

LIGHTNING PROTECTION INTERNATIONAL PTY LTD



Stormaster ESE Installation Manual



Market - Leading Advantages

LPI's fully-accredited and approved family of Stormmaster early streamer emission (ESE) air terminals have the following key characteristics:

- First company to introduce an optimised lightning coupling design using four independent panels;
- Extensive field experience with more than 50,000 installations over 15+ years in more than 75 countries around the world;
- Air terminal family designed to meet all aspects of NF C 17-102 (2011), including the detailed time advance testing criteria and correct test sequencing per the standard;
- Additional testing and certification to IEC 62561-2;
- All testing performed in ENAC and ILAC-accredited high-voltage laboratories;
- Proven technology based on international research findings, modelling and field testing.



Lightning Protection International Pty Ltd

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Protection Performance

The protection radius [R_p] of a Stormaster ESE terminal is calculated using the formula as defined in NF C 17-102 [September 2011], namely:

$$(1) R_p(h) = \sqrt{2rh - h^2 + \Delta(2r + \Delta)} \quad \text{for } h \geq 5 \text{ m}$$

and

$$(2) R_p = h \times R_{p5} / 5 \quad \text{for } 2 \leq h < 5 \text{ m}$$

where h = Stormaster height relative to the area being protected (m)

R_{p5} = value of R_p from Eqn. (2) when $h = 5$ m

r = 20 m for protection level I [Very High protection]

30 m for protection level II [High protection]

45 m for protection level III [Medium protection]

60 m for protection level IV [Standard protection]

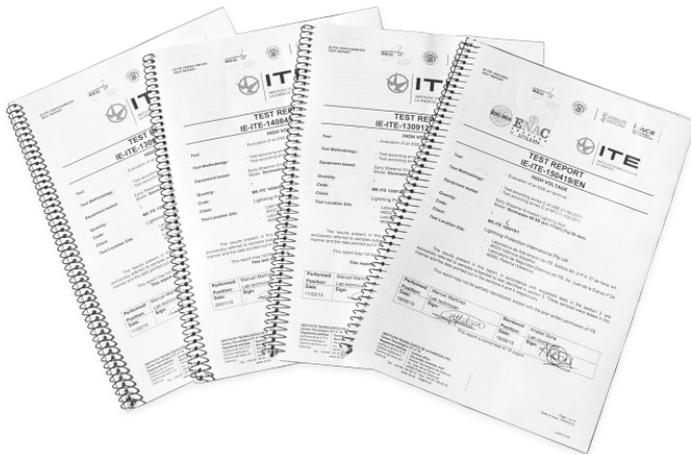
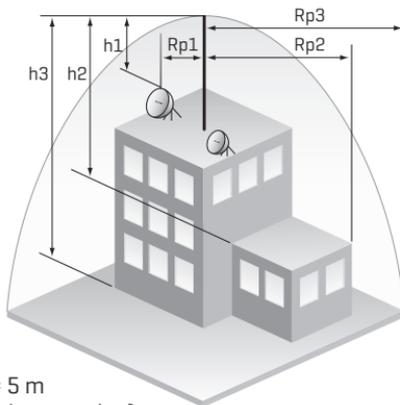
and Δ = Stormaster time and height advantage according to the Stormaster model installed:

Choices: Stormaster ESE 15: $\Delta = 15 \mu\text{s}$

Stormaster ESE 30: $\Delta = 30 \mu\text{s}$

Stormaster ESE 50: $\Delta = 50 \mu\text{s}$

Stormaster ESE 60: $\Delta = 60 \mu\text{s}$



PROTECTION RADIUS, R_p [m]

| h = height of Stormaster ESE terminal above the area to be protected [m] | 2 | 4 | 5 | 6 | 10 | 15 | 20 | 45 | 60 | 80 | 100 |
|--|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Protection Level I (Very High) | | | | | | | | | | | |
| Stormaster ESE 15 | 13 | 25 | 32 | 32 | 34 | 35 | 35 | 35 | 35 | 35 | 35 |
| Stormaster ESE 30 | 19 | 38 | 48 | 48 | 49 | 50 | 50 | 50 | 50 | 50 | 50 |
| Stormaster ESE 50 | 27 | 55 | 68 | 69 | 69 | 70 | 70 | 70 | 70 | 70 | 70 |
| Stormaster ESE 60 | 31 | 63 | 79 | 79 | 79 | 80 | 80 | 80 | 80 | 80 | 80 |
| Protection Level II (High) | | | | | | | | | | | |
| Stormaster ESE 15 | 15 | 30 | 37 | 38 | 40 | 42 | 44 | 44 | 44 | 44 | 44 |
| Stormaster ESE 30 | 22 | 44 | 55 | 55 | 57 | 58 | 59 | 59 | 59 | 59 | 59 |
| Stormaster ESE 50 | 30 | 61 | 76 | 76 | 77 | 79 | 79 | 79 | 79 | 79 | 79 |
| Stormaster ESE 60 | 35 | 69 | 86 | 87 | 88 | 89 | 89 | 89 | 89 | 89 | 89 |
| Protection Level III (Medium) | | | | | | | | | | | |
| Stormaster ESE 15 | 18 | 36 | 45 | 46 | 49 | 52 | 55 | 60 | 60 | 60 | 60 |
| Stormaster ESE 30 | 25 | 51 | 63 | 64 | 66 | 69 | 71 | 75 | 75 | 75 | 75 |
| Stormaster ESE 50 | 35 | 69 | 86 | 87 | 88 | 90 | 92 | 95 | 95 | 95 | 95 |
| Stormaster ESE 60 | 39 | 78 | 97 | 97 | 99 | 101 | 102 | 105 | 105 | 105 | 105 |
| Protection Level IV (Standard) | | | | | | | | | | | |
| Stormaster ESE 15 | 20 | 41 | 51 | 52 | 56 | 60 | 63 | 73 | 75 | 75 | 75 |
| Stormaster ESE 30 | 29 | 57 | 71 | 72 | 75 | 78 | 81 | 89 | 90 | 90 | 90 |
| Stormaster ESE 50 | 38 | 76 | 95 | 96 | 98 | 100 | 102 | 109 | 110 | 110 | 110 |
| Stormaster ESE 60 | 43 | 85 | 107 | 107 | 109 | 111 | 113 | 119 | 120 | 120 | 120 |

Contact LPI for Protection Radius for Level I+ and Level I++

WARRANTY

This product has a limited manufacturer's warranty given by Lightning Protection International Pty Ltd (LPI) to the original purchaser. The warranty covers any manufacturing defects, material defects and workmanship for a period of five (5) years from the date of dispatch from the manufacturer. This warranty is only valid if the purchaser sends a copy of the duly filled warranty card back to LPI within 30 days of purchase.

The purchaser acknowledges 100% protection for direct strike lightning is not possible and cannot be provided due to the lightning discharge process being a natural atmospheric event with statistical variation in behaviour and energy levels, which may exceed product ratings. Hence, the manufacturer's liability is limited to repair or replacement of the faulty product with an equivalent product. The option to repair or replace the product will be at manufacturer's sole decision. The repaired or replacement product will be warranted under the terms of this warranty for the remainder of the warranty period for the product originally supplied. This warranty does not indemnify the purchaser of the product for any consequential claim for damages or loss of operations or service or profits.

This warranty only covers products supplied by LPI or its authorized distributor. The manufacturer also confirms that the warranty will not be applicable (in its judgement) under the following conditions:

- (a) The product being connected to equipment and accessories not authorised by LPI.
- (b) Improper handling, misuse, abuse, neglect, accident, improper installation or non-compliance with the direction of use.
- (c) Any alteration or modification which in the opinion of LPI will affect the performance of the product.
- (d) The product not earthed (where ever applicable) according to LPI's recommendations.

Lightning Protection

Comments on the French Standard NF C 17-102 [2011].

Refer to the section in the standard titled “foreward” which states the following:

Installations for protection against lightning designed and made according to this document, may not, like everything about the natural elements, ensure the absolute protection of structures, people or objects; however, the application of this document must reduce significantly the risk of damage due to lightning on protected structures.



The LPI Stormaster ESE terminal should only be installed during storm free periods.

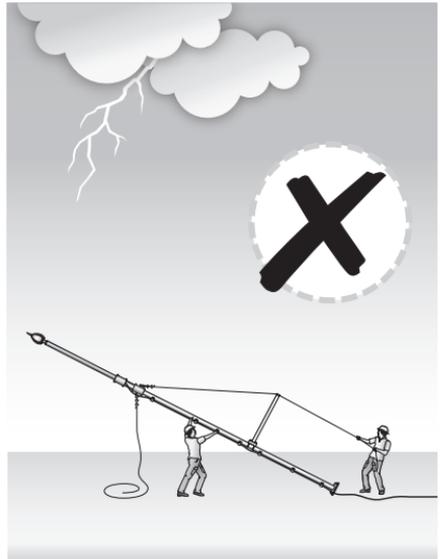


Figure 1.

General Safety Guidelines

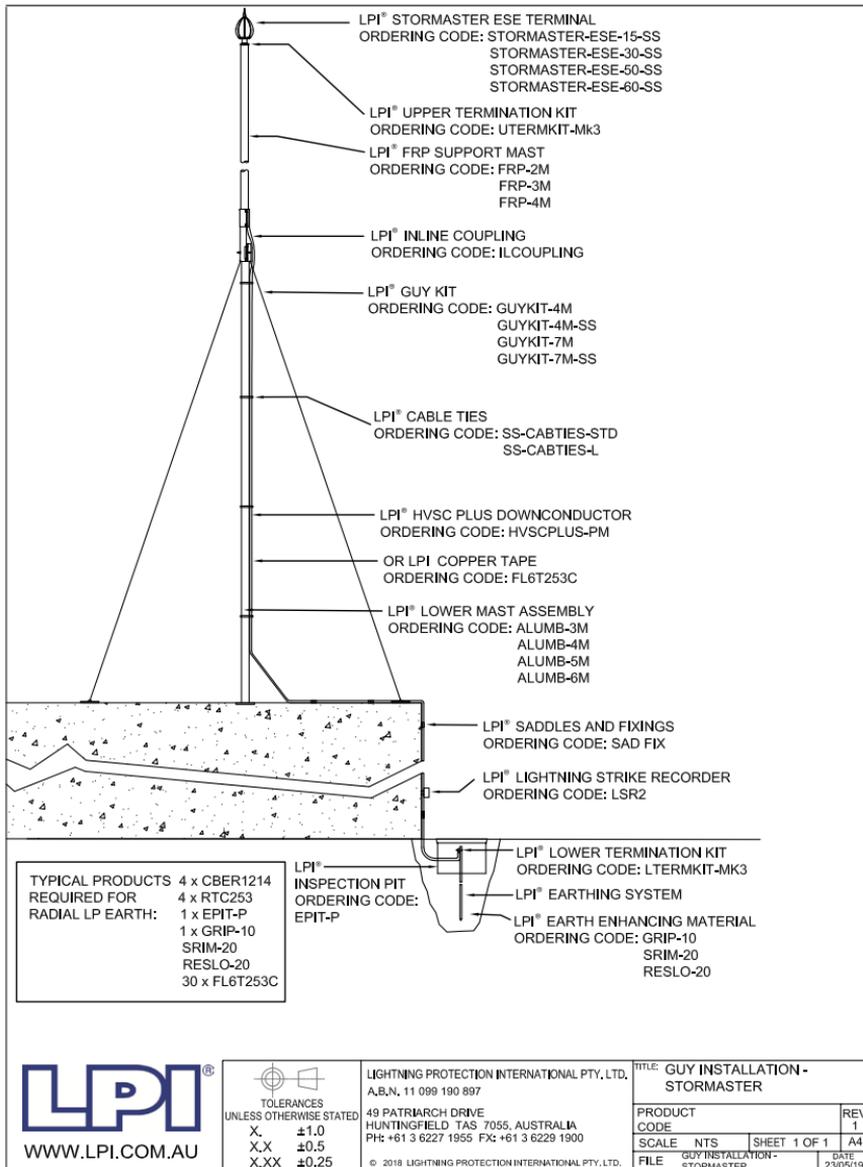
- Ensure safe working environments and practices to local codes
- Use personal protective equipment during installation
- Use mechanical methods of raising and installing masts over 6 m
- Cordon off area below installation point
- Check for overhead powerlines or any other obstructions before lifting or raising
- Ensure enough man power to safely conduct all aspects of installation

Recommended Installation Method

- The installation must conform to all relevant local standards and regulations.

To assist in the installation of the Stormaster ESE terminal and accessories, refer to drawings as illustrated on pages 8 to 15.

1. Installation of the lightning earth.
2. Installation of the HVSC Plus downconductor.
3. Lower termination of the HVSC Plus downconductor and connection to the lightning earth.
4. Upper termination of the HVSC Plus downconductor and connection to the Stormaster ESE terminal.
5. Preparation and raising of the mast into position.



| | |
|--|---|
| | TOLERANCES UNLESS OTHERWISE STATED X. ± 1.0 X.X ± 0.5 X.XX ± 0.25 |
|--|---|

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| | | | |
|--|---------------------------------|--------------|----------|
| TITLE: GUY INSTALLATION - STORMMASTER | | | |
| PRODUCT CODE | | REV | 1 |
| SCALE | NTS | SHEET 1 OF 1 | A4 |
| FILE | SOFT INSTALLATION - STORMMASTER | DATE | 23/05/19 |

Figure 2.

