, replace robot.

## ***CLIFF SENSOR Module inspection and cleaning***

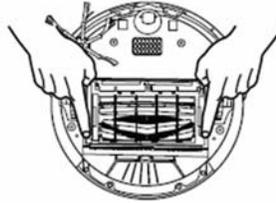
- First determine that Roomba was not started on an uneven surface, or a dark surface that could have triggered a false cliff or a continuous false cliff.
- Turn the robot over and wipe all four cliff sensor windows with a clean, dry cloth.
- Verify that the side brush is spinning properly during runtime.
  - If not, troubleshoot the side brush module. The side brush could block the cliff sensors if it is stalled.
- If cliff sensor failures persist on flat surfaces with no cliff sensor obstructions present, replace robot.
- If Roomba is no longer able to avoid stairs, replace robot.

## ***SIDE BRUSH Module inspection and cleaning***

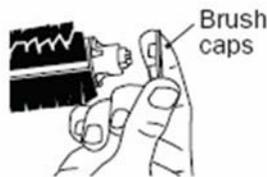
- If side brush is going backwards then the side brush module has entered anti-tassel behavior. The side brush may spin slowly or briefly spin backwards in order to escape from carpet tassels or wires. The robot may occasionally enter this behavior on thick or high-pile carpets. This is normal. If it occurred when there were no tassels or wires, proceed with inspection.
- Use a Philip's screwdriver to remove the side brush and clear away all hair and debris that is wrapped around the hex shaft.
- If the side brush does not spin after cleaning, replace side brush module.

## ***BRUSH & FLAPPER inspection and cleaning***

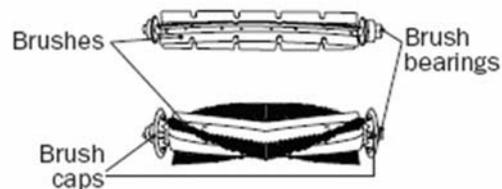
1. Remove brush guard by pulling on both yellow tabs



2. Remove brush caps and use scissors to cut any hair wrapped around the brush. Use the Roomba cleaning tool to comb hair from the brush.



3. Remove and clean hair from Roomba's brush bearings

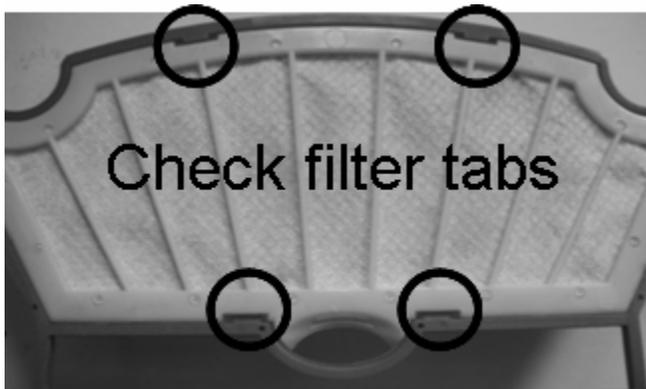
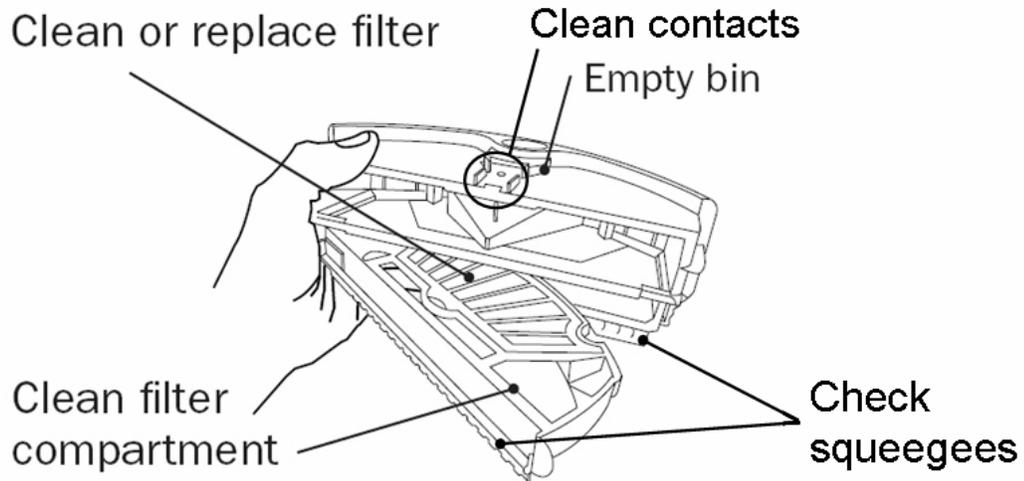


