NORBIT

# Link Master and Link Client user manual

Technical Note

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# TABLE OF CONTENTS

# REVISION HISTORY

| *Rev. #* | *Description* |
|---|---|
| 1 | New Document. |
| 2 | Added safety distance in chapter 2.7. |
| 3 | Added chapter 5, company contact information |

# 1 PREFACE

The Norbit Link Master and Link Client system is a link master/client communication system where the Link Master can request information from and transfer information to Link Clients. Multiple Link Clients may exist, communication with a Link Client that is within the area of communication is initiated and controlled by the Link Master. Link Clients may at any time enter or leave the area of communication.

Both the Link Master and the Link Clients use directional communication. The Link Master is intended to be used for communication with Link Clients at distances of up to 30 feet when Link Master and Link Client antennas are pointing towards each other. The Link Master is preferably installed at a fixed position which is higher than Link Clients.

When a Link Master signal is detected, a Link Client automatically wakes up from a low power sleep state within a few milliseconds. The Link Client will respond to a link communication invitation from the Link Master. The Link Master can handle multiple Link Clients at a time by means of an anti-collision protocol.

The data content of a Link Client data are organised in applications which are identified by Context Marks during an initialisation phase. Each application may constitute of multiple data fields, some of which may have read-only access and others may have read-write access.

Data transfer is typically initiated and concluded within a few tens of milliseconds. Several co-located Link Clients may thus be served by the Link Master even when being located within the Link Master communication area for a short period of time.

The Link Master/client communication system, or any parts thereof, shall not be used for safety critical purposes, medical applications (including any life-saving or life sustaining purposes) or any other purpose where its function or failure to function may cause damage, injury or death. It shall not be used in any area or for any purpose that may be in violation with local, state or federal laws or regulations.

This document describes how to install, maintain and operate the Link Master and the Link Clients.

# 2 LINK MASTER

The Link Master consists of a single unit powered by an external power supply. The Link Master has two communication ports

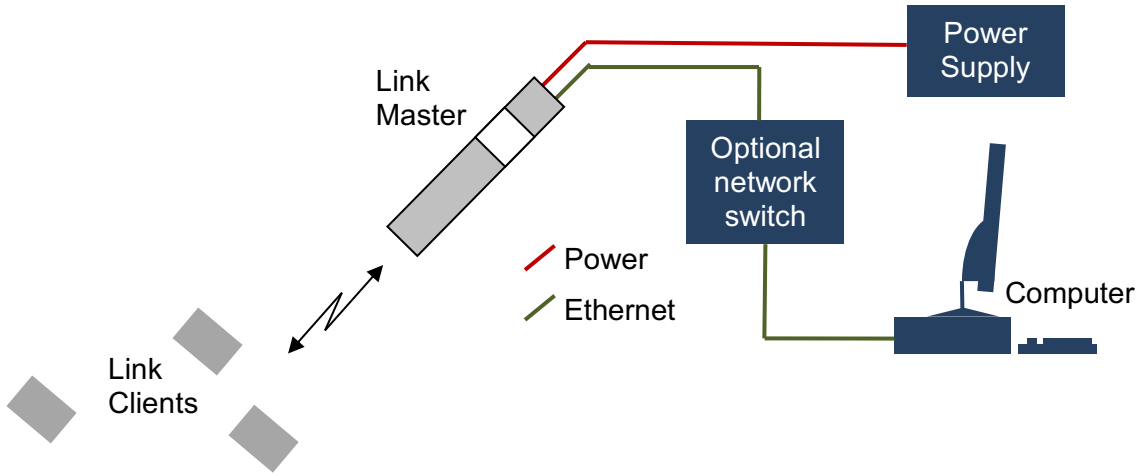
- Wireless communication port towards Link Clients
- Ethernet connection to external network connected equipment.

The Link Master will at the explicit or implicit request of external network connected equipment retrieve requested information from and/or transfer requested information to Link Clients which are present in the communication area.

To ensure optimal operation, the Link Master must be properly installed.

## 2.1 Link Master connection overview

The principal setup of the system is shown below.




## 2.2 Site preparation

The area between the Link Master and where Link Clients may be located should be unobstructed. For optimal communication performance, metal structures or larger metal objects should be kept away from the area forward to the Link Master.

The Link Master should preferably be installed at a height up to 10-15 feet above Link Clients, pointing downwards at an angle of 35-45 degrees towards Link Clients.

The Link Master may be installed at a pole, in a gantry or in other structure suitable for the purpose of the communication.

