OPERATING MANUAL

BTD-1

Thunderstorm

Warning

System

EN

108592.00A

senseca

Contents

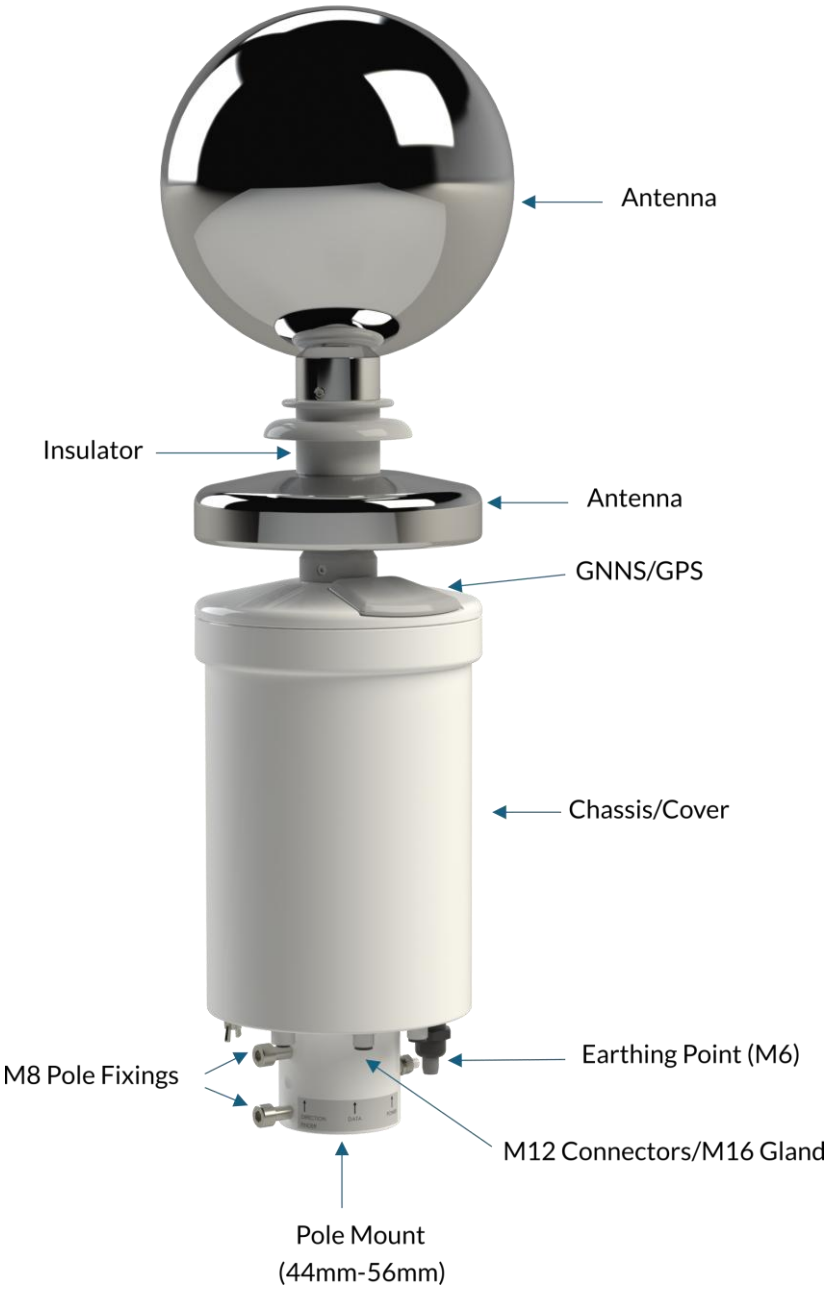
1 Introduction

BTD-1 Thunderstorm Warning System works as a standalone sensor to detect the presence and range of lightning flashes by monitoring the background **quasi-electrostatic field**. This technique offers best in class detection efficiency allowing for lightning related procedures to be put in place to protect personnel and sensitive equipment. When combined with the optional direction finder module the bearing of the flash can be provided, pinpointing the location of the lightning flash.

A suite of hardware and software modules are offered alongside the base unit to provide a comprehensive plug and play solution for both end users and systems integrators.

The **Lightning Eye** software package seamlessly integrates with the BTD-1 to provide a comprehensive user interface. The Lightning Eye package offers the ability to connect to remote clients over the internet in the form of desktop applications.

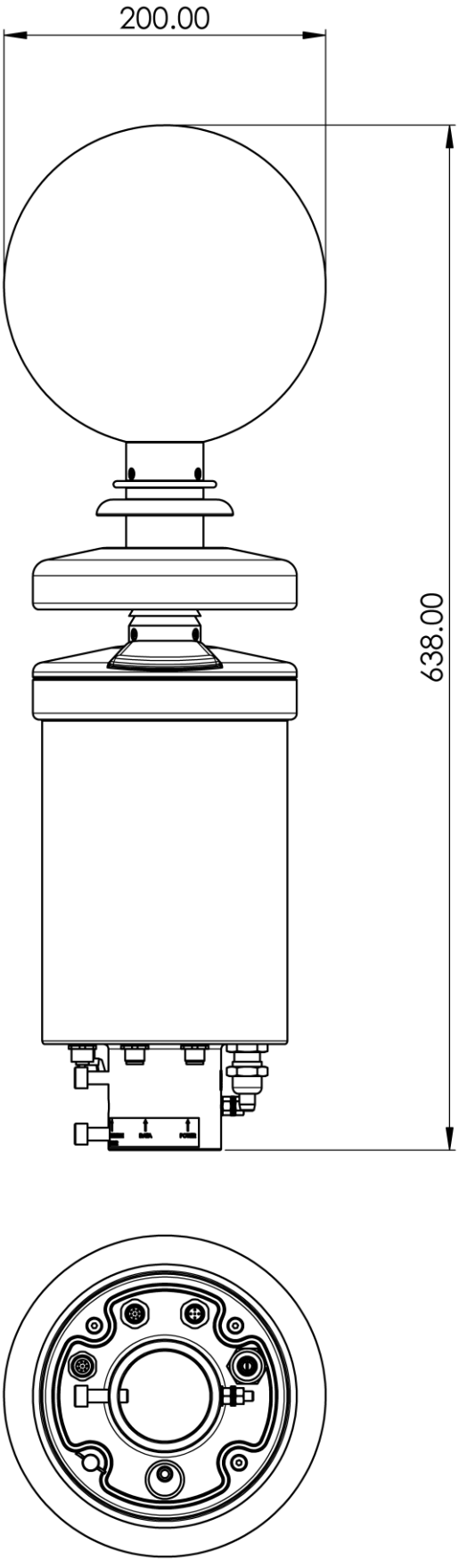
The BTD-1 sensor is detailed below:



2 Technical specifications

Sensor	**BTD-1**
Lightning	Triggered by cloud-to-ground, intracloud and cloud-cloud lightning.
Lightning Events Detected	Charged Precipitation (Prewarning) Strong Electric Field (Prewarning) Severe Storm
Measuring range	35km (Default) / 83km (Option)
Range Resolution	1m
Range Accuracy	For flashes within 20 km : +/-5km For flashes within 83 km : +/-10km
Detection Efficiency	**For flashes within 35 km** 97% for a single lightning flash 99.9% for storm with 2 lightning flashes **For flashes within 56 km** 95% for a single lightning flash 99% for storm with 2 lightning flashes 99.9% for storm with 3 lightning flashes
False Alarm Rate	**For flashes within 35 km** <1% **For flashes within 83 km** <2%
Maximum Flash Rate	120 flashes per minute
Flash Latency	2 seconds
Output	RS422, Relays
Power supply	9…36 Vdc
Consumption	2W Typical Up to 50W with Extreme Heater Module
Connection	M12 Connectors (Stainless Steel)
Weight	4.3kg approx.
Operating conditions	-20…+40 °C / 0…100 %RH / Max. altitude 5000 m
Protection degree	IP 66
Materials	Housing: Aluminium Sphere Antenna: Stainless Steel Insulators: PTFE/Acrylic
Related Standards	EN50536:2011+A1:2012, Class 1 Detector IEC 62793, Class A Detector EN61326-1:2021, Industrial Limits

Dimensions (mm)



3 Installation

This section explains the installation of the BTD from site selection, physical mounting and electrical interfaces. Where Senseca accessories are relevant these are mentioned throughout this document and in section 8.

