SUB10
systems.com

Liberator-V1000
Installation & User Manual

Revision 00v01
Firmware – v02.01.01.03

Document Type	User Manual
Project	Liberator-V1000
Date	2 April 2014
Authors	Malcolm Sellars
Title	V1000 Installation & User Manual
Classification	Sub10 Systems Public
Document Number	SUB10-0098_00v02

Version	Date	Author	Description
00v01	2 April 2014	M. Sellars	Release 02.01.01.03
00v02	8 April 2014	C. Fisher	Additional FCC regulatory requirements in Annex B

1 INTRODUCTION

1.1 Revision
Sub10 Systems reserves the right to revise this documentation periodically without any obligation to provide notification of such revision or changes.

1.2 Intended users & Software Version
This manual is intended for all installation and service personnel who are involved in the planning, installation, operation and maintenance of the Liberator-V1000 equipment. Although the Liberator-V1000 Link is designed for easy installation and setup, optimum performance can be achieved by following the procedures outlined in this manual. Use of this manual requires that the installer has at least a basic experience and understanding of networking equipment, as well as some familiarity with its configuration and operation. The information covered in this manual should be fully understood prior to installation.

This Manual refers to the Liberator-V1000 running Software Version 02.01.01.03. Please ensure that the software version on the radio terminals is the latest version on the Sub10 Systems website: http://www.sub10systems.com Please email: support@sub10systems.com if you encounter any issues.

Note: This manual also covers the installation, operation and regulatory approval of the Liberator-V100 product when running Software Version 01.01.01.03.

1.3 Safety Information

1.3.1 Grounding
The V1000 radio terminal (outdoor unit) must be properly grounded to protect against lightning strikes. It is the user's responsibility to ensure that the equipment is installed in accordance with national regulations:
        USA: Articles 810 & 830 of the National Electric Code ANSI/NFPA No.70-1984
        Canada: Section 54 of the Canadian Electrical Code
Other countries may require different regulations. It is recommended that the outdoor unit be installed by a professional installer.

1.3.2 Operation in hostile environments
The rated operating temperature of the radio terminal (that is, the outdoor unit or ODU), is from -40°C to +55°C. In normal operation, the radio terminal will be at a higher temperature than the ambient temperature. For safety reasons, if the ambient temperature at the location proposed for the radio terminal is likely to exceed +40°C, then the radio terminal must be mounted in a Restricted Access Location. The Restricted Access Location must only be accessible to authorised maintenance personnel through the use of a tool, lock and key or other security mechanism. The maintenance personnel must be advised that the radio terminal is hot and that safety precautions must be taken: either disconnect power from the radio terminal 1 hour before undertaking maintenance/repair, or else wear protective gloves when handling the radio terminal if power disconnection takes place less than 1 hour before access.

1.3.3 Exposure to Non-Ionising Radiation
All radio transmitters emit non-ionising radiation and have to be assessed for the potential impact of the radiation levels on Human Safety. The most stringent limits apply to exposure of the general population to non-ionising radiation. The very conservative analysis[1] has been applied to the Liberator-V1000 radiated power levels and this has indicated a need to ensure that the Liberator-V1000 terminal is mounted so that it is always separated from the location of any human being by a distance of at least 1 metre.

1.3.4 Power Supply
The Sub10 Systems PoE++ power injector should always be used to power the Liberator-V1000. If the correct power supply is not used, this may invalidate the safety certification and cause a safety hazard. The mains power

---

[1] Further details of the analysis can be found in Section B of this User Guide.

supply is the primary disconnect device for the Liberator-V1000. The installer must ensure that a mains voltage supply cable approved for the country of installation is used.

1.3.5 Maintenance and Servicing

- Always disconnect the primary power source before undertaking maintenance/repair of the radio terminal (Outdoor Unit).

- At least once per year, each radio terminal (Outdoor Unit) must be inspected for signs of corrosion. Light corrosion is acceptable in extreme environmental conditions (marine-type deployments), but the structural integrity of the Outdoor Unit must not be in doubt. In the unlikely event that significant corrosion is seen, the radio terminal may need to be replaced: in this case, please contact Sub10 Systems for advice.

1.4 Warranty

Sub10 Systems warrants to the original end user (purchaser) that this product is free from any defects in materials or workmanship for a period of up to 24 months (2 years) from the date of shipment to the end user. During the warranty period and upon proof of purchase, should the product show indications of failure due to faulty workmanship and/or materials, Sub10 Systems will, at its discretion, repair or replace the defective products or components without charge for either parts or labor and to whatever extent it shall deem necessary to restore the product or components to full operating condition. Any replacement will consist of a new or remanufactured, functionally equivalent product of equal value, and will be offered solely at the discretion of Sub10 Systems.

This warranty shall not apply if the product is modified (e.g. warranty seal is broken), misused, tampered with, damaged by an act of God, or subjected to abnormal working conditions. To obtain services under this warranty, contact the Sub10 Systems Service Centre. Products must be returned postage prepaid. It is recommended that the terminal be insured when shipped. Any products returned without either proof of purchase or with an outdated warranty will not be repaired or replaced. The customer will be billed for parts and labour. All repaired or replaced products will be shipped by Sub10 Systems to the corresponding return address 'postage paid'. If the customer specifies an alternative return destination where additional costs are incurred, the customer shall bear the cost of the additional return shipment cost. This warranty gives you specific legal rights, and you may also have other rights that vary from country to country.

1.5 Copyright / Disclaimer

Copyright © 2014 by Sub10 Systems.

The contents of this publication may not be reproduced in any part or as a whole, transcribed, stored in a retrieval system, translated into any language, or transmitted in any form or by any means, electronic, mechanical, magnetic, optical, chemical, photocopying, manual, or otherwise, without the prior written permission of Sub10 Systems.

2 SYSTEM OVERVIEW

2.1 Top Level Description

The Liberator-V1000 system operates as a data link in the unlicensed 60 GHz band between 57 GHz and 64 GHz. The antenna radome face measures only 18cm x 18cm (7" x 7"), making it ideal for unobtrusive urban deployments.

The Liberator-V1000 is a Transparent Layer 2 Wireless Ethernet Bridge, and consists of two radio terminals. Each radio terminal is managed individually through a Web Management Interface or via the SNMP management protocol.

The Liberator-V1000 radio terminal has a single Gigabit Ethernet interface with PoE++ powering.

Figure 1 - V1000 radio terminal

2.1.1 Benefits

•   Easy installation – The concept of the Liberator-V1000 Link allows the end user to install it as easily as any other network component. The single cable solution reduces the complexity of the installation. The terminal is connected to the network, monitored and supplied with power through a single outdoor industrial-rated CAT 5e Ethernet cable, which has a solid or multi-braided screen.

•   A visual alignment tool together with an alignment bracket allows the user to easily line-up the antennas. Subject to correct installation techniques being used, immediate operation without the need for additional configuration is assured.

•   Network performance – Guaranteed 700 Mbps full duplex (QPSK modulation) over the installed link path. Unlike some WLAN equipment, full data rate is delivered irrespective of link length (subject to link budget and losses).

•   Licence-free operation – The system has been approved and can be operated in many countries without needing an individual licence for each link. Always check in-country regulations which may vary.

•   System administration – To monitor the status and the traffic, the user can access the link statistics either via the HTML user interface or by integrating it into a network management tool via SNMP.

•   Security – The coding applied to the proprietary radio interface significantly restricts access to the 60 GHz transmitted data. Additionally a high level of data security is inherent in the product via signal absorption by atmospheric oxygen and the use of high gain/narrow beamwidth antennas.

2.1.2 Applications

•   LAN extension
•   Redundant access
•   Campus connectivity
•   Disaster recovery
•   Wireless backhaul
•   Centralization of IT infrastructure
•   Temporary connections during events
•   Mesh, hub and spoke configuration

2.2 Ethernet switch

Each radio terminal includes an Ethernet switch. The first switch port is connected to the physical Ethernet connection to the terminal. The second switch port is connected to the radio modem and the terminal's management agent.

The switch is capable of learning up to 1024 MAC addresses, but this is only for the purpose of deciding in which direction to send management traffic responses (either over the air interface, or else back over the Ethernet interface). The switch does not implement any kind of Spanning Tree Protocol (STP): it will simply pass all STP messages transparently over the air, but will not perform any routing of data traffic based on the Spanning Tree. This means that all incoming packets on the Ethernet interface are simply passed over the air, without taking any account of STP, and therefore the installer should ensure that there are no data loops in the system, because the switch will not detect the existence of a loop.
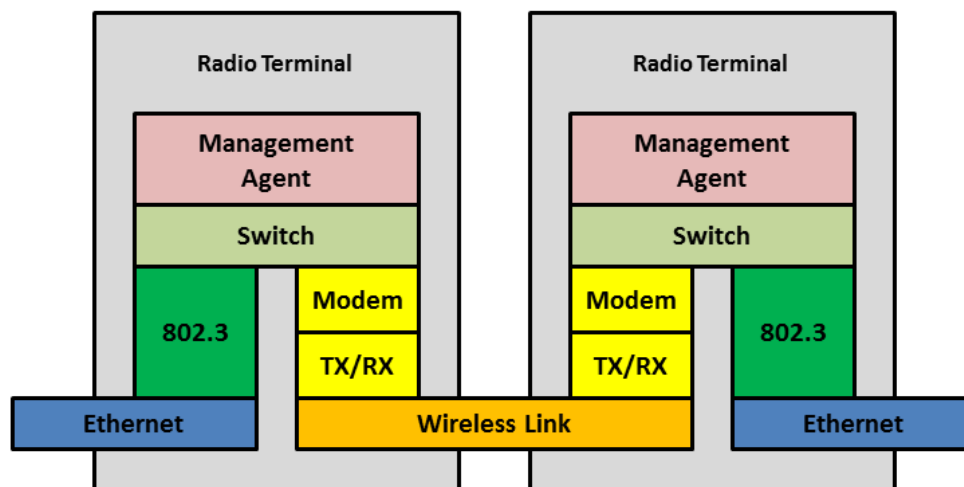
Figure 2 - Network layers of the V1000 system

2.3 Package contents

A complete link is packed in one box. The box contains the following:

- Terminal A
- Terminal B
- Adjustable Alignment Brackets
- Mast brackets
- Sealed Ethernet connectors

- Ice bridges /Sun-shields
- PoE++ mains power injectors and leads
- Fixing and accessory kit
- Quick Start Guide

Figure 3 – Contents of V1000 Link Kit (EU mains plug version), showing parts for one end of the link. Each V1000 Link Kit contains 2 sets of these parts (one set for each end of the link).

2.3.1 Terminals

Each terminal combines the antenna and the transmitter and receiver. Each terminal is connected to the network via an Ethernet cable (to outdoor specification) with RJ-45 connectors. Power is supplied to the terminal through the Ethernet cable.

Figure 4 - V1000 terminal

2.3.2 Wall-Mount/Alignment Bracket

The wall-mount bracket facilitates easy radio alignment owing to its independent axes. It has a locking nut on each axis, so that once aligned on one axis, the alignment will not be disturbed by adjustments to the other axis.

Figure 5 - Alignment bracket

2.3.3 PoE++ Injector

The terminal is powered via an Ethernet cable with a high-power Power-over-Ethernet power supply conforming to "Ultra-PoE" or "PoE++" specifications. It is recommended that the Sub10 Systems PoE++ power injector should always be used to power the Liberator-V1000. If the correct power supply is not used, this may invalidate the safety certification and cause a safety hazard. The mains power supply is the primary disconnect device for the Liberator-V1000. The installer must ensure that a mains voltage supply cable approved for the country of installation is used.

Should the network equipment connected to the Liberator-V1000 Link not offer PoE++, a power injector can be inserted in-line with the Ethernet cable.

Figure 6 (a) SL Power PENT 1040B PoE++ power injector and (b) PhiHong POE61W PoE++ power injector

2.3.4 Mast Bracket

The mast bracket is used to mount the bracket onto a mast. The bracket is suitable for any pole diameter from 50 mm to 115 mm (2" to 4.5").

Figure 7 - Mast bracket

2.3.5 Ice Bridge/Sun-Shield

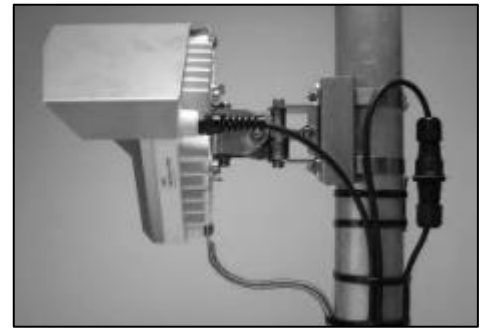The ice bridge offers additional protection for the terminal against rain, snow and ice-formation

Figure 8 - Ice bridge mounted on V1000

2.3.6 RJ45 Seal Kit

The RJ45 seal kit is used to connect the Ethernet tail from the ODU to a CAT 5e drop cable, which then connects to the PoE++ power injector. Important: Inner seal supports a maximum Ethernet cable diameter of 6.50 mm, the use of larger diameter cables will compromise seal integrity.

