Radar Sense and Avoid System
PMI Model: RSAAS-001

User Manual
Rev. 1.4
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Introduction

1.1 General Description:

The PMI Model: RSAAS-001 (Radar Sense and Avoid System) has been designed to provide obstacle detection for the 3DR Solo Drone. This system uses (four) Doppler Radar sensors to detect obstacles from all sides of the drone. Using Doppler Radar allows obstacles from small size (such as a wire or a tree branch) to large (such as a wall) to be detected when in range. Mechanical mounting of this system can be adapted to fit other UAV platforms. Low power requirements make this system ideal for UAV Application. Each sensor has onboard adjustment for distance of detection. Communication with the 3DR Solo is accomplished over USB interface via 30-pin accessories port connector.

This manual will only cover installation and operation of PMI Model: RSAAS-001 specifically for the 3DR Solo Drone. Refer to the 3DR Solo manual for all Drone related information.
1.2 System overview:

The PMI Model: RSAAS-001 is comprised of four Doppler Radar sensors connected to an Interface Board. This Interface Board plugs into the 3DR Solo Accessories Port, providing power to sensors and a USB connection to Flight Controller. See Figure 1.

Obstacle Detection Overview shown in Figure 2.

Sensor operation Overview Diagram shown in Figure 3.

* NOTE: DRONE NOT INCLUDED WITH PMI Model: RSAAS-001
Figure 2

Obstacle

Transmitted Signal

Reflected Radar Signal with Doppler Shift

Threshold of Doppler Radar Signal

Alarm Signal

Distance

Protected Border

Drone

Distance

Figure 3

Doppler Radar Sense and Avoid System

Oscillator (OS)

Mixer (M)

Amplifier (A)

Filter

Autopilot with adjustment of Doppler signal threshold

Optional Connection to Controller

Drone

Tx

Rx
1.3 In the Box: Parts
The PMI Model: RSAAS-001 comes assembled, ready for mounting to a 3DR Solo out of the box. Minimal installation is needed using provided screws and hardware. Please refer to Section 4.1 for Mechanical Assembly. Figure 2 illustrates included items.

**PARTS IN BOX**

*Figure 2*
**Requirements**

### 2.1 Computer Requirements
In order to be able to upload PMI Model: RSAAS-001 firmware to the 3DR Solo, a Windows/Mac computer with WIFI will be necessary. This will be needed for steps outlined in section: **4.2 Firmware Installation**. Please download the following files available at: [www.pmi-rf.com](http://www.pmi-rf.com)

a) *python Solo-Log-Trigger-Testing.py*

b) *Solo-Goto-Relative-Position-Trigger.py*

**Specifications**

### 3.1 System Specifications
All connections to PMI Model: RSAAS-001 are made through the 30 pin Connector installed on the Interface Board. This allows power and USB connections to the 3DR Solo.

**Specifications:**

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPERATING VOLTAGE:</td>
<td>5.0±0.2 VDC</td>
</tr>
<tr>
<td>OPERATING CURRENT:</td>
<td>40mA AVG.</td>
</tr>
<tr>
<td>CENTER OUTPUT FREQUENCY:</td>
<td>10.525 GHz / 10.687 GHz</td>
</tr>
<tr>
<td>ANTENNA CHARACTERISTIC</td>
<td></td>
</tr>
<tr>
<td>H-PLANE BEAMWIDTH:</td>
<td>120°</td>
</tr>
<tr>
<td>E-PLANE BEAMWIDTH:</td>
<td>90°</td>
</tr>
<tr>
<td>RADAR RANGE:</td>
<td>0.3 TO 2 METERS</td>
</tr>
<tr>
<td>OUTPUT POWER:</td>
<td>10dBm</td>
</tr>
<tr>
<td>COMMUNICATION PROTOCOL:</td>
<td>USB 2.0</td>
</tr>
<tr>
<td>SENSOR DIMENSIONS:</td>
<td>12.8” X 7.2” X 1.9”</td>
</tr>
<tr>
<td>SENSOR WEIGHT:</td>
<td>305 GRAMS</td>
</tr>
<tr>
<td>EXTERIOR FINISH:</td>
<td>BLACK ANODIZED ALUMINUM</td>
</tr>
</tbody>
</table>