3.1 Sensor Siting Requirements

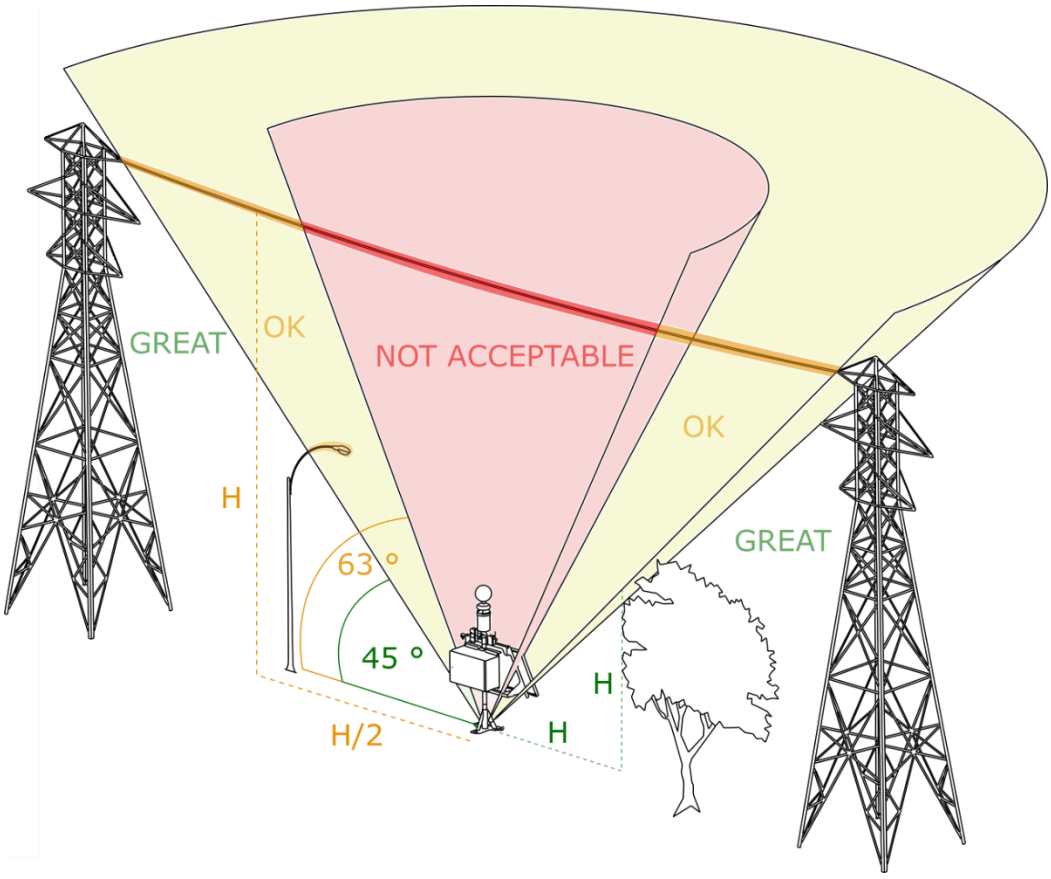
It is very important for the successful operation of the BTD that it is installed at a suitable site. Please consider the following when selecting your installation site:

Acceptable site

- Sensor is positioned at 1.3m – 3.0m above flat ground or, if necessary, a rooftop.
- Ideally obstacles should be located at least their height away from the sensor. Obstacles at half-height distance are OK but may impact sensor performance.

Unacceptable site

- Obstacles closer than their height relative to the sensor.
- Overhead obstructions (e.g. cables, other sensors, radar).
- Frequent movement of people, animals or vehicles within 2m.
- Within 20m of high voltage (1kV+) power transformer.



3.2 Physical Installation

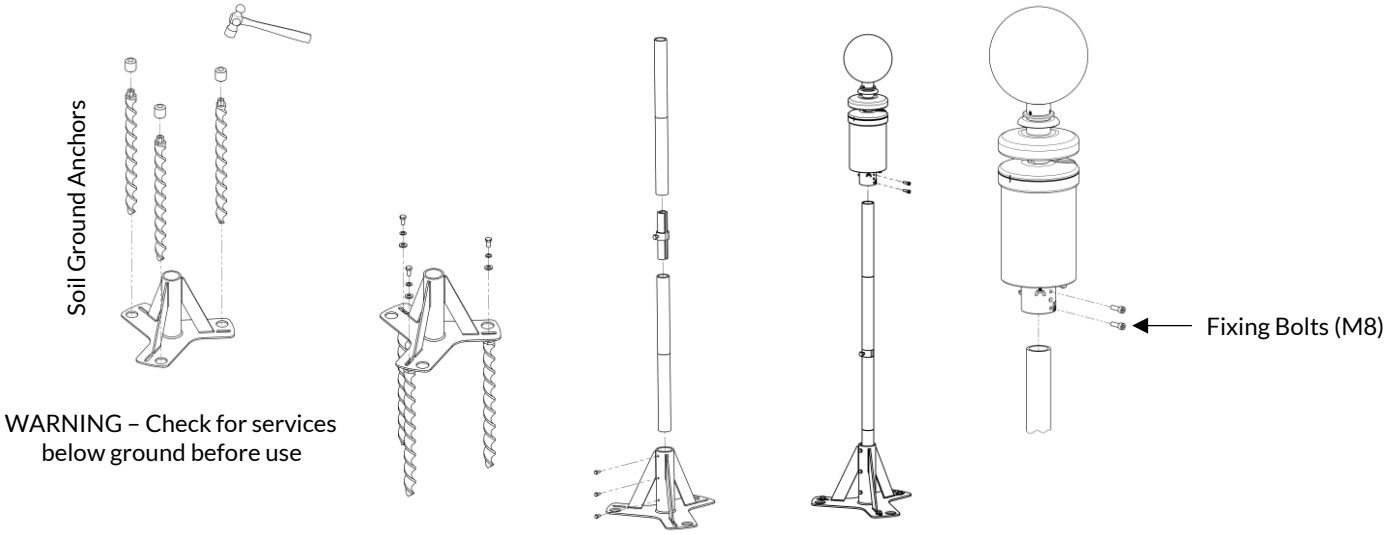
This section details the typical mounting method of the BTD-1, including how to utilise the BTD modules which are available for purchase.

3.2.1 Mounting the BTD to a Pole

Mount the BTD to the top of a pole as shown below and tighten the two M8 bolts using a 6mm hex key. The pole can have any outside diameter between 44mm and 56mm with a height of 1.3m to 3m above ground level.

A field mounting kit suitable for use with self-tapping ground anchors or a concrete foundation is recommended (Part No. B1A.FMK).

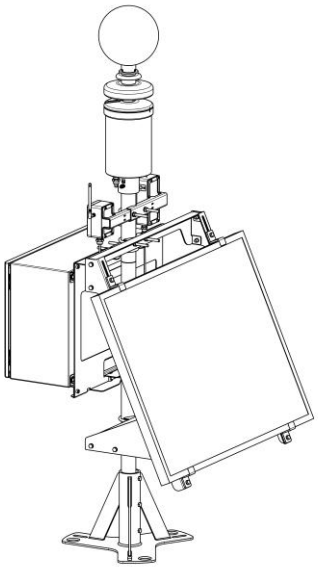
Senseca Field Mounting Kit (Optional)



To install the Field Mount Kit:

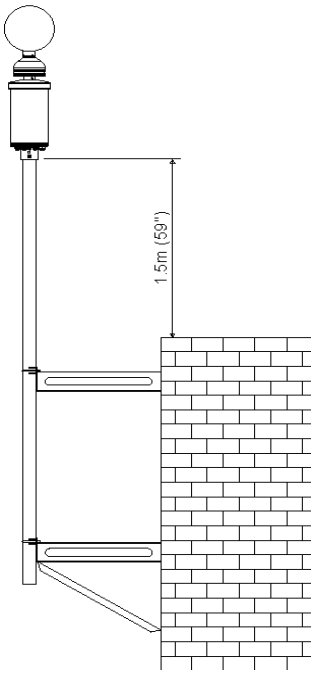
1) Find a suitable location for installation. Ensure no services are located with 1000mm below the installation site. Using the base as a template, hammer the ground anchor screws fully into the ground. A protection cap is required to prevent damage to the anchor bolt threads.
2) Slightly rotate the base so the slots align with the ground anchor fixing points. Attach base to the ground anchor using the M12 bolts (19mm spanner).
3) Attach a section of the pole to the base using the 3 x M8 bolts to secure the pole into position.
4) Attach the section of the pole to the first section using the straight adapter. Tighten the straight adapter using a 21mm spanner.
5) Attach the BTD using the two M8 fixing bolts.

Note, the Field Mounting Kit is suitable for use with the Solar Kit, Radio Modules and Direction Finder.



3.2.2 Mounting the BTD to a Wall

It is possible to mount the BTD to a wall provided that the BTD is at least 1.3m higher than the wall or roof level. An off the shelf BTD wall mounting kit is available for purchase (B1A.WMK).

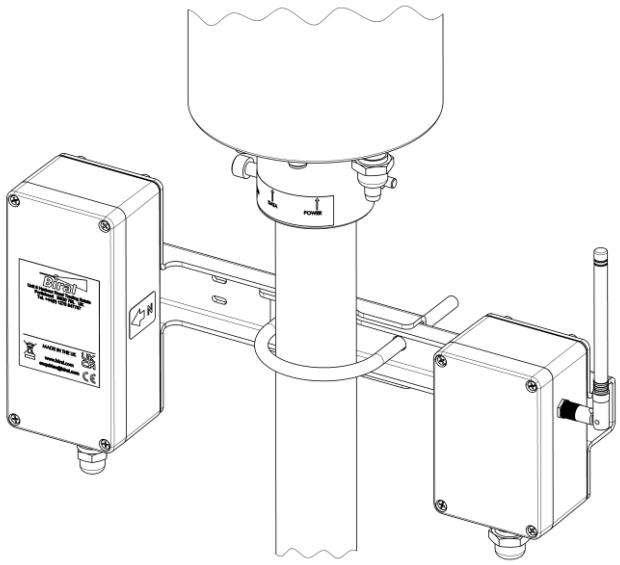


Note: When mounting a sensor at height it may be safer to make all electrical connections before mounting.