Figure 9 - RJ45 seal kit

2.4 Accessories and Spares (available to order as additional parts)

The parts listed in this section are not included with each link, but must be ordered separately if required.

2.4.1 Optical Alignment Tool

The optical alignment tool provided is easily mounted on the terminal using the locator pins and large thumbscrew. It enables both ends of the link to be coarsely-aligned quickly, simply and independently. Note that customers who purchased an optical alignment scope for use with Liberator V320 in the past, may find that the scope does not mount onto the V1000 back-housing. An adaptor plate is available for these early-version optical scopes, please contact your distributor, or else Sub10 Systems Customer Support.

Figure 10 - Optical alignment scope

2.4.2 Surge Arrestor

The surge arrestor is placed between the radio head and the Ethernet cable connecting to the PoE and any other network infrastructure. This device helps to reduce the risk of damage from lightning or high-tension overhead equipment. <u>Sub10 do not supply a surge arrestor with each link, but can supply on request.</u>

Figure 11 - Surge arrestor

2.4.3 Wall-mount bracket

The wall-mount bracket allows the alignment bracket to be mounted directly onto a flat surface.

Figure 12 - Wall-mount plate (bracket)   **Figure 13 - Wall-mount plate with V1000 terminal attached**

3 SITE PLANNING

All installers must perform a full site inspection and plan carefully prior to the physical installation of a Liberator-V1000 link.

This preparation must include:

- Evaluating the most appropriate location for the installation of the terminal.
- Identifying an appropriate mounting structure (wall or mast) for each terminal.
- Planning the cable routing from the network component to the terminal.

3.1 Terminal location

When selecting the best terminal location the following factors should be considered:

- Accessibility (e.g. How to gain access to a roof)
- Type of mounting (e.g. wall or pole)
- Grounding connection point
- Cable runs (max. 100 m / 328 ft)
- Human safety: Exposure to Non-Ionising Radiation - The Liberator-V1000 terminal should be mounted so that it is always separated from the location of any human being by a distance of at least 1 metre.

3.2 Line of sight

To ensure a clear line of sight (LOS), there must be no obstructions between the two terminal locations: the first Fresnel Zone should be completely clear of obstacles, see Figure 14 with n=1. The required clearance can be established visually, or by using Table 1, which gives the worst-case clearance at the centre-point of the link. This table is valid for distances greater than about 4 metres from the radio terminal. Note that this is the minimum clearance distance with perfect antenna alignment. It is recommended to use the widest clearance distance around the LOS path as is practically possible. See Figure 23 for clearance required at close proximity to the antenna.

Table 1 - Fresnel zone clearance for different ranges at 60GHz

Link Distance		Boundary Diameter ($2F_1$)	
100 m	328 ft	0.7 m	2.3 ft
200 m	656 ft	1.0 m	3.3 ft
400 m	1312 ft	1.4 m	4.6 ft
600 m	1968 ft	1.7 m	5.6 ft
800 m	2625 ft	2.0 m	6.6 ft
1000 m	3280 ft	2.2 m	7.3 ft

Fresnel Zone

$$F_n = \sqrt{\frac{n\lambda d_1 d_2}{d_1 + d_2}}$$
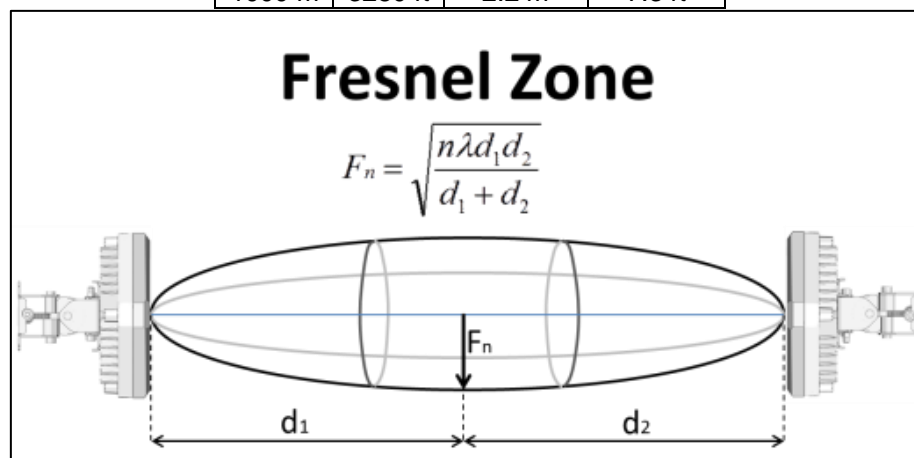
Figure 14 - Fresnel Zone clearance at 60GHz

3.3 Link distance / Link availability

The link distance is directly related to the weather conditions. Optimum link range and availability is influenced by the following environmental conditions:

- Rainfall:- the lower, the better
- Temperature:- the higher, the better
- Air pressure:- the lower, the better

An accurate estimation of the total link distance (line of sight) is important in estimating link range and quality. *For the rain regions in your country, see appendix A.4.*

3.4 Terminal Mounting Options

3.4.1 Wall mounting

The wall mounting location should be strong enough to secure the terminal to the wall, taking into account all foreseeable environmental conditions (e.g. wind, rain, ice).

Depending on the material to which the bracket is mounted, differently-sized mounting hardware may be necessary. To mount the terminals onto the bracket use the enclosed M6 bolts. The bracket allows a tilt angle of +/- 50° in both axes.

3.4.2 Pole mounting

The mast mount bracket will be needed to mount the terminal onto poles with diameters from 50 mm to 115 mm (2" to 4.5").

3.5 Lightning Protection Zones

In order to protect against lightning strikes damaging the equipment, it is important to choose a mounting position for the radio terminal (ODU), which is located in a "Protected Zone". In order to determine the zone of protection against lightning strikes, the rolling sphere method is commonly-used, see Figure 15. In this method, an imaginary sphere is rolled-over the top of the building or mast: regions underneath the lower trajectory of the sphere are in the protection zone, whilst areas above this are in danger of a lightning strike which can damage equipment and be hazardous to life. The imaginary rolling sphere can only be elevated by lightning finials, "air terminations" or adequately-grounded metallic structures, (not simply by the edge of a roof which has no earth bond). The radio terminal should always be installed in a Protected Zone.

The radius of the rolling sphere depends on the level of lightning protection required, which varies between geographical areas. See Table 2 for details. A commonly-used value for the sphere radius is 45 metres, but this will depend on the level of protection needed.

Table 2 - Lightning Protection Levels and Sphere Radius

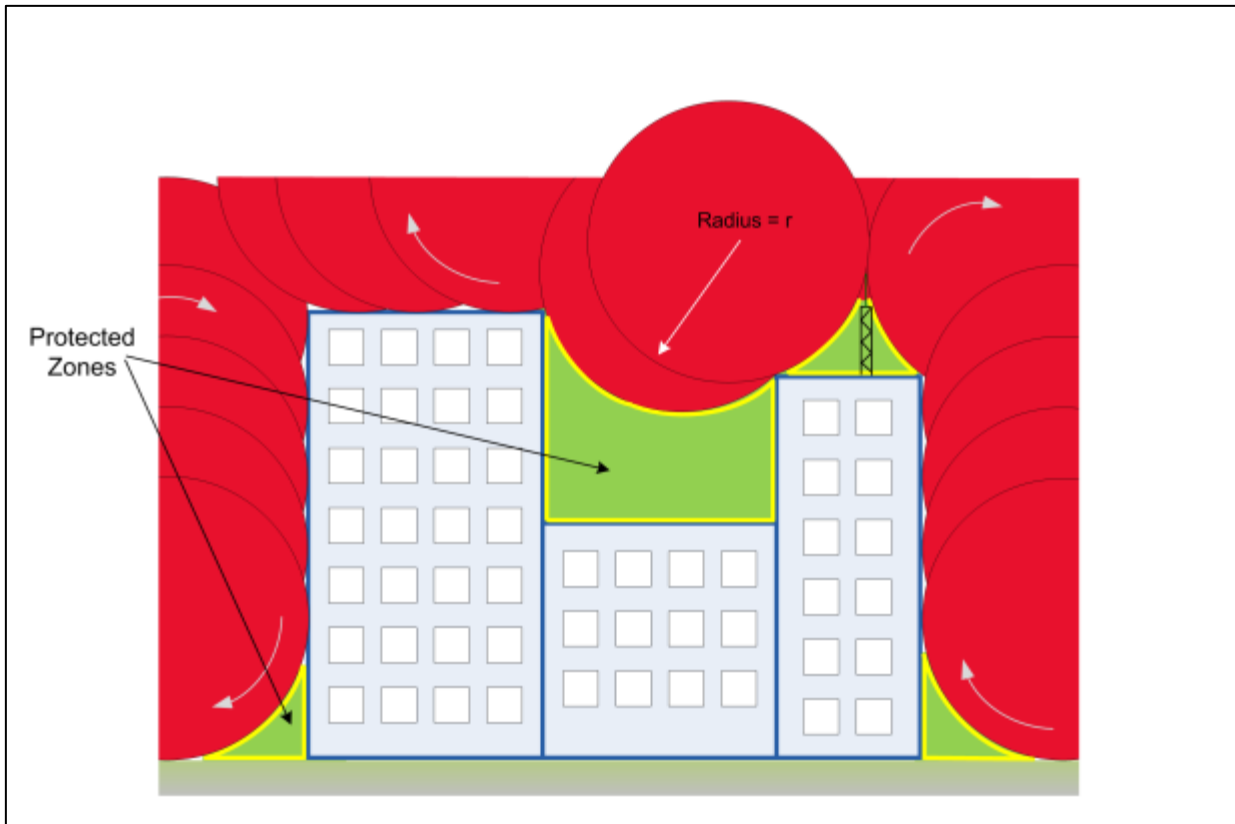| Lightning Protection Level	Sphere radius (m)	Interception Current (kA)
1	20	2.9
2	30	5.4
3	45	10.1
4	60	15.7

Figure 15 - Rolling sphere method for determining lightning protection zone

3.6 Cabling

The terminal is delivered with an Ethernet cable terminated with a RJ-45 connector. To connect the Liberator-V1000 Link to your network, use a Cat 5e Ethernet cable with a maximum length of 100 m to the next network node. The recommended cable specifications are:
- CAT5e Cable
- Outdoor Industrial Rated (includes rating for UV protection)
- Solid or Multi-Braided Screen (avoid cables with a metalised plastic foil screen)
- Screened RJ45 Connectors

Since the power is supplied by the Ethernet cable, please make sure that network equipment used supports power over Ethernet to the "Ultra PoE" or "PoE++" specification.

3.7 Co-located applications

Owing to the compact size of the Liberator-V1000 integrated terminal, it is particularly suitable for co-sited applications.

Possible configurations include:

- Back-to-back - doubles the link distance

- Parallel links – Up to 4 terminals at each end quadruples data capacity or redundancy, see Section 4.2.2

- Star - hub and spoke

4 Installation

Owing to the small size and integrated design of the Liberator-V1000 Link, its correct installation and setup is relatively simple.

When working on a roof, ladder, mast or staging, please take extreme care, observing all facility and OSHA (or other applicable regulatory agency) required safety precautions.
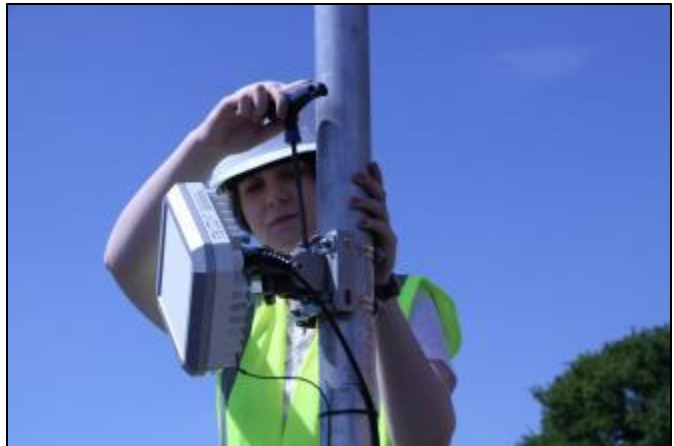
Figure 16 - Professional installation of a V1000 link

4.1 Installation Details

4.1.1 Wall mount

The wall and mounting screws must be able to support a weight of 11 pounds (5 kg), taking into account associated wind and potential ice loading factors.

4.1.2 Mast mount

The alignment bracket with V1000 radio terminal attached is shown in Figure 17.

