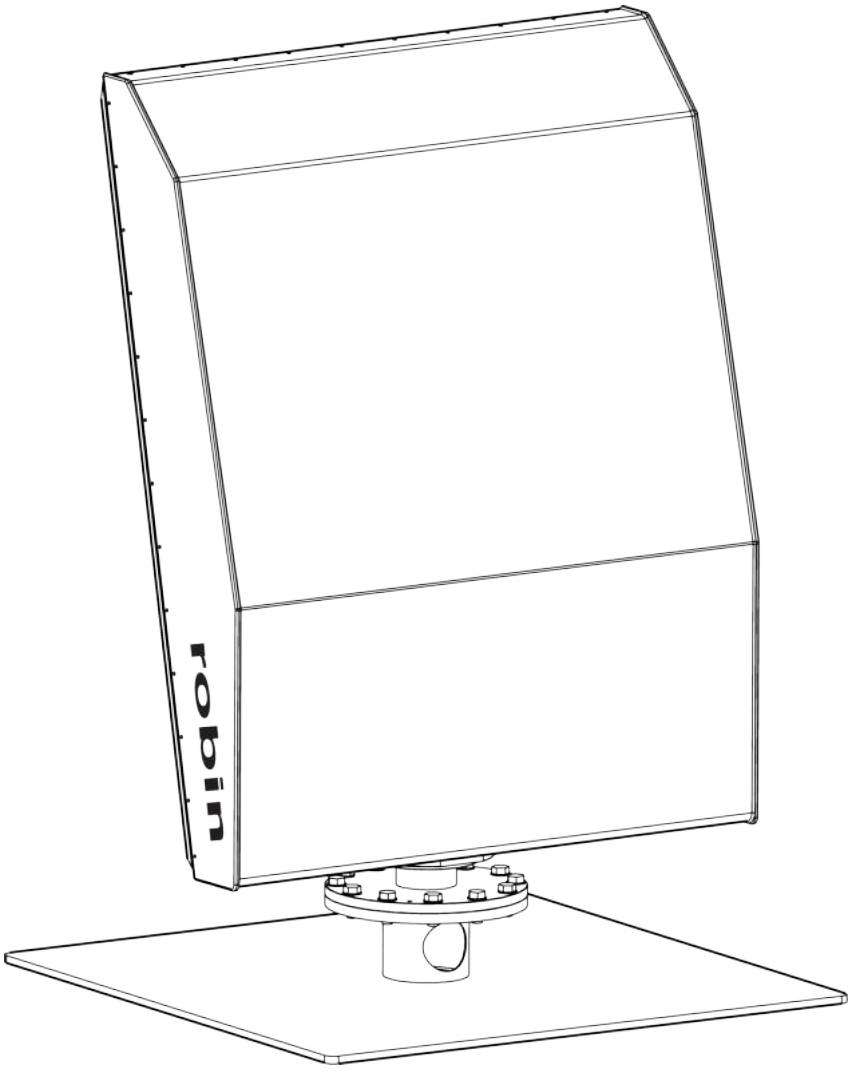
MAX

User Manual (U.S. / Canada)



371.927.008 / VERSION A / FOR SOFTWARE RELEASE 22.07 AND A3 HARDWARE

robin
radar systems

RRS INTERNAL

Disclaimer

This document has been written with great care and attention, however Robin Radar Systems B.V. shall not be liable for any damage or loss of any kind, including but not limited to direct, indirect, incidental or consequential damages, caused by the use of this document. This disclaimer does not apply in case of willful misconduct or gross negligence by Robin. Robin provides, with respect to its products, the warranties described in the relevant product documentation only. Every use and purchase of products from Robin are subject to our General Terms & Conditions which can be found on our website: robinradar.com.
Robin reserves the right to alter the content of all applicable documents, including this disclaimer, in any way and at any time and for any reason without prior notification. Robin will not be liable in any way possible for any consequences of such changes.

Data Classification RRS Internal

This document is strictly accessible to internal company personnel and internal employees or clients who are granted access, and have signed a non-disclosure agreement.

Intellectual Property

Liability and Warranty

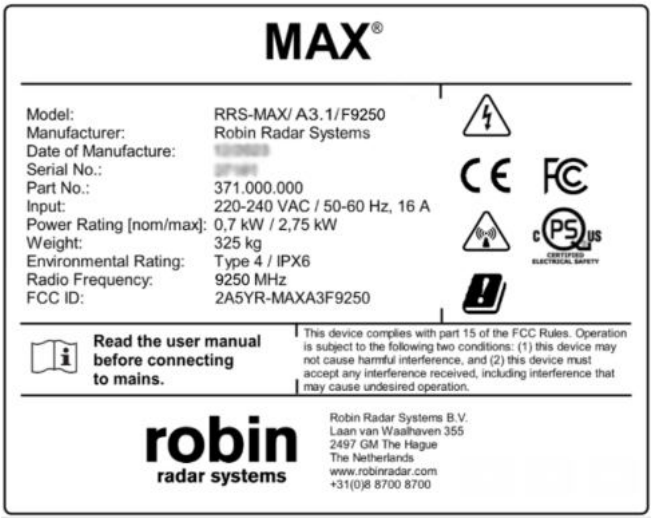
If the radar system supplied/delivered by Robin does not suit a specific purpose that readers of this document, users and operators may have agreed upon the order for delivery, Robin and the system's manufacturers are not to be held responsible. Robin and the manufacturers of the radar system are not responsible that the radar system delivered or supplied by Robin suits the specific purpose that readers, users or operators of this document might have had with the order for delivery. All liability for the (consequences of mis-) use of the radar system by readers, users and operators is excluded. Warranties shall be null and void in the event of

improper installation or operation of the radar system. The "General Terms & Conditions" of Robin apply at all times and in any situation.

Warning Statements Regarding FCC rules

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. Changes or modifications not expressly approved by Robin Radar Systems B.V., could void the user's authority to operate the equipment. Any digital equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.

FCC ID: 2A5YR-MAXA3F9250



Type plate example

Safety Instructions

It is your own responsibility to read and comprehend the full document and other applicable documentation prior to using the radar system, and to follow all safety instructions. Please contact Robin for assistance or clarification in the event that the text of this document is not completely understood or comprehended. Robin does not accept any responsibility or liability for your misunderstanding of the information in this document. To the best of Robin's knowledge, the content of this document is complete, however, Robin does not guarantee the completeness of the content of this document.

Save these instructions for future reference.

Safety Symbols

Indicates a hazardous situation that can result in death or serious injury, if not avoided. May also result in property damage.

Indicates a hazardous situation that can result in minor or moderate injury, if not avoided. May also result in property damage.

States company policy directly or indirectly related to safety of personnel or protection of property or information that is especially significant in understanding the product.

1. **Electrical Safety**
   a. **Connect the radar system to protective earth prior to testing, commissioning or regular operation.** Risk of electric shock, fire or serious injury.
   b. **The radar requires the mains supply to be externally fused using a 16 A fuse.** Risk of electric shock, fire or serious injury.
   c. **The mains voltage of the power source must correspond with the specifications of the rating plate of the breakout box.** Unauthorized voltage can cause damage to the radar system.
   d. **Do not hot plug the interconnect cable. Always disconnect from mains power source when connecting or disconnecting the interconnect cable.** Arc flash and shock hazard.
2. **Work Area Safety**
   a. In accordance with ICNIRP GUIDELINES 2020: **Never expose yourself to the transmitting energy within the advised safety distance of 2.64 m / 8.7 ft for more than six minutes while the radar is in operation.** RF radiation hazard.
   b. **Keep clear from rotating radar.** Rotating parts can cause severe injury or death.
3. **Service**
   a. **Do not open the radar, any part of the processing station or the breakout box.** Risk of electric shock, fire or serious injury. All service must be made by a Robin Radar qualified service agent.Removing the radome or servicing any part of the radar system will void the warranty.

1. **Lifting and Hoisting**
   a. **Never lift the radar by the radome. Always use the supplied lifting bar**. The radome can easily be damaged.
   b. **Never touch the de-humidifier at the bottom side of the radar.** The membrane of the de-humidifier can easily be damaged.
   c. **Always use the lifting bar and hoisting equipment when lifting or lowering the radar.** Risk of injury.
   d. **Remove the pedestal prior to lifting the radar.** The bearings can easily be damaged.
   e. **Remove lifting bar after hoisting is completed.** Failure to follow this instruction will cause damage the radar system or platform.
2. **Commissioning**
   a. **Unauthorised frequency. To safely operate the radar system, permit conditions must be met.** The frequency allocation must be in accordance with the specifications of the rating plate of the radar.
   b. **Protect the breakout box and processing station against heat, e.g., against continuous intense sunlight, water and moisture.** Danger of explosion.
   c. **Do not top load radar. The upper side of the sensor must never be obstructed or covered nor should vertical load be applied.** Failure to follow this instruction can cause damage to the radar system.
   d. **Do not bend cables when temperatures are below -10 °C / 14 °F or above 70 °C / 158 °F.** Failure to follow this instruction can cause damage to cables.
   e. **Do not bend cables beyond the 20 cm / 8" minimum bend radius.** Failure to follow this instruction can generate interference or cause damage to cables.
   f. **Remove the transport bracket prior to commissioning.** Failure to follow this instruction will cause damage the radar system or platform.
3. **Maintenance**
   a. **Disconnect from mains power source prior to maintenance.** Failure to follow this instruction may result in death or serious injury.
   b. **Use covers to seal and protect connectors from harsh environments when disconnected.** Connectors can easily be damaged.
   c. **Maintenance must be made by a Robin Radar qualified service agent whenever the radar, breakout box or processing station need to be opened.** Failure to follow this instruction will void the warranty.
   d. **Check cables and connectors regularly. Check for breakage of parts and any other conditions that may affect radar operation. If damaged, repair before use.**
   e. **Clean radome regularly. Only use a soft damp cloth with warm water and mild soap.** Dust, dirt, grime, stickers and glue will reflect RF signal and negatively impact the performance of the radar.

1. **Transport**

   Bear in mind that this is delicate, electronic equipment, and thus has to be treated carefully. Any damage caused by failure to follow these instructions will relieve Robin Radar Systems of the responsibility for consequential damage to the equipment.

   a. **Disconnect all electronic connections prior to transport and use covers to protect connectors.**
   b. **Secure mount the transport bracket prior to transportation.** Failure to follow this instruction will cause damage the radar system.
   c. **All equipment is packed in the original packing material (or equivalent) prior to transport/shipping of goods.**
   d. **All goods shall be shipped in an upright position, no more than 2 crates in height. No other crates/boxes/materials shall be shipped on top of the goods.**
   e. **Check the contents of the crate/box against the packing list located inside and/or outside the crate/box. If there are any items missing, immediately inform the responsible Site Supervisor and/or Robin Radar Systems.**
   f. **All goods shall be securely braced during shipment.**

2. **Storage**

   a. **Disconnect all electronic connections prior to storage and use covers to protect connectors.** Connectors can easily be damaged.
   b. **Store the radar system in a secure area within a temperature range of 5 °C...50 °C / 41 °F...122 °F and a relative humidity of < 80 % at 40 °C / 104 °F.** Condensation under fluctuating storage temperatures may cause damage to the radar system.
   c. **Avoid the risk of damaging the radar system by weather, dust, dirt and grime.**

Contents

Disclaimer **ii**
Data Classification RRS Internal ii
Intellectual Property ii
Liability and Warranty ii
Warning Statements Regarding FCC rules iii
Safety Instructions **iv**

1. Read Before First Use **10**

2. About MAX **11**
2.1. Device Description 12
2.1.1. MAX 13
2.1.2. Interconnect Cable 14
2.1.3. Processing Station 14
2.1.4. ADS-B Receiver 19

3. Transport and Lifting Instructions **20**
3.1. Transport 20
3.2. Hoisting and Lifting 21

4. Installation **22**
4.1. Overview 22
4.2. Site Selection 23
4.3. Set Up MAX 24
4.3.1. Grounding 25
4.3.2. Lightning Protection 26
4.3.3. Power Supply 26
4.4. Set Up Processing Station 26
4.5. Set Up Weather Station 27
4.5.1. Installation of the Weather Station 27
4.5.2. Weather Station Cable 28
4.6. Connect Interconnect Cable to Radar 30
4.7. Connect Interconnect Cable to Breakout Box 32
4.8. Network Connection 32

5. Startup **33**
5.1. Final Checks 33
5.2. Power On 34

6. Operation **35**
6.1. Remote Monitor 35
6.1.1. Remote Monitor Quick Guide 35
6.2. Bird Viewer Quick Start 37
6.3. Robin Configurator 42

7. Shutdown **43**
7.1. Shutdown with Maintenance Switch 44

8. Effects on Performance **45**
8.1. Radar Principles 45
8.2. What Affects Radar Performance? 45

9. Maintenance and Service Instructions **48**
9.1. Maintenance Switch 48
9.1.1. Activate Maintenance Switch 48
9.1.2. Emergency Stop 48
9.2. Maintenance Schedule 49
9.3. Spare Parts 51
9.4. Disposal 51

10. Technical Specifications **52**
10.1. MAX Specifications U.S./Canada 52
10.2. Processing Station Specifications 56
10.3. Dimensions 58

11. Declaration of Conformity **59**

12. Appendix **62**
12.1. Test Description for Remote Monitor 62
12.1.1. MAX Sensor 62
12.1.2. MAX Registration System 63
12.1.3. MAX Radar Software 65
12.1.4. Bird Monitor Hardware 67
12.1.5. UPS 72
12.1.6. Weather Station 74
12.1.7. Database/LTS DB 75
12.1.8. DbManagement/LTS DbManagement 77
12.1.9. Internet 78
12.1.10. Router 79
12.1.11. RM Service 80

12.1.12. Replication 81
12.2. Quick Guide for MAX on Trailer 81
12.2.1. Setup trailer / radar 81
12.2.2. Apply power to system 84
12.2.3. Start application 85
12.2.4. Trailer Transport Preparation 87
12.3. Quick Guide for MAX Radar Software 87
12.3.1. Start and Stop MAX Software 87
12.3.2. Start Graphical Mode 88
12.3.3. Graphical User Interface 88
12.4. Integration with External Systems 91
12.4.1. Introduction 91
12.4.2. Real-Time Broadcast Interface 92
12.5. Track Classification 98
12.5.1. Track Processing 98
12.5.2. Track Classification 100
12.5.3. Change SA_MAX.config File 100
12.6. Measuring Principle 102
12.6.1. Functions 104
12.7. Abbreviations 106

1. Read Before First Use

It is recommended to read the following documents before using MAX:

- MAX User Manual
- Bird Viewer User Manual
- Robin Configurator User Manual
- Mobile Viewer User Manual
- Robin Database Description

2. About MAX

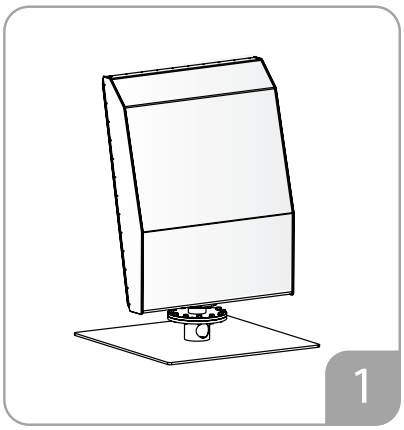
MAX® 3D Bird Radar has the fastest rotation speed in the market, resulting in track updates every second. This allows uniquely detailed 3D visualisation of bird flight paths, including exports to Google Earth.

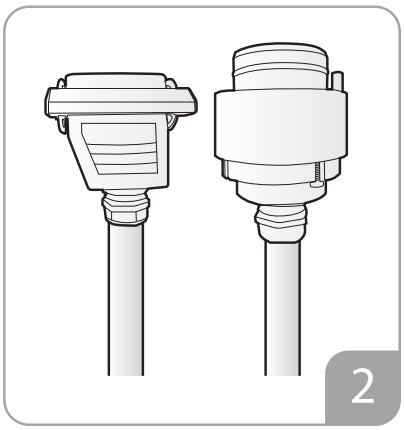
MAX is a single sensor system, providing full 3D information of all birds in the nearby environment. Height information is provided for all bird tracks, and offers full 3D coverage from the horizon, up to at least 1km height.

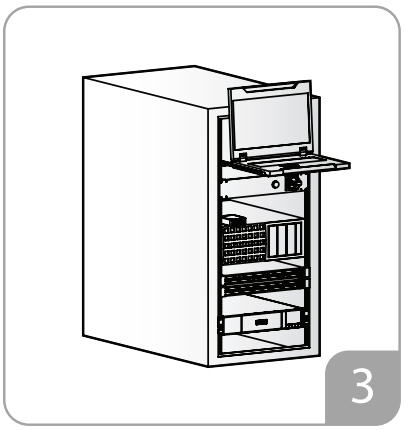
MAX has been built to monitor birds from the start. That's its entire purpose. The antennas are designed explicitly with avian targets in mind. It finally brings phased array radar technology into the hands of bird control units and ornithologists. Bird movements are displayed in real-time on a computer or mobile device (both iOS and Android).

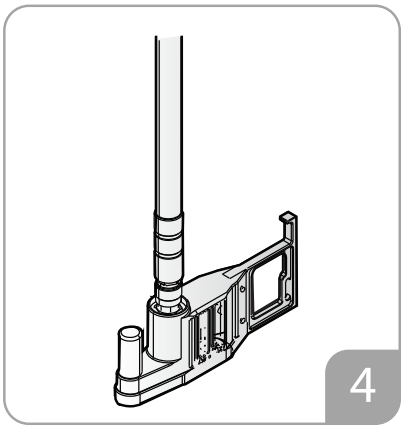
MAX has minimal infrastructure requirements. The computer servers can be placed in already existing server rooms, meaning no shelter or housing is required at the radar location itself. All MAX needs is standard power and ethernet.

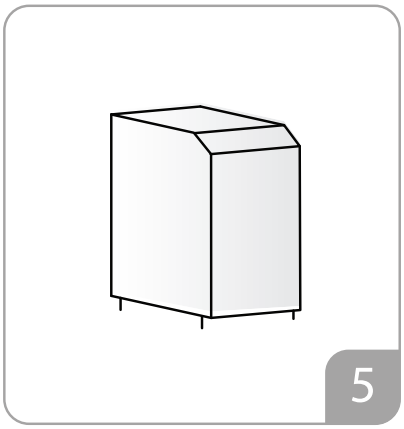
2.1. Device Description

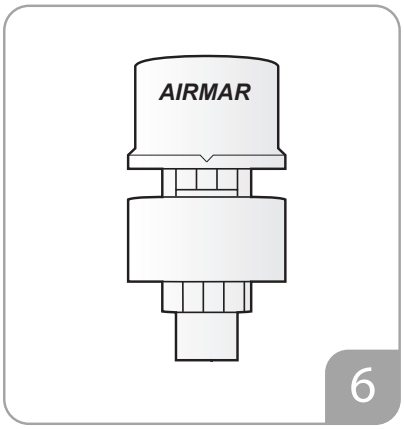

1


2

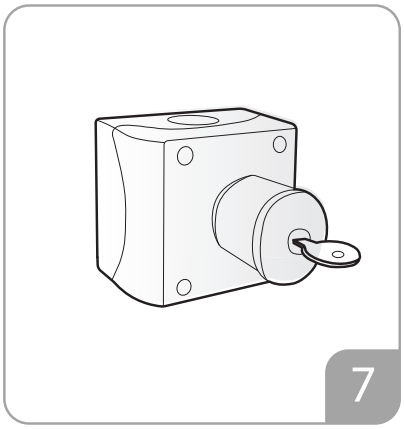

3

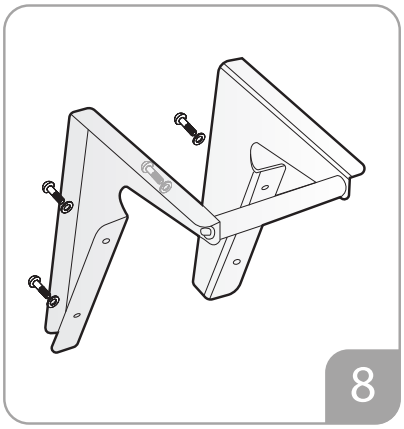

4

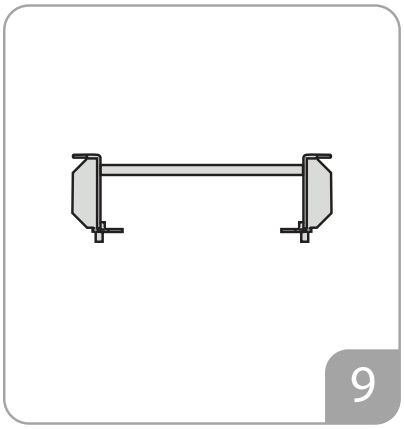

5

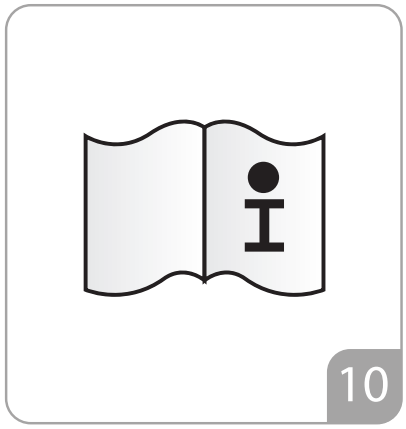


6


7


8


9


10

DESCRIPTION	
1	MAX
2	Interconnect cable
3	Processing station
4	ADS-B Receiver
5	Isolation transformer
6	Weather station
7	Maintenance switch
8	Lifting bar
9	Transport bracket
10	User manuals

2.1.1. MAX

MAX is a single sensor system, providing full 3D information of all birds in the nearby environment. Height information is provided for all bird tracks. The radar offers full 3D coverage from the horizon, up to several kilometers depending on target size.
The antennas are designed explicitly with avian targets in mind. Bird movements are displayed in real-time on a computer or mobile device (both iOS and Android).
MAX has minimal infrastructure requirements and can even be mounted as a mobile system. The computer servers can be placed in already existing server rooms, meaning no shelter or housing is required at the radar location itself.

2.1.2. Interconnect Cable

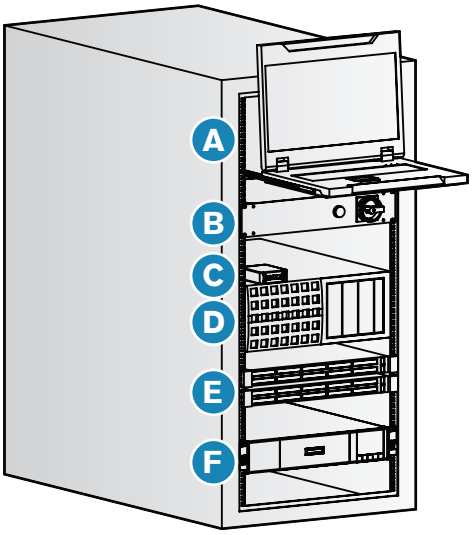
The interconnect cable supports data and power and connects MAX to the breakout box which is rack mounted inside the processing station. This cable can be provided in any length up to 15 meter / 50 feet (contact RRS for different cable length). On one side there is a lever locking connector which connects to the breakout box. The other side connect to the radar

WARNING	**Do not hot plug the interconnect cable. Always disconnect from mains power source when connecting or disconnecting the interconnect cable.** Arc flash and shock hazard.