## 2.3 Mounting

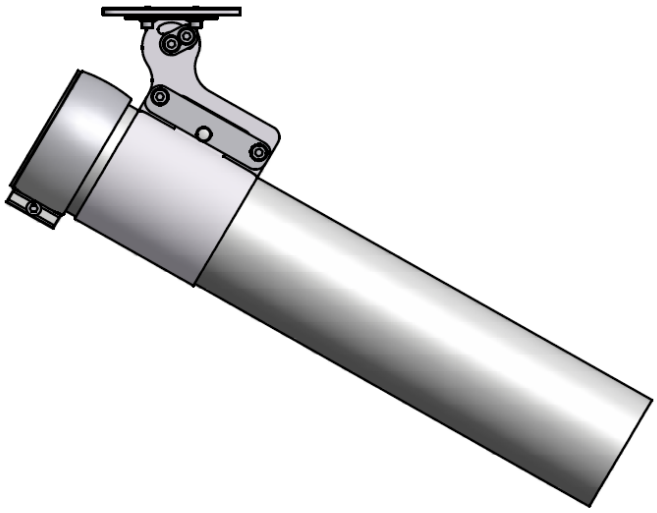
When a suitable Link Master mounting position has been found, the Link Master can be mounted.

### 2.3.1 Preparations

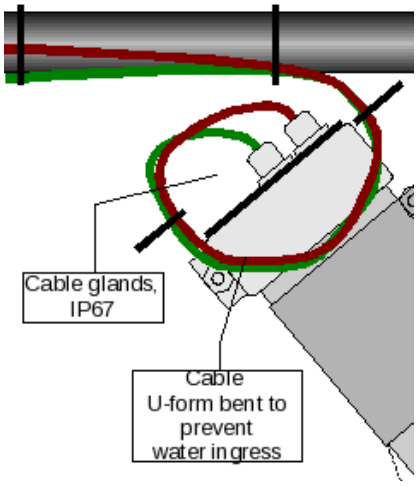
To avoid unnecessary work at the installation site, prefabricated cables may be used. They should be equipped with necessary connectors for the Link Master in one end.

### 2.3.2 Physical mounting

The Link Master should be fixed to a bracket allowing adjustment in the required directions. The figure below shows the Link Master with the optional rotating mounting bracket, allowing full tilt and swivel adjustment. Other mounting brackets may be used as long as they are not obstructing the communication link.



To avoid water ingress, it is important with proper cable routing. Also make sure that proper cable gland and back panel tightening is done.




### 2.3.3 Setting up

The Link Master requires two external connections:

- Power supply (10.2 – 32Vdc)
- Network connection (10Mbit/100Mbit Ethernet)

Two separate wires or a common wire may be used for the two connections. Connecting to both is via the back-panel on the Link Master.

Make sure that the pairs are used appropriately in the cable. LAN Tx and Rx should be on their own pairs. Depending on supply voltage, cable type and cable distance, multiple pairs may be required for the power supply.

Cables should be through tightened cable glands mounted on the back-panel lid.

## 2.4 Back-panel

All connections to the back-panel should preferably be made through a single cable. The cable should go through the back-panel cover using an appropriate cable gland, making sure the through is weatherproof according to IP67.

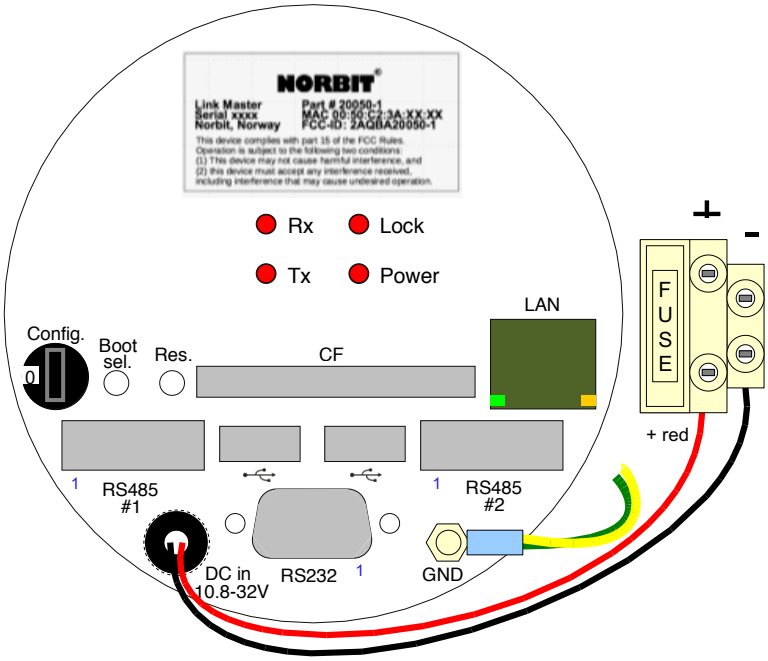
The cable should not be longer than the limits set by power voltage drop and/or Ethernet cable restrictions.