Figure 17 - Alignment bracket

- Ensure that the mast has a diameter of between 50 mm to 115 mm (2" to 4.5"), or else a collar may be required to adapt to the mast bracket.
- Fasten the mast bracket onto the mast using the enclosed stainless steel bands
- Fasten the alignment bracket onto front part of the mast bracket using the enclosed stainless steel screws, nuts and washer (M6). To adjust and lock the bracket, an M8 T-Bar is required.

Do not use zinc-plated screws as these will corrode and endanger link performance and safety to people and equipment.

4.2 Terminal installation

4.2.1 Terminal installation – Polarization

It is important to install the terminal on the bracket with the same orientation (antenna polarization) at both ends of the link. The terminals must be mounted on the brackets in such a way that the polarization arrows point in the same direction (either both ends vertical, or else both ends horizontal). The polarization is indicated by an arrow on the backhousing, as shown in Figure 18.
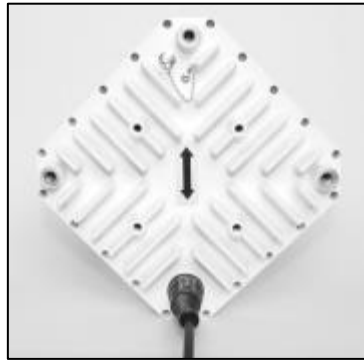
Figure 18 - V1000 backhousing with arrow indicating the polarization direction

The terminal must be mounted on the bracket using the enclosed stainless steel screws (M6 x 12).

Note: Do not use zinc-plated screws as these will corrode and endanger link performance and safety to people and equipment.

4.2.2 Terminal installation – Parallel Links

Up to four parallel links are possible using the V1000 radios. Antennas can be positioned together in clusters of up to 4 terminals, with a separation of not less than 50cm between antenna centres in the cluster, if the following configuration is used:

V = Vertical
H = Horizontal
A = A-End ODU
B = B-End ODU

AV	← →	BV
AH	← →	BH
BV	← →	AV
BH	← →	AH
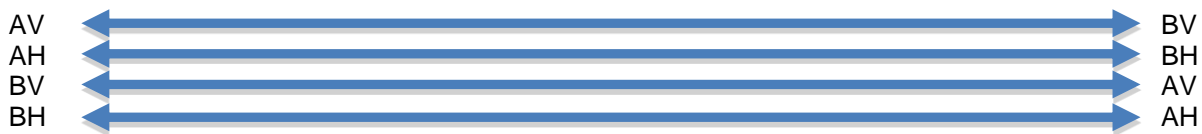
Figure 19 - Configuration for a cluster of 4 links on the same frequency

Vertical mounting onto a single pole is possible, with the top of the pole stabilised to minimise movement. It is possible to repeat the cluster arrangement provided that a spacing of at least 5 metres is allowed between adjacent clusters. For dense networks, especially with multiple clusters terminating on a single building, it is advisable to perform frequency planning prior to installation of the links: Sub10 Systems have a planning tool to help with this, or else an industry-standard tool such as Pathloss may be used. Sub10 can supply Pathloss configuration files on request.

4.2.3 Terminal installation – Co-located terminals

To minimise co-channel interference, some physical separation is required: the ideal configuration is to provide both vertical and horizontal separation where possible, as this offers the greatest discrimination. It is recommended to have a vertical spacing (separation) of at least 0.5m between adjacent terminals where possible, see Figure 20.
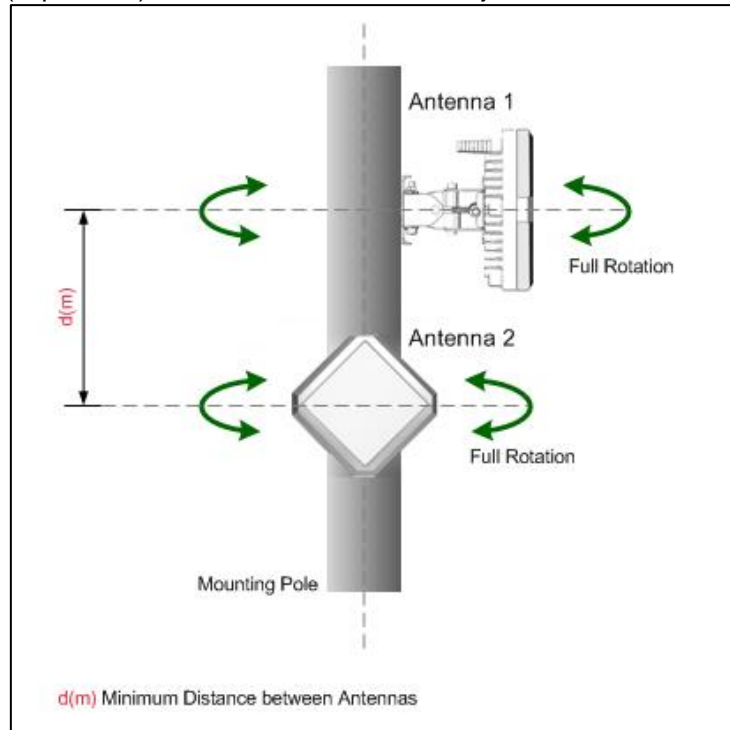

Figure 20 - Vertical separation of co-located terminals

It is recommended to avoid crossing the radio beams by planning horizontal mounting carefully, as shown below between Antenna 1 and both Antennas 2 and 3, see Figure 21.
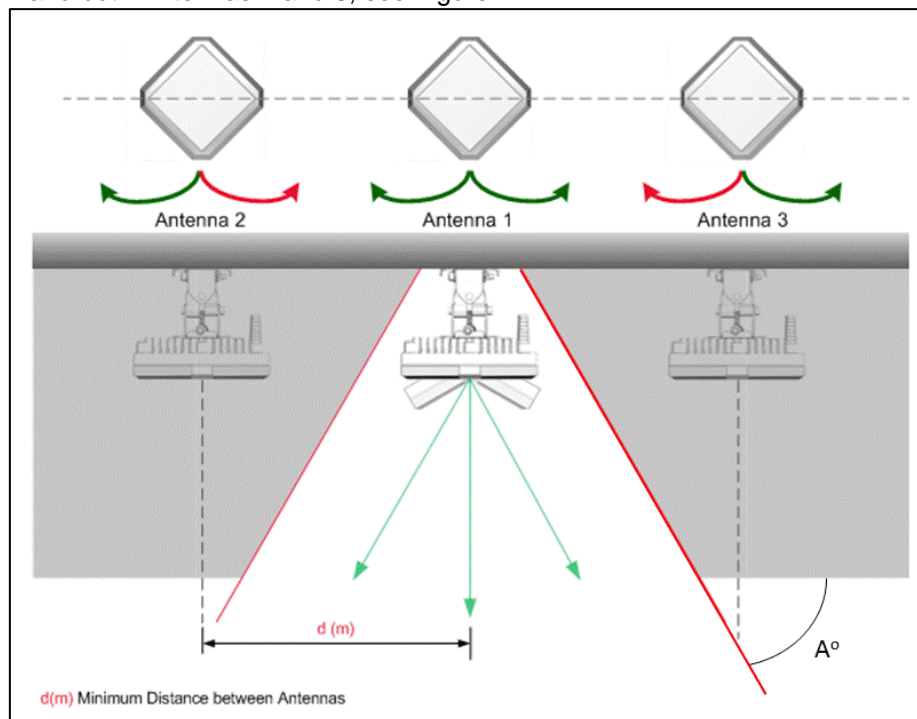
Figure 21 - Avoid overlapping beams
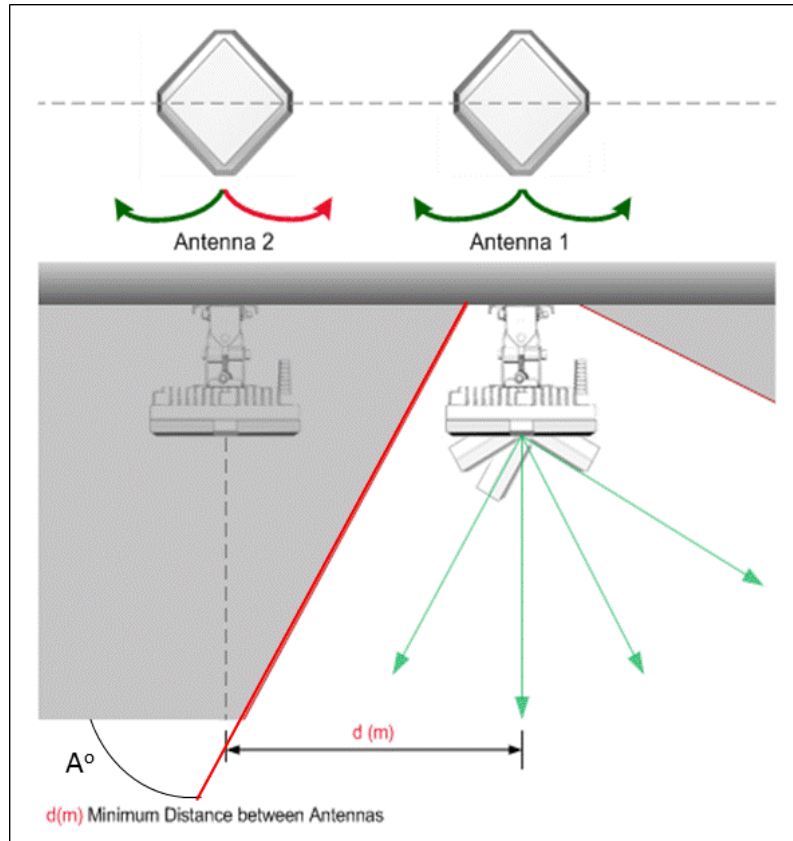
Figure 22 - Minimum distance between antennas

Exchange the location of Antenna 1 with Antenna 2 or Antenna 3 where necessary in order to avoid overlapping beams, see Figure 21. It is recommended to have a horizontal spacing (separation) of d > 0.5m with angle A > 45°.

It is recommended that in the immediate vicinity of the antenna (within 50cm), that the clearance zone shown in the diagram should be kept free of all obstructions, for example building walls and parapets.

4.2.4 Terminal installation – Near-field obstructions

This is a conservative measurement for the site clearance for the Antenna. Note that this only applies to the "Near-field" region, less than 5 metres distant from the panel antenna face.
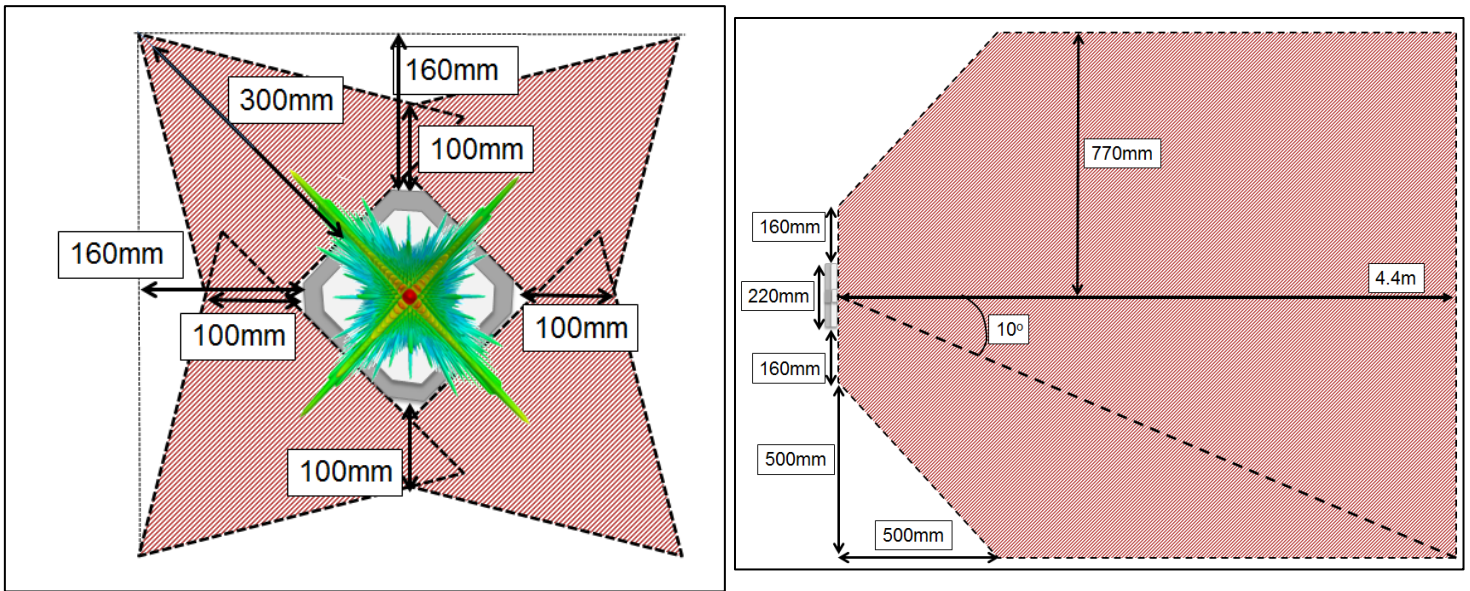
Figure 23 - Clearance zone in the immediate vicinity of the antenna

Note: These clearance zones apply on both vertical and horizontal paths of the installation.