2.1.3. Processing Station

The processing station is connected to the radar and has the following functions:

- Display with keyboard and mouse (A).
- Process radar images.
- Visualize radar data on a map.
- System configuration.
- (De-)activate the system.
- Process weather station data.
- Connect to third-party software to transmit track data.



DESCRIPTION	
A	Display with keyboard and mouse
B	Breakout box
C	Router/gateway
D	MAX® Server

DESCRIPTION	
E	MAX® STS and LTS Server
F	UPS (Uninterrupted Power Supply)

2.1.3.1. Configuration

In this configuration the processing station is installed within the proximity of the radar. The interconnect cable (standard length is 15 m / 50 ft) is routed via the breakout box, which is installed in the same system rack.

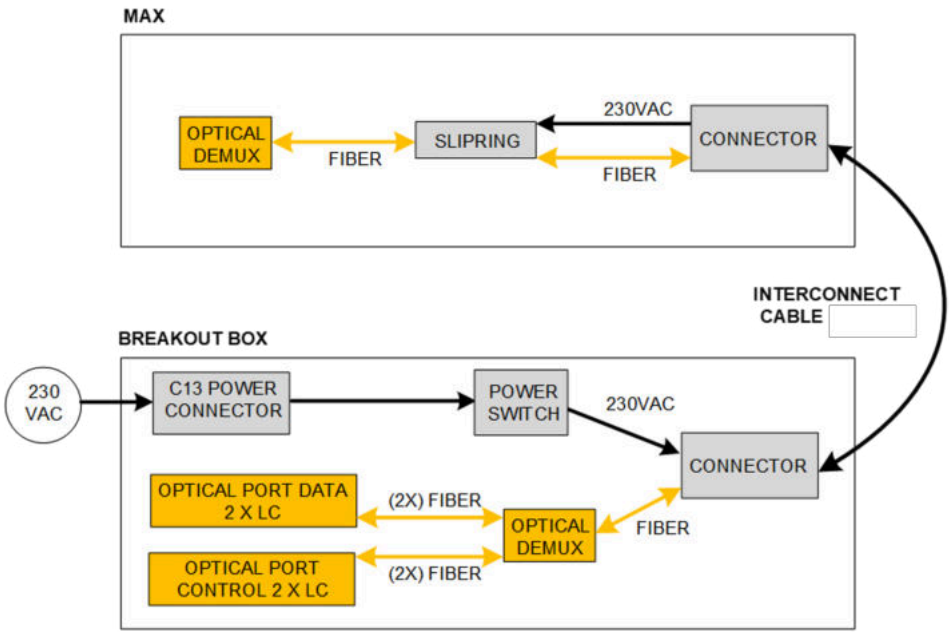


Figure 1: Configuration

2.1.3.2. Weather Station

The weather station provides the processing station with information about the temperature, humidity, wind speed and GPS coordinates. With this information the processing station can correct the measurements, for instance the speed of detected birds.
The weather station also functions as a independent time server. This enables the system to be synchronised to the UTC standard even without internet connection.

2.1.3.3. Isolation Transformer

MAX uses an isolation transformer to maintain equipment separation from a power source. The isolation transformer reduces power surges and ensures equipment can run smoothly.

2.1.3.4. Software

The processing station runs Ubuntu Linux as operating system. The MAX software is pre installed and configured on this processing station as a *Debian package.* This packaging system provides:

- Basic installation
- De-installation
- Installation dependencies
- Updates

The MAX software is part of the software suite that also contains the central tracking and processing software and various visualization tools required for a complete avian bird radar system.

Functional description

The MAX software has the following functions:

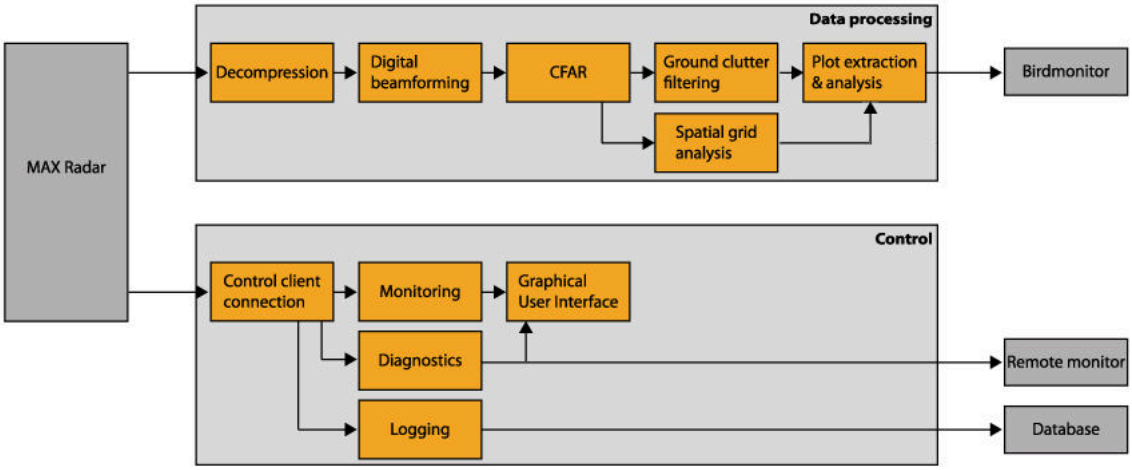


Figure 2: Software description

The upper block of Figure 2: Software description on page 16 represents all the high speed data processing of the raw radar data. The majority of this processing is done on the Graphical Processing Unit (GPU). Output of the data processing is basically a list of detected objects, so called plots. A plot consist of:

- a time
- 3D location
- accuracy
- size of the detection

Some intermediate results of the processing are available on the ‘outside’ of the software for configuration and diagnosis purposes.

Note	An accurate 3D location can only be given if the target is visible in at least two beams. Also read Measuring Principle on page 102.

The lower block of Figure 2: Software description on page 16 represents the control tasks in the software. This part of the software connects to the MAX radar processing module and motor controller in order to retrieve sensor information and to control the:

- motor
- RF signal
- digital signal processing
- etc

A summary of the system health is available in the Remote Monitor software. Relevant sensor values such as motor currents and temperatures are periodically saved to a database for inspection and for detection of regression. If errors occur, these messages are stored in the database.
Interfaces from and to the MAX radar and from and to the Bird Monitor are proprietary interfaces for third-party system integration. These interfaces may change in future revisions or updates without prior notice.

2.1.3.4.1. MAX Classification Drone Module

Description
A software module that can be added to any MAX with appropriate software version and Radar Server video card. The module classifies detections as drones based on radar reflection recognition. The module will not affect detection and/or tracking range. A track will be classified as drone when a minimum number of plots in the track are classified as drone.

System Requirements

- MAX-A1 or later
- MAX server with RTX2080 or RTX3080 video card
- Software version 21.07
- ADS-b functionality (strongly advised)

Specifications
The drone module does not influence detection ranges. However, it will add the classification DRONE to a detection (plot). When the percentage of DRONE classified plots passes a threshold, the corresponding track is fully classified as DRONE-track. The maximum range at which plots can be classified as DRONE is called the classification range. The detection range of a drone is much further than the classification range. Depending on the settings, this range can be higher or lower. The trade-off is the number of false alarms. In an aggressive setting, the classification range is higher, but so will be the number of false alarms. In a conservative setting, the classification range is lower but so will be the false

alarm rate. Standard a balanced setting is used as a trade-off between good classification range and low false alarm rate.

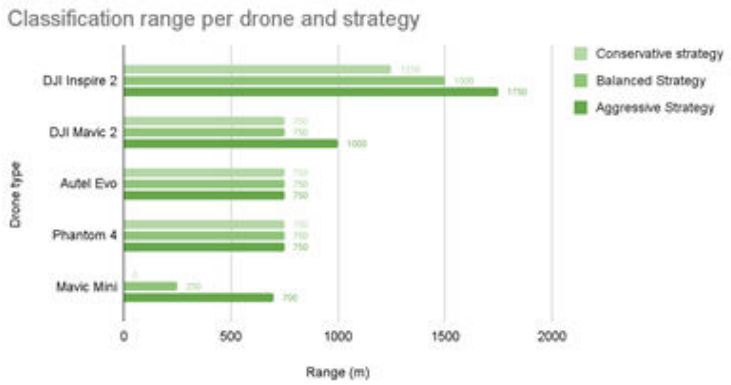


Figure 3: Classification ranges for different drone types as function of setting.

Table 1: Detection performance for different settings

	Conservative strategy	**Balanced strategy**	**Aggressive strategy**
% drone plots per track for drone classification	70%	55%	40%
% false alarms <2000m range	0.01%	0.05%	0.24%
% recall of drones <2000m range	50.15%	60.77%	68.73%
% recall of drones <1000m range	70.65%	81.6%	88.06%

The number of tracks per day MAX detects can be more than 1 million. With a false alarm rate of 0.05% this means 500 false alarms per day or on average 20 false alarms every hour. For a successful deployment of the drone module, the number of false alarms have to be reduced.
Decreasing the number of false alarms can be done in three ways. First, one can use a more conservative setting. This will lower the number of false alarms but also decrease the classification range. Secondly, one can use no classification areas. This works well if false alarms are located to a fixed region e.g. when caused by turbines. Lastly, using ADS-b all small planes that could lead to a drone alarm are classified as Aircraft.

2.1.4. ADS-B Receiver

The ADS-B receiver is an optional extra. MAX® 3D Bird Radar can be equipped with an ADS-B receiver: the uAvionix PingStation. ADS-B stands for ‘Automatic Dependent Surveillance-Broadcast’. ADS-B is a surveillance technology in which an aircraft determines its position via satellite navigation or other sensors and periodically broadcasts it, enabling it to be tracked.

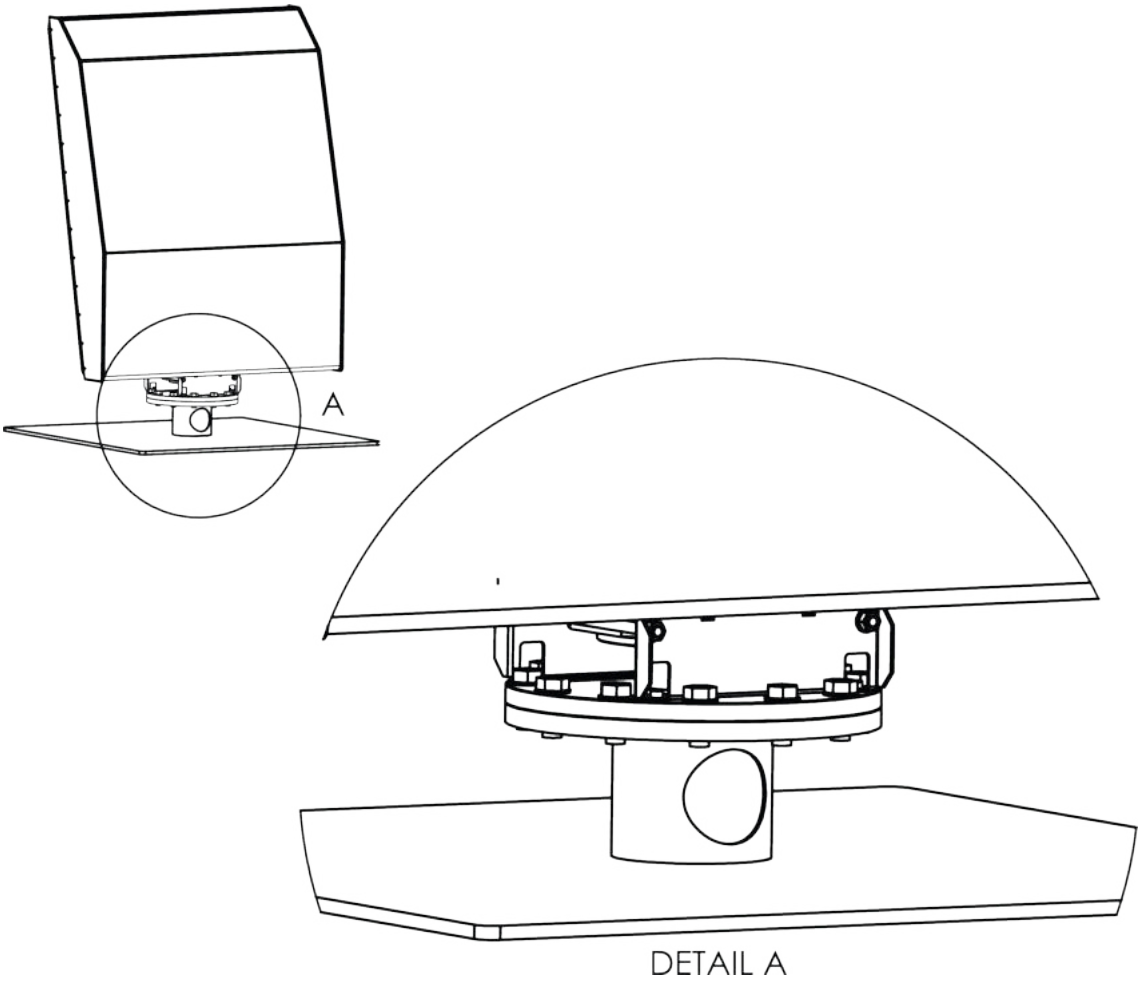
The ADS-B receiver is connected to the MAX server through a network connection. MAX can operate without the ADS-B receiver as well.

Bird Viewer uses the target information obtained through radar to depict the location and classification of the target. When ADS-B information from a target is also available, this information (such as call-sign) is appended to the radar data of the same target. When the drone is registered, the alarm will be deleted and marked as ‘no alarm’.

3. Transport and Lifting Instructions

3.1. Transport

A transport bracket is supplied to prevent rotation during transport. With the supplied bolts it must be mounted to the foot of the radar. Verify that the radar is locked and unable to rotate. Also read the instructions on transport.



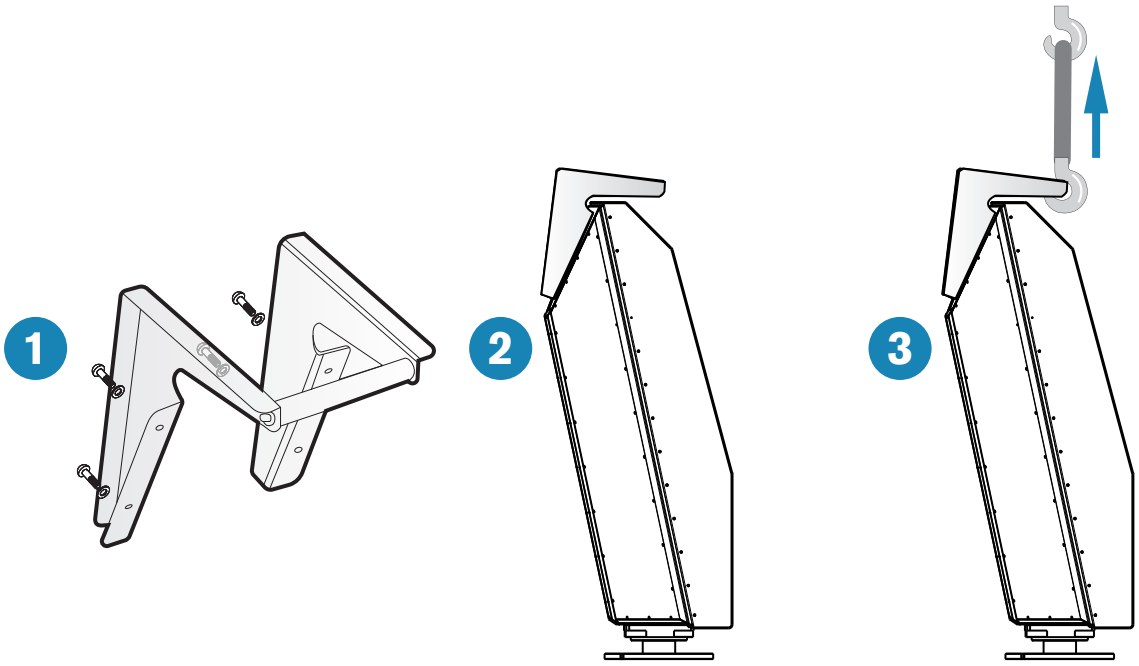
Assemble the transport bracket before secure mounting it to the foot of the radar. With one plate off, slide the bracket in place.

3.2. Hoisting and Lifting

MAX is supplied with a lifting bar and four M12 bolts. Always use the lifting bar and hoisting equipment when lifting or lowering the radar. Make sure that nothing is attached to the mounting flange.

STEPS

1. Install the lifting bar with four M12 bolts [1] to the four designated holes on the backside of MAX [2].
2. Attach hoisting belts or round sling to the lifting bar. Make sure the belt or sling is capable of handling the weight of MAX (325 kg / 715 lb).
3. If MAX is mounted on a pedestal make sure to remove all bolts from the mounting flange that secures the radar to the pedestal. Never hoist the radar when the pedestal is attached.
4. Hoist MAX [3].
5. When lowering, position the radar on top of the mounting flange. Make sure that the holes are aligned.



WARNING

1. **Use covers to seal and protect connectors from harsh environments when disconnected.** Connectors can easily be damaged.
2. **Do not hoist the radar when the pedestal is attached!** Make sure the pedestal has been removed prior to hoisting to avoid damage to the bearings.

4. Installation

4.1. Overview

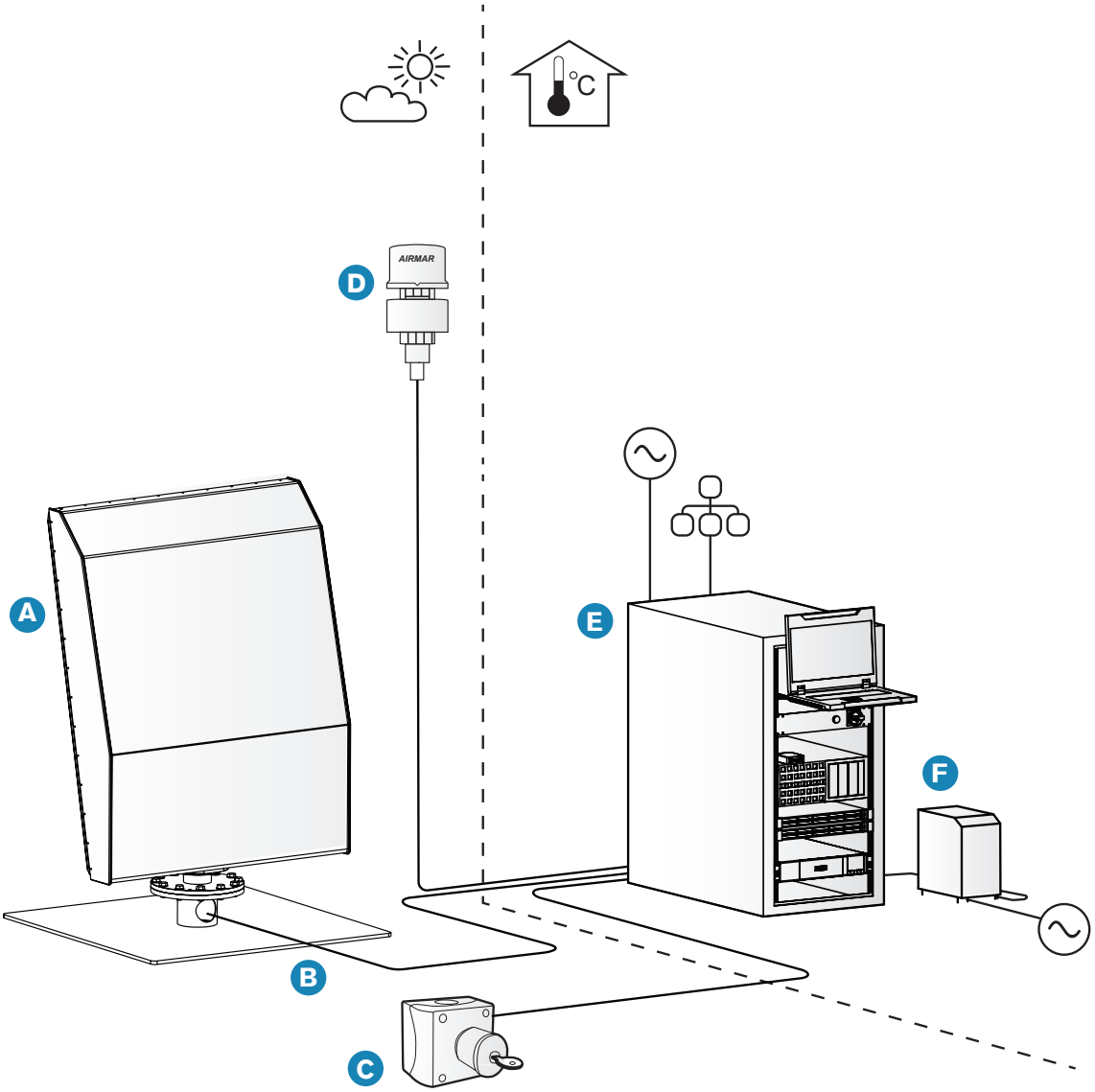


Figure 4: Standard configuration

POS	Description
A	MAX Radar
B	Interconnect cable
C	Maintenance switch
D	Weather station
E	Processing station
F	Isolation transformer[1]

[1] The isolation transformer is connected to mains power and the breakout box.

4.2. Site Selection

Follow the next steps/considerations when selecting a site:

STEPS

1. Solar loading needs to be factored in any time an enclosure will be subjected to direct sunlight. Solar radiation can easily overheat the sensor, causing a wide range of issues and negatively impact the performance. Heat and energy from the sun varies per location, month and period of the year.
2. Consider which areas must be monitored and which areas are nice to be monitored.
3. The radar unit needs a clear, unobstructed view of the area which needs to be monitored. Buildings or large reflecting surfaces degrade the radar performance.
4. If line-of-sight is blocked by small objects in an area, the detection performance in other directions (more than 10° horizontally) is not affected. If a clear line-of-sight in all directions is not achievable, select a location where the blocked directions are less important and focus on the primary region of interest.
5. Prevent interference on and from nearby equipment that operates on the same frequency as the radar system.
6. Make sure that the connector on the underside of the radar remains accessible for maintenance.
7. If the radar is installed several meters above the ground, then lower structures do not block the signal. Therefore, flat rooftops or radar towers are a common location for deployment.
8. Install the radar at least 3 meter / 10 feet from walkways, roads or highways to prevent detection errors.
9. Install the radar at least 5 meter / 17 feet from strong magnetic sources to avoid magnetic interference.
10. Verify that the surface can, and is allowed to support the weight of the radar, including all dynamic forces like wind or forces that exist during driving (when installed on a vehicle).

NOTICE

1. Also read Effects on Performance on page 45.
2. If accurate and detailed terrain elevation data is available (e.g. elevation data per square meter), you can ask Robin to calculate a coverage

diagram for one or more installation locations. This diagram provides an indication for areas that are obstructed for a given flight level.

4.3. Set Up MAX

MAX is fitted with a mounting flange to secure the radar to a pedestal, radar tower or any other suitable structure. Make sure that the structure has a load capacity of at least 450 kg / 990 lb and can withstand 3000 Nm of bending moment in any direction perpendicular to the mounting flange. Bending and torsion of the radar tower/mounting frame on existing structure should be minimised because it has a direct influence on the overall accuracy of the radar. Bending and torsion angles should be well below the measurement accuracy of 0.2° in azimuth and 0.25° in elevation. The suggested value is below 0.1° in both directions during normal wind conditions. Loss of some accuracy in high wind conditions may be acceptable, depending on the local situation.

