Spotter Installation and Configuration Reference Guide

Firmware Version 5.0.3

This reference guide is to be used in conjunction with the Installation Training Video.

Table of Contents

Migration Notes

If upgrading from any version prior to 5.0.1 all training tracks stored in your NIO and your current AI models will no longer work with version 5.0.1 and above. This will require gathering new training tracks and retraining your AI models.

If upgrading from previous versions to the current version, follow this upgrade path:

2.9 -> 3.20 -> 4.0.0 -> 5.0.3

Note on upgrading:

- Contact SpotterRF before upgrading from any beta or dev version of firmware
- If the version is older than 3.20 then the unit may require a physical power cycle to fully upgrade and come back online.
- If downgrading from 4.2 all of the signal health monitoring check boxes must be selected.
- **Downgrading on CK5-CE, CK2b-CE and CK10b-CE to any version below 4.3.0 is not supported on these devices.**

New Features

- Support for better tangential detections.
- Support for exclusion arcs and SNR exclusions.
- Support for exclusion based on altitude.

Bugs Fixed

-

Known Bugs

-

Anatel (Brazil Only)

SpotterRF K band radars are Anatel certified for operations in Brazil.
MODELO: GK100-2D-SMS, GK120-1D-NFS, GK120-2D-SMS, GK150-2D-SMS, GK250-2D-SMS and GK450-2D-SMS
Para maiores informações, consulte o site da ANATEL
Este equipamento não tem direito à proteção contra interferência prejudicial e não pode causar interferência em sistemas devidamente autorizados.
Este produto não é apropriado para uso em ambientes domésticos, pois poderá causar interferências eletromagnéticas que obrigam o usuário a tomar medidas necessárias para minimizar estas interferências.

Understanding how the Radar Works

Before installing the SpotterRF radar, it is crucial to understand basic radar principles. A SpotterRF radar is classified as a Compact Surveillance Radar (CSR). All models of the SpotterRF radar are fixed beam motion tracking indicators (MTI) operating in the X band and transmitting less than 500 milliwatts. (3D-500 is an exception) The radars are range-Doppler systems which means they detect movement by measuring the velocity of objects in their respective coverage area as well as range and angle to the target unlike Doppler radar used by the police that only measure speed. All SpotterRF radars perform all data processing for detection and tracking onboard the Spotter, then report the filtered track data up to 8 times per second in a JSON or XML data packet via IP. The horizontal beamwidth of the C40, C550, C950, and CK10 average 90°. The C20 averages 120°. The A2000 averages 45°. The CK2 has a 40 meter horizontal field of view (FOV). The average vertical beamwidth of the radars is between 10° and 20° depending on the model. For more details on the radar specifications see the SpotterRF Radars datasheet.

When discussing field of view, a key term is “average.” The detection area of the radars is not cone shaped like the FOV of a camera; it is elliptical with the radar sitting at one focal point as seen in the image to the right. The angular FOV starts at nearly 180 degrees then tapers to a one degree beam at the opposite focal point of the ellipse.

This FOV shows the approximate detection area of a person walking on foot. The FOV of the radar is not exact. Detection outside of that FOV is possible, especially for large targets such as vehicles.

Advantages

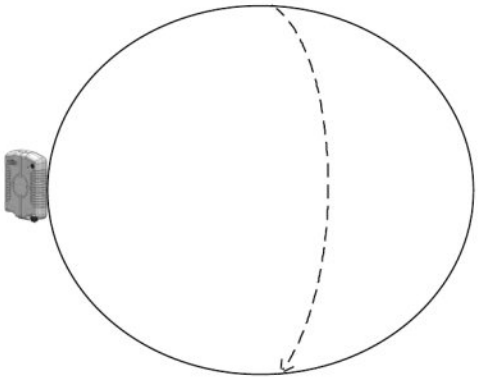
SpotterRF radars are superior to other sensors such as video analytics, motion sensors, vibration sensors, acoustic sensors, and even other radars for detection in wide open areas for the following reasons:

- SpotterRF radars are not affected by rain, snow, fog, smoke, or light conditions.
- SpotterRF radars cover much larger areas than cameras. A single radar can cover as much area as 20 cameras. It can also be paired with a camera, slewing it to focus on the detection.
- SpotterRF radars provide wide area tracking of threats over time as opposed to point detection. This allows for the use of filters in order to alert only on specific behaviors and to reduce nuisance alarms.
- One SpotterRF radar can effectively cover inside and outside the fence line simultaneously.
- SpotterRF radars are solid state which results in decreased size, power consumption, maintenance, and cost compared to rotating radars. This also increases flexibility and MTBF. The 3D-500 Drone radar is a rotating radar and covers a full dome in a cost effective method.
- SpotterRF radars can be mounted practically anywhere and can be oriented to cover almost all terrains as opposed to rotating radars which cannot be easily oriented to account for all terrain.
- SpotterRF radars have relatively large vertical beamwidths compared to other radars (20° vs. 5°). This allows the radar to be mounted up high without creating blind spots under the beam. Most rotating radars must be mounted close to the ground to avoid blind spots.
- SpotterRF radars consume less than 10 watts and can be deployed effectively on solar power (1050, A3000 and 3D500 models draw up to 24 Ws).
- SpotterRF radars are IP based making them easy to integrate with existing IP networks.

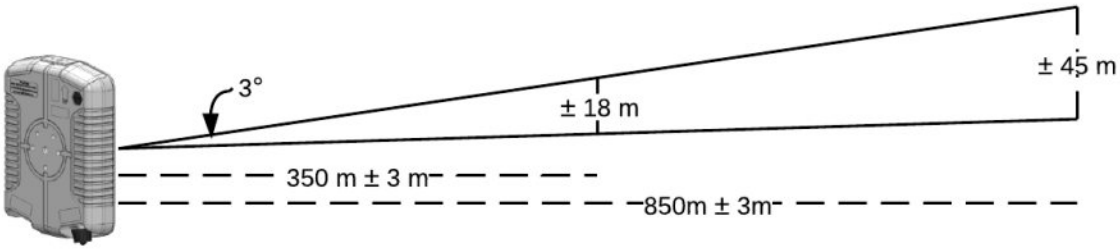
Limitations

While the advantages to using a CSR are extensive, CSRs are only superior to other solutions when used in the appropriate environment for the appropriate application. It is just as important to understand the types of environments and conditions that the radars do NOT work well in, as it is to understand those it does work well in. Some limitations include the following:

- Line of sight is required to detect targets. While there is some foliage penetration, it is very limited. The rule of thumb is that if the target can't be seen, the radar can't see it either.
- SpotterRF radars cannot see through glass.
- SpotterRF radars are Range-Doppler systems which means that they can only detect targets that change in range relative to the radar. The more a target moves towards or away from the radar, the more likely it is to be detected. If a person were to walk in a perfect circle around the radar, never changing in range as shown below, that person would not typically be detected.



- SpotterRF can not identify the number of targets moving in a group. If a group of several targets moves together, it will likely combine them into one or two targets depending on the size.
- SpotterRF radars are limited to 1-3 meters range resolution and ±3 degrees angular resolution. This means that the reported target position may be up to 3 meters and 3 degrees off from the actual position of the target. Thus the farther the target is from the radar, the more variation in track accuracy there will be. This is depicted in the figure below.



This variation in angle accuracy means that pinpoint accuracy is not achievable using the radar. Also, the track displayed on the UI from a target at far ranges may zigzag even though the target is moving in a straight line.

- SpotterRF radars are limited to tracking a total of: 10 simultaneous targets for the CK2; 20 simultaneous targets for the C20, C40, A2000, and CK10; and 30 simultaneous targets for the C550 and C950. Target priority will be assigned automatically based on the target's size, proximity, radial velocity, and metallic properties. For example, the radar will likely not assign tracks to pedestrians walking along a road with a lot of vehicle traffic moving directly towards or away from the radar.
- SpotterRF radars are subject to saturation and reflections in very cluttered environments or when large objects are at close ranges. Saturation is a result of too much energy being reflected back to the radar which causes poor tracking and potential missed detections. As a rule of thumb, avoid mounting the radar where cars will be parked closer than 30 meters and where buildings will be closer than 100 meters.
  Note: The C20 transmits lower power than other SpotterRF radars and thus performs significantly better in cluttered environments.

Pre Installation Preparation

Project Design

Prior to installation it is important to create a site project design which includes the following items:

- Security concern
- Value proposition
- Site layout
- System diagram
- IP addresses and login credentials for each radar, camera, NIO device, and any other devices that will be connected to the radars in any way
- Bill of Materials
- Schedule
- Return on investment analysis

The Project Design Template provides detailed instructions on how to create a project design.

Site survey

A site survey is required, prior to installation, in order to confirm the radars will perform properly according to the project design. The radars should be tested in the location proposed in the design. Performance should be observed and recorded. Other potential mounting locations should be identified and tested as well. Power and communication availability should be confirmed. If needed, the site survey can also be used to determine new mounting locations prior to installing poles, power, and communication. During the site survey, many potential conflicts can be observed and accounted for that may have gone unnoticed unless onsite. New buildings or other obstructions may exist that were not present in the map or mapping software used for the project design. Power and communication restrictions are often uncovered as well.

The Spotter Site Survey and Test Report Checklist is a template that outlines the tasks required to complete an effective site survey. Complete the checklist during the site survey and link it to the project design. The checklist provides step by step instruction on how to check radar performance in each mounting location prior to installing poles, power, and communication. The Impact light stand is a low cost mounting option for testing at heights up to 13 feet. SpotterRF can provide a 4 pound, 200 watt hour battery with a charger and power cable. The battery is capable of running any radar model for up to 24 hours. The checklist should be completed again for each radar at the time of installation and linked to the project design.

Frequency Licensing

Most SpotterRF radar models operate between either 10 and 10.5 GHz or 24 GHz and 24.25 GHz. They may require a frequency approval prior to installation; radars which operate in the unlicensed band (between 10 GHz and 10.5GHz) do not. For FCC grant information, test reports, and instructions on how to file for an FCC license consult please visit fcc.gov. Typically, FCC licenses should be applied for by the end user, and can be granted in 6-8 weeks.

Installation

Once a project design and site survey are completed and the frequency licenses are granted (if applicable), the radars are ready to be installed.

