AireBeam™

Millimeter Wave Transmission Systems

Installation and Maintenance Manual

AireBeam™ Series

AireBeam™ 60-100-xx

AireBeam™ 60-1250-xx

AireBeam™ 70-100-xx

AireBeam™ 70-1250-xx

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Table of Contents

List of Figures

List of Tables

Safety

Cautions and Warnings

The following symbols are used in this manual to indicate that the installer should take particular caution to prevent injury or damage to the equipment.

Exercise caution when you see this symbol. It indicates actions that could be harmful to the installer or to the equipment.
Exercise extreme caution when you see this symbol. It indicates potentially lethal voltages!

Note: There are no serviceable parts within the units and the system should not be opened in the field.

Observe Standard Precautions

All persons having access to this equipment must observe all standard precautions as defined in applicable national statutory health and safety legislation.

The outdoor equipment must be properly grounded to provide protection against voltage surges and prevent the built-up of static electric charges. In the event of a short circuit, grounding considerably reduces the risk of electrical shock.

For installations in the U.S.A., for information with respect to proper grounding and applicable lightning protection for DC cables, please refer to Articles 810830 of the National Electrical Code, ANSI/NFPA No. 70.

In case the system is installed in a country outside of the U.S.A., implement protection in accordance with local safety standards and regulatory requirements.

Do not install or operate this equipment in the presence of or close to flammable gases or fumes. Operation of any electrical equipment in such an environment constitutes a potential safety hazard.

Exposure to Millimeter Wave Frequencies

Please observe the following:

FCC ID : USPAB70100
Warning: This device is a high powered transceiver that operates at frequencies that could be potentially harmful to human tissue if the following precautions are not taken,
(1) Minimum safe operating distance of 1.9 meters must be observed at all times between unit and users*
(2) Unit shall be mounted so that minimum operating distance is no inadvertently impinged by the general public, or non user personnel.
*Please see exposure limits listed in FCC §1.1310

Airebeam™70-100-12

FCC ID : USPAB70100
Warning: This device is a high powered transceiver that operates at frequencies that could be potentially harmful to human tissue if the following precautions are not taken,
(1) Minimum safe operating distance of 4.8 meters must be observed at all times between unit and users*
(2) Unit shall be mounted so that minimum operating distance is no inadvertently impinged by the general public, or non user personnel.
*Please see exposure limits listed in FCC §1.1310

Airebeam™70-100-24

Qualified Personnel

Qualified personnel who understand and are trained to work with the equipment must perform all repair, modification, reconfiguration, and upgrading operations.

Note: Always power the system down before moving or removing the system.

Service

There are no serviceable parts within the radio units. Only factory trained personnel can provide service on any internal components of the radio units.

Regulatory Information

These device have been type approved by FCC in accordance with Part 15B and Part 2, Subpart J, Part 101 Subpart Q of the Federal Communication Commissions rules.

In the U.S. millimeter wave radio transmission equipment operating in the 71-76, 81-86, and 92-96 GHz frequency ranges must be registered with the FCC as provided for in Part 101 of the FCC regulations. Customers in the U.S. are responsible for obtaining proper operator licenses. For more information on how to get a license to install and operate millimeter wave radio transmission equipment contact Rayawave via E-mail support@rayawave.com or call the Rayawave office at 859-350-4259.

Warranty

Rayawave warrants this product against faulty materials or workmanship under the terms of a Standard Warranty and Support Agreement provided that the product was purchased directly from Rayawave or from one of our authorized resellers. Please contact Rayawave for additional information or to obtain a copy of the Warranty Agreement.

Products

This manual covers the following Rayawave products

Product	Description	Model Number
Airebeam™70-1250-24	1.25 - E Band 24" Ant.	E7012501A-24
Airebeam™70-1250-12	1.25 - E Band 12" Ant.	E7012501A-12
AireBeam™60-1250-24	1.25 - 60 Ghz 24" Ant.	S6012501A-24
AireBeam™60-1250-12	1.25 - 60 Ghz 12" Ant.	S6012501A-12
Airebeam™70-100-24	100 - E Band 24" Ant.	E7010001A-24
Airebeam™70-100-12	100 - E Band 12" Ant.	E7010001A-12
AireBeam™60-100-24	100 - 60 Ghz 24" Ant.	S6010001A-24
AireBeam™60-100-12	100 - 60 Ghz 12" Ant.	S6010001A-12

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Rayawave

1. Introduction

This chapter provides a short overview and a general introduction to Rayawave's millimeter wave radio transmission technology.

1.1. General Overview

1.1.1. Millimeter Wave Wireless Transmission Systems

Millimeter wave transmission systems provide a cost-effective solution for high capacity point-to-point wireless network connections. The transmission systems are available for operation in the 60 GHz or 70 GHz millimeter-wave frequency band. The systems support network traffic up to 1.25 Gbps in full-duplex mode. Like any other higher frequency radio transmission system, millimeter wave transmission systems require line-of-sight between locations for proper operation.

In North America the operation of a radio transmission system in the 60 GHz frequency spectrum is license free. Millimeter wave transmission systems in the frequency bands from 71…76, 81…86, and 92…96 GHz require a license for operation. To obtain a license the user has to register the system into a nationwide database. This process is pretty straightforward and a license can be obtained over the Internet. The user has to ensure that such a license is in place before installing a millimeter wave radio transmission system. Please, contact either Rayawave or the reseller if you have any question regarding the licensing process.

Outside of North America the regulations regarding operation of millimeter wave radio products vary from country to country. Please, contact your local regulatory authority or Rayawave if you have questions related to this topic.

1.1.2. Typical Applications

Typical system applications for point-to-point millimeter wave transmission systems include:

Enterprise LAN-LAN connectivity

One of the most common applications of point-to-point millimeter wave transmission system is shown in Fig.1-1. Network administrator operating LAN networks in campus environment very often face the challenge to establish a high-speed network connection between remote buildings. Instead of digging a fiber-optic cable or leasing an expensive network connection from a local service provider, the network administrator can use a millimeter wave radio transmission system to establish network connectivity between remote locations. In the majority of cases using a high capacity millimeter wave solution is not only less expensive, but also drastically reduces the time of deployment when compared to the cumbersome process of dealing with either right-of-way issues, digging fiber, and/or wait for the local service provider to establish a high capacity network connection. There are also no long term leasing agreements and in case that the network connection is temporarily or no longer required, the systems can be easily re-deployed at a different location

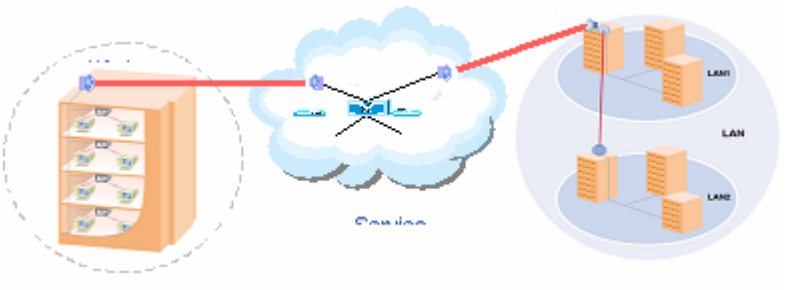

Figure 1-1: Enterprise LAN-LAN building-to-building connection

Camera Surveillance and Security Applications

Security applications very often require the connection and integration of security cameras into a centralized data center. Backhauling CCTV or IP camera signal can be a challenging task especially when multiple high-resolution cameras are part of the camera network. Not only bandwidth but also latency limits very open the use of alternative radio systems such as unlicensed spread spectrum radios. Especially the use of alternative lower frequency and unlicensed spread spectrum radio technology suffer very often from radio interference and consequently the camera signals are not transmitted reliably. Due to the narrowness of the transmission beams, millimeter wave radios due not suffer from interference and in addition these systems are highly secure and are extremely difficult to intercept even without using more sophisticated network encryption.

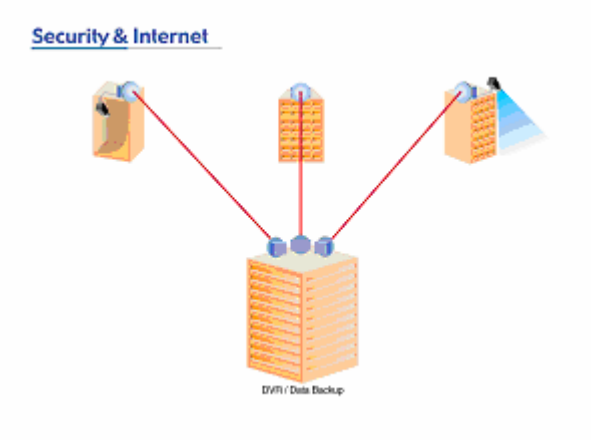

Figure 1-2: Typical security camera application

Mobile Wireless, WiFi / WiMAX backhaul connectivity

Mobile service providers operating either traditional mobile wireless networks based on GSM/CDMA technology or WiFi/WiMAX network operators very often face the challenge to interconnect base stations into the network. Especially over the last few years and due to the appearance of higher bandwidth data applications (as opposed to pure voice applications), the base station traffic backhaul requirements drastically increased. By now the costs for back-hauling base station traffic has become a major expense for mobile operators

that used traditional T1/E1 leased lines to accommodate this task. Besides the fact that slow speed leased lines are not capable to keep up with these traffic requirements in some cases the non-scalable leased line business model does not make financial sense anymore. Millimeter wave transmission radios can help the operators to overcome these technical and financial challenges.

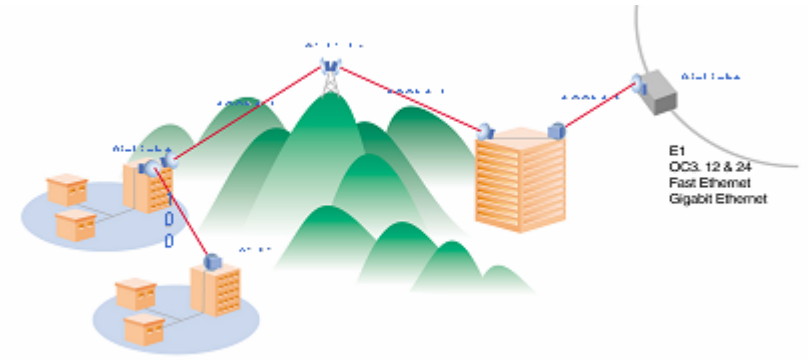

Figure 1-3: Typical mobile wireless backhaul application

Disaster Recovery and network redundancy

Disaster recovery and network redundancy are two applications that gain more and more importance in networks that need to operate at highest level of availability. High capacity millimeter wave radio transmission equipment is gaining more and more market acceptance to fulfill the task of being a redundant network transmission media.

Metro network extensions

With less than 10% of commercial buildings in the United States connected to a high capacity fiber network. However, most of these buildings are closer than 1 mile away from the next fiber hub. Consequently, the "Last Mile" connectivity problem becomes a real challenge for operators trying to increase their customer base especially in metropolitan areas. High capacity millimeter wave radios are a perfect solution to overcome this obstacle without incurring the extremely high costs of digging fiber.

1.2. Network Connection

Rayawave AireBeam™ systems are designed as wireless 100 Mbps (Fast Ethernet) and 1250 Mbps (Gigabit Ethernet) IP bridges and the systems support any point-to-point network architecture. From the networking point of view they provide a physical layer connection to interconnect two remote LAN networking segments. The physical connection to the network (e.g. connection to a switch or router) is done by using a multimode fiber following the 100Base-FX and 1000Base-SX Ethernet industry standard as to wavelength and power. A media converter can be used to convert the optical fiber signal into an electrical signal in case that the networking equipment is not equipped with an optical fiber connection. Please, contact Rayawave or your reseller to obtain more information on media converters.

1.3. Operating Parameters

Millimeter wave systems operating in the 60/70/80 GHz frequency ranges are capable to transmit and receive high data rates such as 1250 Mbps (Gigabit Ethernet) over distances exceeding several kilometers. The actual distance/availability performance of a specific system depends on parameters such as transmission power, antenna size, and receiver sensitivity. In general terms millimeter wave frequencies are attenuated by rain and in addition by oxygen absorption in case of systems operating in the 60 GHz frequency range. Oxygen absorption plays a minor role in the higher 70/80/90 GHz frequency ranges and therefore these systems are typically better suited to establish a connection over longer distances. Unlike other wireless technologies such as free space optics (FSO) and that are also capable to transmit high data rates, millimeter wave transmission does not suffer from attenuation in fog, during sand storms. Figure 1-4 shows the typical atmospheric attenuation of signals in different frequency bands.

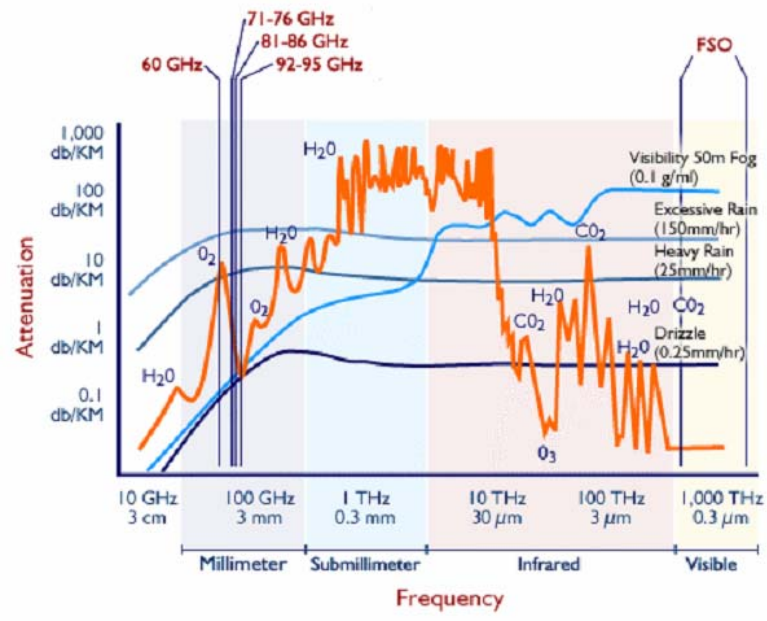

Figure 1-4: Atmospheric attenuation of signals at different frequencies.

Rain attenuation of millimeter wave signals has been studies extensively over several decades and models are available to reliably predict the availability of a millimeter wave transmission system in different rain zones around the world. Depending on the actual rain rates in specific regions around the world, the International Telecommunications Union (ITU) has published charts divided the world into varies rainfall regions. Based on the work of the researcher Crane there are similar charts with slightly different geographical breakdown of the rain regions. Both charts can be used to predict availability performance of millimeter wave transmission systems. Figure 1-5 shows the ITU chart of different rain regions of the United States. The regions are divided by using an alphanumerical notation with region A having the least and region N having the highest rainfall. The same rain charts exist for other regions of the world. Please, contact Rayawave for more information about a specific region outside of the United States.