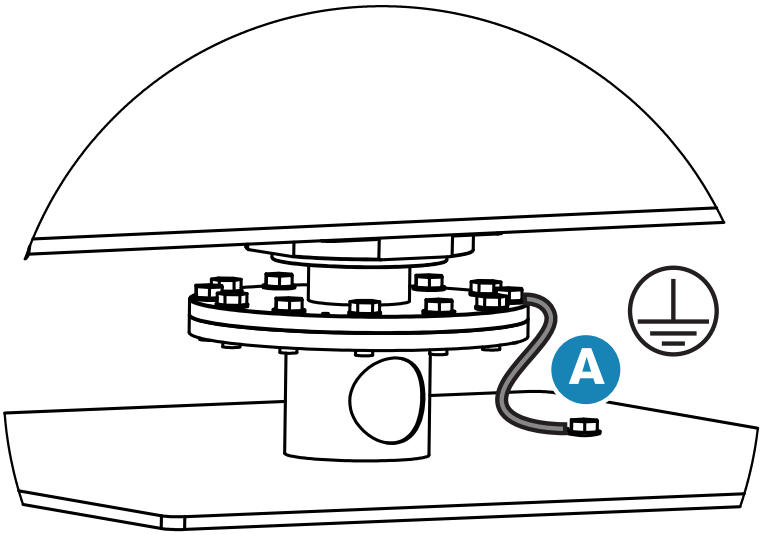
NOTICE

Make sure that the radar tower is stable and will not move beyond the accuracy specifications during (high) wind conditions.
Your failure to obey this instruction can result in a reduced accuracy.

4.3.1. Grounding

WARNING **HIGH LEAKAGE CURRENT!** Earth connection essential before connecting supply.

The radar is primarily grounded via the interconnect cable. For safety reasons, an extra protective earth cable of 10 mm^2 / 8 AWG with ring terminals must be connected on the flange of the radar [A]. Always measure the earth resistance to make sure that the grounding is sufficiently low. The value must be below 166 Ohm. If the radar is installed on a trailer, make sure that the trailer is grounded too.



NOTICE **RESPONSIBILITY OF USER**

1. A protective earth cable is not provided by Robin due to the wide variety of mounting options. Providing this cable is the full responsibility of the user.
2. Loosen one bolt on the flange to connect the ring terminal and tighten with 200 Nm [A].
3. The earth resistance measurement is the full responsibility of the user. Robin is not liable for the execution of these measurements.

4.3.2. Lightning Protection

WARNING	**Install lightning protection!** Lightning protection is not provided with the system and protecting the radar system against lightning is the full responsibility of the user. Robin is not liable for any damage caused by lightning. Risk of electric shock, fire or serious injury.

4.3.3. Power Supply

Only connect the radar to private or industrial low-voltage distribution systems.
Make sure that the radar equipment is connected to a Residual Current Device of 300 mA with a K-characteristic.
The radar system does not have any fuses. **The radar requires the mains supply to be externally fused using a 16 A fuse.** Risk of electric shock, fire or serious injury.
Do NOT start the equipment yet!

4.4. Set Up Processing Station

The processing station must be installed in a climate controlled room. Find the processing station specifications here.

4.5. Set Up Weather Station

It is very important to choose the right location to get accurate readings and a reliable GPS signal. Some recommendations are given below:

- Install the weather station in “clear air”, away from obstructions in any direction that will interfere with air flowing through the unit. If there is an obstruction, keep a minimum distance of two meter. Avoid obstructions such as roofs, chimneys, trees, etc.
- If possible, install the weather station minimum 500 mm / 20" above any other object.
- Install the weather station at a minimum distance of one meter from any structure or equipment that contains ferrous metals and from anything that may create a magnetic field such as magnetized materials, electric motors, electronic equipment, engines, generators, power/ignition cables, and batteries.
- Make sure that the internal GPS has a clear view of the sky to receive satellite signals. A 120° view is optimal.
- Install it as far as possible from high-powered transmitting antennas to avoid mutual interference.
- Install it lower than any Inmarsat communications antenna.
- Install it above or below any radar beam. Do not install it within a radar beam. Positioning a mast next to the radar can degrade performance.

4.5.1. Installation of the Weather Station

NOTICE

RISK OF REDUCED ACCURACY

The weather station must be installed upright and vertical, not tilted to one side. If the weather station Instrument is tilted from the horizontal plane, it may introduce errors in the compass and wind readings.

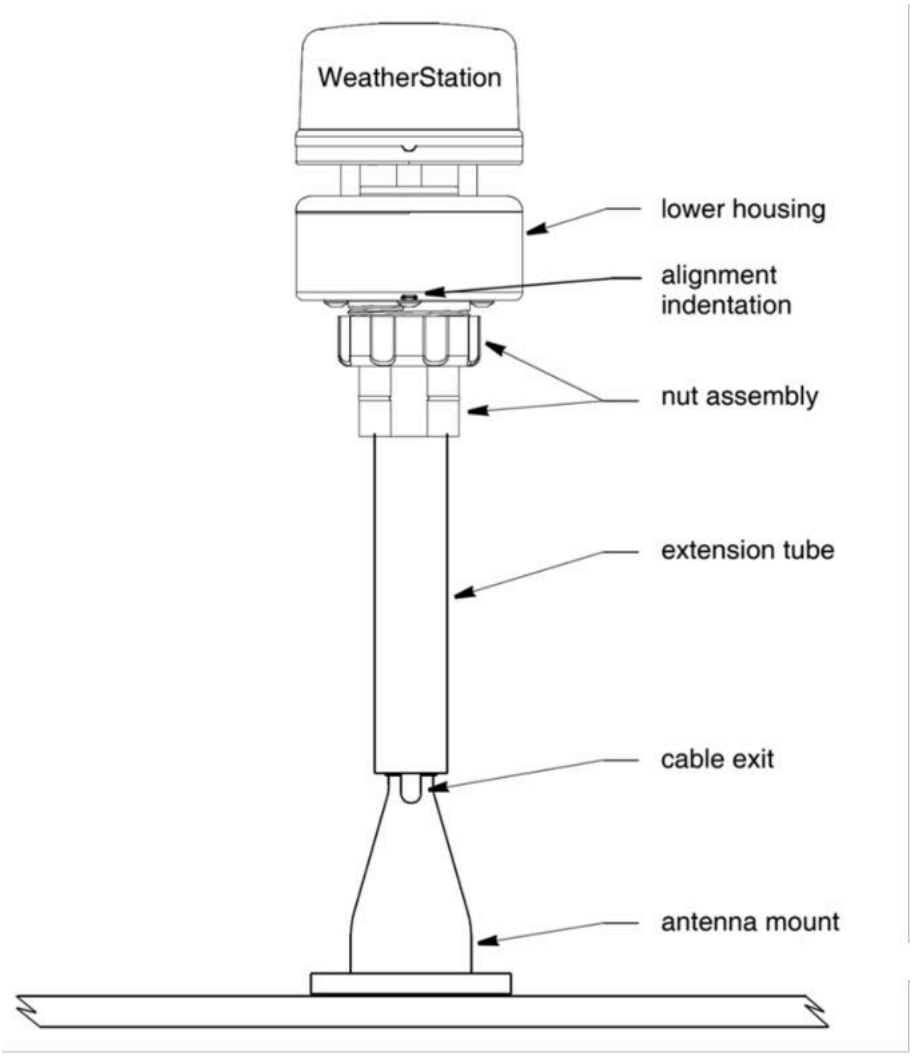
1. Position the weather station at the selected location. Orient the cable exit as wanted.
2. Position the hardware at a 90° angle to the installation surface. If necessary, use shims to level the installation surface.
3. Mark the holes for the installation screws. If the cable will pass through the centre, also mark that hole.
4. Drill the holes for the installation screws and the cable exit if necessary.
5. Tighten the screws to install the foot.
6. Install an extension tube onto the antenna foot if desired.
7. Install the weather station cable.

Note: It is recommended that the alignment notch points toward true north.

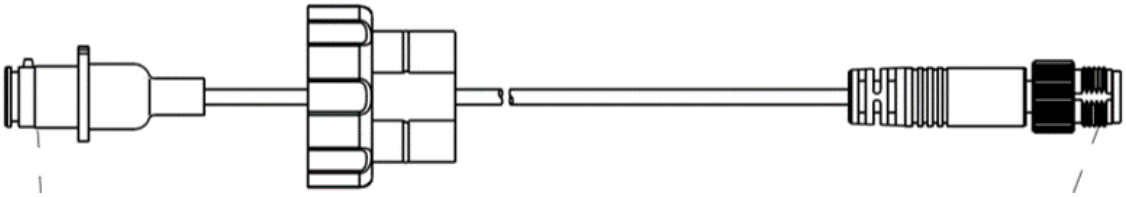
4.5.2. Weather Station Cable

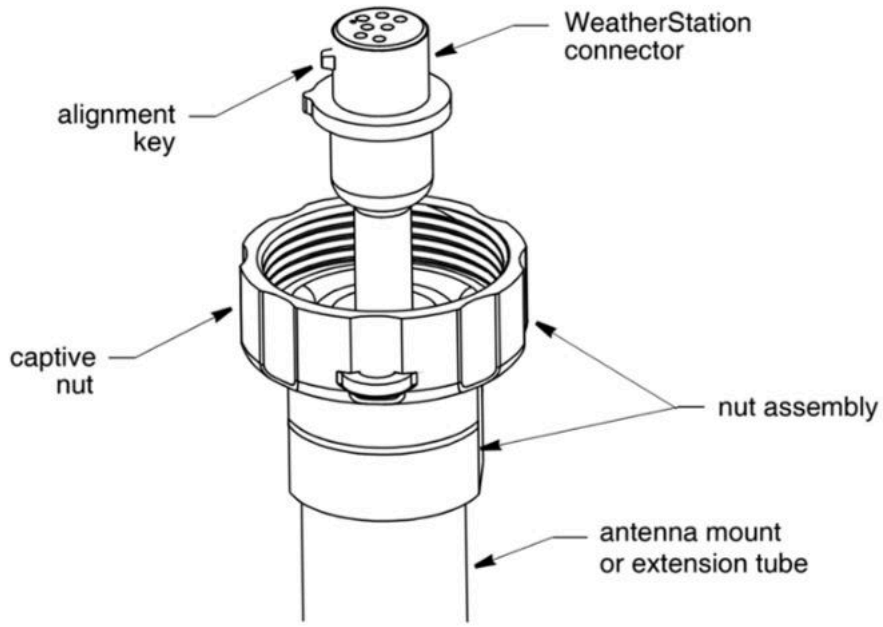
Install the cables at least one meter away from radar equipment, radio transmitters, engines, generators etc to reduce electrical interference from other electrical wiring. Make sure that all cable shields are appropriately grounded.
Do not tear the cable jackets when passing them through compartments, bulkheads, or walls. Use grommets to prevent chafing.

1. With the nut assembly on the cable near the weather station connector, thread the cable through the extension tube, antenna mount, and the cable exit. Be sure to leave several inches of cable extending beyond the nut assembly.
2. Screw the nut assembly onto the top of the antenna mount /extension tube. Hand tighten only. Do not over tighten.
3. Remove the protective cover from the connector. (Save the cap to protect the connector, when the weather station is removed.) Plug the connector into the weather station. The alignment key on the connector fits into a notch in the base of the weather station.
4. To accurately measure the wind direction, be sure to orient the alignment indentation correctly. Grasp the lower housing of the weather station at the lower housing and hold it in the proper position. It is recommended that the alignment indentation point toward true north. Slide the captive nut upward and screw it onto the base of the weather station. Hand tighten only. Do not over tighten. Be careful not to rotate the weather station changing the alignment or loosen the nut assembly from the antenna mount/extension tube.



Weather station





Weather station mount

4.6. Connect Interconnect Cable to Radar

⚠WARNING	**Do not hot plug the interconnect cable. Always disconnect from mains power source when connecting or disconnecting the interconnect cable.** Arc flash and shock hazard.

STEPS

1. **Check cables and connectors regularly. Check for breakage of parts and any other conditions that may affect radar operation. If damaged, repair before use.**
2. **Use covers to seal and protect connectors from harsh environments when disconnected.** Connectors can easily be damaged. Remove covers prior to connecting the cable.
3. Layout the interconnect cable between the radar and the breakout box. **Do not bend cables beyond the 20 cm / 8" minimum bend radius.** Failure to follow this instruction can generate interference or cause damage to cables.
4. Use cable ties or cable mounts with a minimum width of 0.5 cm / 0.2" to fasten the cable every 100 cm / 40".
5. Route the connector [B] through the opening [A] in the foot of the radar.
6. Plug the connector [B] in mating connector of the radar.
7. Tighten the two M4*20 mm Socket Head Hex screws [C] in the connector to secure mount the connector. Do **not** use the two screws [D]!

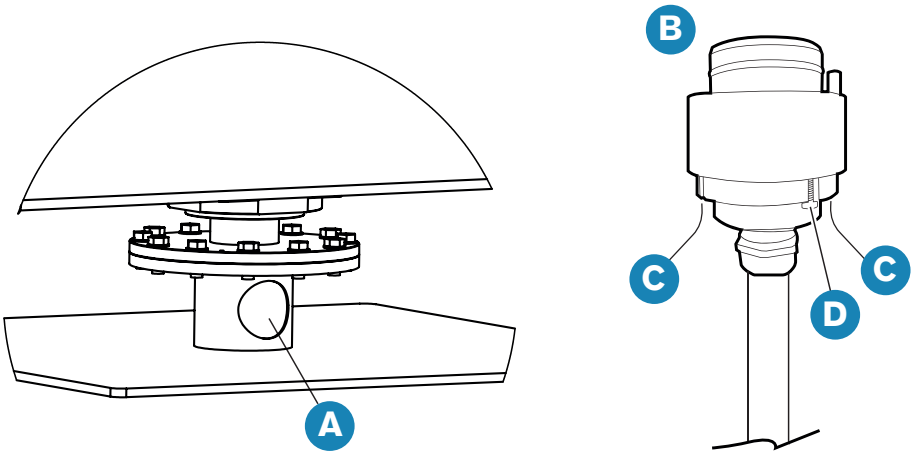
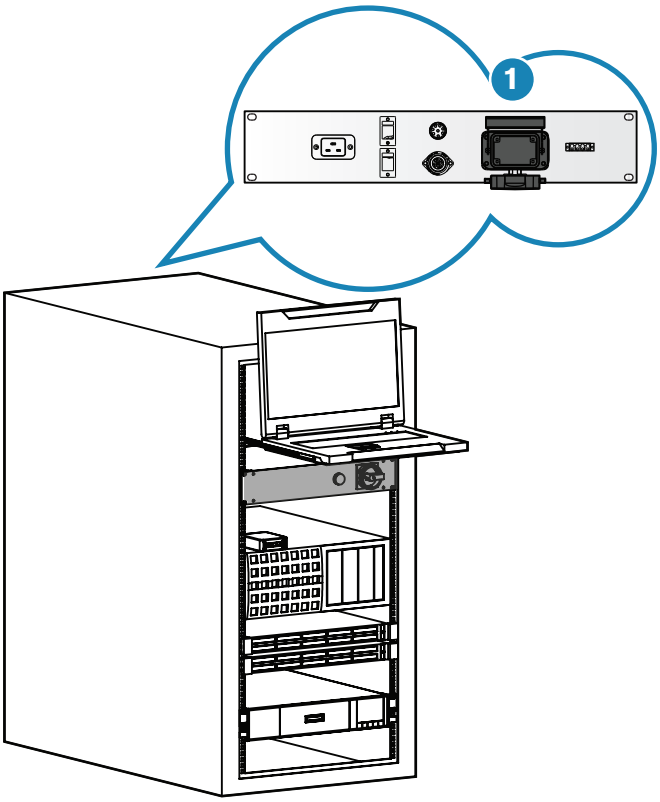


Figure 5: Connect to MAX radar

4.7. Connect Interconnect Cable to Breakout Box

Connect the lever locking connector of the interconnect cable to the backside of the breakout box [1].



4.8. Network Connection

The communications with the radar goes via two main streams: *control* and *data*. Each stream uses two CWDM channels (TX and RX).
The control connection is an ordinary 1 Gbps Ethernet network connection, which can be switched and routed. The data connection is a physical 10 Gbps point-to-point connection between the MAX Radar and MAX processing station. This connection uses Ethernet framing, but lacks support for the IP protocol.
The control connection, after optical demultiplexing, connects to a switch inside the MAX radar. On this switch the following interfaces are connected:

- Profinet interface Motor controller
- Service interface Motor controller
- WebRelay interface for remote shutdown
- Processing module interface

5. Startup

5.1. Final Checks

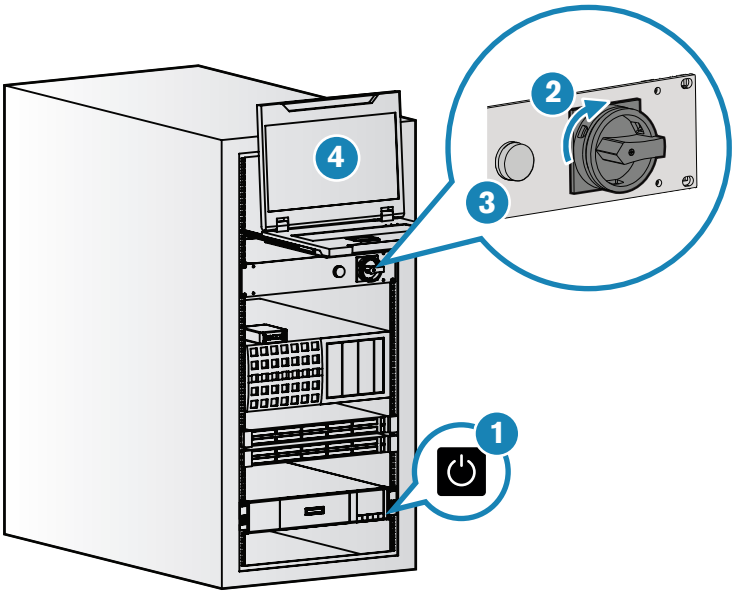
This checklist provides the steps to ensure ease of use, accuracy and safety when operating the radar system.

1. Frequency permit conditions are met.
2. The radar is mounted on a suitable structure.
3. The radar is level on the horizontal and vertical plane.
4. The radome is clear of dust, dirt and debris.
5. The interconnect cable is connected correctly both to the sensor and the breakout box.
6. The power source is present, stable and in accordance with the manual and local regulations.
7. **Connect the radar system to protective earth prior to testing, commissioning or regular operation.** Risk of electric shock, fire or serious injury.
8. **The radar requires the mains supply to be externally fused using a 16 A fuse.** Risk of electric shock, fire or serious injury.
9. **The mains voltage of the power source must correspond with the specifications of the rating plate of the breakout box.** Unauthorized voltage can cause damage to the radar system.
10. The North alignment on MAX points North.
11. The transport bracket has been removed.
12. The lifting bar has been removed.
13. The router/gateway is fully functional.
14. The radar is not obstructed or covered.
15. Keep clear from rotating radar. Maintain a minimum distance of 2.64 m / 8.7 ft from the radar.

5.2. Power On

⚠WARNING

1. **Never expose yourself to the transmitting energy within the advised safety distance of 2.64 m / 8.7 ft for more than six minutes while the radar is in operation.** RF radiation hazard.
2. **Keep clear from rotating radar.** Rotating parts can cause severe injury or death.



STEPS

1. It is safe to apply power to the system when all checks in the previous section are done.
2. Press and hold the ON/OFF button of the UPS [1]. A beeping sound can be heard.
3. Verify that the LED indicators of the UPS, STS and LTS server, MAX server and the router/gateway are on.
4. Turn the main switch on the breakout box clockwise [2].
5. Verify that the LED indicator on the breakout box is green [3].
6. Pull out and open the display with keyboard and mouse [4].

NOTICE

RADAR IS LESS SENSITIVE FOR SOME TIME
The caches of the system are emptied after each installation / positioning of the radar. Therefore the radar is less sensitive during the first minutes.

6. Operation

6.1. Remote Monitor

Remote Monitor is as a web-based application which allows the user to monitor the current status of the system or diagnose various types of issues in the deployment. It automatically checks various components of the system and visualizes the results in a graphical user interface. In addition, it enables the user to perform error recovery (e.g. by restarting processes).

The layout and options of the Remote Monitor can be different than what is described in this manual. Please use the content in this chapter as a general guidance.

6.1.1. Remote Monitor Quick Guide

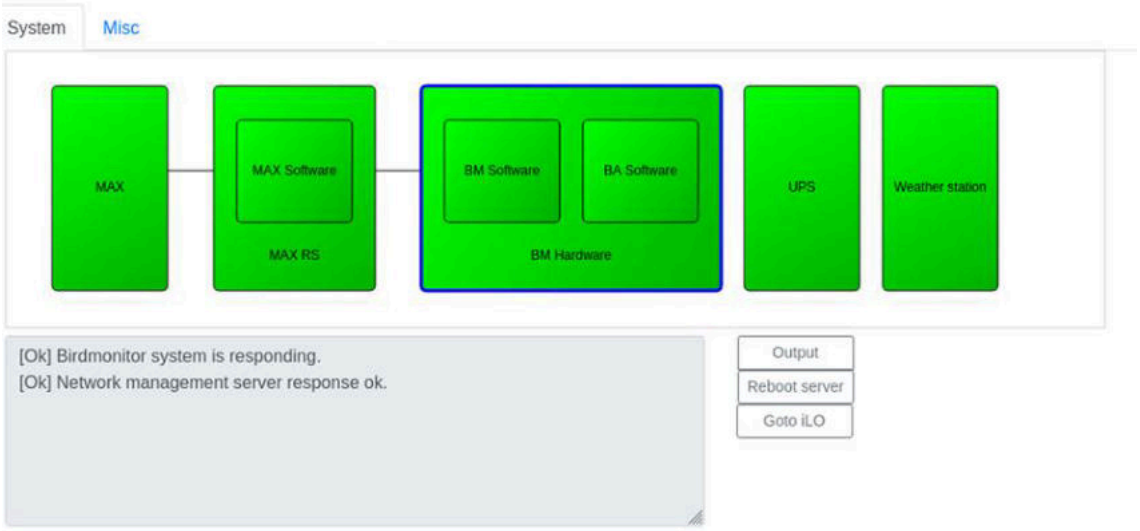
Start Remote Monitor

1. Open a web browser. The application can be started in any browser by typing the correct IP-address and port number (8085) in the address bar. If internet access to the system is possible, the browser can also be on your workstation.
   - When using a browser on the server where the webpage is installed (usually the STS server) IP-address can be: *localhost* As the port number is always 8085, the full address to start the web application would be: *localhost:8085*
   - When running on one of the other servers in the system use the IP-address of the STS server followed by the port number: *IP-adress:8085*.
   - When running on your PC or workstation outside the radar use the external IP address of the radar: *external_IP_adress:8085*
2. Remote Monitor can also be accessed by clicking Start > Other > Remote Monitor.
3. Login with user credentials.

Remote Monitor always starts in viewing mode. Login for full functionality. To go back to viewing mode click Logout.

