BTD-300

Thunderstorm Detector

USER MANUAL

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This manual describes the installation and operation of the Biral thunderstorm detector BTD-300 and should be read **fully** before the instrument is used.

If there are any questions about the equipment supplied or the instructions contained within this manual please consult Biral at the above address.

To assist Biral in the event of questions could you please indicate the equipment type (and serial number if applicable), nature of your question, approximate number of hours in use and your return contact details.

Copyright Declaration

This manual does not create nor include any legally binding obligation for Biral or its customers and end users. This documentation (and any attached appendices) is for customer information only.

All information contained in this manual is correct (to the best knowledge of Biral) at the time of publication. Biral reserves the right to revise this manual without notification.

The Equipment is CE marked and as such is deemed safe for use under normal operating conditions. Failure to comply with these conditions may result in personal injury not covered by the CE classification.

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1 LIGHTNING SAFETY

The BTD-300 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-300 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-300 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-300 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-300 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-300 warning end times after the last trigger has been received.

2 PRODUCT DESCRIPTION

The Biral Thunderstorm Detector BTD-300 is a standalone sensor 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-300 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-300 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-300 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-300 antenna array. For a comprehensive description of the underlying scientific principles used by the BTD-300 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-300 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 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 analog 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 3.8).

The function of the corona initiator spikes 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.

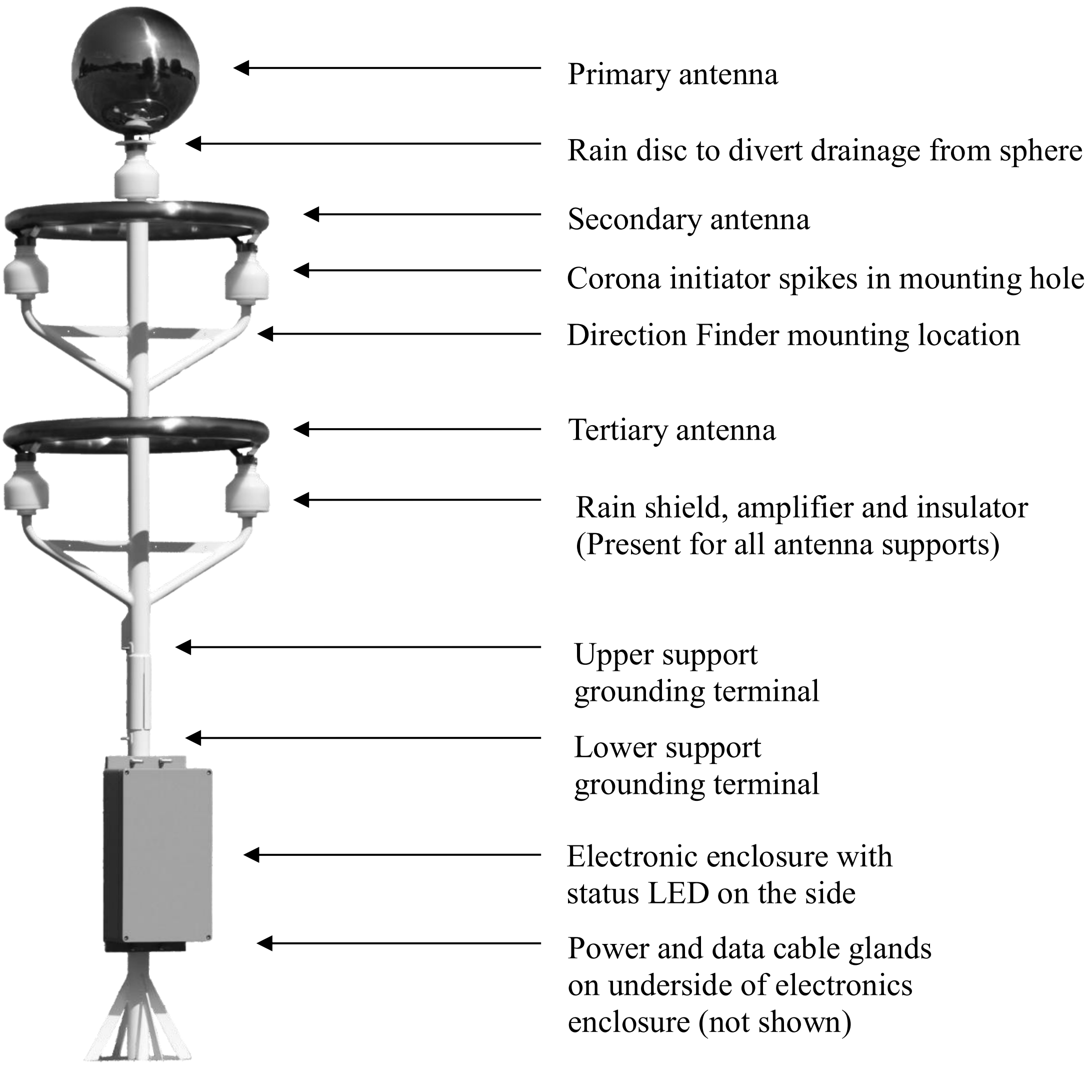


Figure 1: Main components of the BTD-300.

3 INSTALLATION

3.1 Site Selection

It is very important for the successful operation of the BTD-300 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 (including vegetation) within 2 m of the sensor higher than approximately 20 cm.
- 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 on the next page.

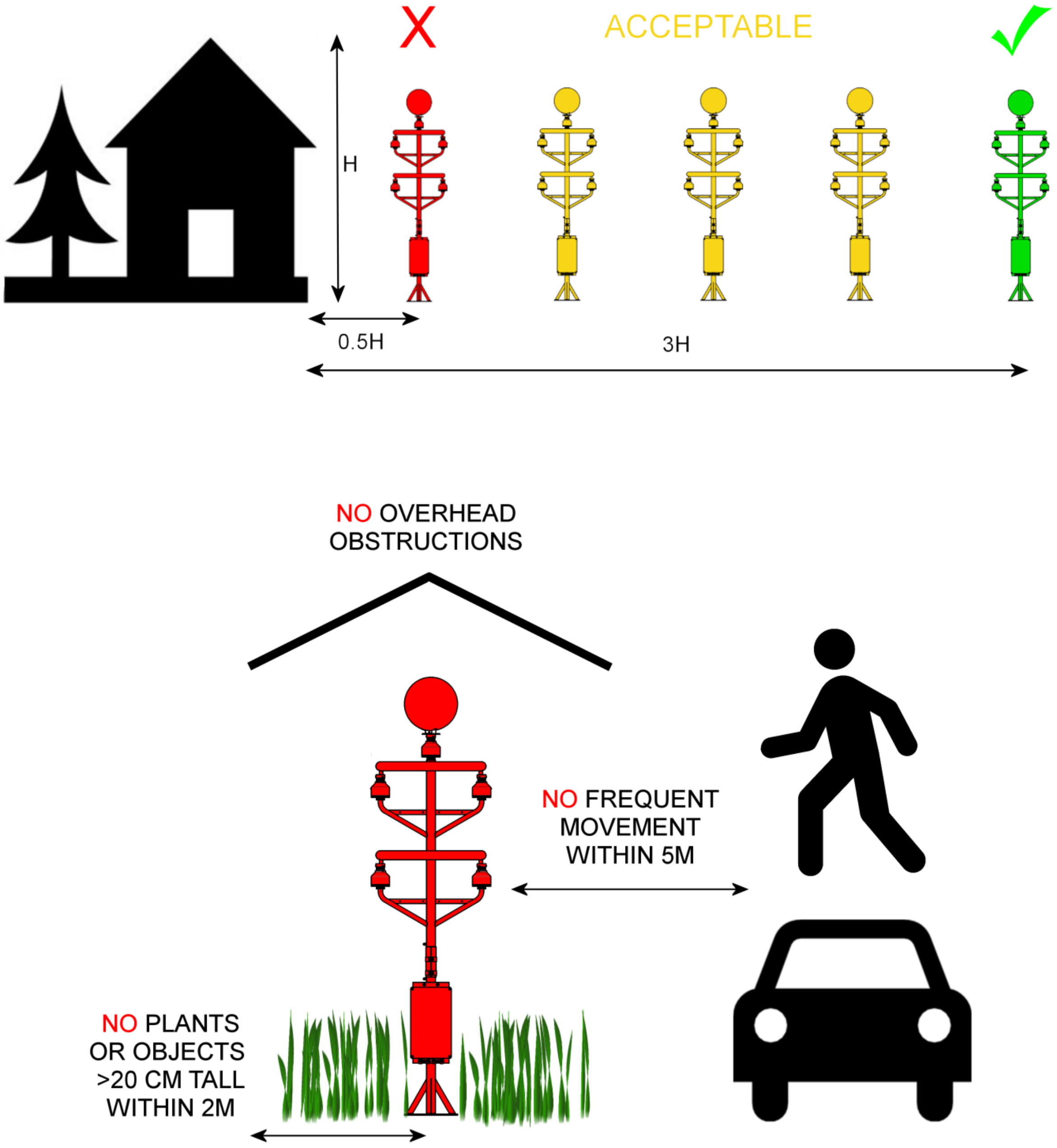


Figure 2: Site suitability considerations

Once a suitable site is selected, the BTD-300 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 Biral 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-300 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.