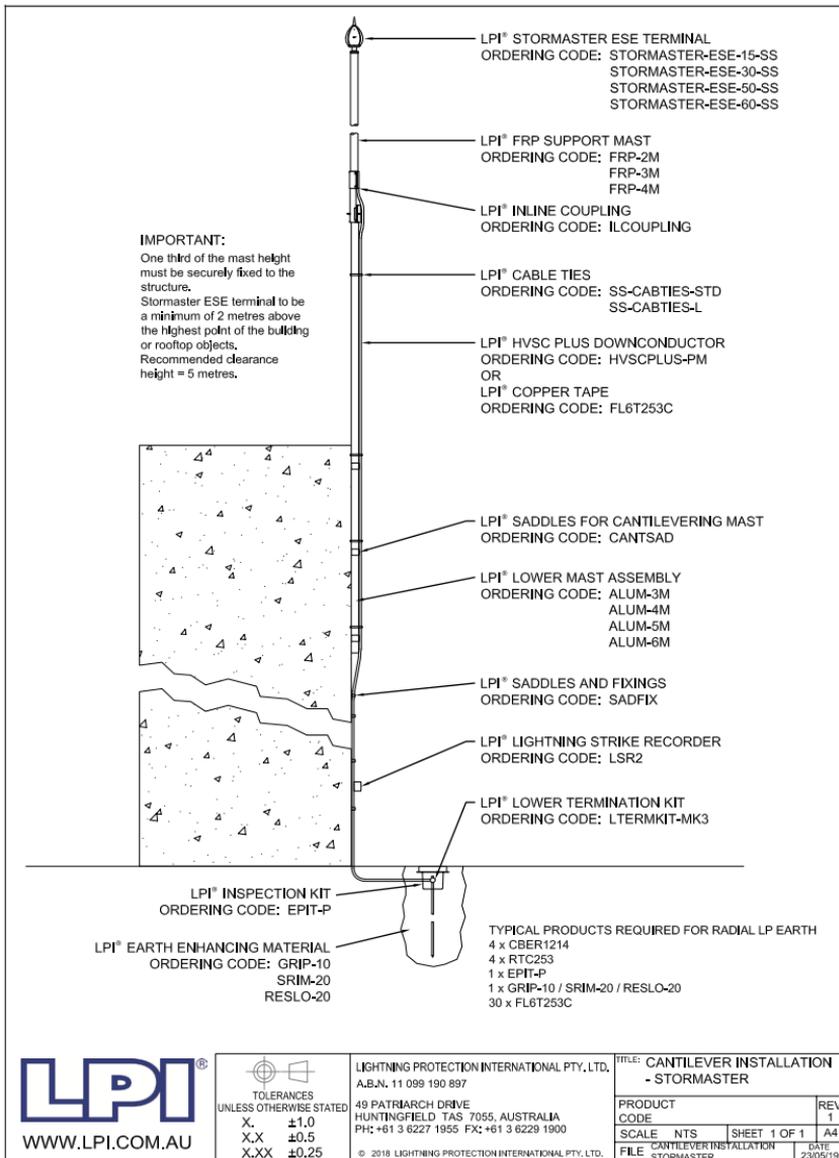


Figure 3.

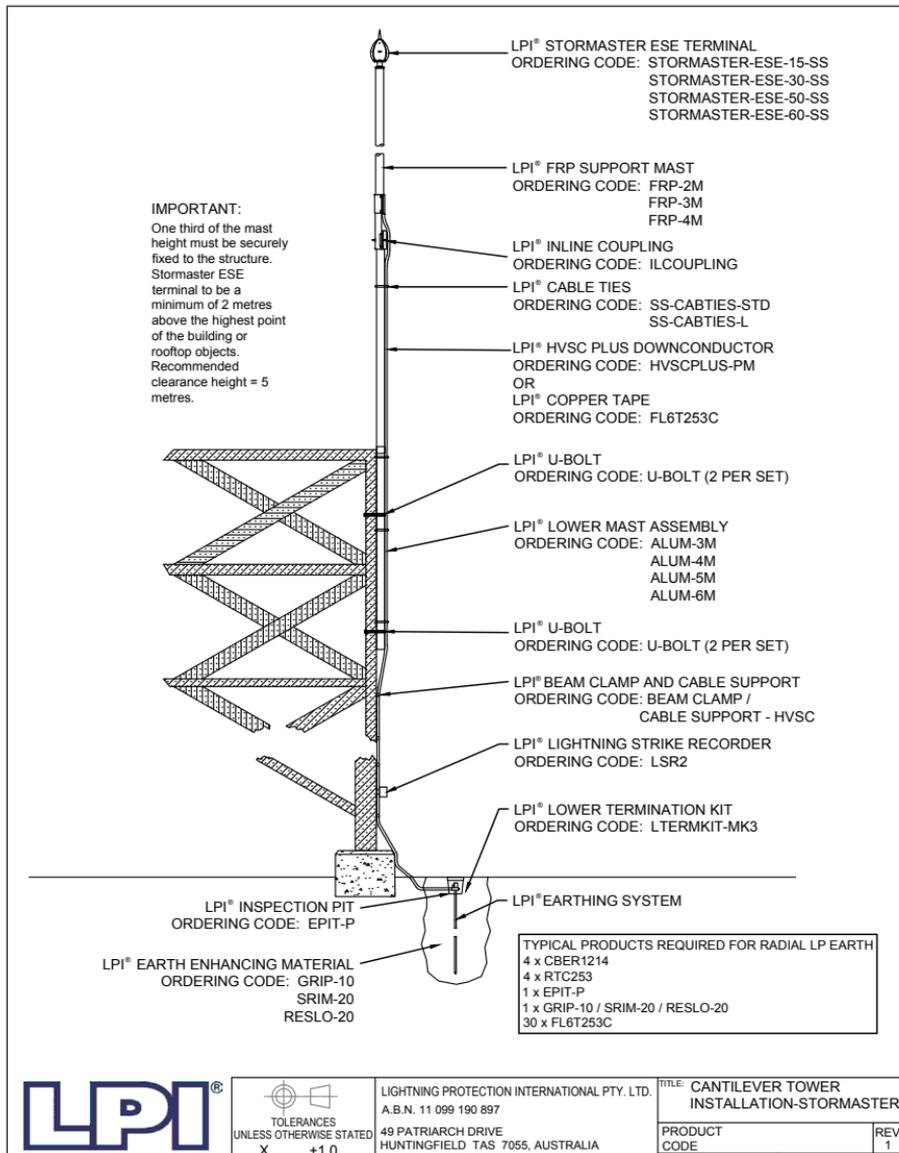


Figure 4.

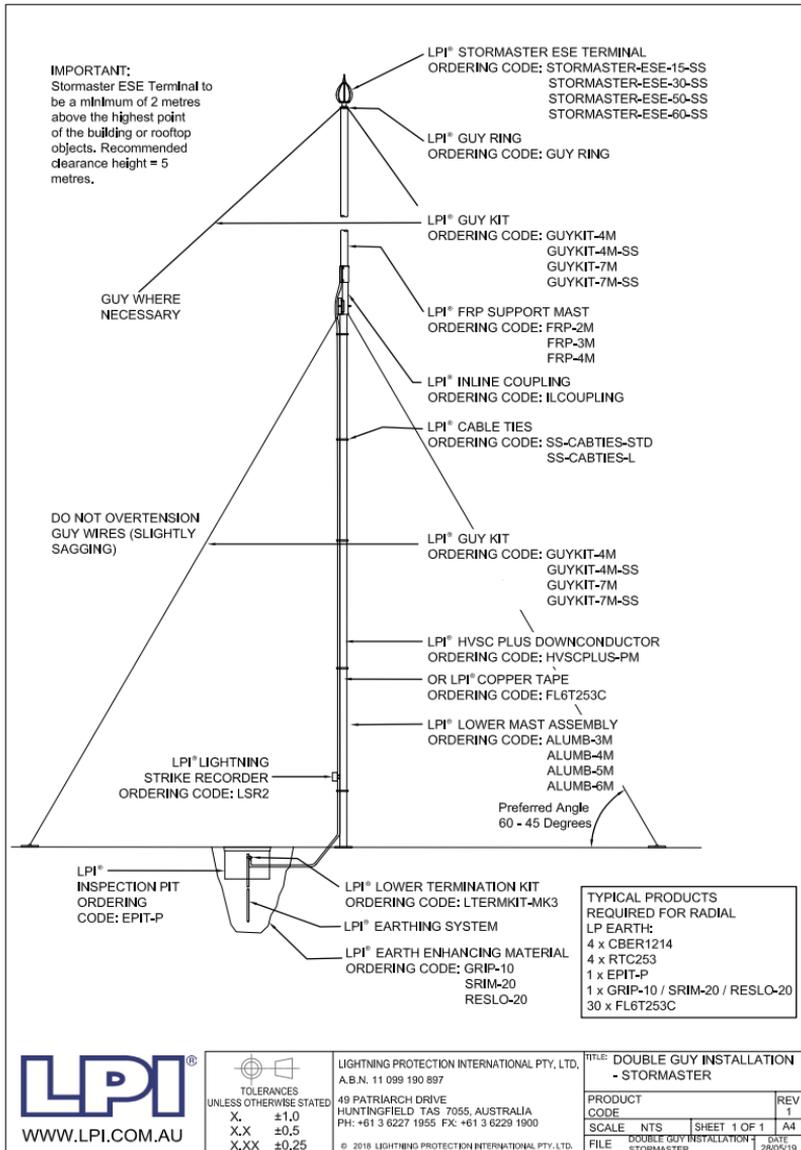
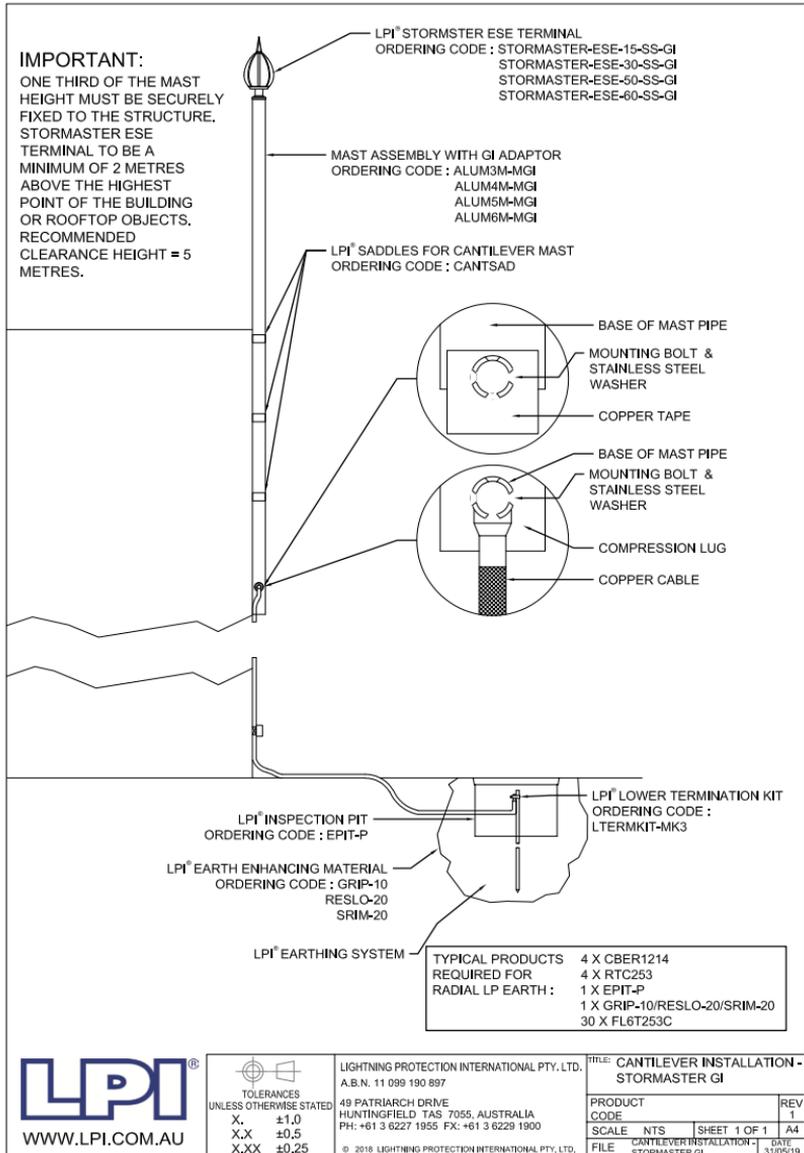


Figure 5.