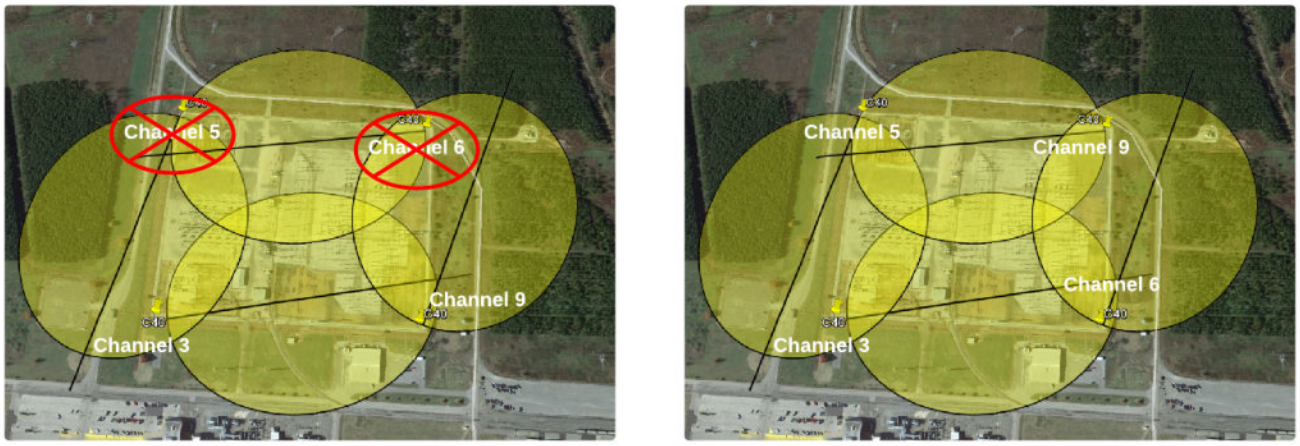
Resolving Radio Frequency Channel Conflicts

The 24 GHz radio frequency (RF) channels used with CK models do not interfere with the 10 GHz RF channels used with C and A models; they can both monitor the same area without causing interference. They can even face each other or face the same direction and not interfere.

Each 10 GHz radar is assigned a specific RF channel or group of channels which is labeled on the side or back of the radar. The channels range from 2 to 9. A channel corresponds to a specific 50 mhz band. Two radars on the same channel (e.g. 5 and 5) or on consecutive channels at 10 GHz (e.g. 5 and 6) will conflict with each other when operating in the same area. Prior to installing any radars with intersecting FOVs, confirm that they are neither on the same channel nor consecutive channels. However, CK radars can be on consecutive channels. Shipments with multiple radars usually include a variety of channels so channel conflicts can be avoided.

Note: The C20B and previous models operate over a 150 MHz band while the C20C and later models operate over a 100 MHz band. The channel sticker includes a range (e.g. 3-5 or 3-4) that correlates to the same channels as the other 10 GHz models.

The diagram below shows a potential conflict with 10 GHz channels on the left and the solution on the right.



New 24 GHz models (Nov, 2017 or later) use channels named K1 (24 GHz - 24.08 GHz), K2 (24.08 GHz - 24.16 GHz), and K3 (24.16 GHz - 24.24 GHz). The channel spacing is designed to prevent interference when multiple radars are on consecutive channels (e.g. K1, K2). Older models (before Nov, 2017) typically will be on K1-K2 spanning 150 MHz, which means that interference can't be eliminated using the same principles discussed previously. Instead, use either pulse channels or timesync channels to reduce interference.

Mounting

The mounting guide provides basic instructions on how to mount the radar to existing structures. When mounting the radar be sure to take into account the following:

- Follow all steps in the Spotter Site Survey and Installation Checklist.
- Once the correct location and orientation have been determined, make sure the arm of the RAM mount is secured as tight as possible. If the arm is too loose, the radar may sag over time.
- If the radar is in a location where it is prone to frequent bird droppings, it is recommended to install a shield or bird spikes over the top to protect it. Some droppings on the face of the radar may not reduce performance, but a significant build up could.

Cabling and Power

All SpotterRF radars are powered using passive Power over Ethernet (POE). This is different from active POE which most POE cameras use. Unlike active POE which passes power over the used pairs of the CAT 5 cable (i.e., pins 1,2,3,6), passive POE passes power over the unused pairs (i.e., pins 4,5,7,8). Also, it does not regulate the voltage but simply passes whatever voltage is put onto the line by the injector. For this reason as well as to maintain a valid warranty, it is necessary to use the proper power supply, POE injector, and **shielded Cat5e** cabling as outlined below.

The radars are rated between 10-30 VDC. It is recommended to use the Phoenix Contact FL Switch SFNT 5TX or Phoenix Contact FL Switch 3005T together with an L-Com BTD-CAT6-P4 POE Injector and a 24 VDC 1 amp or higher power supply. SpotterRF power and mount kits provide all the appropriate power supplies, POE injectors, mounts, and cables needed to install a radar.

The length of the cable between the power supply and the radar will determine the required power supply voltage. POE is not recommended for shielded CAT5 cable longer than 300 feet. Voltage drops at a rate of approximately 5 volts per 100 feet of CAT5e. So, a 12 volt power source, for example, cannot run more than 30 feet of cable reliably. Follow the specifications as detailed in this Tech Note - Design, Build and Testing of Power Over Ethernet (PoE) cable for Spotter radars.

Note: Failure to follow these specifications will void the warranty of the Spotter

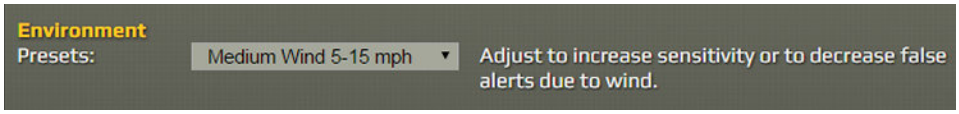
Configuration and Navigating the Interface

Note: Many of the configuration steps are covered in the Spotter Site Survey and Installation Checklist

After the radar is physically installed, cabled, and powered correctly, connect the monitoring computer to the switch so that it has a network connection to the radar. Then open Chrome or Firefox and type the IP address of the radar into the browser address bar. If the IP address is unknown, use the default IP address. To do this, make sure only one radar is connected to the network, set the computer to obtain an IP address automatically, and type 169.254.254.254 into the address bar. (This method may not work if you have a DHCP address assigned) If a username and password have been set on the radar, the login page with appear. Enter the correct username and password and the Quickstart page will load.

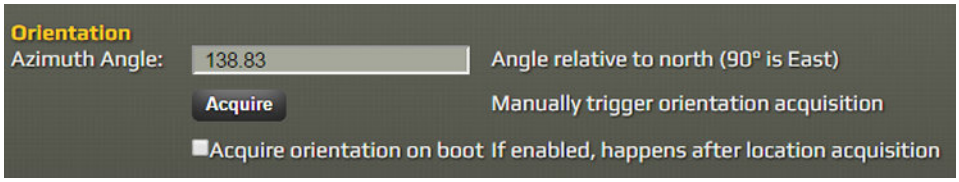
Quickstart Page

Environment



Presets are selected according to the wind setting that best suits the current environment. The lower the wind setting, the more sensitive the radar will be. This can make the radar more likely to detect unwanted moving objects such as small animals, trees, or trash blowing in the wind. Higher wind settings will cause the radar to be less sensitive which results in filtering more nuisance alarms but makes the radar less likely to detect targets that are slow or moving tangentially.

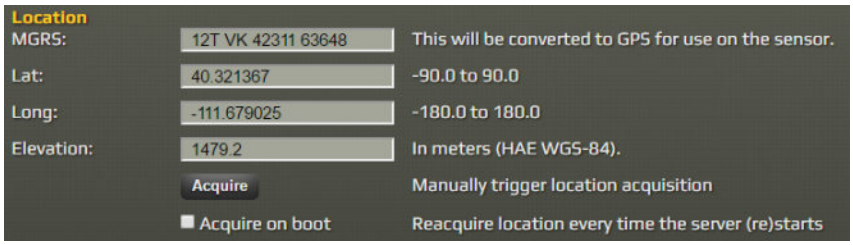
Orientation



Azimuth Angle is the angle between north and the front or transmitting portion of the radar in the horizontal plane. This angle is measured clockwise in degrees. See section 7 for instructions on fine tuning the azimuth angle. If the radar has a Digital Compass, an **Acquire button** will be displayed below the *Azimuth Angle* field which can be used to acquire the approximate azimuth angle. The accuracy of the azimuth using the digital compass is +/- 10 degrees. Selecting the **Acquire orientation on boot** checkbox will force the radar to acquire a new azimuth every time it is power cycled. This box should only be checked if the radar is expected to move locations frequently.

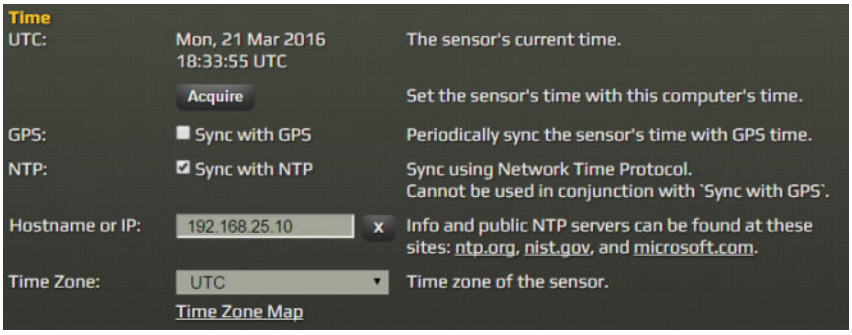
Location

The location is the current *Latitude* and *Longitude* of the radar using decimal degrees or *MGRS* coordinates. If the radar has a GPS and a GPS lock, then the location can be acquired by clicking the **Acquire** button. Otherwise, the coordinates of the radar must be input manually.