System

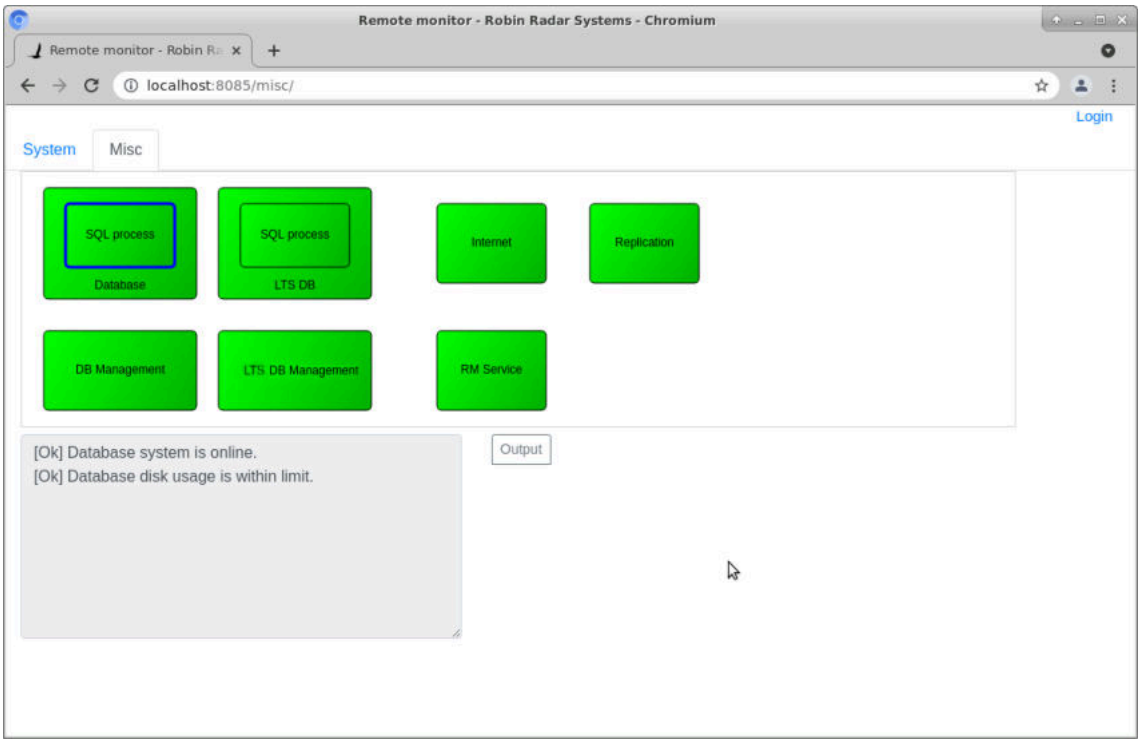
The main window of Remote Monitor (System tab) shows the main hardware components of the radar system. The main software components are visible for the applicable hardware.



Click BA Software to show users that are remotely connected to the system.

Misc

Click Misc tab to view database components. The tab “Misc” (Miscellaneous) presents components which are not specific to a single radar installation but are required for correct system performance, such as the database server and an Internet connection. The complete configuration of the system depends on the use and location of MAX.



Status Colours of Components

- Green: all tests passed, system component is ok.

- Yellow: one or more tests failed indicating a degraded component of the system or a critical state of one of the resources, e.g. disk space. Orange: the system component is working but a dependent system component is failing.
- Red: one or more tests failed, indicating an error condition of the component. MAX is therefore not fully operational. In many cases this indicates that the machine or the process does not respond to status requests.
- Grey: either the system component cannot be verified because it is not available in the system or this component depends on another component which is not working properly.

A tab also reflects the combined state of all components within the applicable tab. When all components are green; the tab shows also green (no error). When at least one component in the tab is yellow/orange (warning) or red (error), the tab shows the most critical colour.

Action Buttons

The following buttons are available depending on the selected component:

- **Output**: Opens the raw test output in a new dialog. This output can be used for further fault investigation.
- **Start**: The start action has different meanings depending on the component. For software components, this action will start the software component. For a radar device, it will start the radar device (start rotating and acquisition).
- **Stop**: The stop action has different meanings depending on the component. For software components, this action will stop the software component. For a radar device, it will stop the radar device (stop rotating and acquisition).
- **Restart**: The restart action will restart (equal to a stop & start sequence) a software component. Reboot: Reboot the corresponding hardware component.
- **Webpage**: Access to the corresponding webpage of the component (configured in the configuration file).
- **ILO**: Opens the iLO (Integrated Lights Out) webpage, this component specific delivered webpage can be used to diagnose (or solve) component problems (HP-server specific).
- **Power Cycle Radar**: Power cycles the radar hardware.

6.2. Bird Viewer Quick Start

NOTICE	Read Bird Viewer User Manual.

1. Open the web browser and navigate to Bird Viewer.

2. Login with your credentials > wait until map loads.

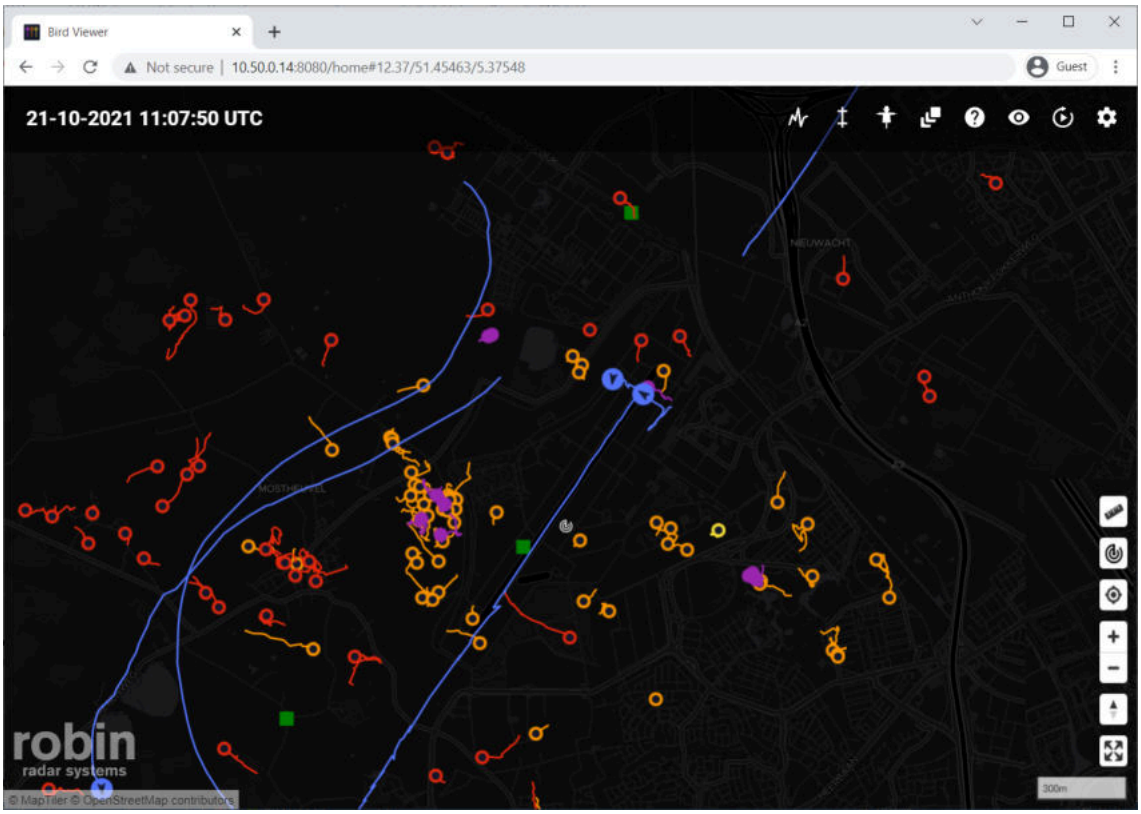


Figure 6: Main window Bird Viewer

3. Navigate:
   - To **move map**, click and hold down the left mouse button + drag.
   - To **rotate map**, click and hold right mouse button + drag.
   - To **zoom in and out**, scroll the mouse wheel up and down or use the zoom buttons at the bottom right of the screen. The map scale is show in the bottom right corner.
4. Check information of a track. Click on a track icon to show a pop-up with information about the track.
5. Use Table 2: Map functions on page 38.
6. Use the Table 3: Toolbar on page 40 to access the different features of .
7. Check Table 4: Status icons on page 41. When activated, status icons appear in the top bar. Move the mouse over an icon to get feedback.

Table 2: Map functions

	Description
	To **measure the distance**, toggle this button and click a track on the map. The **Measure distance** function measures the distance between: ▸ each radar and the track individually, ▸ the user's location and the track. ***Note*:** The option **Find my location** must be active ( ).
	To **center on radar** click button. The map centers on the radar and the icon turns blue ( ). As long as the button is blue. the viewer will always center on the radar when its position changes. Click again to disable the function. Moving the map will also disable the function.
	To **find your location** click button. The map centers on the radar and the icon turns blue ( ). Click again to disable the function.
	To **zoom in** click **+**, to **zoom out**, click **-**.
	Hold button down and move the mouse to tilt the map. To reset the map to **north alignment** click this button. When the map has been reset, the top of the screen is north.
	For **full screen** click this button. Click again to exit or press [ESC].
	Radar location (This icon is also used in the toolbar to update radar settings)
	Your location
300m	Current map scale

***Note*:** The **Find your location** function is only available when connected via localhost or a secure HTTPS connection with location permissions enabled. To enable the location permissions, open in your browser and click the lock button ( ) left next to the address bar. Toggle **Location** ON.

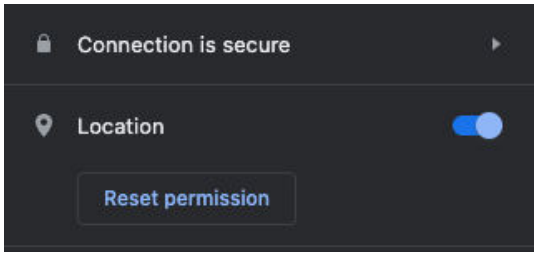


Table 3: Toolbar

	Description
	Settings
	Radar Control Panel (This icon is also used to indicate the radar location on the map)
	Replay
	Observations
	Legend
	Overlays
	Bird Deterrence[2]
	Altitude Filter[3]
	Funnel View

[2] The Bird Deterrence function is only available when this has been preconfigured in Robin Configurator.

[3] The altitude filter is only available for radar types that can view altitudes.

Table 4: Status icons

	Description
	This icon will appear when the alarm is disabled.
	This icon will appear when rain is detected.
	This icon will appear when classifications are filtered in ⚙ (Settings).
	This icon will appear when the altitude filter is active.
	This icon will appear when data simulation is active.

Table 5: Track Icon Legend

Track Icon	Description
	Radar
	Your location
	Aircraft
	Flock
	Large bird
	Medium bird
	Small bird
	Drone
	Fast Flock
	Unknown
	Fast Target
	Slow Target
	Vehicle
	ADSB Aircraft
	ADSB Vehicle

6.3. Robin Configurator

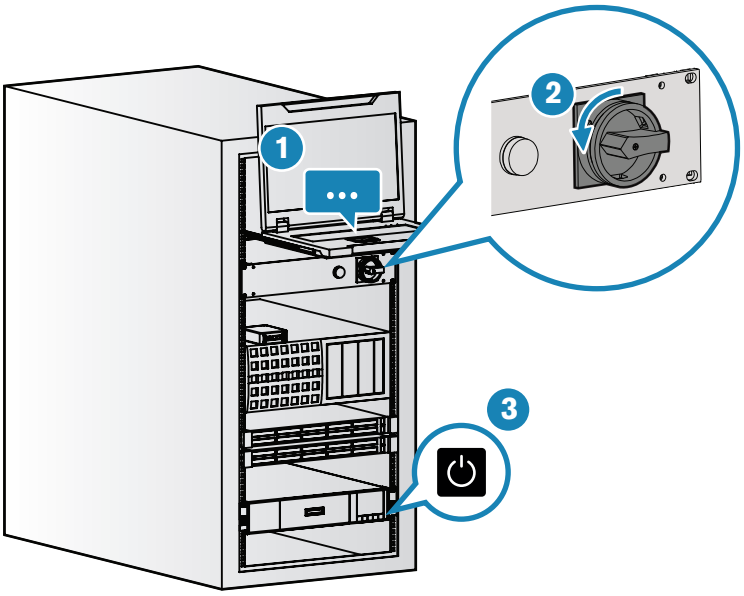
NOTICE

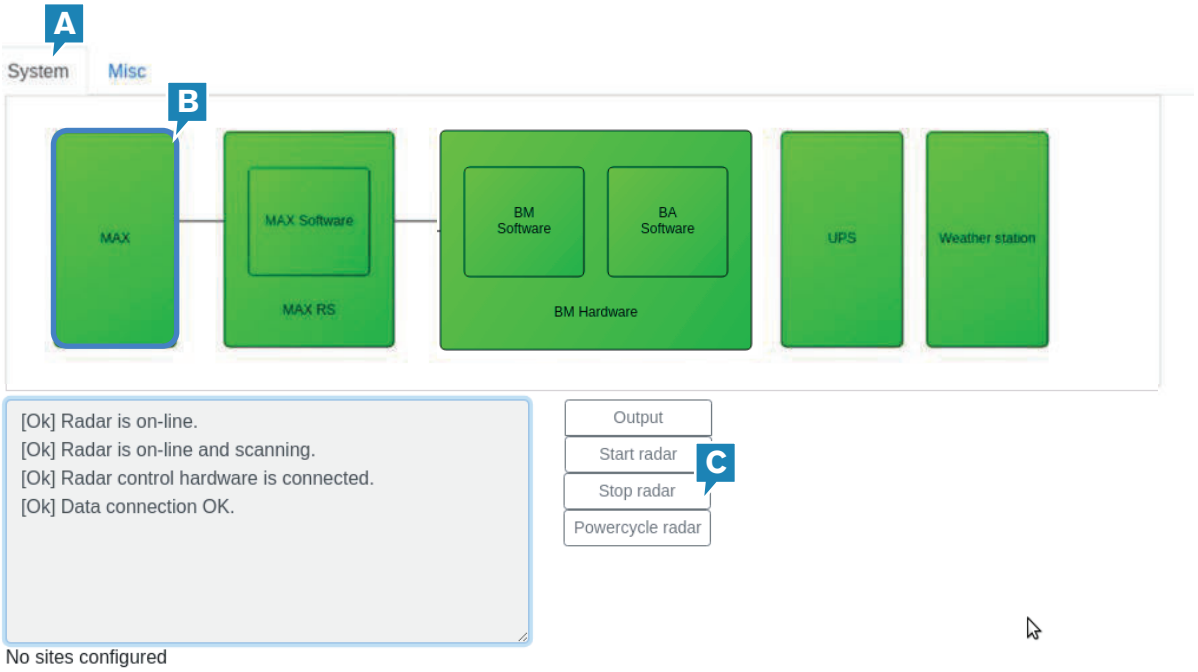
Read Robin Configurator User Manual.

Robin Configurator is a desktop application designed to work with Robin Bird Detection Radar Systems. This tool can be used to configure or reconfigure the system and it can be used to start, stop or restart several applications. Robin Radar installs and configures all customer applicable components.

To go to Robin Configurator click Start > Other > Robin Configurator.

7. Shutdown





STEPS

1. Open Remote Monitor [1].
2. Click System [A].
3. Click component MAX [B].
4. Click Stop radar [C]. At this point the component turns red and the radar stops rotating.
5. Close Remote Monitor.
6. Press the CTRL button twice to go to the KVM switch page.

7. Select and shut down all three servers:
   a. Click  in the upper left corner of the screen
   b. In the lower right corner of the window, click the Log Out icon.
   c. In the Log out Robin Administrator window, click the Shut Down button.
8. Wait five minutes to allow the servers to shutdown.
9. Turn the main switch of the breakout box counter clockwise off [2].
10. Press and hold the ON/OFF button of the UPS [3].
11. Verify that all LED indicators are off.

7.1. Shutdown with Maintenance Switch

In case of emergency or maintenance use the maintenance switch to stop the radar from rotating. The radar stops transmitting if the antenna does not rotate.

8. Effects on Performance

There are various aspects that influence the (range of) detection and classification of birds. The most common effects are listed in this section.

8.1. Radar Principles

The principle of a radar system is to emit a radio frequency signal which reflects against an object. The reflected signal from an object is received by the radar. The strength of the received signal is used to calculate the RCS of a target. The RCS is used for the classification of a target. The time difference between the send and receive moment is used for the object range. This information is combined with the azimuth angle of the radar to determine the location of the target.
MAX is capable of measuring the position of targets in 3D-space.The elevation angle of a target is measured by comparing the signal strength in two receive beams. The elevation angle in combination with the distance to a target will give also the height of a target with respect to the radar.

8.2. What Affects Radar Performance?

All objects within the range of the radar reflect/absorb RF signal in different quantities. All objects of interest are called targets. All other objects are called clutter. The reflected signal is received and filtered for static objects (e.g. terrain, vegetation, buildings etc.), then it is filtered for locally moving objects called variant filtering (e.g. leaves on a tree, etc) and then filtered for rain- and sea-clutter. Based on the type of clutter a threshold is determined such that a maximum of wanted targets is detected but a minimum of false detections are recorded. In heavy clutter areas the detection threshold is increased which is leading to a loss of detection of smaller targets.
The filtering has been adapted with years of experience and in general do not need adaptions in the field.

Bird related aspects	Effect
Bird size	A large object has a better detection rate than a small object, because it has a stronger reflection signal. The radar cross section (RCS) is therefore the value used to decide between large, medium and small birds.
Material	Conducting material (e.g. metals and water) are ideal reflectors for radar signals. Note: Birds are made of about 65..70% of water (Lean body mass).

Bird related aspects	Effect
Bird aspect angle	The radar measures RCS, meaning the surface size of an object is measured. That means that a bird seen from the side (or from e.g. underneath) will give a larger RCS then when it is seen upfront.
Bird wings	A bird with larger wings doesn't mean it will have a better RCS. In general the wings do not contain much water. The main detection surface of a bird is the body of the bird.
Radar beam width	The further a bird flies from the centre of the beam the received signal is decreasing, further outside the beam the signal drops more rapidly. But, larger objects (e.g planes, etc) outside the beam may still give enough signal to be seen and recorded as a bird and therefore has a false-positive detection.
Distance to the radar	Reflected signal levels from an object decrease rapidly with the distance to the radar. The detected radar signals are corrected for range to give a range independent RCS. When the received signal falls below the detection level, that target is no longer seen. For small targets this will happen at shorter distance. Large targets may be detected on a longer distance.
Multipath	Radar signals do not only reflect back from the wanted object to the radar but may re-bounce from surfaces (ground, sea, ..) before being received (the range looks longer) or may re-bounce in such a way that the object is seen twice or several times within the same image line. Some of the multipath effect are filtered. When multipath signals have almost the same time delay as the direct path signals, constructive or destructive interference can occur leading to an over/under estimation of the RCS.
Interference	Other radars (or equipment) may interfere resulting in local image distortion and vice versa.
Line of sight	Objects are only seen when they are in line of sight of the radar.
Heavy cluttered areas	Above heavy clutter areas the detection threshold will be increased. This means that big targets might still be detected but small targets will not.

Weather Related Aspects	Effect
Rain or snow	Rain or snow reflects RF signal. If there is a lot of rain or snow, the signal can be disturbed and it is more difficult to see the targets. Rain also absorbs radar signals. Targets behind a rain shower might be underestimated with respect to RCS.
Fog	Fog is very similar to rain or snow (water droplets) and reflect and disturb RF signal.
Dust or sand	Dust or sand reflect RF signal and may influence measurements.
Sea or large body of water	Waves on a large body of water reflect RF signal, especially when the wind direction is towards the radar. Waves then curve and work as a signal reflector. Therefore, an increasingly high sea state (swell included), will lead to increasingly high clutter level and loss of detection of increasingly bigger targets.

Surrounding Related Aspects	Effect
Trees	Trees reflect RF signal therefore it is not possible to see anything behind a tree. Note that (parts of) trees can also be detected as moving targets when there is enough wind.
Buildings or man-made structures	Buildings reflect RF signal therefore it is not possible to see anything behind a building. Very large buildings can lead to saturation of the receiver. This is especially problematic for FMCW radars.
Uneven terrain: hills or mountains	Hills or mountains reflect RF signal and can disturb the measurement of targets that fly above or in front of the hill or mountain. Behind the hill or mountain and below to top seen from the radar, no targets will be detected.
Heavy ground clutter	Objects flying above a (heavy) cluttered area may still be detected but the detection level decreases.

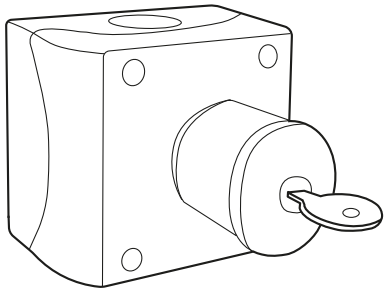
9. Maintenance and Service Instructions

9.1. Maintenance Switch

MAX is equipped with a maintenance switch. The function of this maintenance switch is to safely lock the system in a state where maintenance can be done without running the risk that someone else switches the system back on. This is the so-called Lock Out - Tag out (LOTO) method for safely securing a system for maintenance purposes.

9.1.1. Activate Maintenance Switch

1. Prior to maintenance it is advised to shut down the complete system following the shutdown procedure. This will shutdown servers, exits the operating system and stops the mechanical motion of the radar(s). Switching the main switch on the breakout box only will shutdown the radar but won't shut down the processing station.
2. Activate the maintenance switch by pressing the red button.
3. **It is required to remove the keys after activating the maintenance switch, regardless of the shutdown procedure!** This will ensure that no one else switches the system back on. Please note that it is also not possible to switch on the system remotely, when the maintenance switch has been activated, and keys have been removed. The switch can only be unlocked with the keys.



9.1.2. Emergency Stop

The maintenance switch is routed such that the rotational movement of the sensor is blocked. In case of unintended use of the maintenance switch, for example to create an emergency stop, the system will be stopped in an uncontrolled manner. To be able to operate the system normally again the following steps shall be taken.

STEPS

1. Unlock the maintenance switch.
2. Make sure all final checks are done.
3. Apply power to the system.
4. Perform a power cycle.
5. Check Bird Viewer for tracks to make sure the system is running in normal mode again.

9.2. Maintenance Schedule

The purpose of the maintenance is to detect any signs of deterioration in material and to keep performance optimal. Please note that the work performed by a Robin Radar qualified service agent depends on the terms of the Service Agreement.

WARNING

HIGH VOLTAGE!

1. **Maintenance must be made by a Robin Radar qualified service agent whenever the radar, breakout box or processing station need to be opened.** Failure to follow this instruction will void the warranty.
2. **Disconnect from mains power source prior to maintenance.** Lock the maintenance switch and take the key with you.
3. Read the Safety Instructions on page iv prior to maintenance.

Table 6: ***Maintenance Schedule***

Maintenance		By	Interval
1	**Clean radome regularly. Only use a soft damp cloth with warm water and mild soap.** Dust, dirt, grime, stickers and glue will reflect RF signal and negatively impact the performance of the radar.	Customer	1-3 Months
2	Check audible noises.	Customer	1-3 Months
3	Operating and software updates (minor versions).	RRS qualified service agent	1-3 Months
4	Check diagnostic information.	RRS qualified service agent	1-3 Months
5	Top up bearing grease.	RRS qualified service agent	12 Months
6	Check and replace components with excessive wear e.g. fans, slipring, dehumidifier.	RRS qualified service agent	12 Months
7	Internal cleaning.	RRS qualified service agent	12 Months
8	General inspection of components, e.g. Internal cabling, Connectors, TX Output power, RX Sensitivity, Bearings.	RRS qualified service agent	12 Months
9	Replace Surge Protector (if marker is not fully green).	RRS qualified service agent	12 Months
10	Software update (major versions).	RRS qualified service agent	12 Months
11	Replace bearings / exchange drive train with refurbished drive train.[4]	RRS qualified service agent	8-10 Years
12	Mid-life upgrade of electronic components.[4]	RRS qualified service agent	8-10 Years

[4] Crane to lift 300 kg is to be organised by customer in case of 8-10 years maintenance.