3.2.3 Direction Finder/Radio Module (Optional)

Brackets are supplied with the Direction Finder and Radio Module which are to be mounted approximately 100mm below the collar of the sensor. The Direction Finder and Radio Module brackets fit inside of each other as shown below. They are mounted to the pole using the U-bolt and fitted with a 13mm spanner.

Direction Finder



Radio Module

Direction Finder (B1A.DF)

The Direction Finder has a NORTH symbol on the enclosure which must be accurately aligned with the North magnetic pole. Any alignment error will cause an error in the bearing reporting by the sensor, so it is important to be as accurate as possible.

Plug the cable of the direction finder into the DF port on the BTD. The BTD shall automatically detect the Direction Finder. Note, the DF blanking plug will need to be removed before connection.

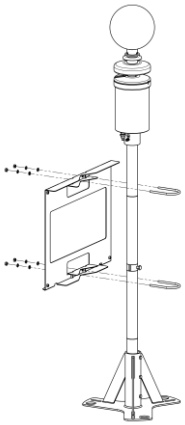
Radio Module (B1A.RMK)

The Radio Module can face any direction. Ensure the antenna is securely fastened to the device. If utilising the Radio Module, the receiver should be within 200m of the sensor. Performance will vary depending on the operating environment with any line-of-sight obstructions hindering operation.

Plug the cable of the Radio Module into the DATA port of the BTD. Power is supplied via the BTD. The receiver module utilises a M12 connector which matches that of the BTD data port meaning the wireless transmission link can be treated the same as a wired link. Note, a 5V (1W) power source must be provided to the receiver module. It is recommended to use the Senseca Serial to USB converter if connecting to a computer. See section 8.2 for more details.

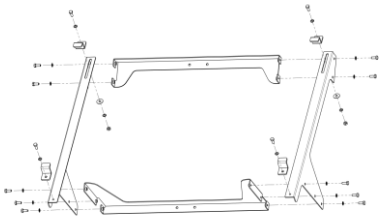
3.2.4 Solar Kit (Optional)

An optional solar kit is available for purchase. When combined with the radio module the system can be remotely installed. In the northern hemisphere the solar panel should be orientated south, in the southern hemisphere the solar panel should be orientated north. To install the solar kit follow the instructions below:



1) Install the Electrical Box Bracket approximately 300mm below the BTD (on the marked line)

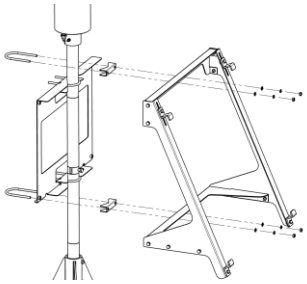
🛠 13mm Spanner



2) Assemble the Solar Bracket

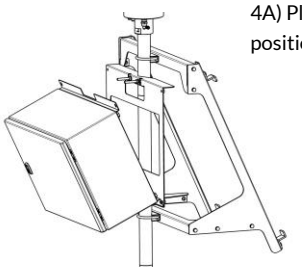
🛠 8mm Hex

🛠 13mm Spanner

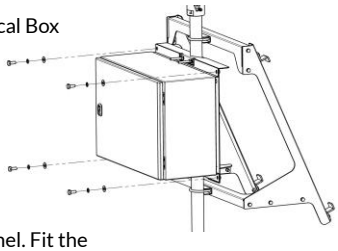


3) Install the Solar Bracket

🛠 13mm Spanner

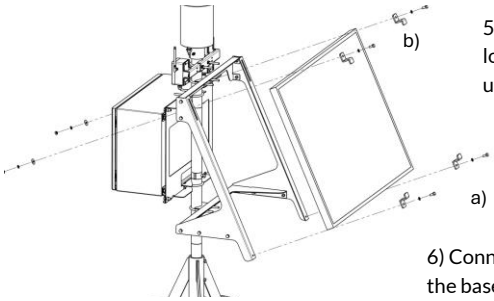


4A) Place the Electrical Box into position



4B) Secure the Electrical Box using 4 x M8 Bolts

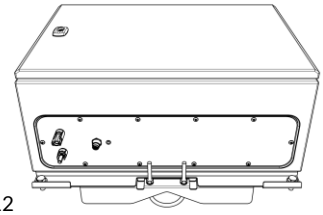
🛠 8mm Hex



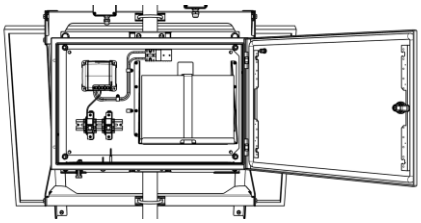
5) Secure the solar panel. Fit the lower clips first, followed by the upper clips

🛠 8mm Hex

🛠 13mm Spanner



6) Connect the solar MCS leads to the base of the Electrical Box, connect the BTD power via the M12 connector



7) Install a suitable battery and connect via the Anderson fused harness (M8 battery terminals)

Preferred 12VDC 100Ah Heated Lithium

Turn on the system by switching MCBs to the ON position. The green LED on the base should illuminate.

A suitable battery (100Ah Heated 12VDC Lithium advised) should be purchased locally through your distributor and installed to the electronics enclosure using the M8 battery harness. Note, the BTD shall be powered by 12VDC (or 24VDC if using 24VDC battery). If you are providing your own battery you may need to setup the charger controller. See:

https://www.victronenergy.com/upload/documents/Manual_SmartSolar_MPPT_75-10_up_to_100-20/29694-MPPT_solar_charger_manual-pdf-en.pdf

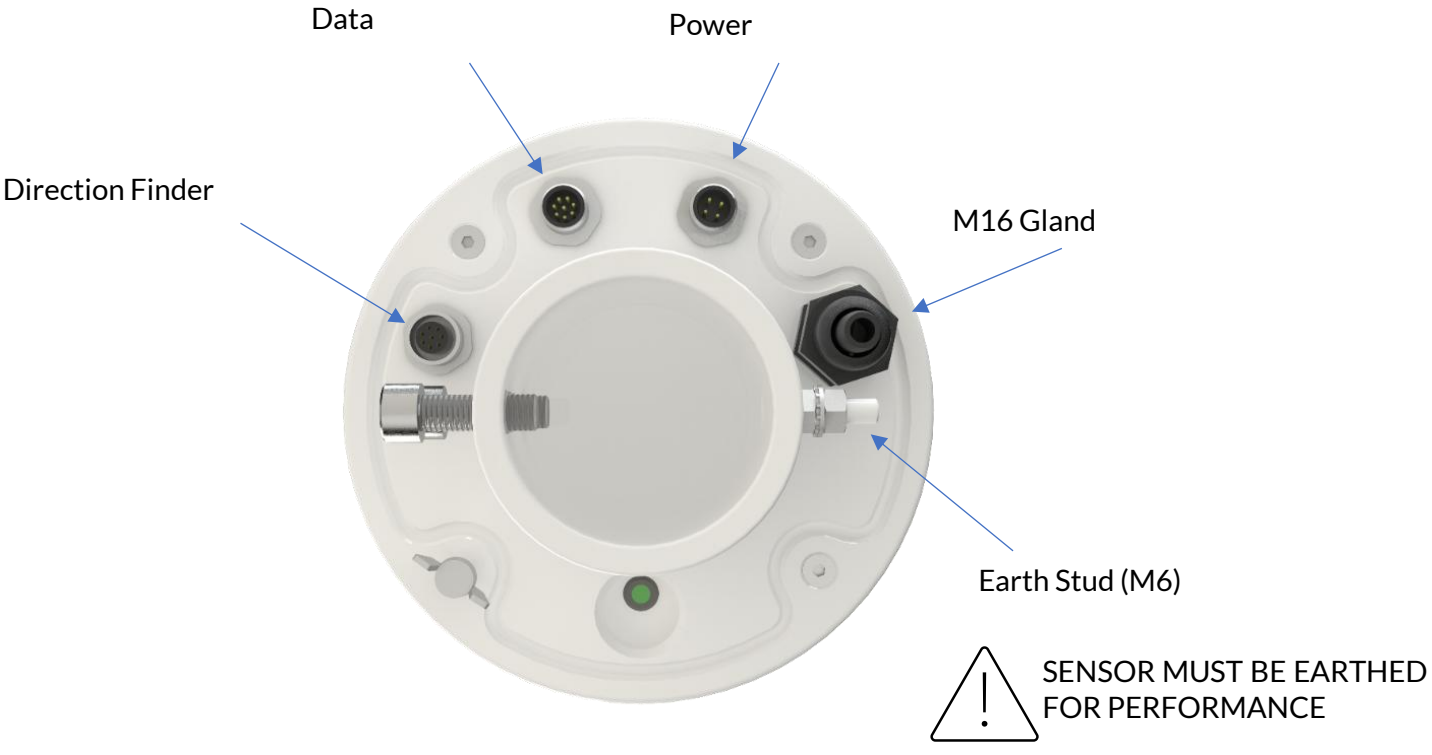
Whilst the solar kit has been designed to operate all-year round, it cannot be guaranteed to provide continuous power during the winter months.