It is required to provide a clearance zone of 660mm = 66 cm of clearance if the radio terminal is installed on a flat rooftop or close to any obstacles.

4.3 Grounding

The terminal must be properly grounded.

Two screws are provided on the rear housing of the terminal to facilitate correct grounding. To fasten the grounding cable onto the terminal, use a screw post and serrated washer combined with an M8 nut.

Connect the terminal to the connection points nearest to the building-to-earth ground point. The grounding conductor must be as short as is practical and should not exceed 6 m (20 ft). For installations in the USA, refer to Articles 810 and 830 of the National Electrical Code. For installations in Canada, refer to Section 54 of the Canadian Electrical Code. For installations in all other countries, refer to the in-country safety standards and regulatory requirements.

Figure 24 - Grounding post on V1000 terminal

4.4 Lightning / Surge protector

Sub10 Systems strongly recommends the use of outdoor data-line protectors.

To protect humans and property, a lightning/surge protector must be installed between the ODU and the drop cable and before the Ethernet cable enters the building.
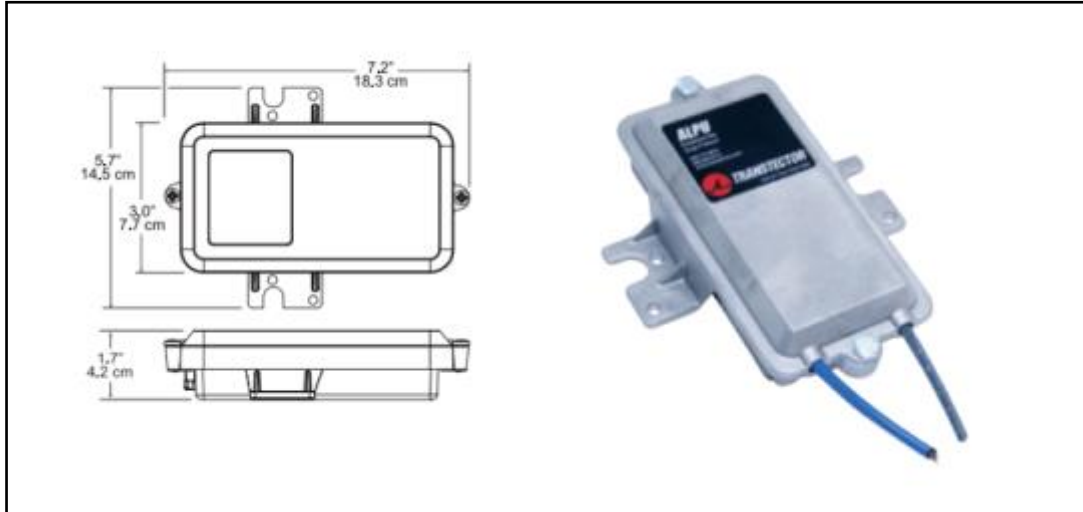
Figure 25 - Surge arrestor

Figure 26 - Surge Arrestor fitted to pole

4.5 RJ45 Seal Kit

If a surge arrestor is not fitted, then the RJ45 seal kit supplied with the link should be used to connect the Ethernet tail from the ODU to a CAT 5e drop cable, which then connects to the PoE++ power injector. Important: The inner seal supports a maximum Ethernet cable diameter of 6.50 mm, the use of larger diameter cables will compromise seal integrity. See section 2.2.6, and also the RJ45 seal kit installation guide.

Figure 27 - RJ45 Seal Kit installation

4.6 Cable installation

The length of the cable from the terminal to the next network component may be up to 100 metres (328 ft), but should be kept as short as practical in order to reduce voltage drop and signal loss. All Ethernet cables must be CAT 5e compliant and suitable for outdoor use. The cable must be UV stable and UL approved and must comply with local and/or national building codes. Cables should be shielded for outdoor use.

4.7 Power injector

The power injector is connected in-line with the data line. The maximum distance between the PoE injector and the Liberator-V1000 Link is 100 metres (328 ft). The PoE injector must be compliant with "Ultra PoE" (PoE++). To check that the injector is functioning correctly, use a PoE Tester.

Figure 28 (a) SL Power PENT 1040B PoE++ power injector   and (b) PhiHong POE61W PoE++ power injector

4.8 Antenna alignment

Accurate antenna alignment is extremely important to achieve the maximum rain fade margin for the link. One of the Liberator-V1000's biggest advantages is its fast, easy alignment procedure. The terminals can be aligned optically by using the optical alignment tool. Electrical alignment is then used to optimize performance, using a Digital Voltmeter (DVM) connected to the alignment port on the back housing of the terminal. The graphs in Figure 58 and Figure 59 give the required alignment voltage for a given RSSI value and a given range. Note that the values of alignment voltage for a given range in Figure 59 are only average values, assuming clear-air conditions, and will vary slightly with geographic location: therefore for the most accurate voltage prediction, it is strongly encouraged to use the Sub10 Link Calculator, available from the "Downloads" section of the Sub10 Systems website.

The table below shows alignment tolerance in terms of absolute position. However, it should be noted that since all alignment is dependent on the angle subtended at the alignment bracket, the distance of the link is not a factor in determining the required tolerance on the alignment angle, which should be the same for all ranges.

Link Distance		Alignment Positional Accuracy	
100 m	328 ft	0.9 m	2.9 ft
400 m	1312 ft	3.5 m	11.5 ft
600 m	1968 ft	5.2 m	17.2 ft
800 m	2625 ft	7.0 m	22.9 ft
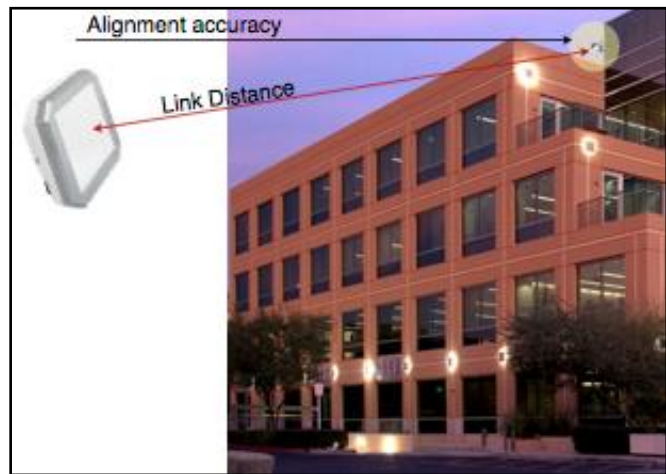
Figure 29 - Alignment positional accuracy

4.8.1 Alignment Procedure

The following procedure achieves fast, accurate alignment. For all operations, the supplied 5 mm Allen key and M8 (6mm) T-Bar can be used.

(a) Using the Alignment Bracket

Use the M8 T-bar tool to adjust the alignment bracket in azimuth (Figure 30), and elevation (Figure 31), and repeat until fully aligned. Then lock-off using the locking bolts for azimuth (Figure 32) and elevation (Figure 33).

Figure 30 - Horizontal (azimuth) adjustment screw

Figure 31 - Vertical (elevation) adjustment screw

Sub10 Systems
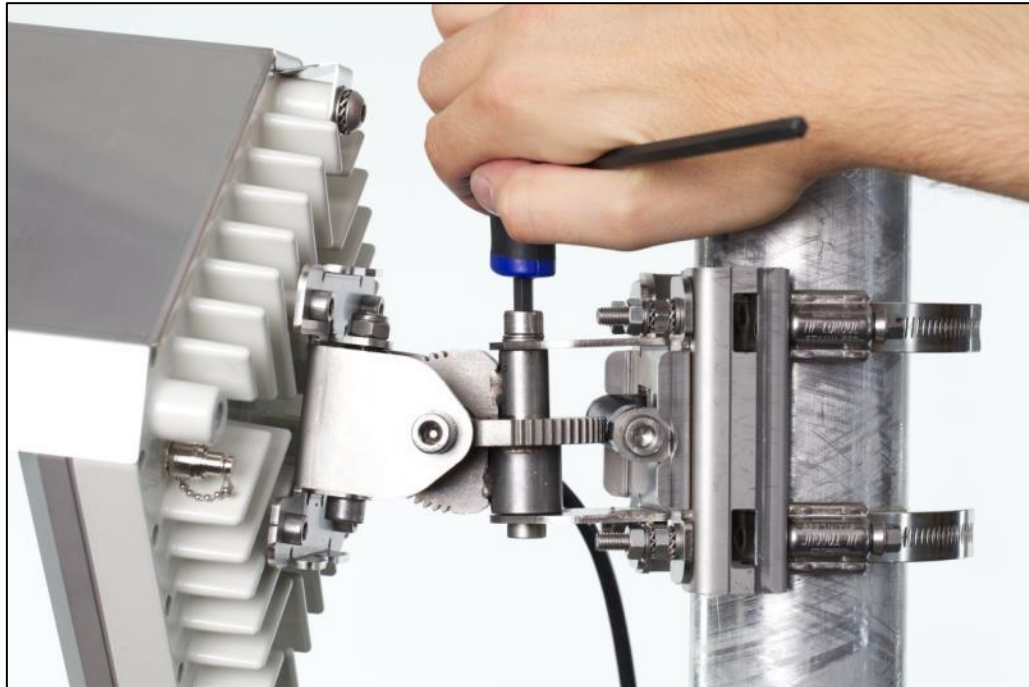
Figure 32 - Locking the horizontal (azimuth) position using the azimuth locking screw
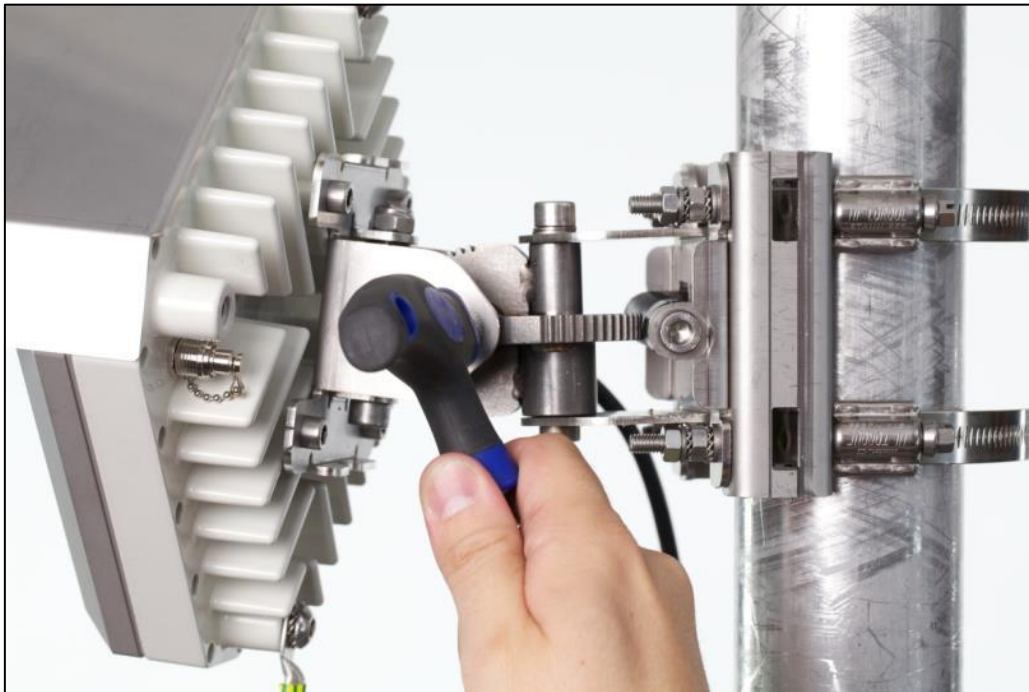
Figure 33 - Locking the vertical (elevation) position using the elevation locking screw

(b) Optical alignment

- Place the alignment tool on the most accessible corner of the radio unit and ensure good visibility to the opposite terminal by rotating the viewfinder.

- Use the M8 T-Bar tool to orientate the bracket in to a position where the alignment scope shows the target location is in the cross hairs.

- Once this is completed correctly at both end, you will be able to measure a Voltage via the DC port (Power Level Alignment)

(c) Alignment using a voltmeter to read RSSI

Following optical alignment, an alignment based on the received power level of each terminal should be performed. Use a voltmeter and cable with a female QMA connector to attach to the QMA connector on the terminal of the procedure for optical alignment, and adjust the alignment bracket to obtain maximum voltage from each terminal.