IMPORTANT:

ONE THIRD OF THE MAST HEIGHT MUST BE SECURELY FIXED TO THE STRUCTURE. STORMMASTER ESE TERMINAL TO BE A MINIMUM OF 2 METRES ABOVE THE HIGHEST POINT OF THE BUILDING OR ROOFTOP OBJECTS. RECOMMENDED CLEARANCE HEIGHT = 5 METRES.



| | |
|--|------------------------------------|
| | TOLERANCES UNLESS OTHERWISE STATED |
| | X ±1.0 |
| | XX ±0.5 |
| | XXX ±0.25 |

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| | | | |
|---|--------------|-----|--------------|
| TITLE: CANTILEVER INSTALLATION - STORMMASTER GI | | | |
| PRODUCT CODE | SCALE | NTS | REV 1 |
| FILE | SHEET 1 OF 1 | A4 | DATE 3/10/19 |

Figure 6.

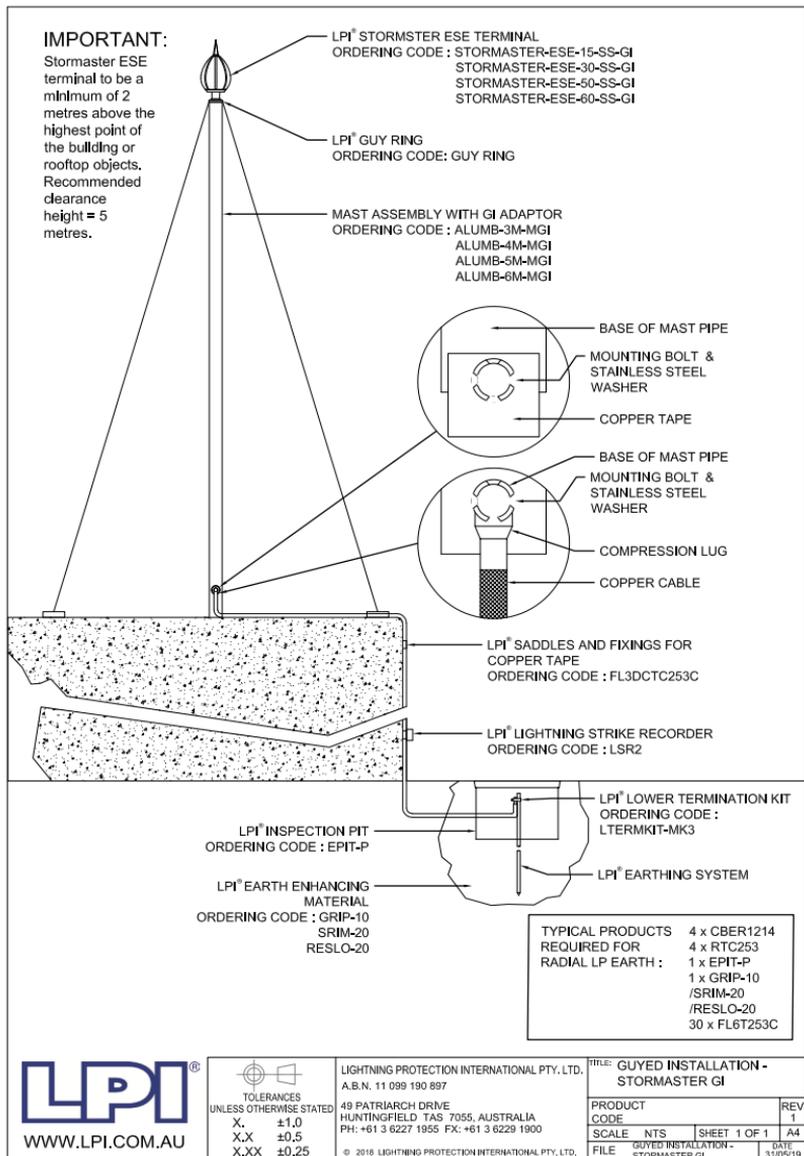


Figure 7.

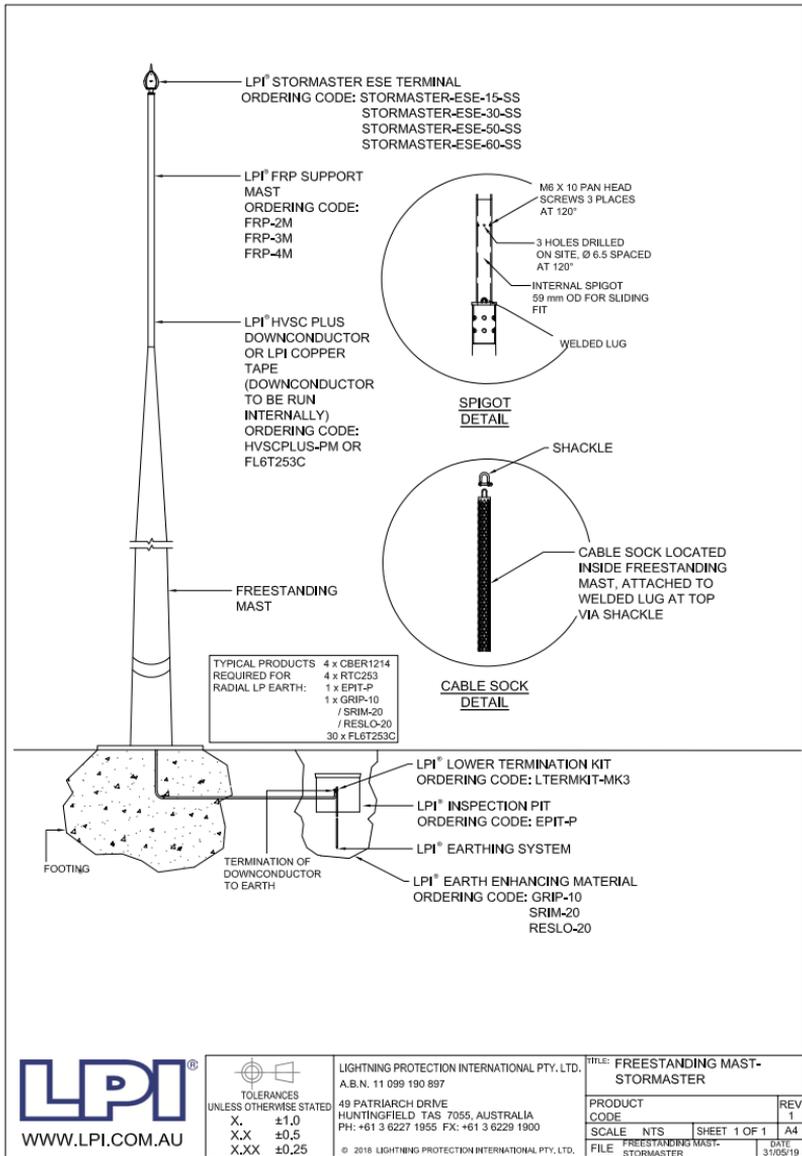


Figure 8.

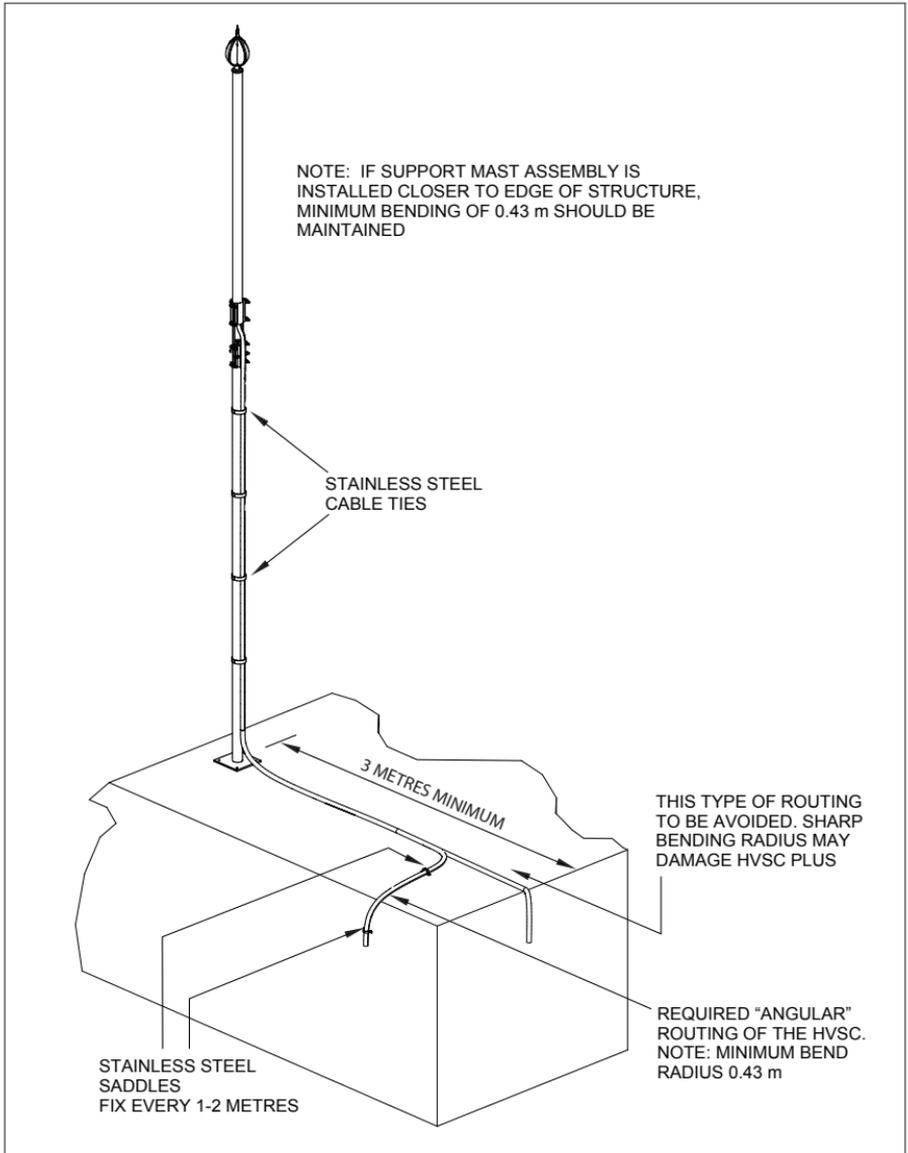


Figure 9.

Checking Lightning Protection Components Supplied

The LPI Stormaster ESE components received should be checked against the “bill of materials” for loss during shipping and for damage.

Check the following:

Terminal(s)

- Terminals have not been dented or damaged in any way during transit
- Instructions, warning labels, warranty, test certificate and relevant mast base components are supplied

Downconductor(s)

- The HVSC Plus cable drum (if supplied) is not damaged
- The correct HVSC Plus length(s) have been supplied
- There is no obvious damage to the HVSC Plus cable
- If a factory completed upper termination is supplied, check to see that the termination is not damaged and confirm inside or outside termination(s)
- Order of lengths and quantities of HVSC Plus (if multiple lengths on one drum), will be shown on the side of the cable drum(s)

LPI Stormaster ESE Installation

All site and safety requirements must be followed during the installation of the LPI Stormaster ESE. The correct order of installation is as follows:

1. Installation of the lightning earth.
2. Installation of the HVSC Plus downconductor.
3. Lower termination of the HVSC Plus downconductor and connection to the lightning earth.
4. Upper termination of the HVSC Plus downconductor and connection to the Stormaster ESE terminal.
5. Preparation and raising of the mast into position.

LPI Stormaster ESE should only be installed during storm free periods.

If the Stormaster ESE terminal needs to be raised prior to connection to the lightning earth or immediate connection is not possible, then connect the lower end of the downconductor to structural steel reinforcing or other suitable earth point.

Installation of the Lightning Earth

Before installation of the lightning protection earth, consult site drawings of underground services so that these are not damaged during installation of the earthing system.

Earth DC resistance [typically <10 ohms] and impedance [typically <30 ohms] is required for successful operation of LPI Stormmaster ESE.

LPI recommends the installation of a radial lightning earth as shown in figure 10.

- It is recommended to install a 3 x 10 metre length radial trench
- Each radial should consist of a trench (Approx: 500 mm Deep x 200 mm wide x 10 m length)
- An earth rod should be driven at the end of each trench
- All rods should be interconnected through the use of 25 x 3 mm copper tape. The use of earth rod clamps to fix the tape to rods is recommended

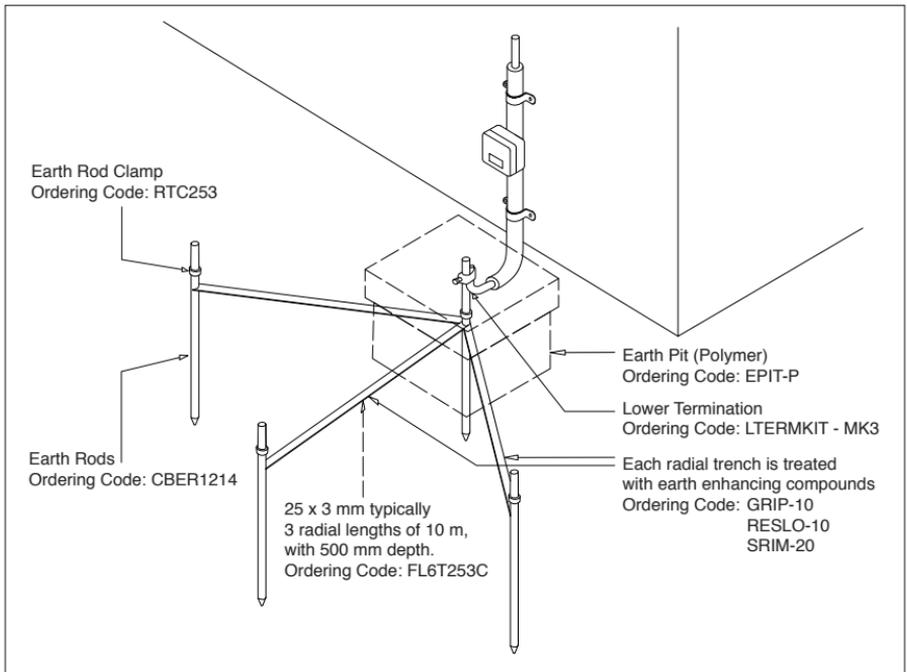


Figure 10.