### 2.4.1 Access to the back-panel

To get access to the Link Master connector panel, the back-panel cover must first be removed. First loosen the back-panel cover with an M6 Allen key, then carefully pull the end panel off.

After finishing work on the connector panel, the end panel should be properly replaced, and the fastening screw tightened again.

### 2.4.2 Back-panel layout




Link Master back-panel

Connectors marked in light grey shall not be used.

### 2.4.3 Back-panel connections

#### 2.4.3.1 LAN

This interface is used for 10/100Base-T LAN connection using a standard RJ45 network connector.

#### 2.4.3.2 Power supply

The Link Master requires 10.8V to 32V DC / 1A power supply in order to operate. Connect the positive voltage to the red cable and the negative voltage to the black cable.

| | |
|---|---|
| Connector | Connector block for 4mm$^2$ wire with fuse |
| Supply voltage | 10 .. 32VDC (suitable for 12V or 24V battery) |
| Supply current | <1A @ 13.8V |
| Galvanic insulation | yes |
| Fuse rating | 2A, 5*20mm |

#### 2.4.3.3 GND

The GND terminal represents the protective ground and is connected to the internal chassis of the unit. The power supply, the RS485 interfaces and the external mounting bracket are all individually isolated from GND, whereas the USB, the RS232 interface and the LAN shield are not.

The Link Master should always be properly grounded to protective ground.

Physical 4mm screw/nut

#### 2.4.3.4 Other items on the back-panel

**Memory card**

The back panel has a memory card inserted. The Link Master will not function without the memory card. The memory card should not be ejected.

**Rotary switch**

The back panel og the Link Master has a rotary switch. The Link Master is delivered with the rotary switch set to position 0. The rotary switch shall be kept at this position.

**Other connectors**

Other connectors on the back panel should not be attempted connected to.

### 2.4.4 Back-panel LEDs

The back-panel itself has four red LEDs (lights). In addition, there are 2 LEDs on the LAN socket.

The red LEDs are:

| LED | Description |
|---|---|
| Rx | Will blink when data is received from Link Client |
| Tx | The Link Master is transmitting information |
| Lock | Internal circuitry power up |
| Power | The Link Master transmitter is powered and transmitting |

The LAN LEDs are:

| LED | Description |
|---|---|
| Left | Green when connected to 100 Mbit Ethernet network |
| Right | Blinking yellow when sending or receiving network traffic |

### 2.4.5 Setting network address

The Link Master is delivered with a static IP address set to

| | |
|---|---|
| IP address: | 192.168.1.200 |
| Subnet mask: | 255.255.255.0 |
| Default gateway: | 192.168.1.1 |

The IP address can be changed to a different static IP address, or it can be configured for DHCP IP address acquisition.

#### 2.4.5.1 Procedure for changing IP address

IP address configuration is in a configuration file on the Link Master (see below). The preferred way to change the IP address is to transfer an updated network configuration file to the Link Master by FTP. Thus, to change the IP address, network access to the Link Master must be available.

a) Prepare a new network configuration file
b) Use FTP to transfer the updated network configuration file to the Link Master directory `/usr/local/etc`
c) Restart the Link Master by power cycling
d) Verify that new IP address is set

#### 2.4.5.2 Network configuration file

The network configuration file is

`usr/local/etc/network`

The configuration file consists of four lines of text

1. IP address mode. Consists of a single digit, 0 is static, 1 is DHCP
2. Static IP address. Specified in standard IP address notation, e.g. 192.168.1.200. Applicable only when address mode is static IP address.
3. Static IP address mask. Specified in standard IP address notation, e.g. 255.255.255.0. Applicable only when address mode is static IP address.
4. Default gateway. Specified in standard IP address notation, e.g. 192.168.1.1. Applicable only when address mode is static IP address.

The network configuration file must be with Linux type line termination, i.e. only using Line Feed (ASCII 10).