Figure 34 - Connection of a voltmeter for fine alignment on Liberator-V1000

The Alignment Interface is to allow the connection of a voltmeter during terminal installation. During installation a DC voltage between 0.5 and 4V is output, which is proportional to the receive signal strength. The higher the voltage, the higher the receive signal strength (RSSI). See Appendix A.2.3 for graphs of the RSSI voltage.
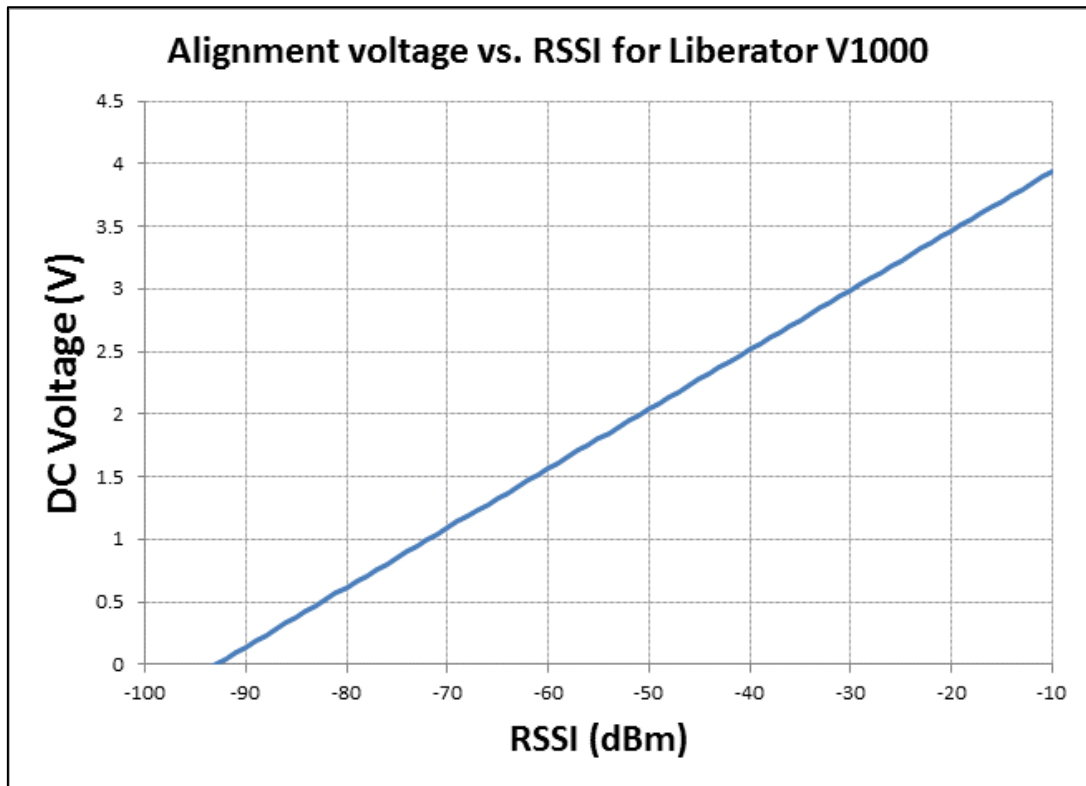
Figure 35 - Alignment voltage vs. RSSI (see Appendix A.2.3)

Follow the scanning pattern example in Figure 36 to find the peak voltage on the voltmeter; you must follow this pattern fully to ensure that you are not aligning on to a side lobe of the antenna. The main beam is **15 dB higher than the side lobes** and in clear line of sight is obvious when found.

Figure 36 - Scan pattern to use during alignment

4.9 Factory-Defaulting a Terminal

Factory-defaulting a terminal may occasionally be necessary to regain access to the unit if the master password is lost, or if it is desired to quickly reset all GUI settings to default. **Note that any Licence Key which has been applied to the terminal will also be lost on factory default, and will need to be re-entered to re-activate the Licensed features.**

(a) The reset procedure below only functions when the terminal is in "Normal" Mode, it will not function when the terminal is in "Alignment" mode. If it is suspected that the terminal is in "Alignment" mode, and does not respond to the reset procedure, then it is necessary to ensure that it is definitely not in "Alignment" mode by either:

1. If the GUI webpage is contactable: Make sure that the alignment cap on the terminal case is closed. Browse to the "Home – Administration – Installation" page on the GUI, and if necessary click on "Change Mode" if the display is showing "Alignment mode". The terminal should now be in "Normal Mode", and this should be displayed on the GUI webpage.

2. If the GUI webpage is not contactable: Make sure that the alignment cap on the terminal case is closed. Power cycle the radio terminal, and it should now restart in "Normal Mode" if the alignment cap is already closed when the power is re-applied.

(b) When it is certain that the radio terminal is in "Normal Mode" (and not "Alignment Mode"), then the following procedure can be used to restore the radio terminal to factory default settings:

Short-out the Alignment interface then and remove and reapply the short four times with 1 second mark space ratio, see Figure 37 . Shorting-out the alignment port can be achieved either by using the protective Alignment Cap fitted, as this acts as an electrical short-circuit, or else by shorting-out the plugs on the voltmeter alignment cable used for installation. If the radio terminal does not reset itself, it may be that the sequence was counted either too slowly or too quickly: there needs to be 1 second between each short-circuit or open-circuit change, as shown in the timing diagram.

(c) Note that if the Alignment Cap is disconnected for a period of more than 30 seconds, then the radio terminal will automatically switch into "Alignment Mode", see (a) above. Therefore it is recommended always to keep the Alignment Cap connected, except when physically aligning the link.
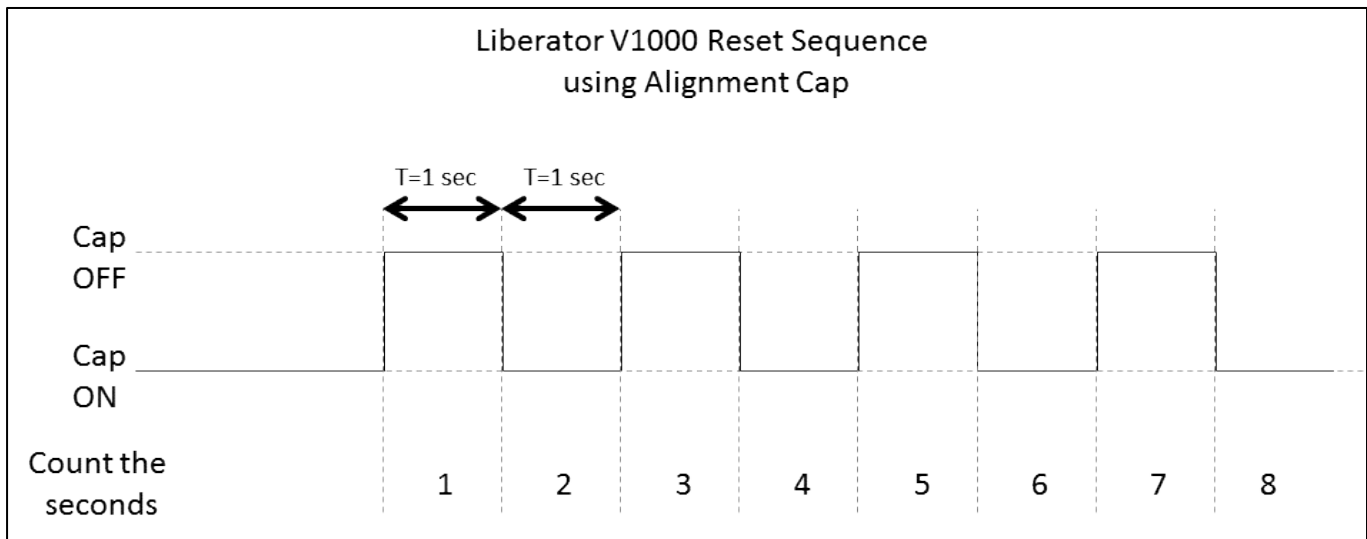
Figure 37 - Reset Sequence using the Alignment Cap

4.10 Maintenance

Warnings:

•   Always disconnect the primary power source before undertaking maintenance/repair of the radio terminal (Outdoor Unit).

•   At least once per year, each radio terminal (Outdoor Unit) must be inspected for signs of corrosion. Light corrosion is acceptable in extreme environmental conditions (marine-type deployments), but the structural integrity of the ODU must not be in doubt. In the unlikely event that significant corrosion is seen, the unit may need to be replaced: in this case, please contact Sub10 Systems for advice.

5. Web Management Interface

5.1 Login Page

Figure 38 - Login Page

The Login Page is used to control access to one or other of the radio terminals. Currently only one user account is supported. This user account has full *Maintenance-Level* privileges.

The default settings for this user account are:

User:	**admin**
Password:	**password**

5.2 Home Page
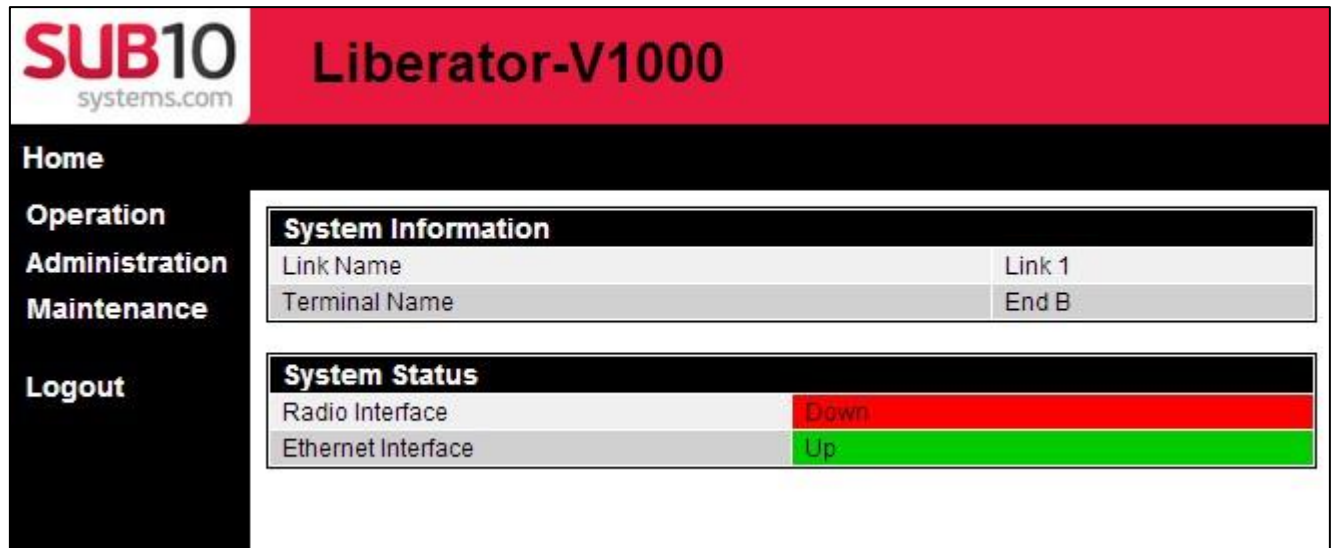
Figure 39 - Welcome Page

After a successful login the Home Page is displayed. This page shows the Site Name, Link Name, and gives a snapshot of current link status. The Status bars are highlighted in GREEN if the Radio Interface and Ethernet Interface are up, otherwise they will be YELLOW for acquiring a radio link, or RED for down.

Following industry standard practice, the menu on the left side of the page has 3 categories:
1. Operation
2. Administration
3. Maintenance

Users having different access privileges may be restricted to only access the Operation, or Operation and Administration pages, whilst the default user will have full access to all pages.

The default setting is a single user with full access privileges (*Maintenance-Level* privileges).

5.3 Operation

5.3.1 Operation - System Status – Wireless Status
The Wireless Status page shows the wireless parameters of the link. Parameters displayed are:

- Transmit Power (dBm):   Transmit power into the antenna port (inside the ODU).

- RSSI (dBm):   Received power at the antenna port (inside the ODU).

- Vector Error (dB):   This is a measure of the signal quality, and should ideally be lower (more negative) than -10dB (the exact value may vary over time).

For each parameter, the local side of the link displays values for the Minimum, Mean, Maximum and Current, while the remote side of the link only displays the Current parameter value. The values may be reset by pressing the "Reset" button (which is useful after a power outage event, for example). The refresh speed can be increased by typing in a smaller number of seconds, as desired, into the "Page Refresh Interval" box, and then pressing the "Change" button.