### Notes:

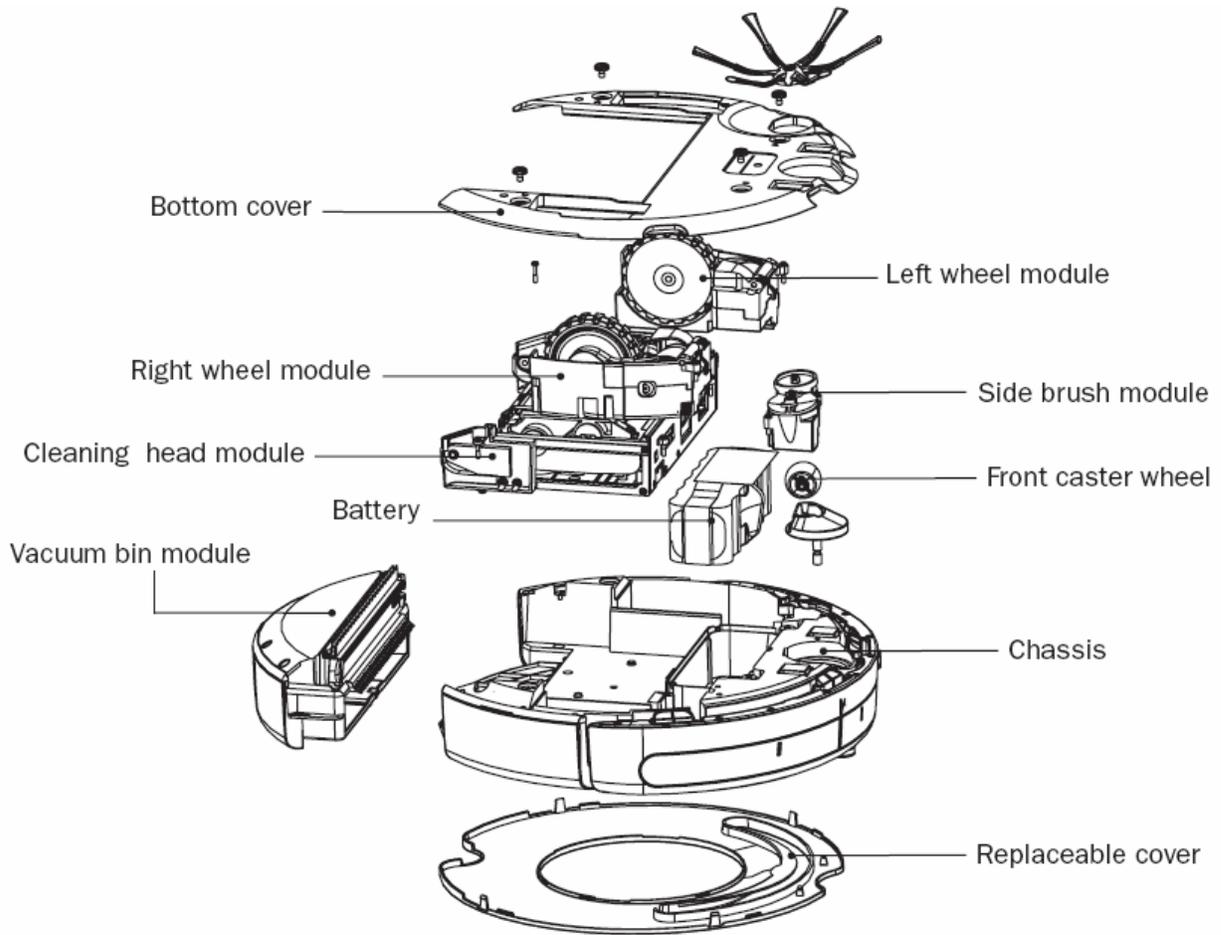
- For easier brush cap removal, try twisting the caps as you pull them off.
- Do not attempt to run Roomba without brush caps or bearings! This could cause permanent damage to the cleaning head module.
- Brushes should be cleaned every 3-5 cycles, depending on the amount of hair and debris in the user's environment.