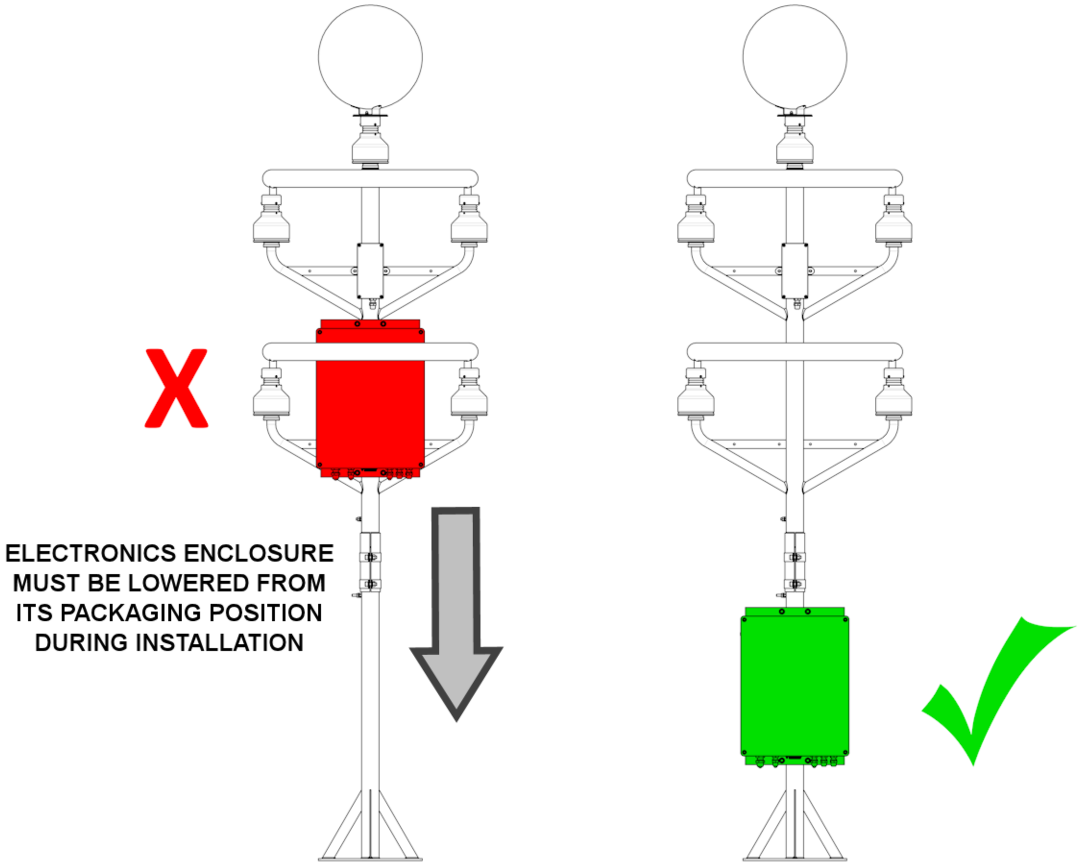


Figure 3: Lowering of electronics enclosure box from its temporary packaging position

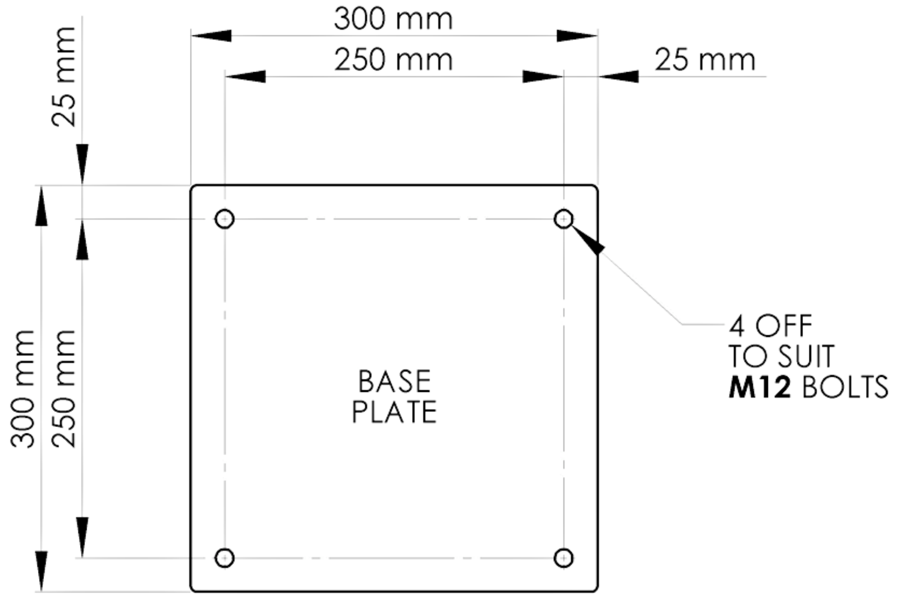


Figure 4: BTD-300 base plate dimensions

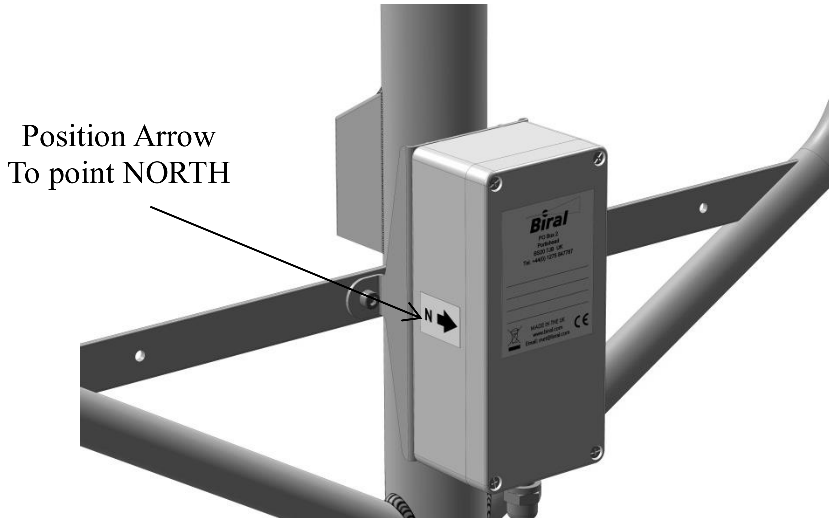


Figure 5: NORTH pointing arrow on Optional Direction Finder.