Figure 40 - Wireless Status Page, showing parameter values for both local and remote terminals

5.3.2 Operation - System Status – Ethernet Status
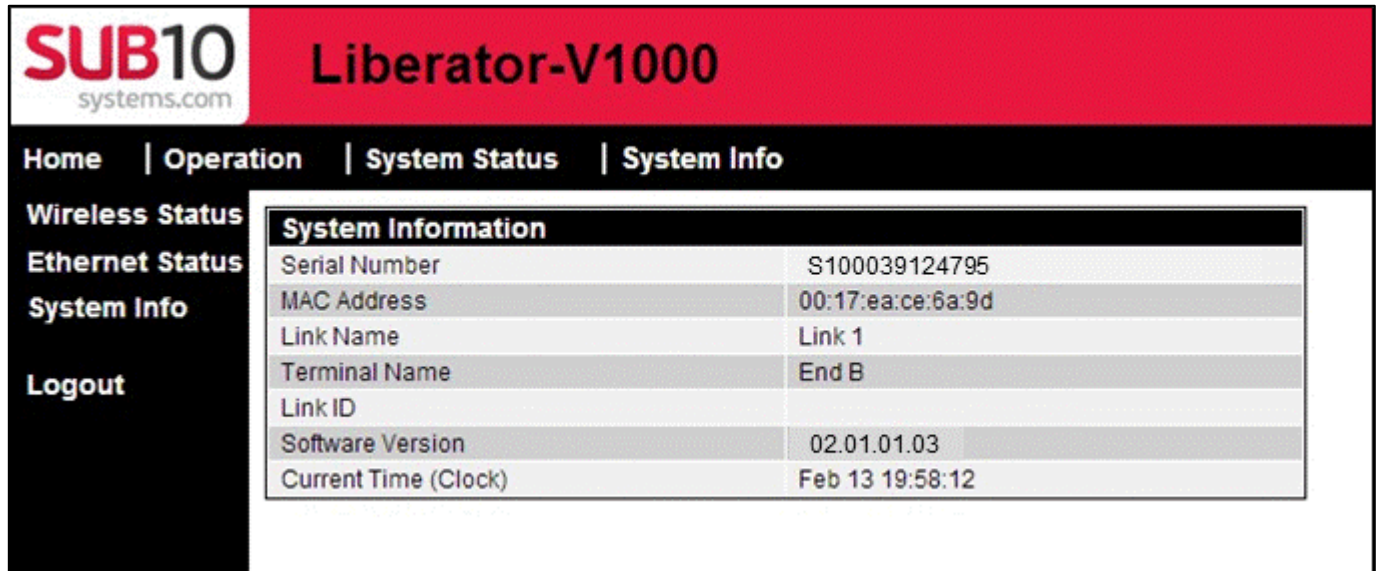
The Ethernet Status page shows the Ethernet port parameters. By default a radio terminal's Ethernet interface is set to auto-negotiate the Ethernet type and rate. This page indicates the Ethernet line-rate, whether it is active or not, and the auto-negotiation setting.

Figure 41 - Ethernet Status Page

5.3.3 Operation - System Status – System Info
The System Info page provides an overview of the radio link.

Figure 42 - Status – System Info Page

Local Terminal

Serial Number – Serial number of the local radio terminal

MAC Address – MAC Address of the local radio terminal

Site Name – This is a free-text field that can be used to store naming information for the Site.

Link Name – This is a free-text field that can be used to store the Link Name.

Link ID – The Link ID must be the same at both ends of the link, and should not be used for any other link. ***Note that if the Link ID is not the same at both ends of the link, then the radio link cannot be established between the 2 ends.*** If the Link ID is left blank, then the link will function correctly, but there is a risk of data communication with any other link which also has the Link ID left blank.
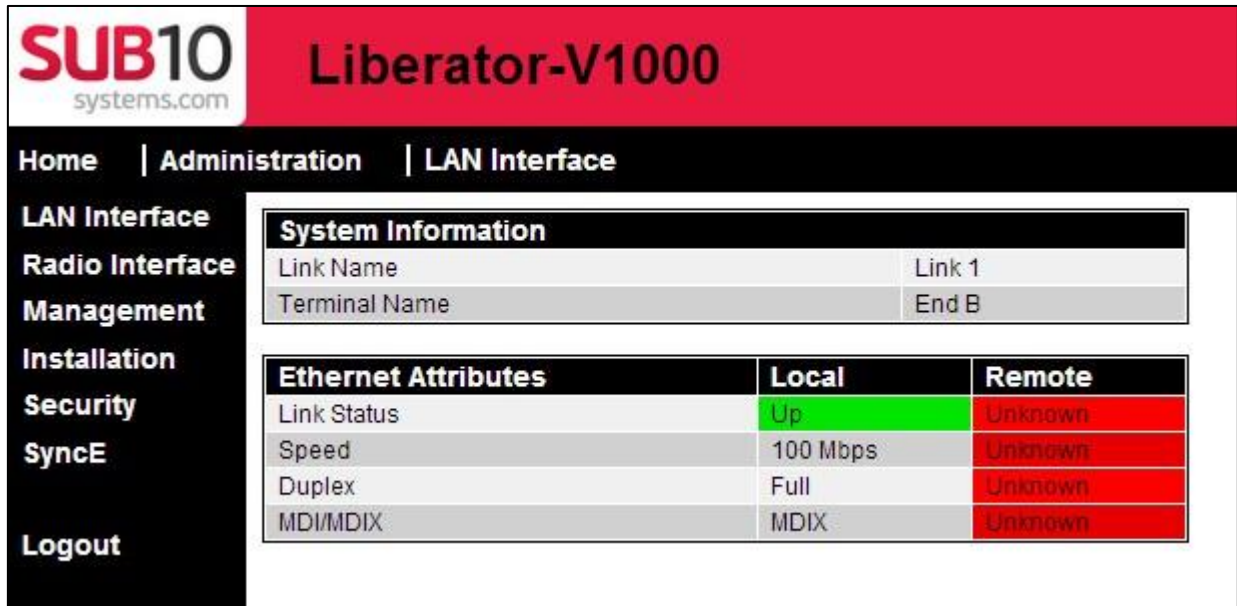
Software Version – Software version running in the active memory bank.

5.4 Administration

The Administration pages are only accessible by users having the required access privileges, which are granted by an administrator.

5.4.1 Administration – LAN Interface

By default a radio terminal's Ethernet interface is set to auto-negotiate the Ethernet type and rate. This page indicates the Ethernet line-rate and whether it is active or not, and the status of the auto-negotiation.

Figure 43 - LAN (Ethernet) Interface

5.4.5 Administration – Radio Interface

This page is used to control the radio interface, this will have more functionality in future software updates. In this software release, this page simply displays the radio parameters, for both the local and remote sides of the link.

Figure 44 - Radio Interface

Tx Power [dBm] – This displays the radio transmit power into the antenna port.

RSSI [dBm] – Indicates the current receive signal level.

TX Frequency [GHz] – Indicates the radio terminal's transmit frequency. An "A" terminal transmits on 59.5 GHz and a "B" Terminal transmits on 62.0 GHz.

RX Frequency [GHz] – Indicates the radio terminal's receive frequency. An "A" terminal receives on 62.0 GHz and a "B" Terminal receives on 59.5 GHz.

A future software release will allow the Tx and Rx frequencies to be selected.

5.4.6 Administration – Management

5.4.6.1 Administration – Management – IP Configuration
The IP Configuration Page is used to configure the Management IP Connectivity, and the Ethernet interface.

Figure 45 – IP Configuration

By default, management connectivity to a terminal is by fixed IPv4 address. The default IP address for an "A" terminal is 192.168.0.21 and the default IP address for a "B" terminal is 192.168.0.22.

When DHCP is selected, the terminal's IP Address, Subnet Mask and Default Gateway are acquired from a DHCP server. When DHCP is selected these fields are greyed out. When using DHCP the terminal cannot be managed until the DHCP client has started up and acquired an IP Address.

5.4.6.2 Administration – Management – SNMP

The SNMP Configuration Page is used to configure the SNMP Agent, see Figure 46.

Figure 46 - Configuring SNMP

The SNMP Agent is compatible with SNMPv1 and SNMPv2c.

The SNMP Configuration is as follows:

- **Enable Agent** - The agent will respond to SNMP requests GET/SET/GET-NEXT and GET-BULK

- **Enable Traps** – The agent will send traps to the configured trap destinations.

Note: **Enable Agent** and **Enable Traps** are independent in functionality, (it is possible to disable the agent for requests but enable it for sending traps and vice-versa).

- **Trap Destinations** - Up to three destination are possible, each requiring:

- **IPv4 Address** - A valid IP address of the receiving management system.
  Note: The IP address must be valid and reachable.

- **Community** - The community string sent in each trap to this destination, this is used by management systems that require authentication using the trap community string.

- **Communities** – SNMPv1/v2c community strings for read-only and read-write operations when accessing MIB object via an SNMP management system.

  - **Read Community** – The community string used for read access

  - **Write Community** – The community string used for write access

The following MIBs should be loaded into communicating network management tools:

Table 3 - V1000 MIB Compliance Table

MIB	Module	Usage
RFC1213-MIB	MIB-II	Standard MIB-II
IF-MIB	ifMIB	For SNMPv2c linkUp, linkDown notifications only. interfaces supported as part of MIB-II.
SNMP-v2-MIB	snmpMIB	System group including SNMP resources. SNMP Traps including well known traps e.g coldStart.
liberator-v320	LIBERATOR-MIB	Sub10 Systems V320 enterprise MIB for backwards compatibility.

5.4.6.3 Administration – Management – Time

The Time page is used to set the internal real time clock on the radio terminal. The real time clock is used to timestamp events in logs and SNMP traps.

Figure 47 - Setting the real-time clock

The first option is simply to set the System Clock date and time, and press the "Apply" button in the "System Clock" section of the page.

For greater accuracy the operator can synchronise the internal real time clock to an NTP (Network Time Protocol) time server. To enable the use of an NTP time server the operator must tick the "NTP Enabled" box, and also enter the IP address of an accessible NTP time server into the "Server 1" field (and also "Server 2" field if an alternative server is available), and then press the "Apply" button in the "NTP" section of the page.

5.4.7 Administration – Installation

When Alignment mode is selected, the System Mode box displays "Alignment Mode" in YELLOW. The Alignment Voltage indication given is in volts and is the same voltage as can be measured with a voltmeter on the alignment port on the back of the terminal, see Figure 48. After alignment is complete, replace the voltage port cap on the back enclosure of the terminal, and click on "Change" to return to Normal mode. The System Mode box displays "Normal" in GREEN, see Figure 49. It is also possible to change mode by clicking on the "Change Mode" box on the Installation page.

Figure 48 - Installation - Alignment Mode

Figure 49 - Installation – Normal Mode

5.4.8 Administration – Security – Users

This page shows the users who are registered to use the system, together with their privilege level ("Role"). It is possible to add new users by clicking on "New", and this allows the new username, password and privilege level ("Role") to be set. Note that the password must always be at least 6 characters long.

Figure 50 - Security: Users Page

A User's role or password may be modified by clicking the "Modify" button. Please note that after following this process, it is necessary to logout and log back in to the terminal for the new privilege level ("role") to take effect. So for example, if it is desired to elevate a User's privilege level to "Maintenance" in order to allow the User to perform firmware upgrades, the User will not actually benefit from the change until they have logged-out and logged in again.

Figure 51 - User Access Control Page

5.4.11 Administration – SyncE

This page allows the SyncE parameters to be configured. Note that setting of these parameters should only be performed by a trained installer, as incorrect SyncE configuration may result in the link being dropped.

SyncE mode may be configured as either:

None: This is the default setting, SyncE is disabled. This is the recommended setting unless a Primary Reference Clock input is available.

Provider: Use this setting if a Primary Reference Clock or other Synchronous Ethernet timing signal is available on the Ethernet port. Note that only one end of the link may be configured as SyncE "Provider", and the remote end must be configured as "Consumer" in this case.

Consumer: Use this setting if the remote end of the link is to be configured as "Provider". Note that only one end of the link may be configured as SyncE "Consumer".