## VACUUM BIN Module inspection and cleaning

- Make sure filter is properly installed. Replace if necessary.
- Make sure rear squeegee is properly installed.
- Check for wear and tear on both front and rear squeegees.
- Wipe dust off vacuum bin contacts with finger or pencil eraser.



## Appendix D: Roomba Spare Parts Replacement Instructions



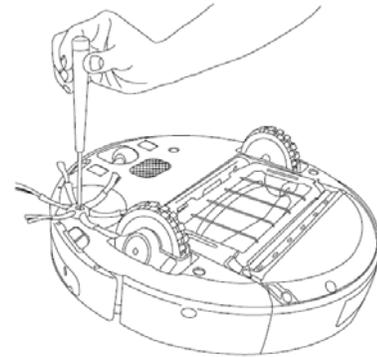
<b>Roomba Spare Parts</b>
Bottom Cover with 4 screws – (US, EU, Sing, Japan, Korea)
Core Robot/Chassis Base Robot 3.0 – (US, EU, Singapore, Japan, Korea)
Core Robot/Chassis Base Robot 3.4 – (US, EU, Singapore, Japan, Korea)
Core Robot/Chassis Base Robot 3.5 – (US, EU, Singapore, Japan, Korea)
Front Caster Wheel Module
Front Caster Wheel only
Right Wheel Module
Left Wheel Module

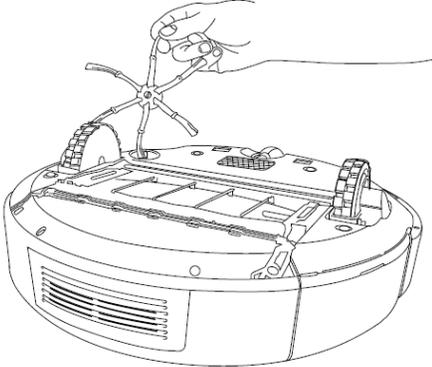
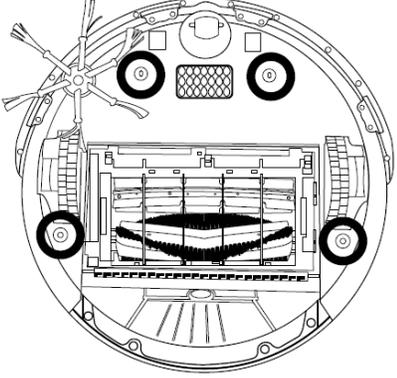
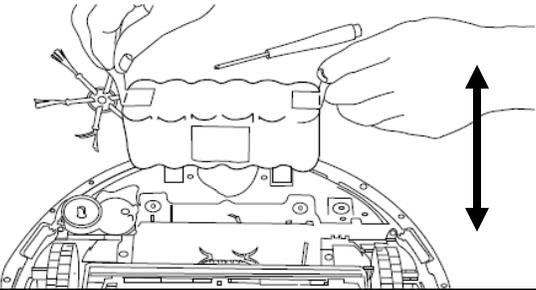
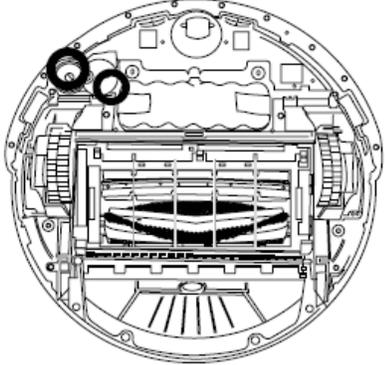
Side Brush Module
Side brush with Screw
Cleaning Head Module
Bristle Brush
Flapper Brush
Brush end caps
Brush Bearings
Wire Bale
Vacuum Bin Module
Filter Frame
Filter
Removable Squeegee
Bin Grill Cover (Green, White, Black)
Battery
Replaceable rubber dust shield