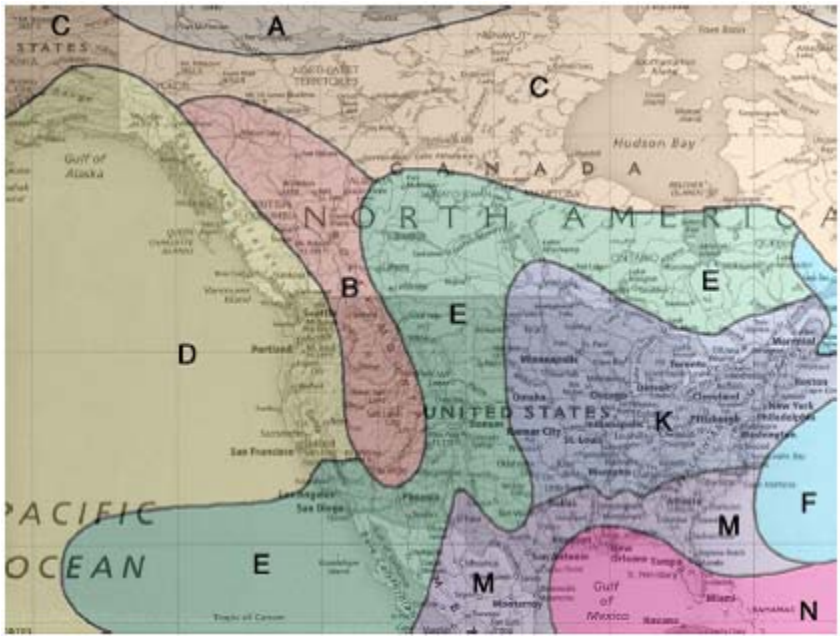

Figure 1-5: ITU rain zone chart

Based on the ITU or Crane rain zone charts one can calculate the availability of a millimeter wave transmission system in a specific rain zone. As an example, Table 1-1 shows the system availability of the AireBeam™ 70-100-24 system within the different North American rain zones. Please, contact Rayawave or your reseller for availability tables of other AireBeam™ products.

Worldwide ITU-R rec. rain region				Range @ BER 10^-12 or error free [km]													
				A	B	C	D	E	F	G	H	J	K	L	M	N	P
Availability	Link outage [min/yr]	Clear	Max	13.35	13.35	13.35	13.35	13.35	13.35	13.35	13.35	13.35	13.35	13.35	13.35	13.35	13.35
			Min	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
99.9%	525.6	drizzle		5.35	4.70	3.90	3.25	3.65	3.25	2.75	2.95	2.15	2.75	2.45	2.05	1.65	1.15
99.99%	52.6	heavy		3.25	2.75	2.45	2.20	2.05	1.85	1.75	1.70	1.65	1.50	1.20	1.20	0.95	0.75
99.999%	5.3	torrential		2.05	1.70	1.50	1.50	1.10	1.05	1.15	1.00	1.30	0.90	0.75	0.85	0.65	0.55

Table 1-1: AireBeam™ 70-100-24 system availability


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2. AireBeam™ Transmission Equipment

Regardless of the specific system ordered, the Rayawave AireBeam™ transmission equipment ships as a complete system ready for installation. The following components are included with the shipment:

- **Two radio transmission units marked 1A and 1B**
- **Two antennas (either 12" or 24") attached to the radio units**
- **Two alignment brackets attached to the radio units**
- **Two RS485 to RS232C converters**
- **One CD with monitoring program**
- **One Installation and Maintenance manual**
- **Two 48 Volts power supplies (optional)**

Figure 2-1: AireBeam™ radio transmission unit with 12" antenna

2.1. Transmission Unit

The radio transmission unit is contained within an aluminum based IP 66 rated outdoor enclosure to protect the electronics from rain, dust and other environmental conditions. Each unit is either marked "1A" or 1B". Because the transmission equipment operates in full-duplex mode (operate in slightly different frequency bands), these numbers indicate if the transmitter inside the unit operates in the lower (1A) or higher (1B) frequency band. The back of the enclosure can be opened to gain access to the fiber optic network transceiver, the power terminal, and the RS485 interface for performance monitoring. A flex tube connector to accommodate 1" or 22 mm flex tube is located in between the alignment bracket to run the power, optical fiber and a 2 wire twisted pair cable (for the RS485 monitoring signal) to a

secure indoor location of the installation site. See chapter "System Installation" for more detailed information.

2.2. Antenna

Depending on the system that was ordered either a 12" or a 24" antenna is directly attached to the transmission unit. The Fig. 2-1 shows the system with a 12" Cassegrain parabolic antenna. Similar to the main radio enclosure the antenna is fully weatherproofed.

2.3. Alignment Bracket

The alignment brackets are different for the 12" and 24" antenna systems, respectively. In particular, the 24" antenna system required a more heavy duty mounting bracket due to the larger size and weight of this antenna when compared to the smaller 12" antenna system.

2.3.1. AireBeam™ system with 12" Antenna

The antenna beam of a millimeter wave radio system is very narrow and a solid design of the alignment bracket is essential for the successful deployment of a millimeter wave radio transmission system. The pedestal type alignment bracket of the 12" antenna system is attached to the bottom of the radio enclosure. It has a pan-tilt feature to ease the alignment of the system during the installation process. The bracket with the position of the adjustment bolts and a rear, side and bottom view is shown in Fig. 2-2. The bracket can be tilted and fine aligned within +/-10 degrees in horizontal direction, and +/-10 degrees in vertical direction.

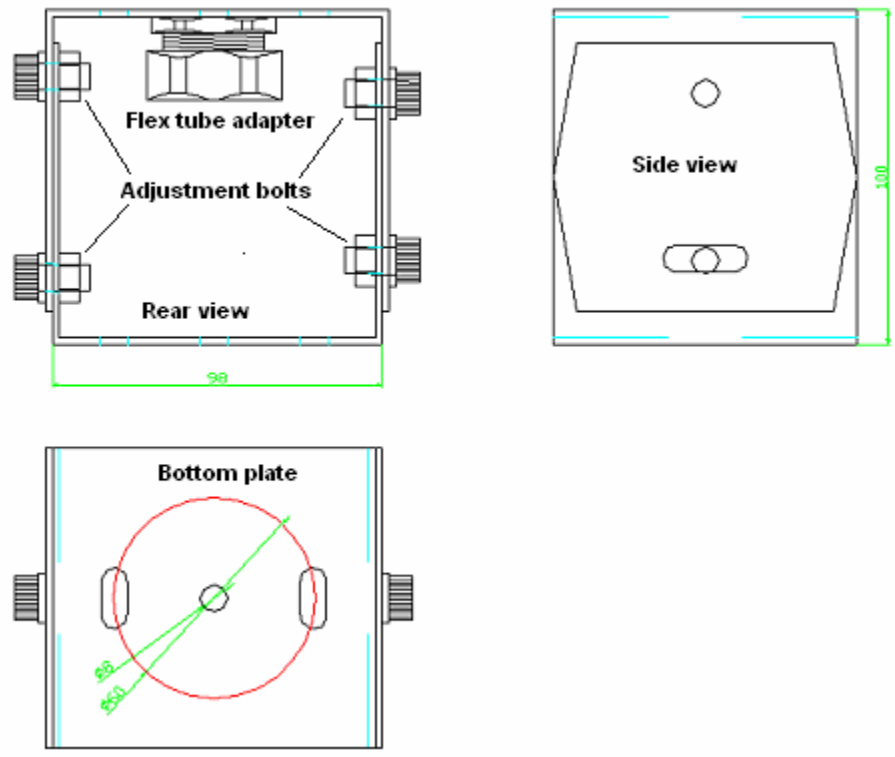
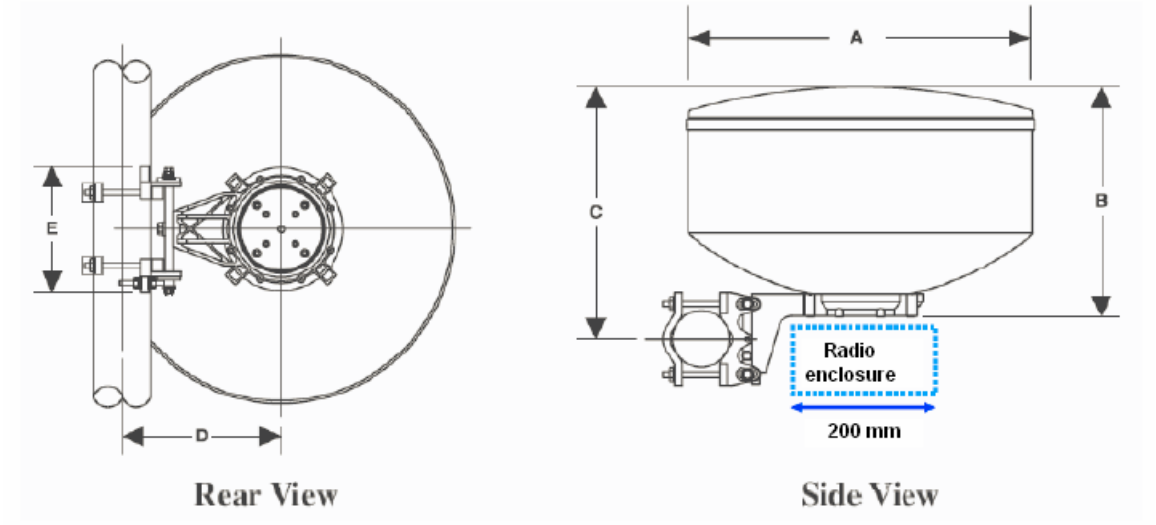


Figure 2-2: Outline and dimensions of the 12" antenna alignment bracket

2.3.2. AireBeam™ system with 24" Antenna

The radio unit with the 24" antenna uses a heavy duty pole mount bracket. The bracket is equipped with two clamp assemblies to accommodate pole diameters between 2" (51 mm) and 4.5" (114 mm). The bracket can be tilted and fine aligned within +/- 30 degrees in horizontal direction, and +/- 10 degrees in vertical direction. Fig. 2-3 shows the schematic drawing and the dimensions of the 24" antenna mounting bracket in a rear view and a side view perspective with the antenna and the radio enclosure attached.



*Dimensions = inches (cm)

Diameter	A	B	C	D	E
	24.5 (62.2)	16.2 (41.1)	17.7 (44.9)	11.2 (28.4)	8.9 (22.6)

Figure 2-3: Outline and dimensions of the 12" antenna alignment bracket

2.4. AireBeam™ Manager

The AireBeam™ Manager is a Windows based monitoring program for status and performance monitoring of the system. It reports parameters such as receive power levels, internal temperature, or network connection status. For detailed information on how to install and run the monitoring program, see chapter "AireBeam™ Manager"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3. System Installation

This chapter explains how to install Rayawave AireBeam™ transmission products. Please read this chapter before installing the system because it provides useful hints on how to install the system correctly. Not following these recommendations might result in bad performance or even malfunction of the system.

3.1. Before starting the installation process

Before starting the installation process, please ensure that the following tools and supplies are available for survey, installation, testing, and maintenance of the Rayawave system hardware. Mandatory items are marked red and optional items are shown in black.

Site Survey:

Get permission by building owner to install the system

Ensure that the installation meets local requirements

Use accurate scaled map for locating sites and doing rough distance calculations

If available, a Laser range finder or GPS for accurate distance measurement

Binoculars to assist in locating opposite end installation location

Sketch pad to make rough drawings and notes

Tape measure to determine approximate distance of fiber, power runs, etc.

Camera to take pictures of the installation sites to reduce need for return visits to sites

Installation:

Standard electro-mechanical tool kit with pliers, screwdrivers, wire cutters, wire strippers, etc.

Two-way radio or cell phones to communicate when aligning transmission units

Optical fiber connector cleaning kit

Plastic tie wraps to secure flexible conduits, etc.

Two each 6mm hex (Allen) wrenches

Two 13mm socket or open end wrenches

Two 14mm socket or open end wrenches

Electrical tape for securing and fastening

Optical light source and fiber power meter to ensure fiber performance from/to transmission unit

Digital voltmeter to check electrical system connection and measure the receive signal level (RSSI)

Power drill or power hammer with appropriate bits to securely install the alignment bracket/mounting platforms

Step or extension ladder for access to elevated locations

High quality rope to use for hoisting materials and/or to be used in conjunction with a safety harness to ensure installer safety

Exterior rated extension cord for power drill

Two DC power cables to connect radio to indoor location of dc power supply (Each cable needs two 16 gauge wires)

Two twisted pair cables for RS-485 monitoring connection (AWG24)

Two multimode (50/62.5 micron) fiber optic cables for network connection with SC type termination

Fish tape for pulling cable

Flex tube (3/4" or 22mm diameter)

3.2. Site Review

When performing a site review there are a few steps that are important to follow to ensure the successful installation of a millimeter wave transmission system.

Determine the appropriate system to meet the needs of each specific location:

Data rate: 100 Mbps or 1250 Mbps?

Measure point-to-point distance using a map, a laser range finder or GPS coordinates

Refer to the ITU rain zone chart and locate the ITU rain zone where the system will be installed

Is a multimode fiber or a copper connection required?

Determine line-of-sight

Ensure that the antenna has sufficient path clearance. Table 3-1 below shows the minimum path clearance required for operation of a pt-to-pt millimeter wave operating at in the 60 and 70 GHz bands.

Can emissions, blowing or swaying trees, or other obstacles in the line of sight interrupt the connection?

Is there a possibility of work activity or people passing in front of the transmission that could interfere with the clear line of sight?

Minimum clearance (60 GHz) [meters]	Path length [meters]	Minimum clearance (70 GHz) [meters]
0.47	500	0.44
0.68	1000	0.62
1.00	2000	0.91
1.27	3000	1.17
1.55	4000	1.29
1.84	5000	1.71

Table 3-1: Fresnel zone clearance

Evaluate environmental mounting conditions.

Only mount the radio transmission equipment to a stable and vibration-free mounting platform – this is a critical factor to successful performance.

Evaluate that the foundation at the mounting location is not susceptible to change due to humidity or temperature (avoid wooden mounting platforms!)

Because the transmission equipment operates at 48 Volts dc it does not require grounding. However, for safety reason we recommend to ground the system by connected the installation mast to a ground source. If you have the need for a lightning protection system contact your certified Reseller or installer.

Evaluate mounting locations for human access

Safe access to the radio transmission unit

Stable location/platform to stand upon

Safety considerations for installers and maintainers of the system in all weather conditions

Evaluate mounting locations to avoid interruptions of transmission

Near roof edge to avoid people walking in front of the transmission unit

Non-penetrating roof mount and at least 7 foot high to avoid people walking in front of the transmission unit

At the side of a building wall without people being able to walk in front of the transmission unit

Weather-protected location if possible

Safe location that will not be subject to damage from vandals

Evaluate mount stability

Solid concrete or steel structural building member

Directly on a flat roof surface if using a non-penetrating mount

Securely fastened to the side or top of parapet wall

3.3. Radio Antenna Installation

It is possible for one person to perform all installation and alignment procedures. However, installation will always be done more effectively and safely when two people install the system. This is especially true during the alignment procedure which is the most critical part of the installation process.

The Rayawave system includes a pan-tilt bracket to properly align the transmission units. The alignment brackets are different for the 12" and 24" antenna options, respectively (see Chapter 2.3). The pedestal type alignment bracket provided with the 12" antenna is already completely assembled and attached to the radio enclosure. A mount itself is not part of the shipment. Rayawave can provide information on where to buy a suitable universal mount for pedestal or wall mount installation.