- Waterproofing mastic tape should be used on all mechanical connections
- It is recommended to apply earth enhancing compound such as LPI RESLO-20, GRIP-10 or SRIM-20 to reduce soil resistivity to less than 10 ohms
- An earth pit should be installed where the end of the downconductor terminates to the lightning earth as shown in figure 10. This gives an access point for disconnection and future testing
- Do not lower terminate (connect) the downconductor to the earthing system at this point in time

Note: If due to space constraints it is not possible to install a radial earth as recommended, consult with LPI or an authorised distributor for further advice

When using earth rods:

- Use driving heads to prevent mushrooming on top of rod
- Use driving heads when using coupled rods
- Use a post or picket driver

Earth Enhancing Compounds

- Earth Enhancing Compounds (such as LPI RESLO-20, GRIP-10 or SRIM-20) are supplied when the existing soil mass has a high resistivity
- Using the compounds can lower earth resistance/impedance
- Compounds will require water and a mixing container
- Follow all installation and safety instructions as supplied with products when applying the compounds

Bonding the Lightning Earth

Where separate earths exist e.g. structure, power, communications and lightning protection, they need to be bonded to form an equipotential ground plane. This will stop ground loops and potential differences arising under transient conditions.

Before bonding of these earths takes place, make sure proper authorisation is gained.

Bonding cable must be 70 mm² [2/0 AWG] minimum depending on local standards. It may be necessary to use a transient earth clamp [TEC100-2L] which bonds all earths to the same potential under transient conditions.

For further information, it is advisable that local applicable standards are used, i.e. IEC 62305, AS1768, NFPA 780, C22.1-98 and NEC.

Labelling

It is the responsibility of the customer/installer to label earth pits or earthing systems to local requirements.

Installation of the HVSC Plus Downconductor

If installing LPI HVSC Plus, the HVSC Plus downconductors[s] may have had the upper terminations completed at a pre-specified end of the cable by the LPI factory before being shipped.

When removing HVSC Plus downconductor packaging, do not use a knife or cut in any way as this can damage the outer layer of termination.

LPI's HVSC Plus has an outer layer which is approximately 2 mm [1/16 in.] thick. Be careful not to damage this layer.

Hauling the HVSC Plus Downconductor

Place the HVSC Plus downconductor cable drum close to where it is to be installed.

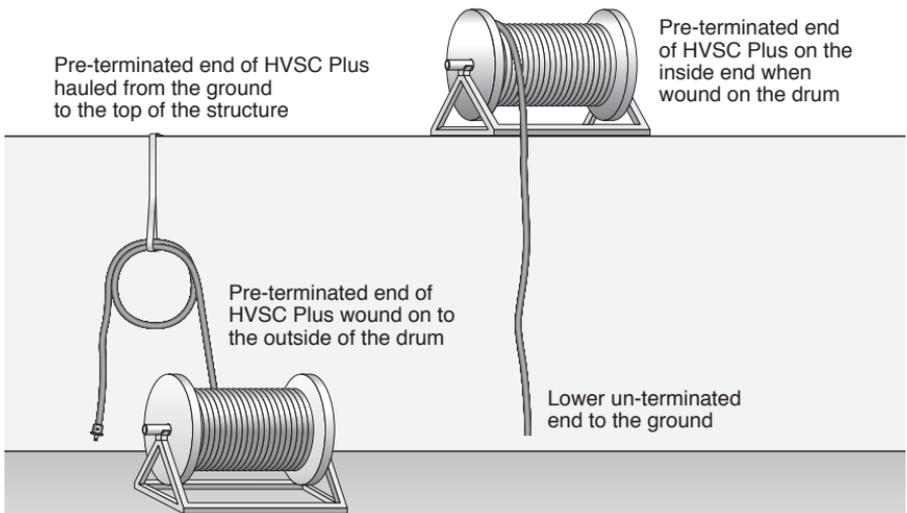


Figure 11.

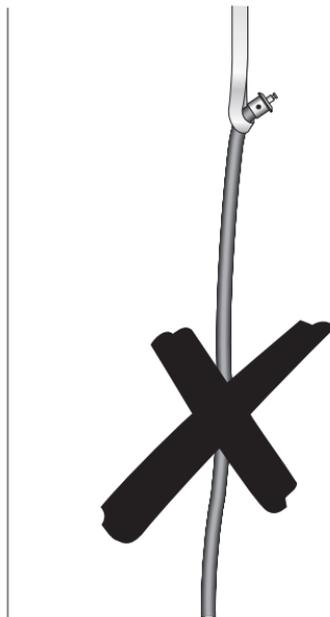
Cable pre-termination and drum locations

- Make sure that the cable drum is in a serviceable condition
- Check that the correct length of HVSC Plus downconductor has been supplied. The length of HVSC Plus will be marked on the drum
- If the HVSC Plus downconductor has been upper terminated on the outside of the drum, then the HVSC Plus downconductor will need to be hauled up the structure with the drum staying on the ground
- If the HVSC Plus downconductor has been upper terminated on the inside of the drum, then the drum has to be taken to the top or near the top of the structure. Then the HVSC Plus downconductor can be hauled downwards from the drum to the ground
- Any lifting slings or ropes must be securely attached
- DO NOT haul the HVSC Plus downconductor from the termination. See Figure 12
- Protect the HVSC Plus downconductor at all times when it is being moved

Figure 12.



**Correct method of hoisting
HVSC Plus**



**Incorrect method of hoisting
HVSC Plus**

HVSC Plus Downconductor Clearance Holes

Before running the HVSC Plus downconductor through any clearance holes, ensure that:

- A minimum hole diameter of 60 mm [2 3/8"] is used
- Enough protection is provided so that the HVSC Plus downconductor is not damaged during or after installation
- A waterproofing sealant or sealing gland should be used if the hole needs to be weatherproof

Routing

The routing of the HVSC Plus downconductor needs to follow these guidelines:

- The route of the HVSC Plus downconductor should be as set out in the original design. Ensure no structural changes such as new antenna or mast installations, air conditioning towers or ducting has been installed
- DO NOT double the HVSC Plus downconductor back against itself after changes of direction, i.e. 180°
- The HVSC Plus downconductor may be installed internally or externally on the structure
- The HVSC Plus downconductor should be installed as close [flush] as possible to the structure
- Minimise the number of bends and use the most direct route to ground
- Minimise strain on the HVSC Plus downconductor
- Ensure minimum bend radius maintained >430 mm [20in.]
- Parallel routing with other services – Minimum separation = 2 m. See Figure 13 on page 22
- If the HVSC Plus downconductor has to cross other services make sure it crosses at right angles using a conduit that extends at least 1 m past either side of the existing service
- The lower end of the HVSC Plus downconductor must terminate close to the initial injection point of the lightning earth
- Be sure to allow for enough slack in the HVSC Plus at the top end for connection to the Stormaster ESE terminal and the raising of the mast
- If it is necessary to isolate the HVSC Plus downconductor from the structure, run the cable in an insulating conduit with a minimum wall thickness of 3 mm [1/8 in.]. The maximum length isolated from the structure should be 2.5 m [9 ft]. The entire length of the HVSC Plus downconductor cannot be run in insulated conduit

- HVSC Plus downconductor should be protected from damage at the lower end by installing a “Top Hat” surface mount cover of no more than 2 m from ground level

The HVSC Plus downconductor must be checked by an LPI representative if it is damaged during installation to see if the damage will affect performance

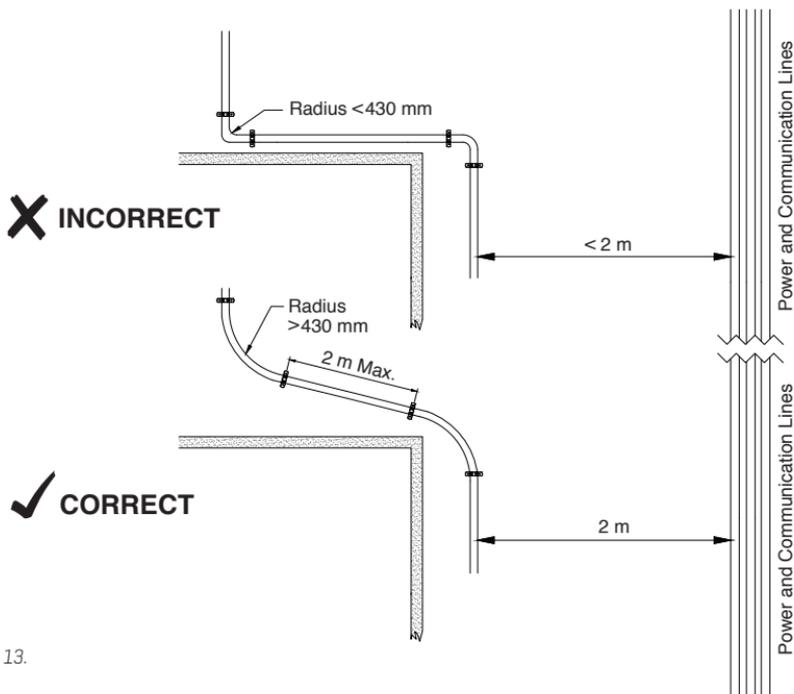


Figure 13.

Fixing the HVSC Plus Downconductor

Using non LPI saddles can damage the downconductor outer sheath.

- The HVSC Plus downconductor should be fixed to the structure every 2 m for the entire length of the run. (Use LPI supplied or recommended saddles, fixing and cable ties)
- For masonry walls or roofs, use the LPI saddles provided. These can be used with masonry anchors, suitable fastenings for wood, fibreglass and metallic surfaces or self-tapping screws
- The most direct path to ground is recommended. Avoid sharp bends (refer to Figure 9 on page 15)

- Use cable ties when fixing to round sections, such as pipes, tower legs, masts, etc.
- If the HVSC Plus downconductor is to be routed above a false ceiling, ensure that it is fixed to the underside of the concrete floor slab
- Do not use explosive fastening methods on LPI saddles or HVSC Plus downconductors

Installation of Conventional Downconductors

In some installations, the use of copper tape or insulated stranded copper cable may be installed as the downconductor. In such cases, it may be necessary to install multiple downconductors in compliance with local and/or international standards such as NFC 17-102, AS1768, and IEC 62305. See the following dot points for further information.

The Stormaster ESE terminal provides a bolt for the lug connection to the lower finial connector of the mast butt adaptor. All conventional downconductors should be lugged and fixed to the terminal per Figure 14 on page 24.

The following are recommendations and points that should be considered when installing conventional downconductors.

- For structures made of combustible materials, downconductors must be separated from the structure by a distance of at least 0.1 m and they must have a cross-sectional area of 100 mm²

Installation on structures:

- Minimum of two downconductors are required, preferably on opposite sides of the structure
- At least one of these downconductors must be a dedicated downconductor per EN 50164-2 and the other can be the natural components of the structure [i.e., both downconductors cannot be natural components]
- For installations where multiple Stormaster terminals are installed, the requirement for two downconductors per terminal is waived

Standalone / isolated installation:

- Only one downconductor is required
- The “structure” may be used if metallic and complies with the requirements for downconductors

Note: EN 50164-2 has a requirement for copper and aluminium downconductors to have a cross-sectional area of at least 50 mm²

Routing and installation:

- Install externally wherever possible. Internal installation requires routing inside a non-flammable insulating pipe

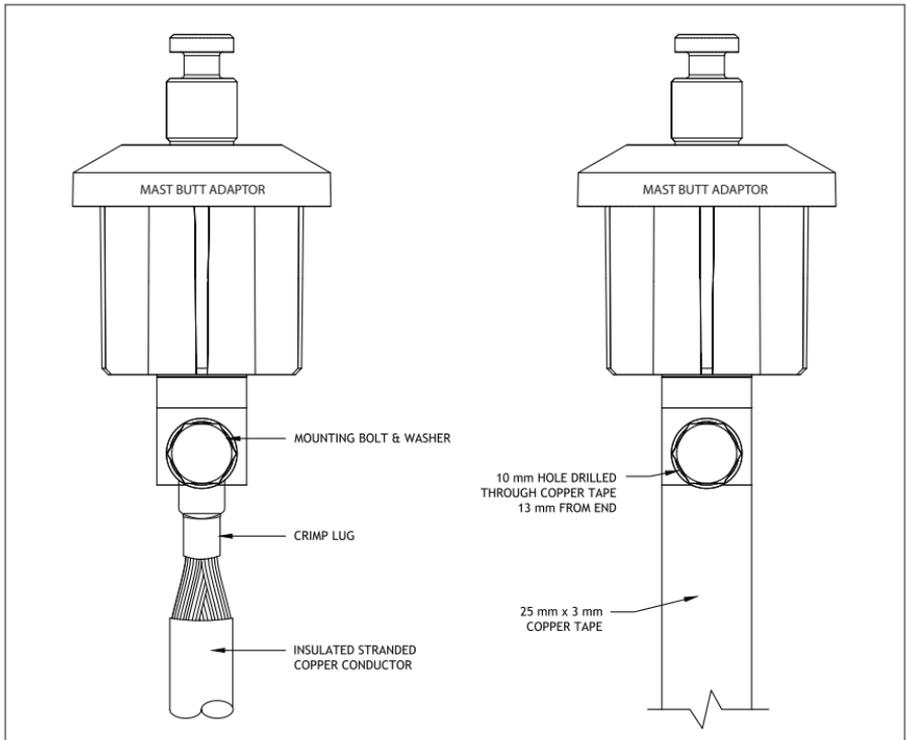


Figure 14.