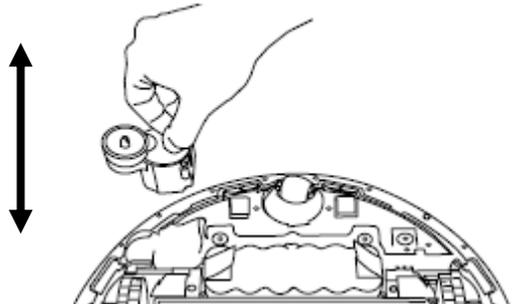
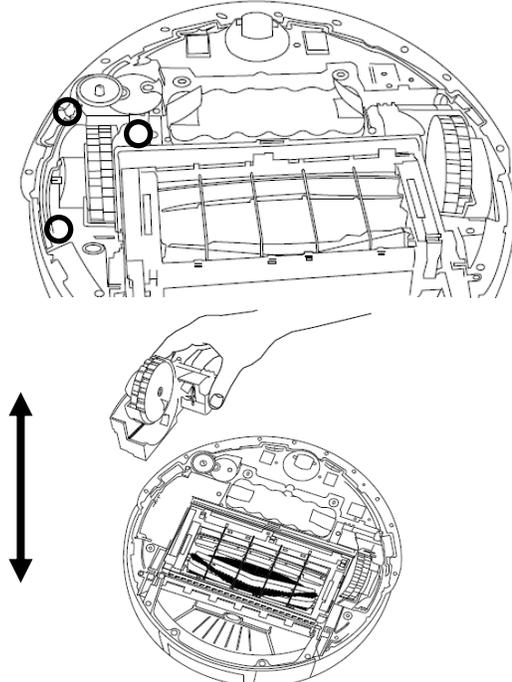
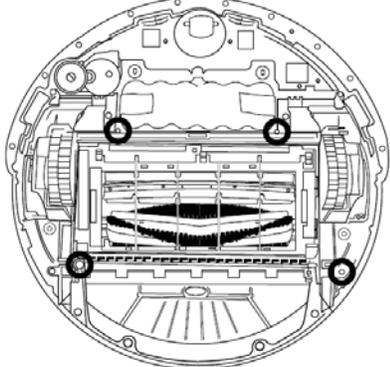
<b>Roomba Accessory Spare Parts</b>
WCC Battery Door
Virtual Wall Battery Door
Light House battery door