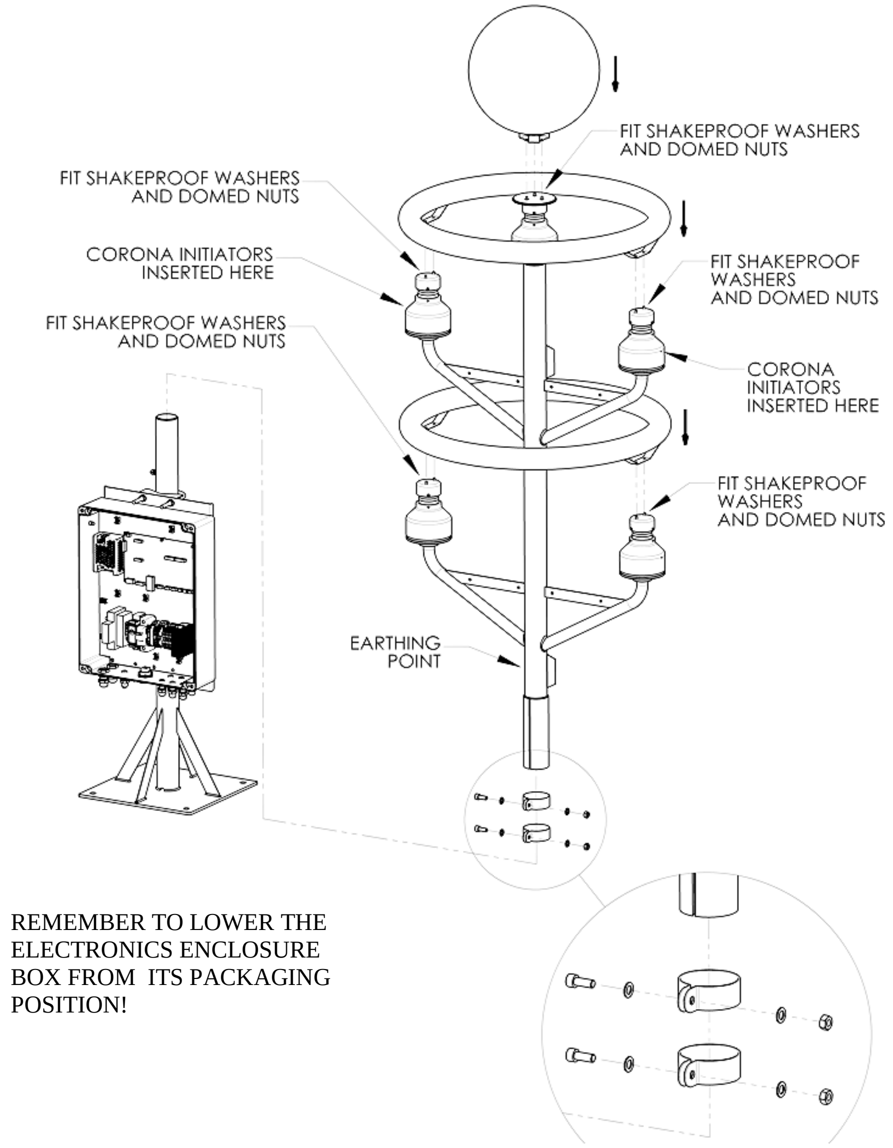


Figure 6: BTD-300 assembly instructions

3.2 Tools Required for Assembly

The following special tools are required for assembly of the BTD-300 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) is identified and not discarded with the packaging. It is advised to insert the corona spikes at the end of the assembly process to reduce the chance of injury to the installers (the spikes are sharp), or damage to the spikes themselves. The spikes have a small hook at one end, which should be inserted into the small hole on the outside of the rain shield (see Figure 7). The hook will secure the spike inside the hole. The spike will still be free to move slightly perpendicular to the hole axis, which does not reduce the spike's performance. The BTD-300 requires two corona spikes; one should be inserted in both of the rain shields supporting the secondary (upper) torus antenna.

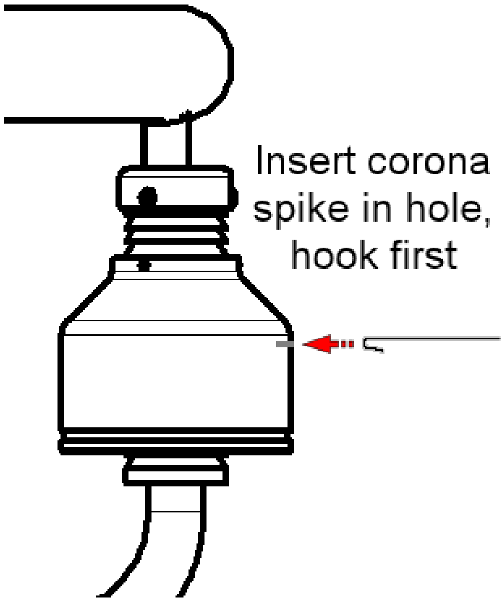


Figure 7: Insertion of a corona spike into one of the rain shields.

These spikes should be allowed to point roughly horizontal away from the unit. Care should be used once the spikes are installed, since they are sharp. Please note that any modification to the BTD-300 support structure or antennas not provided by Biral, such as the introduction of bird spikes, should not be undertaken without prior consultation with Biral, since the unit's geometry is a key factor in maintaining the detection performance.

3.4 Direction finder angle offset

If the (optional) 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-300 control software service screen or via the command line interface (sections 7.6 and 7.7). Angle offsets may be large (±20°) 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 BTD-300 accepts an 80 – 264 AC power supply at 47 – 64 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, 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.

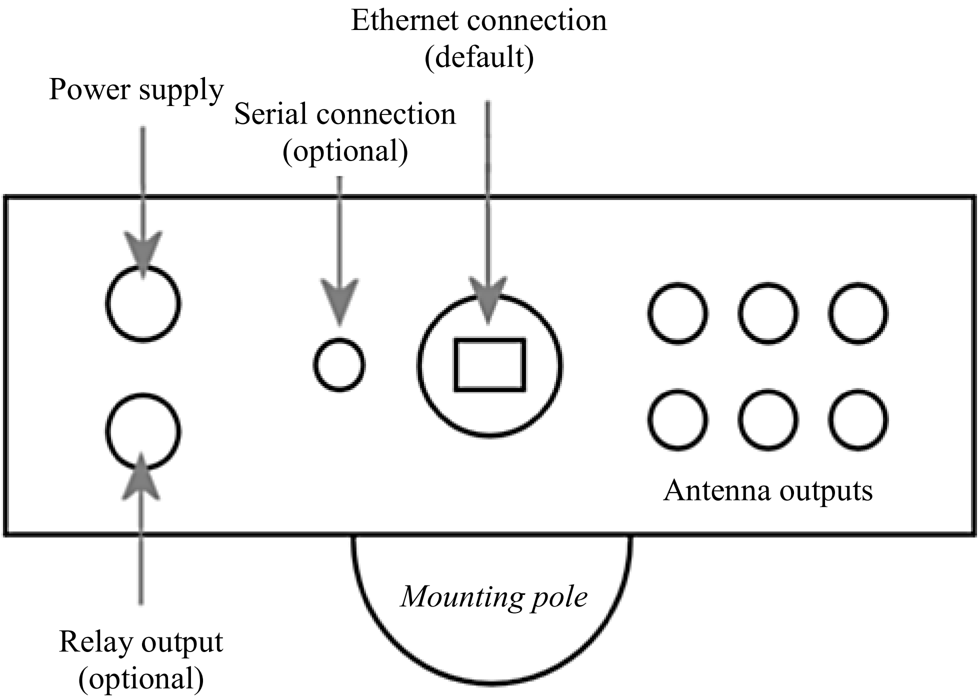


Figure 8: Enclosure box cable gland arrangement (not to scale)