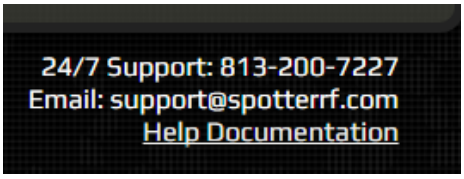


Time

The current time will be displayed once the correct *Time Zone* has been selected. To do this, either select the appropriate time zone corresponding to the location of the radar from the *Time Zone* drop down list or click the **Time Zone Map** link and select the city that corresponds to the appropriate time zone. UTC time may also be selected. Time can either be acquired from the device used to access the radar UI or synced with an NTP server. To sync the time with an NTP server check the **Sync with NTP** checkbox and input the IP address or URL of the NTP server in the *Hostname or IP* text box. A public NTP server, such as pool.ntp.org, can be used if the radar is connected to the Internet. Otherwise, use the IP address of the NetworkedIO server (v1.4.2+) which has a NTP server built. If the radar is not being synced with an NTP server, it is still recommended to acquire the current time. However, it will only acquire the time once and will not continuously sync with the device it is acquiring from.



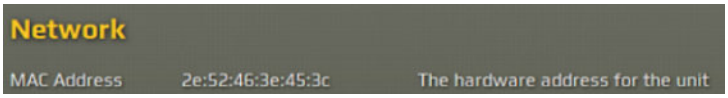
A link to the *Help Documentation* can be found at the bottom right corner of the Quickstart page.



Network Page

MAC Address

The radar's MAC Address is displayed.



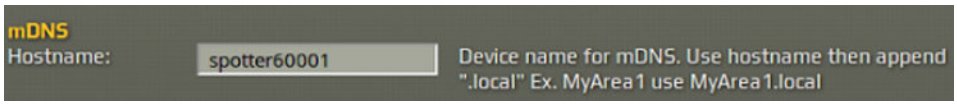
DNS

The radar's DNS server addresses are displayed. DNS servers can be updated through DHCP or set statically.

- DHCP
  - Simply configure the local DNS server (usually a router) and upon obtaining a DHCP address the radar will also obtain the DNS server(s), which will be displayed.
- Set Statically
  - Set the value of the Primary DNS server in the text box. Optionally a Secondary DNS server may be added by setting the value in the Secondary DNS text box.

mDNS

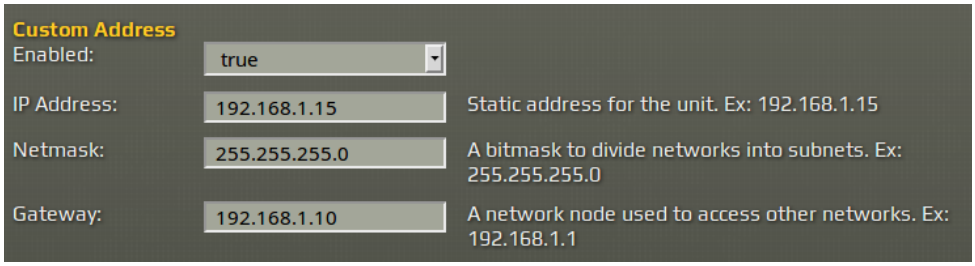
This feature requires a Zeroconf software package (e.g. Avahi or Bonjour). On Windows, this comes bundled with iTunes and there may be other solutions.



A hostname can be specified to locally access the unit. By default this will be the word "spotter" followed by the serial number (e.g. spotter11499). Use the hostname followed by ".local" to access the unit in a browser (e.g. spotter11499.local).

Custom Address

The static *IP address*, *Netmask,* and *Gateway* of the radar can be set in this section.



DHCP Address

DHCP can be enabled by selecting **true** from the *Enabled* drop down list. After true is selected, select either **IPv4** or **IPv6**. Click **Save** and a DHCP address will be obtained

from a local DHCP server (usually a router) if it supports the specified IPv4/IPv6 protocols.

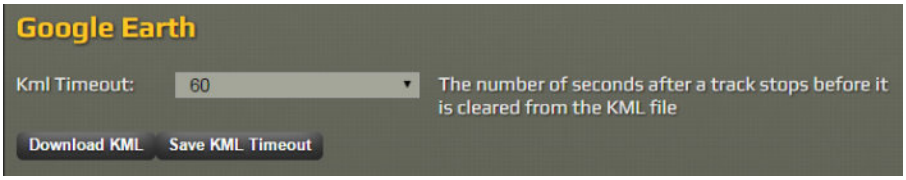
Default Address

The default IP address is 169.254.254.254 and is enabled when shipped. If the default IP address is disabled, then the static IP address CANNOT be recovered. For this reason it is highly recommended to leave the default IP address enabled.

Outputs Page

Google Earth

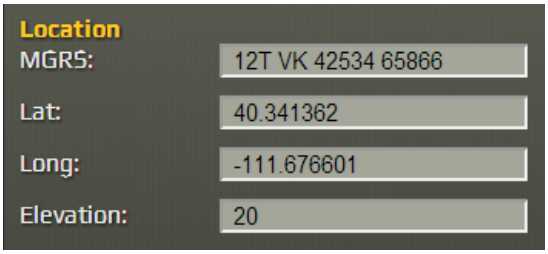
Use this section to view tracks from the radar in Google Earth. This is helpful with calibrating the radar. Refer to section 7 for instructions on calibrating a radar.



The *KML Timeout* is the number of seconds Google Earth will maintain an artifact of the track ID and path AFTER it is no longer detected. To adjust, select the desired time in the drop down list and click **Save KML Timeout**.

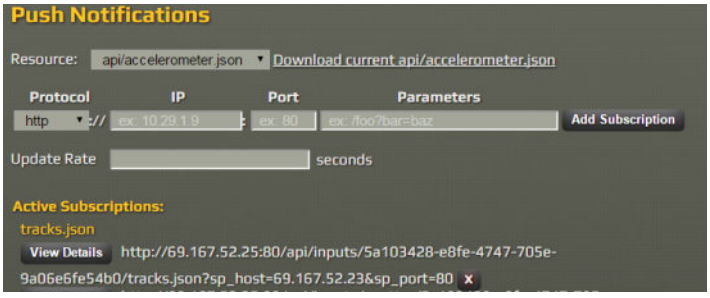
Install Google Earth 7.3.2.5495 or newer if it's not already installed. Click the **Download KML** button from the radar UI. If Google Earth doesn't automatically, find either the downloaded KML or KMZ file and open it in Google Earth. If a username and password are set on the spotter, input this information again in Google Earth when prompted. Under the *Places* section in the left sidebar of Google Earth, find the *Temporary Places* folder. A file folder with the name of the radar will be displayed. Double click on the folder and Google Earth will zoom into the location of the radar. The radar field of view and tracks will be visible in Google Earth. The tracks will update every second.

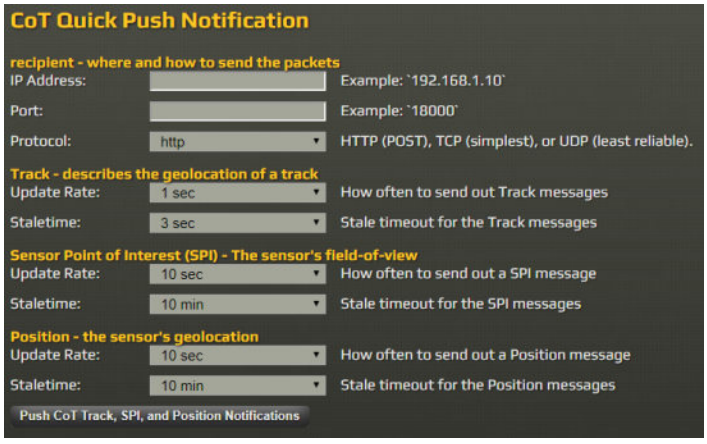
If the radar is displayed in the wrong location, go to the Quickstart page on the radar UI and input the correct GPS location.



Push Notifications and CoT Push Notifications

Push notifications allow integrators to create subscriptions on the radar to push track and radar data to a remote IP address and port in an XML or CoT protocol. Once a subscription is created it will appear in a list under the *Active Subscriptions* section. For details about the types of subscriptions and how to use the notifications for integration, see the Reference document for API Integration.



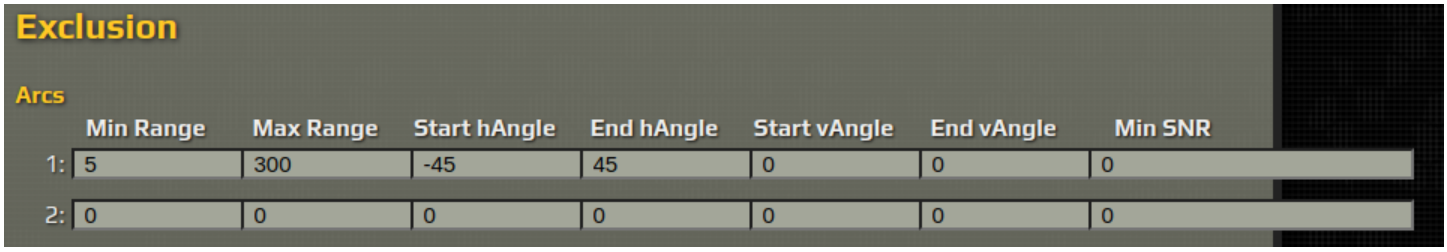


Note: The number of subscriptions is now limited to 5 for any single resource (e.g. tracks.json) and 10 in total.

Advanced Page

Use this page to create exclusion zones, modify parameters affecting the detection sensitivity, change the pitch and roll of the radar, change the data source, and adjust the power settings.

Exclusion Arcs



The radar allows you to define up to 20 exclusion arcs. As more arcs are added an additional empty entry will be shown in the GUI. These areas specify an area in space in which the radar will ignore detections. The fields are:

Min Range and **Max Range** allows you to specify the ground distance (in meters) from the radar that represent the near and far ranges of the exclusion arc.

Start hAngle and **End hAngle** represent the horizontal angles (in degrees) on the radar. 0 degrees represents the boresight of the radar, and increasing angles occur to the right of the boresight.

Start vAngle and **End vAngle** are used in 3D radars to describe the vertical extents (in degrees) of the arc. 0 degrees represents directly level with the radar, and increasing values are up from the horizon. On 2D radars these values are ignored.

Min SNR is an optional field to filter out low-intensity signals. If the value is 0 all detections are removed in the Exclusion Arc. If a non-zero value is provided it represents the minimum SNR that is allowed from this arc. All detections that have a lower SNR will be removed.