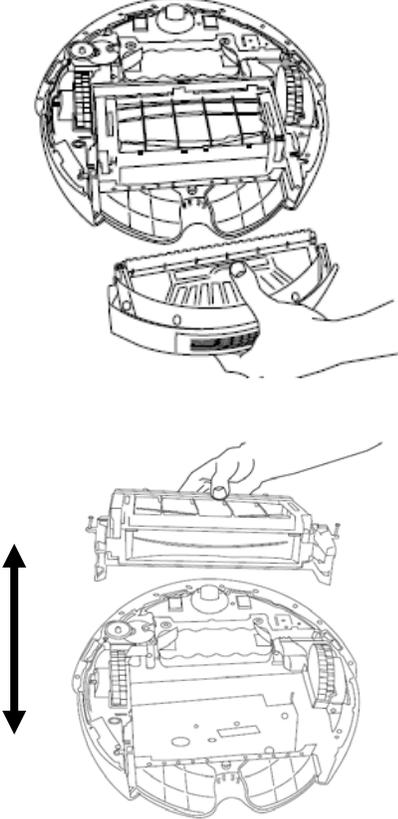
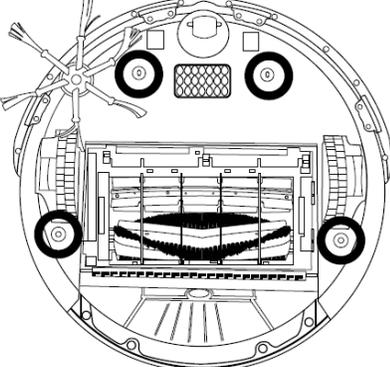
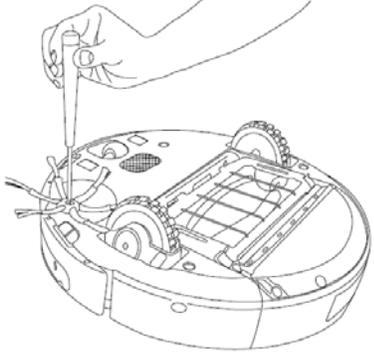
## ***Roomba Spare Parts Replacement (Battery, Side Brush, Cleaning Head and Wheel Modules)***

1. Turn the robot over and remove side screw brush screw

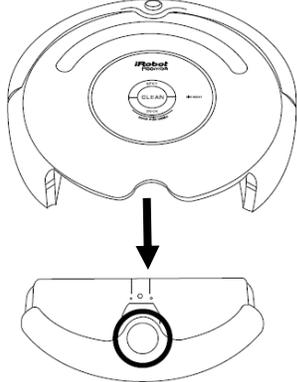
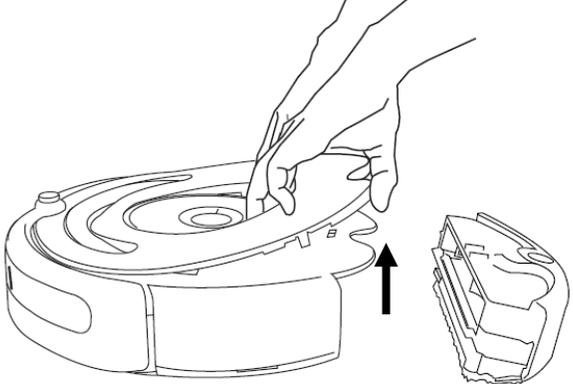
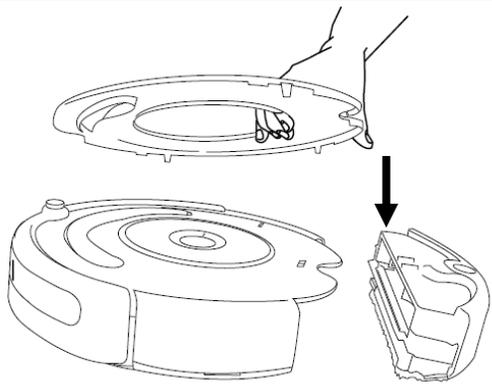


<p>2. Remove spinning side brush</p>	
<p>3. Loosen 4 screws on the base plate. (The screws are captured in the plastic so do not try to take them out.)</p> <p>4. Remove Roomba's base cover and set aside</p>	
<p><b>BATTERY MODULE</b></p> <ul style="list-style-type: none"><li>▪ Remove Battery by lifting the pull tabs.</li><li>▪ Replace with <b>new</b> Battery using pull tabs.</li><li>▪ Press pull tabs against the body of the Battery.</li></ul>	
<p><b>SIDE BRUSH MODULE</b></p> <ul style="list-style-type: none"><li>▪ Replace the 2 screws that retain the new side brush module.</li><li>▪ Remove Roomba's side brush module.</li><li>▪ Install Roomba's <b>new</b> side brush module.</li><li>▪ Replace the 2 screws that retain the side brush module.</li></ul>	