3.3 Electrical Interfaces

The BTD is supplied as a sealed unit with three M12 connectors and an M16 gland on the base of the unit. The M12 connectors are:

Description	Sensor Connector
Power (9-36VDC)	M12 5-Way A Coded (Male)
Data (RS-422)	M12 8-Way A Coded (Male)
Direction Finder	M12 8-Way A Coded (Female)

The M16 gland is for relays or any other custom wiring. For relay use refer to section 4.3.



3.3.1 Power

The power requirements for the sensor are as follows:

Sensor Voltage	**9-36VDC**
Sensor Power (Typ)	**2W**

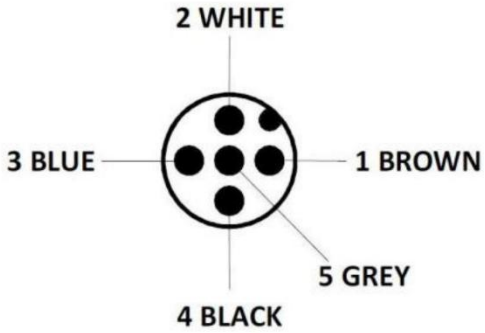
WARNING – Operating outside of the specified voltage range will PERMANENTLY DAMAGE the sensor. In battery or solar operated systems, an automatic low battery voltage disconnect device MUST be used.

The following optional modules increase the total power consumption as follows:

Module	Additional Power Required
Direction Finder	2W
Radio Module	1W
Extended Heater	Up to 50W

The power connection is made via the M12 5 Way A Coded Male connector on the base of the BTD. If using the supplied power lead the internal core colours are provided. Note, the core colours may vary if purchasing your own cabling.

Power Pin	Description	Core Colour
1	Sensor +	BRN
2	Sensor 0V	WHT
3	NC (Heater +)	BLU
4	NC (Heater -)	BLK
5	Functional Earth	GRY



By default, the heater is powered from the sensor power. The heater power can be separated from the sensor power by following section 5.13.

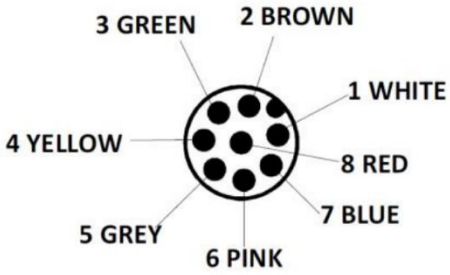
3.3.2 Data

The BTD-1 communicates over RS422 by default.

The data connection is made via the M12 8 Way A Coded Male connector on the base of the BTD. If you are using the Senseca data lead, the internal core colours are provided. Note, the core colours may vary if purchasing separate cabling.

RS422

Data Pinout	Description	Core Colour
1	5V	WHT
2	0V	BRN
3	RS422 TX+	GRN
4	RS422 TX-	YLW
5	RS422 RX+	GRY
6	RS422 RX-	PNK
7	NC	BLU
8	0V Isolated	RED



If utilising the Radio Modules, the transmitter radio module is fitted with a preassembled lead and should be plugged directly into the data port. The receiver radio module connector matches that of the sensor data port including the pinout.

Systems Integration

The BTD communicates over an ASCII command set with a broadcast message transmitted every two seconds. The broadcast message contains details of the sensor status and any lightning related information. An RS422 line is used by default, with an optional ethernet module available for purchase.

Alternatively, three relays are located inside the enclosure which can be triggered by various events. See section 4.3 for more details on the relay operation.

4.1 Serial Communications

The RS422 line has the following specification:

Baud Rate	57600
Data Bits	8
Parity	N
Stop Bits	1

Message Format		
Module ID	ASCII Message	CRLF

<00> from BTD

<01> to BTD

For ethernet usage see the Ethernet Optional Module user guide.

4.2 Broadcast Message

The broadcast data message is transmitted every two seconds. See table for details:

Field	Description	#chars
<00>,	Module ID	5
DATA:,	Message Header	6
ID,	Sensor ID Number *(Default 01)*	3
DDMMYY,HHMMSS,	Current BTD Date/Time	14
WW,	Risk Level	3
CCCC,	Active Flags (Prewarnings, other features)	5
BBBB,	System Level Status	5
RR,	Relay Status	3
+VVVVVV,	E-Field Data	8
AA,	Number of flashes in message	3
UUU,	Flash Index Number	4

Field	Description	#chars
DDMMYY,HHMMSS,	Flash 1 Date & Time	14
CCC,	Number of milliseconds	4
XXXXXX,	Distance to flash in metres	7
XXX,	Direction to flash in degrees	4
TTTT,	Reserved	5
DDMMYY,HHMMSS,	Flash 2 Date & Time	14
CCC,	Number of milliseconds	4
XXXXXX,	Distance to flash in metres	7
XXX,	Direction to flash in degrees	4
TTTT,	Reserved	5
DDMMYY,HHMMSS,	Flash 3 Date & Time	14
CCC,	Number of milliseconds	4
XXXXXX,	Distance to flash in metres	7
XXX,	Direction to flash in degrees	4
TTTT,	Reserved	5
DDMMYY,HHMMSS,	Flash 4 Date & Time	14
CCC,	Number of milliseconds	4
XXXXXX,	Distance to flash in metres	7
XXX,	Direction to flash in degrees	4
TTTT,	Reserved	5

4.2.1 Risk Level

The system operates on four different alert levels. By default, these are:

Description	Risk	Risk Level (WW)	Triggers
All-Clear	Lowest Risk	0	-
Caution	Small Risk	1	Charged Precipitation Range Band 3/4
Warning	Medium Risk	2	Strong Electric Field Range Band 2
Alert	High Risk	3	Range Band 1

The Warning/Alert Flag triggers can be configured by the users, see section 5.2.

The flag shall persist for a given timeframe after being triggered, by default this is 15 minutes and can be changed by the user, see section 5.3. During periods of no thunderstorm activity the sensor shall return to the All-Clear state.

4.2.2 Active Flags

Active Flags are indicators of either events triggered outside of lightning flashes or operation modes of the BTD. These can be used to understand why an alert or warning flag has been triggered. The active flag is transmitted in hex format and can be decoded in a bitwise manner.

Hex (CCCC)	Binary Equivalent	Feature Flag
0001	0000000000000001	Strong Electric Field
0002	0000000000000010	Charged Precipitation
0004	0000000000000100	Severe Storm
0008	0000000000001000	Reserved
0010	0000000000010000	Reserved
0020	0000000000100000	Reserved
0040	0000000001000000	Reserved
0080	0000000010000000	Reserved
0100	0000000100000000	Maintenance Mode
0200	0000001000000000	Site Characterisation Active
0400	0000010000000000	FSG Mode
0800	0000100000000000	Reserved
1000	0001000000000000	Reserved
2000	0010000000000000	Reserved
4000	0100000000000000	Reserved
8000	1000000000000000	Reserved

Multiple flags can be triggered simultaneously. For lightning related events there is a persistence time associated to each flag. For operating status information, the flag remains active for as long as the operating status is valid.

4.2.3 System Status

The system status indicates if the system is fully operational or if there is a fault.

In the event of an error, see the relevant action.

Hex (BBBB)	Binary	Status Flag	Action
0001	0000000000000001	Reserved	-
0002	0000000000000010	1.2V Error	Contact Senseca
0004	0000000000000100	2.5V Error	Contact Senseca
0008	0000000000001000	+5V Error	Contact Senseca
0010	0000000000010000	-5V Error	Contact Senseca
0020	0000000000100000	Input Power Range Exceeded	Check input voltage
0040	0000000001000000	Antenna Saturation	Clean sensor
0080	0000000010000000	Insulator Failure	Clean sensor
0100	0000000100000000	Insulator Leakage	Clean sensor
0200	0000001000000000	FPGA Health check	Contact Senseca
0400	0000010000000000	EEPROM Checksum	Contact Senseca
0800	0000100000000000	Missing or Invalid Site Characterisation	See section 5.16
1000	0001000000000000	GPS Error	See section 5.12 / Contact Senseca
2000	0010000000000000	Direction Finder /FSG Error	Reset sensor / Contact Senseca
4000	0100000000000000	Reserved	-
8000	1000000000000000	Reserved	-

4.2.4 Relay Status

The relay status is transmitted. The relays are tied to either the alert/warning status or a system fault, see section 4.3 for relay use.

Hex (RR)	Binary	Relay Flag
01	00000001	Relay1
02	00000010	Relay2
04	00000100	Relay3
08	00001000	Reserved
10	00010000	Reserved
20	00100000	Reserved
40	01000000	Reserved
80	10000000	Reserved

4.2.5 E-Field Data

The background electric field is reported every two seconds as a dimensionless scalar value (+VVVVVV). This output is designed to convey relative shifts in field strength, it does not represent a calibrated magnitude in V/m.

4.2.6 Flash Data

The number of flashes detected in the previous two seconds is indicated (AA, maximum of four). If no flashes are detected the subsequent data can be ignored and will be set to all zeros. The date and time is given for each flash in UTC, synchronised to GPS time to within 30ms. This is provided in the format DDMMYY,HHMMSS,CCC where CCC is the number of milliseconds. The distance to the flash from the sensor is given in metres. For example, a reading of 1234 is the equivalent of 1234m away from the sensor.