The pole mount bracket of the 24" antenna system is shipped pre-assembled and final assembly is required. Only a few simple steps are required to assemble the pan-tilt bracket and and step-by-step instructions are shown inFig. 3-1

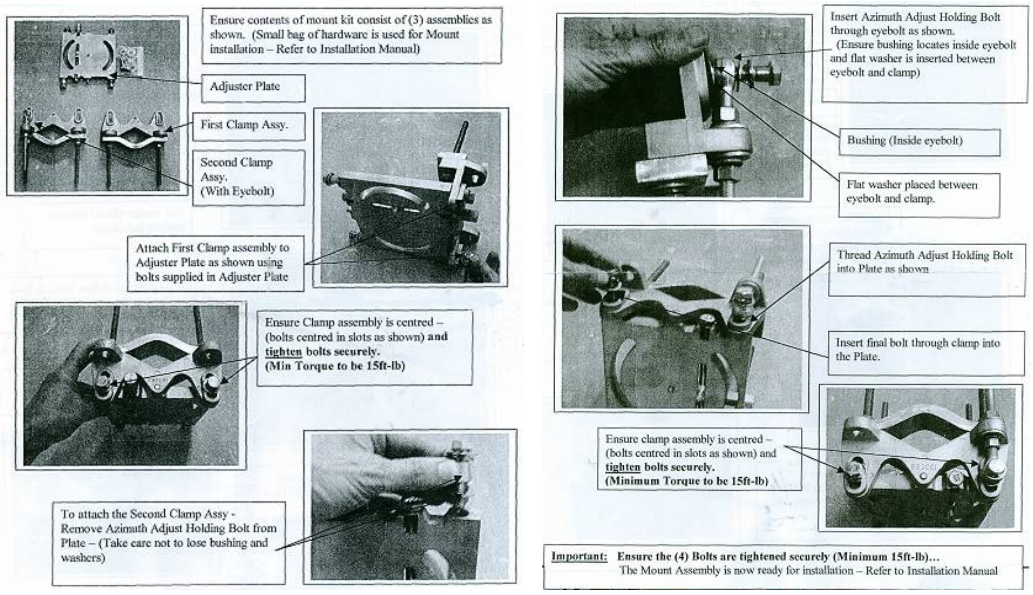


Figure 3-1: Alignment bracket assembly procedure

After completion of the pan-tilt bracket assembly, the bracket is screwed to the bracket holder that is already attached to the antenna. The alignment bracket conveniently clamps onto a standard metal or steel pole with a pole

diameters between 2" (51 mm) and 4.5" (114 mm). The pole is not part of the shipment.

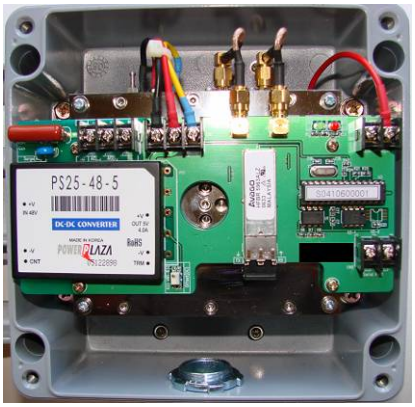
Important:

When mounting the antenna, please ensure that the radios on each side operate in the same polarization. In other words, the physical orientation of the radio must be the same on both sides. There is also an arrow symbol imprinted on the back of the antenna cover, and this arrow must point in the same direction, either upwards or sideways, when looking at the back of each radio. This ensures that both radio antennas operate in the same and either horizontal or vertical polarization plane. A transmission link that uses a different polarization on each side will not work properly.

It is also critically important that a high-band radio on one side is paired with a low band radio on the opposite side to ensure the system will operate properly. Before installing the radio units please check each radio to verify one is a high-band and the other is a low-band version. A low band radio is marked "1A" and the high band radio is marked "1B" at the side of the mounting bracket.

3.4. Cable Installation

After installing the radio transmission unit onto an appropriate mount, one can start the wiring process. For this purpose it is required to open the back of the radio transmission unit by unscrewing the fours screws on the back on the radio unit. Fig 3-1 shows the inside of the radio unit after the back cover is removed. The 100 Mbps and 1250 Mbps radio transmission units have a slightly different physical layout of the interface connectors. In both cases there are three separate terminal connector blocks on the top of a PC board and a fiber optic network transceiver located on the opposite side. Fig. 3-2 shows the inside of the 100 Mbps (left) and 1250 Mbps (right) radio enclosure.



AireBeam xx-100 system

AireBeam xx-1250 system

Figure 3-2: Inside view of the radio transmission enclosure

3.4.1. Power Cabling

1. The radio transmission unit requires a DC voltage of +/-48 Volts (minimum +/-36 Volts) for operation. In case the customer has a +/-48 Volts power connection available on site, the radio units can be directly powered from this source. Total power consumption of the radio is less than 30 Watts. In case the customer does not have direct access to a +/-48 Volt power outlet, Rayawave provides an indoor rail mountable AC-DC power supply that converts 100-240 Volts (50/60 Hz) line voltage into +/-48 Volts.

2. Determine or select an indoor location for direct +/-48 Volts access or placement of the AC-DC power adaptor. Normally it is convenient, but not required, to place the adaptor near the network premise equipment. By doing so, one can run all required cables (power cables, fibers, 2-wire twisted pair cable for monitoring the radio unit) through the same conduit. However, it is up to the user to decide how to best run the cables and alternative approaches are of course possible and sometimes even required.

3. Run two dc wires of 16-gauge type to the radio location. Preferably, and if possible, run the two wires through a 3/4" (22 mm) flex conduit tube to match the water-tight flex conduit connector on the radio. By using a 16-gauge wire the total length to the wire shouldn't be more than 250 meters (750 feet). For all practical purposes this length should be sufficient. However, in case the installation requires a longer power run, please contact Rayawave or your reseller.

   Important:

   _____

   Ensure that that power wires extend about 10 inches beyond the end of the flex conduit at the radio location side. This will ensure to provide enough length to connect the wires to the terminal connector inside the radio enclosure after attaching the flex tube conduit to the water- tight flex tube adapter.

   _____

4. Do NOT yet connect the power wires to either the power outlet or the power terminal inside the radio enclosure. See chapter "Connecting Cables"

3.4.2. Fiber Connection

1. Install a duplex multi-mode fiber from the network premise equipment to the radio. Preferably, and if possible, run the two wires through a 3/4" (22 mm) flex conduit tube to match the water-tight flex conduit connector on the radio. The fiber must be connectorized with a LC type connector to match the internal network transceiver. In case the fiber already has the connector attached, please remove the duplex clip before trying to pull the fiber through the conduit by using a fish tape. There is not sufficient room for both connectors to fit through the conduit at the same time.

2. After inserting the fiber cable through the 3/4" (22 mm) flex tube conduit ensure that the fiber extends roughly 10 inches beyond the end of the flex conduit. This will ensure to provide enough strain-relief after connecting the conduit to the water- tight flex tube adapter located at the bottom part of the radio enclosure and to the network transceiver.

3. Do NOT yet connect the power wires to either the power outlet or the power terminal inside the radio enclosure. See chapter "Connecting Cables"

4. In most cases the premise network equipment will be either a switch or router with either a fiber based 100Base-FX Fast Ethernet port (1300 nm) or a 1000Base-SX Gigabit Ethernet port (850 nm). Please, connect Rayawave or your reseller in case the network premise equipment does not have a fiber connection and we can provide information about suitable media converters.

3.4.3. Management Terminal

1. Radio status information can be obtained remotely by connecting to the monitoring terminals inside the radio unit. Information is transmitted via a two wire RS-485 serial connection is a half duplex mode. The solderless terminal connectors are designated by "TRX+" and "TRX-" on the PC board inside the radio enclosure.

2. The RS485 protocol allows for a 1:N connection and therefore multiple radio units can be monitored from the same terminal or master PC. It is recommended to use the shield cable (AWG-24 Twist) for the communication connection cable and two wires are needed per radio transmission unit. Maximum wire length for the RS485 connection is 1200 meters (4000 feet).

3. Run at least two shielded Twisted pair AWG-24 wires from the monitoring location to the radio location. We suggest that running a standard CAT5e networking cable is probably the easiest solution in case there is any doubt about what kind of cable to use. Preferably, and if possible, run the cable through a 1" flex conduit tube to match the water-tight flex conduit connector on the radio.

   Important:

   Ensure that the terminal cables/wires extend about 10 inches beyond the end of the flex conduit at the radio location side. This will ensure to provide enough length to connect the wires to the terminal connector inside the radio enclosure after attaching the flex conduit tube to the water- tight flex tube adapter located at the bottom part of the radio enclosure.

4. Do NOT yet connect the terminal wires to the terminal connectors inside the radio enclosure. See chapter "Connecting Cables"

3.5. Connecting Cables

At this point during the installation process the radio transmission unit should be installed at both mounting locations. The following wires/cables should be pulled according to the cabling instructions provided in chapter 3.4:

1. Two fiber optic multimode cables with LC-type fiber termination to connect to the networking premise equipment

2. Two 16-gauge electrical wires for +/-48 Volts DC power to the radio transmission unit

3. Either one CAT5e networking cable or alternatively two shielded twisted pair AWG-24 wires for the monitoring terminal connection.

All wires should run within a flex tube conduct and as the next installation step, the flex tube conduit should be connected to the water tight flex tube fitting located at the bottom of the radio transmission unit. Make sure to place the locking screw and the metal insert and the rubber seal around the flex tube conduit and then carefully push the wires through the fitting hole. As a final step, place the conduit into the fitting hole and tighten the locking screws.

Depending on the radio transmission unit to be installed (either a 100 Mbps Fast Ethernet radio or a 1250 Mbps Gigabit Ethernet radio); the solderless terminal connectors and the network transceiver are located at slightly different positions on the PC board. Figure 3-3 shows the terminal locations for the AireBeam™xx-100 Fast Ethernet transmission unit. Figure 3-4 shows the same terminal locations for the AireBeam™xx-1250 Gigabit Ethernet transmission unit.

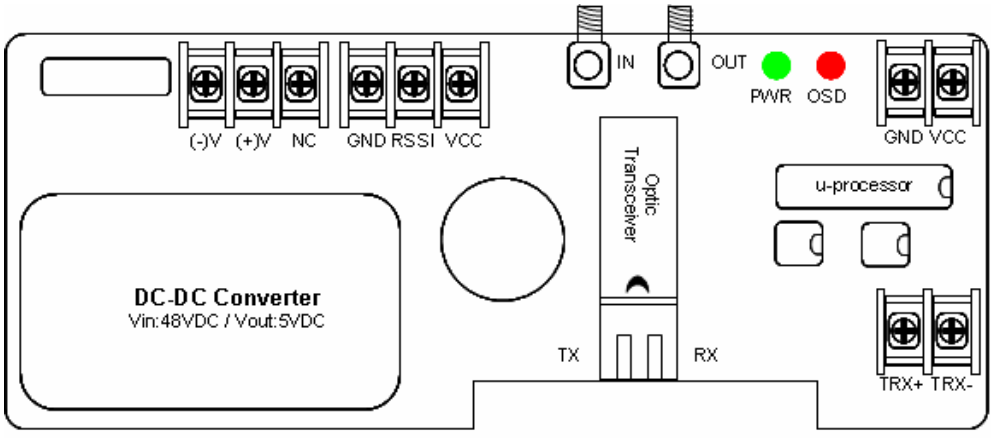


Figure 3-3: Terminal locations (AireBeam™ xx-100 Fast Ethernet system)

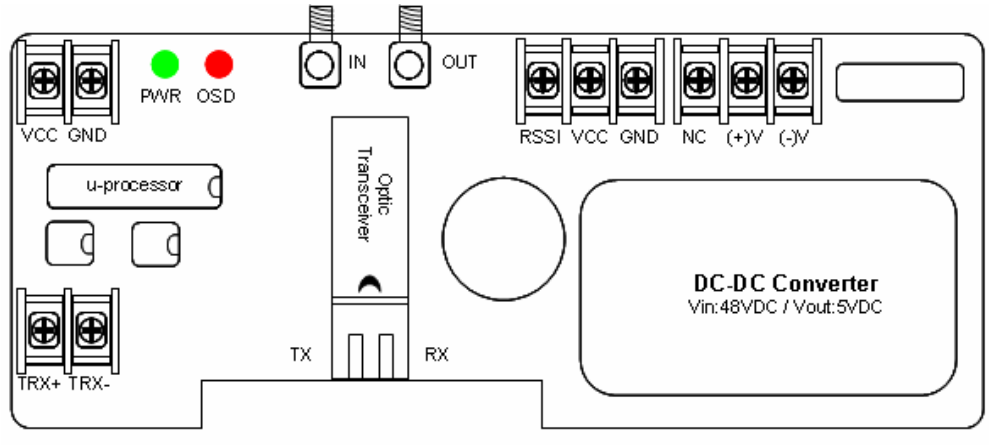


Figure 3-4: Terminal locations (AireBeam™xx-1250 Gigabit Ethernet system)

3.5.1. Power Connection

To connect power to the radio transmission unit, locate the terminal connector marked (+)V and (-)V. They serve as connection point for the +/-48 Volts supply voltage. Rayawave currently ships two versions of indoor rail-mountable +/-48 Volts power supply as optional equipment. The power supplies are shown in Figure 3-5. Both power supplies operate in the same way and the type of power supply shipped will depend on the shipping location. When using these power supplies connect the (+)V terminal connector to the power supply output marked (+), and the (-)V terminal connector to the power supply output marked (-). To locate the (+)V and (-)V terminal connectors inside the radio enclosure, please see Figures 3-3 and 3-4.

The 100-240 Volts line voltage and the grounding terminal are located at the bottom of the power supply and clearly marked. This specific power supply also allow to increase the regular 48 Volts output voltage by 7 Volts to adjust for voltage drop over longer Dc wire runs. It is not needed to adjust this voltage when using 16 gauge wire with a total length of 250 meters and we do not recommend to adjust the voltage of the power supply from its original settings.

Figure 3-5: 48 Volts power supplies

Important:

Rayawave cannot warrant equipment that fails as the result of using a power supply different from the power supply offered by Rayawave. However, in case the customer is using its own 48 Volts power supply it is important determine if the power supply provides +48 Volts or –48 Volts. We also recommend using a power supply that is capable of providing at least 30 Watts of constant electrical power.

In case of a +48 Volts power source connect the +48 Volts output of the power supplies to the terminal connector marked (+)V and the neutral (ground) output to the terminal connector marked (-)V.

In case of a -48 Volts power source connect the -48 Volts output of the power supplies to the terminal connector marked (-)V and the neutral (ground) output to the terminal connector marked (+)V.

Note:	When the power source is connected properly and the power is turned ON the PWR LED shown in Figure 3-3 and Figure 3-4 is turned ON (Green).

3.5.2. Grounding & Lightning Protection

It is important to use proper grounding of the outdoor equipment because it

Reduces electromagnetic interference,

Provides surge protection,

Protects against electrical discharge.

For proper grounding, please locate the source and connection points for the building-to-earth ground in the vicinity of the antenna location. We recommended connecting the radio to the building ground by connecting the building ground to the conductive pole mount hardware structure or the antenna alignment bracket shown in Figure 3-10. The National Electrical Code gives recommendation for the size/diameter of the grounding wire to be used for outdoor equipment installations.
In addition to grounding the equipment, **we recommend and it may also be required by** local building codes, to protect DC electrical cable from electrical surges. Call Rayawave or your reseller if you would like to find out more about suitable lightening or surge protection devices.

3.5.3. Network Connection

To establish the connection with the network premise equipment, plug the TX and RX fibers into the network transceiver module of the radio unit and into

the network equipment fiber port. Cables have to be connected in "cross-over" mode, meaning RX→TX and TX→RX. This is shown in Figure 3-6.

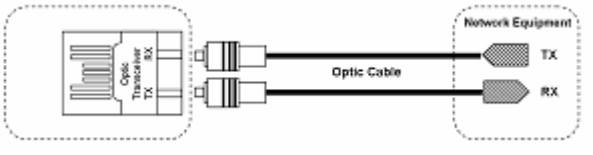


Figure 3-6: Fiber cable connection

Note:	When the radio is powered ON, the OSD LED shown in Figure3-3 and Figure3-4 is turned ON (RED) when the fiber cable is connected correctly to the network equipment.