**Environmental Specifications:**

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature:</td>
<td>0° C TO +45°C (OPERATING)</td>
</tr>
<tr>
<td></td>
<td>-65°C TO +125°C (STORAGE)</td>
</tr>
<tr>
<td>Humidity:</td>
<td>0 TO 85% RH</td>
</tr>
</tbody>
</table>
**Installation**

4.1 **Mechanical Assembly**

Installation of PMI Model: RSAAS-001 has been designed to be simple, requiring only a #1 Phillips screwdriver. See Figure 3 and the following steps to install:

**STEP 1)** Remove (4X) inner screws from legs. Screws to be removed are closest to body of drone.

**STEP 2)** Place (4X) ¼” *Spacer* into recess at drone leg.

**STEP 3)** Place *Frame Assembly* onto drone body. Round cutout in Frame to sit at Gimbal end of Drone. If Gimbal/3-axis Gimbal is mounted, slight manipulation of the gimbal to fit through the Frame Assembly will allow the Frame Assembly to drop into place.

**STEP 4)** Install (4X) M3 X 16MM Screws through *Frame Assembly* and through ¼” *Spacer*. Screw into drone body. This will complete mounting of Frame.

**STEP 5)** Place *Interface board* onto 3DR Solo Accessories port. Align and insert connector until board is fully seated into mating connector. Install *Interface Cover* and (4X) M2 X 10MM Screws.

**STEP 6)** Plug Sensors into Interface Board as notated on label.

This will complete the mechanical assembly portion.
EXPLODED VIEW

Figure 3

3DR SOLO DRONE WITH CAMERA & GIMBAL

PMI Model:
RSAAS-001 SENSOR ASSEMBLY WITH INTERFACE PCB AND COVER
4.2 Firmware Installation

4.2.1 Firmware Introduction
In order to be able to use PMI Model: RSAAS-001, it is required to load the proper python file into the 3DR Solo. Please refer to section: 2.1 Computer Requirements. Use a Windows/Mac/Linux computer to connect and load firmware per instructions below:

4.2.2 PMI Model: RSAAS-001 Configuration

Solo Flight Mode Configuration
**IMPORTANT TO ALLOW ENABLE FLY:MANUAL AS FAILSAFE!!**
1. Open Solo Mobile Application
   a. Connect Mobile Device To Solo Link Wifi Network
2. Select Settings
3. Select Advanced Settings
4. Enable Advanced Flight Modes
5. Go Back to Main Settings Screen
6. Select Solo
7. Set Preset A as FLY:Manual (No GPS, No Sense Avoid)
8. Set Preset B as FLY (GPS, Sense Avoid)
**9. Recommended for testing**
   a. Go to Performance Menu
Set Flight at slowest level

Python Script Upload
1. Connect from a computer to Solo Wifi network
2. OPTION 1: FTP instructions
   a. Download FTP client Filezilla
   b. Connect to Solo Using FTP Client
      i. Host: 10.1.1.10
      ii. Username: root
      iii. Password: TjSDBkAu
      iv. Port: 22
   c. Upload two Python Scripts
      i. Solo-Log-Trigger-Testing.py
      ii. Solo-Goto-Relative-Position-Trigger.py
3. OPTION 2: rsync
   a. TODO: Need to verify mac/windows usage – might be easier than above
4.2.3 Solo Sense and Avoid Operation Instructions

Script Running and Operation
1. SSH into Solo
   a. [https://dev.3dr.com/starting-network.html](https://dev.3dr.com/starting-network.html)
   b. Verify files are in directory
      i. Run 'ls' command to list current directory

2. Logging Only
   a. Run 'python Solo-Log-Trigger-Testing.py' at command prompt
   b. Proper Sensor Configuration should be verified using this mode without taking off or starting motors
   c. Flight in this mode can be in FLY or FLY:Manual
      i. No Avoid but will log and display data to console

