

OPERATING MANUAL

BTD-300 / BTD-350

Thunderstorm
Detector

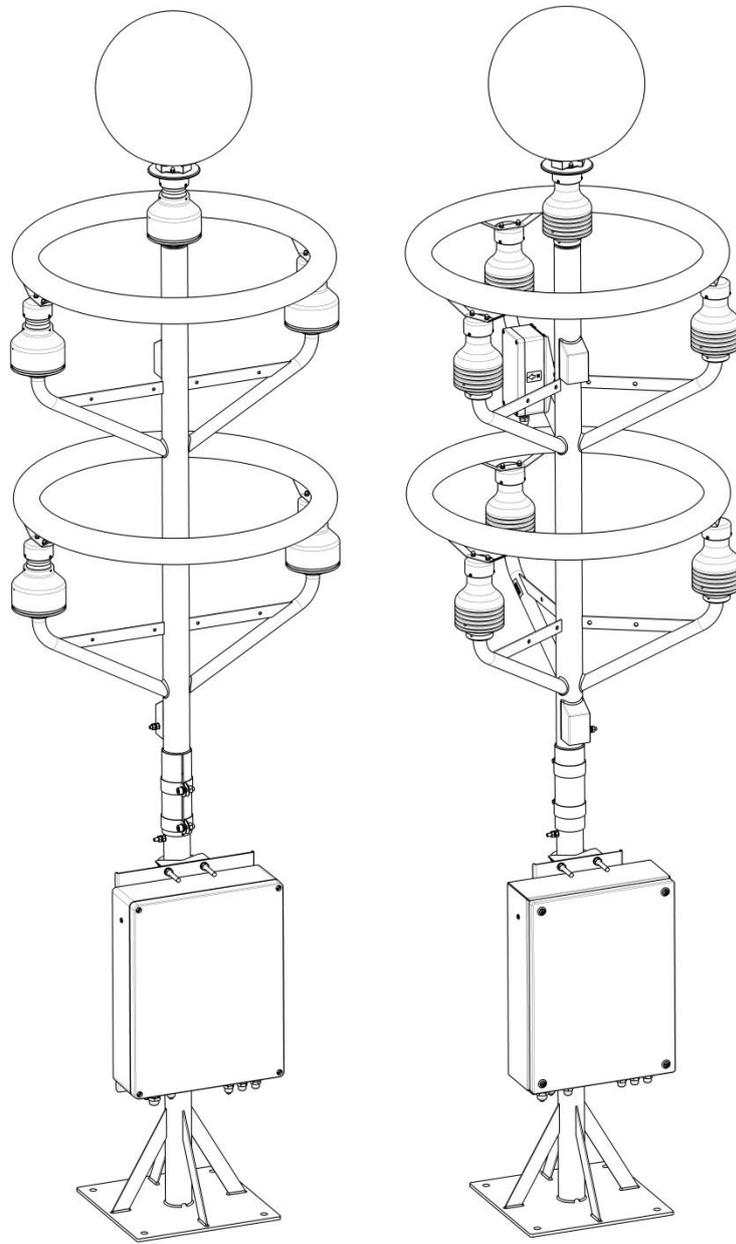


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**BTD-300****BTD-350**

This manual describes and operation of the models:
BTD-300 and **BTD-350**.

Where instructions apply to either, the Detector will be referred to as 'BTD'.

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1 SAFETY

1.1 Lightning Safety

The BTD is a highly sensitive lightning detector, designed to inform the user of any lightning flash within 45 nautical miles (83 km) of the installation site within 2 seconds of its occurrence. This, combined with continuous monitoring of the electrical conditions present at the site prior to any lightning activity, offers a comprehensive local thunderstorm warning solution. It is however essential that the BTD is installed and powered correctly at a suitable site for timely warnings of potentially hazardous weather. Failure to correctly follow the site selection, installation and maintenance instructions provided by this manual, or check for sensor fault alerts, could result in the sensor failing to warn of local thunderstorm activity.

It must be remembered that the BTD can only warn of potential or current thunderstorm activity. The unit does not provide any form of direct lightning protection and it is the responsibility of the user to ensure that all appropriate and timely action to protect personnel and property is made once a thunderstorm threat is identified. If supplementary information on potential thunderstorm activity is identified before the BTD issues an alert (human observation, for example) then we always recommend that action to safeguard personnel and property commences immediately, such as going inside a substantial building, prior to the BTD issuing an alert.

This sensor has been proven to produce timely and reliable warnings during extensive field trials, although even with advance warning of overhead thunderstorm development, the meteorological situation can quickly become hazardous. It is therefore advisable to always be aware of possible local thunderstorm activity provided by the local weather service and produce your lightning safety plan well in advance of hazardous weather. When local thunderstorm activity is detected, the situation should be carefully monitored and you should be prepared for a rapid escalation of the threat level. There is still a significant risk from lightning for several minutes after the thunderstorm has passed overhead, which is reflected in the delay for BTD warning end times after the last trigger has been received.

1.2 Electrical Safety

1.2.1 CE Certification - Safety

All Senseca Sensors comply with the requirements for UKCA and CE marking. Once installed, it is the user's responsibility to ensure that all connections made to the sensor comply with all Local and National safety requirements.

For the Sensor to comply with the requirements of EN 61010-1:2010+A1:2019, 'Safety requirements for electrical equipment for measurement, control, and laboratory use', the following should be observed:

A switch or circuit breaker must be included in the installation.

This switch or circuit breaker must be suitably located and easily reached.

It must be marked as the disconnecting device for this equipment.

 This product **MUST BE EARTHED.**

 Failure to install a suitable earth may result in inaccurate readings and damage to the product and attached equipment.

 Failure to install an earth will make the unit potentially unsafe.

The device is protected internally by a Type D 4A MCB. Large inrush currents are present due to the nature of the AC/DC converter.

2 PRODUCT DESCRIPTION

The BTD-300 and BTD-350 are standalone sensors providing real-time detection and ranging of thunderstorm activity within 45 nautical miles (83 km). The sensor bases thunderstorm warnings on the detection and range of lightning flashes throughout the detection area, as well as the presence of strong electric fields and electrically charged precipitation occurring at the installation site. The strong electric fields and charged precipitation provide the ability to warn of the potential for nearby lightning activity before the occurrence of the first flash, with the subsequent flashes used for thunderstorm intensity and proximity monitoring.

Lightning flashes of all types (cloud-to-ground, cloud-to-cloud and intra-cloud) and polarities are detected, ranged and logged within 2 seconds of their initiation. The BTD is primarily a thunderstorm warning system, so the location and frequency of flashes are considered as the most important parameters for assessing lightning risk. The BTD therefore does not discriminate between different flash types, polarities or strengths, so these properties of the detected flashes are not available.

Electric field disturbances associated with potential overhead thunderstorm development produce an alert after 5 seconds of continuous detection. Such sensitivity and rapid alerts allow the greatest warning time of local thunderstorm development for the user, with the unique monitoring techniques providing an extremely low false alarm rate.

The operating principle of the BTD is based upon sensing changes in the atmospheric electric field in the frequency band of 1-47 Hz. Such low frequency means that the sensor is most sensitive to slow-varying electrostatic fields associated with charge transfer from lightning flashes, nearby corona (point) discharge and the turbulent movement of strongly-charged aerosol associated with thunderstorm activity. In addition, charge transferred to the antennas by precipitation is analysed and used to determine whether the overhead cloud has the potential for thunderstorm activity. Radio emissions (both natural and man-made) are associated with considerably higher frequencies so do not produce interference on the sensor. Noise associated with mains power distribution (typically 50 or 60 Hz and harmonics) are removed by both analog and digital filtering.

In addition to electric field variations associated with lightning and local electric field enhancement, there are unwanted sources such as nearby movement of people, birds and charged materials. These sources of interference are identified and prevented from triggering a false alarm by software algorithms exploiting the unique geometry of the BTD antenna array. For a comprehensive description of the underlying scientific principles used by the BTD the user is referred to the following peer-reviewed journal publication:

Bennett, A. J. (2013). Identification and ranging of lightning flashes using co-located antennas of different geometry. *Measurement Science and Technology*, 24(12), 125801. doi:10.1088/0957-0233/24/12/125801.

The main components of the BTD are shown in Figure 1. The sensor uses three antennas kept electrically isolated from the ground by heated weatherproof insulators, allowing induced currents from distant lightning of less than 1nA to be detected during all weather conditions. Heaters are present inside all 5 (BTD-300) or 7 (BTD-350) insulators and each antenna has a gas discharge unit to ground to protect the amplifier from current surges associated with very close lightning, whilst retaining the sensor's ability to detect them. An amplifier with an analogue filter stage is housed in the primary antenna insulator and one of the antenna insulators for the secondary and tertiary antennas. The amplified signal is then sent along shielded wires to the main circuit board housed inside the electronics enclosure. There are two grounding terminals near the join of the vertical support pole to ensure good grounding of both parts of the support pole and to provide a good earth bonding point (See section 3.9).

The function of the corona initiator spikes (BTD-300 only) are to produce rapid electric field changes detectable by the antennas in the presence of a strong electrostatic field, which is associated with overhead thunderstorm development.

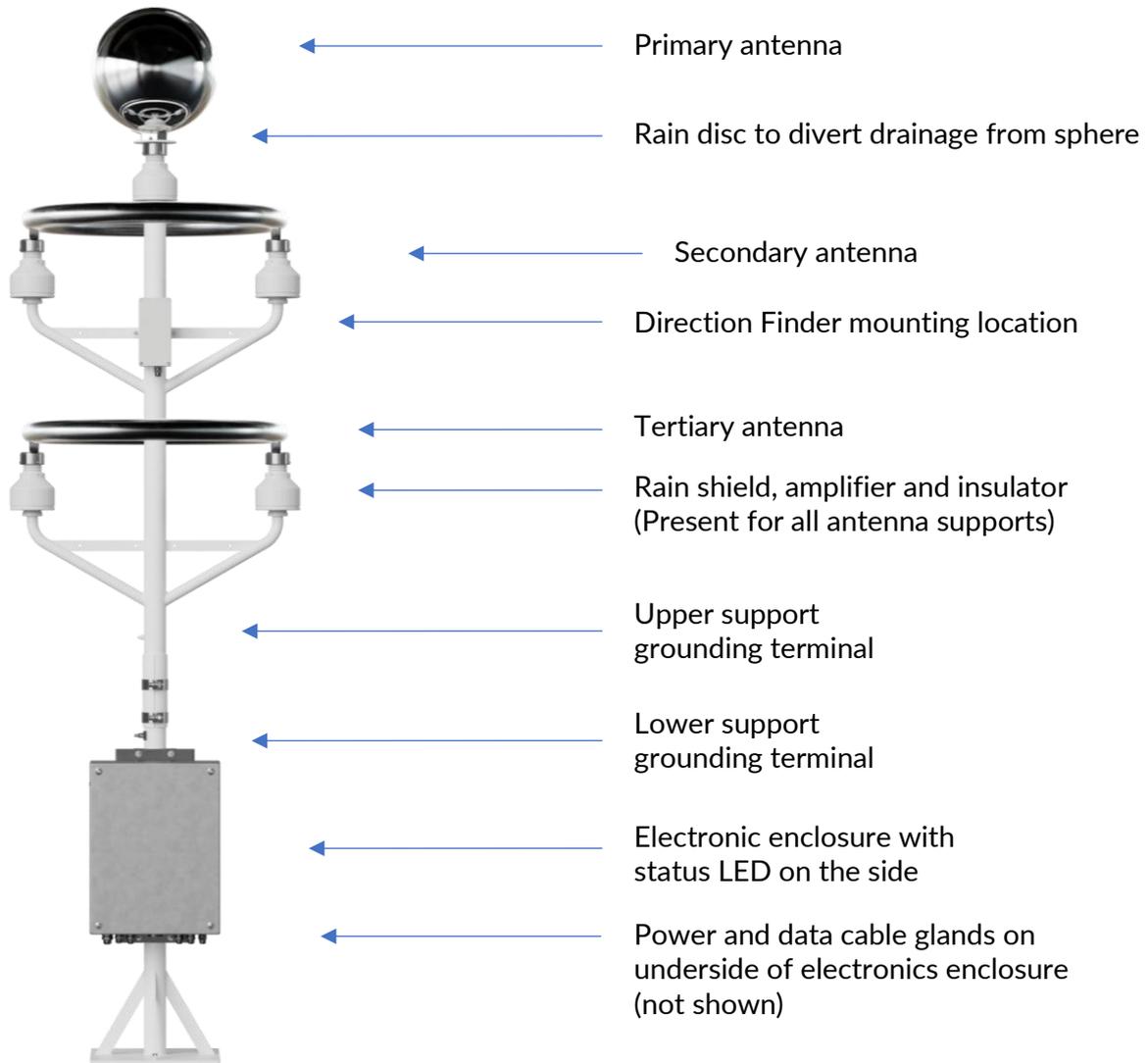


Figure 1: Main components of the BTD

3 INSTALLATION



WARNING!