3.5.4. Monitoring Terminal Connection

To connect the RS485 monitoring system to a PC, locate the two terminal connections marked TRX+ and TRX- on the PC board inside the radio transmission unit. Use either the two terminal wires that were placed inside the flex tube conduit at an earlier stage of the installation process (or pick and mark two wires from the CAT5e cable) and attach the TRX+ and TRX- terminals, respectively. The RS485 protocol allows for monitoring up to 9 radios units from the same master PC. Figure3-7 shows a wiring diagram for monitoring multiple AireBeam™ radio systems from a single Master PC. In case the customer needs to monitor the radio system by using the SNMP protocol, please contact Rayawave or your reseller and ask for optional SNMP capable IDU monitoring equipment.

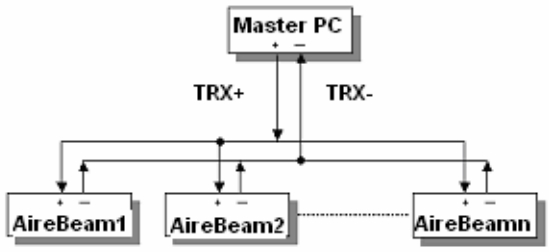


Figure 3-7: Connecting AireBeam™ radios to a monitoring PC

When connecting the RS485 radio terminal interface to a PC, a RS485 to RS232C converter is needed. This converter is part of the standard shipping package. The converter is equipped with a 9-pin sub-D connector that plugs in directly into the serial port of a monitoring PC/laptop. The converter is shown in Figure 3-8. The converter has five screw terminals on the back. For connecting the converter to the radio unit use the terminal connections marked TRX+ and TRX- and connect to the terminal connector inside the radio enclosure.

Note:	When connecting the monitoring wires do not change the polarity. In other words connect the TRX+ terminal inside the radio enclosure to the TRX+ terminal of the converter. Do the same for the TRX- terminal.

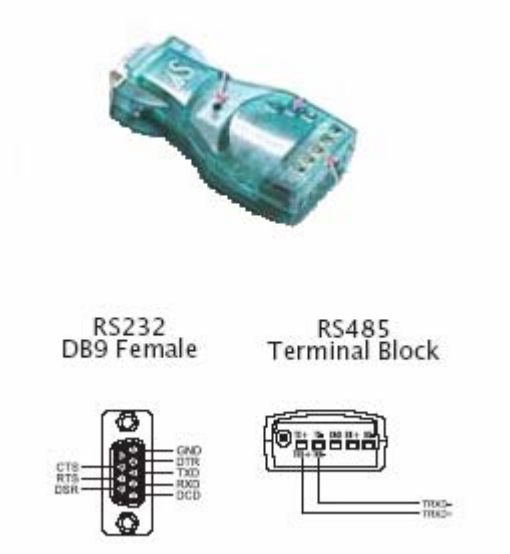


Figure3-8: RS485 to RS232C converter module

3.6. System Alignment

After finishing the mounting, electrical and network connections, the system is now ready for alignment. Most steps during the alignment procedure are independent of the size of the specific antenna option used. Because the 12" and the 24" antennas used different alignment brackets, the corresponding screws for vertical and horizontal alignment are of cause to be found at different locations. We will address these issues further below.

The alignment process itself will be eased if two people (one on each side) are involved in the alignment procedure. This is in particular true for the larger 24" antenna system because it has a narrower beam pattern. Using two-way radios or cell phones is also highly recommended to exchange information of the alignment status between the two people performing the alignment process. It is possible to align the system without having two people involved, but walking or driving back and forth between the two mounting locations can be a cumbersome and time consuming process. The correct alignment of the system is crucial for the proper performance of the system and no rush should be in play when aligning the system. Depending on the experience of the installer(s) to align narrow beam radio transmission equipment, this process can take anywhere from 15 to 60 minutes.

Note:	During the alignment process the installer will need access to the RSSI terminal located inside the radio enclosure. The RSSI terminal locations is shown in Fig. 3-3 and Fig. 3-4 and also clearly marked on the PC board. A digital voltmeter is required to measure the RSSI voltage level and the RSSI signal level provides the indication how well the system is aligned. Therefore do not close the back cover of the enclosure before the alignment procedure is finalized.

3.6.1. Antenna Radiation Pattern and Side Lobes

When aligning a millimeter wave radio with a narrow beam directional antenna pattern, it is important to understand that besides the "antenna main lobe" that contains most of the energy, there are also "antenna side lobes". A "perfect" antenna would contain all energy in the main lobe but this is physically not possible. Although these side lobes contain far less energy, and in case of a good directional Cassegrain antenna the power of the 1st side lobe is typically around 20 dB lower when compared to the main lobe's peak power, one can "see" the 1st side lobe during the alignment process. This is mainly because the main lobe and the 1st antenna side lobe are only separated by an angle on the order of 1-2 degrees. This small value for the angular separation is actually close to the radiation angle of the main lobe itself.

Note:	During the alignment process it is important to find the main lobe and not to align the system on a side. To ensure that the main lobe is found, move the system about 10 degrees in horizontal and vertical direction and away from the perceived highest readout voltage. While "scanning" through the beam pattern from the left to the right (or from the top to the bottom) one can find to higher RSSI voltage readings before the signal drops significantly. These two "local" voltage maxima to the left and the right of the main lobe the 1st side lobe.

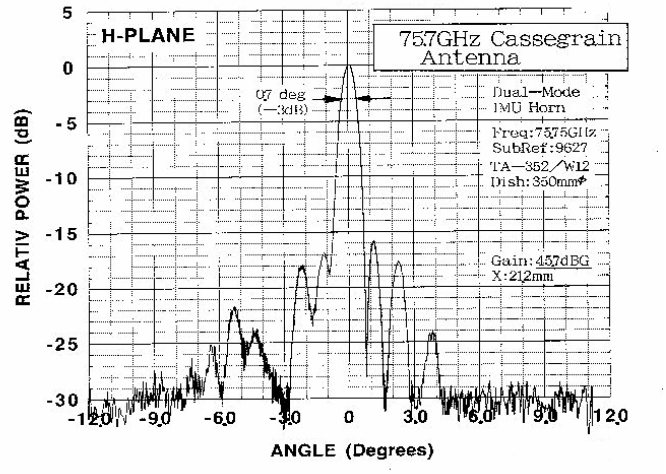


Figure 3-9: Millimeter wave radiation pattern of a Cassegrain antenna

For illustrative purposes Fig. 3-9 shows the typical pattern of a millimeter wave Cassegrain antenna[1]. When installing a millimeter wave radio transmission system it is important to keep in mind that the antenna main

[1] Although the antenna pattern shown in Figure 3_8 is the result of a real measurement it is just an example of an antenna pattern for illustrative purposes and not the actual radiation pattern of the antenna used in Rayawave products.

lobe and the 1st antenna side lobe virtually point in the same direction. Aligning the system on a side lobe instead of aligning it on the main lobe would very negatively impact the performance of the system.

In preparation of the actual alignment process, carry out the following steps:

1. Depending on the specific system to be installed, connect the digital voltmeter to the RSSI and GND terminal connectors shown in Fig. 3-3 or Fig. 3-4. One can either use a probing clamp or attach a separate wire to the terminal connector. Make sure that the digital voltmeter readout can be clearly seen during the installation process.

2. Power on both radios and verify that the green power LED on the PC board inside the radio enclosure is on (see Fig. 3-3 or Fig. 3-4, respectively)

3. Make sure that the system is connected to the network and verify that the red OSD LED on the PC board inside the radio enclosure is on (see Fig. 3-3 or Fig. 3-4, respectively)

3.6.2. Alignment of the 12" antenna system

- Loosen the vertical adjustment bolts located on both sides of the alignment bracket and horizontal adjustment bolt located on the bottom bracket plate. Do NOT completely untighten the bolts but just loosen enough to allow to easily swing the unit in vertical and horizontal direction. Fig. 3-10 shows the location of the vertical adjustment bolts.

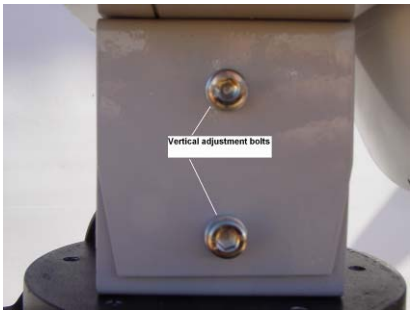


Figure 3-10: Location of the vertical adjustment bolts on 12" bracket

- Try to visually locate the opposite side of the radio link. Use binocular in case you can not locate the far end radio location with the naked eye.

- If you can see the far-end radio terminal estimate the alignment visually and roughly point the antenna into the direction of the far end radio location. Perform the same procedure at both sides.

- Slightly rotate each antenna up/down for best vertical alignment and left/right for best horizontal alignment by finding the maximum RSSI

voltage reading. Fig. 3-11 shows how to adjust the antenna in vertical and horizontal direction.

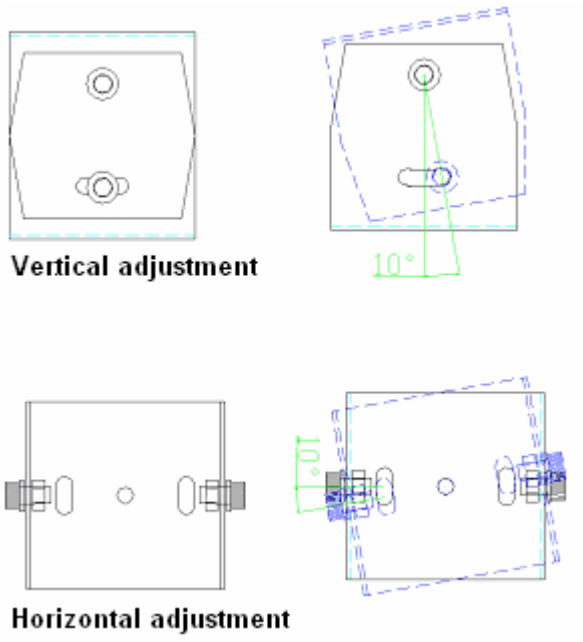


Figure 3-11: Adjusting the antenna in vertical and horizontal direction

Note:	Do NOT move both radios at the same time. Try to optimize the RSSI signal level first at one side and then repeat this process at the opposite side. Communicate changes in signal levels during the adjustment process to the person at the opposite side via a two-way radio or cell phone.

- Ensure that the antennas are not aligned on a side-lobe. When rotating the antenna a few degrees to each side of the perceived alignment center, both side-lobes can be detected as "local RSSI voltage minima". The main lobe which is located right in the middle between the two sides lobes will have a much higher voltage reading. Fig. 3-12 shows a simple illustration of the alignment process.

- Fig. 3-13 shows a diagram of the RSSI voltage as a function of the deployment distance for an AireBeam™ 70-1250-12 Gigabit Ethernet transmission system under clear weather conditions. The RSSI values vary slightly for the low band (1A) and the high band (1B) radio. These values typically also vary slightly and within a few percent from one radio system to another due to manufacturing tolerances. However, the chart provides a very a good indication of expected RSSI values as a function of deployment distance. The overall goal of the alignment process is anyhow not to align the system on the exact value provided in the chart but rather to maximize the value of the RSSI voltage.

- After maximizing the RSSI signal levels on both sides, tighten the screws of the alignment bracket and close the back cover of the radio unit.

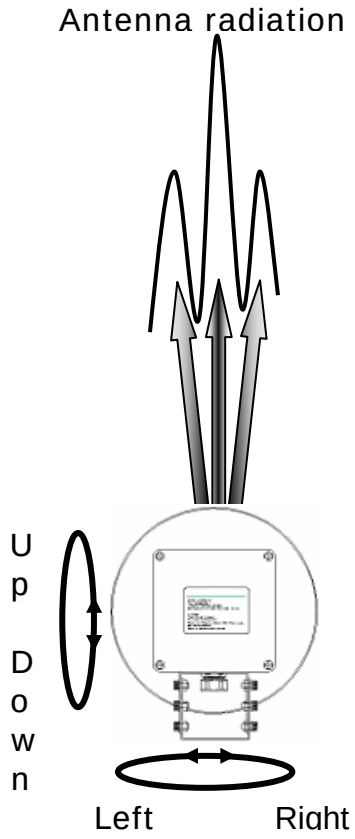


Figure 3-12: Simple illustration of the alignment process

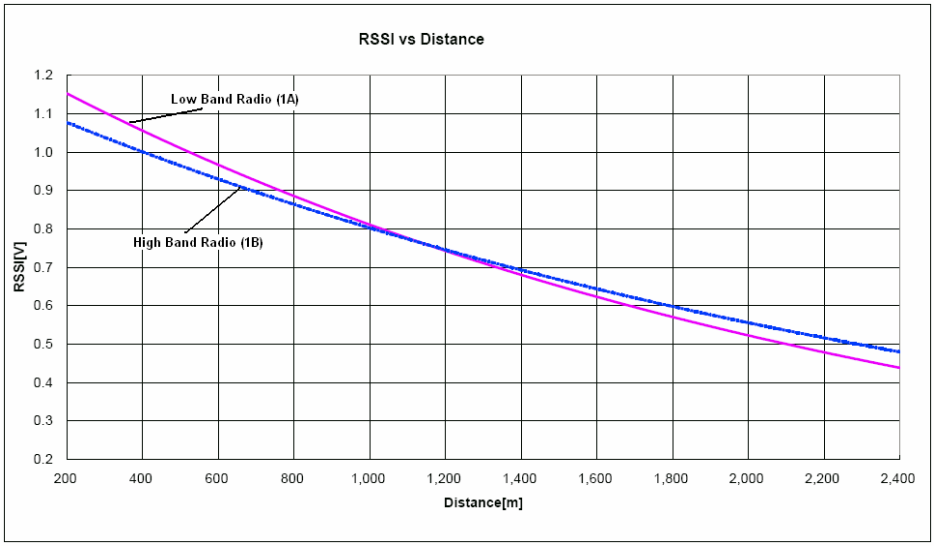


Figure 3-13: RSSI vs. distance chart for the AireBeam™70-1250-12 system

3.6.3. Alignment of the 24" antenna system

The 24" antenna system uses a different heavy duty pole mounted alignment bracket due to the larger size and weight of the 24" antenna. After performing the pan-tilt bracket assembly procedure as shown in Fig.3-1 and attaching the antenna to the pole mount by using the two clamp assemblies, slightly loosen the bolts 1-4 as shown in Fig. 3-14. Keep the bolts tight enough so the antenna does not slide down the mounting pole and proceed with the following steps:

- Try to visually locate the opposite side of the radio link. Use binocular in case you can not locate the far end radio location with the naked eye.
- If you can see the far-end radio terminal estimate the alignment visually and roughly point the antenna into the direction of the far end radio location. Perform the same procedure at both sides.
- Tighten the clamp bolts 1-4 in Fig. 3-14 with a minimum torque of 15ft-lb.
- Slightly loosen the horizontal alignment bolts 5 and 6 as shown in Fig. 3-14. Do NOT completely untighten the bolts but just loosen enough to allow smooth rotation of the horizontal alignment plate when turning the horizontal fine alignment screw 7 during the alignment process.
- Slightly loosen the vertical adjustment bolts 8 and 9 in Fig. 3-14 and also the two bolts on the opposite side of the bracket (not visible in Fig. 3-14). Do NOT completely untighten the bolts but just loosen enough to allow smooth rotation during vertical alignment and when turning the vertical fine alignment screw 10 during the alignment process.