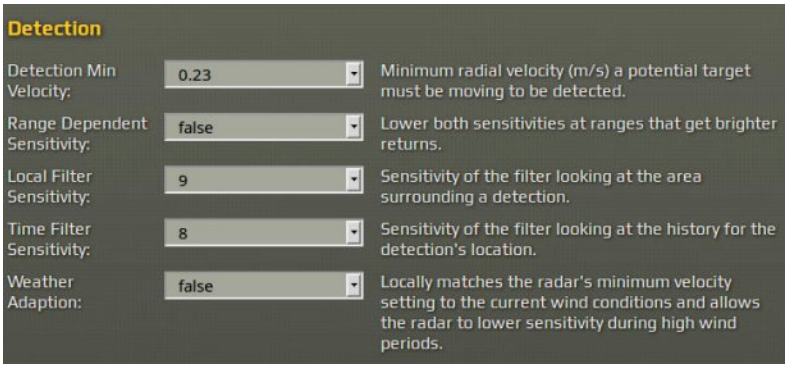
Data Processing

Environment *Presets* can be selected both in this section and on the QuickStart tab. A change in either location will be reflected in both. Changing environment *Presets* will adjust multiple parameters at once. For most applications, using the environment *Presets* is sufficient. Therefore, only adjust *Detection* and *Tracking* parameters if the environment *Presets* are not meeting certain performance requirements. There is a drop down list to the right of each parameter that can be adjusted. *Weather Adaptation* does not change with the environmental presets.

If parameters in the *Detection* and *Tracking* subsections are changed manually, the *Presets* drop down list will read “Custom.” These customer parameters can be saved by entering a name in the *Save As* text box then

clicking **Save Preset**.

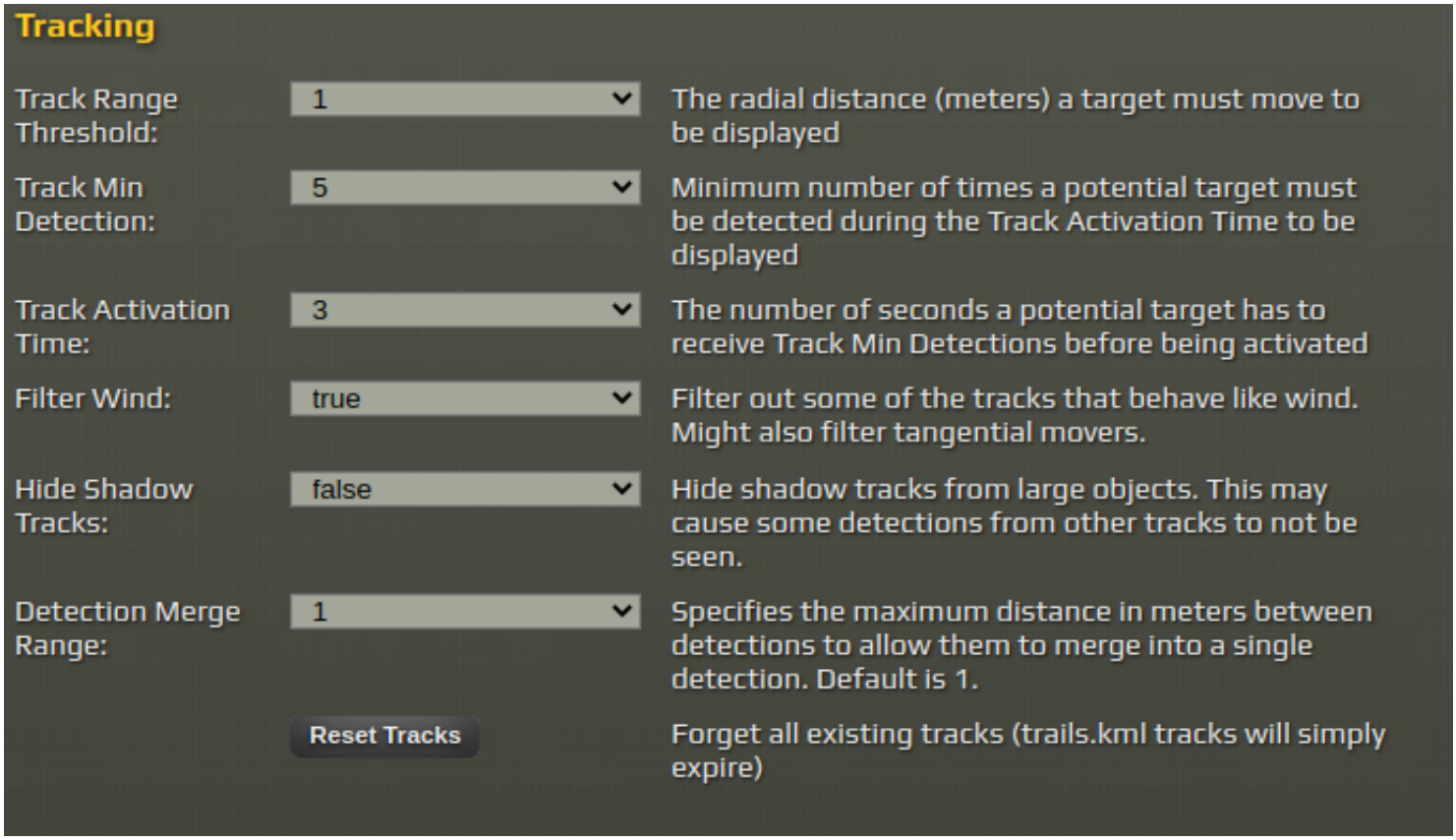
Detection



Detection parameters control the sensitivity of the underlying algorithms that classify detections. A detection candidate (a point with high return signal indicating radial movement) will not become a detection unless it meets all the specified filters. Increasing the value for *Local Filter Sensitivity* and *Time Filter Sensitivity* will increase the overall sensitivity of the radar. Setting the sensitivity too high may result in false detections. It is normal, however, to see detections from periodic random noise. *Local Filter Sensitivity* compares the signal from a given location to the surrounding area at a single moment. It becomes a detection if the signal at that location is higher than the nearby area. *Time Filter Sensitivity* compares the signal from a given location to the recent average signal at that location. It becomes a detection if the signal is a certain degree higher than the recent past. For example, setting it to “1” means the detection strength must be much higher, and setting it to “10” means the detection strength must only be marginally higher. To disable *Time Filter Sensitivity*, select **disabled** in the drop down list.

The *Weather Adaption* setting allows radars to reduce sensitivity when needed. It reduces false alarms by enabling the radar to adapt to weather conditions. It proportionality lowers *Local Filter Sensitivity* and *Time Filter Sensitivity* when medium to strong wind is negatively affecting performance. The *Detection Min Velocity* parameter increases at the specific range where high wind noise is detected. This enables users, in general, to set the minimum detectable velocity lower, relying on the radar to locally increase the parameter when needed. If the parameters are adjusted, the changes are viewable on the RDM. This feature is not modified when changing an environmental *Preset*.

Tracking



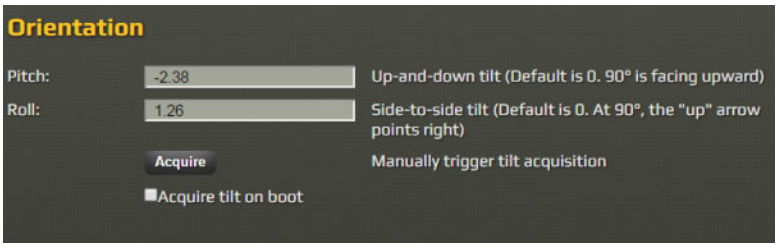
Tracking parameters determine the requirements for generating and killing a track. Detections in an area will become a track once they meet the requirements set for each parameter. When a track hasn't received a detection for a defined period of time, the track will disappear.

Hide Shadow Tracks is for when a radar is in front of a reflective surface that causes false reflective images behind large objects from radar signal bouncing between the radar and the large object.
WARNING: Enabling Hide Shadow Tracks can cause some detections of objects to not be seen.

The Detection Merge Range allows support of larger objects that should be combined into one detection. An example of this would be an airplane where various points on the plane show up as different detections. Increasing the Detection Merge Range allows for combining of these detections into a single track from the radar.
WARNING: Setting this field larger than 1 may incorrectly merge small objects that are within this range.

The **Reset Tracks** button will clear all existing tracks and start the track ID back to 1; however, this doesn't affect NIO track IDs.

Orientation

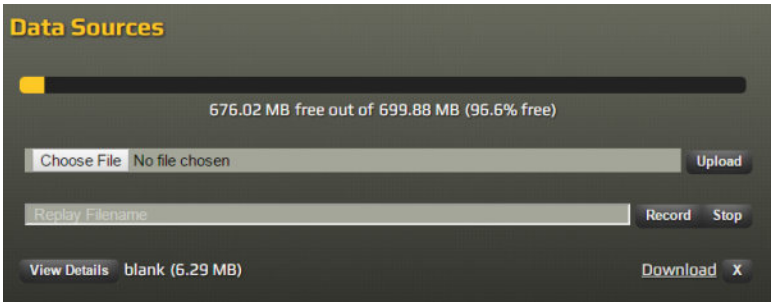


The *Pitch* (up and down tilt) and *Roll* (side tilt) values can be acquired by clicking the **Acquire** button. If these values are incorrect, type the correct values into the textbox and click the **Save** button at the bottom left of the page. See the Orientation section for more information.

WARNING: If NIO firmware 1.5 or below is being used, changing the Pitch and Roll values from 0 will negatively affect how targets are displayed.