Before completing the installation, the sensor **MUST** be grounded and a site characterisation **MUST** be performed. Please see section 3.9 (page 17) and section 5.1 (page 28) of this manual for details.

3.1 Site Selection

It is very important for the successful operation of the BTD that it is installed at a suitable site. Please consider the following criteria for the physical site characteristics:

Ideal site (allows optimal performance)

- Flat, level ground with no obstacles higher than approximately 20 cm (including vegetation) within 2 m of the sensor.
- No obstacles of any kind closer than approximately 3 times their height.
- No overhead obstructions (e.g. cables).
- No frequent movement of people, animals or vehicles within 10 m.
- For sensors incorporating the direction finder, no metallic structure, such as a metal clad building within 40 m of the sensor

Acceptable site (allows adequate performance but likely to require sensor recalibration from factory default)

- Sensor can be positioned above ground level (e.g. on a low roof) – but avoid increasing its exposure to a direct lightning strike, which will damage the unit.
- No obstacles closer than half their height above the base of the sensor.
- No overhead obstructions (e.g. cables).
- No frequent movement of people, animals or vehicles within 5 m.
- For sensors incorporating the direction finder, no metallic structure, such as a metal clad building within 5 m of the sensor

Unacceptable site (likely to severely reduce sensor performance)

- Overhead obstructions.
- Obstacles closer than half their height above the base of the sensor.
- Frequent movement of people, animals or vehicles within 5 m.
- For sensors incorporating the direction finder, a significant size metallic structure, such as a metal clad building within 5 m of the sensor

A pictorial summary of these site requirements is shown in Figure 2 below.

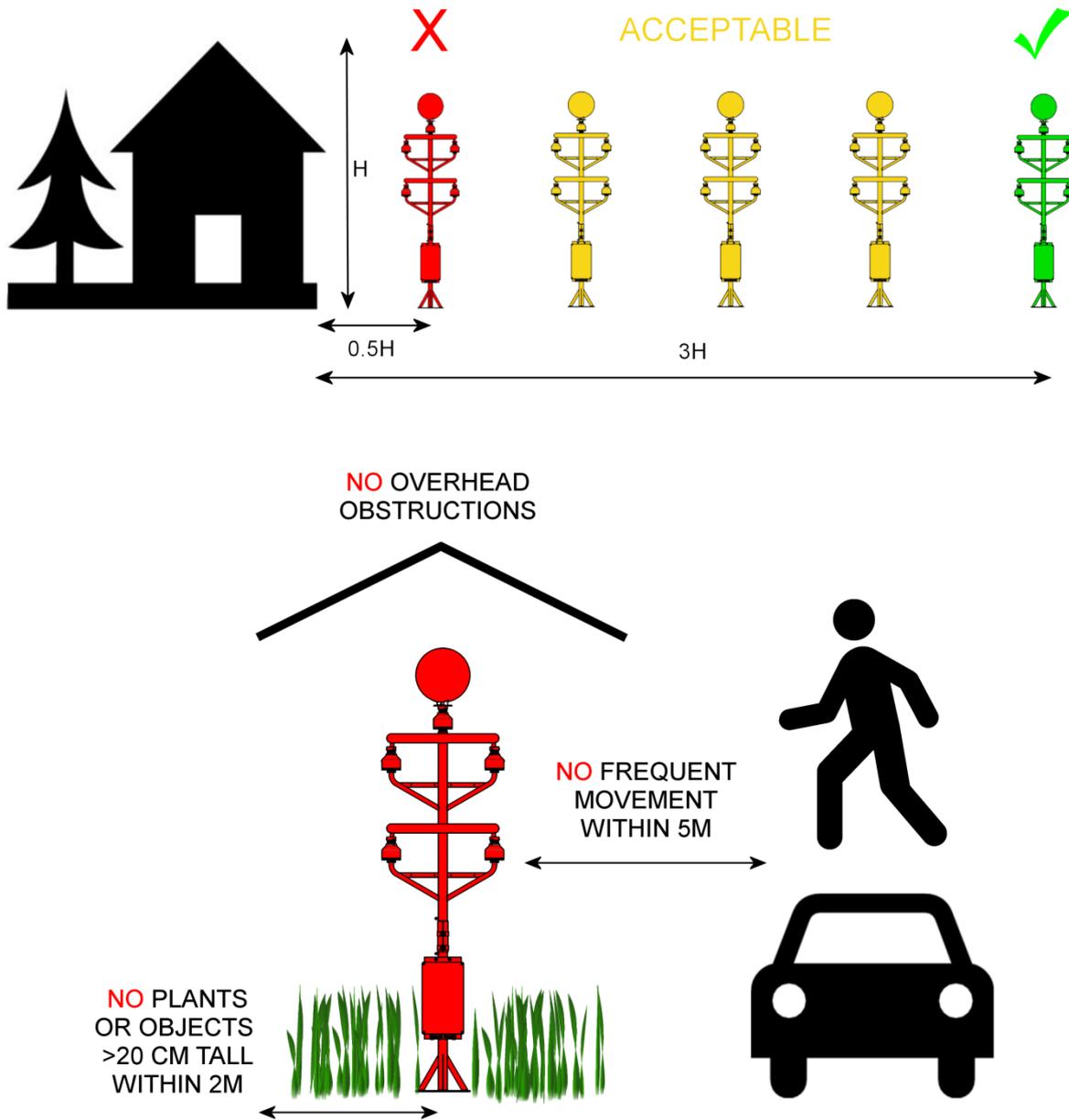


Figure 2: Site suitability considerations

Once a suitable site is selected, the BTD needs to be firmly mounted using the base plate at the bottom of the unit. For unstable ground such as soil it is recommended that a concrete plinth is set into the ground and the unit is bolted to it through the mounting bolt holes in the base plate corners. Alternative mounting options such as exploiting existing mounting poles are possible. Please consult Senseca prior to installation to discuss alternative mounting options.

The base plate dimensions and bolt hole locations are shown in Figure 4. There are no orientation requirements for mounting of the BTD without the direction-finding module, except that the unit is intended to be mounted on a flat, horizontal surface so that the long support pole is vertical. Minor inclinations off vertical are however acceptable. If the direction finder module option is included in the installation, the arrow on the module must be orientated to point due North by rotation of the upper part of the pole, see Figure 5. Assembly instructions are provided in Figure 6.

Please note that the electronics enclosure box is temporarily positioned in the middle of the support structure for packaging purposes but **MUST** be lowered into its correct position at the lowest point of the support pole, just above the four diagonal base plate supports, as shown in Figure 3. The black rubber strips between the enclosure box U-bolts and metalwork are only for packaging and must also be removed.

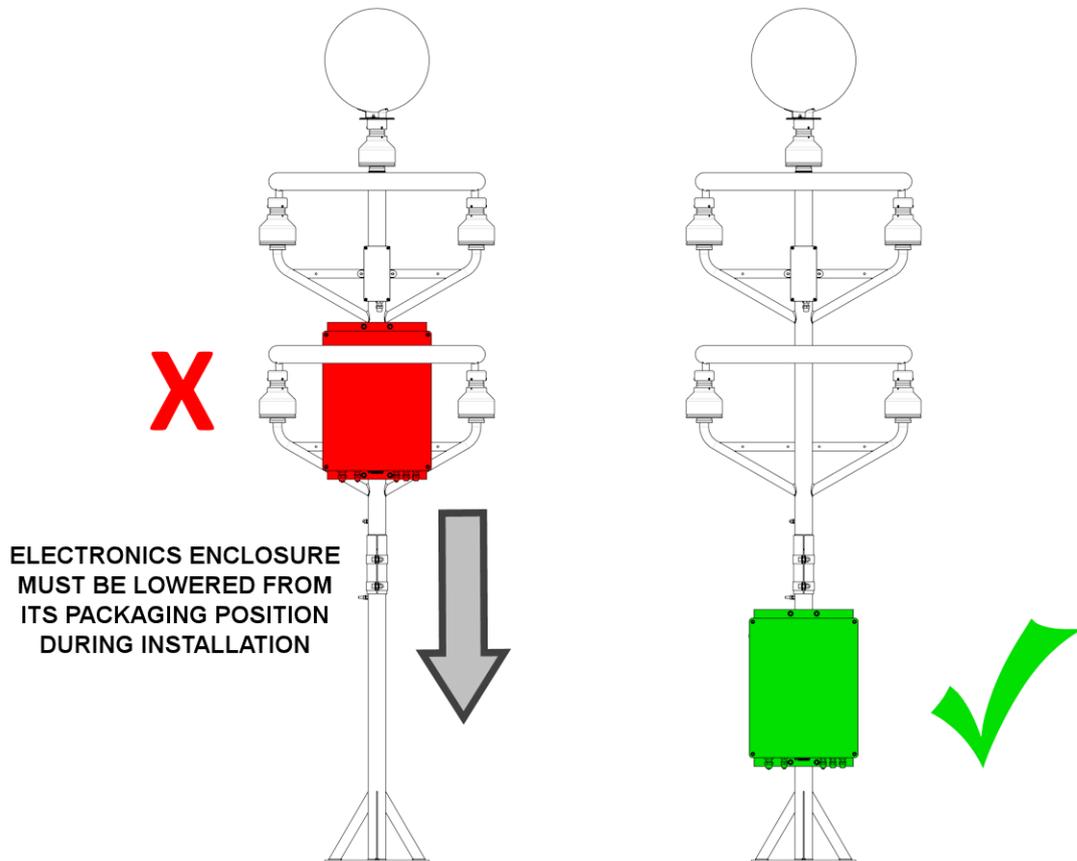


Figure 3: Lowering of electronics enclosure box from its temporary packaging position