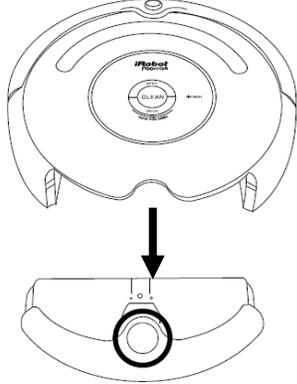
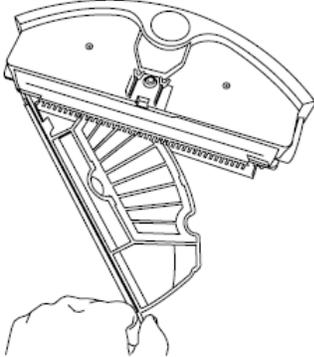
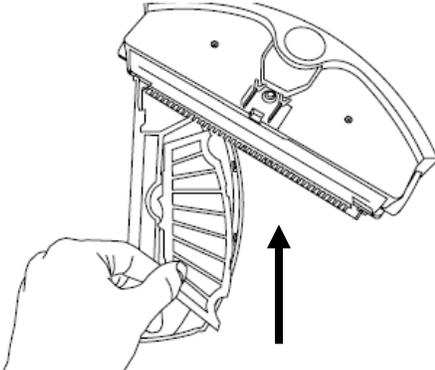
	
<p><b>WHEEL BRUSH MODULE</b></p> <ul style="list-style-type: none"><li>▪ Remove the 3 screws that retain Roomba's wheel module.</li><li>▪ Remove Roomba's wheel module.</li><li>▪ Install Roomba's <b>new</b> wheel module.</li><li>▪ Replace the 3 screws that retain the wheel module.</li></ul>	
<p><b>CLEANING HEAD MODULE</b></p> <ol style="list-style-type: none"><li>1. Remove the 4 screws that retain Roomba's cleaning head module.</li><li>2. Remove Roomba's vacuum bin.</li><li>3. Remove Roomba's cleaning head module.</li><li>4. Install Roomba's <b>new</b> cleaning head module.</li><li>5. Replace the 4 screws that retain the cleaning head module.</li><li>6. Replace the vacuum bin.</li></ol>	

	
<p>5. Replace Roomba's bottom cover and the 4 screws that retain the bottom cover.</p>	
<p>6. Replace spinning side brush and screw</p>	

## Roomba Faceplate Replacement

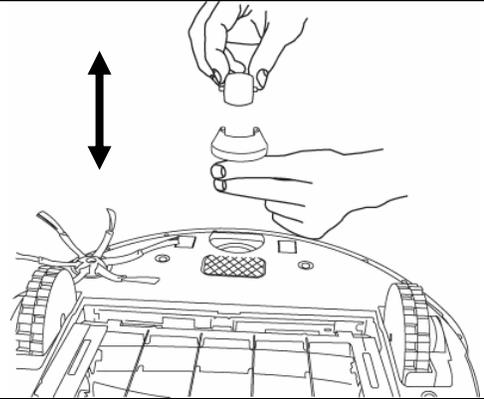
<p>1. Remove Roomba's vacuum bin.</p>	
<p>2. Remove Roomba's faceplate by pulling up from the bin. The faceplate is secured in several places. Lift the handle to make removal easier.</p>	
<p>3. Install Roomba's faceplate by inserting the tabs into the appropriate slots, and then pushing down firmly on the inside and outside edges of Roomba's faceplate.</p> <p>4. Re-insert Roomba's vacuum bin.</p>	

## Roomba Filter Replacement

<p>1. Remove Roomba's vacuum bin.</p>	
<p>2. Open Roomba's filter compartment.</p>	
<p>3. Remove Roomba's old filter by pushing it upward.</p> <p>4. Install Roomba's new filter.</p> <p>5. Close Roomba's filter compartment.</p> <p>6. Re-insert Roomba's vacuum bin.</p>	

## Roomba Front Wheel Replacement

1. Remove the front wheel module by lifting it out of the bottom chassis.
2. Remove the wheel and axle and clear it of hair and debris
3. Reinsert the wheel and module back into the chassis.