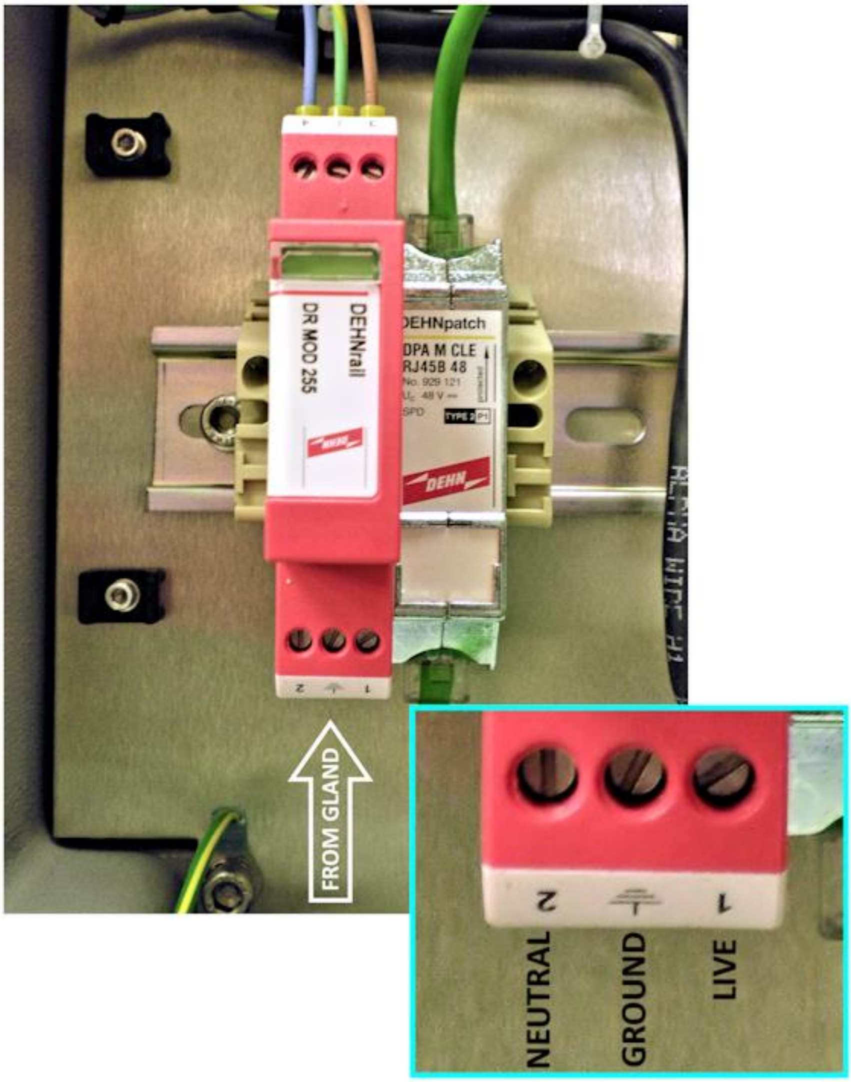


Figure 9: Terminal positions for power connection

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 (1mm^2 to 0.2mm^2), 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.

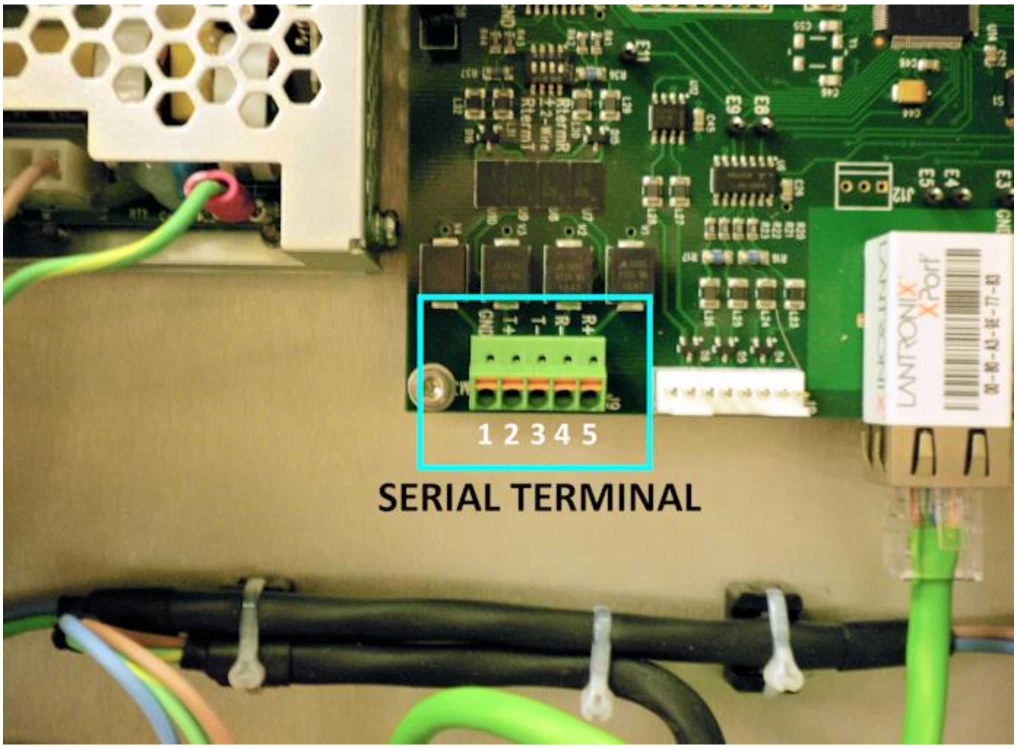


Figure 10: Location and numbering of the RS422 terminals on the main circuit board

Terminal Block Number (left-right)	Function of BTD-300	Host Connections
1	0V	0V
2	Tx+	Rx+
3	Tx-	Rx-
4	Rx-	Tx-
5	Rx+	Tx+

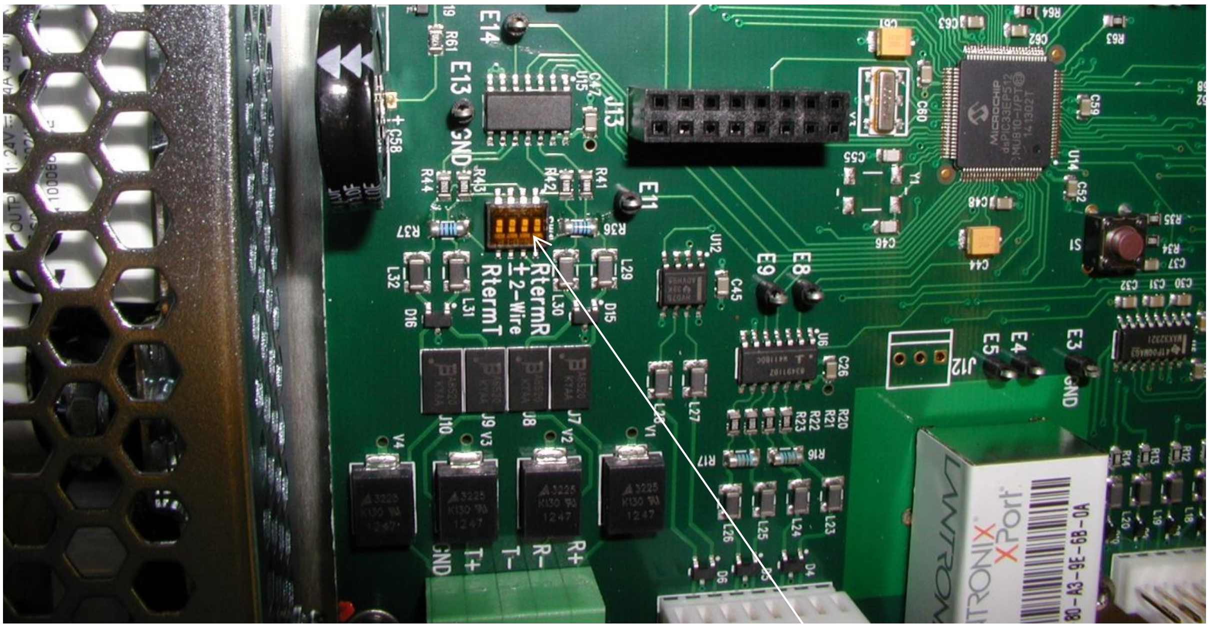
Table 1: RS422 Serial communication terminal designations

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-300 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.

3.6 RS422 Connection Options

The standard RS422 configuration is for a four wire system. This is set up as above. If a two wire system is required, it can be configured using on-board switches, shown in Figure 11.

The circuit board is labelled, defining the action of each switch. If the middle two switches are moved towards the labels (±2-Wire), the transmitter and receiver connections are configured in parallel to provide a two wire connection. This configures the system as half duplex, using a single pair of wires for the differential signal of both the transmit and receive functions. Either the Rx + & -, or the Tx + & - may be used on the terminal block for connections. If switched, the outer two switches 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.



4-Way DIL switch

Figure 11: Location of RS422 configuration switches

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-300. 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 12: 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.