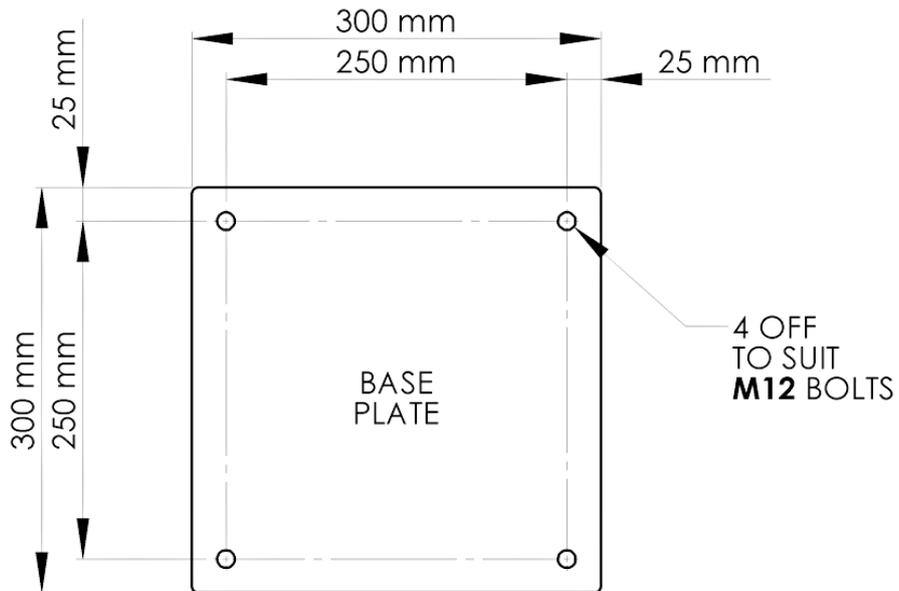


Figure 4: BTD base plate dimensions

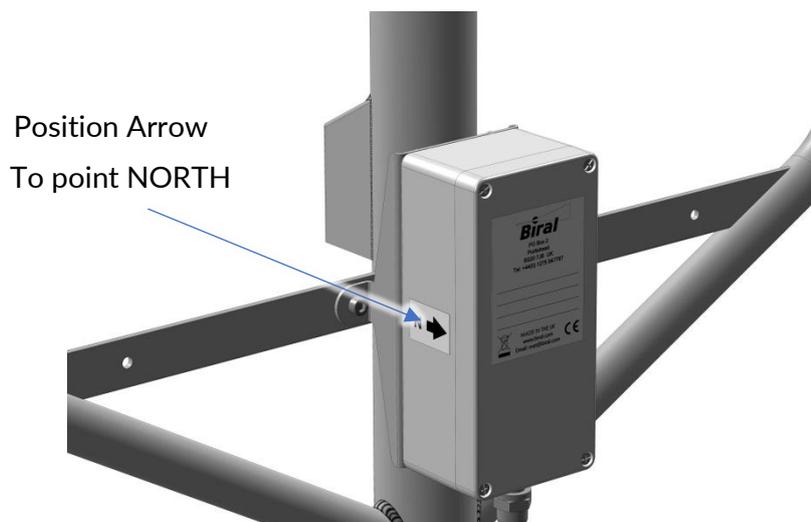


Figure 5: NORTH pointing arrow

Direction Finder is optional on the BTD-300
but always fitted to the BTD-350

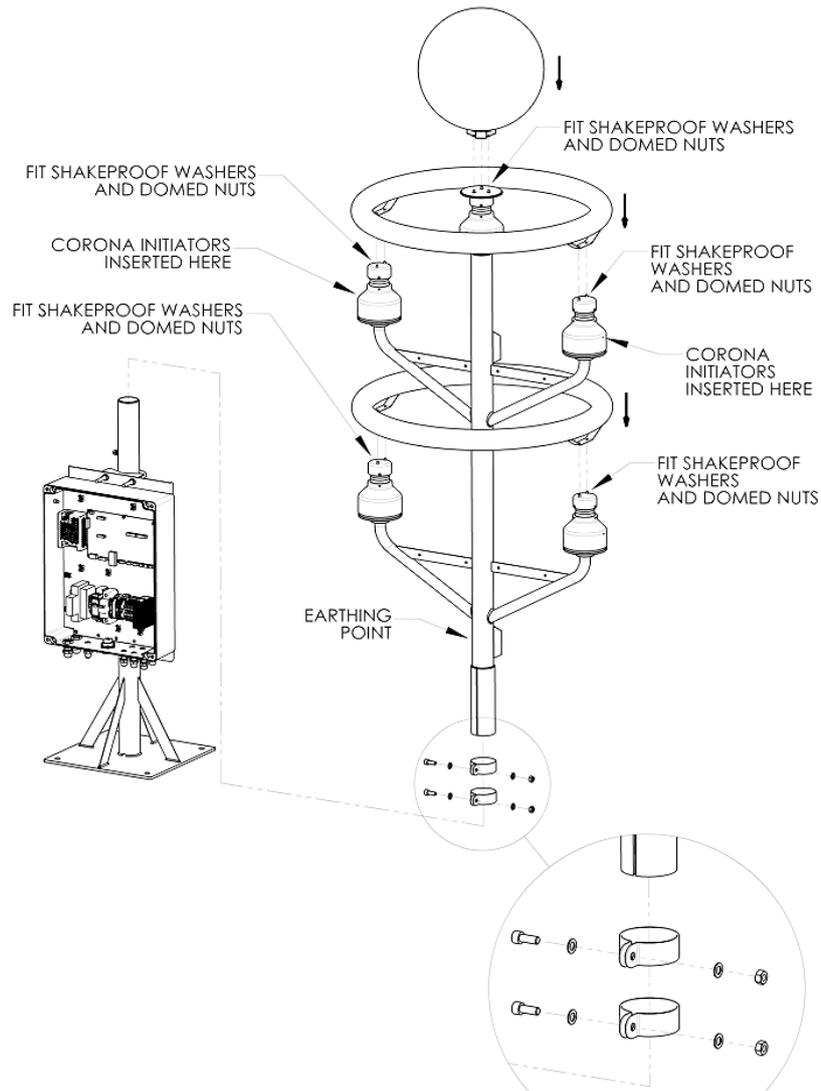


Figure 6: BTD-300/350 Assembly Instructions

3.2 Tools Required for Assembly

The following tools are required for assembly of the BTD Thunderstorm Detector:

- 7mm spanner for the antenna dome nuts.
- 13mm spanner for the electronics enclosure U Bolt and the pole clamp nuts.
- 6mm Allen key for the pole clamp bolts.
- 10mm spanner for the earth stud nuts.

3.3 Package Contents

Ensure that any packaging is removed from the unit and the bag of components for assembly (including corona spikes for BTD-300 only) is identified and not discarded with the packaging.

3.4 Direction Finder Angle Offset

If the Direction Finder is not able to be positioned directly north as instructed, or the installation site produces a systematic bias in magnetic direction finding (a non-ideal site), a fixed offset can be added or subtracted to the derived flash angles using the option in the BTD control software service screen or via the command line interface (sections 7.6 and 7.7). Angle offsets may be large ($\pm 20^\circ$) for sites where significant metallic structures are present nearby. This is a characteristic of all lightning magnetic direction-finding systems and can be identified by comparing reported lightning bearing with true bearing to the storm e.g. from human observation of the flash, coincident data from a reliable lightning location network or appropriate satellite/radar plots.

3.5 Power and Data Cables

3.5.1 Power Connections

In order for the mains version of any sensor to comply with the requirements of EN 61010-1:2010, 'Safety requirements for electrical equipment for measurement, control, and laboratory use', the following should be observed:



“A switch or circuit breaker must be included in the installation. This switch or circuit breaker must be suitably located and easily reached. It must be marked as the disconnecting device for this equipment.”

The customer is responsible for providing a switch or circuit breaker which is deemed suitably located and easily reached.

The BTD is internally protected by a Type D 4A MCB. There is a significant inrush current on switch on due to AC/DC converters. It is recommended that a Type D 4A MCB is used where an external breaker is used.

The BTD accepts an 85 – 264 AC power supply at 47 – 63 Hz. A schematic of the cable gland and connectors found on the lower face of the electronics enclosure is shown in

Figure 8. A suitable three-core power cable (0.5mm core or greater), supplied by the user is passed through the cable gland as indicated on the base of the electronics enclosure and connected to the terminals of the lightning surge protector (red unit). Ensure the power supply is disconnected before attempting to connect to the unit. The lightning surge protector terminals are labelled by the manufacturer. The live wire is connected to position 1 (marked on the terminal block), the ground to the ground symbol (middle terminal) and the neutral is connected to position 2. These positions are shown in Figure 9.

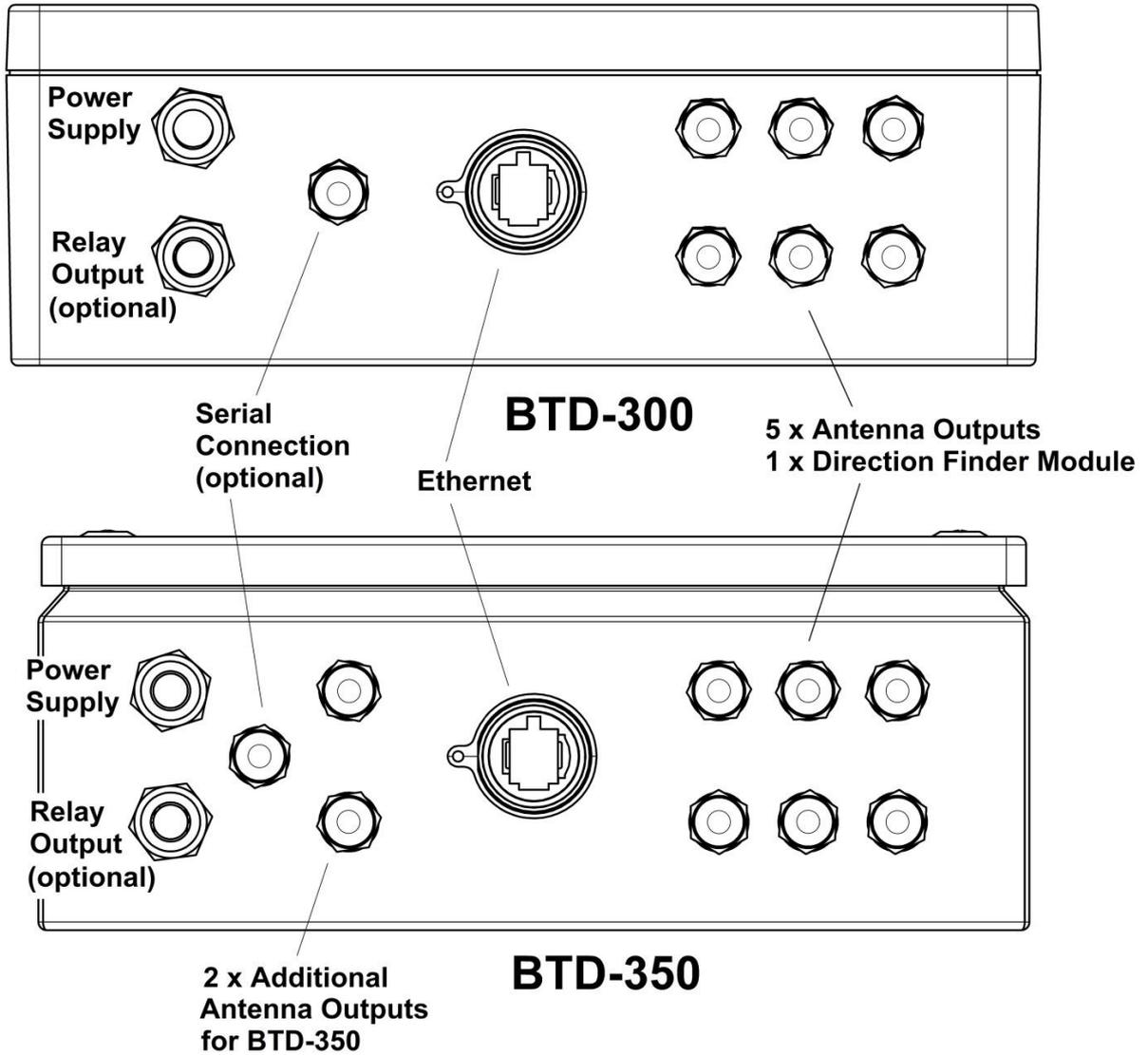


Figure 8: BTD-300 and BTD-350 Enclosure box cable gland arrangement

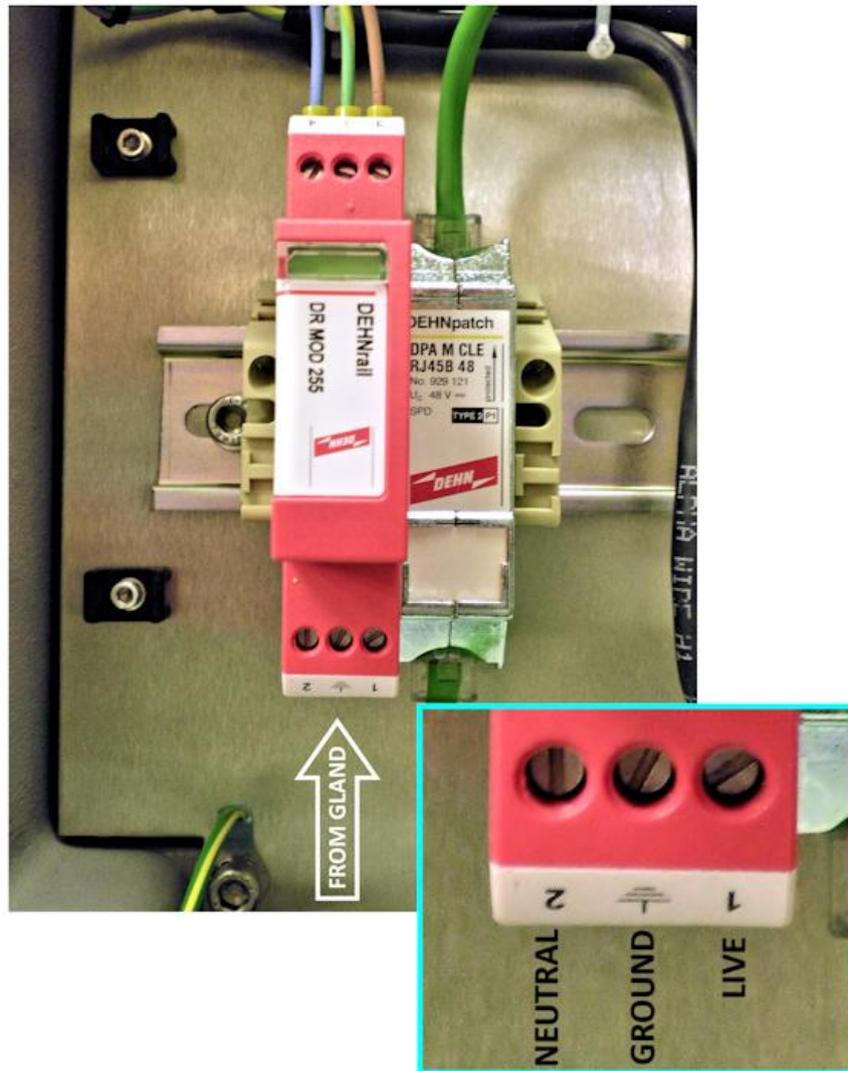


Figure 9: Terminal positions for power connection

3.5.2 Ethernet Connections

The Ethernet connector is located in the centre of the base (see Figure 8), so there is no need to open the enclosure to connect this data cable. The mating IP68 Ethernet connector, provided with the unit, should be used on the input Ethernet cable to retain the system's weatherproof integrity.