## Appendix E: Roomba Software & OSMO

Roomba's software is continuously being updated and latest production will have the most recent software. OSMO is a portable device that can be sent or used by service centers to update Roomba code.



To determine what version of software is in the OSMO, inspect the OSMO date code sticker for the version.

**Example :** KYNxxxxx0707120100047

### OSMO Download procedure

- Remove Roomba's faceplate
- Power Roomba ON and make sure it is not connected to the power supply
- Plug OSMO into the serial port which is accessible when the face plate is removed.
- Wait a few minutes until the update is complete (OSMO stops flashing and Roomba CLEAN button is solid green)



## Appendix F: Battery Test Procedure

Using Battery Voltage Tester	
<i>Objective :</i>	To measure the voltage across a Roomba 500 series battery, to measure voltage across a 5-Ohm resistor, and to measure the thermistor resistance.
<i>Equipment :</i>	Battery Voltage Tester, Multimeter, and <u>fully</u> charged battery under test.
Method	
1.	Fully charge battery with Roomba and latest software. Remove battery from Roomba
2.	To measure voltage across the fully charged battery, set the multimeter to measure DC VOLTAGE (V), and plug the multimeter terminals to the positive (+) and negative (-) terminals of the charge barge. <b>Failure if</b> reading is less than 14.5V.
3.	To measure the voltage across a 5 $\Omega$ resistor, follow step 1 (set the multimeter to measure DC VOLTAGE), and press the 5-Ohm resistor push button ( <u>Caution:</u> Do not press button for more than a few seconds to avoid overheating of the load.) <b>Failure if</b> voltage drop is more than 2 Volts.
4.	Make sure battery is not hot from charging and needs to be equilibrated to room temperature. To measure the thermistor resistance value (thermistor contact to ground contact), set the multimeter to measure RESISTANCE ( $\Omega$ ), and plug the multimeter terminals to the thermistor terminal and the negative (-) terminal. <b>Failure if</b> not within specs in table below.

Ambient Room Temp	Thermistor Min (K Ohm)	Thermistor Max (K Ohm)
10 to 17.5 C	12.0	21.8
17.6 to 25.5 C	8.5	15.5
25.6 to 33.5 C	6.0	11.0
33.6 to 41.5 C	4.3	7.8



## Appendix G: Power Supply Test Procedure

For 1.25A Power Supply	
<i>Equipment:</i>	AC Voltmeter, DC voltmeter, ammeter, variable voltage AC supply, power resistor (18 ohm 50 W for 1.25 A charging brick).
<b>Method</b>	
1.	Plug power supply into variable voltage AC supply with AC voltmeter connected across AC supply. Connect resistive load (18 ohm 50 W) across output of power supply, with DC ammeter connected in series to measure current supplied to load. Connect DC voltmeter across resistive load and ammeter, so ammeter voltage drop is included in voltage reading
2.	Set AC supply voltage for 240, 132, 108 and 60 VAC. <b>Failure if</b> DC output voltage is <b>not</b> between 21.1 VDC and 24 VDC. <b>Failure if</b> DC output current is <b>not</b> between 1.0A and 1.45 A.
3.	Plug Power Supply into wall outlet or AC supply (120 – 240VAC). Measure open circuit voltage, idle current and power <b>Failure if</b> DC output voltage is <b>not</b> between 21.1 VDC and 24 VDC. <b>Failure if</b> DC output current greater than 18 mA; <b>Failure if</b> Power is greater than 0.5W.
4.	Disconnect power supply from wall outlet or AC supply. Set AC supply voltage for 60 VAC. Reconnect power supply to AC supply. <b>Failure if</b> output current isn't zero (power supply should shut down)

## Appendix H: Home Base Test Procedure

**Home Base Failure** if it is shaken and something is loose inside or if contacts do not spring back

**Home Base Failure** 'Power' LED on the Home Base is not lit or 'Docked' LED is lit when only plugged into Power Supply.