- As direct and straight as possible
- Avoid sharp bends. Bend radius must not be smaller than 20 cm
- Avoid routing along or across electrical conduits
- Use three fasteners per metre
- Protect against the risk of mechanical impact damage with guard tubes up to a height of at least 2 m above the ground level

Natural components:

- External interconnected steel frames [metal structures] may be used in place of dedicated downconductors if it is shown that the electrical continuity / resistance is $\leq 0.1 \Omega$

- Internal metallic structures, concrete reinforcements, metal structures inside walls, metal sheets and pipes at least 2 mm thick may be used to *supplement* dedicated downconductors[s]

Equipotential bonding:

Dangerous sparking may occur between the external Stormaster system and the following components:

- Metal installations
- Internal systems
- External conductive parts and lines connected to the structure

The dangerous sparking can be avoided by means of:

- Equipotential bonding, using conductors and/or SPDs or
- Electrical insulation between the parts (must comply with separation distance requirements)

Installation of Stormaster GI Terminal to Threaded Pipe

LPI offers within its range of Stormaster terminals a GI version which is designed for a threaded connection to a 2 inch BSP GI pipe. Please refer to drawings on pages 12 and 13 along with Figure 15 for further details.

The Stormaster GI terminal is supplied with a threaded coupler (female thread) fixed to the terminal and designed for connection to a 2 inch pipe (male thread).

- Following installation of the Stormaster GI terminal to the threaded pipe as per Figure 15 it will be necessary to connect the metallic pipe to a conventional downconductor in order to convey the lightning energy to the earthing system
- Ideally the connection between the metallic pipe and the conventional downconductor should be completed by lugging the downconductor at a practical point somewhere along the length of the pipe
- Particular care should be taken to ensure that compatible metals are used when connecting the downconductor to the metallic pipe
- For installation details of the conventional downconductor please review instructions and comments as detailed per “Installation of Conventional Downconductors” on page 23

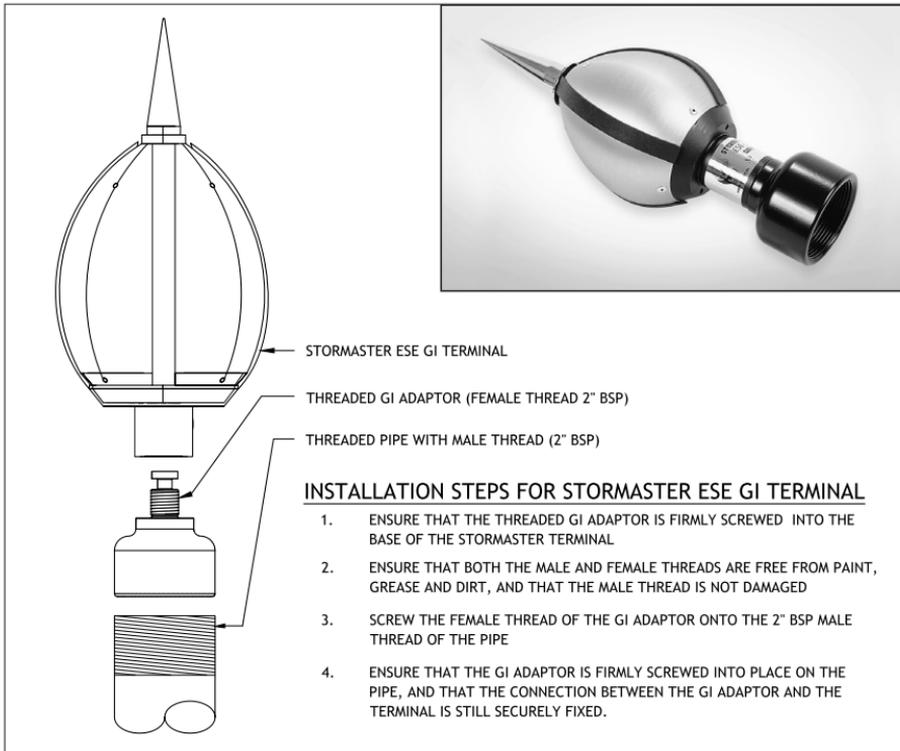


Figure 15.

Termination of the HVSC Plus Lower End

Note: This Document is to be used in conjunction with the LTERMKIT-MK3 on HVSC Plus cable only. Using the following guide, check the cable first prior to performing the termination to ensure the use of the correct lower termination kit.

HVSC Plus cable has an outer diameter of approximately 35 mm and has an aluminium stranded centre conductor and copper tape screen (which can be easily seen from the end of the cable).

This termination kit will not work with any other cable.

Tools and parts required for the completion of HVSC Plus lower termination include:

- Compression or mechanical crimping tool (for 70 mm² crimp lug)
- Sharp knife
- Shifting spanner (or 17 mm A.F. spanner/socket)
- Rubber gloves
- Tape measure (metric)

Lower Termination Kit consists of:

- Instructions
- 1 x Roll of waterproofing mastic tape
- 1 x 70 mm² crimp lug
- 2 x Warning labels
- U-Bolt earth clamp
- 1 x Tube of conductive paste

The following steps outline the termination of the lower end of the HVSC Plus to the lightning earth.

The diagram below shows the different layers of the HVSC Plus cable and indicates their names as referred to in the following instructions:

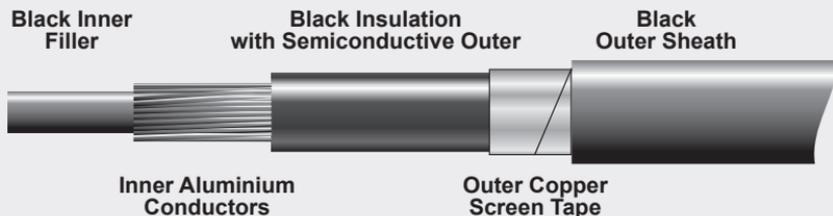


Figure 16.

1. First, remove the black outer sheath for a length of 15 cm by cutting radially round the HVSC Plus cable with a sharp knife. The lengthwise cut can also be completed with a knife, but take great care not to score or damage the copper tape. Cut and remove the material lining over the copper tape [Figure 17].

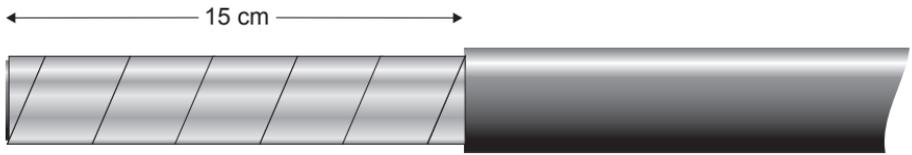


Figure 17.

2. Carefully unwind the copper tape to expose about 7 cm of the sheath underneath. Again, be careful not to damage the copper tape during this process. Measure 5 cm from the end of the cable and remove the black insulation section of the sheath over the aluminium conductors [Figure 18]. Note: There are many valid ways of removing this layer, but it is very important that the aluminium conductor strands are not scored or damaged in any way as this will decrease their strength and may lead to breakage when bending them for insertion into the crimp lug.

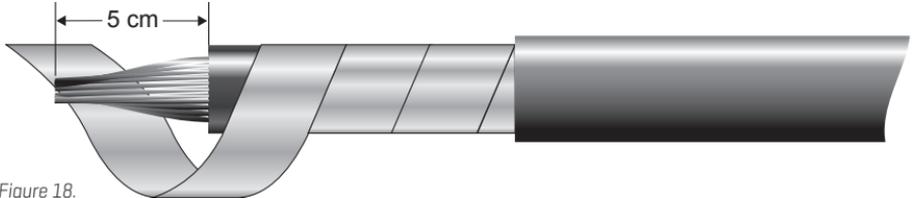


Figure 18.

3. Cut and remove the black binding tape from over the aluminium strands. Remove at least 3 cm of the black inner filler core under the inner aluminium conductors by carefully bending back the conductor strands to expose the filler core then cut and remove the core with a knife. Carefully bend the conductors back to allow them to be fed into the lug.



Figure 19.

4. Using a rubber glove, apply all conductive paste evenly over the 5 cm length of aluminium strands prior to re-wrapping the copper tape.
5. Re-wrap the copper tape back into its original position neatly over the aluminium conductors. Wrap the tape as tight as possible over the aluminium strands and place both the tape and strands into the supplied 70 mm² crimp lug and crimp securely using a suitable compression or mechanical crimping tool [Figure 19]. Note, this will require crimping at 70 mm² to obtain a secure compression.
6. If terminating the lower end of the HVSC Plus to a bus bar, connect to the bus bar as per Figure 20.
7. Connect the crimp lug to the earthing system using the supplied U-Bolt earth clamp if necessary [Figure 21]. Ensure the connection is aligned correctly and tightly secured using a 17 mm spanner, socket or shifting spanner.
8. Use the waterproofing mastic tape to completely cover all exposed conductive areas of the lower termination and to seal the termination from moisture ingress where it connects to the earthing system [Figure 21].
9. Place the warning labels on or next to the HVSC Plus cable where they can be easily seen and read by anyone with access to that area.

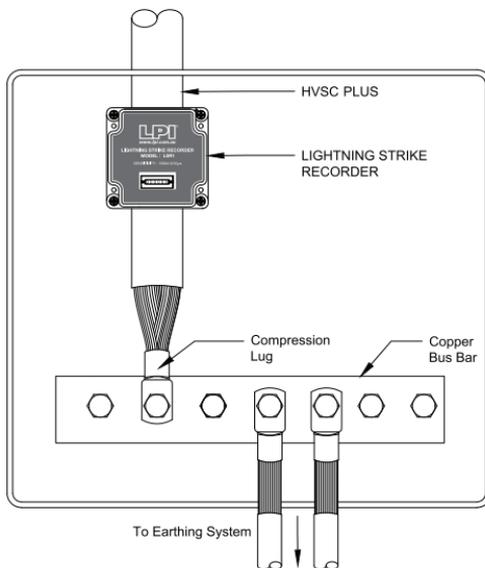


Figure 20.

Lower Termination of Conventional Downconductor to the Lightning Earth

- If installing stranded copper cable as a downconductor then the lower end should be connected to the lightning earth through the use of an earth rod clamp and then wrapped with waterproofing tape to avoid oxidation
- If installing copper tape [25 x 3 mm] as a downconductor then the lower end should be directly connected to the lightning earth through the use of a suitable earth rod clamp and then wrapped with waterproofing tape to avoid oxidation

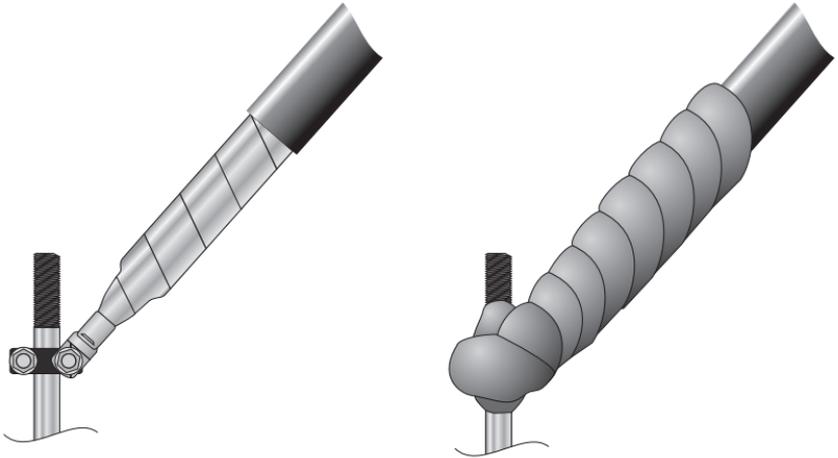


Figure 21.