3.5.3 Serial Data Connections (RS422)

If an RS422 serial data connection was specified at time of purchase, the following procedure should be used to connect the appropriate cable. Pass the prepared end of the RS422 cable into the enclosure through the small cable gland adjacent to the Ethernet connector (see Figure 8). Connect the wires to the serial terminals as shown in the Figure 10 and Table 1.

The wires must be between 16 and 24 AWG (1 mm² to 0.2 mm²), either stranded or solid. They should be stripped to a length of 8mm. Use a small flat blade screwdriver to depress the orange wire clamp and insert the prepared end of the wire into the adjacent hole. When the clamp is released, the wire will be held firmly in the terminal.

Use tie wraps or equivalent to attach the cable to suitable internal fixing points to ensure there is no strain on the connections. Tighten the cable gland.

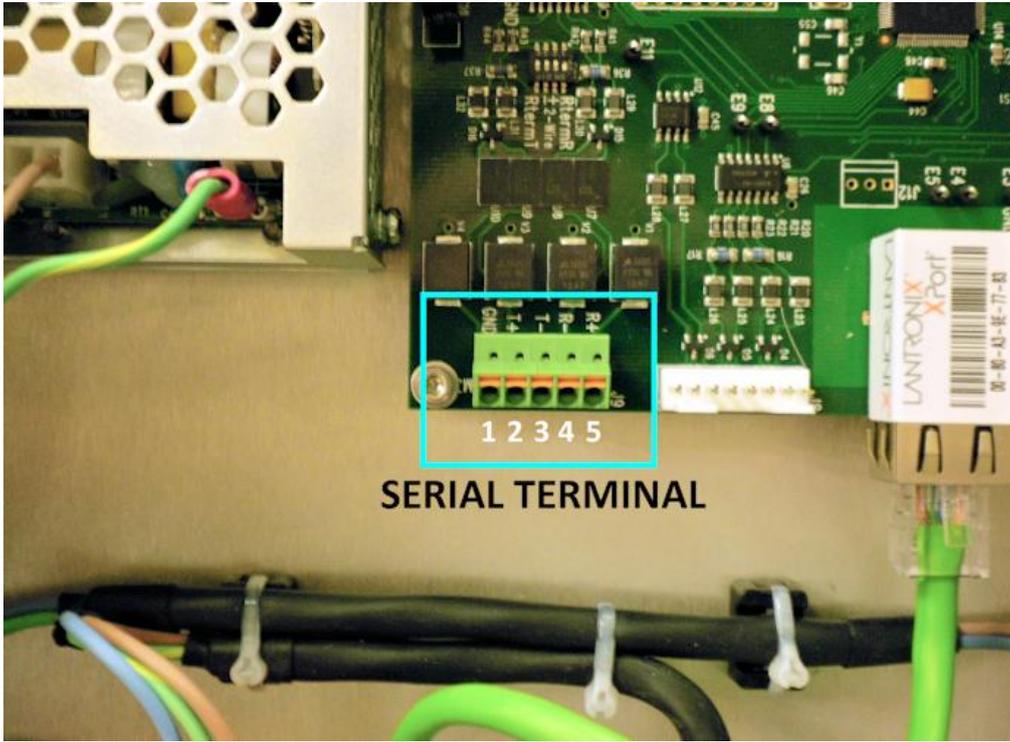


Figure 10: Location and numbering of the RS422 terminals on the main circuit board

Terminal Block Number (left-right)	Function of BTD	Host Connections
1	0V	0V
2	Tx+	Rx+
3	Tx-	Rx-
4	Rx-	Tx-
5	Rx+	Tx+

Table 1: RS422 Serial communication terminal designations

NOTE:

Extreme care must be exercised to ensure that these connections are correct in both the polarity of the signals and their definitions. The BTD transmitter signals (Tx+ and Tx-, terminals 2 and 3) MUST be linked to the host receiver (Rx+ and Rx-) signals. If this is not wired correctly, the system will not work.

3.5.4 Switching Between Ethernet and RS422 Communications

To switch between Ethernet and RS422 communications, power down the sensor and locate the 4-way DIL switch labelled “SW2” on the processor board as shown in Figure 11.

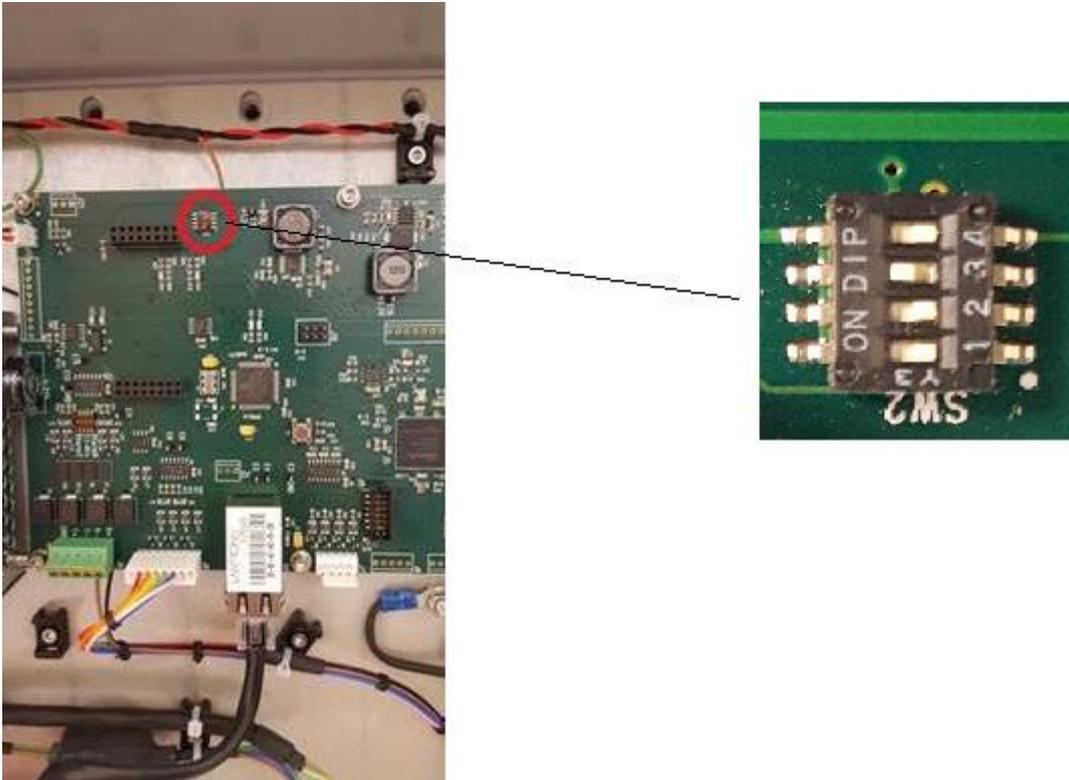


Figure 11: Location of SW2 switch

For Ethernet communications change switch 3 to the 'Off' position.

For RS422 communications change switch 3 to the 'On' position.

Make sure the correct data connections (either serial or Ethernet) are applied to the sensor.

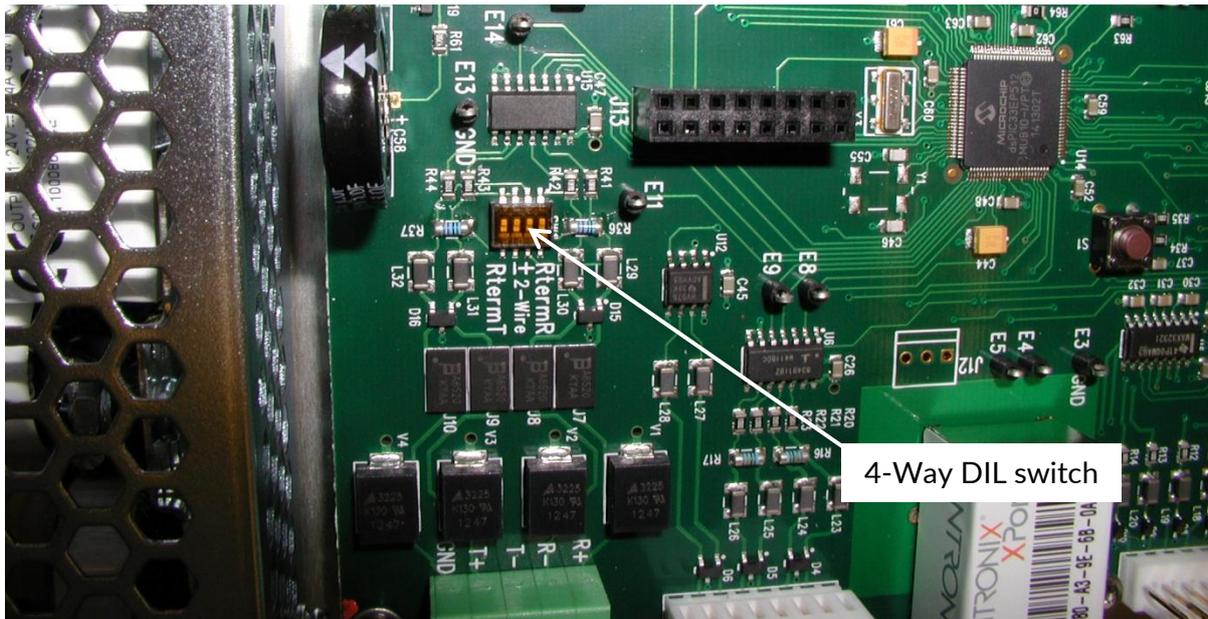
When the sensor power is reapplied, the sensor will communicate using the selected protocol.

3.6 RS422 Connection Options

The RS422 interface only supports 4-wire full-duplex communications. The selection of RS422 communications is described above. Termination of the transmit and receive lines can be configured using on-board switches, shown in Figure 12.

The circuit board is labelled, defining the action of each switch. The middle two switches are reserved for two-wire operation in other sensors and must not be changed from the factory default position. If two-wire operation is selected the sensor will fail to communicate correctly.

The outer two switches, if switched from the default position, place termination resistors (120R) on the receiver and transmitter lines (as labelled). These are not normally required. However, if a fast baud rate is used over a long transmission line, one or both of these may be required.



3.7 Relay Connections

The gland for the optional relay output cable is found adjacent to the power supply gland, closest to the support pole side of the box. If this is not used, the gland filler plug must be left in place to retain the IP66 rating of the equipment.

The cable for the relay outputs must be selected to comply with any local or national regulations concerning its use for carrying the voltage and current for the specific relay application. This is of particular importance when mains voltages are being switched by the BTD. The specification for the relay contacts is given in Section 8.3, Specification for the Optional Relay Contacts.

Connections for the relay outputs are shown in Figure 13: Relay Connections. These terminals are only present if the relay option was selected at time of purchase. They are positioned to the left of the power connections. Looking from left to right there is an earth terminal for earthing the cable screen, then terminals 1 (for relay 1), 2 (for relay 2) and 3 (for relay 3). Each terminal block has three connection levels, with the lowest being relay NO, the centre being relay COM and the top being relay NC.