**Home Base Failure** if open circuit voltage is **not** between 2.3 VDC and 3.8 VDC.

**Home Base Failure** if it fails Home Base Mobility test (manual dock and Home Base avoidance)



## Appendix I: Roomba Serial Number

### Robot Barcode Serial Number Format

*(barcode sticker on inside chassis – seen when vacuum bin is removed)*



manufacturer ID		status	model					year		month		day		revision		sequence				
M	M	U	L	L	L	L	L	Y	Y	m	m	d	d	R	R	s	s	s	s	s

- MM Manufacturer ID: 'JE' or 'KY' or 'PR'
- Status: 'N' for new, 'R' for remanufactured
- LLLLL Model number (00000 - 09999)
- YY Year (since 2000) this robot was manufactured
- mm Month this robot was manufactured
- dd Day of the month this robot was manufactured
- RR Model revision for this robot
- SSSSS Order that robot was made on date of manufacture

Example: KYN535010707120100047

## Appendix J: User Interface

### CLEAN Light

*While charging :*

No Light	Green	Yellow	Red
-Battery depleted.	-Solid green when finished charging.	-Pulsing slow when charging in normal mode. -Pulsing fast when charging in recovery mode.	-Flashes red if battery has failed

*While cleaning :*

No Light	Green	Yellow	Red
-	-Battery charged	-Battery partially depleted	-Battery discharged

### SPOT Light

No Light	Green
-Spot mode not activated	- Solid green when cleaning in spot mode - Flashes green in Voice Tutorial

### DOCK Light

No Light	Green
- Dock mode not activated	- Flashes green when attempting to dock - Flashes green in Voice Tutorial

### CHECK ROBOT Light

No Light	Red
-Robot functioning normally	-Blinks for 'Pause errors' or 'Charging errors'

### DIRT DETECT Light

No Light	Blue (solid)	Blue (blinking)
-During normal operation and floor is clean. -Debris sensor is broken if not activating on dirty floor.	-Solid blue when in DIRT DETECT mode. Blinks Slowly	-Blinks slowly when in DIRT DETECT OVERRIDE mode. This happens when the sensor is overloaded or malfunctioning. -Occurs when dirt detection occurs for over 40 seconds, or a high dose of dirt, or a high frequency signal that may indicate a loose debris sensor



## Appendix K: Glossary

BiT	○ Built in test
Black Box	○ Robot data recorder that tracks information during the robot's life.
Chassis	○ The plastic structure/frame of the Roomba
Cleaning frame assembly	○ The cleaning assembly includes the pivoting self adjusting frame that supports the brushes, brush guard, brush motor and gearbox.
Debris	○ Dirt that is being picked up by the Roomba
Encoder	○ A sensor that relays information to the pcb
Force field	○ An IR avoidance beam that ensures the Roomba does not bump into it. Present in the Home Base and virtual Wall
Home base	○ The self charging station
Infra Red (IR)	○ A wave of light with wavelengths greater than those of visible light (0.75 and 1000 $\mu\text{m}$ ). IR does not pass through walls.
Light Emitting Diode (LED)	○ Semiconductor light source that emits visible light or invisible infrared radiation.
Mobility	○ Capable of moving or being moved readily
Panic Spin	○ A systematic escape behavior that the robot enters when it thinks it is stuck. The robot senses that its front wheel is not turning and abruptly changes course with a rapid spin.
PWM	○ Pulse width modulation
Radio Frequency (RF)	○ The frequency range from 10 kHz to 100 GHz used for transmitting data, audio, or video. RF passes through walls.
RCON	○ Room Confinement (reference to the omni-directional IR sensor that sits on top of Roomba's bumper)
Stasis	○ Refers to things that are not moving or changing
User interface (UI)	○ The physical means and method of interaction between users and products
Virtual	○ Is not physical