Upper Termination Instructions for UTERMKIT-Mk3 [Heatshrink] for HVSC Plus

Termination of the HVSC Plus Upper End

Note: This Document is to be used in conjunction with the UTERMKIT-MK3 on HVSC Plus cable only. Using the following guide, check the cable first prior to performing the termination to ensure the use of the correct upper termination kit.

HVSC Plus cable has an outer diameter of approximately 35 mm and has an aluminium stranded centre conductor and copper tape screen [which can be easily seen from the end of the cable].

This Termination Kit will not work with any other cable.

Tools and parts required for the completion of the HVSC Plus Upper Termination include:

- Compression or mechanical crimping tool (for 50 mm² crimp lug)
- Sharp knife
- Scissors
- #2 Phillips head screwdriver
- Shifting spanner (or 17 mm spanner/socket)
- Heat gun or gas torch (LPG)
- Tape measure (metric)
- Combination pliers/cutters
- Mast base assembly (supplied with the Stormaster Terminal)

Upper Termination Kit consists of:

- Instructions
- 1 x Roll of semi-conductive tape
- 1 x 50 mm² crimp lug
- 2 Heatshrink tubes [1 x 1200 mm & 1 x 600 mm length]

Upper Termination Instructions for UTERMKIT-Mk3 (Heatshrink)

The diagram below (Figure 22) shows the different layers of the HVSC Plus cable and indicates their names as referred to in the following instructions:

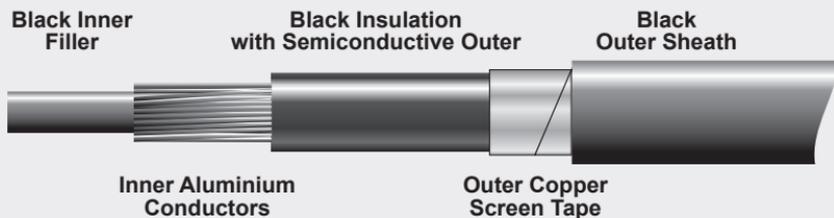


Figure 22.

1. First, remove the black outer sheath for a length of 160 cm by cutting radially round the HVSC Plus cable with a sharp knife. The lengthwise cut is also performed with a knife, but take great care not to score the black insulation under the copper tape as well as the 1st 3 cm of copper tape against the outer sheath. Cut and remove the material lining over the copper tape [Figure 23].
2. With a knife, cut and remove the fabric tape material over the copper tape up to the outer sheath. Measure and mark with a pen the outer copper screen tape at 3 cm along from the end of the outer sheath [Figure 23]. With a knife or scissors, carefully cut and remove the copper tape, again without damaging the black insulation below. If using a knife, carefully score the tape without cutting through it and use this score line to tear the tape along the line.

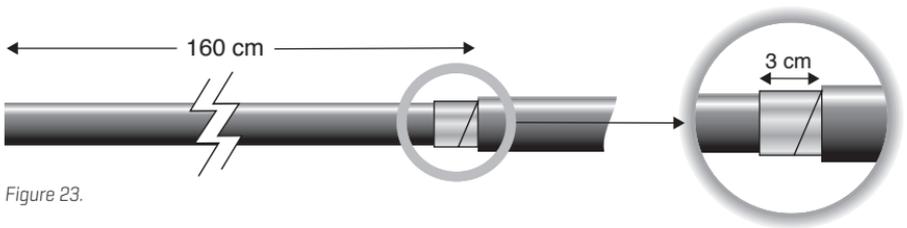


Figure 23.

3. Using a sharp knife, remove the black insulation to expose the inner aluminium conductors for a length of 5 cm from the top end of the HVSC Plus [Figure 24]. Also remove the black fabric material lining over the aluminium conductors. Be careful not to damage the conductor strands during this process. Note: There are many valid ways of removing this layer, but it is very important that the aluminium conductor strands are not scored or damaged in any way as this will decrease their strength and may lead to breakage when bending them for insertion into the crimp lug.
4. Remove at least 3 cm of the black inner filler core under the inner aluminium conductors by carefully bending back the conductors to expose the filler core then cut and remove the core with a knife. Carefully bend the conductors back to allow them to be fed into the lug.



Figure 24.

5. Straighten the cable back to the black outer sheath as much as possible then crimp the inner aluminium conductors into the supplied 50 mm² crimp lug using a suitable compression or mechanical crimping tool (Figure 25).



Figure 25.

6. Connect the crimp lug to the Stormaster mast base assembly using the bolt and washers as supplied with the assembly. Ensure the connection is aligned correctly and tightly secured using a 17 mm spanner, socket or shifting spanner. Note orientation of lug on lower finial connector (Figure 26).

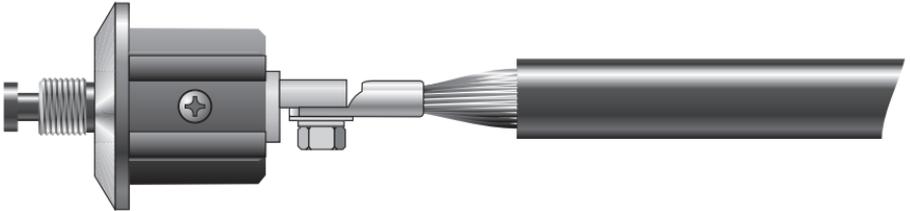


Figure 26.

7. Using the semi-conductive tape provided, starting 2 cm in front of the end of the outer copper screen tape (or 5 cm in front of the black outer sheath), stretch and wrap the tape back over the tape and 3 cm over the black with 50 % overlap, securing the outer copper screen tape in place. This should use approximately 50 cm of the tape (Figure 27).

Note: DO NOT cut the tape at this stage.

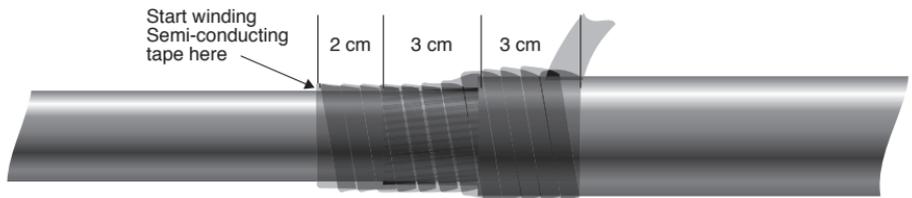


Figure 27.

8. Over wrap back towards the crimp end of the cable, again stretching the tape and with 50 % overlap, leaving 5 cm covering the outer copper screen tape and black insulation and 3 cm covering the black outer sheath. This should use approximately another 50 cm of the tape. Wrap another 2 layers, again stretched with 50 % overlap back up to where the black outer sheath ends, to build up the cable diameter and to smooth out transitions in diameter Figure 28. Cut the tape and press down firmly to ensure it amalgamates with the tape below it.

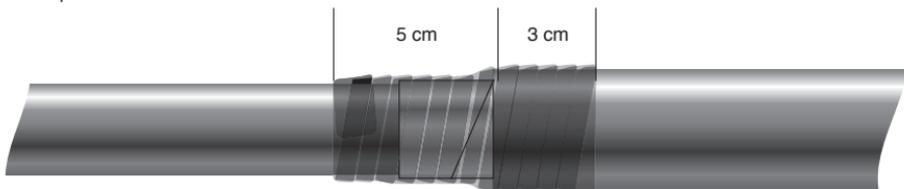


Figure 28.

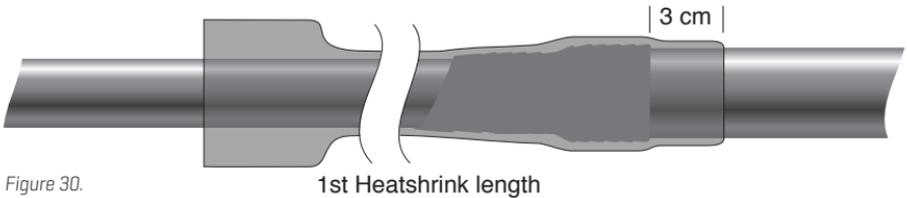
9. Again using the semi-conductive tape, start stretching and wrapping over the aluminium conductor strands and connection to the lower finial connector to start building up in multiple layers. Continue wrapping the tape over the area shown to cover the last 3 cm of the black insulation, over the lower finial connector and up to the black plastic section of the mast base assembly in multiple layers, completely covering the crimp and achieving as smooth and level a surface as possible, removing all sharp edges [Figure 29].



Figure 29.

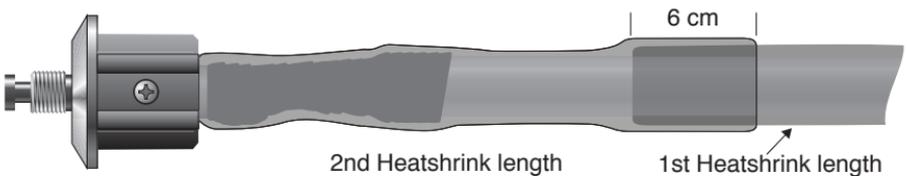
10. Remove the plastic mast butt adaptor section of the mast base assembly [if fitted] by unscrewing the M6 Phillips head screw on the side. Straighten the cable as much as possible then carefully slip the first 1.2 m length of heatshrink over the cable until the end of the heatshrink tube covers and overlaps the semi-conductive tape [over the black outer sheath] by at least 3 cm [Figure 30]. Ensure that the semi-conducting tape is not damaged or lifted during this process. Using a gas torch or heat gun, carefully shrink the lower end of the heatshrink into the correct position and gradually work up towards the top of the heatshrink ensuring there are no pockets of air trapped under the heatshrink.

Note: Ensure that the heat gun or gas torch is not pointed in the same area for too long as this will burn the heatshrink. Also be careful around the ends of the tube as too much heat will damage the black outer sheath, semi-conductive tape and black insulation.



11. Place the 2nd 600 mm heatshrink tube into place over the cable, again ensuring that the semi-conductive tape is not damaged, overlapping the previous heatshrink tube by approximately 6 cm. Shrink about 7 cm of the upper end of the heatshrink into place so that it will sit flush with the base of the plastic mast butt adaptor when fitted back into place. Note: That there is a mark on the lower finial connector indicating where the heatshrink needs to be fitted to. Shrink the rest of the heatshrink from the top down, ensuring that it overlaps the previous piece of heatshrink by at least 6 cm Figure 31. Ensure the rest of the heatshrink has a smooth overall finish. Note: Do not bend the cable while the heatshrink is still hot.

Note: If required, feed the cable through the mast sections & guying ring prior to refitting the mast butt adaptor. Replace the plastic mast butt adaptor section of the mast base assembly back onto the lower finial connector and ensure that the M6 Phillips head screw is tight and secure.



12. The lugged HVSC Plus is now ready to be connected to the base of the Stormmaster terminal. Screw the terminal onto the completed terminal base assembly and secure with the supplied M6 locking grub screw.

Connection of Factory Pre-Terminated HVSC Plus (Upper End) to Stormaster ESE Terminal

Tools required for the installation of the factory completed upper termination include:

- Sharp knife
 - PH2 Phillips head screw driver
 - 3 mm Hex/Allen Key
1. Firstly remove the protective packaging from the cable and upper terminated end section taking care not to cut cable or associated upper termination parts in the process.
 2. Using a Phillips Head screwdriver, remove the M6 Phillips Head screw holding the mast butt adaptor (if fitted) to the lower connector and retain both screw and mast butt adaptor.
 3. Feed the HVSC Plus cable through the FRP support mast.
 4. Slide the black plastic mast butt adaptor back onto the lower finial connector, line up holes and screw the Phillips Head screw into position tightly. Now screw the mast butt adaptor into the Stormaster ESE terminal and tighten the M6 Grub screw at the base of the terminal to lock the assembly.

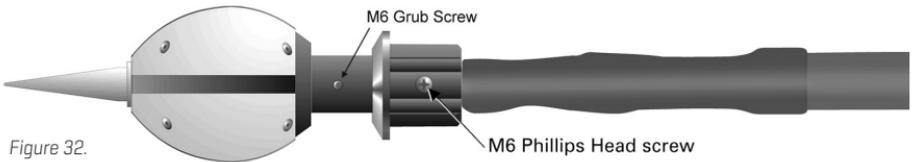


Figure 32.

Labelling

Warning labels are supplied with all Stormaster ESE terminals and should be installed as per the following.

- In locations where personnel may be in close proximity to the HVSC Plus downconductor
- Where the HVSC Plus downconductor connects to the earthing system
- At the base of the support mast

There are 2 warning labels supplied in the front cover of this manual and also 2 supplied in the lower termination kit. If more labels are required, contact your nearest LPI supplier or distributor.

Masts

The mast chosen for the application must:

- Raise the terminal to a height of at least 2 metres higher than the structure

- Have an FRP mast section of at least 2 metres below the air terminal if using LPI HVSC Plus
- Be suitable for local weather conditions. Seek guidance from a local civil engineer
- Be guyed and securely attached to the dedicated mounting points [if required]

Types of Mast Configurations

When mounting a Stormmaster ESE terminal, there are generally three types of mast configurations that can be used.