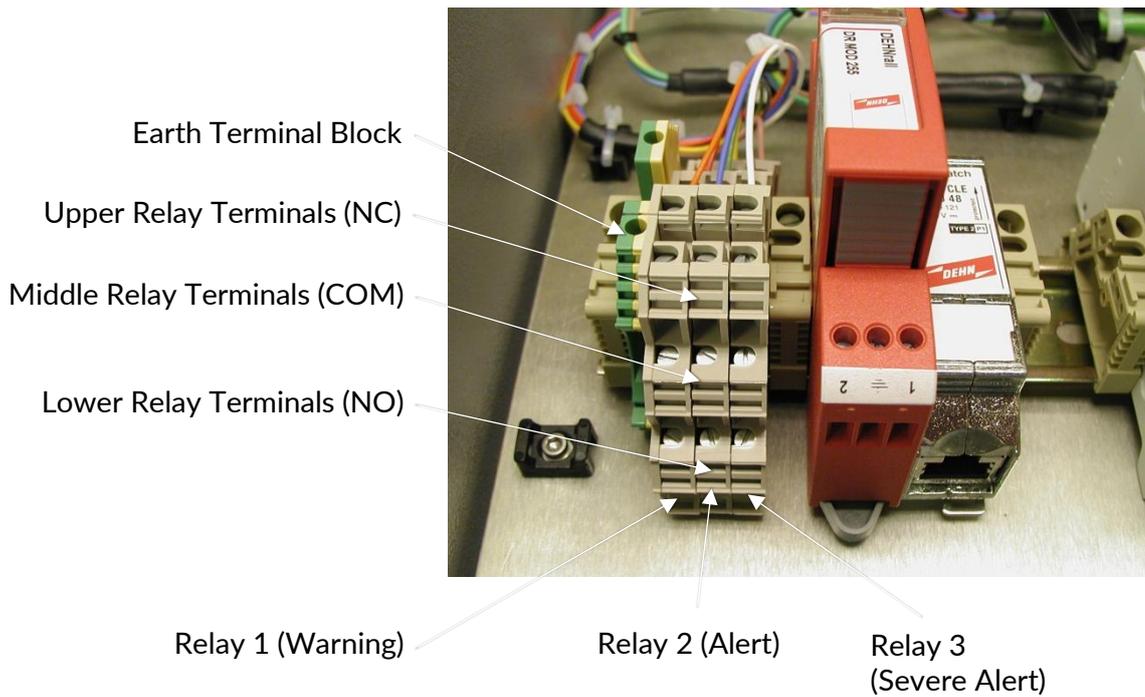


Figure 13: Relay Connections

3.8 Electrical Grounding

Possible instrument failure can result from the damaging effects of over-voltage transients induced on the power line and the signal distribution lines. Destruction of sensitive components can result from unprotected lines, or instrument failure may occur over a long period of time due to slow device degradation. Destructive over volt transients can occur in many ways; e.g., lightning induced transients, AC power line transients and EMI/RFI electromagnetic noise. The power/control subsystem of the sensor contains transient surge- arrestors on all power and signal lines as a standard feature. EMI filters are present on the power and data lines entering the power/control subsystem.

It is essential to connect the sensor to earth ground for maximum protection of the instrument during nearby lightning strikes. The following notes are intended to provide some guidance in the design and construction of an electrical grounding system:

- **Ground Rod:** An eight-foot ground rod should be used to make contact with moist soil during even the driest periods.
- **Lead Lengths:** No. 6 AWG solid copper wire should be used to connect the instrument (and thus the transient voltage suppressers) to the ground rod. Use the shortest and most direct paths to the ground. Simply connect the ground lead to the lower of the two grounding terminals provided (see Figure 1 for grounding terminal location). Ensure that the grounding terminals on the upper and lower parts of the mounting pole are joined with the earth link provided with the equipment.
- **System Interconnections:** Eliminate all isolated ground loops. The shield of the signal output cable, for example, should be attached only at one end of the cable and left floating at the other end. Preferably, it should be attached to ground at the sensor end of the signal cable.
- **Connections:** Use tight, corrosion-proof bare metal connections throughout the grounding system.

3.9 Installation Completion

- Check that the power switch, near the centre of the DIN rail, is set to 'ON'
- Fasten the lid of the thunderstorm Detector Electronics enclosure firmly back in place.
- Restore power to the system.
- Ensure that any drivers for any RS422 converters if applicable are installed on the host PC.
- Re-start the BTD Control Software, or equivalent terminal software.

The Thunderstorm Detector Control Software will search for (virtual) Com Ports and select the one connected to the BTD automatically. Alternatively, if using a programme such as HyperTerminal, the correct port should be selected manually.

If an adaptor has been used, such as an RS422 to USB converter, the appropriate software for that device must be loaded and operational before starting the BTD Control Software. If the adaptor software has not loaded correctly, the BTD will be unable to find the (virtual) serial port.

3.10 Initial System Calibration

Once the system is installed at a suitable site, an initial site calibration is required to identify antenna offsets and background variability. This calibration is quick and straightforward and must be done at the earliest possible opportunity. The procedure for this is given in Section 5.1.

To achieve the highest reliability for lightning range measurements, it is recommended that the lightning range calibration is checked and amended as necessary by following the procedure given in Section 5.3. For ideal sites, lightning range calibration after installation may not be necessary since it is likely to be the same as the default factory setting, but re-calibration is strongly recommended if the BTD is installed at a non-ideal site as defined in section 3.1.

3.11 Relay Option

An option, specified at time of purchase, is for the provision of three relays, contained within the electronics enclosure of the instrument. These relays have change-over volts-free contacts to provide switching capability for external circuits.

3.11.1 Relay Configuration

The relays are normally in their de-energised state when there is no thunderstorm activity. The relays are configured to indicate the current thunderstorm status.

1. No Warning – No relays
2. Local Thunderstorm Warning – Relay 1 only ON
3. Local Thunderstorm Alert – Relay 2 only ON
4. Local Thunderstorm Severe Alert – Relay 3 only ON

The distance limits for each of these ranges can be set by the user if an external PC is connected to the instrument. Use the BTD Control Software, or see section 7. The defaults settings are the FAA settings of:

1. **No relays:** No thunderstorm activity, or activity > 30 Nautical Miles (NM) (55.56km)
2. **Relay 1:** Distant Thunderstorm Warning – > 10NM (18.52km) <= 30 NM (55.56km)
3. **Relay 2:** Vicinity Thunderstorm Alert – > 5 NM (9.26km) <= 10 NM (18.52km)
4. **Relay 3:** Overhead Thunderstorm Severe Alert – <= 5 NM (9.26km)

Relay 1 (Warning) will also activate if the sensor detects charged precipitation.

Relay 2 (Alert) will also activate if the sensor detects the presence of a high electric field.

3.11.2 Relay Operation

The operation of the relays can be modified by the user using an external PC running the BTD Control Software. See section 7 for commands to use if the BTD software is not available. The following parameters can be set.

Relay ON hysteresis. This defines the ON time of the relays following the occurrence of an event. This can be set to any time between 2 and 1200 seconds. The default is 900 seconds (15 minutes), to retain the alarm for 15 minutes following detection of lightning to allow the storm to recede or the instrument to detect further lightning events.

Relay Inactive Start Time. It may be a requirement for the site to prevent any thunderstorm warnings occurring between say midnight and 6.00 am. This parameter is the start time for this relay inactive period. It can be set in minutes from 0 (Midnight) to 1439 (23.59). If it is required to prevent an alarm occurring before midnight, this parameter can be set for the previous day. For example to prevent an alarm after 23.00 hrs, this should be set to 1380 minutes. The default setting is 0.

Relay Inactive Stop Time. This parameter is the stop time for this relay inactive period. It can be set in minutes from 0 (Midnight) to 1439 (23.59). The relays will not operate between the start and the stop times. For example, to activate the alarm after 6.00 hrs, this should be set to 360 minutes. The default setting is 0.

NOTE: Relay Inactive Start and Stop Times, as specified above, use the BTD instrument 'Real Time Clock', located on the internal processor circuit board. It is therefore essential to set this internal clock before making use of this relay Inactive Time Setting facility. This can be done using the BTD Control Software, or by utilising the Command Line Interface command, specified in Paragraph 7.24.

4 DATA OUTPUT

4.1 General

Once the BTD system is installed and connected to a suitable power source, it starts monitoring the electrical conditions at the site for thunderstorm activity. It sends a message via the serial data connection every 2 seconds. This data connection is either an Ethernet link (default) or an RS422 line, depending on the option selected when purchased. The data message contains details of any lightning flashes, the warning status and the system status determined over the previous 2 seconds. Up to four flashes can be detected and reported in any 2 second period.

4.2 Data Interpretation

The data can be fed into a self-contained PC, running the BTD Control software. This software, provided with each thunderstorm detector, will store the data, and process it to provide a real time display of any lightning occurrence within 45 Nautical Miles (83 km) of the site, and any potential local thunderstorm activity. See the User Manual for the BTD Control Software (Part Number: 106546) for a full description of the capabilities of this software.

Alternatively, the user can utilise the data in their own central processing system to integrate the thunderstorm warnings and alerts into an existing meteorological reporting system. The following paragraphs detail the data messages to enable such integration to be carried out by the user.

NOTE: Lightning detected at distances greater than the furthest warning threshold (45 NM maximum) are included in the data message for information, but will not activate an alert. Please be aware that lightning reported at distances exceeding the maximum warning threshold limit of 45 NM are subject to greater location uncertainty and lower detection efficiency than stated in the BTD specifications (section 8). It is therefore advised that flashes reported as exceeding 45 NM (83 km) on a calibrated BTD should not be used for thunderstorm monitoring.

If the “Warn on Second Distant Flash” option is checked in the Service Screen or through the command prompt (section 7.32), a distant thunderstorm warning will only be activated if two distant flashes are detected within the warning hysteresis time (default 15 minutes), not just one. This feature allows distant thunderstorms producing isolated or low lightning activity to be ignored (although their flashes will still be logged). The BTD will however always warn on the first flash detected in the vicinity or overhead range sectors, due to the more immediate risk they present to the site.

4.3 Data Message

The message is transmitted automatically every two seconds (default):

```
DATA:,ID,DDMMYY,HHMMSS,A,B,CC,DDDDD,DDMMYY,HHMMSS,CCC,XXXXX,      XXX,
DDMMYY,HHMMSS,CCC,XXXXX,XXX,DDMMYY,HHMMSS,
CCC,XXXXX,XXX,DDMMYY,HHMMSS,CCC,XXXXX,XXX
```

Field	Description
DATA:,	Message Header
ID,	Sensor Identification Number (value between 01-99)
DDMMYY,HHMMSS,	Current system date
A,	Number of flashes detected in the 2 second interval
B,	Warning Indicator – Integer representing warning state (details below, section Error! Reference source not found.)
CC,	Warning Flags Integer representing state of each warning indicator (corona, strongly charged precipitation, lightning etc. – details below, section Error! Reference source not found.)
DDDDD,	Self-Test Flags (details below, section Error! Reference source not found.)
DDMMYY,HHMMSS,	Date and Time of flash 1 (first flash of interval)
CCC,	Number of 10 millisecond intervals since start of period for flash 1 (for sub-second flash timing)
XXXXX,	Distance of flash 1 in decametres
XXX,	Direction of flash 1 in degrees (requires direction finder)*
DDMMYY,HHMMSS,	Date and Time of flash 2 (second flash of interval)
CCC,	Number of 10 millisecond intervals since start of period for flash 2 (for sub-second flash timing)
XXXXX,	Distance of flash 2 in decametres
XXX,	Direction of flash 2 in degrees (requires direction finder)*
DDMMYY,HHMMSS,	Date and Time of flash 3 (third flash of interval)
CCC,	Number of 10 millisecond intervals since start of period for flash 3 (for sub-second flash timing)
XXXXX,	Distance of flash 3 in decametres
XXX,	Direction of flash 3 in degrees (requires direction finder)*
DDMMYY,HHMMSS,	Date and Time of flash 4 (forth flash of interval)
CCC,	Number of 10 millisecond intervals since start of period for flash 4 (for sub-second flash timing)
XXXXX,	Distance of flash 4 in decametres
XXX,	Direction of flash 4 in degrees (requires direction finder)

Table 2: Standard Data Message

***NOTE:** If the direction is reported as '999', this indicates that the direction could not be determined for that flash, or the direction finder option is not connected.

4.3.1 Warning Indicator (B) is defined as follows:

- 0 No Warning
- 1 Warning - Charged precipitation or distant flash (default 10-30 Nautical Miles) detected. No strong electric field detected at the site
- 2 Alert – Strong electric field detected with or without Charged Precipitation or Vicinity Flash (default 5-10 Nautical Miles)
- 3 Severe Alert - Overhead flash (default <5 Nautical Miles)

If the “Warn on Second Distant Flash” option is checked in the Service Screen or through the command prompt (section 7.32), the warning indicator will only change to 1 if two flashes are detected within the warning hysteresis time (default 15 minutes), not just one.