9.3. Spare Parts

The following spare parts can be ordered:

- Fans
- Dehumidifier
- Slipring
- Internal cabling
- Connectors
- Surge protector

9.4. Disposal

NOTICE	If at any time in the future you should need to dispose of this product please note that waste electrical products should not be disposed of with household waste. Please recycle where facilities exist. Check with your local authority or retailer for recycling advice. (Waste Electrical and Electronic Equipment Directive)

10. Technical Specifications

10.1. MAX Specifications U.S./Canada

Table 7:

Rated Data	
Voltage Rating	207...253 VAC, 50…60 Hz
Power Rating [nominal / maximum]	700 W / 2750 W
Technology	FMCW
Frequency Band	X-band
Standard Frequency	9250 MHz
Alternative Frequencies	N.A.
Power Output	44 W
Rotation / Scanspeed	60 rpm / 1 s
Instrumented Range	15 km / 9.3 mi.
Azimuth Coverage	360°
Elevation Coverage	60°
ERP / EIRP	80.4 dBm, 50.4 dBW / 82.4 dBm, 52.4 dBW
10 W/m^2 Point (radiation safe distance)	2.64 m / 8.7 ft

Table 8:

Ambient Conditions	
Ambient Temperature	N.A.
Operating Temperature	-32 °C…40 °C / -13 °F…104 °F
Operating Relative Humidity	< 95 % at 40 °C / 104 °F
Storage Temperature	5 °C...50 °C / 41 °F...122 °F
Storage Relative Humidity	< 80 % at 40 °C / 104 °F
Vibration Tolerance	13.2...100 Hz, 0.7 g, 2 h.
Operational Height (AMSL)	< 1000 m / < 3280 ft
Operational Wind Speed	# 17 m/s / 38 mph overload protect

Ambient Conditions	
Idle Wind Speed	# 32 m/s / 72 mph

Table 9:

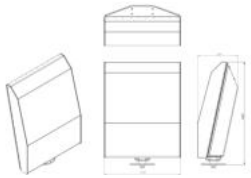
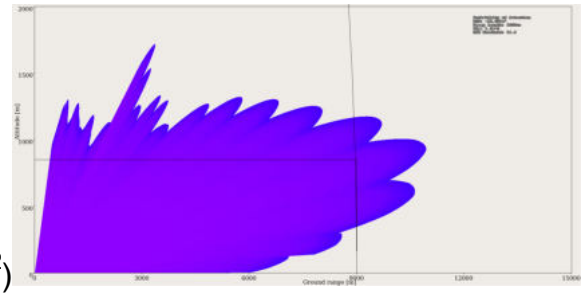
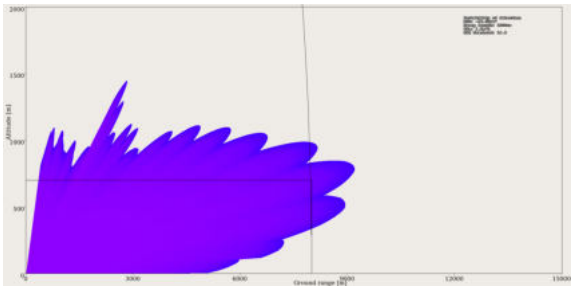
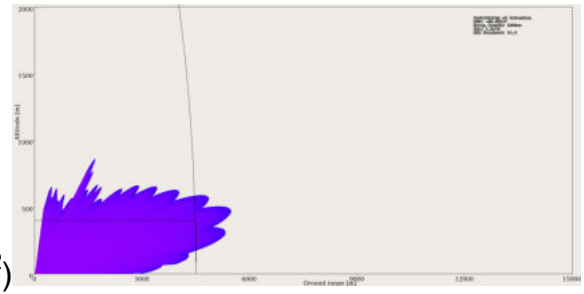
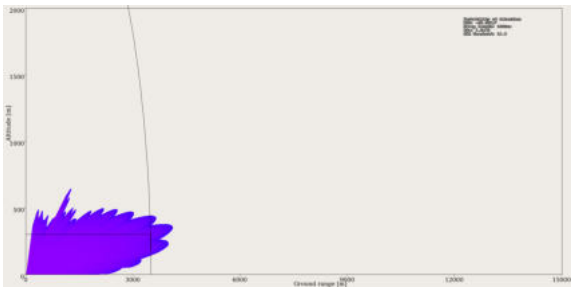
Mechanical Data	
Drawing	
Upmast Dimensions (W*D*H [mm][inch])	1237*654*1660 / 48.7*25.7*65.35
Upmast Weight (Excluding Foot / Pedestal)	325 kg / 715 lb
Radome Colour	N.A.
IP Rating	Type 4
Sound Level	< 65 dBA[5]

Table 10:

System Performance	
Detection Range Large Targets	10.0 km / 6.2 mi. at 700 m / 2300 ft alt (2 SAT, -13 dBm^2 / 0.050 m^2) 

[5] Sound level measurements were carried out in an indoor environment. A decibel meter was placed at 1m distance from the center of the antenna slightly above the lower bearing.

System Performance	
Detection Range Medium Targets	8.0 km / 5 mi. at 600 m / 1970 ft alt (1 SAT, -16 dBm^2 / 0.025 m^2) 
Detection Range Small Targets	4.0 km / 2.5 mi. at 400 m / 1300 ft alt (-25 dBm^2 / 0.0032 m^2) 
Detection Range Micro Targets	3.3 km / 2.1 mi. @ 300 m / 980 ft alt (-30 dBm^2/ 0.0010 m^2) 
Classification Range Large Targets	N.A.
Classification Range Medium Targets	N.A.
Classification Range Small Targets	N.A.
Classification Range Micro Targets	N.A.
Detection Probability	Under investigation
Angular Resolution	1.8°
Angular Accuracy	0.18°
Range Resolution	5.8 m / 19 ft
Range Accuracy	0.5 m / 1.6 ft
Elevation Resolution	4°

System Performance	
Elevation Accuracy	0.2°

Table 11:

Cables	
Number of Cables Sensor to Server	1
Cable Material	PUR-black
Standard Cable Length	15 m / 50 ft
Maximum Cable Length	15 m / 50 ft

Table 12:

Software	
Operating System	LTS Xubuntu
Core Software	Robin Software Package
Standard Tools	▸ Bird Viewer, 1 user ▸ Mobile Viewer, 2 users ▸ Report Viewer ▸ Remote Monitor ▸ Robin Configurator ▸ XML interface
Optional Tools	▸ Bird Viewer, extra user ▸ Mobile Viewer, extra user ▸ Wind Turbine Shutdown

10.2. Processing Station Specifications

Table 13:

Rated Data	
Voltage Rating	207...253 VAC, 50…60 Hz
Power Rating (incl. sensor) [nominal / maximum]	to be determined
Power Rating (excl. sensor) [nominal / maximum]	400 W - 1100 W / to be determined
Main Internal Components	▸ Display with keyboard and mouse ▸ KVM switch ▸ Breakout box ▸ Router/gateway ▸ Network switch ▸ MAX Server ▸ STS and LTS Server ▸ UPS
External Connections	▸ Power input ▸ Ethernet ▸ Weather station ▸ ADS-B receiver (optional) ▸ Interconnect (to radar) ▸ Maintenance switch
Wireless Connections	N.A.
Controls	▸ Radar power switch ▸ Maintenance switch
Indicators	Radar power on/off

Rated Data	
Intended Use	▸ Static ▸ Indoor

Table 14:

Ambient Conditions	
Installation Altitude	< 1000 m / < 3280 ft
Storage Temperature	-20 °C…50 °C / -4 °F...122 °F
Operating Temperature	10 °C…35 °C / 50 °F...95 °F
Operating Relative Humidity	35 %…65 % RH, non-condensing
Shock Tolerance	N.A.
Vibration Tolerance	N.A.

Table 15:

Mechanical Data	
Dimensions (L*W*H [mm][inch])	1070*600*1198 / 42.1*23.6* 47.2 (24U)
Weight	244 kg / 537 lb depending on auxiliary
IP Rating	IP40

10.3. Dimensions

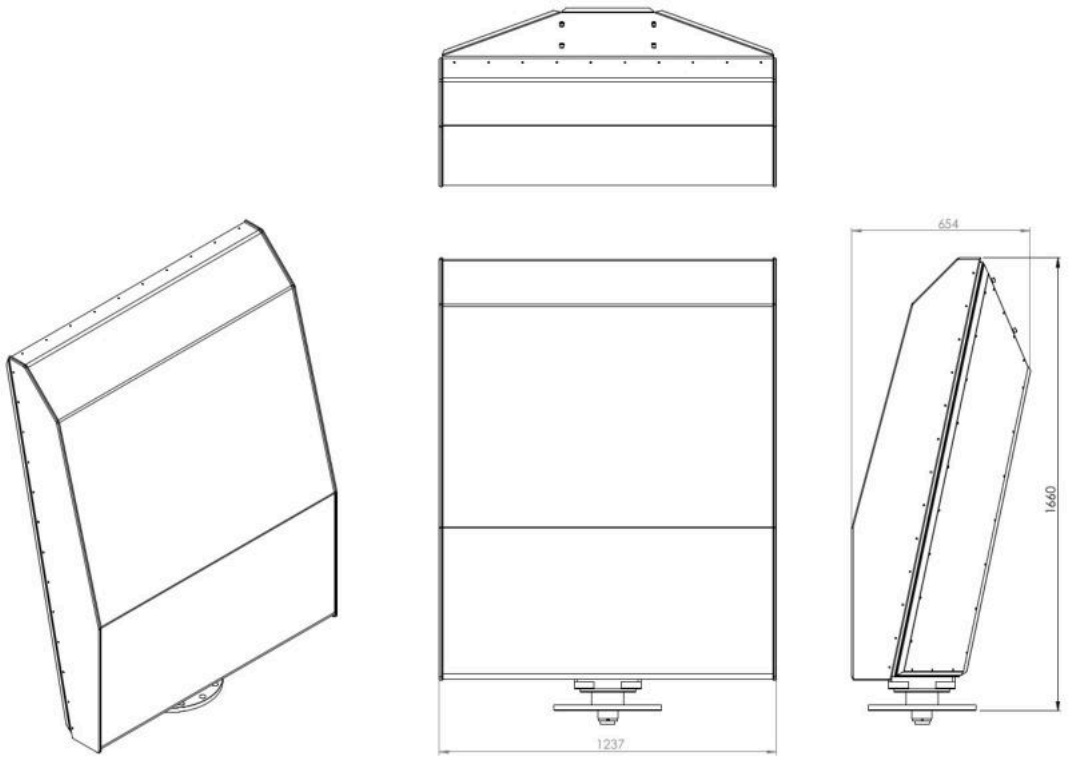


Figure 7: MAX dimensions

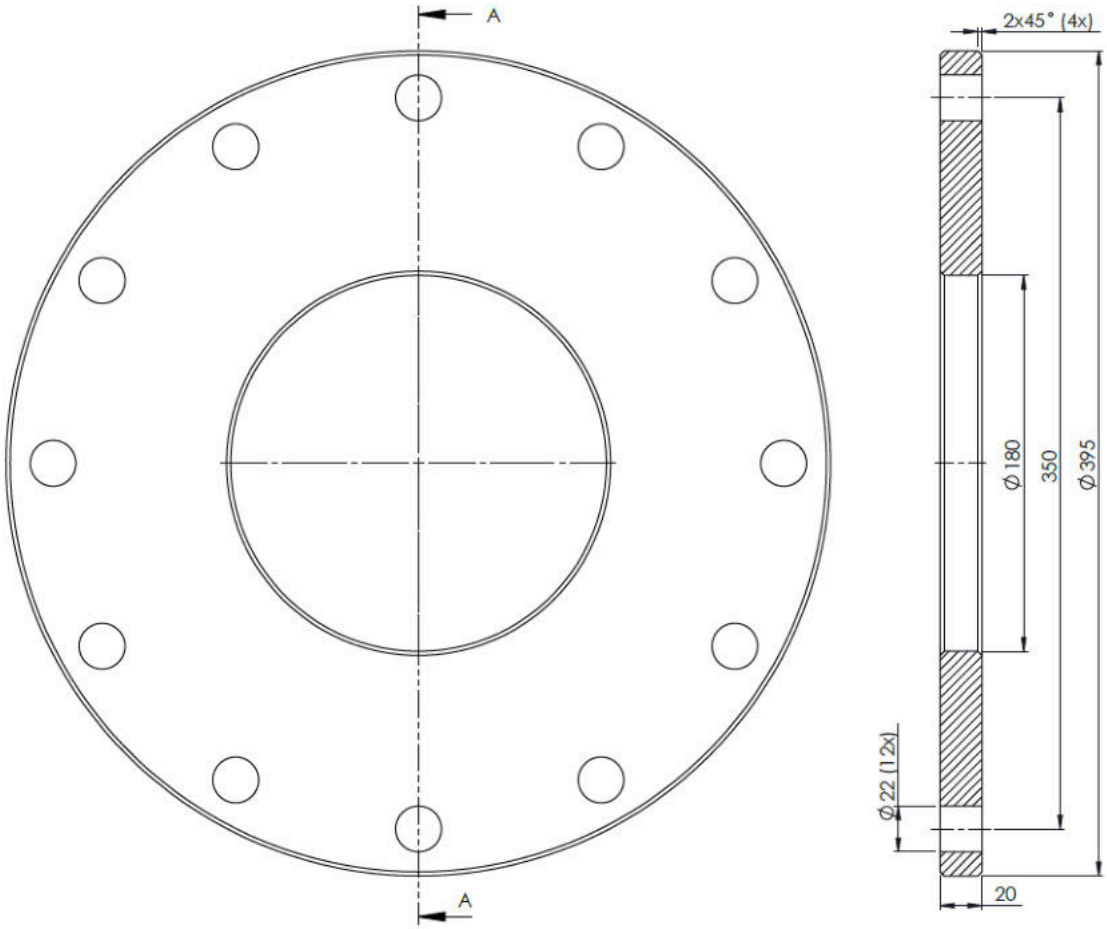


Figure 8: Radar flange dimensions

11. Declaration of Conformity

371.950.003 VERSION A

Declaration of Conformity Non-ionising Radiation Safety

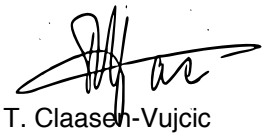
We:	Robin Radar Systems B.V. Laan van Waalhaven 355 2497 GM The Hague The Netherlands
Declare that:	
Machine:	MAX® 3D Bird Radar
Brand name:	Robin Radar Systems B.V.
Model/type numbers:	RRS-MAX/A3/F9250, RRS-MAX/A3/F9650 & RRS-MAX/A3/F8900

Regarding radiation safety the MAX® 3D Bird Radar complies to the ICNIRP regulation. For this particular radar, the regulation prescribes a maximum continuous exposure of 10 W/m².

At zero meter from a non-rotating radar the radiation power is 44 W. However, due to the fact that the radar rotates, the average radiation is much lower. The radar only spends 0.5 % on a target. This results in an average radiation power of 0.22 W. The resulting safe distance is 2.64 m / 8.7 ft.

The radar stops transmitting if the antenna does not rotate (e.g. motor failure, blocked rotor). So even without precautions residing in the vicinity (2.64 m / 8.7 ft) of the radar it is safe according to ICNIRP.

The Netherlands
The Hague,
June 28, 2022



T. Claasen-Vujcic
COO

© 2022 Robin Radar Systems All Rights Reserved.

371.950.002 VERSION B

EC Declaration of Conformity for Machinery

We:

Robin Radar Systems B.V.
Laan van Waalhaven 355
2497 GM The Hague The
Netherlands

Declare that:

Machine:	MAX® 3D Bird Radar
Brand name:	Robin Radar Systems B.V.
Model/type numbers:	RRS-MAX/A3/F9250, RRS-MAX/A3/F9650 & RRS-MAX/A3/F8900

Is in accordance with:

- The Machinery Directive (2006/42/EC)
- RED Directive (2014/53/EU)
- FAA AC 150/5220-25
- RoHS Directive (2011/65/EU; replaceable battery excluded)

Complies with the harmonized European standards:

- EN 301 489-01 V2.1.1 & EN 301 489-03 V1.6.1, class B
- ETSI EN 303 364-3 v1.1.1
- EN-IEC 60204-1: 2006 + A1: 2009 + AC: 2010 supplemented with: EN-IEC 61010-1:2010 + AC:2011

Notified Body Telefication B.V. with Notified Body number 0560 performed the following:

- Module B + C

Examination certificate: 212140654/AA/01

The Netherlands
The Hague,
May 31, 2022

T. Claasen-Vujcic
COO

02 Jun 2022 13:45 +0200
The Hague
T. Vujcic
QUALIFIED SIGNATURE

© 2022 Robin Radar Systems All Rights Reserved.

12. Appendix

12.1. Test Description for Remote Monitor

In this chapter all components will be described as well as the tests and possible outcome that are performed on the component. For many of the tests the standard “Simple Network Management Protocol” (SNMP) is used, the detailed outcome of these SNMP request can be read in the output button window.

12.1.1. MAX Sensor

Shows the checks for the physical hardware (antenna).

Test no.	Test Description	OK	Degrading	Not Operational
1	Radar	online and scanning	online not scanning	
2	Control hardware	connected		
3	Data connection	OK		

Dependencies:
Buttons:

Buttons	Button Description	Comments
Output	Shows the individual test results in a separate window	
Start radar	Starts radar	
Stop radar	Stops radar	
Powercycle radar	Generate powercycle command for radar antenna	

12.1.2. MAX Registration System

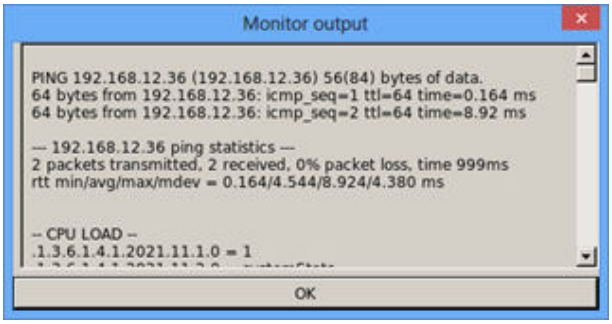
Shows the checks for the physical hardware and operating system on which the Horizontal Registration software is running.

Test no.	Test Description	OK	Degrading	Not Operational
1	Verify if the component can be reached over the network (Ping test)	Radar registration system is responding	N.A.	The radar registration system is not responding
2	Component interrogation (SNMP)	Network management server response is ok	No network management server response	
3	Indicates if the disk usage is below a critical level	N.A.	Disk <disk> has <Y>% free disk space this is less than the required <X>%	N.A.
4	Indicates if the CPU load is below a critical level	N.A.	Machine has <Y>% idle time this is less than required <X>% percent idle time	N.A.
5	HP-server state interrogations			
5.1	Verify from the server its ambient minimum temperature		Ambient temperature <current> is less than <allowed> minimum temperature	
5.2	Verify from the server its ambient MAXimum temperature		Ambient temperature <current> is more than <allowed> MAXimum temperature	

Test no.	Test Description	OK	Degrading	Not Operational
5.3	Verify from the server its supply status		Power supply status not okay HP error code: <errorcode>	
5.4	Verify server fan status		Fan status not okay, HP error code: <errorcode>	
5.5	Verify server disk status		Disk status not okay, HP error code: <errorcode>	
5.6	Verify interrogation status		Retrieving ambient temperature failed	
			Retrieving power supply status failed	
			Retrieving fan status failed	
			Retrieving disk status failed	
6	Verify connection between WS and RS			

Buttons:

Buttons	Button Description	Comments
Output	Shows the individual test results in a separate window	e.g.:

Buttons	Button Description	Comments
		
Reboot	Will reboot (restart) the MAX RS Hardware (server)	
iLO	Opens the iLO (Integrated Lights Out) webpage	The iLO webpage allows the user to diagnose system problem

12.1.3. MAX Radar Software

This button test if all pre-processing up-to plot extraction is working properly.

Test no.	Test Description	OK	Degrading	Not Operational
1	Weather_station connected	Connection with weatherstation OK	No connection to weatherstation	
2	Verify if the Radar software is running	Radarsoftware is operational		
3	Connection to BM	Radar is connected to Birdmonitor		
4	Connection to database	Radar images in Live-database OK		
5	Calibration	Calibration valid		
6	Tx-settings	TX settings valid		

Dependencies:

Buttons:

Buttons	Button Description	Comments
Output	Shows the individual test results in a separate window	
Start	Starts and initializes the software application	
Stop	Ends the software application	
Restart	Does a Stop & Start sequence	

12.1.4. Bird Monitor Hardware

Indicates the physical hardware and operation system on which the Bird Monitor software is running.

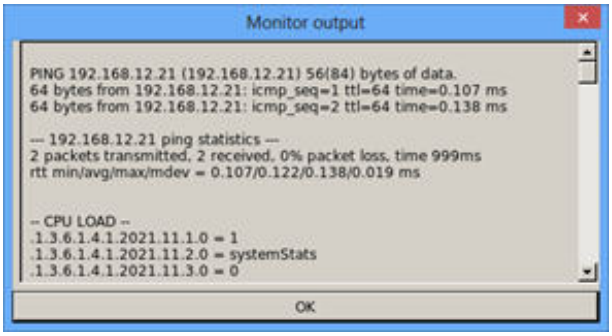
Test no.	Test Description	OK	Degrading	Not Operational
1	Verify if the Bird Monitor hardware is running	Bird Monitor system is responding	N.A.	Bird Monitor system is not responding
2	Component interrogation (SNMP)	Network management server response ok	No network management server response	No network management server response
3	Indicates if the disk usage is below a critical level	N.A.	Disk <disk> has <Y>% free disk space this is less than the required <X>%	N.A.
4	Indicates if the CPU usage is below a critical level	N.A.	Machine has <Y>% idle time this is less than required <X>% percent idle time	N.A.
5	See the tests as described on the Registration System table.			

Dependencies:

In reality the Registration machine is the same as the BM machine. Any action here will also occur on the BM-Hardware and vice-versa.