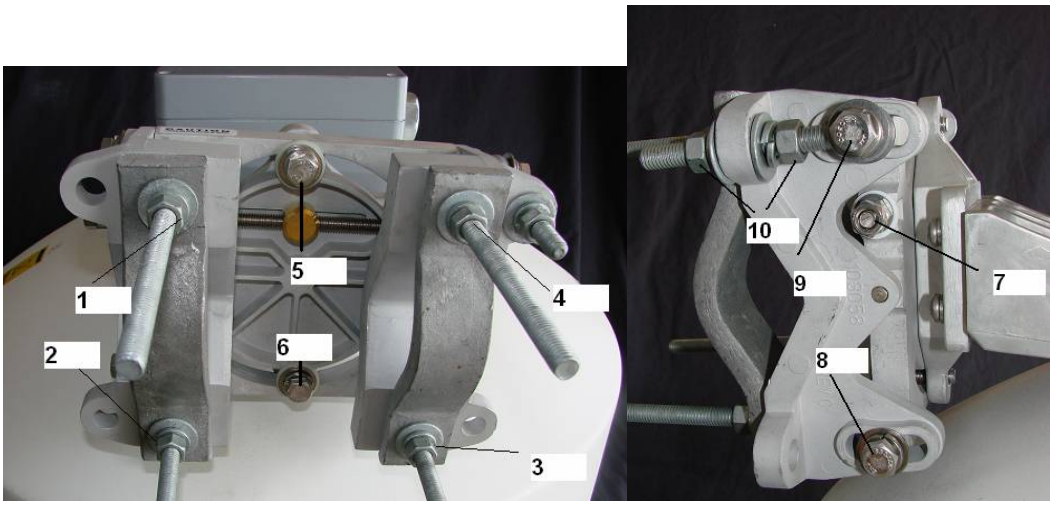


Figure 3-14: Location of alignment bolts on the 24" pan-tilt bracket.

- Slightly rotate each antenna up/down and left/right for best vertical and horizontal alignment and by finding the maximum RSSI voltage reading. Use the fine alignment screws/bolts 7 and 10 as shown in Fig. 3-14.

Note:	Do NOT move both radios at the same time. Try to optimize the RSSI signal level first at one side and then repeat this process at the opposite side. Communicate changes in signal levels during the adjustment process to the person at the opposite side via a two-way radio or cell phone.

- Ensure that the antennas are not aligned on a side-lobe. When rotating the antenna a few degrees to each side of the perceived alignment center, both side-lobes can be detected as "local RSSI voltage minima". The main lobe which is located right in the middle between the two sides lobes will have a much higher voltage reading. Fig. 3-15 shows a simple illustration of the alignment process.

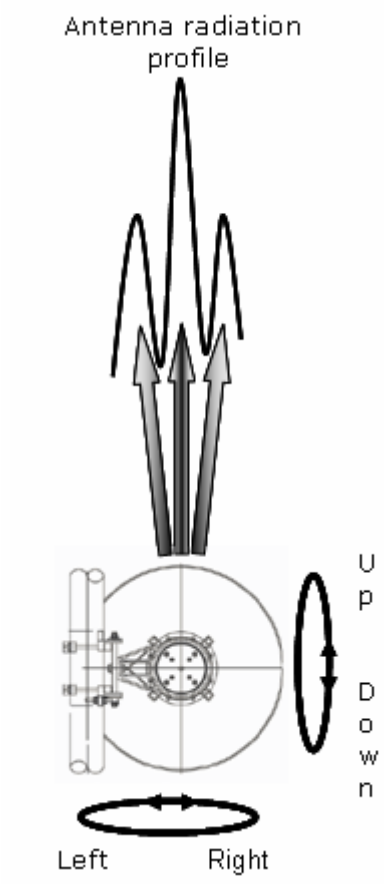


Figure 3-15: Simple illustration of the alignment process

- Fig. 3-16 shows a diagram of the RSSI voltage as a function of the deployment distance for an AireBeam™ 70-1250-12 Gigabit Ethernet transmission system under clear weather conditions. The RSSI values vary slightly for the low band (1A) and the high band (1B) radio.

These values typically also vary slightly and within a few percent from one radio system to another due to manufacturing tolerances. However, the chart provides a very a good indication of expected RSSI values as a function of deployment distance. The overall goal of the alignment process is anyhow not to align the system on the exact value provided in the chart but rather to maximize the value of the RSSI voltage.

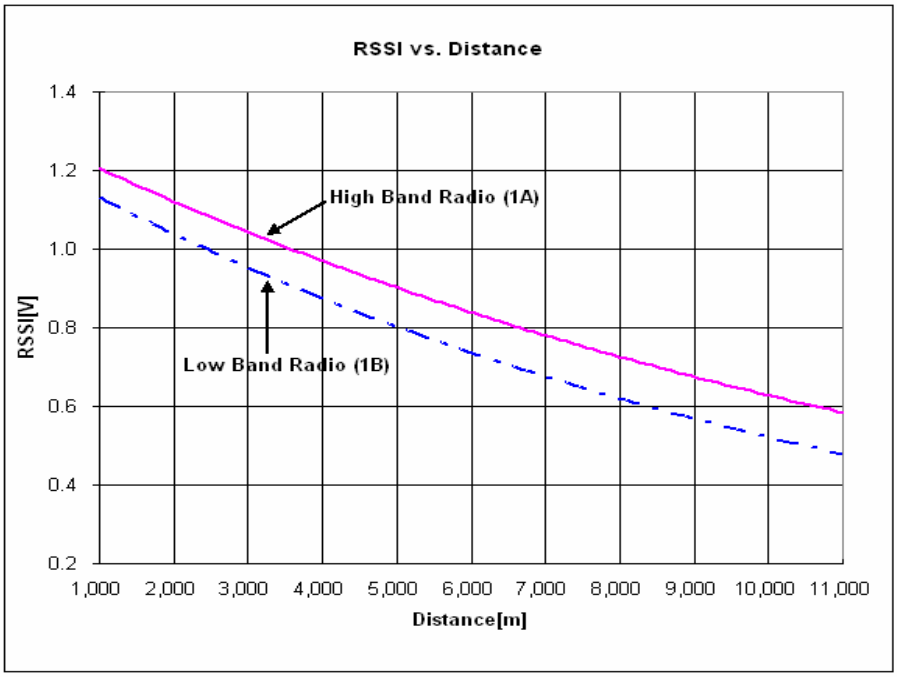


Figure 3-16: RSSI vs. distance chart for the AireBeam™70-1250-24 system

- After maximizing the RSSI signal levels on both sides, tighten all bolts and screws of the alignment bracket with a minimum torque of 15ft-lb and close the back cover of the radio unit

The Installation, Alignment and Connection procedures are now completed and the system is ready for use!


Rayawave

4. AireBeam™ Manager

The AireBeam™Manager is a PC based monitoring utility for monitoring the status and performance of al AireBeam™ Series millimeter wave radio transmission equipment. Please refer to this manual for information concerning the remote monitoring of the radio units and how to use this capability to assist in trouble-shooting system performance.

4.1. Introduction

The **AireBeam™ Manager** utility communicates radio status information back to a PC or laptop computer via a RS485 connection. Using the RS485 protocol provides the advantage that the actual device to be monitored can be up to 1200 meters away from the monitoring computer and the transmission media is a shielded twisted pair copper wire. The program provides the functionality to monitor specific real-time parameters as well as the capability to store history log file. The list below summarizes the basic functionality of the **AireBeam™ Manager** program:

Real-time monitoring of the receive power level

Real-time monitoring of internal temperature

Real-time monitoring of the fiber optic cable connection status

Real-time monitoring visual and acoustic alarm and warning functionality

Real-time monitoring of up to 9 radio transmission units

Auto-detect capability of attached radio transmission units

History log functionality of critical system parameters

The following chapter will describe the functionality and monitoring capability of the **AireBeam™ Manager** program utility in more detail.

4.2. System Requirement and Installation

Recommended Operating Environment

CPU: Intel Pentium Processor Cel 400MHz or higher

RAM: 64 Mbytes (minimum 16 Mbytes)

Hard Disk: 20 Mbytes (minimum 10 Mbytes)

OS: Window 98, NT/2000, XP[Service Pack 2.0]

Video mode: 1024 X 768 (Minimum: 640 X 480)

Interface: Serial COM port (9 pin DB 9 connector)

Others: RS232 to RS485 converter

4.3. Getting Started

The **AireBeam™ Manager** monitoring program is ship on a CD. Although the program runs directly of the CD, we recommend copying the complete folder that included the **AireBeam™ Manager** program onto the hard disk of the monitoring PC or laptop. After copying the folder on the system hard disk, the software components shown in Figure 4-1 should be present.

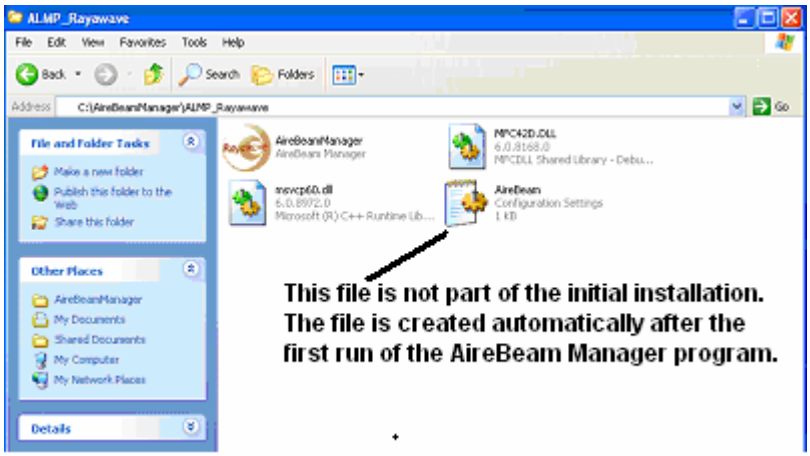


Figure 4-1: Content of the installation folder

In order to start **AireBeam™ Manager** program open the folder that contains the executable file. Double-click the **AireBeam™ Manager** file to start the program. When the program starts, a status window with a progress bar appears. After the program has started successfully, a serial port configuration window appears and the user will be asked to select from a list of serial communication parameters.

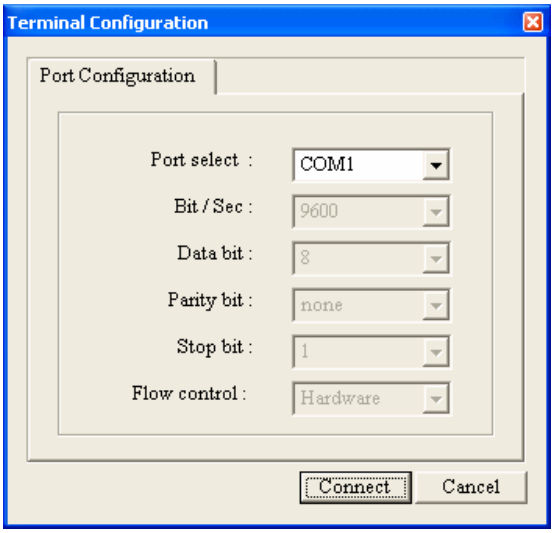


Figure 4-2: Serial port configuration window

The serial port configuration window is shown in Fig. 4-2. Besides the **Port Select** menu, all other serial communication parameters are already set to

the default status of the RS232 converter module. If COM port 1 is already in use by another application, please choose another COM port from the list.

Press the Connect button after setting up the correct serial port and the program window is activated. If the selected port is in use, a warning window will appear.

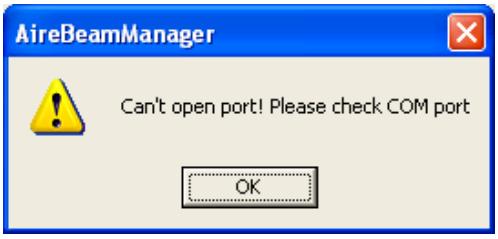


Figure 4-3: Port Open Warning Window

Note:	If the warning window appears, press the OK button to close the warning window and check if the selected port is in use.

Processing the **Cancel** button will start the program without the COM port being opened. When the program was executed without opening the port, the program information file (AirBeam.ini) has to be opened to activate the COM port so that the program operates correctly.

After the port setup was completed successfully, the program window is activated. In case the program was started already earlier, the program has created an information (.ini) file and information contained in this file is loaded. Among others, the .ini file keeps track on radios units that had been attached to the monitoring program before.

Note:	The program information file is automatically created in the folder where the executable file is located.

If the program is started for the first time, the program information file is created and an automatic search function is executed to find attached radio units. Discovered radio units are displayed in the “Discovery window” shown in Figure 4-4. When the search is completed, the message “AireBeam discovery Complete” is displayed.

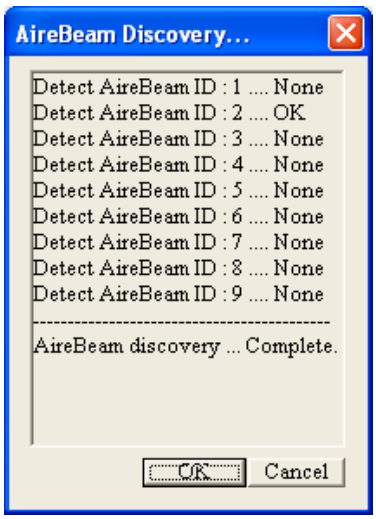


Figure 4-4: Equipment Search Result Window

Pressing the **OK** button after the message is displayed enters the equipment found into the "AireBeam_List" of the main program window shown in Figure 4-5. In case that multiple radio units have been discovered they are registered in the ascending order of their specific equipment IDs.

To stop the search during the execution of the automatic search function, press the **Cancel** button.

4.4. Main Program Window

The main program window is shown in Figure 4-5. The program is composed of four functional components. Each component comprises menus, icon buttons, the information display section, and the real time status display section.

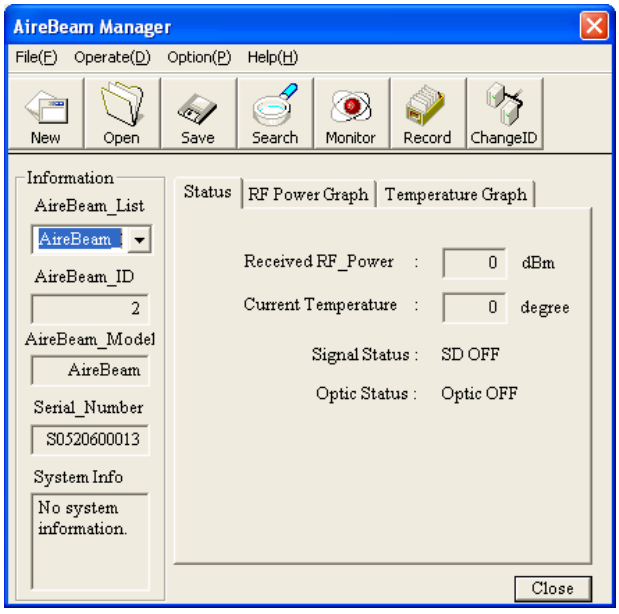


Figure 4-5: Main window of the Program

(1) Menus

The menu bar provides has four entries (**File**, **Operate**, **Option**, and **Help**) and controls events related to the entire program operation.

(2) Icons

The icon type buttons (**New**, **Open**, **Save**, **Search**, **Monitor**, **Record**, and **ChangeID**) are also used for triggering events related to the program operation.