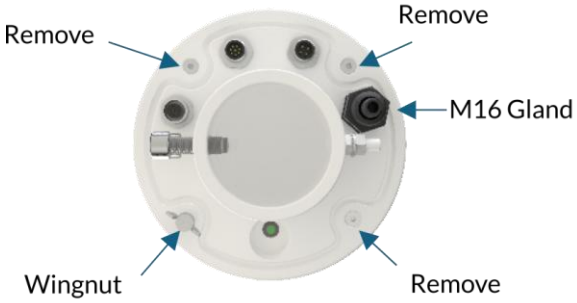
For sensors with a direction finder fitted, the bearing of the flash will be given in degrees. For flashes which the direction finder has been unable to identify a direction, or if where a direction finder has not been fitted, this value will be 999.

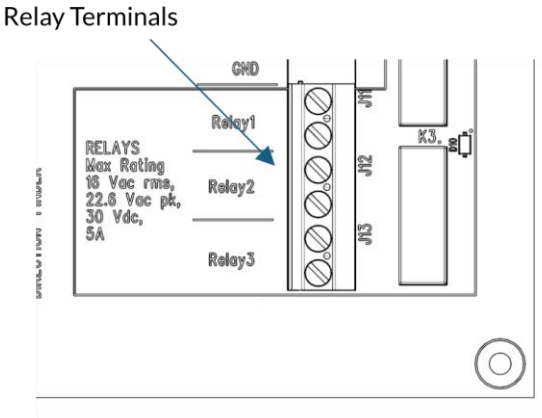
The last 4 characters of each flash block are reserved for internal use.

The flash index can be used to retrieve missing flash data, see section 5.10.

4.3 Relays

For users who wish to use relays for integration the device must be opened. This requires the use of a 2.5mm hex key. Locate the three countersunk bolts on the connector face of the device and remove. Turn the wingnut clockwise fully to push the cover away from the top face and then remove the thumbscrew by turning anticlockwise. Pull the cover downwards towards the connectors and the cover should slide off, an earthing strap prevents full removal. Feed a suitable cable through the M16 gland (OD between 5-10mm) and connect the relays.





By default, the relays are configured such they will trigger as follows:

Relay	Trigger	Contacts
1	Alert	NO
2	Warning	NO
3	Sensor Fault	NC (NO during fault)

It is possible for the user to reconfigure the relays, see section 5.15.

The maximum ratings of the relays are as follows:

Voltage – 30VDC or 18VAC rms

Current – 5A

In the no power condition, the relays are normally open and continue in this state until the relevant trigger is active. The exception being a sensor fault whereby the relay is closed upon sensor power and remains closed until either no sensor power is applied, or a sensor fault is detected.

To replace the cover, align the notches and push the cover onto the BTD. Re-insert the three countersunk bolts and fully tighten. Once tightened reinsert and tighten the thumbscrew.

5 Advanced Sensor Options

The BTD features can be configured to suit the customer requirements through a series of commands and responses. Certain features are obtainable through purchasable software modules, see section 5.19 for available modules.

5.1 Sensor Commands and Responses

The sensor utilises a message timing protocol. The message timing protocol allows for integration with other Senseca accessories (e.g. Radio Module) without clashes occurring on the network. If no Senseca accessories are utilised the message timing protocol can be ignored. See section 5.14 for more information on the message timing protocol.

Use the table below to view the complete list of commands available. Each command relates to an option which is described in a later section.

Command	Description	Response/Section
ALERTTRIGGER?	Request the number of triggers required to activate each system level	See Section 5.4
ALERTTRIGGER,X,Y	Set the number of triggers required to activate each system level	See Section5.4
ALERTPERSIST?	Request the persistence time of each system level	See Section 5.3
ALERTPERSIST,X,Y	Set the persistence time of each system level	See Section 5.3
BROADCAST?	Query if the broadcast message is enabled	See Section 5.5
BROADCAST,X	Set automatic broadcast on or off	See Section 5.5
BUILDINFO?	Request sensor build information	See Section 5.18
CALCSCF,A,R	Request sensor to calculate the Flash Correction Factor	See Section 7.2
DATA?	Request the latest broadcast message	See Section 5.5
DIST?	Request the range band distance thresholds	See Section 5.11
DIST,A,B,C,D	Set the range band distance thresholds	See Section 5.11
DFCONNECTED?	Query if a direction finder is connected	See Section 5.6
FEATUREALERT?	Query all feature system level subscriptions	See Section 5.2
FEATUREWARN,X,Y	Set feature system level subscription	See Section 5.2
FLASHDATA,X?	Get flash data from rolling buffer	See Section 5.10
FLASHPARAMS?	Request flash data rolling buffer current index	See Section 5.10
GPS?	Request device location and time (UTC)	See Section 5.12
HEATERPOWER?	Request heater power	See Section 5.13
HEATERPOWER,X	Set heater power (requires module licence)	See Section 5.13

Command	Description	Response/Section
ID?	Query sensor ID number	See Section 5.17
ID,X	Set sensor ID number	See Section 5.17
MAXRANGE?	Query the maximum range of sensor	See Section 5.11
MODULEKEY,bbbbbbbb,ssssss	Send activation key to BTD	See Section 5.19
PAUSE,X	Pause BTD sampling	See Section 6
RANGEALERT?	Query flash range band system level subscriptions	See Section 5.2
RANGEALERT,X,Y	Set flash range band system level subscription	See Section 5.2
RELAYINACTIVE,X,Y	Set relay inactive times	See Section 5.15
RELAYSTAT?	Query relay status	See Section 5.15
RELAYSUB,X,Y	Set relay alert subscription	See Section 5.15
RESET	Restart the BTD	-
SEFLEVEL?	Query the Strong Electric Field Level	See Section 5.9
SEFLEVEL,X	Adjust Strong Electric Field Level	See Section 5.9
SEVEREPARAMS?	Query the severe storm feature parameters	See Section 5.7
SEVEREPARAMS,X,Y	Set the severe storm feature parameters	See Section 5.7
STARTSITE	Start a manual site calibration	See Section 5.16

5.2 Alert/Warning Subscriptions

By default, the system level alerts/warnings are configured as follows:

Description	Risk	Risk Level	Triggers
All-Clear	Lowest Risk	0	-
Caution	Small Risk	1	Charged Precipitation, Strong Electric Field Range Band 3/4
Warning	Medium Risk	2	Range Band 2
Alert	High Risk	3	Range Band 1

The BTD can be reconfigured to suit the customers perceived level of risk, for example, the prewarning's can be removed from any system level warning. It is not possible to prevent a flash from the range 1 flash band from triggering an alert (highest risk) flag.

Range Band Subscriptions

Use the command **RANGEALERT,X,Y** to alter which system level is triggered from a flash within each range band, where:

X is the range band to be assigned (1-4)

Y is the alert/risk level to be assigned (0-3)

For example, **RANGEALERT,2,3** would assign a flash in range band 2 to trigger the Alert (highest risk) system level.

For details on how to configure the range band distances, see section 5.11.

Use the command **RANGEALERT?** to query the current settings. The sensor will respond with:

RANGEALERT:,AA,BB,CC,DD

Where AA,BB,CC,DD are the assigned risk levels for each of the range bands. AA being range band 1.

Lightning Feature Subscriptions

The system level status can be triggered on other BTD features, for example lightning pre-warnings and severe storm detection. To assign a feature to a system level status use the command **FEATUREWARN,X,Y** where:

X is the feature to be assigned

Y is the risk level to be assigned (0-3)

See the table below for each of the features and the corresponding feature number.

	Feature Flag
1	Strong Electric Field
2	Charged Precipitation
3	Severe Storm
4	Reserved
5	Reserved
6	Reserved
7	Reserved
8	Reserved

Use the command **FEATUREALERT?** to query the current settings. The sensor will respond with:

FEATUREALERT:.AA,BB,CC,DD,EE,FF,GG,HH

Where the features assigned risk levels are detailed in order of feature number, for example AA is the assigned risk level for feature 1.

5.3 Alert/Warning Persistence

By default, the persistence of each alert/warning is as follows:

System Severity Level	Risk Level	Persistence Time
Alert	3	15 Minutes
Warning	2	15 Minutes
Caution	1	15 Minutes

The persistence time is adjusted using the **ALERTPERSIST,X,Y** command where:

X – Risk Level (1-3)

Y – Persistence time in seconds (maximum 999 seconds)

5.4 Alert/Warning Required Triggers

By default, the BTD shall trigger an alert/warning based on the following:

System Severity Level	Number of Triggers
Alert	1
Warning	1
Caution	2

A trigger is an event that occurs that would cause the relevant system level status according to section 5.2. For example, a flash would count as one trigger event. Whereas when a prewarning or other persistent condition occurs each corresponding broadcast message counts as a trigger.

It is possible to configure the number of triggers required for each severity level using the command **ALERTTRIGGER,X,Y** where:

X – is the risk level (1-3)

Y – number of triggers required to trigger risk level (1-4)

To query the current settings, use the command **ALERTTRIGGER?** The response shall be in the format:

ALERTTRIGGER;,AA,BB,CC

5.5 Broadcast Message Enable/Disable

By default, the BTD broadcasts an output message every two seconds. For systems where the BTD acts as a slave the broadcast message can be disabled.