4.3.2 Warning flags (CC)

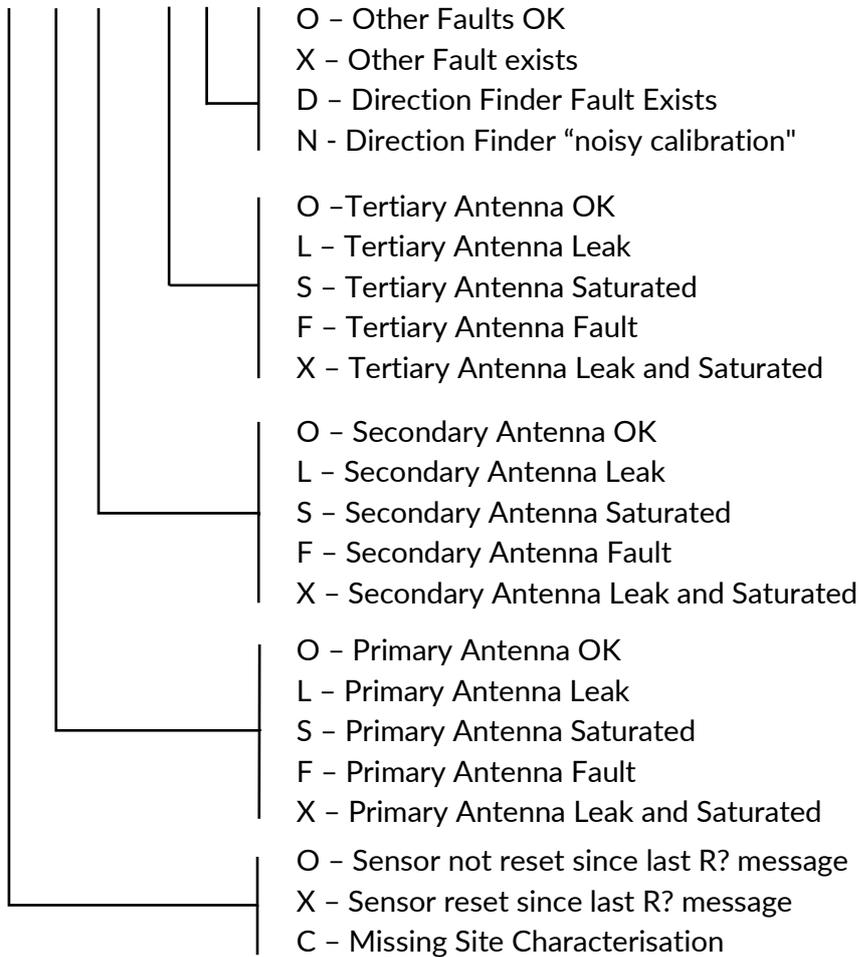
The warning flag is a 2-character decimal where individual bits have been set to correspond to certain warnings. Warnings can be combined e.g. a distant flash and charged precipitation combination will set the Warning flags to value 10.

Flag	Description of Warning
1	Corona
2	Charged Precipitation
4	Corona + Charged precipitation
8	Distant or far distant flash
16	Vicinity flash
32	Overhead flash

Table 3: Warning Flag Description

4.3.3 Self-Test Flags (DDDDD) are defined as follows:

D D D D D



4.4 Local Calibration Values

The message is transmitted if the local calibration values have been automatically updated by the sensor. The message serves as a notice that a recalibration has occurred and provides details of the calibration values used for future reference.

Note: This message will be automatically transmitted from the sensor.

LOCAL:;DDMMYY,HHMMSS,AAAAA,BBBBB,CCCCC,DDDDD

Field	Description
LOCAL:;	Message Header
DDMMYY,HHMMSS	Date and Time of last calibration
AAAAA,	Calibration Value 1
BBBBB,	Calibration Value 2
CCCCC,	Calibration Value 3
DDDDD	Calibration Value 4

Table 4: Local Calibration Message

4.5 Site Characterisation Message

The message is transmitted on completion of the site characterisation process. The message serves as a notice that a successful characterisation has occurred and provides details of the site characterisation values for future reference.

SITE:;DDMMYY,HHMMSS,±AAAA,±BBBB,±CCCC,DDDDD,EEEE,FFFF,±GGGGGGGG,HH
HHH,IIII,JJJJ,KKKKKKKKK,LLLLLLLLL,MMM,OOOO

Field	Description
LOCAL;	Message Header
DDMMYY,HHMMSS	Date and Time of last site characteristic check
±AAAA,	Site Characterisation Value 1
±BBBB,	Site Characterisation Value 2
±CCCC,	Site Characterisation Value 3
DDDDD,	Site Characterisation Value 4
EEEE,	Site Characterisation Value 5
FFFF,	Site Characterisation Value 6
±GGGGGGGG	Site Characterisation Value 7
HHHHH	Site Characterisation Value 8
IIII	Site Characterisation Value 9
JJJJ	Site Characterisation Value 10
KKKKKKKKK	Site Characterisation Value 11
LLLLLLLLL	Site Characterisation Value 12
MMM	Site Characterisation Value 13
OOOO	Site Characterisation Value 14

Table 5: Site Characterisation Message

4.6 Self-Test Message

This message is transmitted in response to the R? Command – see section 7.16:

STATUS:;DDMMYY,HHMMSS,CCC,M,AAAA,BBBB,CCCC,±DDDD,
EEEE,FFFF,GGGG,HHHH,IIII,JJJJ,KKK,LLLL,MMMMM, NNN,OOOO,PPPP,QQQQ

Field	Description	Limits
STATUS:;	Message Header	
DDMMYY,HHMMSS,	Current system date and time	
CCC,	Current centi-second internal data counter	
M,	Operating Mode (0=idle,1=sampling)	
AAAA,	2.5V voltage rail (in millivolts)	2249-2748 mv
BBBB,	1.2V voltage rail (in millivolts)	1079-1318 mv
CCCC,	+5V voltage rail (in millivolts)	4498-5497 mv
±DDDD,	-5V voltage rail (in millivolts)	-4498 - -5498 mv

EEEE,	Primary Leakage Value	0-900
FFFF,	Secondary Leakage Value	0-900
GGGG,	Tertiary Leakage Value	0-900
HHHH,	Primary Saturation Value	0-500
IIII,	Secondary Saturation Value	0-500
JJJJ,	Tertiary Saturation Value	0-500
KKK,	FPGA Status	0
LLLL	Integer representing status flag	0
MMMMM	Self-Test flags	
NNN	Integer representing Second status flag	
OOOOO,	Primary Failure Count	
PPPPP,	Secondary Failure Count	
QQQQQ,	Tertiary Failure Count	

Table 6: Self-Test Message

The Status flag (LLLL) is a 5 character decimal where individual bits have been set to correspond to certain errors.

Flag	Description of error
1	1.2V Error
2	2.5V Error
4	+5V Error
8	-5V Error
16	Primary Antenna Leak
32	Secondary Antenna Leak
64	Tertiary Antenna Leak
128	Primary Antenna Saturation
256	Secondary Antenna Saturation
512	Tertiary Antenna Saturation
1024	PIC Health Error
2048	FPGA Health Error
4096	EEPROM Checksum Error
8192	Sensor Reset since last R?
16384	Direction Finder Error
32768	Unused

Table 7: Status Flag Description

The antenna leakage fault is activated if the system suspects a leakage current, which diverts the signal past the amplification stage. This may be caused by an insulation failure, so in the event of this fault it is advisable to check the insulators are clean and free of any debris which may allow the current on the antenna to pass directly to ground. Antenna saturation occurs when current exceeding approximately 200nA is passed from the antenna to the amplifier for at least a few seconds. This may occur as a result of an ungrounded charged object in contact with the antenna.

The Second Status flag (NNN) is a 3 character decimal where individual bits have been set to correspond to certain errors.

Flag	Description of error
1	Primary Antenna Fault
2	Secondary Antenna Fault
4	Tertiary Antenna Fault
8	Missing Site Characterisation

Table 8: Second Status Flag Description

The antenna fault is activated when the unit detects an anomaly with the front end amplifier, such as continuous saturation, which indicates the amplifier may have developed a fault or been damaged and needs to be replaced.

The self-test flags (MMMMM) are described in section 4.3.3.

4.7 Sensitivity Level Message

This message is transmitted in response to the LEVEL? Command – see section 7.12. The threshold sensitivity ranges from 0 (most sensitive) to 10 (least sensitive).

LEVELS:;AA,BB,CC,DD,EE,FF

Field	Description	#Bytes
LEVELS:;	Message Header	7
AA,	SNR Sensitivity Level (0-10)	3
BB,	P:S Ratio Sensitivity Level (0-10)	3
CC,	P:T Ratio Sensitivity Level (0-10)	3
DD,	Charged Precipitation Sensitivity Level (0-10)	3
EE,	Electric Field Sensitivity Level (0-10)	3
FF	Direction Finder Amplitude Sensitivity Level (0-10)	3

Table 9: Sensitivity Level Message

4.8 Distance Limit Message

This message is transmitted in response to the DIST? Command – see section 7.1

DIST:;AAAAA,BBBBB,CCCCC,DDDDD

Field	Description	#Bytes
DIST:;	Message Header	6
AAAAA,	Overhead Lightning Limit in decametres	6
BBBBB,	Vicinity Lightning Limit in decametres	6
CCCCC,	Near Distant Lightning Limit in decametres	6
DDDDD,	Far Distant Lightning Limit in decametres	6

Table 10: Distance Limit Message

4.9 Relay Parameters Message

This message is transmitted in response to the RELAY? Command – see section 7.17. The values reported are the values stored in NVRAM.

RELAY:;AAA,BBB,CCCC,DDDD

Field	Description	#Bytes
RELAY:;	Message Header	7
AAA,	Relay On Hysteresis Time (seconds)	4
BBB,	For Future Use	4
CCCC,	Relay Inactive Start Time (minutes from midnight)	5
DDDD	Relay Inactive Stop Time (minutes from midnight)	4

Table 11: Relay Parameter Message

4.10 Real Time Clock Message

The Real Time Clock message (RTC?) displays the current date and time from the RTC chip on the sensor.

The format is:

RTC:;AAAAAAAAAA,DD\MM\YY,HH:MM:SS,ccc

Field	Description	#Bytes
RTC:;	Message Header	5
AAAAAAAAAA,	Day of the Week e.g. Monday	12
DD\MM\YY,	Date – in form Day(1..31)\Month(1..12)\ Year (0..99)	9
HH:MM:SS,	Time – in form Hour(0..23):Min(0..59):Second(0..59)	9
ccc	Calibration factor (0..255)	3

Table 12: Real Time Clock Message

4.11 Hysteresis Time Message

This message is transmitted in response to the HYST? Command – see section 7.10

HYSTERESIS:;AAAAA, BBBBB

Field	Description	#Bytes
HYSTERESIS:;	Message Header	12
AAAAA,	Relay On Hysteresis Time (Seconds)	6
BBBBB	Warning Hysteresis Time (Seconds)	5

Table 13: Hysteresis Time Message

4.12 Distant Warning Message

This message is transmitted in response to the W? Command – see section 7.31

WARNING:,AA,BBBBB

Field	Description	#Bytes
WARNING:,	Message Header	9
AA,	Number of flashes per Warning	3
BBBBB	Warning Hysteresis Time (Seconds)	5

Table 14: Distant Warning Message

5 CALIBRATION

5.1 Site Characterisation

When the BTD is installed at a site it is necessary for it to determine the background variability of electric field changes present at the site in order to identify anomalies associated with thunderstorm activity. Additionally, antenna offsets are measured during the site calibration so they can be removed by the detector in data processing. Site characterisation is performed automatically by the BTD once the user presses the “perform site characteristics” button in the configuration screen of the control software. If the control software is not being used, the site characterisation is initiated using the command line interface (see section 7.9). This can only be performed when the detector is not sampling.

Ensure that there is no precipitation, local thunderstorm activity or movement of people or animals within ~10m during the site characterisation procedure. Once the characterisation process is activated there is a 60 second delay before the calibration is performed to allow all persons to retreat away from the detector by least 10 m to avoid incorrect characterisation caused by nearby movement. The characterisation takes approximately 32 seconds, where antenna offsets and ambient variability are measured. The sensor will begin sampling again automatically 10 seconds after characterisation is complete.

5.2 Flash Detection and Ranging

The BTD is shipped with a flash detection and ranging calibration assuming installation at an ideal site (subsection 3.1). The detector monitors all signals with similar characteristics to lightning and decides whether the current flash detection calibration constants are still appropriate. The detector will automatically re-calibrate if the constants do not appear appropriate for the site and inform the user it has performed a successful calibration.

Lightning proximity alert distances can be customised using the service tab of the BTD control software or via the command line interface (section 7.3). These distances can be stated in either kilometres or nautical miles using the control software, or decametres (1 km = 100 decametres) using the command line interface. The default lightning proximity levels are those required by the US Federal Aviation Authority (FAA). The range thresholds can be stated to the nearest decametre (10 metres, i.e. two decimal places) and must be within 2-45 nautical miles (3.70-83.34 km).

The flash detection sensitivity can be adjusted through the command line or the control software using two characteristics - lightning strength (effectively the signal-to-noise ratio) and lightning ratio. In the control software this is achieved by altering the relevant thresholds in the service tab (default setting is midway – level 5). If the control software is not used, sensitivities are altered using the command line interface (see section 7.13). The threshold sensitivity ranges from 0 (most sensitive) to 10 (least sensitive). Alteration of the sensitivities should only be attempted by users competent in the operation of the detector since some combinations may significantly reduce overall performance. Increasing the lightning strength sensitivity will increase the probability that distant and/or weak flashes are detected, at the increased risk of producing false alarms from non-lightning signals. The lightning ratio represents the balance between ensuring all lightning flashes are detected whilst retaining a very low false alarm rate. Increasing the sensitivity of this parameter will widen the signal acceptance band and reduce the probability of missing a flash, although increasing the chance of a false alert. The default (midway) position is considered optimal for most purposes, so should not normally be changed. More information on the flash detection and ranging process can be found in section 9.1 of the appendix.