(3) Information Display

This section displays a list of radio units found in the network and display the unique ID number, Name, Serial number, and optional information related to a specific system chosen from the list.

(4) Status Display

When executing the "Monitoring" function this section displays real time operating parameters. In particular the following parameters are display on a real time basis:

Received signal power (dBm)

Internal temperature (^{o}C)

Signal status (On/Off)

Optic status (On/Off).

By selecting **RF Power Graph** or **Temperature Graph** from the horizontal tabs the receive signal power and the internal temperature are displayed in real time in a graphical format. The display of the RF power graph and the Temperature graph are shown in Figure 4-6 and Figure 4-7

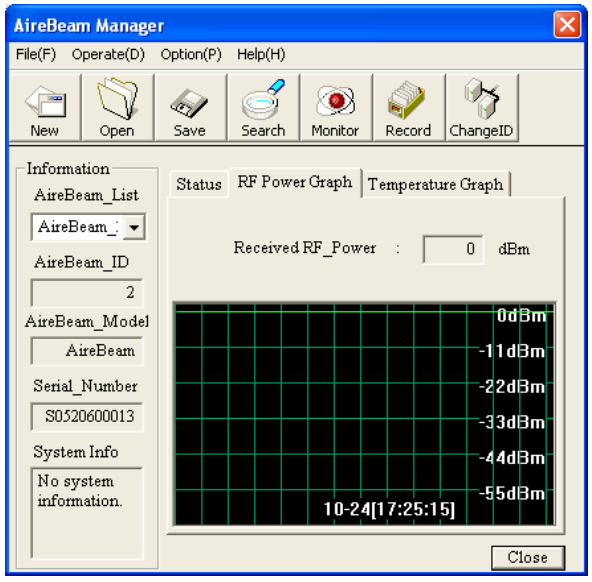


Figure 4-6: RF power monitoring window

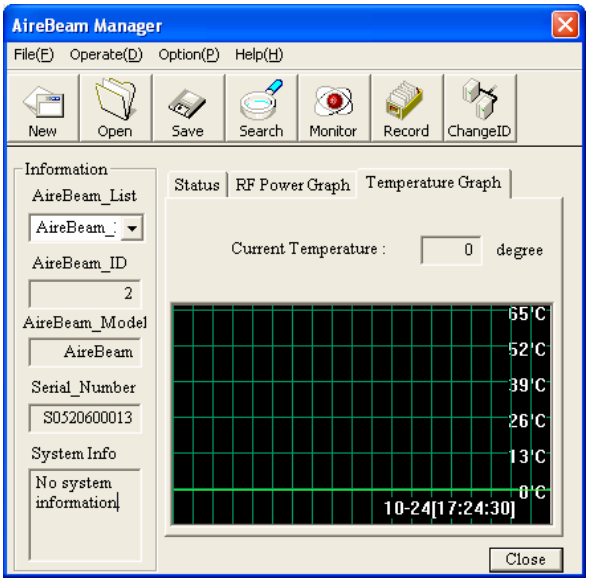


Figure 4-7: Temperature monitoring window

Note:	**If the monitoring function is not operating correctly, the system will display default values.**

4.5. The Menu Bar

The program menu bar shown in Figure 4-8 has four separate entries (**File**, **Operate**, **Option**, and **Help**) and each of the entries contain several sub items. Other than using the right mouse key, the menu can also be opened by using an Alt+Key key combination (Ex.: File -> Alt+F).

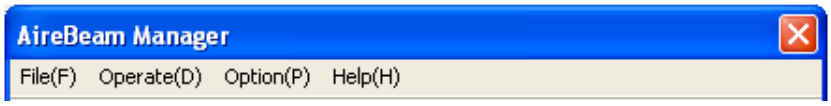


Figure 4-8: Menu Screen

(1) Menu -> File [File(F)]

This menu has several sub items related to the file handling functionality and the sub items are shown in Figure 4-9.

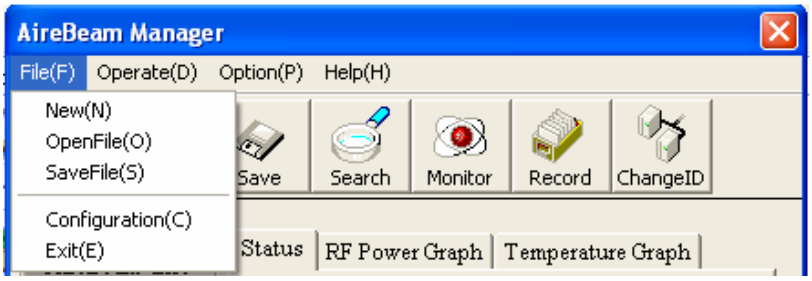


Figure 4-9: Subitems of 'File'

File → New

Stops open monitoring session and starts a new session. Pressing **New** opens the terminal setup window to establish a new connection.

File → OpenFile

At startup the program creates an information file (.ini) and this file contains information related to previous sessions. By default this file is stored in the folder that contains the main program (AireBeam Manager.exe).

Pressing **OpenFile** opens the file input window shown in Fig. 4-10. When selecting and opening an information file, the previously saved terminal connection settings and the list of previously discovered and registered radio units are loaded back into the program.

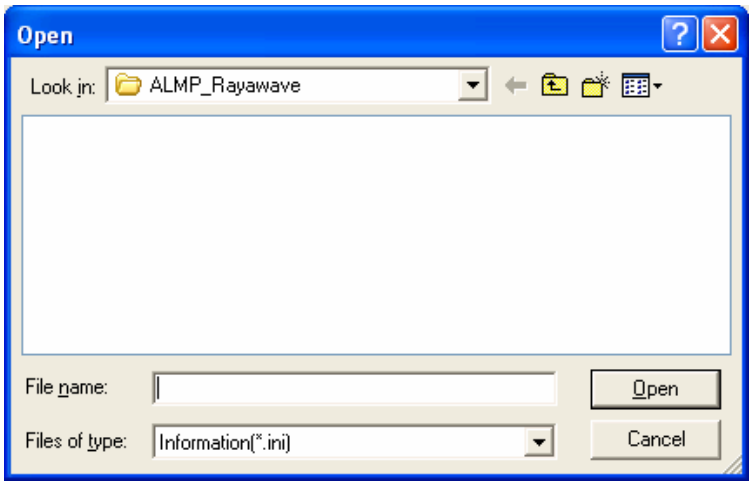


Figure 4-10: File Open window

If the selected file is not correct file, a warning window as shown in Figure **4-11** will appear. Press the **OK** button and select the correct file.

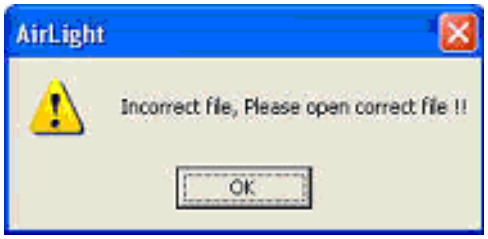


Figure 4-11: File Open Error Warning window

Note:	If the correct information file does not exist, select New to create a new information file.

File → SaveFile

The current status is saved. The terminal setup information and the equipment list registered in the program are saved in the information file (AirLight.ini). The file can be used later on with **FileOpen**. By default the .ini file is saved in the folder where AireBeamManager.exe file is located.

File → Configuration

This sub items allows creating or making changes to the program information file. If such a file was already created, this information is shown in the **Configuration** window shown in Figure 4-12.

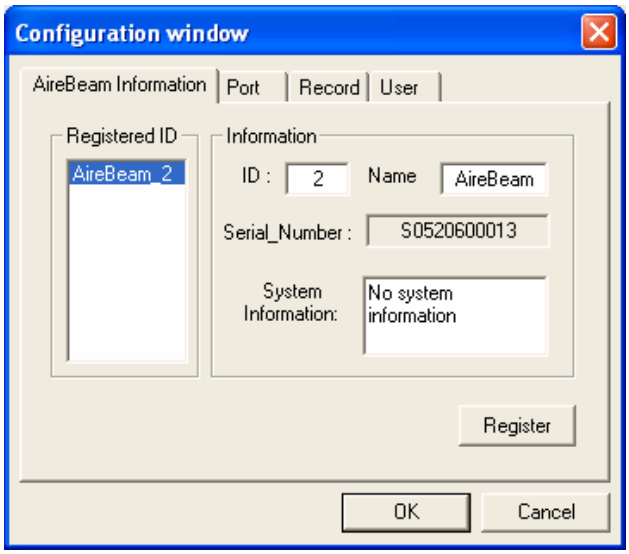


Figure 4-12: Information Configuration Window

File → Configuration window→ AireBeam Information

The equipment list currently registered can be checked, and the properties of equipments registered can be changed. A new equipment list can be added by user if needed.

Note:	To display information on equipment already registered, double-click on the equipment ID in Registered ID window.

To change equipment properties (ID, Name, Description) first select the equipment from the **RegisteredID** list and then modify the information entries. Press the **Register** button will update the information in the equipment information file.

In order to register new equipment, enter equipment properties and press the **Register** button. The newly registered equipment will be displayed in the **RegisteredID** list.

After performing the registration of new equipment and pressing the **OK** button, new or modified equipment is available for being monitored. The registration of new equipment is permitted for ID ranges [1…9], and the warning window shown in Fig. 4-13 is activated for any other value. Press the **OK** button, when **Warning** window appears and then register the correct equipment number within the permitted ID range.

Figure 4-13: Equipment ID Input Warning Window

File → Configuration window → Port

The port setup can be modified just like the terminal setup. Most of the port setting are protected default settings but is possible to change the COM port. Pressing the update button in Figure 4-14 will perform the change and overwrite previous settings

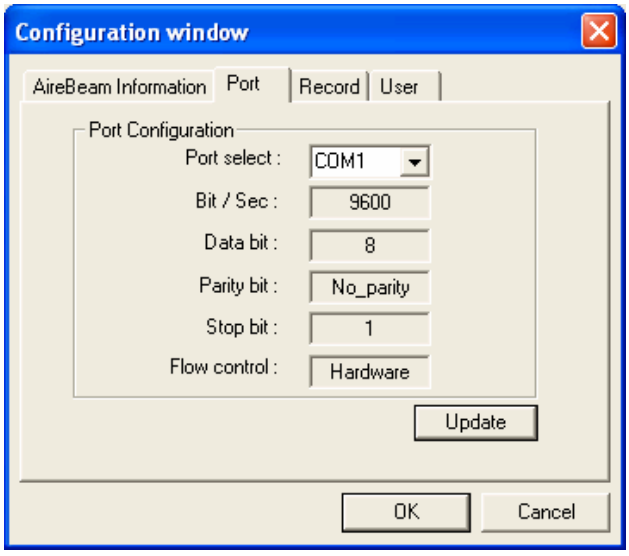


Figure 4-14: Port Setup Configuration Window

File → Configuration window →Record

This sub menu shown in Figure 4-15 has three functions:

Setting up the record time interval for storing monitoring data

Modify the display speed when the graphical display mode is chosen (see Figure 4-5).

Turn a warning sound On/Off. The warning sound is activated when the program detects a problem with the monitored equipment.

Input the data to change and press the **Update** button to register the change. If the record time interval is not correctly entered, the warning window shown in Fig. 4-16 is activated. Press the **OK** button and re-enter a correct time interval.

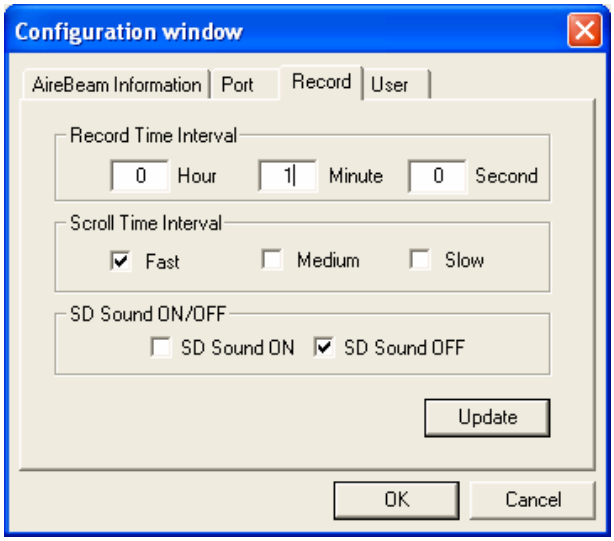


Figure 4-15: Additional Function Configuration Windows

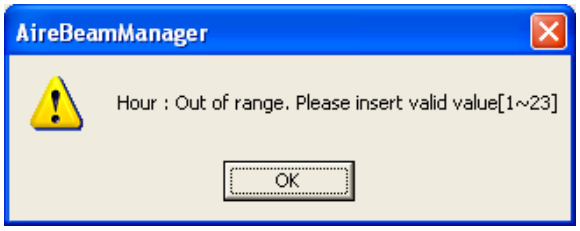


Figure 4-16: Record Time Input Warning Window

File → Configuration window →User

This tab allows entering specific user information such as user name, company information, e-mail address, phone number, fax number, etc. Figure 4-17 shows the configuration widow for entering user information. Enter the information as appropriate and needed and press the **Update** button. Press the **OK** button and the entered information is stored in the information file.

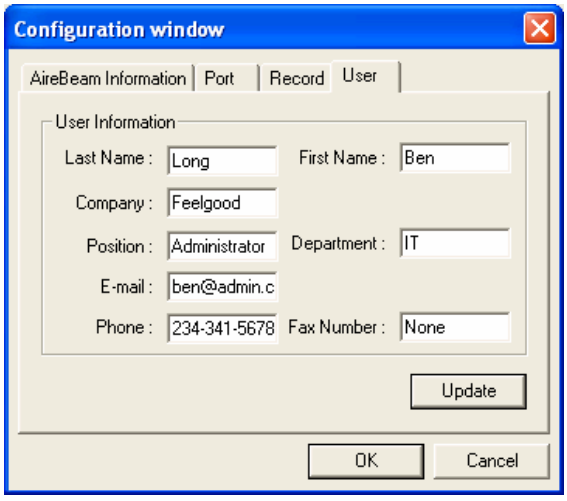


Figure 4-17: User Information Windows

File → Exit

The program is terminated.

(2) Menu -> Operation [Operate(D)]

The operation menu shown in Figure 4-18 has four sub menus (**Start Monitor**, **Stop Monitor**, **ChangeID**, and **Detect**)

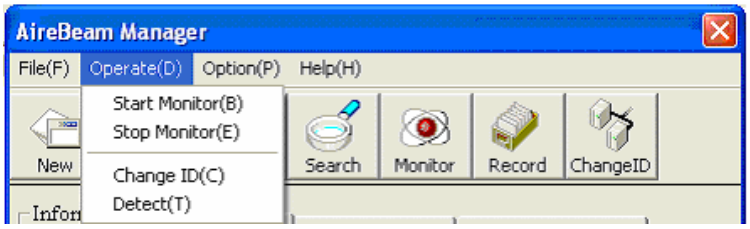


Figure 4-18: The "Operation" menu

Operation → Start Monitor

The "Start Monitor" function starts the monitoring process of user-selected equipment. If equipment isn't selected from the AireBeam_List, the warning window shown in Fig. 4-19 is activated. Press the **OK** button in the warning window and select the equipment from AireBeam_List. Selecting the equipment and pressing **Start Monitor** makes the monitoring function execute.