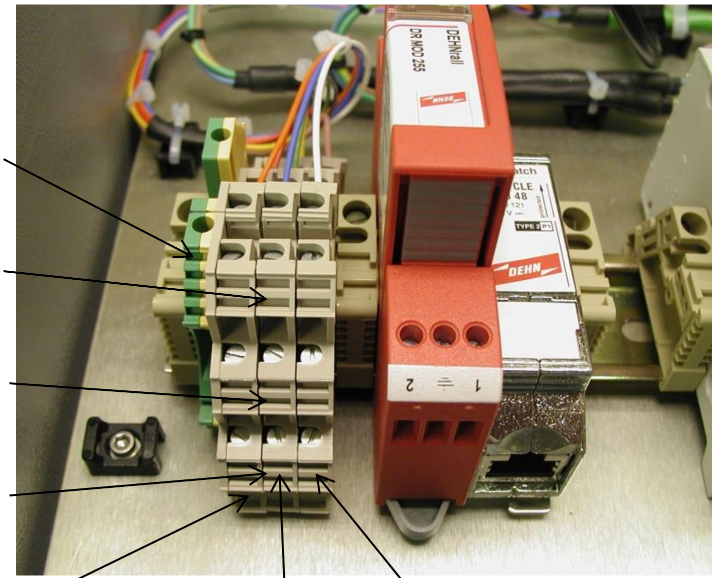


Figure 12: Relay Connections

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-300 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-300 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-300 Control Software. If the adaptor software has not loaded correctly, the BTD-300 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-300 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 Biral 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 Biral Control Software. See section 7 for commands to use if the Biral 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-300 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 Biral Control Software, or by utilising the Command Line Interface command, specified in Paragraph 7.24.*

4 DATA OUTPUT

4.1 General

Once the BTD-300 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 Biral 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-300 specifications (section 8). It is therefore advised that flashes reported as exceeding 45 NM (83 km) on a calibrated BTD-300 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-300 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 4.3.1)
CC,	Warning Flags Integer representing state of each warning indicator (corona, strongly charged precipitation, lightning etc. – details below, section 4.3.2)
DDDDD,	Self Test Flags (details below, section 4.3.3)
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

O – Other Faults OK
X – Other Fault exists
D – Direction Finder Fault Exists
N- Direction Finder "noisy calibration"

O –Tertiary Antenna OK
L – Tertiary Antenna Leak
S – Tertiary Antenna Saturated
F – Tertiary Antenna Fault
X – Tertiary Antenna Leak and Saturated

O – Secondary Antenna OK
L – Secondary Antenna Leak
S – Secondary Antenna Saturated
F – Secondary Antenna Fault
X – Secondary Antenna Leak and Saturated

O – Primary Antenna OK
L – Primary Antenna Leak
S – Primary Antenna Saturated
F – Primary Antenna Fault
X – Primary Antenna Leak and Saturated

O – Sensor not reset since last R? message
X – Sensor reset since last R? message

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,±AAAAA,±BBBBB,±CCCCC,DDDDD,EEEEE,FFFFF ,±GGGGGGGGG,HHHHH,IIIII,JJJJJ,KKKKKKKKKK,LLLLLLLLLL,MMM

Field	Description
LOCAL:,	Message Header
DDMMYY,HHMMSS	Date and Time of last site characteristic check
±AAAAA,	Site Characterisation Value 1
±BBBBB,	Site Characterisation Value 2
±CCCCC,	Site Characterisation Value 3
DDDDD,	Site Characterisation Value 4
EEEEE,	Site Characterisation Value 5
FFFFF,	Site Characterisation Value 6
±GGGGGGGGG	Site Characterisation Value 7
HHHHH	Site Characterisation Value 8
IIIII	Site Characterisation Value 9
JJJJJ	Site Characterisation Value 10
KKKKKKKKKK	Site Characterisation Value 11
LLLLLLLLLL	Site Characterisation Value 12
MMM	Site Characterisation Value 13

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,
EEEEE,FFFFF,GGGGG,HHHHH,IIIII,JJJJJ,KKK,LLLLL,MMMMM,
NNN,OOOOO,PPPPP,QQQQQ

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
EEEEE,	Primary Leakage Value	0-900
FFFFF,	Secondary Leakage Value	0-900
GGGGG,	Tertiary Leakage Value	0-900
HHHHH,	Primary Saturation Value	0-500
IIIII,	Secondary Saturation Value	0-500
JJJJJ,	Tertiary Saturation Value	0-500
KKK,	FPGA Status	0
LLLLL	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 (LLLLL) 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

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

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

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:,AAAAAAAAAAA,DD\MM\YY,HH:MM:SS,ccc

Field	Description	#Bytes
RTC:,	Message Header	5
AAAAAAAAAAA,	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-300 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-300 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-300 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-300 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-300 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-300 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-300 control software manual and is particularly useful when calibrating a BTD-300 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-300 (“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-300 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-300 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 Biral for advice on the most appropriate sensitivity levels for your requirements.

6 MAINTENANCE

The BTD-300 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-300 system fault status is identified in the data output message and in the configuration screen of the supplied software. For BTD-300 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 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.

- 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 13.

- 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-300 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-300 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.

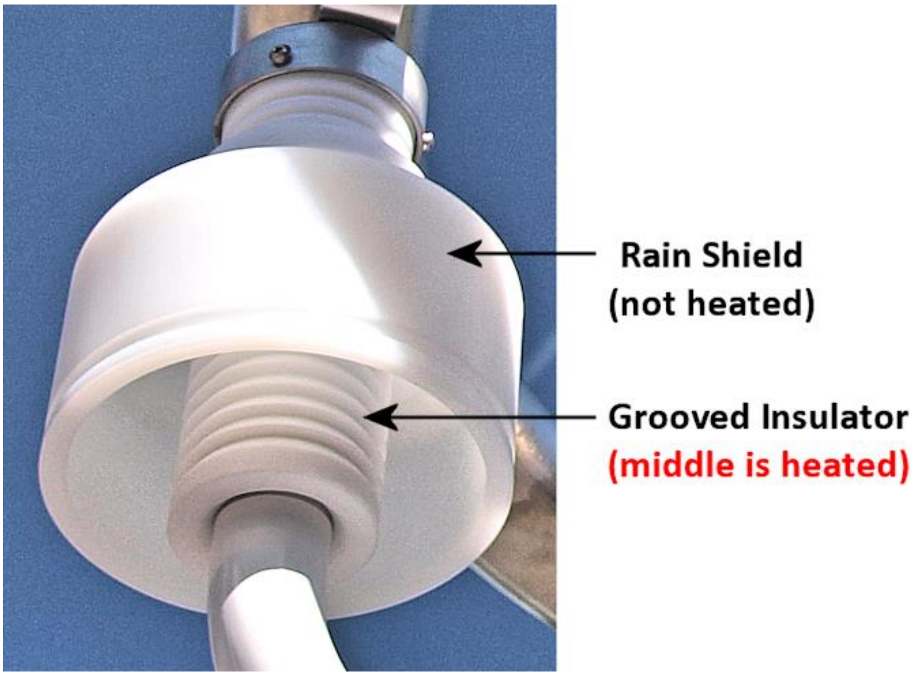


Figure 13: Antenna insulator unit
showing the location of the unheated outer rain shield and inner heated grooved insulator block.

7 COMMAND LINE INTERFACE

These commands are used to change parameters of a more technical nature or in the absence of the BTD-300 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 HYSTxxxxx – 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 – 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).