Cantilevered

Typically used for mounting to a tower or the side wall of a plant room when a mast and base are not suitable. See drawings on pages 9, 10 and 12 Figure 33.

- 1/3 of the overall mast height must be fixed to the structure for adequate mechanical strength
- Cantilevered masts can be guyed for additional strength. If guying, the use of a guy ring and/or the eyelets provided on the inline coupling can be utilized

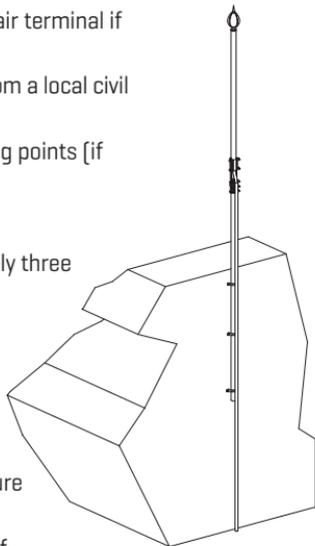


Figure 33.
Cantilevered Mast

Guyed

When mounting a Stormmaster ESE terminal, a typical guyed configuration would involve the following. See drawing on pages 8 and 11 Figure 34.

- Two sections of mast (aluminium mast & FRP mast coupled together with an inline coupling. Securing of guy wires is completed at the eyelets as provided on the inline coupling
- Alternatively or in addition, a guy ring can be supplied which is installed at the neck of the mast in between the Stormmaster terminal and the top section of the FRP. The guy ring provides eyelets for connection of the guy wires

Freestanding

A freestanding mast configuration is typically used in situations where protection by isolation is required. For example a Stormmaster ESE terminal is installed 5 metres or more away from a fuel storage tank.

Prior to installing the freestanding mast, ensure that:

- A spigot has been supplied with the freestanding mast which allows for external or internal mounting of the FRP mast

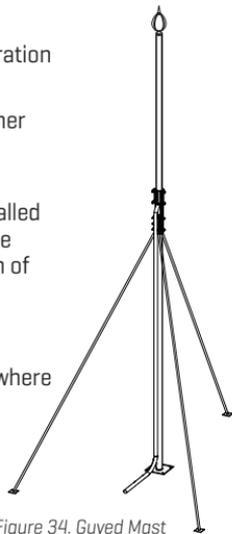


Figure 34. Guyed Mast

- The downconductor can exit through the base of the freestanding mast if run internally
- Adequate information is provided for mast foundation requirements. Contact LPI or an authorised dealer for further detail if required

Mast Bases

LPI supplies a mast base welded directly onto the required length of aluminium mast.

Mast Couplings and Guying Points

There are two methods of coupling two sections of mast:

1. The U-Bolt set uses two stainless steel U-Bolts to clamp the two masts together Figure 36
2. The inline coupling fixes the upper and lower mast sections together and provides guying points and an exit point for the HVSC Plus downconductor

U-Bolts and inline couplings nuts must be tightened to no more than 55 kg/cm [45 in/lb].

A guying ring is supplied for guy points for any two piece masts that require double guying. This fits on the terminals mast butt adaptor between the Stormmaster ESE terminal and the top of the mast. See Figure 37.



Figure 35.
Freestanding Mast

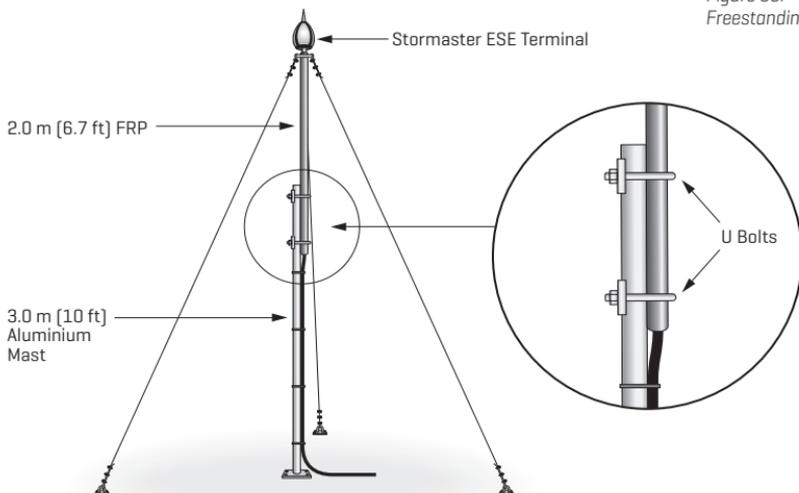


Figure 36.

Guying

LPI offers a standard 4 m and 7 m guy kit made up of light weight synthetic, non-conductive cable. The LPI GUYKIT-4M and GUYKIT-7M are both non-conductive guying kits. They are designed to be installed with the use of a guy ring at the top section of the FRP mast as illustrated in figure 37. When guying from the LPI inline coupling, the use of stainless steel guy wire kits [GUYKIT-4M-SS, GUYKIT-7M-SS] is recommended.

Important Recommendations:

- The guying angle must be no greater than 60° from horizontal
- The inline coupling couples the upper and lower mast sections and provides guying points and an exit point for the HVSC Plus downconductor
- Minimum of 3 guying grips per guy end
- Guying grips spaced at a minimum of 25 mm
- Grips are correctly orientated. Saddle on the longer length side of the guy and U-bolt over the tail side of the guy
- Tighten grips to no more than 60 cN.m [5 lbf.in] of torque
- Protect guying from abrasion
- Customised guy kits can be supplied upon request

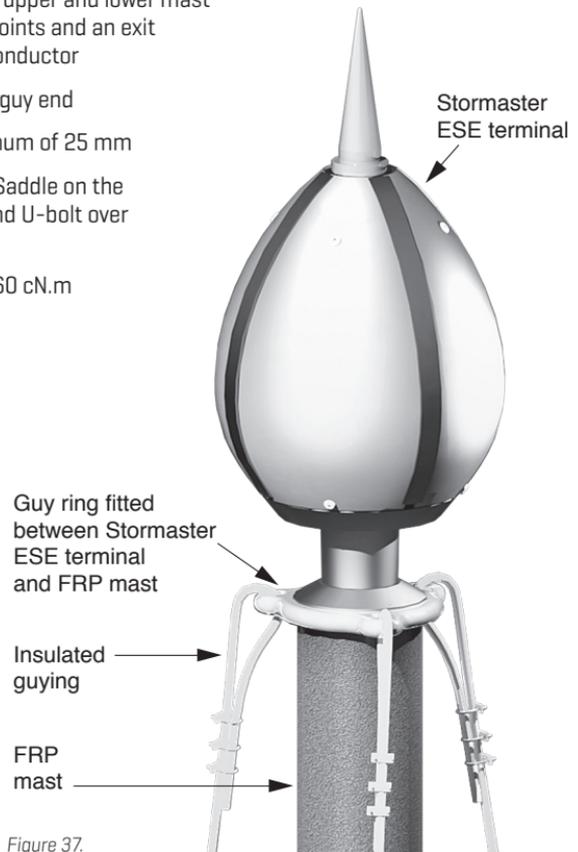


Figure 37.

Preparation for Raising the Mast into Position

With the upper termination of the HVSC Plus completed and the FRP mast in position it is now time to finalise the mounting arrangement so that the mast can be raised and secured into position.

- If using the recommended installation methods as per drawings [on pages 8-11] fit the inline coupling to the lower mast material
- If required, fit the HVSC Plus downconductor through the side entry of the inline coupling and through the FRP mast. Refer to Figure 39 on page 42
- Feed the upper termination through the guying ring if required
- Carefully fit the mast adaptor of the Stormaster terminal into the top of the FRP
- It may be necessary to pull back any slack of HVSC Plus downconductor through the FRP support mast to achieve a tight fit for the Stormaster terminal. This should be completed carefully so as to not damage the upper termination
- Fix the FRP support mast firmly into the inline coupling and tighten the coupling so that the FRP mast and lower mast material are secured firmly into position with no more than 55 kg/cm [45 in/lb]
- If a guy kit is to be installed, the guys should be securely fixed to the eyelets as provided on the inline coupling and or the guy ring. See text and graphics as detailed under the heading Guying for more information

Raising of the Mast

When raising the mast, ensure:

- Guys to inline coupling and/or guy ring are properly secured
- Guys are not twisted, kinked or damaged
- Guys are able to be easily secured at the lower guy anchoring points when the mast has been raised

Turnbuckles or rigging screws are recommended at the base anchor points of the guys.

Other guying methods such as conductive stainless steel can be used only on aluminium masts or inline couplings below an FRP section.

Using a crane is recommended [or other suitable equipment] for anything over 6 metres in height, or for hazardous areas or high areas.

- It is very important to keep the mast straight during the lift to avoid damaging the mast

- The Stormmaster ESE terminal must NOT be used as a slinging point
- When lifting the mast, ensure that the slings or ropes cannot damage the Stormmaster ESE terminal. See Figure 38

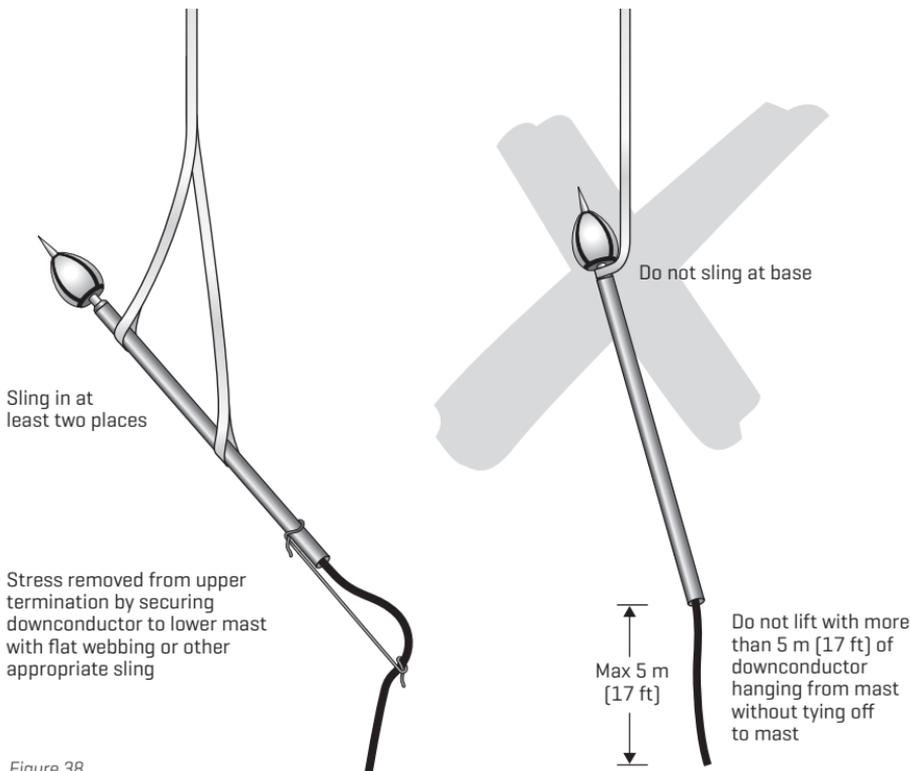


Figure 38.

- When lifting the mast, the HVSC Plus downconductor must be tied off to the mast to remove any strain on the HVSC Plus downconductor termination to the Stormmaster ESE terminal
- Protect the HVSC Plus downconductor at the base of the mast when lifting, maintain a minimum bending radius of 430 mm and ensure it does not drag over rough or sharp surfaces

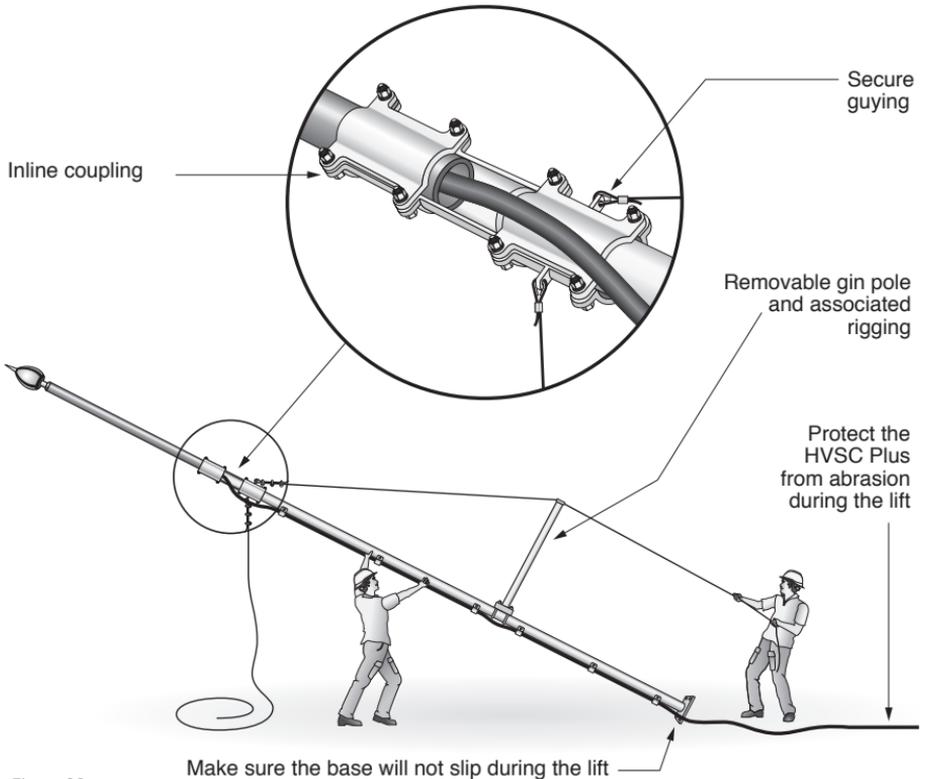


Figure 39.