**Examples:**

Network configuration is set to DHCP

```
1
192.168.001.200
255.255.255.000
192.168.001.001
```

Network configuration is set to static IP address 10.138.43.9 with subnet mask 255.255.255.240.

```
0
10.138.43.9
255.255.255.240
10.138.43.1
```

Note: Change in network configuration take effect when the Link Master is restarted.

## 2.5 Maintenance

No regular maintenance is required. The Link Master should be kept free from layered mud, dust or slush. If found necessary, the Link Master may be cleaned by water hosing or gently using a high-pressure washer.

## 2.6 Troubleshooting

When troubleshooting, always try power cycling the units in questions before doing more exhaustive troubleshooting.

In all symptom descriptions below, it is assumed that the Link Master has previously been working. In case this troubleshooting a new installation, there may be additional causes. Specifically, make sure that the failing Link Master has been upgraded with the correct software.

Note that networking problems can cause occasional loss of communication between the PC and the Link Master. Be especially aware of the possibility that one of the 4 network cable signal lines may be disconnected (cable or plug failure). This may cause occasional temporary problems without any obvious cause. A standard off-the-shelf network cable tester is an efficient way to check network cable continuity.

### 2.6.1 No network communication with the Link Master

If no communication can be achieved with a Link Master, check the table below.

| Symptom | Check |
|---|---|
| No LOCK LED | Check power supply and the fuse in the power connection terminal.<br>Check that voltage is within specified range.<br>If power is OK, consider replacing the Link Master |
| No green LAN LED | Check that the switch/router the port the Link Master is connected to shows connection with the Link Master.<br>Check LAN cabling. The Link Master is configured as standard MDI and does not support Auto MDI-X. A network cross-over cable may be required with some network equipment.<br>If all seems to be OK, consider replacing the Link Master. |
| No blinking yellow LAN LED | Check that e.g. the charging point computer is actually trying to connect to the Link Master.<br>Check that connected network equipment is working properly (power cycle it).<br>Check that network equipment is not set up with fixed duplex/speed settings. |

If none of the above seems to be a problem, consider replacing the Link Master.

### 2.6.2 No response from Link Client

If no response from Link Clients in the communication area, this may be due to a multitude of causes.

| Symptom | Check |
|---|---|
| No POWER LED | Check that PC is actually connecting to the Link Master TCP port 12345.<br>If PC and connection is OK, consider replacing the Link Master. |
| No TX LED | Check that PC is actually connecting to the Link Master TCP port 12345.<br>If PC and connection is OK, consider replacing the Link Master. |
| TX LED blinks slower than normal | Check that network connection is stable. |
| No RX LED | First check with multiple Link Clients.<br>Check that Link Client is within communication range of Link Master, there are no obstructions and no interference sources.<br>Replace Link Master if no obvious reason found. |
| No visible symptom | Check if there is any external interference signal (special equipment may be needed).<br>Check if replacing the Link Master solves the problem. |

If none of the above seems to be a problem, consider replacing the Link Master.

### 2.6.3 Unstable Link Client communication

If the Link Client read rate is unacceptable, this may be caused a several reasons:

- Too long distance between Link Master and Link Client
- Link Master points towards Link Client at a marginal angle, horizontally and/or vertically
- Extreme weather conditions
- Interference from external transmitting equipment

If none of the above seems to be a problem, consider replacing the Link Master.