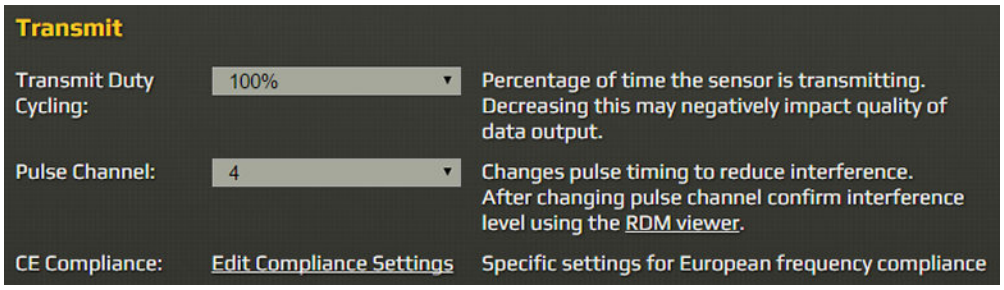
System

Radars can be set to transmit live, not transmit at all, or replay a recorded data file. Select the desired data source from the *Data Source* drop down list. Select **live** for normal operation. Select **blank** to turn off the transmitter; the radar will stop detecting. If the radar has a replay file saved, select it from the list and the radar will continuously replay the data file. This can be helpful when testing inside, but be certain to set the *Data Source* back to “live” prior to deploying it in an operational environment.



Select **Manage Data Sources** to record raw data to the unit, download raw data files, and delete raw data files. Some SD cards do not allow raw data capture through the UI for diagnostic purposes. The workaround is to reboot the unit. Name the file before selecting the **Record** button. Don’t use capital letters or spaces.

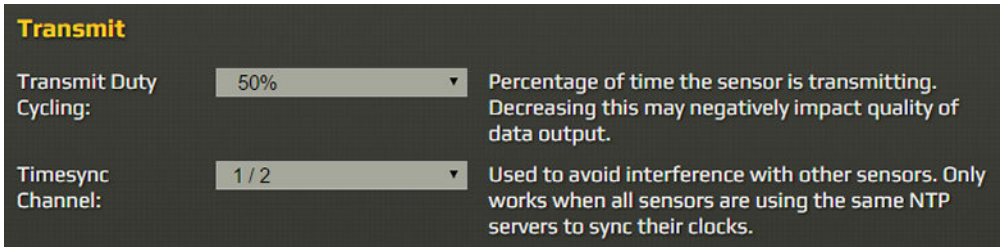
Transmit



Both *Transmit Duty Cycling* and *Pulse Channel* can be used to reduce interference. It is recommended to try *Pulse Channels* first.

Transmit Duty Cycling specifies the percentage of time the radar is transmitting. At 50% *Transmit Duty Cycling,* the transmitter is on for approximately 524 ms and off for 578 ms. At 25% *Transmit Duty Cycling,* the transmitter is on for approximately 274 ms and off 886 ms. CK models may have different timing. Reducing *Transmit Duty Cycling*

can reduce power consumption, but it will also reduce the probability of detection.

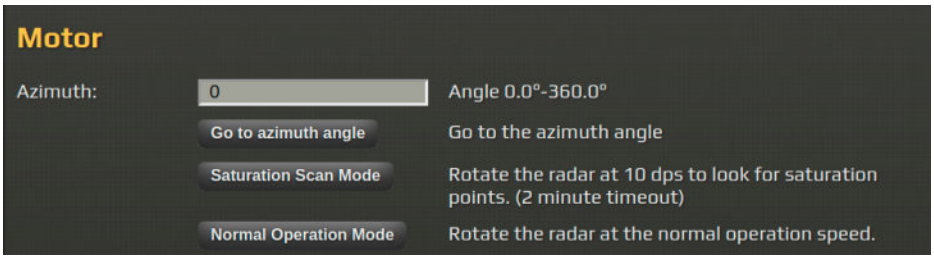


Timesync Channels can be used to resolve interference with other radars. Either **50%** or **25%** must be selected from the *Transmit Duty Cycling* drop down list for *Timesync Channel* to appear. Both radar's experiencing interference must be synced to the same NTP server, set to the same *Transmit Duty Cycling* percentage, and set to different *Timesync Channels* to work properly. For example, to reduce interference on radars 1 and 2, set both to **50%** Transmit Duty Cycling; then set radar 1 to Timesync Channel **1/2** and radar 2 to Timesync Channel **2/2**. This synchronizes a duty cycle between radars causing them to alternate transmit on and off so neither radar transmits and receives at the same time as the other. Use 25% duty cycle if more than two timesync channels are needed. However, this may cause a slight reduction in the speed the radar detects an object.

Pulse Channels are used to reduce interference. It will appear below *Transmit Duty Cycling* if the radar hardware supports it. Radars that don't support pulse channels act as if they were on pulse channel 4. It may require trial and error to find the appropriate channel. Pull up the RDM of the radars. Set the radars at least two channels apart by selecting the channel from the *Pulse Channel* drop down list and clicking **Save**. If this does not reduce or eliminate interference, continue to try other channels until the interference is eliminated.

CE Compliance (firmware v3.5.0+ only for C550B,C550B-EXT, C550C-EXT and A600) can be used to reduce the transmit power to a level acceptable for unlicensed operation in Europe. Setting the radar to *Unlicensed compliance* **WILL SIGNIFICANTLY REDUCE** performance. Only check this box if compliance requires it. For CE compliance for other Spotter models refer to SpotterRF certification documentation

Motor (Rotating Systems only)



Azimuth allows the user to set the Motor to a static location in degrees.

The **Go To Azimuth Angle** button moves the motor to the value specified in the Azimuth box.

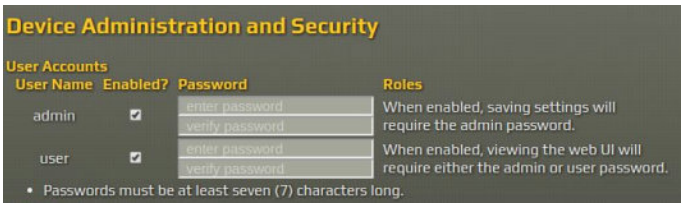
The **Saturation Scan Mode** button initiates Saturation Scan Mode. Saturation Scan Mode rotates the unit at a slow rotation speed of 10 degrees/second. This allows the user to find saturation points by viewing the RDM. Normal operation will resume after 120 seconds.

The **Normal Operation Mode** button causes the unit to rotate at the normal operating speed.

Admin Page

Use this page to manage accounts and high level system parameters.

Device Administration and Security

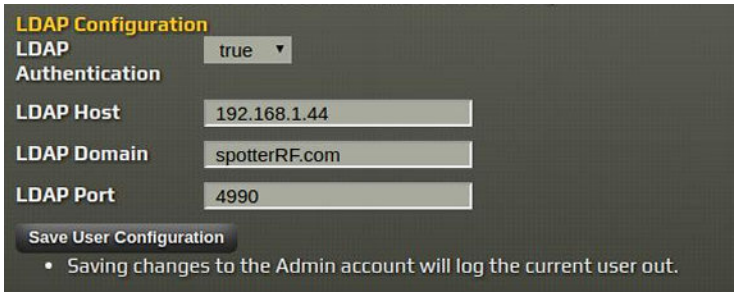


There are two levels of accounts that can be created: *admin* and *user*. An *admin* account has edit privileges to all radar settings. A *user* account only has privileges to view the Quickstart page, the KML Timeout on the Outputs page, the Health page, and the Tracker page.

Usernames cannot be changed. The default username for the *admin* account is admin and user for the *user* account. The password must be a minimum of 7 characters long.

LDAP

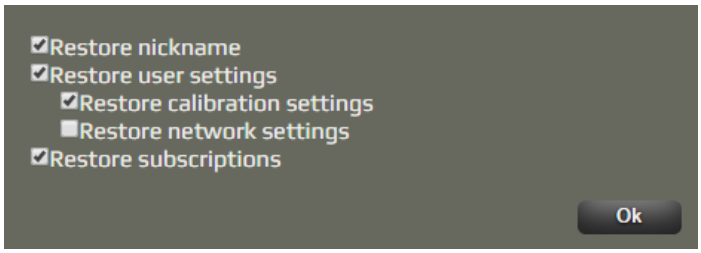
LDAP credentials can be used to login in place of the admin or user account credential. Specify the *Host*, *Domain*, and *Port* of the LDAP server. An admin account must be present (and preferably a user account). LDAP users must belong to a group named SpotterManager or SpotterViewer to have the respective privileges of an admin and user.



System

The **Download Config** button downloads all the current settings on the radar in a .json file format including: all settings on the Quickstart, Network, Advanced, and Health tabs as well as any existing subscriptions on the Outputs tab. This file should be saved for restoration purposes after the radar has been configured.

To restore a radar to an earlier configuration, click the **Upload Config** button, navigate to the saved configuration file, then click **Open**. A prompt will appear. Check the box(es) next to the desired configuration setting(s). The options are as follows:



- *Nickname:* restores all nicknames
- *User settings*: restores all settings displayed on the Quickstart, Advanced, and Health pages
- *Calibration Settings*: restores changes to the radar calibration executed via the API
  Note: these settings can be viewed at ipaddr/api/calibration.
- *Network Settings:* restores all settings displayed on the Network tab
- *Subscriptions:* restores all subscriptions created on the radar

Select **Ok** and the settings will be restored. This process takes about 1 minute to complete; any settings changed during this time will be overridden.

In addition to restoring configurations, the system can be reset to factory defaults by clicking the **Reset** button.
Caution: Resetting to defaults or restoring a configuration will erase all settings and cannot be undone.

Health Page

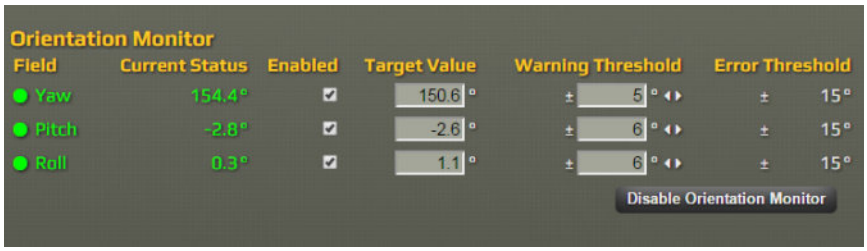
The health page allows users to view the overall health of the radar and manage error notifications on potential health issues. *Target Value* is the value the radar should report during ideal operation. *Warning Threshold* defines the value or range the current status must vary from the *Target Value* to trigger a warning message.

These values can be adjusted by the user. *Error Threshold* defines the value or range the *Current Status* must vary from the *Target Value* before triggering an error message.