Buttons:

Buttons	Button Description	Comments
Output	Shows the individual test results in a separate window.	e.g.:

Buttons	Button Description	Comments
		
Reboot		
iLO		

12.1.4.1. Bird Monitor Software

This test checks if the processing and analysis of the radar images software is alive and running. The status of this software is checked with a proprietary protocol indicating:

Test no.	Test Description	OK	Degrading	Not Operational	Unknown
1	Verify if the BM software is running	Birdmonitor software is operational	N.A.	Birdmonitor software could not be reached	Birdmonitor software is not operational
2	DB Connection	DB Connection ok	N.A.	No DB Connection or DB not initialized	
3	HR* Connection	HR* Connection ok	N.A.	No HR* Connection	
4	VR* Connection	VR* Connection ok	N.A.	No VR* Connection	
5	Radar Connection	RS <radar> Connection ok	N.A.	No RS <radar> Connection ok	
6	Verify the WS connection	Weather station is connected	N.A.	No weather station connection	
7	Verify if HR* is configured	N.A.	N.A.	N.A.	HR* not configured in RM configuration
8	Verify if VR* is configured	N.A.	N.A.	N.A.	VR* not configured in RM configuration
9	Verify if DB is configured	N.A.	N.A.	N.A.	DB not configured in RM configuration

Test no.	Test Description	OK	Degrading	Not Operational	Unknown
10	Verify if RS<radar> is configured	N.A.	N.A.	N.A.	RS <radar> not configured in RM configuration

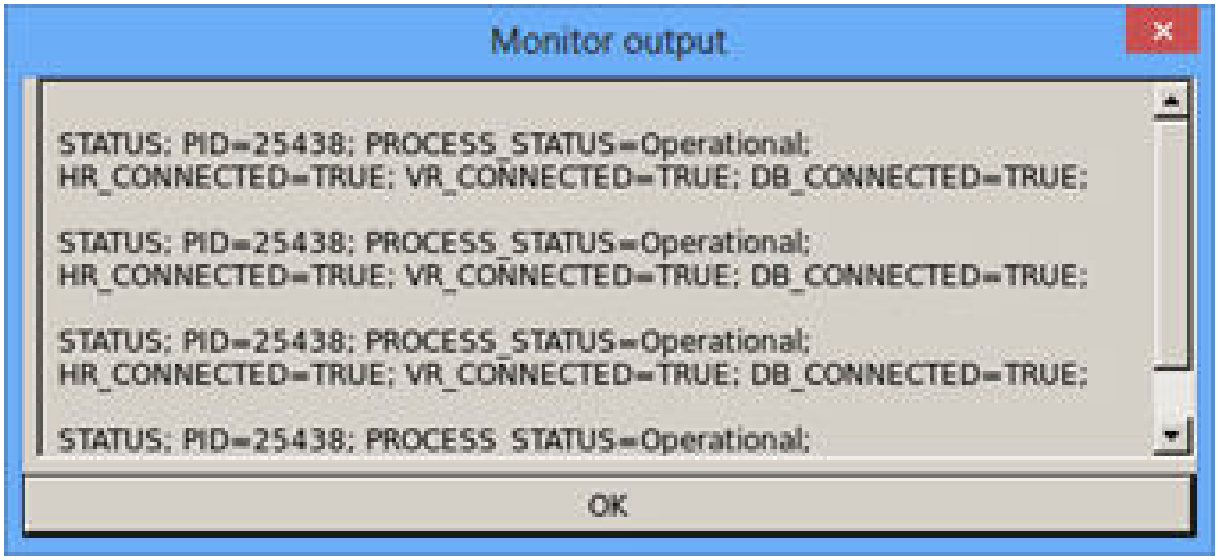
Dependencies:

*Note: <radar> may be either “HR”, “VR” or “FMCW”

Buttons:

The following buttons are available:

Buttons	Button Description	Comments
Output	Shows the individual test results in a separate window	e.g.:



Start	Starts and initializes the software application	
Stop	Ends the software application	
Restart	Does a Stop & Start sequence	

12.1.4.2. Bird Analysis Software

This test checks if the Bird Analyses (BA) process is alive and running. Depending on the system configuration the BA consist of different plugins. The text “<name >” is replaced by the name of the applicable plugins. The status of this software and its plugins is checked with a proprietary protocol indicating:

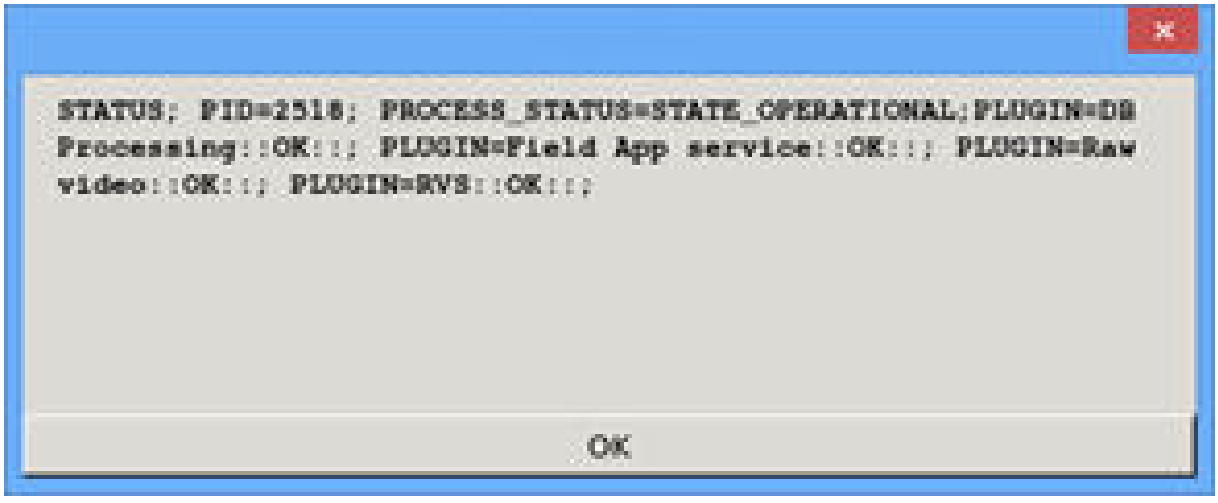
Test no.	Test Description	OK	Degrading	Not Operational	Unknown
1	Verify if the BA software is running	Bird Analysis server is operational	N.A.	Bird Analysis server could not be reached	Bird Analysis server is not operational
2	Verify the correct working of the plugins	Plugin <name> status ok	Plugin <name> status warning	Plugin <name> status error	Plugin <name> status unknown

Dependencies:

Buttons:

The following buttons are available:

Buttons	Button Description	Comments
Output	Shows the individual test results in a separate window	e.g.:



Start	Starts and initializes the software application	
Stop	Ends the software application	
Restart	Does a Stop & Start sequence	

12.1.5. UPS

Verifies the uninterruptible power supply (UPS) unit. The following tests are performed on the UPS:

Test no.	Test Description	OK	Degrading	Not Operational
1	Verify if the component can be reached over the network (Ping test)	UPS is responding	N.A.	UPS is not responding
2	Component interrogation (SNMP)	UPS Network management server response ok	No network management server response from UPS	No Network management server response from UPS
3	Verifies the output state of the UPS	N.A.	Main power failure	N.A.
4	Verifies the mains voltage level	N.A.	Unstable main power supply	N.A.
5	Verifies the temperature of the UPS	N.A.	UPS Temperature: <YY> is above MAX allowed temperature: <XX>	
6	Verifies the input voltages (mains) for the UPS		UPS Mains voltage <YY> is <under/over> <XX> volt	

Dependencies:

N.A.

Buttons:

Buttons	Button Description	Comments
Output	Shows the individual test results in a separate window.	

Buttons	Button Description	Comments
Webpage	Shows the UPS webpage in a separate browser for more status and configuration info on the UPS itself.	

12.1.6. Weather Station

This test shows the state of the weather station (e.g. the Airmar). The status of this component is checked by interrogating the Weather Station software on the database server over a proprietary protocol.

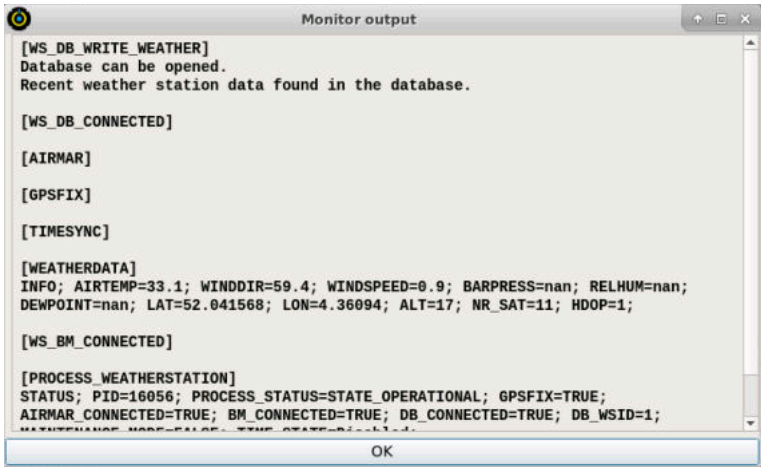
Test no.	Test Description	OK	Degrading	Not Operational
1	Verify if the software can be reached over the network	Weather station software is running		Weather station software is not running
				Weather station software is not responding
2	Component interrogation (SNMP)	Airmar is connected		Airmar is not available
3	Component interrogation (SNMP)	Weather data can be received	Weather data is not received	Weather data is not received
4	Component interrogation (SNMP)	GPS is running	GPS is not available	GPS is not available
5	Time sync	Time of weather station corresponds with time of system	Output: OutOfSync	Output: OutOfRange
6	Actual measurements			
6.1	Measures the temperature	Air temperature: xx.x Degrees	N.A.	N.A.
6.2	Measures the wind direction	Wind direction: xxx#	N.A.	N.A.
6.3	Measures the wind speed	Wind speed xx.x m/s	N.A.	N.A.
6.4	Shows the GPS position	Position: ±xx.xxx#, ±xx.xxx#, xx.x m	N.A.	N.A.

Test no.	Test Description	OK	Degrading	Not Operational
7	Verifies the connection with the Bird Monitor	Bird Monitor connection established		Bird Monitor not connected
8	Verifies the connection with the Database	Database connection established		Database not connected

Dependencies:

The state of this device is obtained by the Database Server. If this machine does not work properly the Weather station data cannot be seen.

Buttons:

Buttons	Button Description	Comments
Output	Shows the individual test results in a separate window.	e.g.:
		
Start	Starts and initializes the software application		
Stop	Ends the software application		
Restart	Does a Stop & Start sequence		

12.1.7. Database/LTS DB

The database server is the same server as the BM hardware. See Bird Monitor Hardware on page 67. The LTS DB hardware is a similar server.

12.1.7.1. SQL Process

Indicates the central database process (postgresql) which stores all the track data obtained from the Bird Monitor software and enables other components to access this data (e.g. the Reporting software).

Test no.	Test Description	OK	Degrading	Not Operational
1	Verify the SQL connection	Database system is online	Database system does not respond	Database system does not respond
2	Verifies the size of the database	Database disk usage is within limits	Database disk usage is critical	
3	Verify if Weather station data is written in the database	Weather station write data in database ok	N.A.	No recent Weather station data in the database
4	Verify if Remote Monitor Service data is written in the database	Recent remote monitor service data in database	N.A.	No recent Remote Monitor Service (RMS) data in database

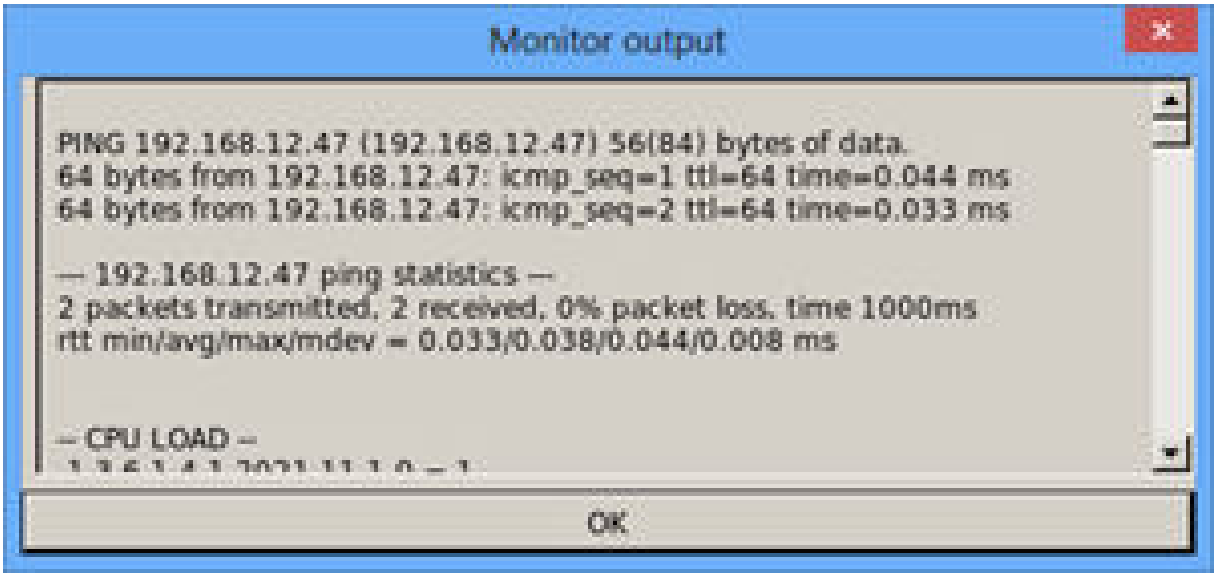
Dependencies:

2 : The value for the database size message is configurable in the Remote Monitor configuration file.

Buttons:

The following buttons are available:

Buttons	Button Description	Comments
Output	Shows the individual test results in a separate window.	e.g.:

Buttons	Button Description	Comments
		
Start	Starts and initializes the software application	
Stop	Ends the software application	
Restart	Does a Stop & Start sequence	

12.1.8. DbManagement/LTS DbManagement

This button gives information on the management of the database. This includes creation of month schemes and removal of old data.

Test no.	Test Description	OK	Degrading	Not Operational
1	Verify if software is running	Db Management is operational	N.A.	Internet connection is not responding
2	Tasks	DBM tasks finished		DbM tasks failed
3	Due tasks	No due tasks		Due tasks
4	Analytics running	Analytics is running; recent analytics data found		No recent data found

Buttons:

Buttons	Button Description	Comments
Output	Shows the individual test results in a separate window	
Start	Starts and initializes the software application	
Stop	Ends the software application	
Restart	Does a Stop & Start sequence	

12.1.9. Internet

The Internet button does indicate the connection to the Internet. The state of this connection is checked by a Ping test to an Internet server.

Test no.	Test Description	OK	Degrading	Not Operational
1	Verify if the component can be reached over the network (Ping test)	Internet connection is responding	Internet connection is not responding	Internet connection is not responding

Dependencies:

The Internet component is a test for the internet connection from where the Remote Monitor is running.

Buttons:

Buttons	Button Description	Comments
Output	Shows the individual test results in a separate window.	

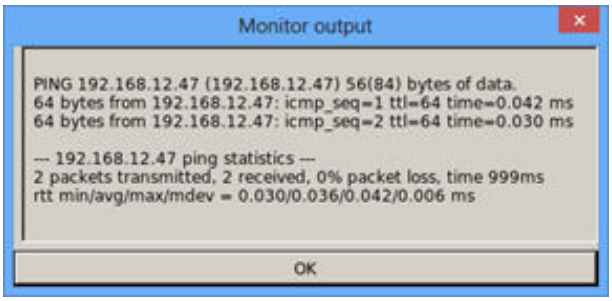
12.1.10. Router

Indicates the corporate router (if available), this network component is essential for Internet access and remote maintenance. The state of this system is checked by a Ping test.

Test no.	Test Description	OK	Degrading	Not Operational
1	Verify if the component can be reached over the network (Ping test)	Router is responding	N.A.	Router is not responding

Dependencies:

Buttons:

Buttons	Button Description	Comments
Output	Shows the individual test results in a separate window.	e.g.:
		
Webpage	Shows in a separate browser a webpage for more info on the device	

12.1.11. RM Service

The Remote Monitor Service (RMS) writes (independently of the Remote Monitor) the system component states to the database. The user can check the RMS using the Remote Monitor GUI. The RMS does the exact same tests as the Remote Monitor.

Test no.	Test Description	OK	Degrading	Not Operational
1	Verify if the RM-service is running	Remote monitor service is operational	N.A.	Remote monitor service could not be reached

Dependencies:

The Remote monitor service is installed only on one system, typically the database server. The installation package is “robin-remotemonitor” dependent and therefore will be installed automatically also.

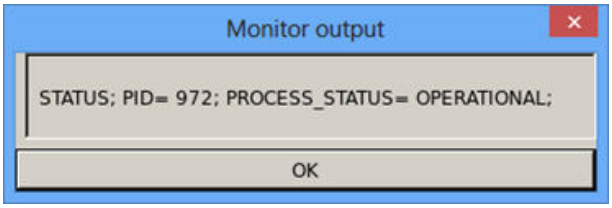
$> sudo apt-get install robin-remotemonitor-service

To either start/stop the remote-service application execute:

$> sudo start robin-rms

$> sudo stop robin-rms

Buttons:

Buttons	Button Description	Comments
Output	Shows the individual test results in a separate window.	e.g.:
		
Start	Starts and initializes the software application	
Stop	Ends the software application	
Restart	Does a Stop & Start sequence	

12.1.12. Replication

Test no.	Test Description	OK	Degrading	Not Operational
1	Check replication to LTS	Task ‘STS_to_LTS_Replicatio’: OK	N.A.	Task ‘STS_to_LTS_Replicatio’: Failed
2		Task ‘STS_to_LTS_Tableau_Insights’: OK	N.A.	Task ‘STS_to_LTS_Tableau_Insi Failed

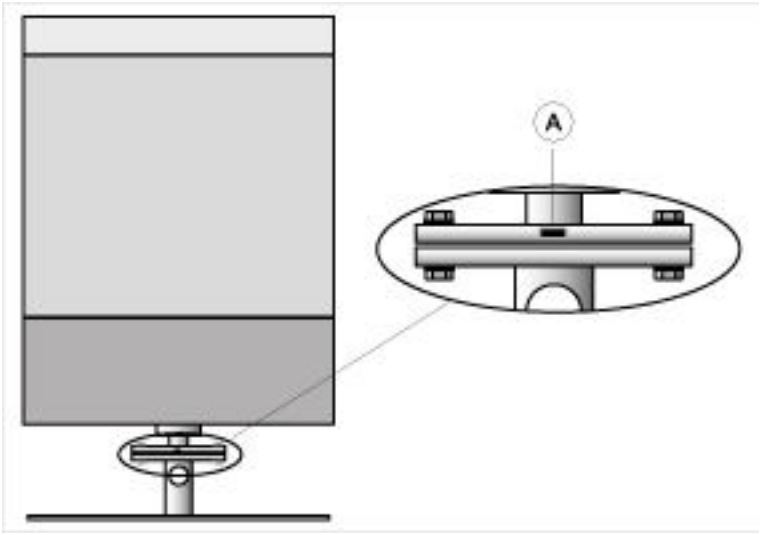
Dependencies:
Test 2: only when configured
Buttons:

Buttons	Button Description	Comments
Output	Shows the individual test results in a separate window	
Start	Starts and initializes the software application	
Stop	Ends the software application	
Restart	Does a Stop & Start sequence	

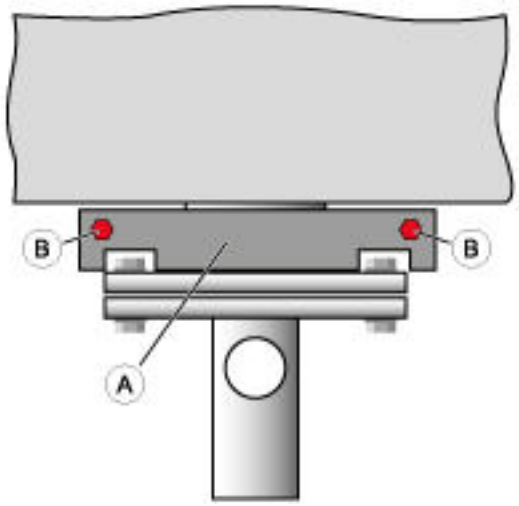
12.2. Quick Guide for MAX on Trailer

12.2.1. Setup trailer / radar

1. Choose a location for the radar where it has a free line of sight at the area of interest.

2. 

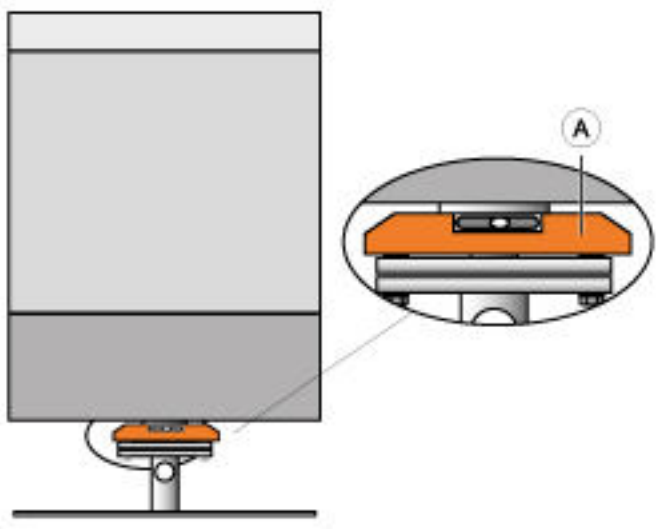
   Try to position the trailer in such a way that the 'North' indicator (A) on the mounting flange of the radar points towards north.

3. 

   Find the transport locks (A) on top of the flange.

4. Use two 19 mm wrenches to loosen the two bolts (B) to remove the transport locks.
5. Verify that the radar can rotate freely.

6.



Use the support legs of the trailer to level the radar in both directions.

a. Use a cordless drill with socket 19 mm to lower the support legs.

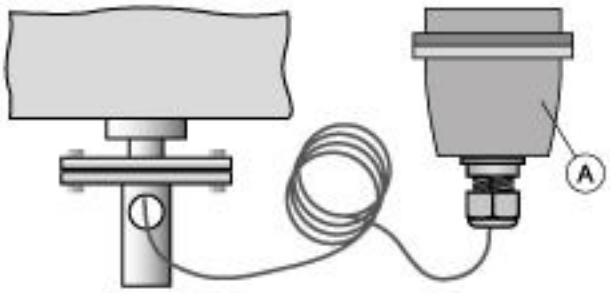
b. Put stamping plates under the support legs.

c. Put the level on top of the flange of the radar.

d. Make sure that the nose wheel of the trailer is lifted.

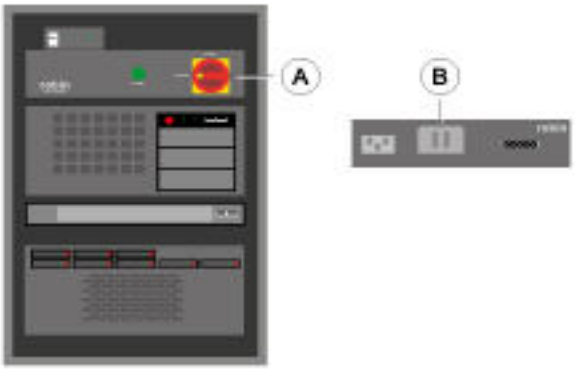
12.2.2. Apply power to system

1.



Unbundle the interconnect cable and bring the loose connector (A) to the breakout box.