To enable / disable the BTD 2-second broadcast message use the command **BROADCAST,X** Where X:

0 – Disable Broadcast

1 – Enable Broadcast

To query the current broadcast mode, use the command **BROADCAST?**

Use the command **DATA?** to retrieve the latest broadcast message. Note, the broadcast message is built every two seconds regardless of the broadcast enable setting.

5.6 Direction Finder Query

The BTD shall automatically detect any direction finder hardware that is fitted. When no direction finder is fitted or for flashes with little radio frequency content, the flash bearing will be indicated as 999.

In the event a direction finder is fitted, but the user is unsure if it is connected it is possible to query the BTD with the **DFCONNECTED?** command.

The response **DF CONNECTION:,AA,BB** indicates:

AA – 01 DF Fitted 00 DF Not Fitted

BB – 00 No DF Error

5.7 Feature – Severe Storm

The BTD can warn of localised severe storms by monitoring the number of flashes per minute. During periods of high activity, storm cells are much more likely to produce strong winds and large hailstones.

By default, the severe storm threshold is set by 10 flashes per minute and a range of 8km. Once triggered, the severe storm feature flag will be present in the broadcast message. The flag remains persistent for 5 minutes. It is possible for the user to change the severe storm settings using the command:

SEVEREPARMS,X,Y where:

X – Distance to threshold in km

Y – Flash rate per minute to trigger (1-20)

To query the severe storm parameters using the command **SEVEREPARAMS?**

The response shall be **SEVEREPARARMS,X,Y** where X and Y are the same as above.

It is possible to link the severe storm to an alert/warning, see section 5.2.

5.8 Feature – Charged Precipitation

The BTD warns of charged precipitation from an overhead cumulonimbus cloud (Cb). When charged precipitation is detected the charged precipitation flag within feature flags of the broadcast message is set and persists for 10 broadcast messages from the last trigger.

By default, the detection of charged precipitation triggers a caution. Whilst no lightning flashes may have occurred yet, 1 in 10 of these cumulonimbus clouds go on to produce lightning flashes. It is possible to change the link to an alert/warning, see section 5.2.

5.9 Feature – Strong Electric Field

The BTD warns of a strong electric field produced from a nearby cumulonimbus cloud (Cb). When a strong electric field is detected the strong electric field flag within feature flags of the broadcast message is set and persists for 10 broadcast messages from the last trigger.

By default, the detection of a strong electric field triggers a warning. Whilst no lightning flashes may have occurred yet, 1 in 5 of these cumulonimbus clouds go on to produce lightning flashes. It is possible to change the link to an alert/warning, see section 5.2.

The threshold in which the strong electric field flag is triggered is adjustable between 0-10, with 0 being the most sensitive and 10 being the least sensitive. To adjust the electric field sensitivity, use the command **SEFLEVEL,X** where X is between 0-10. The default being 5.

To query the current sensitivity level use the command **SEFLEVEL?**

5.10 Flash Data Recovery

The BTD stores data from the previous 128 flashes on a rolling memory buffer. To recover the data the user must first query the index number of the flash memory rolling buffer using the command **FLASHPARAMS?** which returns **FLASHPARAMS:,X,Y** where X is a rolling count to 65535 and Y is the current flash index (1-128). The flash data can then be recovered using the command **FLASHDATA,Z?** where Z is the flash index to be recovered. The response is in the format:

FLASHDATA:,AAA,DDMMYY,HHMMSS.MMM,DDDDDD,EEE,0xGGGG

AAA – Flash Index Number

DDMMYY – Flash Date Day/Month/Year

HHMMSS.MMM – Flash Time Hours/Minutes/Seconds/Milliseconds

DDDDDD – Distance in metres

EEE – Direction (999 if no direction)

0xGGGG – Not currently used

Note, all flash timing is given in UTC.

5.11 Flash Range Bands

The BTD features four flash range bands. The range bands by default are:

Flash Range Band	Flash Distance
1	0-8km
2	8km-16km
3	16km - 24km
4	24km+

The range bands are linked to the system risk level, see section 5.2.

The user may configure the flash range bands using the command **DIST,A,B,C,D**. Where each band upper limit is set in units of kilometres.

A – Range Band 1 B – Range Band 2 C – Range Band 3 D-Range Band 4

Range band 1 cannot be set to less than 3km. Subsequent range bands must be either the same or higher value than the previous range band. Flash data will always be present in the broadcast message but may not always be assigned to a range band or system alert level.

The maximum range by default is 35km, and extended range of 83km is possible through the purchase of the Extended Range Module. To query if the extended range module is active use the command **MAXRANGE?** If range band 4 is set to default, it will automatically extend to 83km on module activation. See section 5.19 on how to activate modules.

5.12 GPS/GNNS Query/Settings

The BTD includes a GNNS module in the housing which retrieves satellite location and timing in UTC. The user may query the location and time of the device using the command **GPS?**. The sensor will respond with:

GPS:, ±AAA.AAAAAA, ±BBB.BBBBBB,Date:,DDMMYY,Time:,HHMMSS

±AAA.AAAAAA – Latitude Coordinate

±BBB.BBBBBB – Longitude Coordinate

DDMMYY – Date in Day/Month/Year

HHMMSS – Time in Hours/Minutes/Seconds

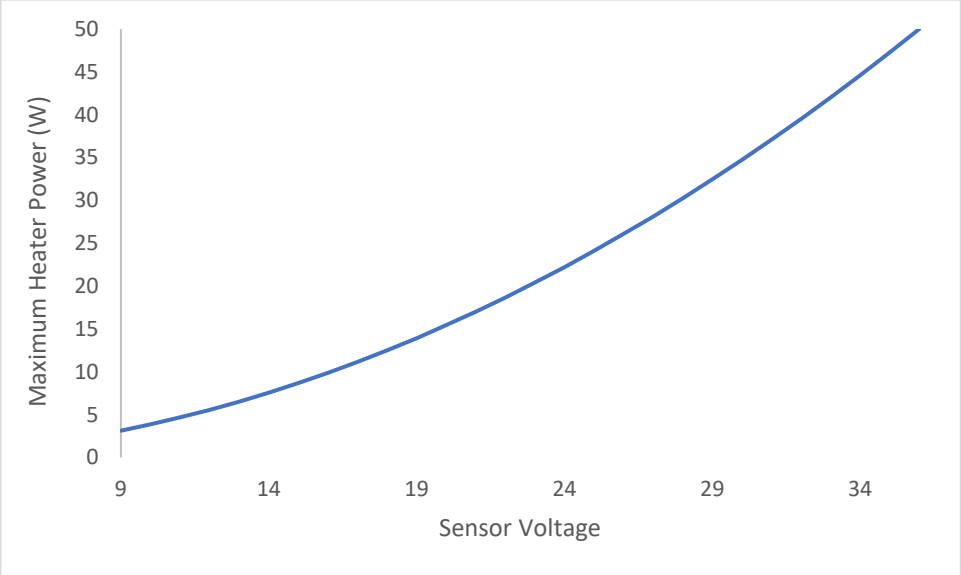
For systems that utilise the GPS location from the sensor for mapping purposes (Lightning Eye), it is possible to set the GPS location using the command **GPSLOC,X,Y** where X is the latitude and Y is the longitude coordinate. This may be used in locations where GNNS signal is not reliable.

5.13 Heater Settings

The BTD houses a heater within the enclosure with a default power of 1W. The heater prevents dew from building up on the sensor during normal use.

It is possible to increase the heater power for extreme environments, e.g. snow/ice, by purchasing the **Extended Heating Module.** This module allows for the heater power to be adjusted up to 50W. To adjust the heating power, use the command **HEATERPOWER,X** where X is the power target in Watts. Note, for a heater power of 50W a supply voltage of 36VDC is required, see below table.

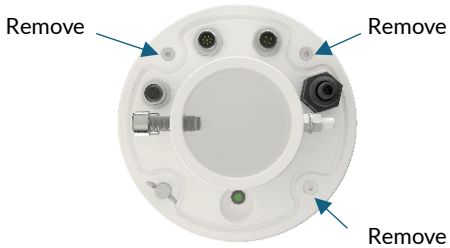
To query the current heater power setting use the command **HEATERPOWER?**



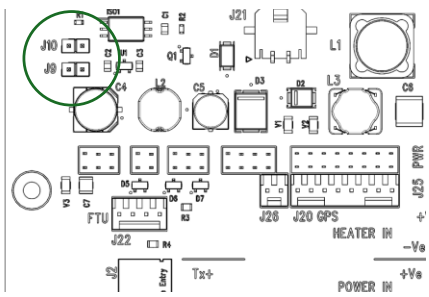
It is possible to separate out the heater power from the sensor power. To do so, the device must be opened. This requires the use of a 2.5mm hex key. Locate the three countersunk bolts on the connector face of the device and remove. Pull the cover downwards towards to remove.

Locate the heater power jumpers and remove. Note, the heater power is now isolated from the sensor power and can be connected as per section 3.3.1.

To refit the cover, follow the reversal of removal. Note, there are notches to facilitate alignment of the cover.



Remove Jumpers



5.14 Message Timing Protocol

If you are using the BTD-1 as a standalone sensor with no additional modules the timing protocol can be ignored.