Time

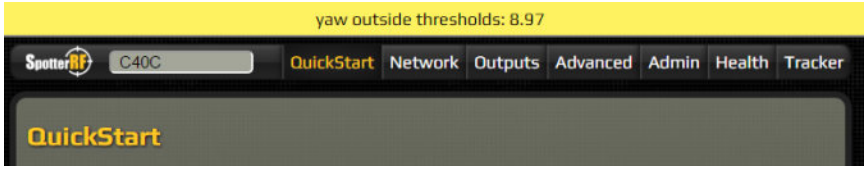
Accumulated Runtime is a record of the number of hours a unit is powered on and persists between power cycles. For example, a radar that has been powered on for 20 hours, is power cycled, then powered on for an additional 5 hours will have an accumulated runtime of 25 hours. The updates to this value only run every hour. So if a new unit is powered on for 6 hours, power cycled, powered on for 55 minutes, then power cycled the accumulated runtime will read 6 hours. *System Uptime* and *Server Uptime* are used for debugging purposes.

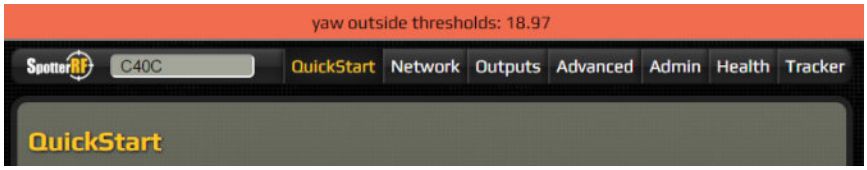
Orientation Monitor



All radars have magnetometers that report the yaw (bearing), pitch, and roll. The magnetometer must be calibrated in order for the values to report correctly. Older models required an additional purchase of SP-ADD-MAG to have the magnetometer calibrated. If it is not purchased, the reported values are likely incorrect. A calibrated magnetometer is especially useful when orienting the radar during installation. An uncalibrated magnetometer can still be used, however, to detect changes in position. Newer models all have included the magnetometer (compass) and work much like a cell phone for calibration. Just moving it around will calibrate the compass. The values reported in *Current Status* will remain fairly consistent when the radar is not moving. The expected variation for the *Current Status*, assuming the radar does not move, are as follows:

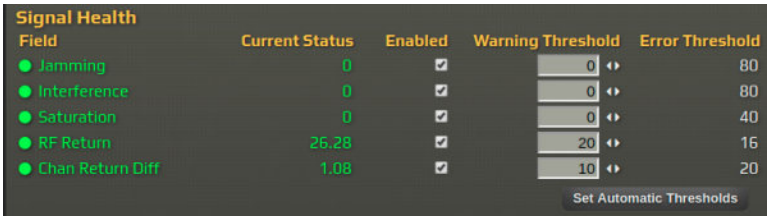
- Yaw: +/- 6°
- Pitch:+/- 6°
- Roll: +/- 6°





If the *Enabled* box is checked and the difference between the *Current Status* and *Target Value* is greater than the *Warning Threshold*, a yellow warning messages will be displayed at the top of the page as shown below. A red error message will be displayed when the difference between the *Current Status* and the *Target Value* is greater than 15°, as shown below. These orientation monitors are helpful in identifying if the radar has moved from its original orientation.

Signal Health



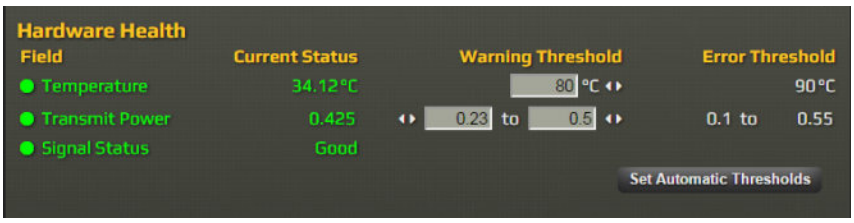
This section provides feedback on the performance of the radar. The *Warning Threshold* values set for jamming, interference, and saturation can vary based on the environment as well as the required detection range. For open environments with minimal saturation set the *Warning Threshold* for *Jamming* to 20, *Interference* to 40, and *Saturation* to 25. If a warning is generated after the appropriate thresholds have been set, something has changed in the environment that is adversely affecting the performance of the radar. The likely cause of a saturation warning is a vehicle or new structure that has been placed directly in front of the radar. The likely cause of an interference or jamming warning is another device in the vicinity that is transmitting at the same frequency. If any of these warnings occur see sections 5.0 and 6.0 to resolve the problem. Increase the *Warning Threshold* if warnings persist during normal operation where performance isn't reduced.

RF Return is dependent on the transmit power which varies between units as well as between environments. The more energy reflected back to the radar the higher the RF return will be; a radar pointed directly up into the air will have a very low RF return, while one pointed directly at the ground will have a high RF return. The expected RF return variation is +/- 5 for low traffic environments. High traffic environments, like roadways, may have greater variation.

If the *RF Return* drops and the environment hasn't significantly changed, the radar may experience a decrease in detection performance resulting in the need to be serviced. It is a good rule of thumb to set the *Warning Threshold* to a value of 15 below the *Current Status*. If warnings are occurring frequently and the radar is still reliably detecting targets, then the *Warning Threshold* should be decreased.

The *Chan Return Diff* is the difference between RF receive channels. The further away this value is from zero, the less accurate tracks will be. It's typically lower than 3, and should almost always be lower than 5. Some possible causes of a persistent high channel return difference include a bad RF channel, poor location, or hardware issues.

Hardware Health



Temperature reflects the internal temperature of the radar. A warning threshold of 80° C is recommended. If the temperature reaches higher than 80°C it is recommended to deploy a sun shield or other means of cooling the radar. If the temperature reaches above 90° C the radar is in danger of heat related failure.

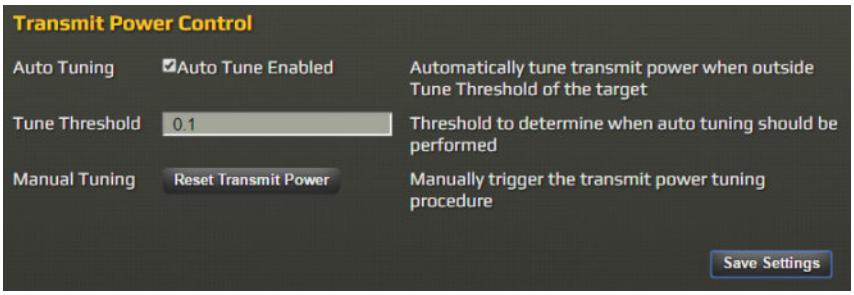
Transmit Power, Signal Status, and the Transmit Power Control section that are detailed in the following

paragraphs, only apply to radar model versions A and B.

Transmit Power, like RF return, varies from unit to unit, but unlike RF return, does not vary based on reflected signal. Low transmit power is an indicator of poor detection performance. A good rule of thumb is to set the lower *Warning Threshold* to 0.2 watts below the *Current Status* and the upper threshold to 0.8 watts above the *Current Status*.

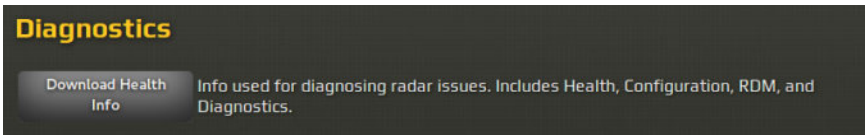
Transmit Power Control

Check the **Auto Tuning Enabled** box to auto tune the *Transmit Power* when the Transmit Power falls outside the *Tune Threshold*. If the Transmit Power drops too low, it can be returned manually by clicking the **Reset Transmit Power** button.



Diagnostics

Current health status parameters and diagnostic information can be downloaded in this section.



Select the **Download Health Info** button to download a zip folder that includes the following 123 files:

- 60 snapshots (1 every second for 60 seconds) of all the health parameters shown on the health page in a .json format that can be viewed using notepad.
- 60 snapshots (1 every second for 60 seconds) of the RDM
- 1 JSON file with all the current settings of the radar
- 1 JSON file of all the current subscriptions on the outputs page of the radar
- software diagnostic in a .bin format that can be used by SpotterRF Software Engineers to determine existing software related issues.

Security Page

The Security page is only available to the admin user. In order to view the security features an admin account must be set up and the admin must be logged in and the **Security** tab will become visible

Enabling/Disabling http connections

To ensure that all HTTP web page traffic is encrypted the Admin user should choose to disable http connections. If they choose to disable HTTP then only HTTPS connections are allowed. One should make this change when they are accessing the unit on https to ensure their work station has the right TLS configuration deemed secure enough to connect to the spotter. Also if you are modifying the TLS ciphers it is recommended to set http enabled until you verify you can access the spotter on https as desired.

Enabling/Disabling SSH connections

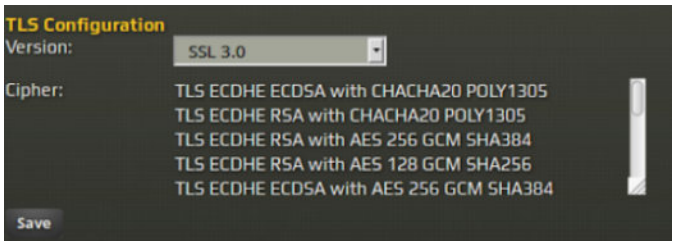
For additional security the Admin should disable SSH connections. These connections are only used by the manufacturer with the consent of the unit's Admin to debug issues in the field. The Admin should only reenable the SSH connection when authorized debugging is taking place and then disable the SSH after debugging is complete.

Enabling/Disabling Password Reset

For the utmost security the Admin may disable the password reset capability. If the password reset has been disabled there is no way that anyone can recover or reset a Spotter in the field. If the Admin password is lost then the Spotter will have to be returned to SpotterRF and the memory replaced (there is an additional cost for this service).

TLS configuration

For encrypted connections using https, select the desired minimum version of TLS that connections will use (default is TLS 1.2). Also, it can be specified which ciphers will be accepted. By default, no ciphers are selected which means that all ciphers are accepted.