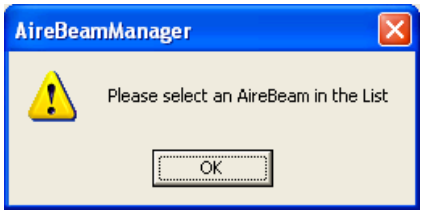


Figure 4-19: Selection Error Warning window

If there is a problem with the communication line or data loss during monitoring, the warning window shown in Fig. 4-20 is displayed. Press the **OK** button and check the terminal connection for potential problems

Figure 4-20: Connection error window

Operation → Stop Monitor

The monitoring function of the selected equipment is stopped.

Operation → Change ID

The ID, name and other details of the selected equipment can be modified. Select the equipment in **AireBeam_List** and click on the Change ID entry. The **ID Change** window shown in Fig. 4-21 will be activated. The name, ID and system information of the selected equipment are displayed, and the existing name and ID are displayed with the inactivated status.

Note:	If a name and System information are to be changed, enter the existing ID in Change ID and enter the name and details to change.

Enter the requested name and ID change in the **Change ID** section. To change the system information, first erase the old information and then type the new information as required. Press the **Insert** button to overwrite the information stored the information file.

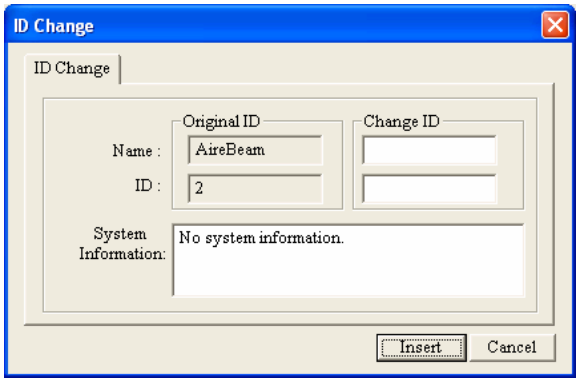


Figure 4-21: ID Change window

When performing an ID change, one needs to change both, the ID and the name. Otherwise the warning window shown in Fig. 4-22 is activated. Press the **OK** button in the warning window, and enter both, a new ID and a new name.

Figure 4-22: ID Change Error widows

Operation → Detect

The function makes it possible to automatically or manually detect AireBeam equipment connected to the monitoring PC. Press **Detect** to execute this function and the **Equipment Detection** window shown in Fig. 4-23 will open.

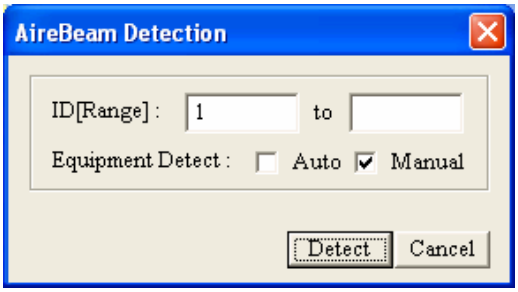


Figure 4-23: Equipment Detection Window

Checking the **Auto** check box of **Equipment Detection** window de-activates the **ID(Range)** selection part and the system automatically checks for equipment in allowed ID range from 1…9.

Checking the **Manual** check box allows for selecting a specified **ID(Range)** within the allowed ID range from 1…9. If no ID is entered in the **Manual** mode of operation or the values entered are not within the range between 1 and 9, the warning window shown in Fig. 4-24 will open.

Figure 4-24: Equipment Detection Error window

Pressing the **Detect** button either in automatic or manual mode will start the detection process.

Note:	If the detection range is not correct, the equipment is not detected. Check the input value one more time.

If the entered ID is correct, the detection result window will appear as in Fig. 4-25. The detection result is displayed with the input ID and detection result (**OK** or **None**). When the equipment detection is completed, the message, "AireBeam discovery .. Complete." is displayed. After this message is displayed, press the **OK** button to close the detection result window. Pressing the **Cancel** button during detection will stop the equipment detection process.

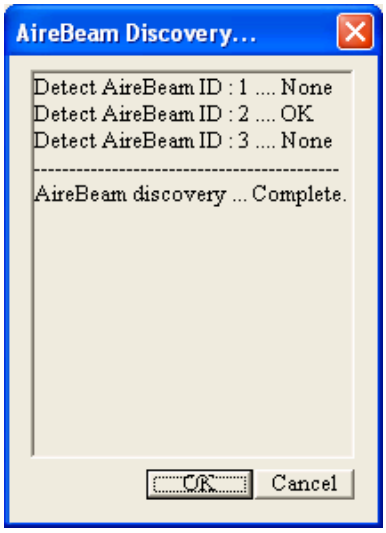


Figure 4-25: Equipment Detection Status Display Window

Menu -> Option [Option(P)]

The Option menu provides some additional functions like recording a history log file and turning alarm sounds on and off. The Option sub menu is shown in Figure 4-26.

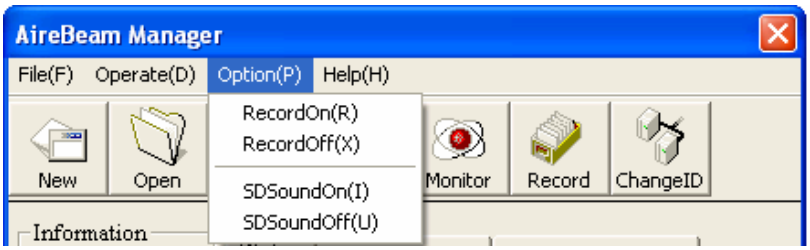


Figure 4-26: Subitems of the Option

Option → RecordOn

By activating the "**RecordOn**" function, equipment status information (Time stamp, ID, Receive power level, Temperature, SD Status and Optic Status) is saved in a log file. After clicking the **RecordOn** menu the record time input

window opens and the time interval between records can be specific. The record time input window is shown in Figure 4-27.

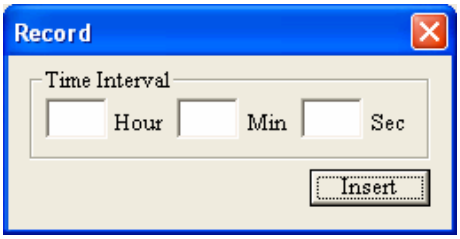


Figure 4-27: Record Time input window

If the record time interval was already saved before in the information file, the warning window shown in Fig. 4-28 will appear.

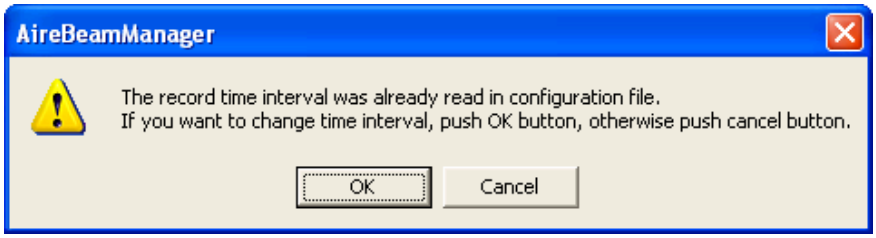


Figure 4-28: Record Time Warning window

To change the record time interval, press the **OK** button and enter the time interval in hours, minutes, seconds or any combination. To maintain the existing time interval, press the **Cancel** button and use the value entered at an earlier stage. If the **Insert** button in Figure 4-27 is pressed after the time is entered or if the existing value is read from the information file, the **Save As** window shown in Fig. 4-29 will open.

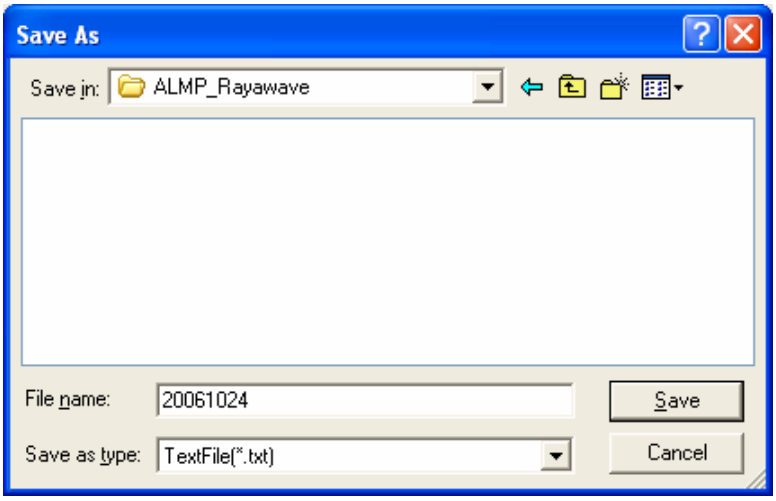


Figure 4-29: Save as Record File window

After the **Save as File** window opens, enter the record file name and press the **Save** button. The equipment status information will then be stored in the specified file when the **RecordON** menu is activated. The file is saved in a general text document format, and the file extension (*.txt) is automatically inserted behind the file name.

Option → RecordOff

Recording of information into the record log file stops when **RecordOff** is activated.

Option → SDSoundON

An acoustic alarm can be generated when the **SD(Signal Detect) Status** changes from ON to OFF . If **SDSoundON** function is activated, the alarm sounds when the monitored equipment the signal detect status to OFF. This typically indicates that there is a problem with the equipment and the user needs to check the status.

Since the **SDSoundON** operation is tied to monitoring the specific equipment from the **AireBeam_List**, the warning window shown in Fig. 4-30 open in case that no specific equipment has been selected for being monitored. Press the **OK** button in the warning window and selecting the equipment to be monitored will resolve this condition.

Figure 4-30: SD Sound Warning Window

Option → SDSoundOff

The alarm function based on **SD(Signal Detect) Status** is stopped.

Menu -> Help [Help(H)]

Activates a Help menu as shown in Figure 4-31

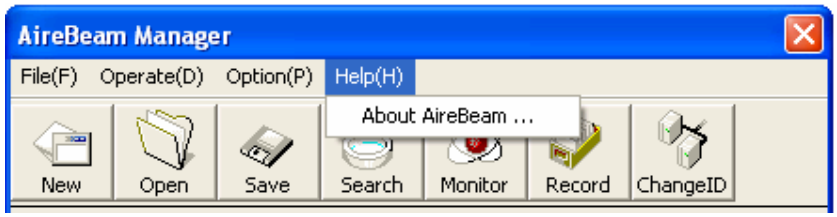


Figure 4-31: Sub items of the Help

Help → About AireBeam

Pressing 'About AireBeam…' displays the program version information and provides a link for technical support.

Figure 4-32: Program Information window

Icon Buttons

The program can be controlled and specific functions can be activated by using the icon buttons. The function of the icons is the same as some of the entries that can be found in the Menu item tab. The icons provide a faster way to change certain functions that are used more frequently and without having to navigate through the menu tab. Icon buttons that are available are shown in Figure 4-33.

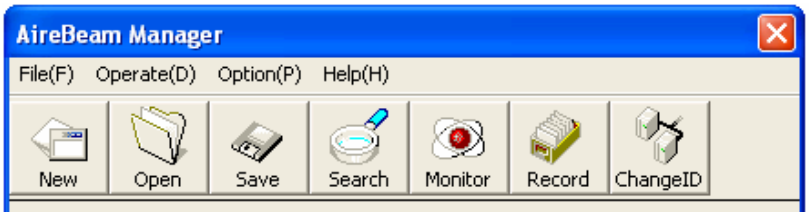


Figure 4-33: Icon Buttons

Monitor Icon

After pressing the **Monitor** button with a left mouse click to check on the status of a particular equipment, the icon changes its appearance and the **Monitor** icon changes to [M]Stop (See Figure 4-34).

Note:	If the equipment is disconnected, [M]Stop changes to Monitor with the connection termination message displayed.

In order to stop monitoring, pressing the [M]Stop button will terminate the monitoring function, and subsequently the [M]Stop icon changes back to the **Monitor** icon again. The detection function can't be used during monitoring, so pressing the **Search** button doesn't make any events occur.

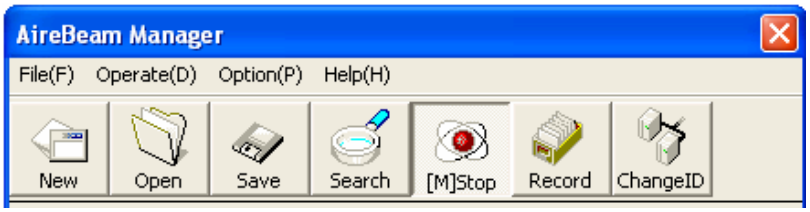


Figure 4-34: Executing the Monitor function

Record Icon

If the **Record** button is pressed to save the equipment status information into a log file, real time status information will be saved at user specified time intervals. Just like the **Monitor** operation, pressing the **Record** button changes the appearance and the **Record** icon and it will display [R]Stop (see Figure 4-35)

In order to stop recording process, pressing the **[R]Stop** button will terminate the recording process and the icon changes its appearance back to the **Record** icon again.

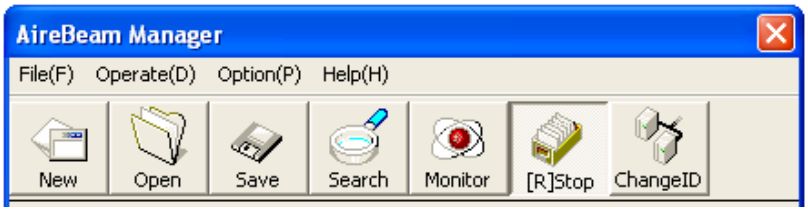


Figure 4-35: Executing the Record function

Save File Formats

As mentioned earlier, executing the **Record** function creates a log file containing information about the equipment status at specific user defined time interval. This information is very helpful during troubleshooting or when the user is interested in the performance of the system in general. The saved files are stored in a text formats as shown in Table 4-1. The data actually saved appear with the formats shown in Table 4-2.

2005-00-00[Year-Month-Day]					
hh:mm:ss [Hour:Minute:Second]	ID [ID]	RF [RF power]	Temper [Temperature]	SD_Status Signal Statis	Optic Optic Cable
00:00:00	0	-20	38	ON	OFF

Table 4-1: Record File Formats

2005-01-19

hh:mm:ss	ID	RF[dBm]	Temper	SD_Status	Optic
17:05:29	2	-38	26	ON	OFF
17:06:29	2	-39	27	ON	OFF
17:06:29	2	-39	27	ON	OFF
17:06:29	2	-38	28	ON	OFF

Table 4-2: Record File Types


Rayawave

5. Troubleshooting and Diagnostics

This chapter will provide some helpful tips on trouble shooting the equipment and it covers the following topics

Types of Failure

Fault isolation troubleshooting charts

Additional troubleshooting methods

Technical support

RMA procedures

To some extend the radio units can be considered a as being a simple layer 1 pipe that moves data from point A to point be. Since no processing of the data occurs inside the radio the analogy of using a fiber instead of a wireless radio system, is valid in this case. If the radio units are aligned are aligned correctly and data is transmitted, the problem is usually outside the system.

5.1. Failure Types

Three different kinds of failures can affect system performance:

Failures caused by attached network components

Failures caused by the environment

System failure of one of the radio units

The use of the AireBeam™Manager program is highly recommended during the troubleshooting process. Although the AireBeam™Manager is not needed to transmit information through the system, the installation of the program onto a management PC is an essential part of the installation procedure and was therefore extensively covered in this manual.

Caution: If a failure is caused by a malfunction of power supply unit, please remember that only authorized technical personnel may conduct checks of the AC input to the power supply. In all cases, the linkhead should always be disconnected from the AC or DC power supply during a maintenance procedure.

5.2. Troubleshooting Charts

The troubleshooting charts are meant to guide the user through some simple a failure analysis procedures. Following these procedures will greatly help to ease the troubleshooting process and many problems can be solved on a short notice by the user of the equipment and consequently minimize the downtime of the system in case of a malfunction. Please, use these charts first to locate the problem and before contacting Rayawave or your reseller.