A message timing protocol is active by default on the BTD. The message timing protocol is required when utilising Senseca accessories such as the wireless module.

The timing protocol splits the time between the 2 second broadcasts into timing slots whereby only one device is permitted to transmit a message at a time. The broadcast message signals T=0. See below timing diagram.

The BTD transmits a broadcast message between 0-100ms, and responds to any communication within the free slots at 800ms and 1600ms.

5.15 Relays

The relays can be assigned to either alert/warning levels, or a fault condition. By default, the relays are configured to match the alert/warning levels.

Relay	Relay Subscription
1	Alert
2	Warning
3	Fault

To reassign the relay subscription, use the command **RELAYSUB,X,Y** where X is the relay, Y is any of the following:

0 – Fault

1 – Alert

2 – Warning

3 – Caution

Using a combination of the alert subscriptions and the relay subscriptions the relays can be linked to any feature.

The status of the relay (on/off) is detailed in the broadcast message and can be queried separately using the **RELAYSTAT?** command. The response will be in hex in the following format **RELAY STATUS:0xAA** where AA is decoded using the following table:

Hex Value	Binary	Relay Flag
01	00000001	Relay1
02	00000010	Relay2
04	00000100	Relay3

Relay operation can be disabled during certain hours to prevent nuisance alarms during unsociable hours. For example, if the relays are connected to a local sounder. Use the command **RELAYINACTIVE,X,Y** where:

X – Relay Inactive Start Minute (from midnight UTC)

Y – Relay Inactive Stop Minute (from midnight UTC)

E.g. **RELAYINACTIVE,1140,420** shall disable the relays from 7pm to 7am UTC. Setting the inactive time to 0,0 disables the relay inhibit feature.

5.16 Site Calibration

The BTD uses the location provided by the GPS module to identify if the sensor has moved on startup. In the event the sensor has moved more than 1km the BTD shall attempt to perform a site calibration automatically. A site calibration requires no background thunderstorm activity or movement near the sensor. In the event the site calibration fails the sensor shall attempt to repeat the site calibration every 30 minutes until successful. A site calibration error flag shall be present in the broadcast message in the event the site calibration fails. A poorly grounded BTD is the most common cause of a site calibration failure.

If the BTD does not move, and the local environment does not change, for example no additional infrastructure is placed around the sensor, the site calibration shall remain valid. In the event of a small movement of less than 1km the site calibration must be performed manually using the command **STARTSITE**. The sensor will acknowledge the command by responding with **OK**. A site calibration error flag shall be present in the broadcast message in the event the site calibration fails.

5.17 Sensor ID

The sensor ID forms part of the broadcast message. By default, the ID is set to 1 and may be changed by the user using the command **ID,XX** where **XX** is between 00 and 99.

The sensor ID is typically used where multiple BTDs are utilised within one system.

5.18 Sensor Information

The build information of the sensor can be request using the command **BUILDINFO?** where the response is:

BUILDINFO:,AAA,HHH,SI100BBB.BBB,DD.DD

AAA- Sensor Serial Number

HHH – Model (BTD-1)

BBB.BBB – Software Version

DD.DD – FPGA Version

5.19 Software Modules

Additional features of the BTD can be enabled using software module licences. The following list of Modules are currently available:

Software Module	Ordering Code
Extended Range	B1A.EXT
Extended Heating	B1A.EH
Lightning Eye (V1)	B1A.LE1

To enable a module the licence code must first be purchased from Senseca. To generate a licence code the serial number of the device must be provided. The licence code is only valid for the sensor serial number provided and is non-transferable to another sensor.

To enable the module, send the command **MODULEKEY,bbbbbbbb,SSSSSS** where **bbbbbbbb,SSSSSS** is the code provided by Senseca.

To view active modules the sensor must be connected to the Lightning Eye package. See the Lightning Eye user manual for further details.

6 Maintenance

The BTD-1 requires no routine maintenance, however, it is recommended the following checks are carried out at least annually to ensure your system continues to work reliably. Before carrying out maintenance ensure there is no lightning activity in the area. To prevent any unwanted alarms caused by activity in the proximity of the sensor use the command **PAUSE,X** to temporarily stop the sensor (X minutes). If maintenance lasts longer than X minutes use the **PAUSE,X** command to reset the timer. After X minutes has passed the sensor will operate as normal.

6.1 Clearing Vegetation

Ensure that no vegetation has grown up around the BTD that could interfere with operation. See Section 3.1 for the required site conditions.

6.2 Cables, Corrosion and Fasteners

The BTD is made from aluminum and stainless steel. However, it is recommended that all mounting hardware and associated fasteners (nuts and bolts) are checked to ensure they are corrosion free and tight.

When the BTD is installed in a very corrosive environment, such as close to the sea or in some industrial areas, some discolouration of the sphere may occur. If this happens, clean the sphere, and apply a thin coat of light oil using a cloth.

Check the condition of all cables going to the BTD. Ensure the cables are secured so they cannot be damaged by moving around in the wind.

6.3 General Cleaning

It is recommended that any heavy buildup of spider webs and dirt is removed from the BTD sensor. This can be achieved with a brush and water as required.

Small amounts of detergent can be used to clean the sensor but make sure the sensor is thoroughly rinsed to remove all traces of detergent.

6.4 Fuse Replacement

The BTD is protected by two fuses internally, one for the sensor, one for the heater, located on the terminal board.

In the unlikely event that the fuse fails it should be replaced by a fuse of the same rating. The specification of the fuse is as follows:

Type: 5 x 20 mm
Speed: Anti Surge
Current: 2 A
Voltage: 250 V

If the fuse continues to fail, contact your local supplier or Senseca for further assistance.

6.5 BTD Status Indicator

An indicator light is located on the base of the BTD to provide a visual check of the sensor's status. When the BTD is powered and operating without any faults the indicator will show steady green. If a fault is detected the indicator will flash on and off.

7 Adjusting the Flash correction factor

If the BTD is installed at a different height than recommended, on the roof of a building or close to tall objects, the lightning distance reported by the detector may be inaccurate. If you notice a systematic difference between actual distance to a storm and distance reported by your BTD, you will need to re-calibrate the Flash Correction Factor.

7.1 Finding the Actual Lightning Distance

There are several options to independently find the actual distance to lightning, the recommended methods are detailed below.

For all the methods discussed below; to increase confidence of the comparison distances, it is best to compare many flashes and find a typical distance reported by the BTD and the independent method. Always make sure that you are comparing lightning flashes detected by the BTD and an independent method which occurred at the same time. Note, the BTD is typically much more sensitive to flashes than a lightning network.

7.1.1 National Lightning Location Network

Lightning detection by a national lightning location network is usually the best option for locating lightning flashes as you can see individual flashes in near real-time. This service can normally be found on your national weather service website or good quality lightning data sites such as www.lightningmaps.org.

Identify individual flashes that are shown by both the BTD and the lightning location network and record the distance reported by the BTD and the distance from the BTD to the flash as shown on the lightning location network. For best results choose a small, localised storm and average the BTD distance and lightning network distance for several flashes. Note, the lightning network will typically show multiple strokes instead of the overall flash. The BTD reports these as a singular flash.

7.1.2 Visible Lightning

If lightning is within about 10 km you should be able to see the lightning flash and hear the thunder, especially at night. To determine the distance to the lightning flash, measure the time between seeing the flash and arrival of thunder, in seconds. Divide this time by 3 to find the distance to lightning in kilometres (divide by 5 for miles). For each measured flash record the distance reported by the BTD. As before average the distances you calculated and those reported by the BTD over several flashes for best results.

You will find this process easier if you choose a storm that is not too active, so that you do not confuse individual lightning flashes. Avoid using nearby flashes, closer than 5km, as it is hard to accurately measure the time in such cases.

7.2 Adjusting the Flash Correction Factor

To adjust the flash correction factor use the command CALCSCF,YY.Y,ZZ.Z where:

YY.Y = Third-party reported distance in km

ZZ.Z = BTD reported distance in km

8 Accessories

The BTD can be supplied with a number of optional accessories. This section provides an overview for each accessory/module. Additional details for accessories may be found in individual product manuals.

8.1 Direction Finder

The direction finder utilises radio frequency content from flashes to provide a flash bearing, see section 4.2.6 for installation. The direction finder is available as a plug and play module for the BTD, use the ordering code B1A.DF.

The direction finder utilises up to an additional 2W of power from the basic sensor.

8.2 Radio Modules

The radio modules provide a proprietary data link between the BTD and a server. When combined with the solar module kit the BTD can be installed in a remote location without the need for cabling.