5.3 Lightning Range Calibration

The range calibration cannot be automatically configured so needs to be checked by the user. The default calibration should be correct for installation at an ideal site, but is likely to require modification if installed where tall objects are nearby. Once the BTD first reports the range of lightning after installation, the user should compare this range with that determined from other means (e.g. accurate lightning location network data, thunderstorm location on rainfall radar or satellite imagery). The last 128 flash times and distances detected by the BTD can be downloaded in CSV format by pressing the “download flash data” button in the configuration screen of the control software. The format of the output message is described in the BTD control software manual and is particularly useful when calibrating a BTD that is not routinely connected to a PC (e.g. using relays to activate warning lights/sirens directly) or if the data message is not being logged. If a systematic bias is evident, the user should press the “Calculate Site Correction Factor” button and input the range estimated by the BTD (“Reported Distance”) and that from other means (“Actual Distance”) into the pop-up box. This information will be used by the software to set the range calibration factor for the installation site. The range calibration cannot be set using the command line interface, so the control software will be required to perform this procedure.

5.4 Overhead Thunderstorm Development Sensitivity

It is possible to alter the sensitivity of the BTD for the presence of overhead thunderstorm potential (charged precipitation and strong electric field) in the same way as for flash detection, through the control software or command line interface. For the control software, this is achieved by altering the thresholds in the service tab of the control software (default setting is midway – level 5). If the control software is not used, sensitivities are altered using the command line interface (see section 7.13). The threshold sensitivity ranges from 0 (most sensitive) to 10 (least sensitive). Increasing the sensitivity to precipitation charge means that less electrical charge is required on each hydrometeor to activate an alert, although the requirement for relatively high precipitation intensity remains the same (see appendix section 9.2). Increasing the sensitivity to strong electric field will lower the field strength required to activate an alert, detected by the antennas through the use of the installed corona initiator spikes (see appendix section 9.3), as well as other sources of electric field variability near to the detector present during stormy conditions.

Increasing either of these sensitivities will also increase the probability that charged particles present in nearby turbulent eddies will activate an overhead thunderstorm development alert. Charged particles present in the air (referred to as “space charge”) is also an indicator of the electrical state of the atmosphere, with the formation of ions near the surface resulting from charged precipitation and corona (point) discharge during strong atmospheric electric fields. These ions become attached to aerosol particles and are blown past the detector where they can be analysed by the antennas. Space charge can also be generated by man-made activities such as nearby air-conditioning units, water jet washing or exhaust gasses from nearby combustion engines. The BTD control algorithms are designed to reject such artificial sources, although a substantial increase of the sensitivity thresholds will increase the probability of non-thunderstorm space charge sources generating a false alarm.

Alteration of any sensitivity threshold should only be attempted by users competent in the operation of the detector, since inappropriate levels will degrade performance. If in doubt, please contact Senseca for advice on the most appropriate sensitivity levels for your requirements.

6 MAINTENANCE

The BTD is designed to withstand harsh weather conditions and requires very little maintenance. The antennas are constructed from stainless steel and will not corrode under normal operation. The framework is painted aluminium with good resistance to corrosion. The PTFE insulators are resistant to adhesion of impurities, chemically inert and offer high resistance to extreme atmospheric temperatures and ultraviolet radiation.

As a precaution, monitoring the automatic system fault status should be conducted as often as possible (ideally every day). The BTD system fault status is identified in the data output message and in the configuration screen of the supplied software. For BTD units not connected to a computer interface, the fault status can be identified by the green LED on the side of the instrument enclosure box. A static green light signifies no fault is detected, with a flashing light identifying a fault has been detected and the unit is not operating correctly, requiring prompt investigation. No light means that the unit is not supplied with power and is therefore not operating.

The following checks are advised upon installation and at least once per year thereafter, ideally before the start of the season where most thunderstorms occur:

- Visual check on cables and cable glands, ensuring no degradation of electrical insulation.
- Visual check on all metalwork, corona initiators (BTD-300 only) and electronics enclosure box, to identify any degradation or physical defects which may compromise the correct operation of the unit.
- Cleaning of the antennas and their insulators to remove any accumulated dirt, vegetation, spider's webs or other material which may provide a leakage current between the antennas and ground. Ensure that any cleaning agents used will not leave a residue on the surface of the antennas and especially the insulators.
- In corrosive environments light corrosion may appear on the antennas, this has no impact on the operation of the sensor. Remove the corrosion with a light abrasive material, such as Scotch-Brite, and apply a thin coat of a light oil to the metallic surfaces.
- Identification and removal of vegetation or other objects which exceed the recommended height for their distance to the unit (see section 3.1).
- Check that all the site requirements stated in section 3.1 are still upheld at the installation site.
- If possible, check the insulator heaters are still operating by identifying that the temperature near the middle of the grooved insulator cylinder behind the rain shield is at least 1°C (typically 5°C) warmer than the surrounding air temperature. A picture showing the location of the inner grooved insulator block is provided in Figure 14.
- Check the detector's date and time setting using the "get BTD date/time" button found in the configuration screen in the BTD control software, or using the command line interface (see section 7.22). Set to correct time if necessary, by pressing the "set BTD date/time button, which will sync the internal time to the time on the connected computer, or using the command line interface (see sections 7.23 and 7.24). This is important since the flash and warning status times are logged using the BTD internal time, not the server time.
- Once the sensor is cleaned and any modifications to the site have been made, a site characterisation should be performed (see section 5.1).
- Check that the site correction factor has not changed significantly by comparing the thunderstorm range given by the BTD to the range estimated from other means e.g. radar, high resolution satellite imagery or accurate lightning location network output. If a

significant and systematic difference is identified the site correction factor can be changed by following the process described in section 5.3.

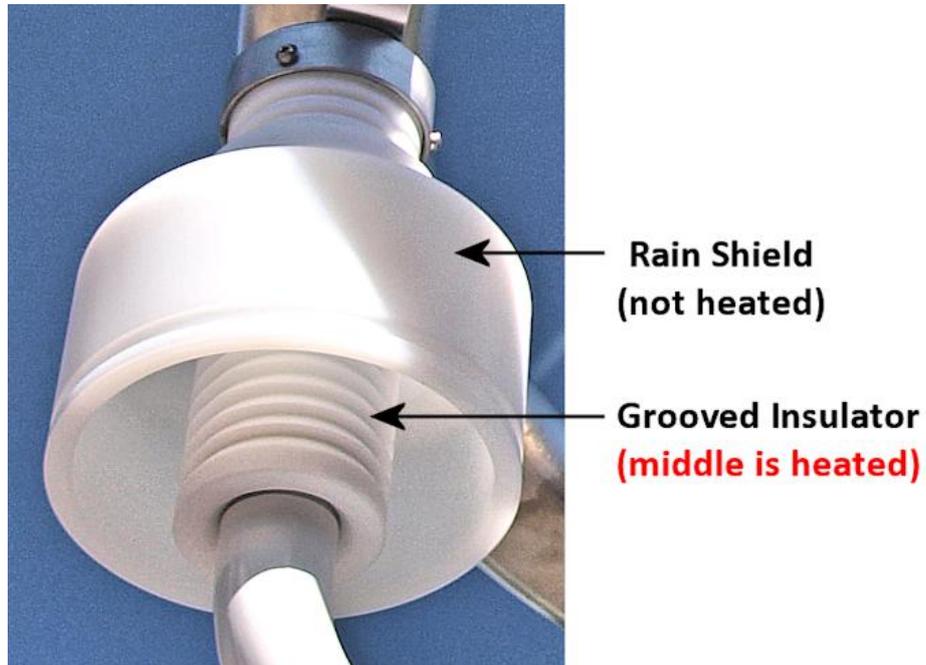


Figure 14: Antenna insulator unit (BTD-300 shown)

Showing the location of the unheated outer rain shield and inner heated grooved insulator block.

7 COMMAND LINE INTERFACE

These commands are used to change parameters of a more technical nature or in the absence of the BTD control software. If an invalid command is detected it will be rejected and the sensor will respond with "BAD CMD".

7.1 DISTDEF – Set Distance Defaults

This command is for service personnel only.

The command will reset the flash distance limits to the default FAA values of:

- Overhead lightning - 5 Nautical miles or 9.26 Km.
- Vicinity Lightning – 10 Nautical miles or 18.52 Km.
- Near Distant lightning – 20 Nautical miles or 37.04 Km.
- Far Distant Lightning – 30 Nautical miles or 55.56 Km.

This command is only allowed when the sensor is idle, if the sensor is in sampling mode the sensor will respond with "COMMAND NOT ALLOWED".

If the command is allowed, the Sensor will respond with "OK".

7.2 DIST? – Get Distance Limits

This command is for service personnel only.

Return the distance limits in decametres for the different areas.

If the command is allowed, the Sensor will respond with the distance limit message.

Details of the message are in section 4.8.

7.3 DISTx,yyyy – Set Distance Limits

This command is for service personnel only.

Set the distance limit in decametres for the different areas:

Setting x indicates which area to set the limit for:

- 0 – Overhead lightning.
- 1 – Vicinity Lightning.
- 2 – Near Distant lightning.
- 3 – Far Distant Lightning.

Parameter y is the value in decametres.

This command is only allowed when the sensor is idle, if the sensor is in sampling mode the sensor will respond with "COMMAND NOT ALLOWED".

If the command is allowed, the Sensor will respond with "OK".

7.4 DFENABLE? – Get Direction Finder Enable State

This command is for service personnel only.

Return the state of the Direction Finder enable EEPROM location.

Returned value will be either 0 or 1 (0 indicates not fitted, 1= fitted).

This command is only allowed when the sensor is idle, if the sensor is in sampling mode the sensor will respond with "COMMAND NOT ALLOWED".

7.5 DFSTAT? – Get Direction Finder Status

Return the Direction Finder Status.

This command is only allowed when the sensor is idle, if the sensor is in sampling mode the sensor will respond with "COMMAND NOT ALLOWED".

7.6 DF-OFFSET? – Get Direction Finder Angle Correction Factor offset

This command is only allowed when the sensor is idle, if the sensor is in sampling mode the sensor will respond with "COMMAND NOT ALLOWED"

The DF-OFFSET? command causes the Angle correction factor offset (in degrees, positive clockwise, negative anticlockwise) to be displayed as follows:

OFFSET: <value>

e.g. OFFSET: -5

7.7 DF-OFFSETxxxx – Set Direction Finder Angle Correction Factor offset

This command is only allowed when the sensor is idle, if the sensor is in sampling mode the sensor will respond with "COMMAND NOT ALLOWED"

This command will set the correction factor offset

xxxx can be in the range ± 180 degrees (positive clockwise, negative anticlockwise). Any values outside this range will cause the sensor to respond BAD-VALUE.

If the value is acceptable, the Sensor will change the value and respond with "OK"

7.8 DF-PV? – Get Direction Finder Program Version

When a "DF-PV?" command is received the sensor calls the routine to build and transmit the Program Version and date in the form

SI100xxx.01A, 09/01/2012

7.9 DOSITE – Start Site Characterisation Process

This command will start the site characterisation process.

If the command is acceptable, the sensor will respond with "OK".

This command is only allowed when the sensor is idle, if the sensor is in sampling mode the sensor will respond with “COMMAND NOT ALLOWED”.

7.10 HYST? – Get Hysteresis Times

This command is for service personnel only.

This command will return the relay and warning hysteresis times in seconds. Details of the message are in section 4.11

This command is only allowed when the sensor is idle, if the sensor is in sampling mode the sensor will respond with “COMMAND NOT ALLOWED”

7.11 HYSTxxxx – Set Hysteresis Times

This command is for service personnel only.

This command will set the relay and warning hysteresis times in seconds.

xxxx –hysteresis time

The time can be set to a value between 2 and 1800 seconds. Attempting to set the time outside these limits will result in a "BAD CMD" and the entry will be discarded.

If the command is acceptable, the sensor will respond with “OK”

This command is only allowed when the sensor is idle, if the sensor is in sampling mode the sensor will respond with “COMMAND NOT ALLOWED”

NOTE: This will set both times to the same value.

7.12 LEVEL? – Get Sensitivity Levels

This command is for service personnel only.

This command will cause the sensor to transmit the sensitivity Level message to the host.

If the command is allowed, the Sensor will respond with the sensitivity level message.

Details of the message are in section 4.7.