Lightning Strike Recorder (LSR2)

The Lightning Strike Recorder (LSR2) should be installed at a position along the downconductor length where it can be accessed easily for inspection. Typically the LSR2 should be installed approximately 1.5 m from ground level or alternatively within the earth pit at the lower termination point of the HVSC Plus.

When installing the LSR2 the following should be considered:

- The LSR2 should be mounted away from areas where damage may occur due to theft, vandalism or nearby operations
- The LSR2 can be enclosed in a security enclosure but the display should be kept visible to allow for the checking of recorded strikes

Figure 40.
Lightning Strike Recorder
installed on HVSC Plus
Downconductor

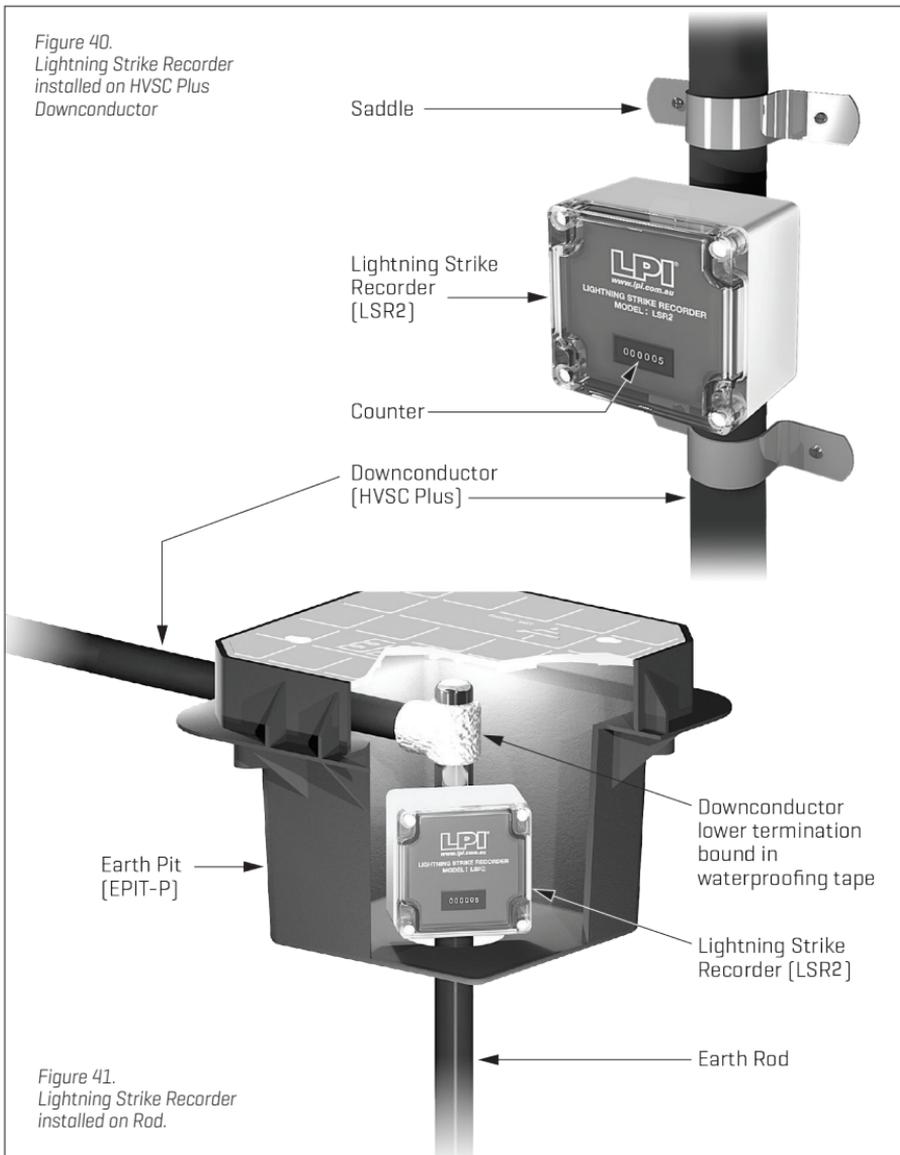


Figure 41.
Lightning Strike Recorder
installed on Rod.

Certification

The certification of the LPI Stormaster ESE installation should be performed by an authorised LPI representative.

A certificate of compliance and warranty registration is provided with the installation manual. This certificate should be completed in full following the successful inspection and certification of the installation.

The following should be checked for quality of workmanship and compliance to recommended installation instructions.

Certification checklist:

- Correct mast and any associated brackets and fastenings have been used for installation
- Guying, anchor points and fastenings
- HVSC Plus downconductor routing, fixing and weatherproofing
- Lower termination of HVSC Plus downconductor
- Earthing system
- Labelling

Operation and Maintenance

The LPI Stormaster ESE lightning protection system is designed to react to the rise in electric field which is present in approaching thunder storms. The Stormaster ESE terminal becomes active only during storm activity.

- The system operates without the need for external power supply or spare parts for standard operation
- To keep the LPI Stormaster ESE lightning protection system operating at optimum levels it needs to be regularly checked

Maintenance checks must be done:

- After each known lightning strike to the terminal
- Once every twelve months
- If changes have been made to the structure

Checks to be conducted in standard maintenance inspection:

- Is there any damage to Stormaster ESE system?
- Has the structure to be protected been modified since the last maintenance check?

- Check finial tip for excessive pitting
- Check all rigging, mast mounts, saddles and conductor fixings are secure and tight
- Ensure that no dirt or other matter is sitting in the air gap between the finial tip and the surrounding panel edges
- If conventional downconductors are used, check that all conductors are securely fixed and not damaged
- Check for damage to the LPI HVSC Plus. The downconductor should not be able to be accessed by non authorised people or machinery
- All warning labels must still be in place
- Check LSR2 for secure installation and record number of strikes

Testing the Stormaster Terminal

LPI manufactures and supplies a terminal spark-over tester suitable for testing the Stormaster ESE range of terminals. Contact your local distributor for further details.

Testing the HVSC Plus Downconductor

The HVSC Plus downconductor can be tested at various stages of its preparation for service. These stages and the tests that can be performed are summarised below.

1. Before upper or lower terminations are made [raw cable]:
 - Use a digital multimeter or, preferably, a Megger to measure the continuity between the inner and outer conductors of the HVSC Plus downconductor. The measurement should be “open circuit” (exceeding 1 M Ω)
2. After the upper termination is made but before the lower termination is made:
 - Use a digital multimeter or, preferably, a Megger to measure the continuity between the inner conductor at the top [upper termination] and the shield [outer copper tape conductor] at the bottom of the cable. The measurement should give a resistance greater than about 3 k Ω and no more than about 15 k Ω
3. After the upper termination and lower termination are first made:
 - Use a digital multimeter or, preferably, a Megger to measure the continuity between the inner conductor at the top [upper termination] and the shield [outer copper tape conductor] at the bottom of the cable. The measurement should be a “short circuit” (less than 1 Ω , excluding the resistance of the leads, the exact value depending on the length of HVSC Plus)

4. After installation of the HVSC Plus downconductor:
 - Remove the waterproofing tape from the lower termination
 - Disconnect the HVSC Plus downconductor from the lightning earth
 - Use a digital multimeter or, preferably, a Megger to measure the continuity between the inner conductor at the top [upper termination] and the shield [outer copper tape conductor] at the bottom of the cable. The measurement should be a “short circuit” [less than 1 Ω , excluding the resistance of the leads, the exact value depending on the length of HVSC Plus]
 - Reconnect the HVSC Plus lower termination to the lightning earth and re-seal the termination using waterproofing tape to ensure that it is waterproof
5. Report any problems arising from the above tests to your local LPI distributor for further advice

Testing the Lightning Earth

The procedure for obtaining the resistance of the lightning earth is described below. The method that is used is called the “fall-of-potential” (FOP) or “three-point” method. It relies on the use of a suitable 3-point or 4-point earth tester. As testing is carried out, please record all values per the table on page 48.

1. Disconnect the bonding cable from the structure to the lightning earth, as shown in Figure 42.
2. A “standard” LPI lightning earth will comprise radials of length 10 m. Assuming a 10 x 10 m earthing system, the current injection point for the FOP test should be at least 50 m, but preferably 100 m away from the lightning earth, with no intervening buried conductors. For a larger earthing system, this distance should be increased. Install a remote current injection electrode (RCIE) at a suitable location at about the above distance. This electrode may be a simple driven rod of sufficient depth to get a low resistance. [Note: if the resistance of this rod is too high, the instrument may be incapable of injecting a current to make the test].
3. Now install a rod at about 62 % of the distance between the RCIE and the lightning earth. The depth of this “potential rod” is not important [it can be less than 100 mm]. Make a 3-point resistance measurement and note the value.
4. Shift the potential rod 1 m closer to the lightning earth, measure and note the value.
5. Shift the potential rod 1 m further away from the original test point, measure and note the value.
6. If the RCIE is sufficiently far away and there are no buried conductors affecting the results, the three values recorded should all be within 5 % of each other. If this is the case, then the resistance value measured is a true indication of the resistance of the lightning earth.

Record the value in the table on page 48 [lightning earth resistance].

7. The same procedure can be used to measure the resistance of the structure earth, bearing in mind that the RCIE distance needs to be 5-10 times the size of the earth grid. Record the resistance in the table on page 48 [structure earth resistance].
8. Reconnect the structure earth bonding cable to the lightning earth and measure and record resistance in the table on page 48 [overall earth resistance].
9. Record the lightning strike recorder [LSR] reading in the table on page 48.
10. Report any problems arising from the above tests to your local LPI distributor for further advice.

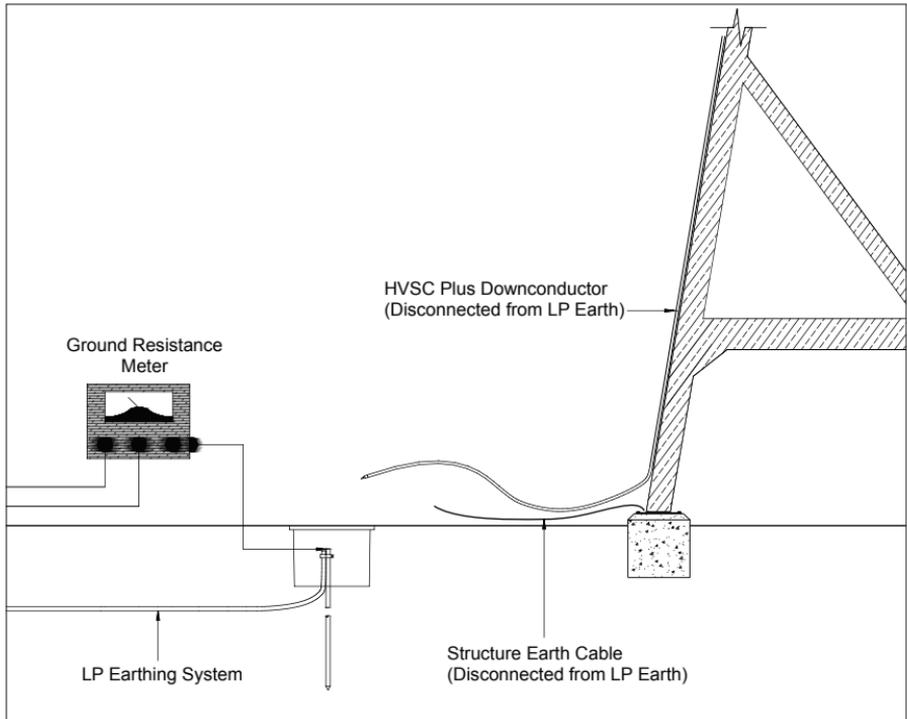


Figure 42.

STORMASTER ESE INSTALLATION MANUAL

As a result of continuing research and product development in the area of lightning and lightning protection, LPI reserves the right to alter any detail contained within at any time without notice.

Prior to installation of the Stormaster ESE system, installers should check with LPI or an authorised distributor to confirm they have the most recent version of the Stormaster ESE Installation manual.

It should be noted that 100% [100 percent] protection for direct lightning strikes is not possible and cannot be provided due to the lightning discharge process being a natural atmospheric event.

Stormaster ESE Lightning Protection System

System Owner: _____

Date Installed: _____

Installation Contractor: _____

Supplied by: _____

Location of Installation: _____



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