Figure 52 - SyncE configuration page

5.4.7 Administration – Logout

This page allows the user to Logout securely, and is necessary when multiple user accounts have been configured. Simply click "OK" to confirm that you wish to Logout.
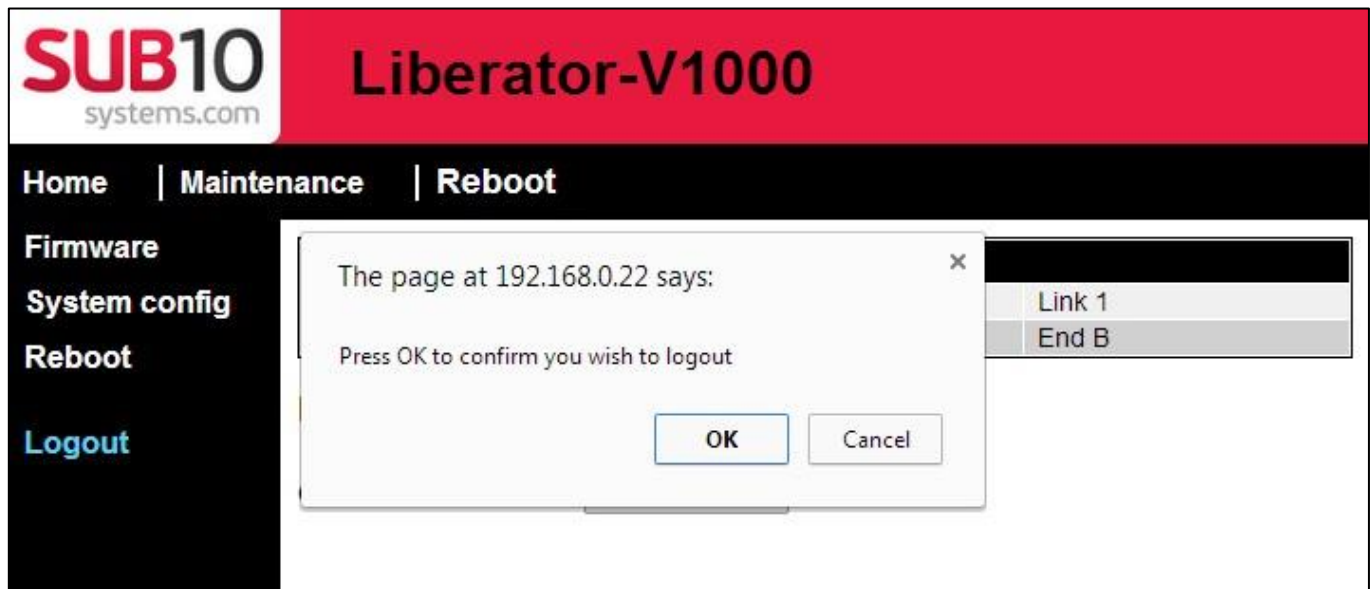

Figure 53 - User Account Logout Page

5.5 Maintenance

The Maintenance pages are only accessible by users having the required access privileges, which are granted by an administrator.

5.5.1 Maintenance - Firmware Upgrade

This section allows the operator to upgrade a radio terminal's firmware. There are 2 memory banks. The firmware upgrade process will upload the new firmware to the INACTIVE memory bank. Therefore, before performing a firmware upload, first be sure that a stable firmware version is in the ACTIVE memory bank. Click on the "Change" button in the "Switch bank" section to swap the active and inactive banks if necessary. The "Copy" button in the "Duplicate bank" section allows a firmware version to be copied into both banks if desired.

Firmware upload uses a TFTP server, simply select the server IP address and filename. There is also the option to upload a firmware file using HTTP.

Figure 54 - Firmware Upgrade page

Once initiated the firmware upgrade process should not be interrupted. Interrupting the process could result in a corrupt firmware image and a non-operational radio terminal.

5.5.2 Maintenance – System Configuration

The System Configuration page is used to Download (save) the existing user configuration, and also to Upload a previously-saved user configuration. This is very useful when a customer needs to configure multiple links with the same settings.

Figure 55 - System Configuration page

5.5.3 Maintenance - Reboot

This page allows the user to reboot the radio terminal, by clicking on "Reboot". It is important to first check the Site Name on the top of this, page to ensure that the intended radio terminal is being rebooted (either the local or the remote end).

Figure 56 - Reboot page

6 SNMP Management Interface

See Section 5.4.3.2. The SNMP Agent is compatible with SNMPv1 and SNMPv2c. The SNMP Configuration is as follows:

- **Enable Agent** - The agent will respond to SNMP requests GET/SET/GET-NEXT and GET-BULK

- **Enable Traps** – The agent will send traps to the configured trap destinations.

Note: **Enable Agent** and **Enable Traps** are independent in functionality, (it is possible to disable the agent for requests but enable it for sending traps and vice-versa).

- **Trap Destinations** - Up to three destination are possible, each requiring:

  - **IPv4 Address** - A valid IP address of the receiving management system.
    Note: The IP address must be valid and reachable.

  - **Community** - The community string sent in each trap to this destination, this is used by management systems that require authentication using the trap community string.

- **Communities** – SNMPv1/v2c community strings for read-only and read-write operations when accessing MIB object via an SNMP management system.

  - **Read Community** – The community string used for read access

  - **Write Community** – The community string used for write access

The following MIBs should be loaded into communicating network management tools:

Table 4 - V1000 MIB Compliance Table

MIB	Module	Usage
RFC1213-MIB	MIB-II	Standard MIB-II
IF-MIB	ifMIB	For SNMPv2c linkUp, linkDown notifications only. interfaces supported as part of MIB-II.
SNMP-v2-MIB	snmpMIB	System group including SNMP resources. SNMP Traps including well known traps e.g coldStart.
liberator-v320	LIBERATOR-MIB	Sub10 Systems V320 enterprise MIB for backwards compatibility.

A TECHNICAL INFORMATION

A.1 Troubleshooting

This chapter provides solutions to problems that can occur during the installation and operation of the Liberator-V1000. It covers various aspects of installation and network setup.

> **Note:** Each of the following points must be checked at both ends of the link. Start by running the entire procedure on one side (e.g. Terminal A). If this does not solve the problem, repeat all the steps at the opposite terminal.

A.1.1 Power and network connection

You must verify that the terminal is connected to the power. The PoE injector must be installed and plugged in. Go to the terminal, disconnect the RJ-45 connector and verify if there is power in the cable using a PoE++ tester.

Take the cable and plug it into a notebook or a network testing device and verify that there is a valid network connection. If there is any problem, please replace the cable and validate the connection again.

A.1.2 Network configuration

Check that the PC's IP address is in the same range and subnet as the Liberator-V1000.

Note: The default IP address of the Liberator-V1000 is 192.168.0.21 and 192.168.0.22 for terminal A and B respectively. All terminals on the network must have a unique IP address in the same range, e.g. 192.168.0.X. Any terminal with identical IP addresses will not be visible on the network. They must all also have the same subnet mask (e.g. 255.255.255.0).

Ping the terminal to make sure that the Liberator-V1000 is responding. On a Windows PC, go to Start → Run → Type "Command" → Type "ping 192.168.0.21/22". A successful ping will generate four replies. As soon as the network configuration is correct you can access the GUI (Graphical User Interface) and check the settings according to section 4.9.

A.1.3 Misalignment

On the Installation screen (see section 5.6) you see the signal strength in dBm (e.g. -30 dBm). The correct RSSI value can be obtained from the Sub10 Systems Link Availability Calculator. If the value is more than 5dB below below the Link Availability Calculator value, then the antenna is not properly aligned to receive the signal. You therefore need to re-align the terminal to its opposite terminal (please follow the instructions in Section 4.8).

![SUB10 systems.com]

A.2 Specifications

A.2.1 – Physical size of ODU terminal

All dimensions are in millimetres. Dimensions are approximate with accuracy limited to +/- 3mm, and should be used for information purposes only.
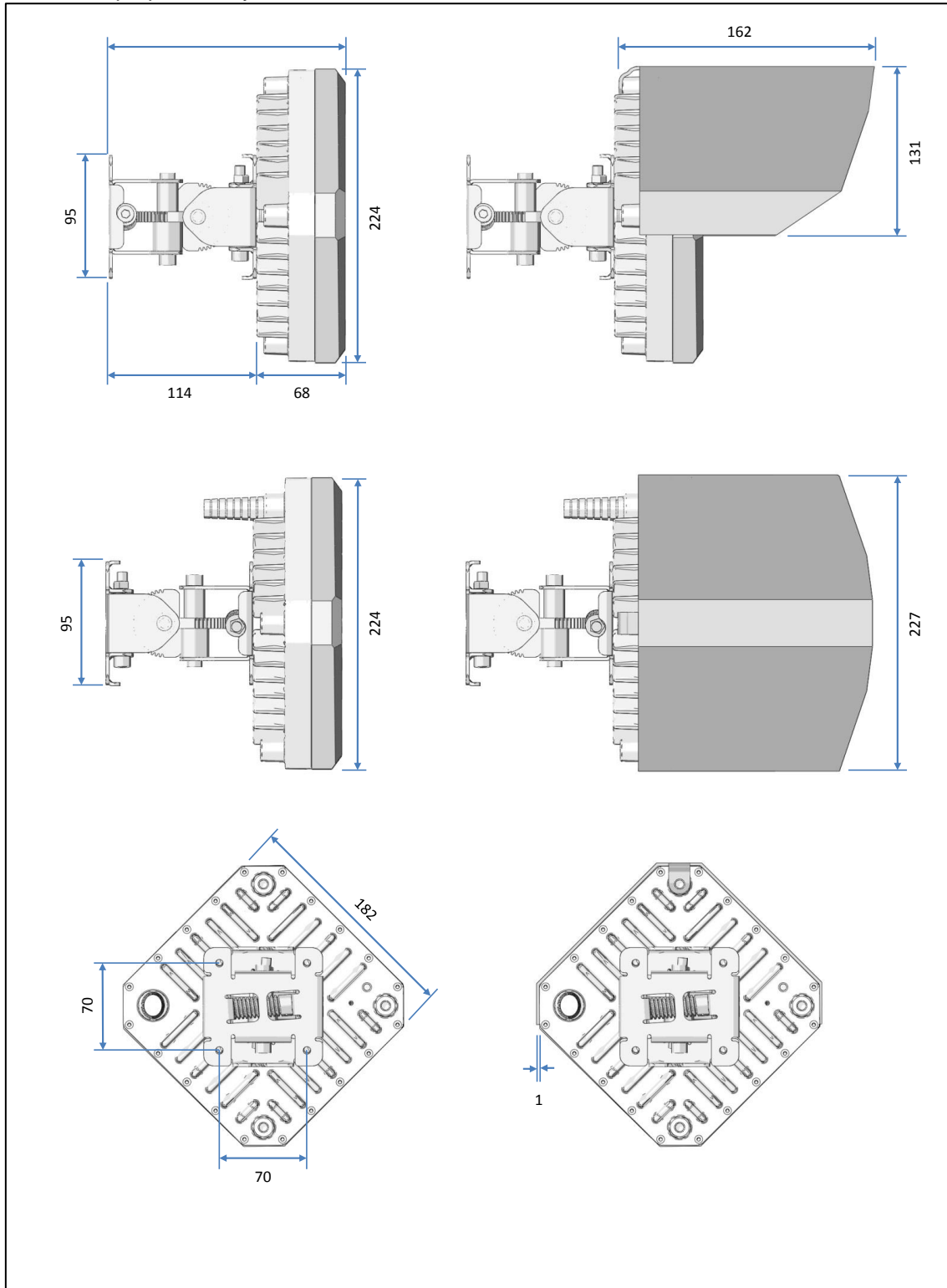

Figure 57 - Dimensions of radio terminal in mm

A.2.2 – General system information

Technical specifications for V1000:

Modulation	QPSK and 8-PSK
Range	QPSK: up to 800 metres
Ethernet throughput (full duplex)	700 Mbps (QPSK) and 1Gbps (8-PSK)
Max Tx Power (at antenna port)	QPSK: 8 dBm
Max EIRP	QPSK: 46 dBm
Sensitivity	-65 dBm
Channel width	500 MHz
Antenna gain	38 dBi
FEC	Reed-Solomon
Availability	Up to 99.999% (use Sub10 Link Availability Calculator)
MTBF	25 years
Wind load	160 km/h (operating) and 200 km/h (survival)
Ethernet frame size	64 bytes up to 9000 bytes
Latency	< 200 microseconds (single-trip delay)
VLAN support	IEEE 802.1Q (future software release)
QoS	Strict Priority, 8 queues (future software release)
Network management	SNMP v1, v2c (current firmware) and SNMP v3 (future software release)
GUI	HTTP web-browser
Interface	1000 Base-T
Drop cable	Cat5e, 100 metres max length
Connector	RJ-45 (outdoor gigabit Ethernet seal kit included)
Voltage alignment port	Waterproofed QMA socket
ODU Terminal dimensions	182 x 182 x 68mm
Power supply	Power Over Ethernet ("Ultra-PoE" / PoE++), consumption 35W
Operating temperature	-40°C to +55°C
Regulatory approvals	Safety: IEC60950-1/-22 and EN50385(2002) EMC: EN301 489-1/-4 Radio: EN302 217-3 FCC/IC Approvals pending

Please use the Sub10 Link Availability Calculator (free download from the Sub10 Systems website), for a prediction of the V1000 link performance at your precise geographic location.

Technical Specifications for V100
This is generally as above, except that the Channel Width is reduced to 100MHz with a consequent reduction in throughput and an improvement in receiver sensitivity. Full details are TBC.