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 RINXxxx – Relay Inactive Stop Time

This command is used to set the Relay Inactive Stop time in in minutes from midnigh. 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 a "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-300 Instrument

Biral BTD-300 Specification	
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	80-264V AC supply 47 – 64 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
Weight	23 Kg
Installation site	Outdoors only, no overhead obstructions

8.2 Dimensions for the BTD-300 Instrument

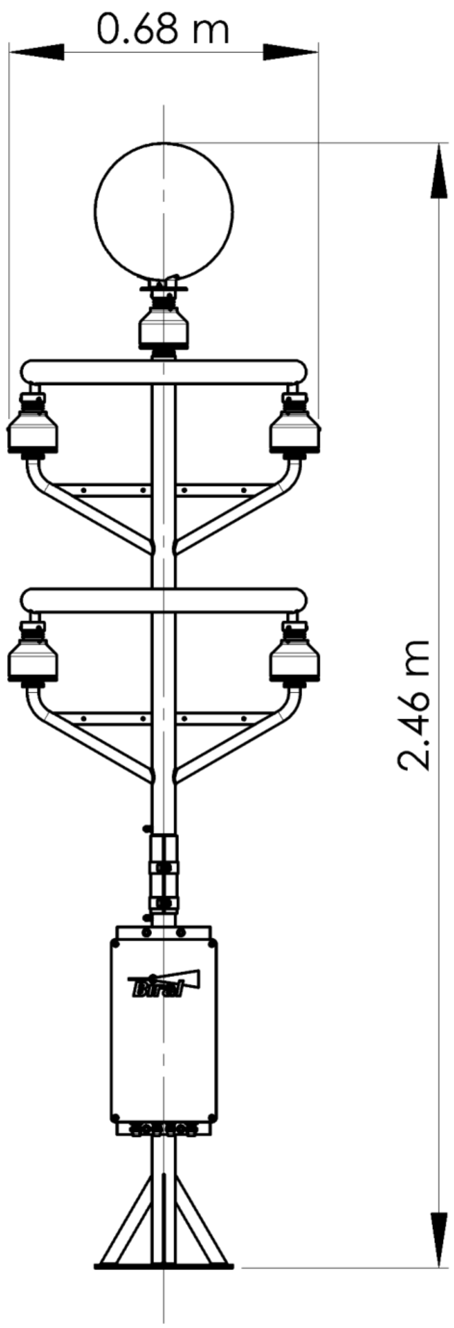


Figure 14: BTD-300 Dimensions

8.3 Specification for the Optional Relay Contacts

Biral BTD-300 Relay Specification	
Maximum Switching Voltage	250 Vac, 220Vdc
Maximum Switching Current	2A
Maximum Carrying Current	2A
Maximum Switching Power	60W, 125VA

9 APPENDIX

9.1 Lightning Flash Detection and Ranging

The BTD-300 is capable of detecting a wide range of electric field changes between 1-47 Hz. The low frequency means that the electrostatic component of lightning signals dominates the electromagnetic ("radio wave") component within the operational distance. The strength of the electric field change will be related to the inverse of the distance cubed, as the vertical extent of the lightning channel is typically small compared to the distance to the detector, so a small dipole field can be assumed. The change in electrostatic field (ΔE_S) produced by a lightning channel of mean height H over a flat conducting surface and charge neutralisation Q at a distance D from the receiver can be calculated as follows:

$$\Delta E_S = \frac{2QH}{4\pi\varepsilon_0\left(D^2 + H^2\right)^{\frac{3}{2}}} \qquad (1),$$

where ε_0 is the permittivity of free space (which is a constant). This equation can be re-arranged to provide an estimate of lightning range based upon the measured change of electric field, when values of Q and H are assumed. Due to the sensitive inverse cube relationship between the electrostatic field change and distance D compared to that for the lightning charge moment (2QH), range uncertainty due to the natural variation of lightning strength is relatively low and sufficiently accurate to identify the range of thunderstorms, given their length scales of kilometres or more.

Lightning flashes are not the only source of transient changes in the atmospheric electric field. For examples, fast moving charged objects near to the detector such as birds will produce large and rapid changes to the electric field. A method of lightning discrimination is therefore required to achieve an acceptably low false alarm rate. The BTD-300 separates lightning flash signals from non-lightning sources by a unique method developed by Biral which compares the signal characteristics on the three antennas. Due to the special geometry of the detector and antennas, only lightning produces the correct combination of relative signal amplitudes compared with local, non-lightning sources of electric field change. This is termed the "lightning ratio" and the sensitivity of this filter can be adjusted by the user using the BTD control software, although the default is designed to provide optimal performance for most users.

9.2 Charged Precipitation and Overhead Thunderstorm Development

The BTD-300 offers the unique ability to warn of potential overhead thunderstorm development before lightning is produced through the measurement of electrical charge on individual hydrometeors (e.g. raindrops, hailstones or snowflakes) making contact with the antennas. Results from scientific research conducted by both Biral and the wider academic community indicate that convective clouds with strong updrafts produce significantly greater charged hydrometeors than more stratified non-thunderstorm rain clouds. The magnitude of hydrometeor charge is generally proportional to the electric field near the ground, a phenomenon called the "mirror image effect". Such deep convective clouds are indicative of the atmospheric conditions favourable for thunderstorm development. Hydrometeor charge is not necessarily a function of rainfall intensity, although given that developing thunderstorms are commonly associated with heavy showers, the BTD-300 algorithm also takes the precipitation intensity into account when issuing an overhead thunderstorm development alert. Precipitation charge complements thunderstorm alerts produced by detection of a strong electric field as the hydrometeor charge is more sensitive to lower electric fields compared with corona initiation. This feature allows a lower threshold for storm development warning and is why the charged precipitation warning only produces a level 1 (yellow) warning compared with the level 2 (orange) alert for detection of a strong electric field produced by corona or strong space charge, which is present either with or without precipitation.

9.3 Use of the Corona Initiator Spikes

The BTD-300 is shipped with short 0.5 mm diameter stainless-steel wires which are to be installed on the upper torus antenna rain shields. The purpose of these spikes is to generate a distinct signal on the antennas in the presence of strong and rapidly changing overhead electric fields. When the electric field strength rapidly builds to a magnitude indicative of overhead thunderstorm development (few thousand volts per metre) corona discharge will be initiated at the tip of the wire. The exchange of charge between the wires and the atmosphere will result in a rapid variation of electric field surrounding the wires, which is readily identifiable by the antennas. Signals from other nearby objects less than a few metres around the detector will also contribute to the signals. Such signals are clear evidence of the increased threat of overhead thunderstorm development and consequently activate a mid-level (orange) alert status. The signal emitted by the spikes will not affect the ability of the sensor to detect lightning occurring at a moderate to close range, where the resultant warning level would equal or exceed orange alert status generated by the spikes.

The ability to warn of strong overhead electric fields is a key feature of the BTD-300 compared with conventional lightning detectors. Whilst the corona spikes are designed to provide a source of local corona, in practise nearly all sites will have sufficient objects in the vicinity to produce sufficient amounts of corona ions and high frequency variability of the electric field. It is therefore acceptable for the user not to install (or remove) these corona spikes if the strong electric field alert feature is not required (for example, if only lightning data is required for research purposes), or the site is over land, with sharp grounded objects (vegetation, buildings etc.) in the area. The spikes can simply be removed from their holes with a pair of pliers, as they are not directly connected to any electronics. If you do not want to install the corona spikes but you are unsure whether your site requires them, please contact Biral for advice.

Corona initiation during strong electric fields is prevented at locations on the BTD-300 other than the initiator spikes by the smooth, rounded surface of the antennas. Prevention of corona on any lightning detector antennas is important since it would otherwise create an unacceptable high noise level (including at radio frequencies). The BTD-300 antennas have been designed using electrostatic modelling software to withstand corona initiation in electric fields exceeding 100 KV/m, which is considerably below that measured near the surface during the most severe thunderstorms.

9.4 BTD-300 fault detection and appropriate response

9.4.1 Fault flags during normal operation

If the BTD-300 detects a fault, the fault status in the DATA message is changed to indicate the type of fault(s) it has detected (see section 4.3.3). If a fault is reported, the following actions are recommended:

Antenna Leak

The antenna(s) on the BTD-300 are registering extremely low variability but are unsaturated, so a leakage of their signal to ground is suspected. Check that there is no object in contact with the antenna, including vegetation or spider's webs, which can divert current from the antenna to ground. Check that the antenna insulators are clean and free of extensive surface contamination. Depending on the severity of the anomalous signal, the unit may still be able to function, although the performance may be adversely affected. During periods of highly stable atmospheric conditions with very little air turbulence at the site (usually during the night under calm, anticyclonic conditions), it is possible that the antennas will detect sufficiently low natural variability to activate a suspected leakage warning. Such specific atmospheric conditions are uncommon and do not usually persist for more than a few hours, so the fault indicator will stop once usual atmospheric conditions return. If this is the cause then no further action is required since these conditions will not affect the performance of the BTD-300. If the problem persists in more disturbed weather and after the antenna has been cleaned and checked for debris, then the antenna amplifier may be faulty and requires replacement. Please contact your BTD-300 supplier for a replacement part.