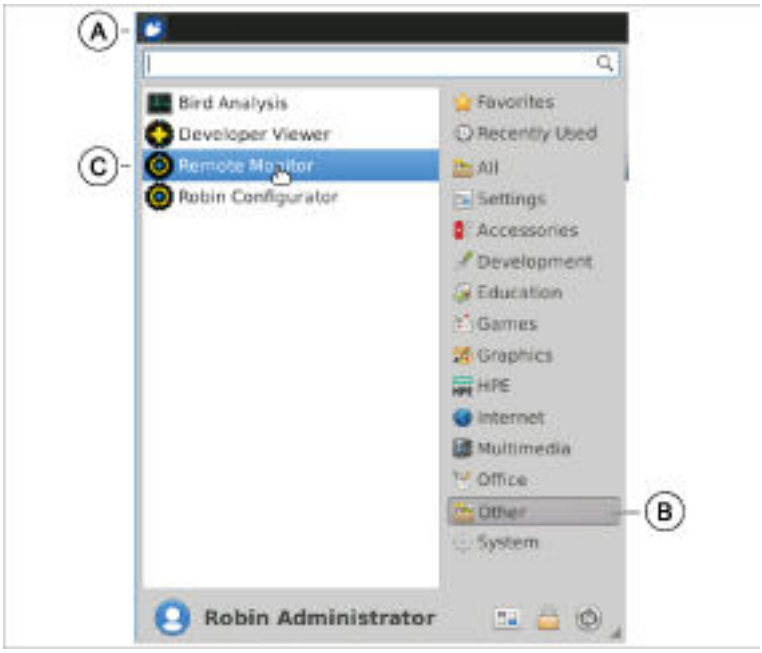
2.



Make sure that the main switch (A) of the breakout box is in the OFF position.

3. Connect the interconnect cable to the backside of the breakout box (B).
4. Apply power to the installation.
   a. Use either mains power in combination with an isolation transformer **or** use an inverter type generator with a minimum power of 3 kW.
5. In the processing station rack, switch on the UPS.
6. In the processing station rack, switch on the two servers.
7. Wait 10 minutes.
8. Put the main switch (A) of the breakout box in the ON position.

12.2.3. Start application

1. In the processing station, open the laptop.
2. Login with the password.
3. Press the CTRL button twice to go to the KVM switch page.
4. Select the first server and login with the same password.
5. Repeat this for the second server.
6. Use the KVM switch to select the database computer.
7. 

   Open the *Remote Monitor*.
   a. Click on the icon (A) in the upper left corner.
   b. If the Remote Monitor is not shown in the left-hand area, then click on *Other* (B) in the right-hand area.
   c. Click on *Remote Monitor* (C).
8. Make sure that the surrounding of the radar is safe.
   a. If necessary to keep people away, use fences.
   b. Check that there are no loose parts.
9. 

   On the *System* tab, click on the red *MAX Radar* button (A).

10. Click the *Start* button (B).

***Note*:** The *MAX Radar* button becomes green. If the radar is started for the first time after power is connected, then the radar gives a short buzzing noise.

11. Verify that the radar rotates.

12. Make sure that no error messages show.

13. Leave the *Remote Monitor* screen open.

14. Click *Robin configurator* to open it.

15. In the *Robin configurator* window, click *Site Deployment Wizard*.

16. In the *Location Name* field, type a name of your choice.

***Note*:** It is advised to use a name of the location.

17. Click the *Get GPS data* button.

***Note*:** Fields above this button will be filled in now.

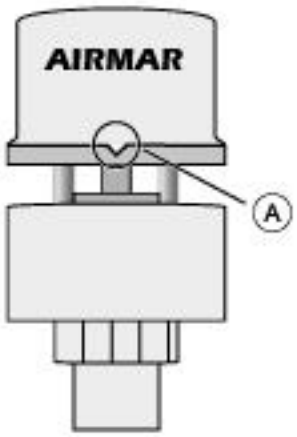
18. Make sure that the *Azimuth correction* field is empty or set to 0.

19. At the bottom of the screen, click the *Next* button.

20. In the *Ground level* field, type the height of the flange of the radar.

21. At the bottom of the screen, click the *Next* button.

22.



In the *Azimuth correction* field, type the correction for the north direction of the Weather Station.

a. If you installed the weather station with the notch (A) towards north, then type *0*.

23. In the bottom of the screen, click the *Next* button.

24. In the *Execute changes* window, click the *Apply* button.

25. Make sure that the green check marks show for every line.

26. Click the *Close* button.

27. Click *Developer Viewer* to open it.

28. In the panel at the right-hand side, make sure that *Map* and *Raw Image* are selected.

29. From the menu at the top of the screen, select *MAX* > *Connection* > *Send Raw Image*.

***Note*:** The radar image is shown now with a 1 km range.

30. Use the slider at the right-hand side until you get a useful image with only the main reflections.
31. From the menu at the top of the screen, select *MAX* > *Alignment Control*.
32. Use the slider at the bottom of the image to align the measured reflections with the Google maps image.
33. If the alignment is ok, read and record the value for the correction between the two sliders at the bottom of the screen.
34. Go back to the *Site Deployment Wizard* screen.
35. In the *Azimuth correction* field, add the found correction to the number that was filled in.
36. At the bottom of the screen, click the *Next* button.
37. At the bottom of the next screen, click the *Next* button again.
38. In the *Execute changes* window, click the *Apply* button.
39. Make sure that the green check marks show for every line.
40. Click the *Close* button.
41. Go back to the *Developer Viewer* screen and check the alignment again.

***Note*:** The system is now operational. It can take approximately 30 minutes until you get reliable tracks.

12.2.4. Trailer Transport Preparation

1. Bundle the interconnect cable and fixate it on the foot of the radar.
2. Use two 19 mm wrenches to install the transport bracket at the top of the flange.
3. Lower the nose wheel until it is on the ground.
4. If necessary, use the hand brake.
5. Lift the support legs of the trailer.
6. Keep the stamping plates at a safe location.
7. Make sure that there are no loose parts before leaving.

12.3. Quick Guide for MAX Radar Software

12.3.1. Start and Stop MAX Software

The MAX software is started automatically and runs in the background as a service. This means that there is no graphical user interface.
To start the software as a service, type the following command in a terminal:

```
sudo service robin-max-radar start
```

To stop the software, type:

```
sudo service robin-max-radar stop
```

The software can also be restarted via the Remote Monitor application installed on the system.

12.3.2. Start Graphical Mode

To diagnose or configure the software, it must be restarted in the graphical mode. In this mode, a user interface is available that provides radar images, sensor values, manual control etc.
First, the system background service must be stopped (see above). Then the application can be started via the start menu launcher (the easiest way) or from the command line:
Go to the directory where the software is installed. In a terminal, type:

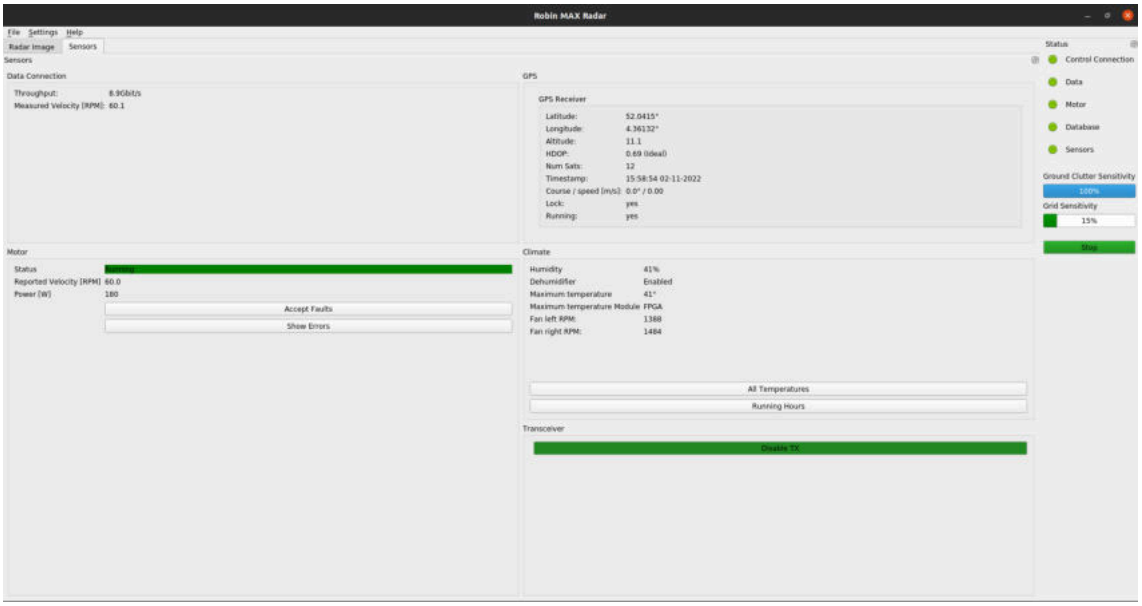
```
cd /usr/local/robin/MaxRadar/bin
```

To start the software, type:

```
sudo ./MaxRadar -g
```

12.3.3. Graphical User Interface

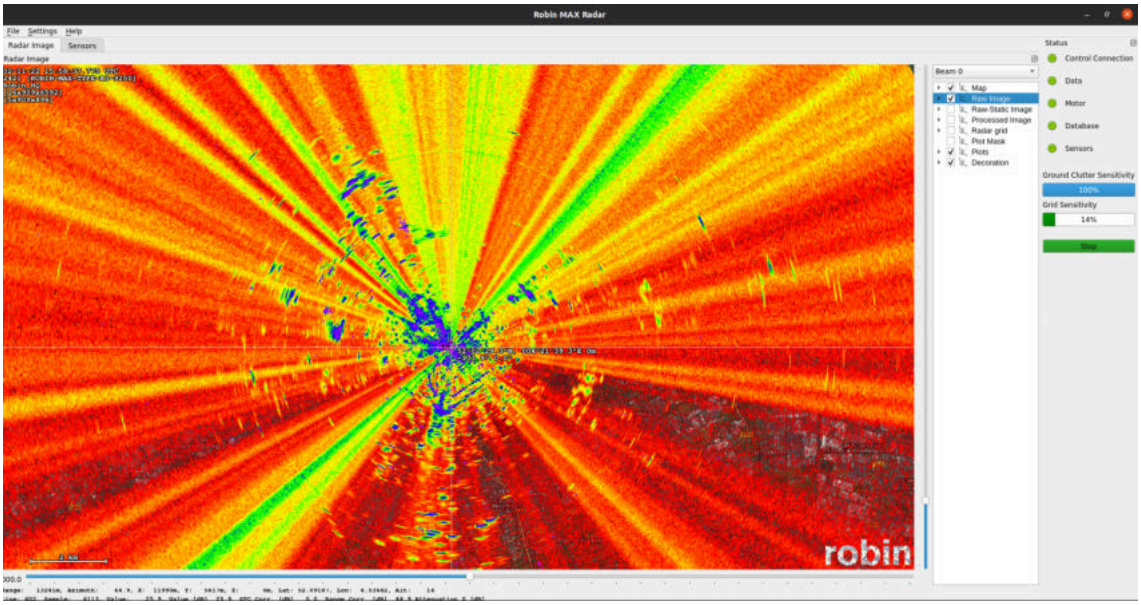
The user interface provides two tabs (*Radar Image* and *Sensors*), sensitivitu bars and a status panel to check the status of the major components. A green indicator means all is well, an orange or red indicator indicates a problem. If necessary, hover over the indicator to open a tooltip with a suggestion on how to solve the problem.



The help menu of the application contains a document with the keyboard shortcuts for the application, including the map control.

12.3.3.1. Radar Image tab

The *Radar Image* tab shows the actual image of the radar. The screen has three main parts:
- main view: actual image of the radar
- right-hand side: settings / visualisation
- bottom: status bar



Radar image

At startup the map is zoomed to the maximum range of the radar.

Table 16: Mouse behaviour

ACTION	RESULT
left button click	select something
right button click	zoom out (fixed decrement on single click)
left button drag	zoom in (draw rectangle)
	hold the CTRL key to reverse activate the pan function for a left button drag.
	hold the CTRL and the SHIFT key to display a ruler during left button drag. This will assist in measuring distances and bearings.
right button drag	pan (draw line)
wheel	zoom in or out with a fixed increment and decrement

If the map is zoomed out beyond the maximum range, it automatically re-centers on the radar. This can be used to quickly reset the view.

Range and line bar

The **Range** and **Line** bar shows the position of the mouse cursor, both in distance from the radar and angle with respect to the radar as well as in latitude and longitude.

Settings / visualisation

The layer control panel is used to enable or disable layers and to adjust the representation of layers, e.g. making the background map black and white or changing the colors.

Normally, the following layers are available:

- Background map: satellite imagery of a roadmap
- Raw image: original radar image

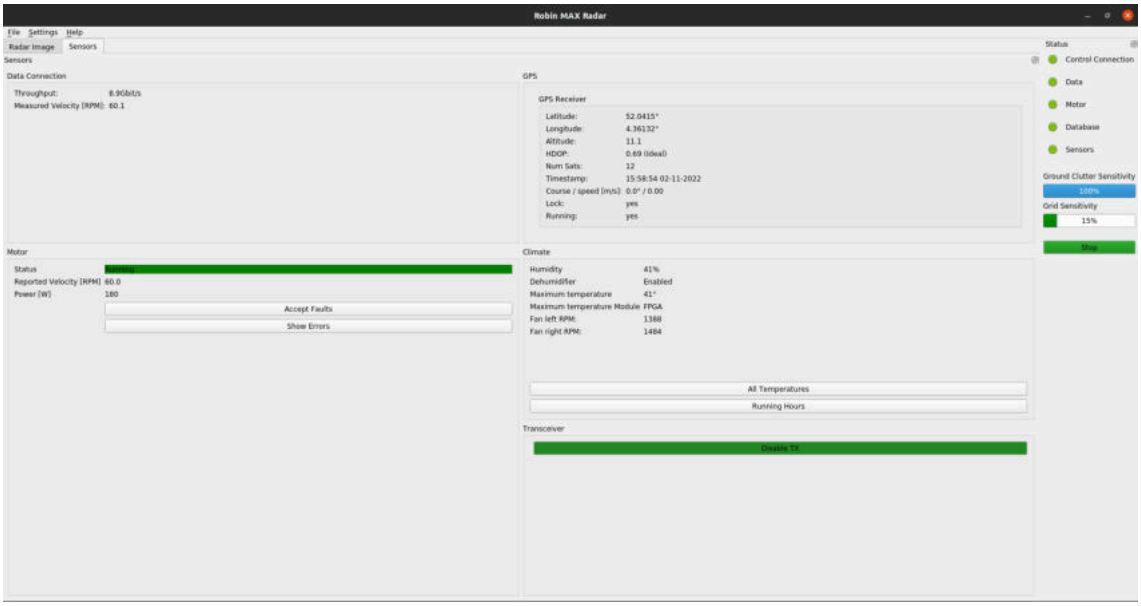
- Processed image: radar image with all the clutter removed
- Plots: detections in the current image not (yet) part of a track
- Decoration: the axis, a basic grid, range rings and metadata as text

In the layer control panel, each layer can be expanded with the + or > sign to show/hide specific attributes for this layer. Click or double-click on a attribute to change it.
Commonly used attributes for several layers are:

- Make the background layer darker or make it black and white. A black and white darkened map helps to discriminate the track easier, but still provides basic orientation.
- Enabling or disabling the raw image. This should be off during normal operation.
- Enabling or disabling plots.
- Enabling or disabling decoration options such as the axis and metadata.

12.3.3.2. Sensors tab

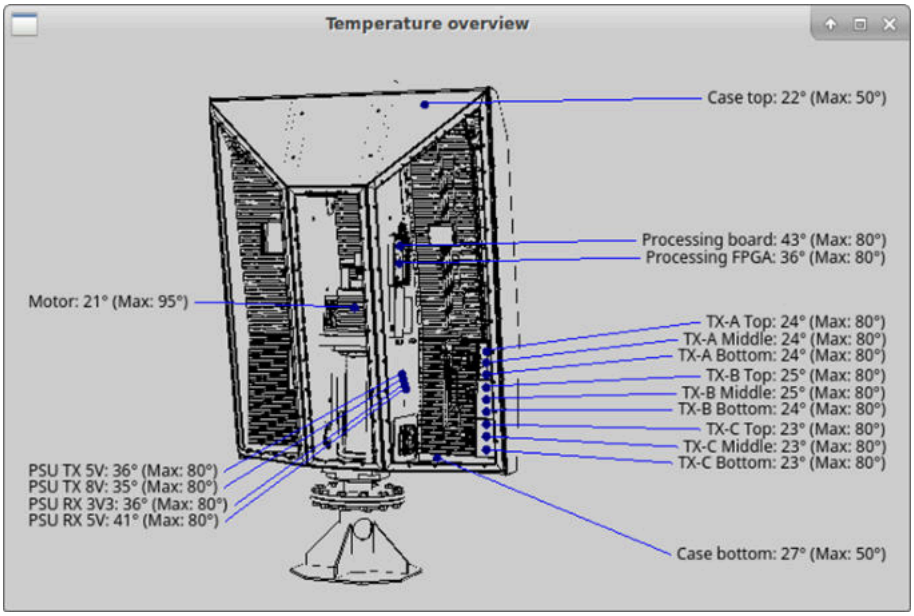
The *Sensors* tab displays the detailed status of all the components of the radar.



The *Sensors* tab has five sections:

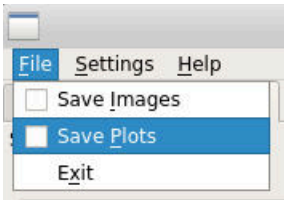
POS	SECTION	REMARKS
A	Data Connection	information about the received data over the 10 GBit fiber connection
B	Motor	status of the motor controller and control over the faults register
C	GPS	status of the GPS receiver and the position of the radar
D	Temperature	MAXimum temperature measured inside the radar and the component this temperature is measured at. Click the *All Temperatures* button to display a schematic overview of the radar and the measures values of all the temperature sensors (see example below).

POS	SECTION	REMARKS
E	Transceiver	to disable the transmitter for testing purposes



12.3.3.3. File menu

In the *File* menu, you have the option to enable the *Save Plots* option:



If you enable this option, each minute a file is written to the hard disk with the plots information.

12.4. Integration with External Systems

12.4.1. Introduction

The radar system can communicate with any system that requires real-time track information and/or control. Examples of these systems are:

- Bird track visualisation.
- Track analysing systems.

The following interfaces are available:

- Broadcast XML: provides real-time track and status data. This TCP/IP interface uses one-way communication and can therefore be used on any communication channel that supports either peer-to-peer communication or broadcast communication.

- ASTERIX Broadcast Streamer interface: ASTERIX is used for ATM - Air Traffic Management. It is a protocol that is supported by EUROCONTROL. Since it is a standard, it makes integration easier with client applications that want to receive ASTERIX. The protocol defines several CATs (data categories). IRIS can provide CAT34 and CAT48. This means that for CAT34 status messages are sent, for CAT48 tracks are sent. See https://www.eurocontrol.int/asterix for more information.
- SAPIENT interface: SAPIENT is the abbreviation for Sensing for Asset Protection using Integrated Electronic Network Technology protocol. SAPIENT is a standard for multi-sensor data fusion in UAS (Unmanned Aerial System) detection systems. A radar detection area normally has to deal with all kinds of sensors: radars but also cameras, RF, etc. If each sensor supports SAPIENT, all sensors can be integrated more easily to make a multi-sensor detection system.

  Note: In 21.10 Robin released support for SAPIENT. This was NATO's version 1.0 and used XML. From 22.10 Robin releases support for SAPIENT version 2.0. The main difference is the use of protocol buffers (protobuf). This simply means that the data being exchanged is in binary format instead of text.
- C2 XML: used to send commands to start/stop and to configure the radar. This is also a TCP/IP interface and allows only a single connection/master.

All communication protocols are based on XML (except for ASTERIX, which is binary), which is a versatile format to exchange information. The structure of the contents are defined with an XML Schema Definition (XSD), which is on the Bird Monitor system (/usr/local/robin/api/*.xsd).

If necessary, please contact your supplier for a sample of an XML file and the XSD file.

12.4.2. Real-Time Broadcast Interface

This real-time data interface listens on port 16710 (configurable) and streams the XML. Each update sends one root element. Each closing tag is followed by a newline character to facilitate parsing. The root element is named "Robin". The next level element is one or more of the following elements:

- *Status*
- *Tracks*
- *Image*
- *Events*

The *Status* element is used to convey status information such as the operational state of the system and any warnings or errors that may have been detected at the system level.

The *Tracks* element is used to send current information about the radar tracks. Each track has a unique identifier, so changes over time can be observed. The latest state of each track is represented, even if it is unchanged since the last update. A timestamp of the last update

is included in the state. Tracks that are no longer in the list can be considered to be gone/ dropped.

The *Image* element is used to send information about the last image received from the RS with RsId. This includes the percentage of tiles in the radar image where rain or sea has been detected, and the wind speed.

The *event* element can be used to actively warn client systems about certain events. An example could be an alarm if a drone has been detected. Another example could be a warning about degraded performance due to interference. These events are configurable and most likely application specific. For the purpose of this document we consider this element a placeholder for future expansion.

Status
The radar system can consist of a central processing system and one or more sensors. The status element contains status information about the individual sensors.

The *SystemStatus* element contains the following elements:

1. *Name;* a generic name of the system
2. *Version*; a version number of the software
3. *OperationalState*; the operational state of the central processing system, i.e. *idle*, *operational*, *initializing*, *error*
4. *Messages*; contains any number of child elements for event messages. These can be any type of messages, but most commonly used for error messages. Messages contain a timestamp and unique id attribute.
5. *Sensors*; a list of *SensorStatus* elements for each sensor system attached.
6. <attribute> *timestamp;* the time the message was created.

The *Sensor Status* shows status information from the radar sensor (RS) with id 'RsId'. One such entry is sent per radar in the installation. The *SensorStatus* element contains the following elements:

1. *Name;* a generic name of the system
2. *Version*; a version number of the software
3. *Position*; location (latitude, longitude, altitude) of the device using the WGS84 coordinate system. Latitude and longitude are in decimal degrees, altitude in meters above mean sea level.
4. *Type:* the type of sensor system, *i.e. search radar, acquisition radar, camera,* etc.
5. *OperationalState*; i.e. *idle*, *operational*, *initializing*, *error*
6. *BlankingSector;* zero or more definitions of a blanking sector. The *BlankingSector* element itself contains two child elements: *Angle* and *Span* (both floating point values in radians).

7. *Messages*; contains any number of child elements for event messages. These can be any type of messages, but most commonly used for error messages. Messages contain a timestamp and unique id attribute.
8. *Components*; gives the status of the monitored components/hardware. The components have the same status as the Status in the side bar of the ELVIRA Radar application.

Tracks

The *Tracks* element contains the following elements:

- A sequence of *Track* elements

<attribute> timestamp; the time this track list was produced, i.e. all track information is up to date up to this timestamp.

The regular *Track* element contains the following elements:

1. *Timestamp*; the time this track was last updated.
2. *Position*; current location (latitude, longitude, altitude) of the track using the WGS84 coordinate system. Latitude and longitude are in decimal degrees, altitude in meters above mean sea level.
3. *Velocity*; the speed vector of the track. Defined as bearing in degrees, elevation (change of altitude) in degrees and velocity in meters/second.
4. *Classification*; The classification of the track. This is a string value and will match the names in the file SA.config (i.e. LARGE_BIRD, AIRCRAFT, etc.). The classification can also be empty.
5. *Reflection*; the measured radar reflection of the track which is indicative for the radar cross section (RCS). The unit is [dBm^2].
6. *Score*; the score of the track, a measure of the tracking quality. Value is between 0 and 1, where 0 is poor and 1 is a perfect quality track.
7. *Alarm*; a boolean value that indicates if this track triggered an alarm.