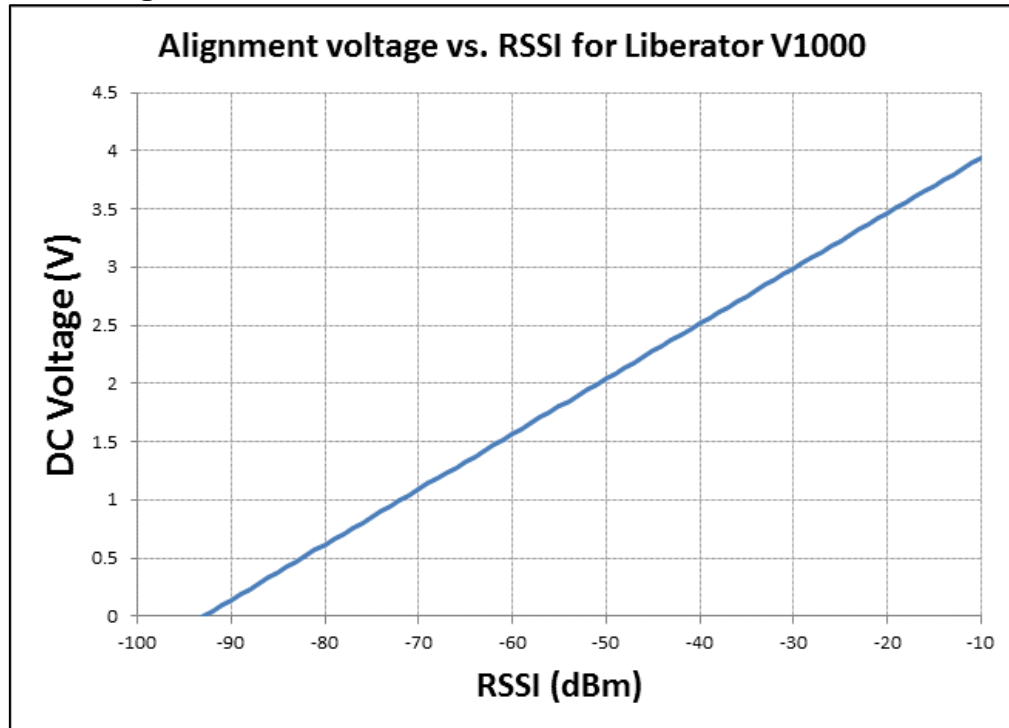## A.2.3 RSSI DC Voltage vs Received Power

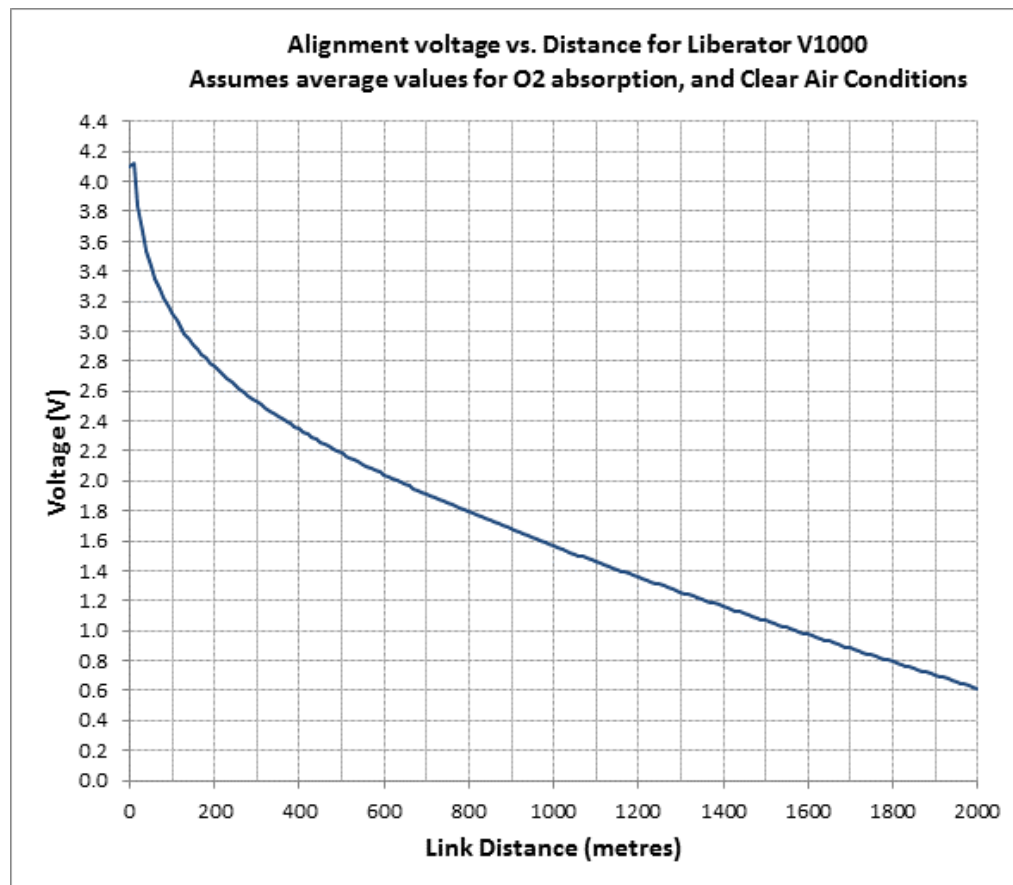**Figure 58 - Alignment voltage measured on Voltmeter for a given RSSI**
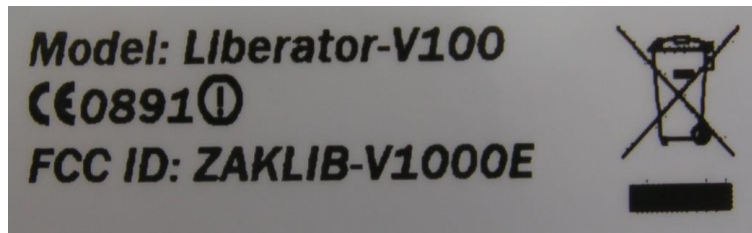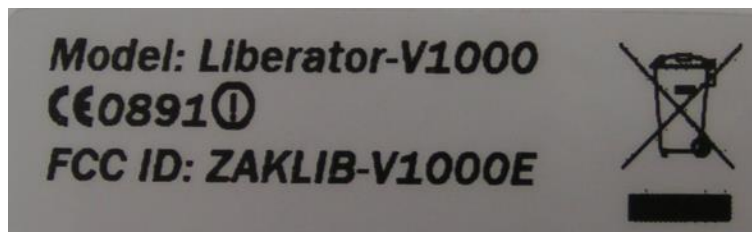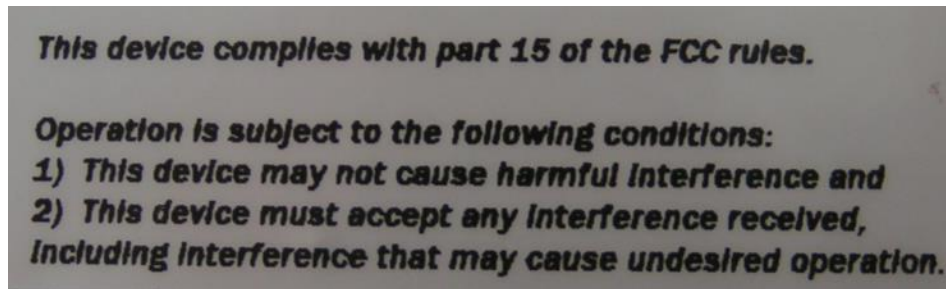

Figure 59 - Alignment Voltage vs. Distance for Liberator-V1000 in Clear Air Conditions

(always use Sub10 Link Calculator for most accurate voltage based on geographic location)

B REGULATORY INFORMATION

B.1.1 FCC statement

B1.1.1 Regulatory Statements and Labels

The Liberator-V1000 (and Liberator-V100) have been certified as compliant with the FCC Rules under Part15.255 and have been assigned the same FCC ID:ZAKLIB-V1000E as they use common hardware. The following labels are affixed to the product in clearly visible locations to reflect this Certification.

This device complies with part 15 of the FCC rules.

Operation is subject to the following conditions:
1) This device may not cause harmful interference and
2) This device must accept any interference received, including interference that may cause undesired operation.

Model: Liberator-V1000
CE0891①
FCC ID: ZAKLIB-V1000E

Model: Liberator-V100
CE0891①
FCC ID: ZAKLIB-V1000E

NOTE: The installer/user must not make any changes to the products operation without the express approval of Sub10 Systems Ltd., as unauthorised changes will invalidate the certification and may lead to action by the FCC.

B1.1.2 Human Exposure to Non-Ionising Radiation

There are regulations defining limits for exposure of the general public to non-ionising radiation which is produced by radio transmitters. This is called "RF Exposure".

B1.1.2.1 Reference Documents

The documents applicable here are :
[1] US Code of Federal Regulations, in particlar the policies, guidelines and requirements in Part 1 of Title 47 of the CF. See (www.fcc.gov)
[2] Guidelines and recommendations for evaluating compliance contained in FCC Bulletin 65
[3] ICNIRP Guidelines for Limiting Exposure to Time Varying Electric, Magnetic and Electromagnetic Fields (up to 300 GHz); see www.icnirp.de/
[4] Safety Code 6 on the Health Canada Website www.hc-sc.gc/ca/

B1.1.2.2 Applicable Limits

The limits to be applied depend on the operating frequency of the transmitter

All the reference documents agree that exposure limits for the general public in the band around 60GHz are that the applicable limit should be the RF Power Density level. The general population should not be exposed to a level ≥10W/m^2.

Reference [2], which is applicable under USA regulations, provides a simple method of calculating the exposure level at different separation distances and this can be used to identify the minimum separation distance from the product to any member of the general public.

$$S = \frac{P.G}{4.\pi.d^2}$$

Where:

RF Power Density (S) in Watts/metre^2

Transmitted Power (P) in Watts

Antenna Gain (G) as a linear number

Separation distance (d) in metres

B1.1.2.3 Results of Analysis

The analysis below uses the maximum transmitted fundamental power level from the Liberator-V100 and Liberator-V1000 products to calculate the RF Power Density level and the recommended separation distance.

Operating Mode	Antenna Gain		Maximum Power Level		Separation Distance (m) for S = 10W/m2	Recommended Separation Distance (m)
	dBi	Linear	dBm	W		
V100	38	6310	11.6	0.0145	0.85	1
V1000	38	6310	10.9	0.0123	0.79	1

a) At the recommended separation distance[2], the power density of the fundamental emission is 1.4 to 1.6 times lower than the limit.

b) All unwanted emissions from the Liberator-V100 and Liberator-V1000 are much lower than the fundamental emission and therefore do not increase the Recommended Separation Distance above.

Sub10 Systems confirms that the Liberator-V100 and Liberator-V1000 products, when operated with the Recommended Separation Distance of 1m, meet the applicable of radiation exposure requirements specified in 47CFR Parts1.1307(b), 2.1091 and 2.1093 for both fundamental and unwanted emsissions.

B1.1.2.4 Limitations on Operation

FCC Regulations specifically prohibit the use of the Liberator-V100 and Liberator-V1000 products on board aircraft or on satellites.

B.1.2 Industry Canada statement

Industry Canada is currently revising its rules for this frequency band and therefore the Liberator-V1000 cannot currently be certified for Compliance in Canada.

---

[2] NOTE: The analysis above is very conservative as it is based on point source radiation and not a practical point-to-point, narrow-beam antenna, where the full antenna gain used in the calculation is not achieved until the separation distance exceeds 6m.

B.1.3 ETSI Conformity

ETSI EN 301 489-4 V1.3.1 (2002): Electromagnetic compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 4: Specific conditions for fixed radio links and ancillary equipment and services

ETSI EN 302 217-3 V1.3.1 (2009-07): Harmonized European Standard (Telecommunications series) Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas; Part 3: Equipment operating in frequency bands where both frequency coordinated or uncoordinated deployment might be applied; Harmonised EN covering the essential requirements of article 3.2 of the R&TTE Directive

ETSI EN 302 217-4-2 V1.4.1: Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas; Part 4-2: Harmonised EN covering essential requirements of Article 3.2 of the T&TTE Directive for antennas

B.1.4 CE – Declaration of conformity

Please see the Sub10 Systems website for the updated signed Declaration of Conformity:
http://www.sub10systems.com/products/downloads/

C   CONTACTS

C.1 Technical assistance

Installers and users please visit the Sub10 Systems Support website:
http://support.sub10systems.com/

Or Contact - support@sub10systems.com

C.2 Sales & General Product Information

Customers please visit the Sub10 Systems website:
http://www.sub10systems.com

Or Contact - info@sub10systems.com

Our Address:

Sub10 Systems Limited

Ash House

Canal Way

Kingsteignton

Newton Abbot

TQ12 3RZ

United Kingdom

Tel: +44 (0) 1626 818520

Fax: +44 (0) 1626 818566