Antenna Saturated

The antenna(s) on the BTD-300 are registering a signal which contains a significant proportion of current which has saturated the amplifier, indicating that the antenna is either receiving an external DC current source of >300nA magnitude or suffering from persistent and strong interference in the 1-45 Hz range. The interference could occur at 50 Hz mains power frequency under exceptional circumstances sufficient to exceed the powerful digital filters of the BTD-300, but this is only usually a possibility under high voltage power distribution lines (which would also violate the site requirements). Check that the BTD-300 is properly grounded and there is no object in contact with the antenna, including vegetation or spider's webs, which can transmit a current between the antenna and ground. Check that the antenna insulators are clean and free from extensive surface contamination. If the problem persists after the antenna has been cleaned, checked for debris and strong 1-47 Hz noise sources discarded, then the antenna amplifier may be faulty and requires replacement. Please contact your BTD-300 supplier for a replacement part.

Antenna Leak and Saturated

This is a combination of both of the previously described faults, whereby the signal is near-continuously saturated and with little variability. Mitigation procedure same as previously described for leakage and saturation faults.

Antenna Fault

The antenna fault is activated when the unit detects an anomaly with the front end amplifier(s) embedded inside the insulators, such as continuous saturation, which indicates the amplifier may have developed a fault or been damaged and needs to be replaced. Please contact your BTD-300 supplier for a replacement part.

Other fault

If this fault occurs, pressing the "Update Status" button in the BTD-300 control software will request the status and a more specific fault message will then be displayed. Please contact your BTD-300 supplier or Biral with the fault description for advice on how to proceed.

Sensor not reset since last R? message

Please update the display by pressing the "Update Status" button.

Direction Finder Fault Exists
A fault has occurred with the (optional) direction finder module, such as a failure to communicate with it. Check that the direction finder module is installed and connected to its communication and power cable, which is in turn connected to the appropriate terminals in the main electronic enclosure box. Please contact your supplier if the problem persists.

Direction Finder "noisy calibration"
The direction finder automatically calibrates and has determined that the background radio noise at the site is very strong. If this happens there will be no direction data reported by the BTD-300 (will report 999). The source of radio interference should be identified and removed/shielded, or the BTD-300 relocated to a less noisy site.. Note that the direction finder module itself cannot be shielded from radio interference, since it needs to be free to receive signals from the lightning flashes.

9.4.2 Warning flags during site characterisation

During the site characterisation process (section 5.1) the BTD-300 performs a series of checks on the antenna outputs, including the direction finder (if installed). If any antenna system is recording unexpected offsets, leakage or variability, a warning code is included in the site characterisation message. Further details on the display of this warning are available in the BTD-300 Control Software user manual.

The BTD-300 and Direction Finder site characterisation warning flag values will be calculated from Table 15. The warnings could be added together, e.g. if all three BTD-300 antenna offsets were out of range the BTD-300 warning would be 0x07. If the Direction Finder background noise was too high on both antennae then the Direction Finder Warning would be 0x18.

Value	BTD-300 Warning	Direction Finder Warning
0x00	Site Characterisation passed	Site Characterisation passed
0x01	Primary Offset out of range	NS Offset out of range
0x02	Secondary Offset out of range	EW Offset out of range
0x04	Tertiary Offset out of range	E-field Offset out of range
0x08	Primary Leakage threshold out of range	NS Background noise too high
0x10	Secondary Leakage threshold out of range	EW Background noise too high
0x20	Tertiary Leakage threshold out of range	Flash occurred during calibration
0x30	Corona threshold out of range	Not used

Table 15: Site characterisation warnings

Recommended action in response to these warnings is as follows:

0x00: Site characterisation successful. No action required.

BTD-300 antenna offset warnings
An unexpectedly high DC current is being registered from the antenna(s). Check that the BTD-300 is properly grounded and there is no precipitation or object in contact with the antenna, including vegetation or spider's webs, which can transmit a current to the antenna. Check that the antenna insulators are clean and free of extensive surface contamination.

When the antenna is clean and clear of all foreign objects repeat the site characterisation. Depending on the severity of the anomalous signal, the unit may still be able to function, although the performance may be adversely affected. If the problem persists then the antenna amplifier may be faulty and requires replacement. Please contact your BTD-300 supplier for a replacement part.

BTD-300 antenna leakage threshold warnings

An unexpectedly low or high variability in current is being registered from the antenna(s). Check that the BTD-300 is properly grounded and there is no object in contact with the antenna, including vegetation or spider's webs, which can transmit a current to the antenna. Check that the PTFE antenna insulators are clean and free of extensive surface contamination. Check for possible sources of interference in the 1-47 Hz range, such as local thunderstorm activity or overhead precipitation. If present, repeat the site characterisation during fair weather when no precipitation or local thunderstorms are present. Check for nearby movement of objects, animals or people, slow electrostatic charging/discharging of nearby objects or nearby AC power supplies which may be operating below 50 Hz (e.g. faulty generators) or are of significant power (such as overhead high voltage cables). If such sources are suspected, it is recommended that they are removed if practical or the BTD-300 is relocated further from these objects. When the antenna is clean, unobstructed and clear of potential sources of electrostatic variability, repeat the site characterisation. Depending on the severity of the anomalous signal, the unit may still be able to function, although the performance may be adversely affected. If the problem persists then the antenna amplifier may be faulty and requires replacement. Please contact your BTD-300 supplier for a replacement part.

BTD-300 corona threshold out of range

An unexpectedly high variability in current is being registered from the antenna(s). Check that the BTD-300 is properly grounded and there is no foreign object in contact with the antenna, including vegetation or spider's webs, which can transmit a current to the antenna. Check that the PTFE antenna insulators are clean and free of extensive surface contamination. Check for possible sources of interference in the 1-47 Hz range, such as local thunderstorm activity or overhead precipitation. If present, repeat the site characterisation during fair weather when no precipitation or local thunderstorms are present. Check for possible sources of interference in the 1-47 Hz range, such as nearby movement of objects, animals or people, slow electrostatic charging/discharging of nearby objects or nearby AC power supplies which may be operating below 50 Hz (e.g. faulty generators) or are of significant power (such as overhead high voltage cables). If such sources are suspected, it is recommended that they are removed if practical or the BTD-300 is located further from these objects. When the antenna is clean, unobstructed and clear of potential sources of electrostatic variability, repeat the site characterisation. Depending on the severity of the anomalous signal, the unit may still be able to function, although the performance may be adversely affected. If the problem persists then the antenna amplifier may be faulty and requires replacement. Please contact your BTD-300 supplier for a replacement part.

Direction Finder module offset out of range

An unexpectedly high near DC current is being registered from the direction finder radio antenna(s). Check there are no suspected sources of VLF/LF radio interference at the site (e.g. local thunderstorms, nearby sparking/faulty electrical equipment, fluorescent/dimmed lights, powerful switch-mode power supplies, VLF transmitters etc.) and wait for thunderstorms to clear and re-locate the BTD-300/interfering equipment if nearby strong artificial sources are suspected. If this happens there will be no direction data reported by the BTD-300 (will report 999). Retry the site characterisation. . If the problem persists then the antenna amplifier may be faulty and the direction finder circuit board requires replacement. Please contact your BTD-300 supplier for a replacement part.

Direction Finder module background noise too high
A continuous, unexpectedly strong low frequency radio signal is being registered from the direction finder radio antenna(s). Check there are no suspected sources of VLF/LF radio interference at the site (e.g. local thunderstorms, nearby sparking/faulty electrical equipment, fluorescent/dimmed lights, powerful switch-mode power supplies, VLF transmitters etc.) and wait for thunderstorms to clear or re-locate the BTD-300/interfering equipment if nearby strong artificial sources are suspected. If this happens there will be no direction data reported by the BTD-300 (will report 999) Retry the site characterisation. If the problem persists then it is possible that the site has too much VLF/LF radio interference. If this is considered unlikely (e.g. following the results of a professional broadband radio sweep covering the VLF/LF/MF bands), then the antenna amplifier may be faulty and the direction finder circuit board requires replacement. Please contact your BTD-300 supplier for a replacement part.

Direction Finder module flash occurred during calibration
This message is reported when an isolated strong signal is received during the direction finder calibration routine, which may have been the result of a local lightning stroke. Repeat the characterisation procedure, ensuring that no thunderstorms are active in the area.

9.5 Performance FAQs

9.5.1 The manual states that no movement of animals should occur near the detector. My BTD-300 is often overflown by birds. Will this produce false alarms?