Image

The image element contains the following elements:

1. *Rsid*: unique ID of the radar sensor, that sends the message.
2. *RainPercentage*: percentage of tiles in the radar image where rain has been detected.
3. *SeaPercentage*: percentage of tiles in the radar image where sea has been detected.
4. *WindSpeed*: wind speed (m/s).

The real-time broadcast interface is a plugin in the Bird Analysis software. It can be configured in the config file PluginXmlBroadcastStreamer.config. You can enable/disable the service and you can change the port number. If you enable the config item SEND_LOCAL_POLAR, the radar will output local polar coordinates : range [m], azimuth [deg], elevation [deg].

If you enable the config item SEND_LOCAL_CARTESIAN, the radar will output local cartesian coordinates : X [m], Y [m], Z [m].
If you enable the config item SEND_COVARIANCE_XYZ, the radar will output a 3x3 covariance matrix of the position state vector (local cartesian coordinates). Each row is marked by square brackets []. With this information, you can estimate an uncertainty area which can be used in a multi-sensor tracker.

Example of real-time messages:

```
normal operation
<SystemStatus timestamp="2020-10-29T13:05:06.191Z">
        <Name>Bird Analysis</Name>
        <Version>20.04.0 (REL-20.04.x 32963)</Version>
        <OperationalState>operational</OperationalState>
        <Messages/>
        <Sensors>
                <SensorStatus>
                        <Name>RAF-LOS</Name>
                        <Version>20.04.0 (REL-20.04.x 32963)</Version>
                        <OperationalState>operational</OperationalState>
                        <BMProcessingState>running</BMProcessingState>
                        <Position>
                                <Latitude>57.70541300</Latitude>
                                <Longitude>-3.34541330</Longitude>
                                <Altitude>4.00000000</Altitude>
                        </Position>
                        <SensorType>SearchRadar</SensorType>
                        <Messages/>
                </SensorStatus>
        </Sensors>
</SystemStatus>

radar stop
<SystemStatus timestamp="2020-10-29T13:06:44.218Z">
        <Name>Bird Analysis</Name>
        <Version>20.04.0 (REL-20.04.x 32963)</Version>
        <OperationalState>operational</OperationalState>
        <Messages/>
        <Sensors>
                <SensorStatus>
                        <Name>RAF-LOS</Name>
                        <Version>20.04.0 (REL-20.04.x 32963)</Version>
                        <OperationalState>idle</OperationalState>
                        <BMProcessingState>idle</BMProcessingState>
```

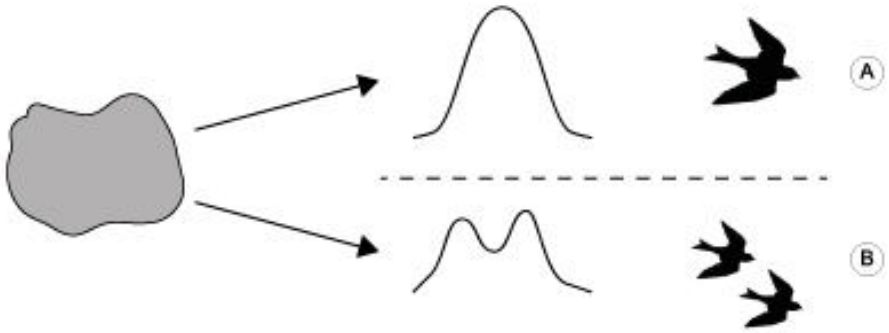
```
                        <Position>
                                <Latitude>57.70541300</Latitude>
                                <Longitude>-3.34541330</Longitude>
                                <Altitude>4.00000000</Altitude>
                        </Position>
                        <SensorType>SearchRadar</SensorType>
                        <Messages/>
                </SensorStatus>
          </Sensors>
</SystemStatus>

radar software off
<SystemStatus timestamp="2020-10-29T13:08:16.125Z">
        <Name>Bird Analysis</Name>
        <Version>20.04.0 (REL-20.04.x 32963)</Version>
        <OperationalState>operational</OperationalState>
        <Messages/>
        <Sensors>
                <SensorStatus>
                        <Name>RAF-LOS</Name>
                        <Version>20.04.0 (REL-20.04.x 32963)</Version>
                        <OperationalState>idle</OperationalState>
                        <BMProcessingState>idle</BMProcessingState>
                        <Position>
                                <Latitude>57.70541300</Latitude>
                                <Longitude>-3.34541330</Longitude>
                                <Altitude>4.00000000</Altitude>
                        </Position>
                        <SensorType>SearchRadar</SensorType>
                        <Messages/>
                </SensorStatus>
        </Sensors>
</SystemStatus>

Track info
<Robin>
        <Tracks timestamp="2020-10-29T14:00:13.085Z">
                <Track id="50967">
                <Timestamp>2020-10-29T14:00:11.796Z</Timestamp>
                <Position>
                        <Latitude>57.70535724</Latitude>
                        <Longitude>-3.33762374</Longitude>
                        <Altitude>1.70460737</Altitude>
```

```
                </Position>
                <Velocity>
                        <Azimuth>188.05856323</Azimuth>
                        <Elevation>41.65518570</Elevation>
                        <Speed>0.14458258</Speed>
                </Velocity>
                <Classification>VEHICLE</Classification>
                <Reflection>-1.26561737</Reflection>
                <Score>0.99602032</Score>
                <Alarm>false</Alarm>
                </Track>

        <Track id="103538">
        <Timestamp>2020-10-29T14:00:12.230Z</Timestamp>
                <Position>
                        <Latitude>57.70040621</Latitude>
                        <Longitude>-3.35845669</Longitude>
                        <Altitude>19.92139763</Altitude>
                </Position>
                <Velocity>
                        <Azimuth>194.34893799</Azimuth>
                        <Elevation>13.29569435</Elevation>
                        <Speed>20.80492020</Speed>
                </Velocity>
                <Classification>FLOCK</Classification>
                <Reflection>-23.70399857</Reflection>
                <Score>0.72189337</Score>
                <Alarm>false</Alarm>
                </Track>
        </Tracks>
</Robin>

Image
<Robin>
    <Image RsId="1">
         <RainPercentage>0.12</RainPercentage>
         <SeaPercentage>0.11</SeaPercentage>
         <WindSpeed>10</WindSpeed>
    </Image>
</Robin>
```

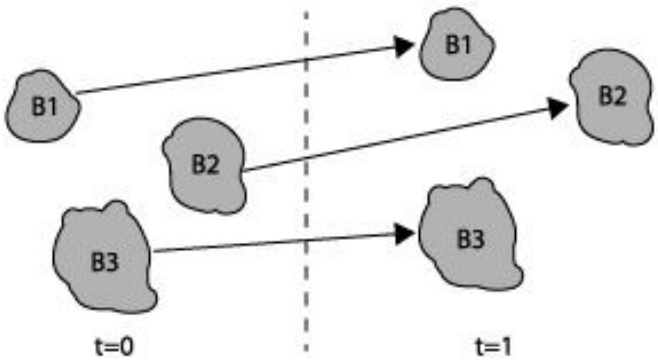
12.5. Track Classification

12.5.1. Track Processing

If an object is detected and recognised as a plot, then the plots are checked. If it has one peak value, then it is probably caused by one object (bird) (A). But if it has two peak values, then it will be caused by two objects (birds) that fly close to each other (B). In that case, a property of both tracks will be set to 'in_blob_formation'. This property will be used later to define that the birds are part of a flock.



For each plot, the size and the distance to the radar are used to determine a size value that is corrected for the distance (Radar Cross Section).
The tracking process is done constantly and plots are formed into tracks and given a certain reliability value (score). Only a track with a sufficient score is classified and stored in the database.



Of all reliable tracks, the speed of the track is calculated. Also, the median value of the RCS is calculated, giving the Median Radar Cross Section value. Tracks can get a 'in_track_formation' property set if it recognised that they fly close to each other in the same direction. The rules are defined in the configuration file SA_MAX.config.

IN_TRACK_FORMATION property

A typical definition is:

```
FORMATION_ASSIGNER
{
 ENABLED TRUE
 MAX_TRACK_DISTANCE 100
 MAX_SPEED_DIFFERENCE 5
 MAX_COURSE_DIFFERENCE 35
```

```
 MIN_NUMBER_OF_TRACKS 3
 MIN_SCORE 0.7
}
```

With this definition, each track will get an 'in_track_formation' property set if there are at least three tracks, each with a reliability score of 0.7 or higher, that fly within 100 m from each other with a maximum speed difference of 5 m/s and a maximum difference in the direction of 35 degrees.

12.5.2. Track Classification

The SA_MAX.config file defines how tracks are classified.

ROAD ADHERENCE property

If a track only moves on pre-defined roads on the map, it is assumed to be a vehicle. These settings are defined by MAX and should not be changed.

TRACK CLASSIFICATION

The calculated Median RCS value and the property 'in_blob_formation' are the basis for the bird classification. The default values are listed below. The classification is done in top-down sequence.

Table 17: Track classification criteria

CRITERIA			TRACK CLASSIFICATION
Median RCS VALUE	**AND**	**PROPERTY**	
no limits		AIRCRAFTSTATE_AIRBORNE_AIRCRAFT	AIRCRAFT
no limits		ROAD_ADHERENCE	VEHICLE
-30...+10		in_blob_formation	FLOCK
-20...+5		-	LARGE
-20...-15		-	MEDIUM
-40...-20		-	SMALL

12.5.3. Change SA_MAX.config File

Changes can also be made in Robin Configurator

If you want to use different names for the classifications (i.e. high_risk_bird instead of large_bird) or want to redefine the limits for the different sizes, then you have to change the SA_MAX.config file that is stored in the directory */user/local/robin/BirdMonitor/cfg*.

To change the file, either go to *Place* > *Home* and open the file with the Xubuntu file browser or go to *Applications* > *Accessories* > *Terminal* to open a terminal and type:

```
gedit /user/local/robin/BirdMonitor/cfg/SA_MAX.config
```

In the file, you can define the definition for the 'in_track_formation' property, names of classifications and the limits for the various sizes of birds.

If you want to change definition for the 'formation' property, search for a line that starts with

```
FORMATION_ASSIGNER {
```

If you want to change the name of a classification or the limts for the sizes, search for a line that starts with

```
CLASSIFICATION_ASSIGNER {
```

. Within this assigner, all available classifications are listed.

EXAMPLE:

Suppose you want to rename LARGE_BIRD into HIGH_RISK_BIRD and you want to set the limits to MCM values of -10...+10.

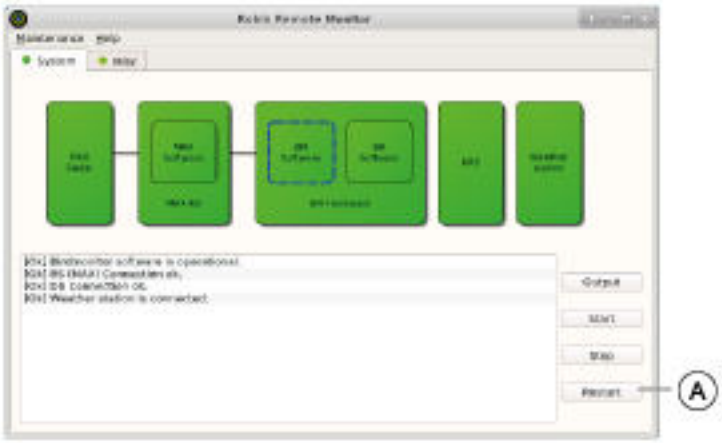
In the file, search for the classification part of the large birds:

```
CLASSIFICATION
{
CLASSIFICATION LARGE_BIRD
NAME "Large bird"
DEFAULT_COLOR #ff0000
CRITERIUM
{
CRITERIUM MEDIAN_RADAR_CROSS_SECTION
CRITERIUM_TYPE FIXED
MINIMUM -20
MAXIMUM 5}
}

Make changes to this part so it looks like this:
CLASSIFICATION
{
 CLASSIFICATION HIGH_RISK_BIRD
NAME "High risk bird"
DEFAULT_COLOR #ff0000
CRITERIUM
{
CRITERIUM MEDIAN_RADAR_CROSS_SECTION
CRITERIUM_TYPE FIXED
MINIMUM -10
MAXIMUM 10}
}
```

***Note*:** Make sure that you also change the maximum limit of the medium sized birds from *-15* to *-10* to avoid a gap between the two sizes.

After saving the file, restart the Bird Monitor.

In the *Robin Remote Monitor*, make sure that the *BM Software* button is selected. Then click the *Restart* button (A).



12.6. Measuring Principle

The principle of radar is to emit a radio frequency signal. This signal will reflect against any object. The reflection of a target is received by the radar. The amplitude of the signal and the time difference between send and receive is an indication of the size and distance of the target.

There are two main differences between a conventional pulse radar system and the MAX system:

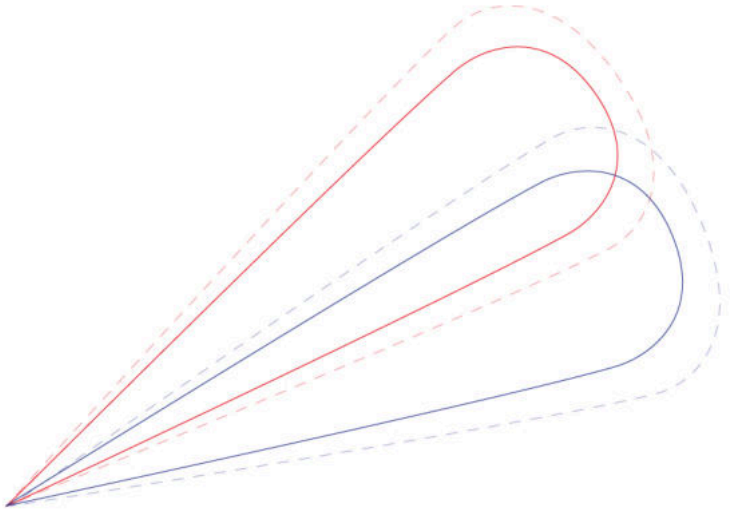
- Frequency modulated continuous wave
- Stacked elevation beams

MAX is a continuous wave radar, so it continuously transmits RF energy. This principle has the advantage that the peak power of the system is equal to the average power of the system. A pulse radar system has a low duty-cycle, so it needs high peak power to get the same average power.

Example: A 60 kW magnetron pulse radar with 120 ns pulses at a pulse repetition frequency of 1800 Hz has an average power of 14 Watt, less than the MAX /> system which has a continuous output power of 44 W Watt.

The arrays of wave guides both in TX and in RX provide beam forming. This means that the RF energy is pointed into a specific elevation direction, i.e. shaping the beam. The TX antenna uses beam forming to point the majority of the RF energy in the direction where the radar must be the most sensitive (between 50 meter and 1 kilometre altitude). This provides improved efficiency and clutter reduction compared to a conventional fan beam.

The RX arrays uses beam forming to make narrow elevation beams to measure the elevation of a detected target. The elevation beams are stacked upon each other, partly overlapping. When a target is detected, it will be detected in two beams simultaneously but with different strengths. This allows the processing to calculate an accurate elevation of the target. This technique is comparable to a conventional technique called ‘monopulse detection’.



NOTE: this figure shows sharp-formed beams, but in practice the signals degrade gradually.
The beam forming of the receiver is done by software and is called Digital Beam Forming (DBF). In the MAX system it is done by a Graphical Processing Unit (GPU) in the processing station. The RX beams can be changed easily if it is required (e.g. excessive sea clutter or installation at a high altitude compared to ground).
The processing software processes the data of all RX beams to get a full 3D image of the detection area. It uses advanced filtering to discriminate clutter from moving targets. A detection of a moving target is reported to the central processing as a ‘plot’ with the time, position and size. The Bird Monitor software processes the plots into tracks.

12.6.1. Functions

Detection range

The detection range of a radar is dependent on a lot of aspects:

- Size of the target
- Precipitation
- Clutter
- Propagation effects

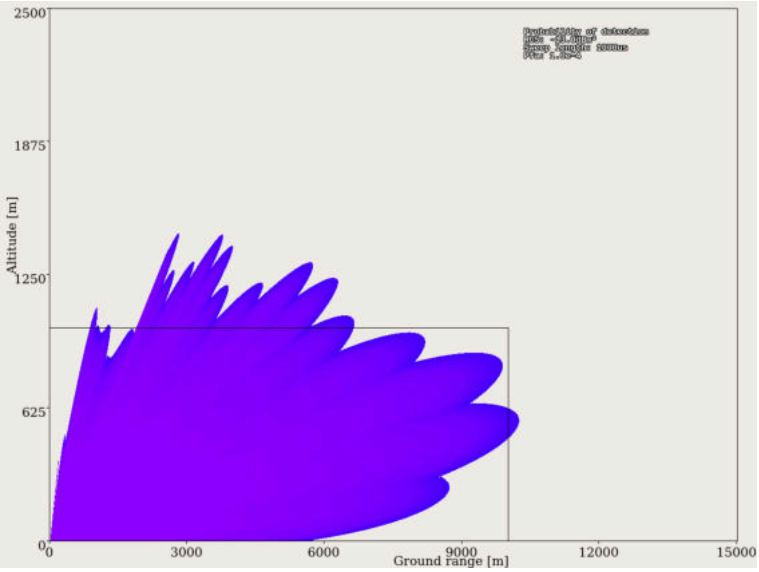
In the following diagrams, the probability of detection of the MAX radar is given for three different targets:

- 2 Standard Avian Target (SAT, barnacle goose): -13 dBm²
- 1 Standard Avian Target (carrion crow): -16 dBm²
- A small sized bird (songbird): -25 dBm²

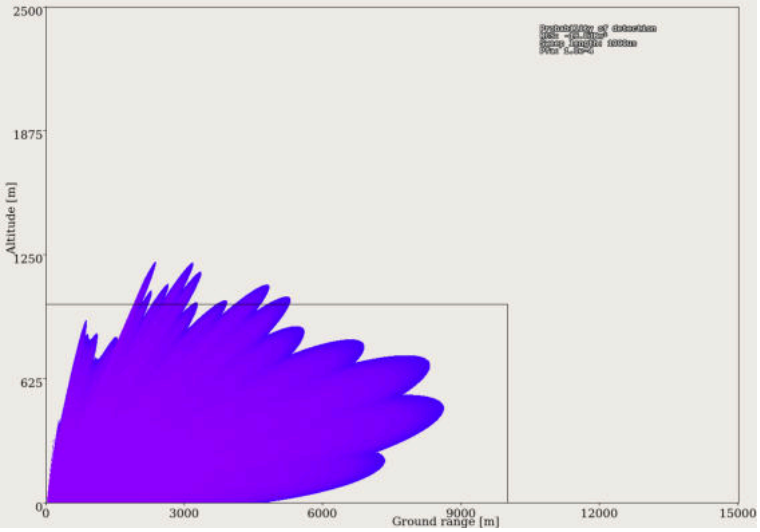
In this diagrams the following physical aspects are taken into account:

- Size of the target
- Transmit antenna pattern
- Receive antenna pattern
- Beam forming losses
- Atmospheric losses
- System losses and radar noise figure

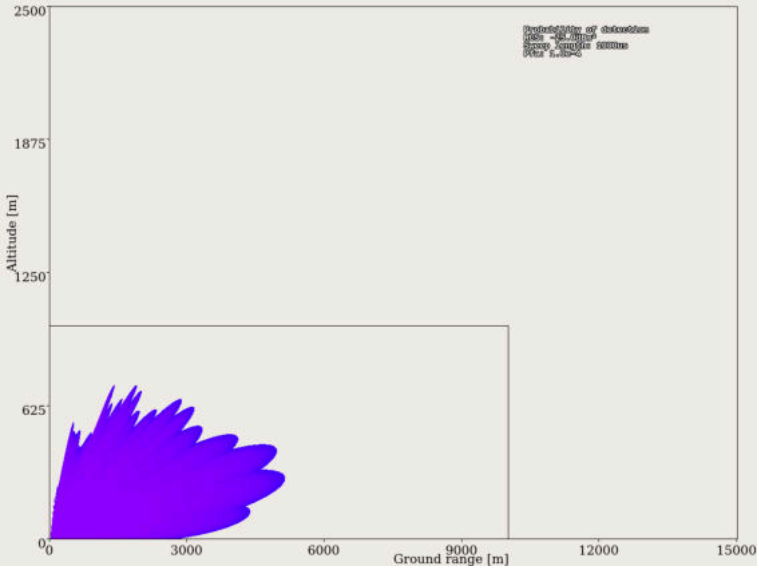
Detection range 2 SAT / -13 dBm²



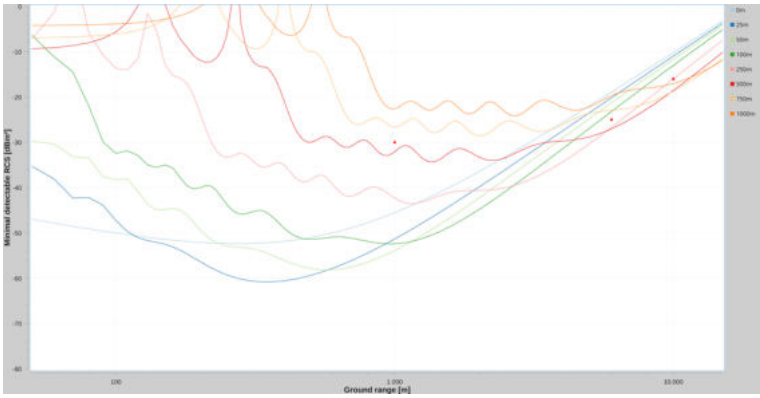
Detection range 1 SAT / -16 dBm²



Detection range songbird / -25 dBm²



Another useful representation is the lowest detectable Radar Cross Section (RCS) vs the ground range for several fixed altitudes. This diagram tells in which minimum and maximum range a target is detectable given its RCS and flight altitude.



The X-axis and Y-axis are in logarithmic scale.

12.7. Abbreviations

Abbreviation	Description
AOI	Area Of Interest
BA	Bird Analyser
BM	Bird Monitor
CFAR	Constant False Alarm Rate
CWDM	Coarse Wavelength Division Multiplexing
DBF	Digital Beamforming
dBi	Decibel relative to isotropic antenna
dBm	Decibel relative to one milliwatt
dBm^2	Decibel per square meter
DHCP	Dynamic Host Configuration Protocol
EIRP/ERP	Equivalent (Isotropic) Radiated Power
FFT	Fast Fourier Transform
FMCW	Frequency Modulated Continuous Wave
FORJ	Fiber Optic Rotary Joint
GPS	Global Positioning System
GPU	Graphical Processing Unit
GUI	Graphical User Interface
ICNIRP	International Commission of Non Ionizing Radiation Protection
IF	Intermediate Frequency
ITAR	International Traffic in Arms Regulations
KVM	Keyboard, Video & Mouse
LAN	Local Area Network
LTS and STS	Long Term Storage and Short Term Storage
PA	Power Amplifier
PSU	Power Supply Unit
QRC	Quick Reference Card
RCCB	Residual Current Circuit Breaker
RCS	Radar Cross Section

Abbreviation	Description
RF	Radio Frequency
RH	Relative Humidity
RPM	Rotations Per Minute
RRS	Robin Radar Systems
RX	Receive
SAT	Standard Avian Target
SNR	Signal to Noise Ratio
TX	Transmit
UAS	Unmanned Aircraft System
UI	User Interface
UPS	Uninterruptable Power Supply
XML	eXtensible Markup Language

This content is subject to changes.

If you have any questions about this document, please contact Robin Radar by sending a message to info@robinradar.com.
www.robinradar.com