3. React in 'Fly Mode'
   a. Wait for GPS Prior to starting
   b. Run 'python Solo-Goto-Relative-Position-Trigger.py'
      i. Verify Proper USB connection
         1. TODO: ADD CONSOLE OUTPUT WHEN SUCCESS
   c. Take Off
      i. Set Flight Mode on Controller to FLY:Manual prior to takeoff by pressing the A button
         1. This is done to avoid sense and avoid trigger during takeoff
         ii. Get drone to 2-5 meters to clear ground
   d. To enable GPS Flight and Sense and Avoid Function
      i. Set Flight Mode on Controller to FLY mode by pressing the B button on controller
   e. Current Software configuration will react .75 meters and hold drone in position for 4 seconds and then put drone into FLY:Manual Mode– this is to allow radar to go back to not triggered
   f. To Re-enable Sense and Avoid put drone into FLY mode by pressing the B button on controller
   g. Landing Should be done using the FLY:Manual Mode to prevent sense and avoid during landing

IN EVENT SENSOR CONTINUES TO TRIGGER FALSELY, REACTING WHEN IT SHOULD NOT, PUT DRONE INTO FLY: MANUAL MODE AND LAND.
4.3 Adjusting Trigger Distance of Sensors

Sensors used in PMI Model: RSAAS-001 have a Sensitivity Adjustment screw (from here on referred to as Trigger Distance Adjustment). Each sensor has this Trigger Distance Adjustment screw (colored blue) on the right side of sensor. By turning the Trigger Distance Adjustment screw in the clockwise direction, Trigger Distance is increased. By turning the Trigger Distance Adjustment screw in the counter-clockwise direction, Trigger Distance is decreased. Do not set range to absolute minimum, as this may cause the radar sensor to be non-responsive, essentially turning off this sensor. To test Trigger Distance of Sensor:

1) Place hand in front of sensor and wave back and forth (moving hand to and away from sensor).
2) By starting from further away and moving closer, Trigger Distance can be established.
3) Observe that when the sensor is Triggered, the LED turns on for several seconds. Turn adjustment screw to set desired Trigger Distance.

Recommended setting for sensor Trigger Distance should be no less than two feet from the drone. Ideal distance will depend on the application. With slow flying, a small Trigger Distance will give the drone sufficient time to respond to sensor trigger; with faster flying, a larger Trigger Distance will allow the drone additional response time. It is up to operator to determine proper Trigger Distance setting. See Figure 4:

Figure 4
**Flying**

5.1 Preflight checks:

Testing sensor operation is to be performed prior to each flight. To test, check that the sensor triggers are at desired Trigger Distance. If there is a need to adjust, see section: 4.3. To fly the 3DR Solo with PMI Model: RSAAS-001 enabled, refer to: Section 4, for proper firmware loading. Once the proper firmware has been loaded, the 3DR Solo is ready to fly. As always, take caution when flying to always have full control of the drone. If any unexpected movements are observed during flight, immediately place the drone into _FLY: Manual_ mode and land the drone. Refer to Section 7.1 for Troubleshooting.

**Maintenance**

6.1 System Maintenance

PMI Model: RSAAS-001 requires minimal maintenance. Prior to every flight verify that all screws are present and snug, Radar Sensors are clean of any contamination and Trigger Distance is at desired range. Verify that all wiring is properly fastened. If any faults are found do not fly the drone until all concerns are resolved.

Proper cleaning of PMI Model: RSAAS-001 is limited to wiping all mechanical parts & cables with a damp cloth to remove surface contamination. DO NOT allow any liquid or other contaminants to enter the Sensors or Interface Board Assembly.
Troubleshooting

7.1 Common Sense
Proper care and handling of the PMI Model: RSAAS-001 will result in a trouble-free, dependable system. Care must be taken to avoid impact, ESD (electrostatic Discharge), and maintain cleanliness of system. This System has not been designed or intended to be operated in rain, snow or other adverse weather conditions. Moisture or other contaminants within the sensors or electronics may cause faulty operation or system failure.