TLS Certificate Authentication

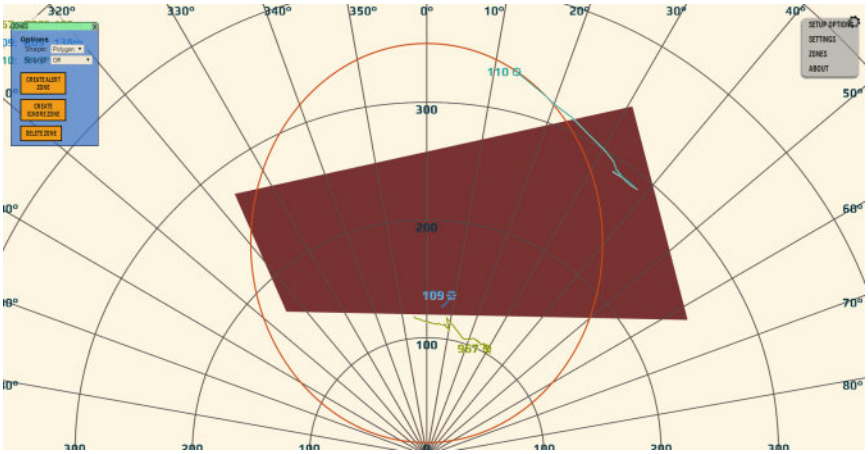
Users can upload their own public and private keys for certificate authentication with a private protected password. Both of the keys must be uploaded at the same time with accompanying password and be a valid key pair; otherwise, a self signed certificate (key pair) from SpotterRF will be generated and overwrite the keys. The private key will not display after saving and will not be accessible to users.

It is recommended to copy and paste the keys because the "enter" button inside the text box saves changes. Hit **Shift + Enter** to insert a new line in the text box. The size of the text boxes can be adjusted by clicking and dragging the lower right hand corner of the text box.

802.1X

Users can enable 801.1X authentication by using the same TLS certificate that is used for HTTPS with an optional private-key password. The radar does not support every type of key pair, so it is recommended to contact support with any issues with enabling 802.1X.

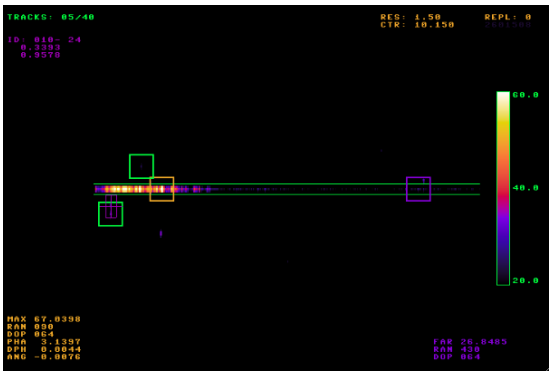
Tracker Page



Open this page to view radar detections on a web UI based tracker display, create alert zones, change the display of the targets, as well as view the RDM (Range Doppler Matrix). To create an alert zone click the gear icon in the top right corner and click on **Zones**. A pop out window will appear. Select the desired *Shape* and *Sound* from the drop down lists, then select either **Create Alert Zone** or **Create Ignore Zone**. Ignore zones mask any targets detected within the zone. To create a *Box* zone simply left click and drag. To create a *Polygon* zone left click around the perimeter of the desired area then click back on the first point to complete the zone. Alert zones will be red and ignore zones will be gray. To delete a zone click on **Delete Zone** button then click on the zone.

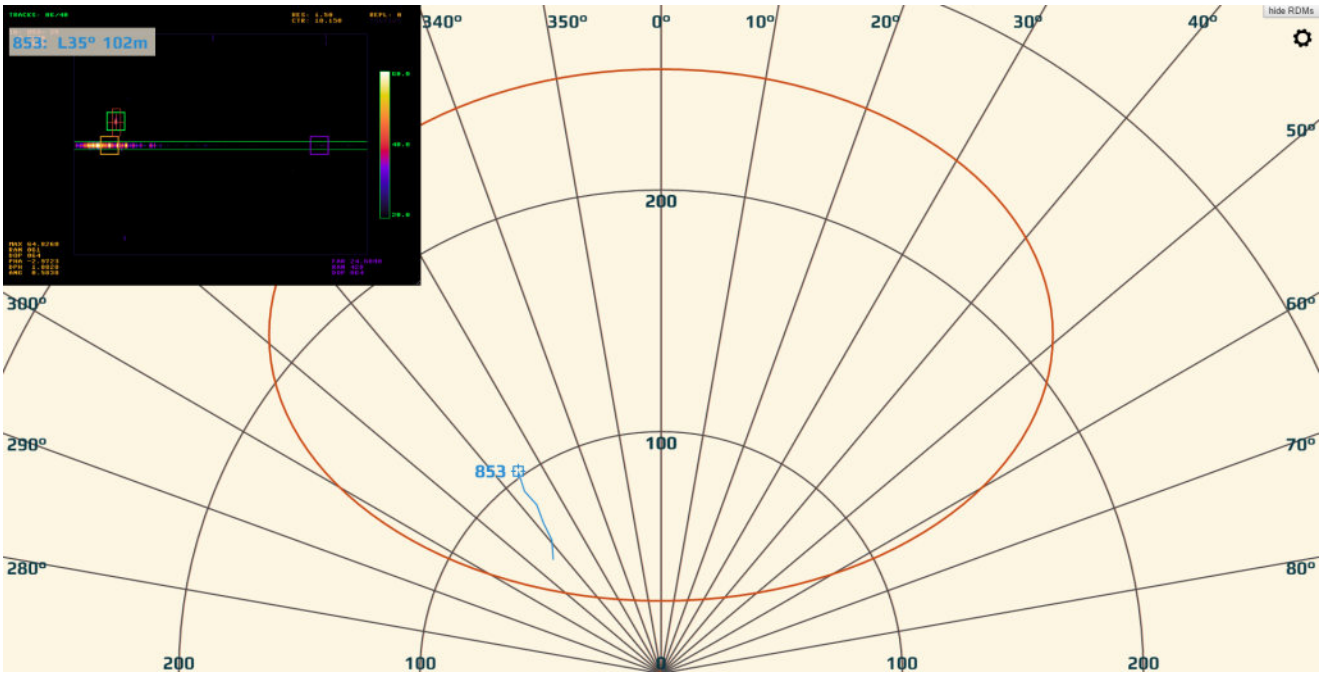
Note: The zones are native to the UI of the user's PC ONLY and are not saved on the unit itself or displayed on other devices.

RDM



The Range Doppler Matrix, or RDM, displays the low level view of what the radar sees and provides detail on the range and power levels. The image automatically refreshes multiple times per second. The vertical axis of the graph is velocity, and the horizontal axis is range. There are 512 range bins. Each bin corresponds to 1 to 3.75 meters depending on the range resolution of the radar. The latest C20s are 1.5 meter resolution units which means the max detection range is 768 meters (512 bins x 1.5 meter). CK units do not utilize all the range bins and will have smaller max distances. For 3 meter resolution models like the C40 and C550, the max detection range is 1536 meters (512 bins x 3 meter).

To view the RDM, go to the Tracker tab and click **show RDMs** in the top right corner; the RDM will open in the top left corner. The *show RDMs* button will then change to *hide RDMs*. Click **hide RDMs** to stop showing the RDM. The RDM will disappear after being idle for two and a half minutes in order to conserve processing resources. Click and drag the RDM window to move. Resize it by clicking and dragging the bottom right corner. The RDM can also be viewed by typing `/rdm` after the IP address of the radar in the web browser. For example, if a radar is being accessed from the default IP address type 169.254.254.254/rdm.

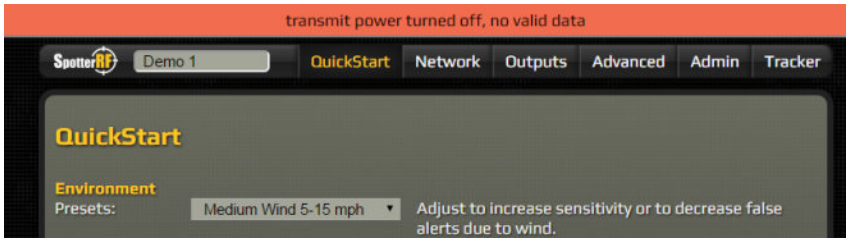


Upgrading Firmware

The firmware version is displayed at the bottom of every page except the tracker page. The latest firmware can be accessed from the spotterRF.com web site under technical support. To upgrade, either click the **Drop or Click to Upgrade** button at the bottom of the page and navigate to the proper .bin file or drag and drop the appropriate file over the **Drop or Click to Upgrade** button. A countdown timer will appear. Upgrades may not always work the first attempt. Power cycle in between attempts for best results. If the firmware version did not change, try refreshing and clearing the browser's cache. If the hardware is supported, downgrades to previous versions (after 3.8) are possible but not recommended. The upgrade will not be possible if the hardware isn't supported.

Banner Notifications

Banner notifications will appear at the top of all pages when there are performance issues that need attention.



Notifications include:

Transmit power turned off, no valid data: The *Data Source* under the Advanced page is set to "blank" and the radar is not transmitting.

***Unit has no angular calibration*:** The tracks will likely be displayed in the wrong location relative to the radar. The radar should be returned to SpotterRF to complete the calibration.

***Sensor is being jammed*:** Another radar in the vicinity is transmitting on the same channel. Disable the other radar to resolve the issue.

Sensor is experiencing interference: See section 5.0

Sensor is saturated: See section 6.0

Low signal return: Detection performance will be low and the radar should be returned to SpotterRF for repair. In *v4.1 added a software fix that automatically fixes the error if is caused by a software problem*

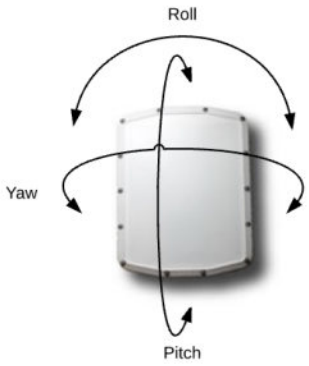
Sensor's temperature above threshold: The internal temperature of the radar is out of the recommended temperature operation range and could be subject to heat related failure.

Transmit power below/above threshold: Poor performance is likely. The radar should be returned to the SpotterRF for repair.

Pitch outside threshold: The radar has moved outside the warning threshold set on the health page.