The threshold sensitivity ranges from 0 (most sensitive) to 10 (least sensitive).

7.13 LEVELAA,BB,CC,DD,EE,FF – Set Sensitivity Levels

This command is for service personnel only.

This command receives the new sensitivity levels from the host.

This command is only allowed when the sensor is idle, if the sensor is in sampling mode the sensor will respond with “COMMAND NOT ALLOWED”.

If the command is allowed, the Sensor will respond with “OK”.

The threshold sensitivity ranges from 0 (most sensitive) to 10 (least sensitive).

Parameters:

- AA – Lightning “strength” (SNR) sensitivity Level (range 0-10).
- BB – PS Ratio sensitivity Level (range 0-10).
- CC – PT Ratio sensitivity Level (range 0-10).
- DD – Charged Precipitation sensitivity Level (range 0-10).
- EE – Electric Field sensitivity Level (range 0-10).
- FF – Direction Finder sensitivity Level (range 0-10).

7.14 LOCAL? – Get Local Calibration Values

This command will cause the sensor to transmit the local calibration values to the host. Details of the message are in section 4.4.

7.15 PV? – Get Program Version

When a "PV?" command is received the sensor transmits the Program Version and date in the form: SI100xxx.01A, 09/01/2012.

7.16 R? – Self-Test Message

When an "R?" command is received the sensor transmits the Self-Test Message. Details of the message are in section 4.6.

7.17 RELAY? – Get Relay Information

When a “RELAY?” command is received the sensors transmits the Relay Parameters Message. Details of the message are in section 4.9.

7.18 RHOxxx – Relay On Hysteresis Time

This command is used to set the Relay On Hysteresis time in seconds. The current setting can be determined by reading the first field of the Relay Parameters Message. The time can be set to a value between 2 and 1800 seconds. Attempting to set the time outside these limits will result in a "BAD CMD" and the entry will be discarded.

If the command is acceptable, the sensor will respond with “OK”.

This command is only allowed when the sensor is idle, if the sensor is in sampling mode the sensor will respond with “COMMAND NOT ALLOWED”.

7.19 RINOxxxx – Relay Inactive Start Time

This command is used to set the Relay Inactive Start time in minutes from midnight. The current setting can be determined by reading the third field of the Relay Parameters Message. The

time can be set to a value between 0 and 1439 minutes. Attempting to set the time outside these limits will result in a "BAD CMD" and the entry will be discarded.

If the command is acceptable, the sensor will respond with "OK".

This command is only allowed when the sensor is idle, if the sensor is in sampling mode the sensor will respond with "COMMAND NOT ALLOWED".

7.20 RINxxx – Relay Inactive Stop Time

This command is used to set the Relay Inactive Stop time in minutes from midnight. The current setting can be determined by reading the fourth field of the Relay Parameters Message. The time can be set to a value between 1 and 1440 minutes. Attempting to set the time outside these limits will result in a "BAD CMD" and the entry will be discarded.

If the command is acceptable, the sensor will respond with "OK".

This command is only allowed when the sensor is idle, if the sensor is in sampling mode the sensor will respond with "COMMAND NOT ALLOWED".

7.21 RST – Reset Command

When an "RST" command is received the sensor is reset.

7.22 RTC? – Get Date and Time

When an "RTC?" command is received the sensor transmits the Real Time Clock Message. Details of the message are in section 4.10.

7.23 RTCDATEW,DD,MM,YY – Set Real Time Clock Date

This command allows the user to change the date on the Real Time Clock chip.

The format of the command is :

RTCDATEW,DD,MM,YY

where:

W - is the day of the week (1..7) with Sunday being 7.

DD - is the date (01..31).

MM - is the month (01..12).

YY- is the year (00..99).

The sensor will respond with 'OK'.

7.24 RTCTIMEHH,MM,SS – Set Real Time Clock Time

This command allows the user to change the time on the Real Time clock chip.

The format of the command is:

```
RTCTIMEHH,MM,SS
```

where:

HH - is the hours in 24 hour clock (00..23).

MM - is the minutes (00..59).

SS - is the seconds (00..59).

The sensor will respond with 'OK'.

7.25 RUN – Start normal sampling

This command begins the normal sampling mode.

If the command is acceptable, the sensor will respond with "OK".

This command is only allowed when the sensor is idle, if the sensor is in sampling mode the sensor will respond with "COMMAND NOT ALLOWED".

7.26 SCF? – Query Site Correction Factor

When an "SCF?" command is received the sensor transmits the current site Correction Factor in the form:

```
SCF,xx.xxx
```

This command is only allowed when the sensor is idle, if the sensor is in sampling mode the sensor will respond with "COMMAND NOT ALLOWED".

7.27 SCFxx.xxx – Set Site Correction Factor

When this command is received the sensor updates the current site Correction Factor in the sensor.

The number xx.xxx will be a floating point number.

If the value is acceptable, the Sensor will respond with "OK".

Changing this value will change the value in the EEPROM and all associated internal variables in the sensor.

This command is only allowed when the sensor is idle, if the sensor is in sampling mode the sensor will respond with "COMMAND NOT ALLOWED".

7.28 SN? – Query Serial Number

When an "SN?" command is received the sensor transmits the sensor serial number– this is a 12 character string.

7.29 SITE? – Get Site Characteristics

When a "SITE?" command is received the sensor transmits the Site Characteristics Message. Details of the message are in section 4.5.

7.30 STOP – Stop Sampling

This command will stop the sampling process and put the sensor into Idle Mode.

If the command is acceptable, the sensor will respond with "OK".

This command is only allowed when the sensor is sampling, if the sensor is in idle mode the sensor will respond with "COMMAND NOT ALLOWED".

7.31 W? – Get Distant Flash Warning Parameters

This command is for service personnel only.

This command gets the number of warning flashes and the hysteresis time. Details of the message are in section 4.12

This command is only allowed when the sensor is idle, if the sensor is in sampling mode the sensor will respond with "COMMAND NOT ALLOWED"

7.32 Wx,yyyy? – Set Distant Flash Warning Params

This command is for service personnel only.

This command sets the number of warning flashes and the hysteresis time from the PC.

x Number of flashes – can be 1 or 2

yyyy Hysteresis time in seconds – value between 2 and 1800 seconds

This command is only allowed when the sensor is idle, if the sensor is in sampling mode the sensor will respond with "COMMAND NOT ALLOWED"

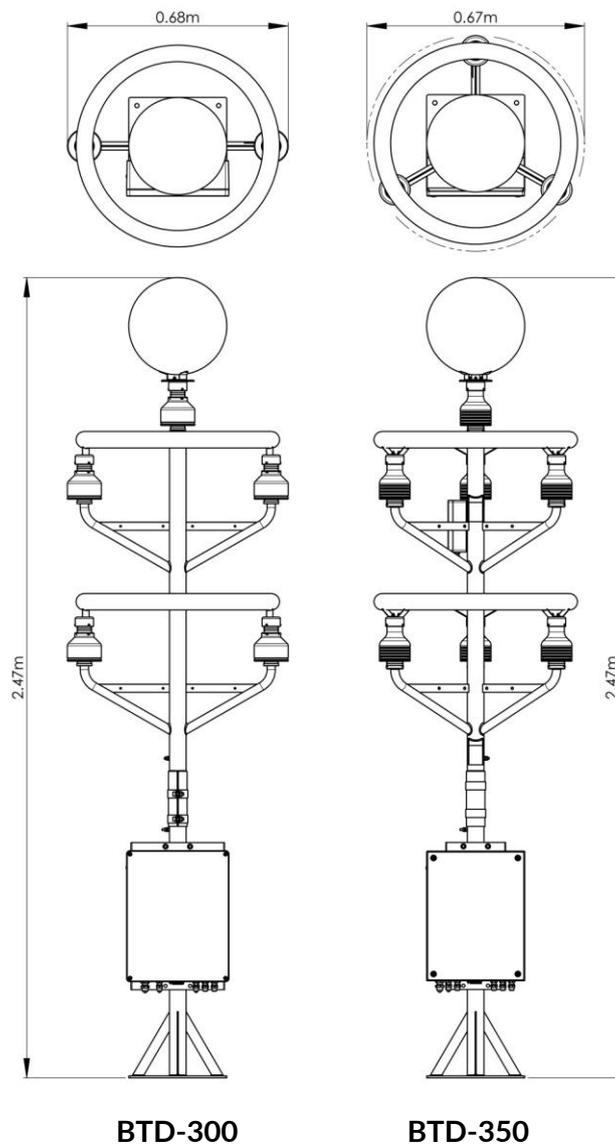
8 SPECIFICATIONS

8.1 Specification for the Basic BTD Instrument

Sensor	BTD-3XX
Maximum reporting range	83 km (45 nautical miles), reported to nearest 0.01 km
Customisable lightning proximity alerts?	Yes, four proximity alert ranges can be chosen between 2-45 nautical miles (3.70-83.3 km) (FAA regulations as default)
Flash detection efficiency	>95% for single lightning flash (any type) 99% for storm with 2 flashes 99.9% for storm with 3 flashes For flashes within 56 km (30 nautical miles)
False alarm rate	<2%
Flash range measurement uncertainty	±3 NM between a range of 0-10 NM and ±5.5 NM between 10-45 NM
Flash range measurement repeatability	±300 m between a range of 0-10 NM and ±1000 m between 10-45 NM
Flash types detected and ranged	All types – cloud-to-ground (CG), intra-cloud (IC), cloud-to-cloud (CC)
Flash polarity, multiplicity and type reporting?	No
Direction finding	Yes, reported to nearest degree (requires optional module)
Update period	2s
Report time of each flash	Yes, to nearest 10 ms
Maximum detectable flash rate	120 flashes per minute
Automatic self-checking	Yes
Detection method	Passive, quasi-electrostatic (RF for optional direction finder)
Operating (listening) frequency	1-47 Hz for the main unit. The optional direction finder receiving band is ~30 kHz to 2 MHz
Filter for RF interference	Analog front end with additional digital filtering
Additional environmental monitoring	Overhead Cumulonimbus warning via detection of strong electric field and charged precipitation
Operating environment	Designed to meet US FAA harsh weather conditions (FAA class 2) Temperature: -55°C to +60°C (below -40°C requires optional enclosure heater) Relative humidity: 5% to 100% condensing Wind: Up to 85 kt (44m/s)
Power supply	85-264V AC supply 47 – 63 Hz

Power consumption	<10W (excluding optional 30W enclosure heater)
IP rating	IP66
Connections	Ethernet (default) or RS422
External indicators	Status LED
Interface	Computer, with option for additional relay outputs (x3)
Visualisation software	Included for use on PC computer systems
Approx. Weight	25 Kg
Installation site	Outdoors only, no overhead obstructions

8.2 Dimensions of the BTD-300 and BTD-350



BTD-300

BTD-350

(all dimensions are approximate)
Figure 15: BTD Dimensions

8.3 Specification for the Optional Relay Contacts

BTD Relay Specification	
Maximum Switching Voltage	250 Vac, 220Vdc
Maximum Switching Current	2A
Maximum Carrying Current	2A
Maximum Switching Power	60W, 125VA

NOTES

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WARRANTY

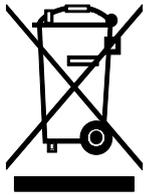
The manufacturer is required to respond to the "factory warranty" only in those cases provided by the Consumer Rights Act 2015. Each instrument is sold after rigorous inspections; if any manufacturing defect is found, it is necessary to contact the distributor where the instrument was purchased from. During the warranty period (12 months from the date of invoice) any manufacturing defects found will be repaired free of charge. Misuse, wear, neglect, lack or inefficient maintenance as well as theft and damage during transport are excluded. Warranty does not apply if changes, tampering or unauthorized repairs are made on the product.

The manufacturer repairs the products that show defects of construction in accordance with the terms and conditions of warranty included in the manual of the product.

TECHNICAL INFORMATION

The quality level of our instruments is the result of the continuous product development. This may lead to differences between the information reported in the manual and the instrument you have purchased. We reserve the right to change technical specifications and dimensions to fit the product requirements without prior notice.

DISPOSAL INFORMATION



Electrical and electronic equipment marked with specific symbol in compliance with 2012/19/EU Directive must be disposed of separately from household waste. European users can hand them over to the dealer or to the manufacturer when purchasing a new electrical and electronic equipment, or to a WEEE collection point designated by local authorities. Illegal disposal is punished by law.

Disposing of electrical and electronic equipment separately from normal waste helps to preserve natural resources and allows materials to be recycled in an environmentally friendly way without risks to human health.



senseca.com



Senseca UK Ltd.
Unit 8 Harbour Road Trading Estate
Portishead, Bristol
BS20 7BL
UK
info.bristol@senseca.com