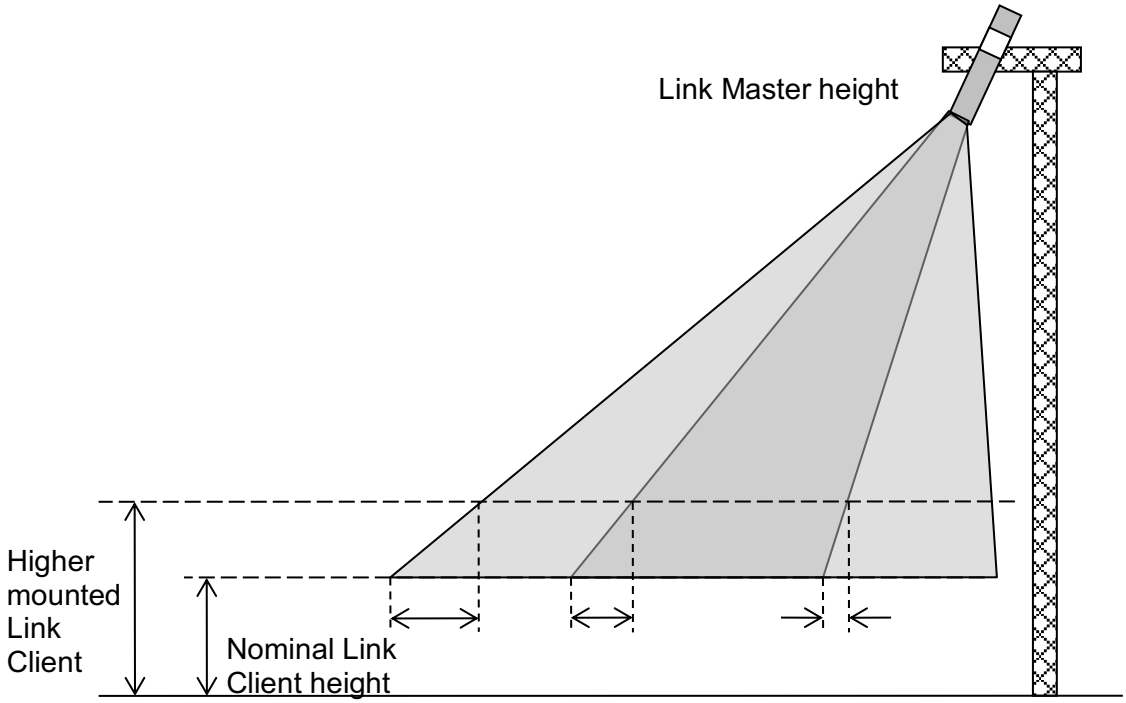
### 2.6.4 Communication zone is too small

If the communication zone for a Link Master too small, this may be due to:

- The Link Master is too close to the communication zone
- Hardware problem

If the small communication zone is due to the Link Master being too close to the communication zone, consider moving the communication zone further away by tilting up the Link Master. If this is not feasible, an Link Master with a wider antenna lobe may be considered.

Be aware that the height of the Link Client will influence on the effective communication area. The wider the antenna lobe, the more height dependent the communication area will be. Height dependency will also be affected by azimuth rotation of the Link Master, the more rotated the Link Master is, the more height dependent the communication zone will be in the far end. The figure shows the effect in an exaggerated way.




### 2.6.5 Incorrectly set to DHCP or static IP address

It may be that the IP address settings are configured to a value that makes it impossible or impractical to connect to the Link Master. By using the 'Config' rotary switch on the back-panel, the IP address may be set back to DHCP or a preset static IP address.

The 'Config' switch is normally set in a fixed position. However, to be able to reset network configuration, the switch needs to be set to three different settings with 10 seconds in between. If the procedure fails, please try again a few times. The switch position is read every 10 seconds, and the switch position may be read while it is being changed.

The currently selected switch position is seen in the 'window' of the switch cap. Should the cap be missing, use a screw driver to change the switch position. A small arrow is engraved which points to the selected number.

To be able to perform this procedure, make sure that the Link Master has properly booted up before trying the procedure. Wait at least 5 minutes seconds after the Link Master has been powered up before trying the procedures below.

To reset network configuration to DHCP, do the following

1) Set 'Config' switch to 15
2) Wait 10 seconds
3) Quickly rotate switch to 2 (3 steps clockwise)
4) Wait 10 seconds
5) Quickly rotate switch to 5 (3 steps clockwise)
6) Wait 10 seconds

The Link Master should now restart and be in DHCP mode.

To reset network configuration to a static IP address, do the following

1) Set ‘Config’ switch to 4
2) Wait 10 seconds
3) Quickly rotate switch to 1 (3 steps counterclockwise)
4) Wait 10 seconds
5) Quickly rotate switch to 14 (3 steps counterclockwise)
6) Wait 10 seconds

The Link Master should now restart, and be set to static IP address 192.168.1.200, network mask 255.255.255.0 and default gateway 192.168.1.1

## 2.7 Safety distance

The Link Master is subject to the radio frequency radiation exposure requirements specified in FCC Title 47 Chapter I Subchapter A Part 2 Subpart J Section 2.1093 general population/uncontrolled exposure.

The safety distance is 20 cm.

## 2.8 FCC information

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

# 3 OPERATION OF THE LINK MASTER

Once set up, a Link Master is controlled by making a TCP connection to it.

## 3.1 Enabling the Link Master

The Link Master starts transmitting when it receives a connection to TCP port 12345. The Link Master may use a few seconds before communication performance is optimal. In its simplest form, a telnet connection can be made from a PC.