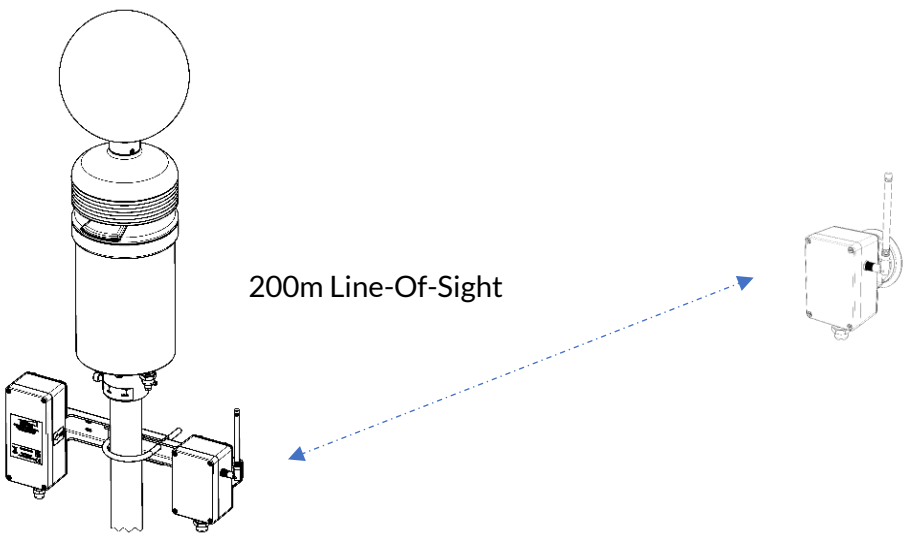
UK/EU radio modules operate over 868MHz

USA/ASIA radio modules operate over 915MHz

It is recommended that the distance between the transmitter (TX) module and the receiver (RX) module is kept below 200m and preferably a clear line of sight is provided. The maximum working range of the radio modules is 1000m. At a distance of 1000m any obstruction to the radio path shall result in a loss of signal.

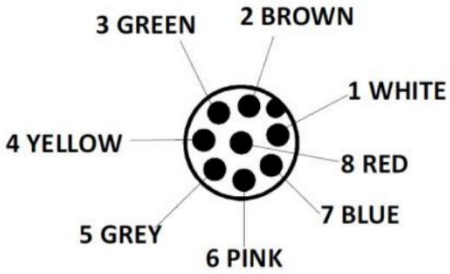
Each radio module requires 1W to operate.

The TX module is provided with a 500mm preassembled lead and connects directly to the data port of the BTD.



The RX module is provided with an M12 connector which matches that of the BTD sensor RS-422 data port. A BTD data cable can be used to connect the RX unit to the RS-422 to USB converter. A suction mount is provided to place the device in a window for clear line of sight to the transmitter.

Data Pinout	Description	Core Colour
1	5V In	WHT
2	0V	BRN
3	RS422 TX+	GRN
4	RS422 TX-	YLW
5	RS422 RX+	GRY
6	RS422 RX-	PNK
7	NC	BLU
8	NC	RED



8.3 Field Mounting Kit

The field mounting kit provides a universal support base and a 1.2m pole. The universal support base can be used in a variety of applications as it is supplied with three ground anchors for use in:

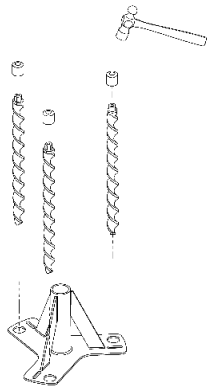
- Soil
- Concrete

Soil

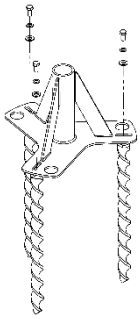
To use the support base in soil first place the base in the area in which the BTD is to be installed. The base acts as a template for the three anchors to be hammered into the soil using the supplied protection cap and mallet. The bolts must be removed from the anchors and the protection cap fitted over the top. Hitting the anchors with the mallet forces them to screw themselves into the ground. **WARNING: Ensure there are no services located underground where you are mounting the BTD**

Once the anchors have been inserted using the base as a template and are flush to the base the protection cap can be removed. The base should be rotated such the slots align with the three anchors and the bolts refitted. The pole is fixed to the base using 3 x M8 bolts. A straight adapter is used to separate the pole in two and is tightened using a 22mm spanner.

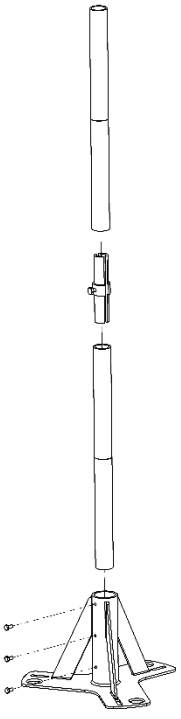
1.



2.



3.



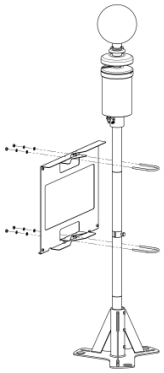
Concrete

When fitting to concrete it is recommended the concrete is poured and a suitable fixing method is obtained by the customer. An example of fixing method would be an M8 Rawlplug shield anchor.

8.4 Solar Kit

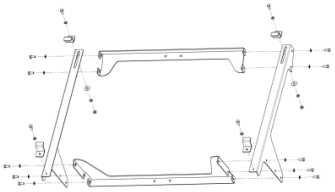
The BTD solar kit compromises of an electrical cabinet and solar panel to provide continuous power to the BTD without the need for a fixed power supply. When combined with the radio module kit a complete remote installation is possible.

To install the solar kit follow the instructions below:



1) Install the Electrical Box Bracket approximately 300mm below the BTD (on the marked line)

🛠 13mm Spanner



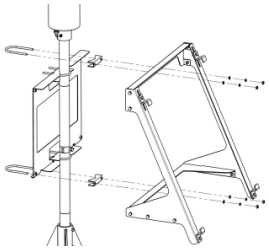
2) Assemble the Solar Bracket

🛠 8mm Hex

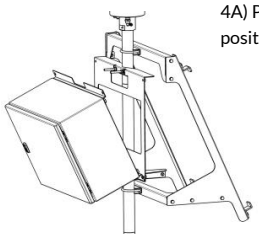
🛠 13mm Spanner

3) Install the Solar Bracket

🛠 13mm Spanner

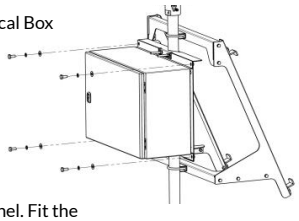


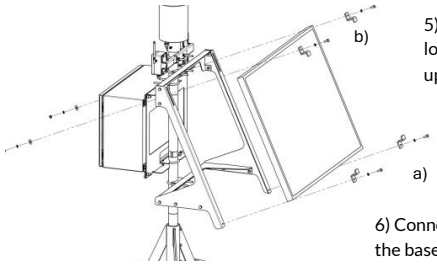
4A) Place the Electrical Box into position



4B) Secure the Electrical Box using 4 x M8 Bolts

🛠 8mm Hex

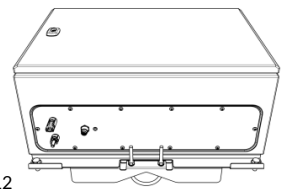




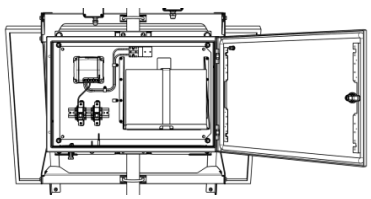
5) Secure the solar panel. Fit the lower clips first, followed by the upper clips

🛠 8mm Hex

🛠 13mm Spanner



6) Connect the solar MCS leads to the base of the Electrical Box, connect the BTD power via the M12 connector



7) Install a suitable battery and connect via the Anderson fused harness (M8 battery terminals)

Preferred 12VDC 100Ah Heated Lithium

Turn on the system by switching MCBs to the ON position. The green LED on the base should illuminate.

A suitable battery can be purchased from your local distributor. Note, if you are providing your own battery you will need to setup the charger controller. See

https://www.victronenergy.com/upload/documents/Manual_SmartSolar_MPPT_75-10_up_to_100-20/29694-MPPT_solar_charger_manual-pdf-en.pdf

The solar system must be turned off for any maintenance to the solar kit. To turn off the solar system turn the circuit breakers to the OFF position. Note, the circuit breakers should remain in the OFF position whenever a battery is not fitted.

8.5 Configuration Kit

The configuration kit comprises of all the necessary equipment to operate the BTD with a Windows computer:

- 2m Data Cable
- 2m Power Cable
- AC/DC Power Supply (UK/EU adapter)
- Senseca USB to RS422 Converter
- USB Cable

To utilise the USB to RS422 converter the FTDI COM drivers must be installed. When utilising the Lightning Eye software package these drivers are included in the installation files. Alternatively, these drivers may be downloaded directly from:

https://ftdichip.com/wp-content/uploads/2025/03/CDM2123620_Setup.zip

The AC/DC power supply is for indoor use only. The output of the power adaptor is fully isolated from the mains input supply and ground connection. The sensor must be grounded separately.

The AC/DC adapter has the following properties:

Output Voltage 12VDC

Output Power 3A

8.6 Cabling

The BTD sensor features M12 connectors for Plug and Play connectivity. A series of preassembled cable lengths (2m,5m,10m) are available to purchase. To order use the codes B1A.POWER.Xm or B1A.DATA.Xm where X is the length of cable in metres.

Alternatively, cable lengths and field wirable connectors are available. Please contact Senseca for more information.

NOTES

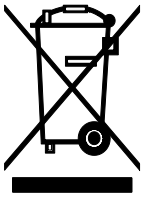
WARRANTY

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

TECHNICAL INFORMATION

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

DISPOSAL INFORMATION



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

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

CE RoHS

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