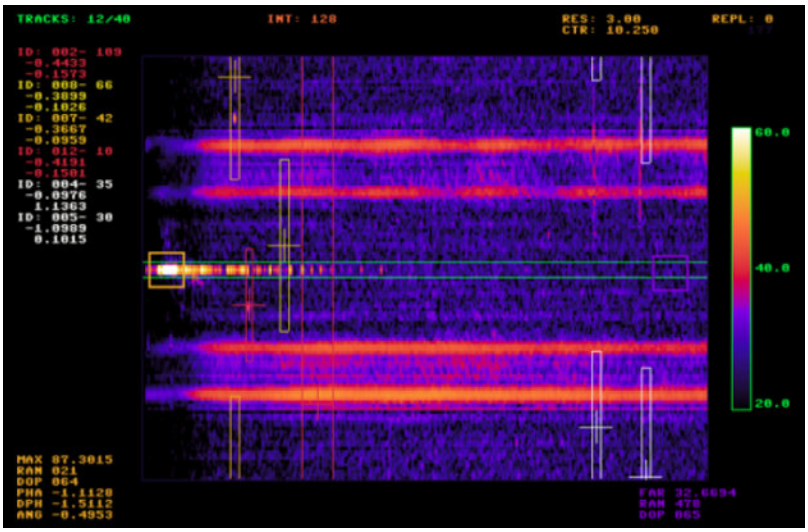
Yaw outside threshold: The radar has moved outside the warning threshold set on the health page.

Roll outside threshold: The radar has moved outside the warning threshold set on the health page.



Motor drive rotation is not within normal operating requirement: For spinning models 3D-500, 3D-250, 2D-500 and 2D-250. This indicates that the radar is not rotating at its required operation speed.

Eliminating Interference



Each radar is assigned an RF channel and calibrated for optimal performance at that RF channel. If two radars with the same RF Channels are placed in close proximity or are oriented towards each other, it is possible for them to experience interference. The radar will warn when this occurs by displaying a banner notification in the Web UI that reads *sensor is experiencing interference*.

If a radar is experiencing interference, the RDM will display long, horizontal, bright bands above and below the center band as illustrated in the RDM to the right.

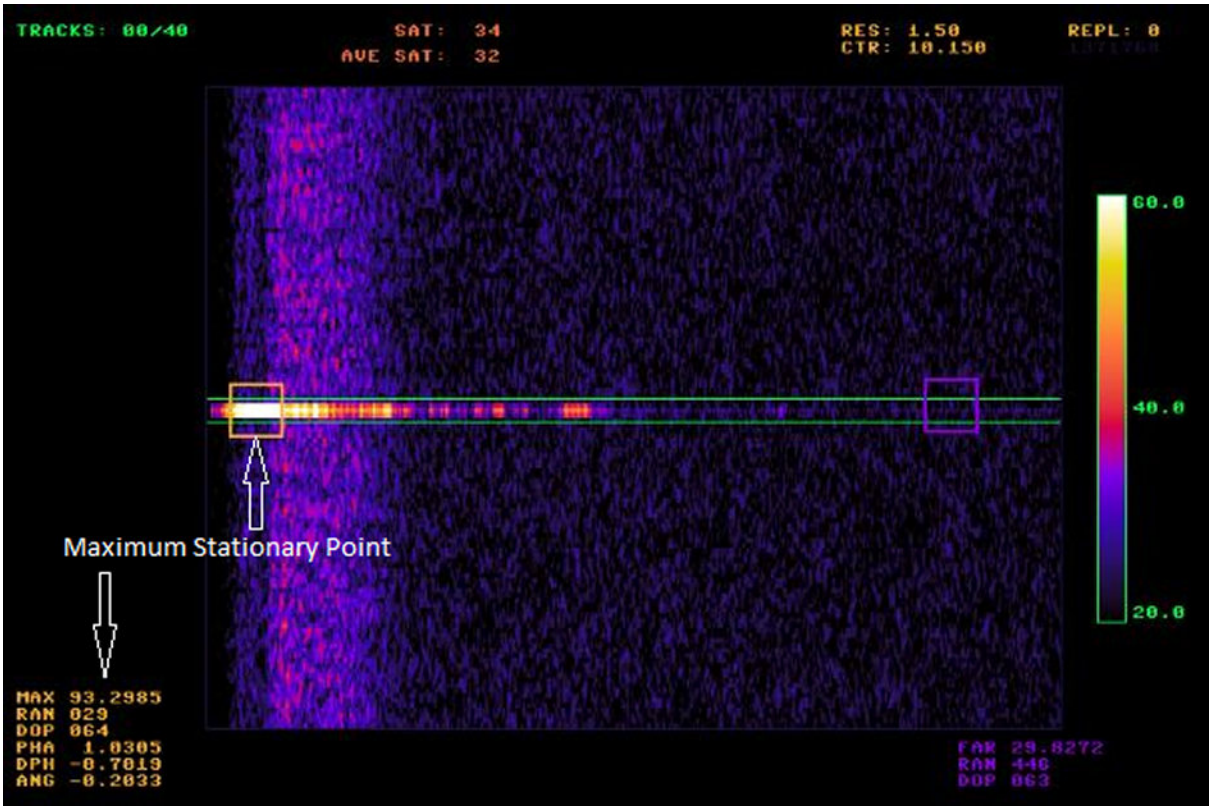
To resolve channel conflicts see section 3.1.

Reducing Saturation

Saturation is caused by too much energy being reflected off large objects in close proximity to the radar (<100m for objects the size of a building and <30m for objects the size of a vehicle). Saturation may cause a degradation in performance; however, in many situations the radar is able to function while experiencing saturation. Reduce saturation as much as possible using the techniques discussed in the following sections.

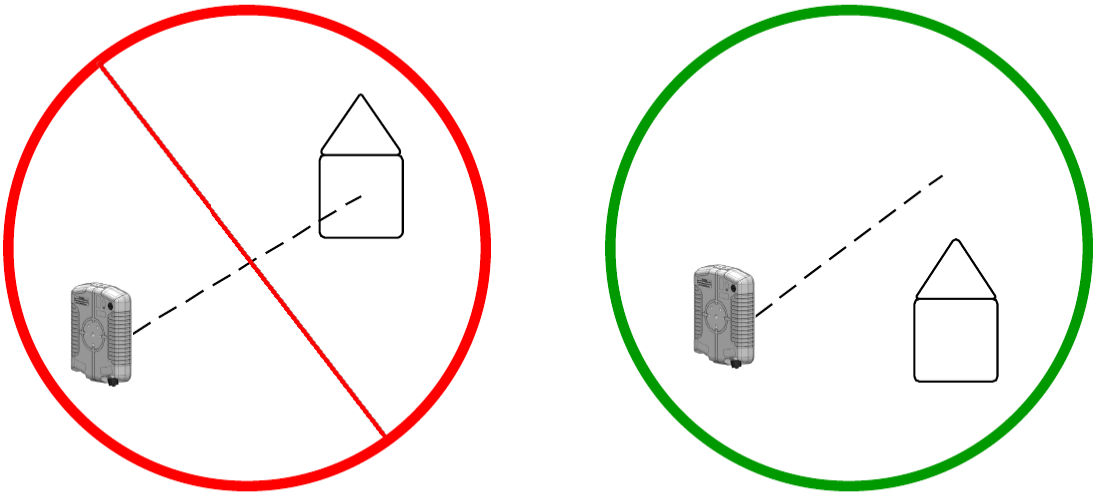
The amount of energy that is reflected back is dependent on the size and orientation of the target as well as the orientation of the radar. For example, a radar pointed directly at the side of a large building will receive considerable amounts of energy reflected off the building even at long ranges. This will cause saturation in the radar that corresponds to that range making it more difficult to detect threats at that range. A banner notification will appear at the top of the page when saturation is occurring.

Saturation is occurring in the RDM shown below. At the top center of the RDM the label *SAT: 34* appears indicating a saturation level of 34. This corresponds to the brightest stationary object which is labeled in the image as *Maximum Stationary Point*. The bottom left corner displays key information for that point such as an amplitude of 93 dB at range bin 029. This particular radar has a range resolution of 1.5 meters; so, that would put the brightest stationary object at 43.5 meters from the radar (29x1.5).

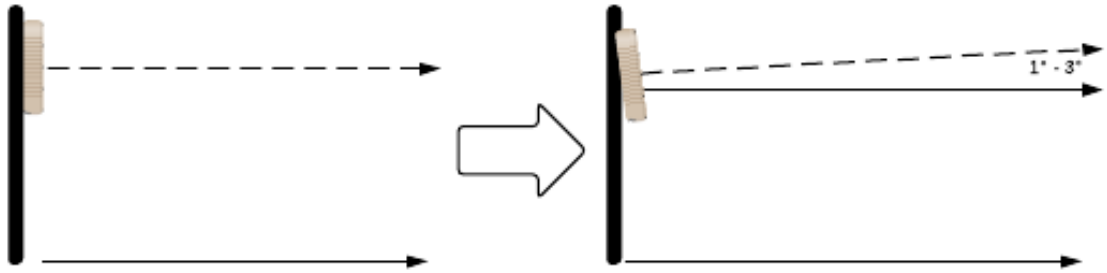


In order to reduce the saturation caused by this and other bright reflective objects, follow the steps below:

1. Change the angle of the CSR so its face is not perpendicular to any flat surfaces of the objects causing the saturation (e.g., if it's pointed directly at a building, turn it away from the building)



2. Tilt the radar up so it is pointing slightly above the horizon. This is helpful if the radar is picking up too much ground return when it is mounted at a high elevation.



3. Change the installation point of the CSR so that it is farther away from the large object.
4. If the saturation is caused by vehicles, mount the CSR up higher to look over the vehicles.
5. For more congested areas, use a C20 that transmits less power and is less susceptible to saturation.

Calibrating the Radar

Calibrate the radar after it has been installed and after saturation and interference have been reduced. Calibration is only required when using a map overlay. The goal is to display targets on the map overlay as closely as possible to their actual location. Use NIO to calibrate radars whenever possible. Follow the instructions in the on-line NIO Reference Guide and in this Video How To: Align radar tracks to a Map

Authority	Initials	Date
Author		
Software Manager		
FAE Manager		
Released		