The Link Master will stop transmitting a few seconds after the TCP connection to port 12345 has been closed.

When transmitting, the Link Master will regularly send out a broadcast message. Link Clients within communication range will respond to a broadcast, and the Link Master will request the client to return information as requested. Depending on the application, the Link Master may also transfer information to the Link Client.

## 3.2 Network interface messages

When connected to TCP port 12345, the Link Master may output text messages for various purposes. Do not attempt to send any characters or text back to the Link Master.

### 3.2.1 General format

A message on the interface consist of a number of printable ASCII characters ended with Line Feed (ASCII code 10).

Each message consists of a number of fields delimited by space characters. The content of individual fields depend on the type of message, except for the first field.

The first field of a message is always a timestamp. The timestamp is according to the Link Master's internal clock. If the clock is synchronized with an external NTP (Network Time Protocol) master, the timestamp will be approximately correct. If the Link Master's clock is not synchronized, the timestamp is valid only for relative time measurements.

The timestamp consist of year (4 digits), month (2 digits), day (2 digits), the character 'T', hours (2 digits – 24 hour format), minutes (2 digits), seconds (2 digits), decimal point ('.') and milliseconds (3 digits).

### 3.2.2 Connection message

Each time connecting to the network interface, the connection message will be presented.

**Example:**

```
20180702T091157.869 Connected to Simple EFC Interface Protocol
```

### 3.2.3 Transaction message

When requested information has been retrieved from a Link Client, parts of the retrieved information will be output on the connected TCP port 12345. Information pertaining to communication link quality will also be output.

The transaction message consists of the following fields

| Field | Description |
|---|---|
| Timestamp | See above |
| ContextMark | Determines the class of Link Client. Is normally the same for all Link Clients in a system |

| Field | Description |
|---|---|
| Client identity + extra | Unique identity number for the Link Client as 20 BCD digits, 8 BCD digits as extra information. The Client identity may contain trailing BCD 'F' digits. BCD 'F' means remaining BCD digits in the Client identity should be ignored.<br>Dashes at the end are not part of the Link Client's identity |
| Manufacturer code | Identifies the manufacturer of the Link Client |
| Battery status | If different from 0, the Link Client's battery is low |
| Reserved#1 | Field is not used, may contain arbitrary information |
| Colon | Field delimiter |
| Link Master # | An identification of the Link Master within the system. Will normally be 100 |
| Signal strength | Relative signal strength of received response signal from Link Client. |
| Reserved#2..11 | Fields are not used, may contain arbitrary information |

For most purposes, only the identity of the Link Client is of interest.

**Example:**

```
20180702T091159.950 010.16368.00000.000
00000000000000004366 00000000--- 42 0000 0220 : 100  1568 (0.0 10.0
0.0) [0 22/22]
```

Above, the Link Client's identity is highlighted in yellow. The extra information is highlighted in grey.

(Note: Line breaks above are for presentation only)

# 4 LINK CLIENTS

Link Clients are small, self-contained units that may installed such that they may be inside communication range of the Link Master at n arbitrary time. Link Clients are equipped with a small battery. Link Clients cannot transmit or initiate communication by themselves but rely entirely on requests from a Link Master.


For illustration only

## 4.1 Installation

A Link Client is intended to be mounted on a surface transparent to microwave communication, such as glass, laminated glass or ABS plastic, with the mounting surface facing the Link Master. The Link Client Should be mounted so that it is unobstructed on the side facing the Link Master in an area of at least one inch around its perimeter.

For proper operation, the Link Client should not be installed within areas that are covered or coated by any metal or metalized material.

## 4.2 Maintenance

No regular maintenance is required for Link Clients. There are no user-replaceable parts in the Link Client.

If the Link Client battery is empty, the Link Client should be replaced. The old Link Client should be disposed as electronic waste.

## 4.3 Operation

Once proper installed, no user actions are required for the operation of a Link Client.

The Link Client may emit a beep when within the communication range of a Link Master, controlled by the Link Master.

## 4.4 Safety precautions

The Link Client should be mounted at a position or in a way that does not impact safe use of the device or compound apparatus at which it is mounted.

The Link Client should be handled with care and should never be attempted opened. The battery contains Lithium Thionyl Chloride and should not be subject to fire or temperatures above 185°F.

## 4.5 FCC information

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

# 5 COMPANY CONTACT INFORMATION

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