- Generally no. However, in rare instances some fast-flying birds can produce false alarms of distant lightning if they fly directly overhead within approximately 2m of the antennas. Birds landing on the antennas should not produce false alarms, although it is advised that an appropriate installation site is selected which avoids regular bird activity within a few metres of the antennas. If nearby birds become a concern then increasing the lightning strength threshold from its default setting (level 5) will effectively remove any bird signals without compromising on performance, for correctly sighted units.

9.5.2 Why does my BTD-300 report occasional flashes greater than 45 NM (83 km) away when no storms are in the region?

- Depending on your selected sensitivity settings, the BTD-300 may occasionally pick up very weak signals from natural or man-made sources within the 1-47 Hz listening frequency which are not related to thunderstorm activity in the region. Like we advise in this manual, although strong lightning flashes can sometimes be detected at ranges exceeding the maximum warning range (45 NM / 83 km), these events will not activate any warning and should not be used for the purpose of thunderstorm monitoring due to their increased ambiguity compared to events detected within the maximum operating range.

For some non-ideal sites there may be rare occasions where nearby electrostatic discharges occur of sufficient strength to register as distant flashes. Such discharges could be the result of nearby faulty electrical equipment, for example. Such occurrences are usually isolated or infrequent, so can be prevented from activating a warning if the “Warn on Second Distant Flash” option is checked in the Service Screen or through the command prompt (section 7.32). The distant thunderstorm warning will then only activate 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), and can also be used to ignore infrequent, large electrostatic discharges at a non-ideal site. The BTD-300 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.

9.5.3 Data from a lightning location network shows more lightning strikes in the area than my BTD-300. Is my unit working correctly?

- Providing the BTD-300 is installed and operated in accordance with the instructions provided by the manual, the unit will detect nearly all of the lightning within range. Due to its high sensitivity to weak intra-cloud activity, the BTD-300 usually reports significantly more flashes than other detectors and networks. When comparing the BTD-300 output with that of a radio-detection based system such as a lightning location network it is important to remember that the BTD-300 reports lightning **flashes**, unlike nearly all networks which report lightning **strokes** (the supplier will be able to confirm whether their data are strokes or flashes).

These lightning strokes usually reported by networks represent the individual pulses of strong current which occur during a complete lightning discharge. The complete discharge is referred to as a lightning flash. Strokes from the same flash occur within half a second of each other (usually considerably shorter). This is why a lightning flash appears to flicker to an observer. Many strokes of the same flash follow the same path, but some form a new one within a few kilometres. Whilst some flashes only contain a single stroke, most comprise of two or three, although occasionally flashes may contain more than ten! This, combined with the location uncertainty of the network can show multiple nearby points on their lightning map at the same time for what was actually produced by the same lightning flash.

Since the BTD-300 reports the location of the flash, i.e. the complete discharge and not the individual components, it may appear to count less lightning than a network reporting lightning strokes, which have not been grouped into flashes by the supplier. From a thunderstorm warning perspective, there is no advantage to reporting strokes compared to flashes (networks usually only do so since it is the fundamental unit derived from the radio pulses they detect). It is lightning flash rates (not strokes) that normally define a storm’s overall electrical activity and these will be the same as that identified by a human observer.

If you are concerned that a correctly sited and calibrated BTD-300 is not detecting sufficient nearby (within 30 NM/56 km) flashes in your area, you could try decreasing the lightning ratio threshold from the default (level 5). If you are concerned more with improving detection of the most distant (30-45 NM / 56-83 km) flashes detectable by the BTD-300, you could try lowering the lightning strength threshold from the default (level 5). It is important to be aware however that lowering any threshold from the default (level 5) setting has the potential to increase false alarms. If in doubt, please contact Biral for advice on the most suitable sensitivity levels for your requirements.

9.5.4 Why does my BTD-300 sometimes produce a different distance/bearing to the same lightning flash compared to that derived from a lightning location network?

- If the BTD-300 is installed at a non-ideal site (as defined by the manual), it may need a site correction factor due to the distortion of the ambient electric field by nearby obstructions. This is achieved by identifying the correct distance to a storm and entering it into the system as described by the manual (section 5.3). Sites with nearby metallic structures may also require an offset correction to the (optional) direction finder module (section 3.4). These procedures only need to be completed once for each non-ideal site. Once your BTD-300 is correctly configured there may still be occasional instances where the distance is noticeably different from that derived from a good quality lightning location network. Interestingly, both can be correct! This is because the network will locate the part of the flash producing the strongest radio signal (which depends on the radio frequency used and orientation of the channel). The BTD-300 will weight its distance estimation to the nearest location of the storm where significant charge neutralisation occurred. For most flashes these are approximately the same, although since lightning can have a significant horizontal extent (sometimes tens of kilometres), the portion of the lightning flash located by the radio detector network may be several kilometres from the closest approach of the flash to the BTD-300. The BTD-300 will therefore tend to report the flash as being closer. Weighting the thunderstorm distance to the closest region of significant electrical activity for horizontally extensive flashes has clear advantages from an early warning and safety perspective.

The BTD-300 is programmed with knowledge of the typical lightning strengths found throughout the world. However, there will be cases where a thunderstorm produces some extremely weak or strong lightning flashes which may be incorrectly ranged as being too far (weak flashes) or close (strong flashes). Even for these uncommon events the deviation from the actual distance is usually small compared to other standalone lightning detectors, due to the unique operating principle of the BTD-300.

Strong background VLF/LF radio frequency noise present at the installation site can also generate deviations in the flash bearing, especially for distant flashes where the signal amplitude is small. The BTD-300 will issue a fault if the background noise is determined to be excessively strong during calibration, although even relatively moderate interference has the capacity to affect the bearing of distant flashes with weak RF signals. Consequently, a BTD-300 with the optional DF module should be sited away from sources of significant VLF/LF interference.

9.5.5 Why are some flashes given a range but no direction (bearing 999) when the direction finder module is installed and operating correctly?

- There will sometimes be lightning flashes which do not generate sufficient low frequency radio signals for the direction finder module to be confident of their bearing, despite producing sufficient quasi-electrostatic field change for the main unit to provide a range.

Typically these flashes are weak intra-cloud and distant from the detector. This situation highlights the advantage provided by the BTD-300 of being able to detect and range these weak flashes which would otherwise not have been detected (and certainly not ranged) by a conventional system using low frequency radio detection.

It is worth noting that the diversity of radio signal amplitudes produced by different lightning strokes means that a signal from lightning 1000 km away can have the same strength as a stroke only 30 km away! The same does not apply to its quasi-electrostatic signal used by the BTD-300, which therefore provides a substantially more reliable measure of lightning range than by using radio signal amplitude alone. Nonetheless, radio signals are the only practical method of lightning direction finding available for single site systems, so the direction finder module used by the BTD-300 must rely upon these signals.

9.5.6 My BTD-300 is covered in snow and ice. Will this affect its performance?

- The BTD-300 is designed to operate in harsh weather conditions and the antenna insulators are shielded and heated, so providing there is no contact between the snow and ice on the antennas with the metal support pole or other antennas, the unit should perform as expected.

Since the top of the snow represents the ground plane, the effective height of the antennas will be reduced according to the snow depth around the base of the unit. This is not expected to significantly affect performance (principally detection of distant flashes) until the snow depth exceeds approximately 60 cm (2 ft). For persistent snow depths in excess of 60 cm the BTD-300 will tend to overestimate lightning distance, so will require re-calibration, and have a lower detection efficiency for far away (>20 NM / 37 km) flashes. Snow depths exceeding 140 cm (~4.5 ft) will likely make contact with the tertiary antenna and prevent the system from detecting lightning (although it will still detect charged precipitation and strong electric field variability), so the area immediately surrounding the BTD-300 will need clearing of snow. The optional electronics enclosure heater available for the BTD-300 upon initial order is recommended for installation in cold environments where the minimum ambient temperature is lower than -20°C (-4°F).

Although lightning is relatively uncommon during snowstorms, it does occur during certain meteorological conditions so there is still a risk to be considered. For example, winter rain/hail showers in mid-latitudes can produce extremely powerful cloud-to-ground lightning, although the storm's lightning flash rate is usually low compared to summer thunderstorms. Such winter storms tend to produce highly charged precipitation and strong electric fields, allowing the BTD-300 to warn of their potential overhead development.