Observation: AireBeamManager can't detect AireBeam™ radio equipment

Problem	Cause	Action
Power Source	Power source terminal connection error	Check the wire connection and ensure that all wires are attached correctly (See chapter 3.5). Use a voltmeter to check that +/- 48 Volts are present at radio power terminal. Check if power LED inside the radio unit is turned on.
	Broken cable	Replace it with a new cable. Use a voltmeter to check that +/- 48 Volts are present at radio power terminal. Check if power LED inside the radio unit is turned on.
	Power supply switched off	Turn power supply on. Check if power LED inside the radio unit is turned on.
	Power supply broken	Replace power supply. Call Rayawave or reseller in case the power supply was part of the shipment.
Administration Communication via RS232 port	Terminal connection error	Check that the connection is wired correctly. See Figure 3-7 in this manual.
	Broken cable	Replace it with a new cable
	Bad converter	Replace the converter with a new one. Contact Rayawave or reseller.
	PC port setup error	Set it up the correct communication port. See Figure 4-2 in this manual.
	A bad PC serial port	Contact the PC vendor.

Table 5-1: Troubleshooting Chart I

Observation: Network connection cannot be established with the opposite radio. Received power is “low” or signal status is “off”

Problem	Cause	Action
Power Source	The equipment power supply at the opposite side is switched off.	Turn power supply on. Check that the green LED inside the radio unit is turned on.
	Broken power supply	Replace power supply. Call Rayawave or reseller in case the power supply was part of the shipment.
System Setup	System is misaligned.	Realign system. See chapter 3.6 in this manual.
	Dirt or dust in the antenna	Clean the antenna.
	Distance between locations exceeds specific system specification.	System can still be used but availability will be lower.
	Antenna is mounted incorrectly and the polarization is crossed.	Re-install the antenna and ensure that both antennas transmit at the same polarization. See chapter 3.3 in this manual.
Environment	High signal attenuation due to heavy rain	Wait until the rain stops and observe if this resolves the problem.
	Antenna covered with snow.	Remove snow from antenna.

Table 5-2: Troubleshooting Chart II

Observation: 'Optic Status' reports "OFF", OSD LED is off

Problem	Cause	Action
Optic Cables or Transceiver	TX and RX terminal connection error	Check fiber cables and ensure that transceivers are connected correctly. See Figure 3-5
	Optical transceiver standards do not match	ONLY use 100Base-FX (1300nm) in case of AireBeam 100, or 1000Base-SX (850nm) multimode transceivers in case of AireBeam 1250.
	Dirt or dust or breakage of optical fiber	Clean fiber output or replace the cable with a new one.
	Broken transceiver at the network premise equipment side	Replace transceiver
	Broken transceiver at the radio side	Replace radio. Call Rayawave or reseller.
Premise Equipment Connection	The network premise equipment at the opposite side is turned off	Power on premise equipment
	Network port of premise equipment is de-activated	Activate network port

Table 5-3: Troubleshooting Chart III

5.3. Advanced Troubleshooting Methods

5.3.1. Performing a PING test

A ping test is not a very sophisticated networking test but it provides the user with an easy method to check the connection status of IP based networking equipment. When performing a ping test between two laptops and without having other network equipment attached, the ping test provides valuable information about the performance of the radio transmission link itself. Other test involving networking equipment as part of the setup do not isolate the radio transmission equipment form the rest network, and consequently it can be difficult to find the root cause of a potential problem. The following equipment and software are needed to perform a ping test.

Equipment required to perform a Ping Test

- Two laptops or PCs with Ethernet cards
- Two Ethernet cables with RJ45 connectors
- Two media converters
  - Multimode 100Base-FX (1300 nm) with SC connection in case of AireBeam 100 testing
  - Multimode 1000Base-SX (850 nm) with SC connection in case of AireBeam 1250 testing. In case of using an older laptop that does not have a 1250 Mbps RJ45 (Gigabit Ethernet) connection, a 100/1000 switched media converter will be required.
- Four simplex (or two duplex) optical fiber patch cords with SC type termination

5.3.2. Equipment connection and network settings

To perform a ping test directly connect the two laptops/PCs to the radio link heads by using a media converter on each side. Ensure that the radio units are aligned and that all status indicators show that the system is physically connected by following the instructions in chapters 3.5 and 3.6.

Note:	This ping test is based on using two computers. It is possible to do a ping test with just one laptop if the remote radio side is connected to the network and equipment (switch/router) with a known IP is available at the remote side. However, by doing so it might be difficult a potential networking problem and draw a definite conclusion.

5.3.3. Step-By Step instructions to perform a ping test

Step 1 Locate the required equipment listed above.

Step 2 On each side, attach two optical fiber cables to the TX/RX ports of the network transceiver inside the radio unit enclosures (see Figure 3-3 and Figure 3-4) Connect the opposite ends of the fiber cables to the TX/RX ports of the media converters.

Step 3 Connect an Ethernet cable between the PC RJ45 network port and the media converter RJ45 port on each laptop/PC and complete the following setup instructions on each laptop. The exact procedure will depend on the actual Windows operating system installed but the procedure is basically the same for any Windows operating system.

Step 4 From Windows click the **Start** button.

Step 5 Click on **Settings.**

Step 6 Click on **Control Panel.**

Step 7 Click on the **Network And Dial-Up Connector** icon.

Step 8 Click on **Incoming Connection.**

Step 9 Click on the **Network** tab**.**

Step 10 Double click on **Internet** Protocol **TCP/IP**.

Step 11 Select the **Specify TCP/IP Address** radio button.

Step 12 The local side should type **192.0.0.1** in the IP Address Box. The remote side should type **192.0.0.2** in the IP address box. The Subnet address will automatically generate.

Step 13 Click the **Okay** button.

Step 14 Exit all dialog boxes.

Step 15 Click on the **Start** button.

Step 16 Select **Programs**.

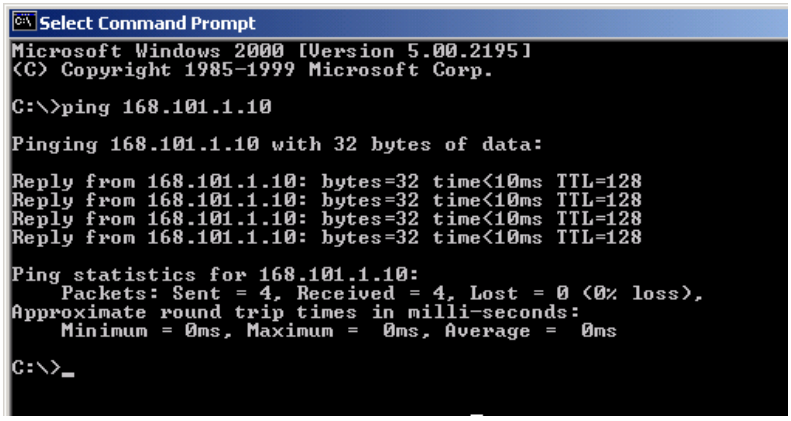
Step 17 Select the **MS-DOS** Prompt.

Step 18 Type the word **ping** and the different **ping** command options will be displayed.

Step 19 To perform the ping test, the local laptop has to ping the IP address of the laptop and the other way around. From C:\> Type: **ping -t 192.0.0.2** on the local laptop**.** The remote side laptop can ping by typing: **ping -t 192.0.0.1**.

To stop the ping tests, type **<Ctrl> C**.

Step 20 A successful **ping** will display the following information on the PC screen.



Step 21 Let the **ping** program run for several minutes and then type **<Ctrl> C** to stop the program. Take a look at the lost ping counter to verify that the system operates correctly. We using two laptops, no packet should be lost during the transmission.

5.3.4. BER Testing

Bit Error Rate (BER) testing is the most advanced way to check on the performance of a communication link. Since the radio transmission link operates virtually as a layer 1 connection. The radio operates in full-duplex mode at real network throughput speed and extremely low latency of typically < 50 microseconds. Higher protocol layer performance is not determined by the radio but by the attached networking equipment. Due to the fact that the system acts virtually like a bit pipe, it is possible to physically loop back the system by connecting the RX and TX fiber at the remote location and use only one BER tester at the local radio installation side. There are several vendors in the market that provide BER testing equipment. In case you are interested in performing a BER test and do not have a BER tester, please contact Rayawave for information on test equipment companies that lease BER Testers.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6. Terminal Locations

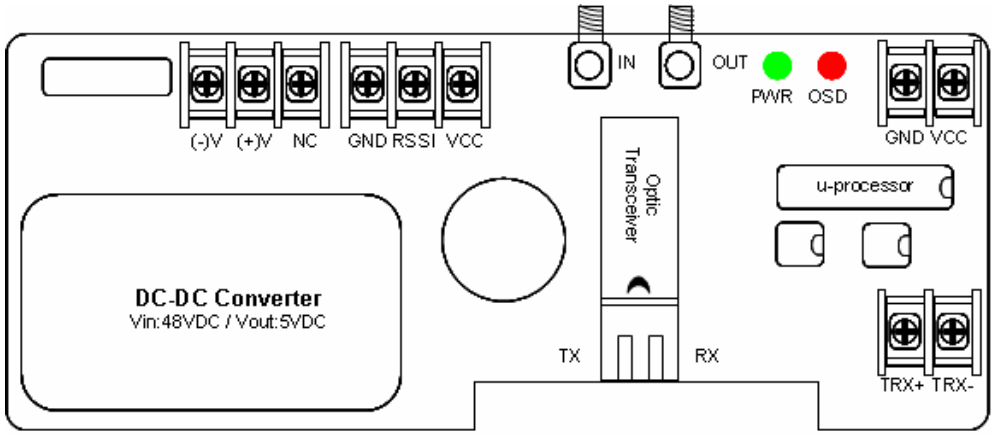

Figure 6-1: Terminal locations (AireBeam™ Fast Ethernet system)

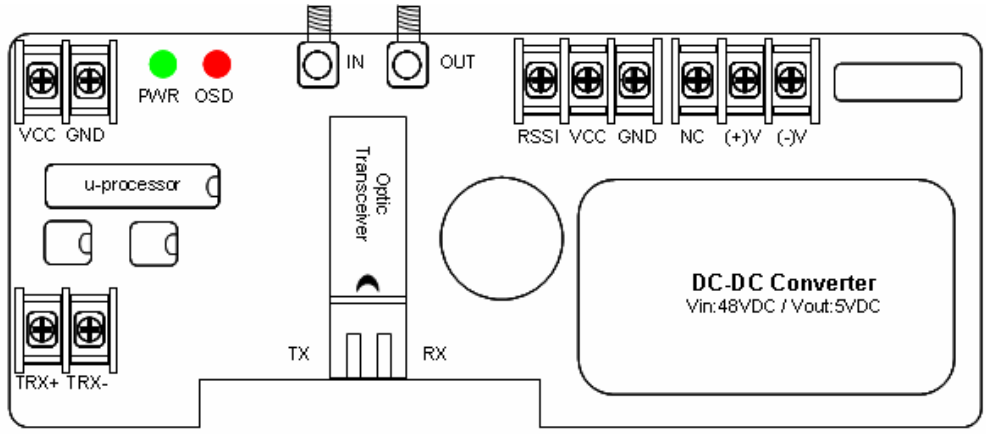

Figure 6-2: Terminal locations (AireBeam™ Gigabit Ethernet system)


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7. Specifications

7.1. AireBeam™ 60-xxxx-12 Series Specification

Parameter		AireBeam™ 60-100-12	AireBeam™ 60-1250-12
Frequency Range		57~64(FCC), 59~66(JAPAN)	
Output Power		+10dBm (10mW) max	
Modulation		ASK	
Main Power		DC +/-48V	
Interface (Multimode)		1310nm, LC	850nm, LC
Datarate		125Mbps	1.25Gbps
Operation Temperature		-30 ~ +70°C	
Size (L×WxH)		180x100x180mm (except antenna)	
Weight		6kg [13.2lbs]	
Antenna	Type	Cassegrain	
	Size	1ft	
	Gain	43dBi	
	HPBW	0.9	

7.2. AireBeam™ 60-xxxx-24 Series Specification

Parameter		AireBeam™ 60-100-24	AireBeam™ 60-1250-24
Frequency Range		57~64(FCC), 59~66(JAPAN)	
Output Power		+10dBm (50mW) max	
Modulation		ASK	
Main Power		DC +/-48V	
Interface (Multimode)		1310nm, LC	850nm, LC
Datarate		125Mbps	1.25Gbps
Operation Temperature		-30 ~ +70°C	
Size (L×WxH)		180x100x180mm (except antenna)	
Weight		6kg [13.2lbs]	
Antenna	Type	Cassegrain	
	Size	2ft	
	Gain	49dBi	
	HPBW	0.5	

7.3. AireBeam™ 70-xxxx-12 Series Specification

Parameter		AireBeam™ 70-100-12	AireBeam™ 70-1250-12
Frequency Range		71~76GHz	
Output Power		+17dBm (10mW) max	
Modulation		ASK	
Main Power		DC +/-48V	
Interface (Multimode)		1310nm, LC	850nm, LC
Datarate		125Mbps	1.25Gbps
Operation Temperature		-30 ~ +70°C	
Size (LxWxH)		180x100x180mm (except antenna)	
Weight		6kg [13.2lbs]	
Antenna	Type	Cassegrain	
	Size	1ft	
	Gain	43dBi	
	HPBW	0.9	

7.4. AireBeam™ 70-xxxx-24 Series Specification

Parameter		AireBeam™ 70-100-24	AireBeam™ 70-1250-24
Frequency Range		71~76GHz	
Output Power		+17dBm (50mW) max	
Modulation		ASK	
Main Power		DC +/-48V	
Interface (Multimode)		1310nm, LC	850nm, LC
Datarate		125Mbps	1.25Gbps
Operation Temperature		-30 ~ +70°C	
Size (LxWxH)		180x100x180mm (except antenna)	
Weight		6kg [13.2lbs]	
Antenna	Type	Cassegrain	
	Size	2ft	
	Gain	51dBi	
	HPBW	0.5	


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8. Technical Support

Be sure to fill out the following checklist before calling your reseller on contacting Rayawave Technical Support.

General Information	Your Installation
❑ Application (Fast Ethernet or GbE)?	
❑ Distance?	
❑ How long has system been in operation?	
How does the error show up?	
❑ Temporary/permanent error?	
❑ Is error observed for the first time?	
How was the weather when error showed up?	
❑ Light or Dark?	
❑ Weather conditions (fog, snowfall)	
❑ Outside temperature	
Status of LEDs (inside radio unit)	
❑ Is the power LED on (green)?	Yes/No
❑ Is the OSD LED on (red)?	Yes/No
❑ Did you measure the RSSI voltage?	Yes/No If yes, what was the reading?
Status in AireBeam™ Manger	
❑ AireBeam™ Manger connection ok?	Yes/No
❑ Is RF receive power value displayed?	Yes/No If yes, what is the reading in dBm?
❑ Is temperature value displayed?	Yes/No If yes, what is the reading in ^{O}C?
What type of system is installed?	
❑ Model number	
❑ Serial number	

8.1. Return Material Authorization (RMA) Procedure

Please contact Rayawave before returning any system or system components for repair or replacement. A RMA number is required before sending back potentially defective equipment. Please, keep in mind that sending back equipment without a RMA number can delay the repair of the equipment.

RMA contact information:

Phone: 858.350.4259

Email: support@Rayawave.com


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