This system has only one user adjustable feature: Trigger Distance Adjustment. There is no other user serviceable or adjustable feature on this system. If Sensor does not trigger at desired distance, please refer to section 4.3 Adjusting Range of Sensors.

7.2 Troubleshooting Chart

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED does not come On</td>
<td>Drone is powered off</td>
<td>Power on Drone</td>
</tr>
<tr>
<td></td>
<td>Interface Board is not connected to Drone</td>
<td>Connect Interface Board to Drone</td>
</tr>
<tr>
<td></td>
<td></td>
<td>See: Section 4.1</td>
</tr>
<tr>
<td></td>
<td>Sensor cable is disconnected from Drone</td>
<td>Connect Sensor Cable to Interface Board</td>
</tr>
<tr>
<td></td>
<td></td>
<td>See Section 4.1</td>
</tr>
<tr>
<td></td>
<td>Trigger Distance is set to minimal</td>
<td>Increase Trigger Distance. See section: 4.3</td>
</tr>
<tr>
<td>LED is constantly On</td>
<td>Trigger Distance is set to Max.</td>
<td>Decrease Trigger Distance. See section: 4.3</td>
</tr>
<tr>
<td></td>
<td>Contamination of Radar Sensor</td>
<td>Wipe any contamination from front of Radar</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sensor. See section: 6.1</td>
</tr>
<tr>
<td></td>
<td>Defective Sensor</td>
<td>Power cycle Drone. If not resolved, replace</td>
</tr>
<tr>
<td></td>
<td></td>
<td>sensor. See section: 4.1 &amp; 8.1</td>
</tr>
<tr>
<td>Trigger Range is to Short</td>
<td>Trigger Distance set for Short Range</td>
<td>Adjust Trigger Distance. See section: 4.3</td>
</tr>
<tr>
<td>Trigger Range is to Far</td>
<td>Trigger Distance set for Far Range</td>
<td>Adjust Trigger Distance. See section: 4.3</td>
</tr>
<tr>
<td>All Sensors not responding</td>
<td>No power to system</td>
<td>Power on Drone</td>
</tr>
<tr>
<td></td>
<td>Interface Board not connected to Drone</td>
<td>Connect Interface Board to Drone</td>
</tr>
<tr>
<td></td>
<td></td>
<td>See: Section 4.1</td>
</tr>
<tr>
<td>False Triggers while Airborn</td>
<td>Sensors detecting Propellers</td>
<td>Verify that sensors do not Trigger from</td>
</tr>
<tr>
<td></td>
<td></td>
<td>turning Propellers on ground. If needed,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>adjust sensor away from Propellers</td>
</tr>
<tr>
<td></td>
<td>Contamination on Sensors</td>
<td>Clean Sensors. See section: 6.1</td>
</tr>
<tr>
<td></td>
<td>Trigger Distance set to Max</td>
<td>Decrease Trigger Distance of Sensor.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>See section: 4.3</td>
</tr>
</tbody>
</table>
Warranty

8.1 Warranty

PLANAR MONOLITHICS INDUSTRIES, INC. warrants all equipment/parts of its manufacture to be free from defects in material and workmanship for a period of one year after the delivery of the equipment to the original purchaser.

Liability under the warranty is limited to the repair or replacement of the equipment/parts at the discretion of PMI after inspection of the equipment/part in question at our facility. Repair charges will be applied to any product found to be damaged from either neglect, misuse or any product that has been disassembled, modified, physically or electrically damaged or any product that has been subjected to conditions exceeding the applicable specifications or ratings of that of normal use and service within the warranty time period.

All equipment/parts returned under warranty must be accompanied by a Return Material Authorization (RMA) number which is obtainable from the factory. Original equipment/parts must be returned to PMI, transportation charges prepaid FOB factory, Frederick, Maryland. If warranty repair is applicable, the unit will be returned freight prepaid, FOB destination. If warranty repair is not applicable, the customer will be advised of the repair charges and their authorization to proceed awaited before any costs are incurred. Non-warranty repairs will be returned FOB factory, Frederick, Maryland.