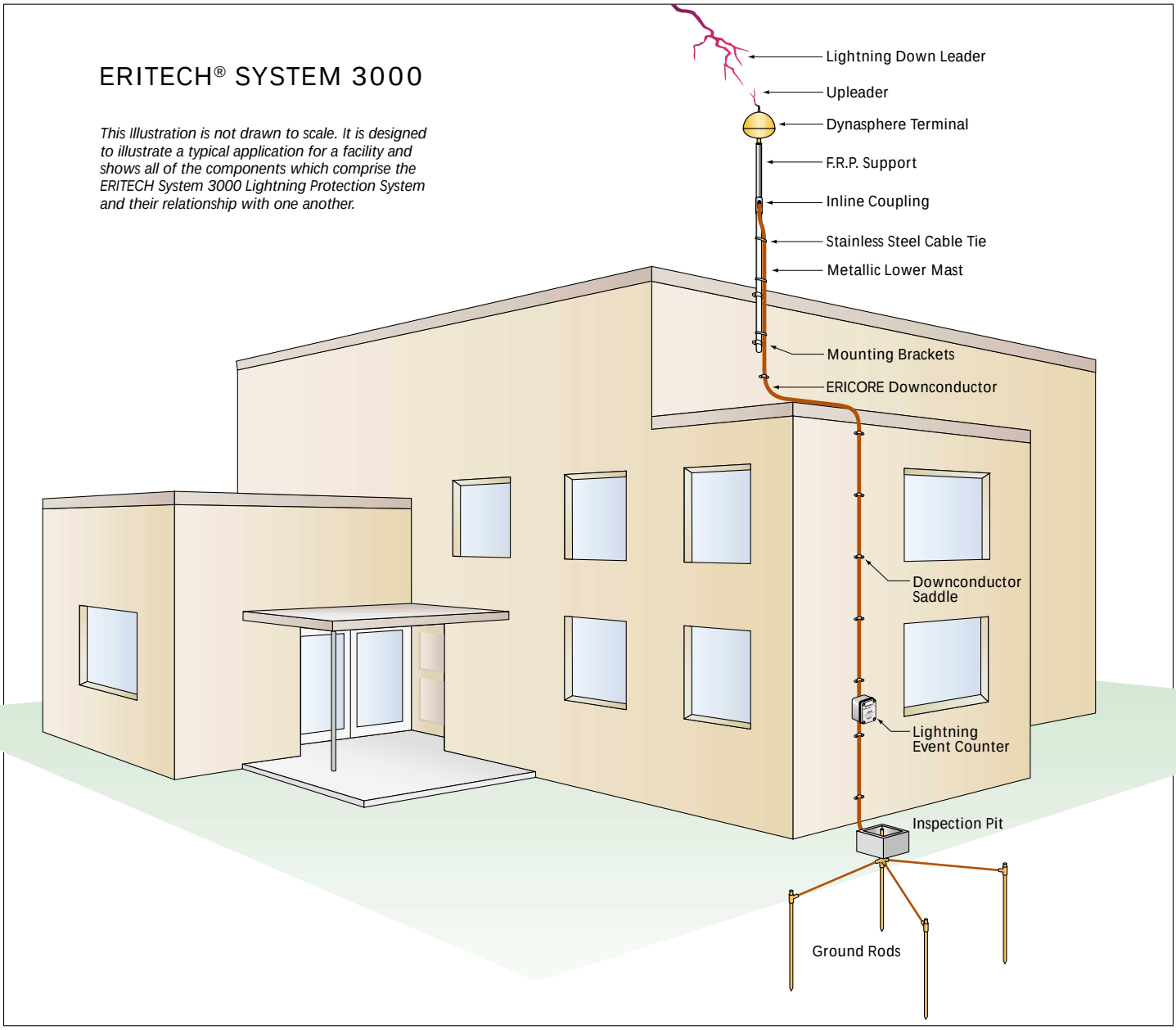


System 3000 comprises the following elements:

- Dynasphere™ air terminal
- ERICORE™ downconductor
- Purpose designed low impedance ground system
- LEC IV lightning event counter

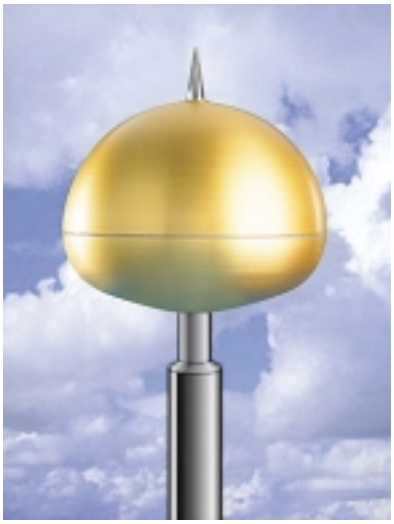
What is the System?

The ERITECH® System 3000 is a technically advanced lightning protection system. The unique features of this system allow the achievement of superior technical performance, and hence more reliable lightning capture.

The Dynasphere™ air terminal provides a preferred point for lightning discharges which would otherwise strike and damage an unprotected structure and/or its contents. The Dynasphere™ is connected to an ERICORE™ downconductor and the ground system in such a way as to provide a totally integrated system.

Figure 16. Diagram shows un-congested installation of ERITECH® System 3000.

AIR TERMINAL



The System 3000 Dynasphere air terminal.

The Dynasphere™ Enhanced Air Terminal

The patented ERITECH® System 3000 Dynasphere™ is an enhanced air terminal. It features the following:

- Non radio-active
- Not externally powered
- Has no moving parts
- Responds dynamically to the approach of a lightning downleader.

Principles of the Dynasphere™

For over 200 years little improvement was made in lightning protection systems.

Modern research and recording methods have led to a better understanding of the lightning discharge process, and various breakthroughs have been achieved in the simulation of lightning electric-field conditions.

Two fundamental concepts have emerged from recent research into the lightning attachment process and air terminal performance:

1. Air terminals that produce copious quantities of corona (space charge) are likely to be less efficient in the interception of a lightning downward leader.

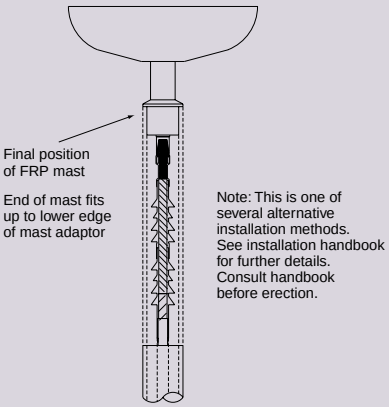
2. An optimum air terminal is one which launches an upward streamer when it is highly likely to convert into a stable, propagating leader (to intercept the downward leader)

The ERITECH® System 3000 Dynasphere™ has been developed with these two concepts in mind.

The Dynasphere™ is an enhanced Franklin rod with a spherical dome which is capacitively coupled to the electric field of an approaching lightning downleader.

This spherical conductive surface surrounds a central earthed lightning rod. The sphere is insulated from the rod but connected to ground via a high impedance with DC conduction.

The Dynasphere is isolated from the structure using an insulated support mast. The mast also enables the safe connection of the ERICORE downconductor to the air terminal.



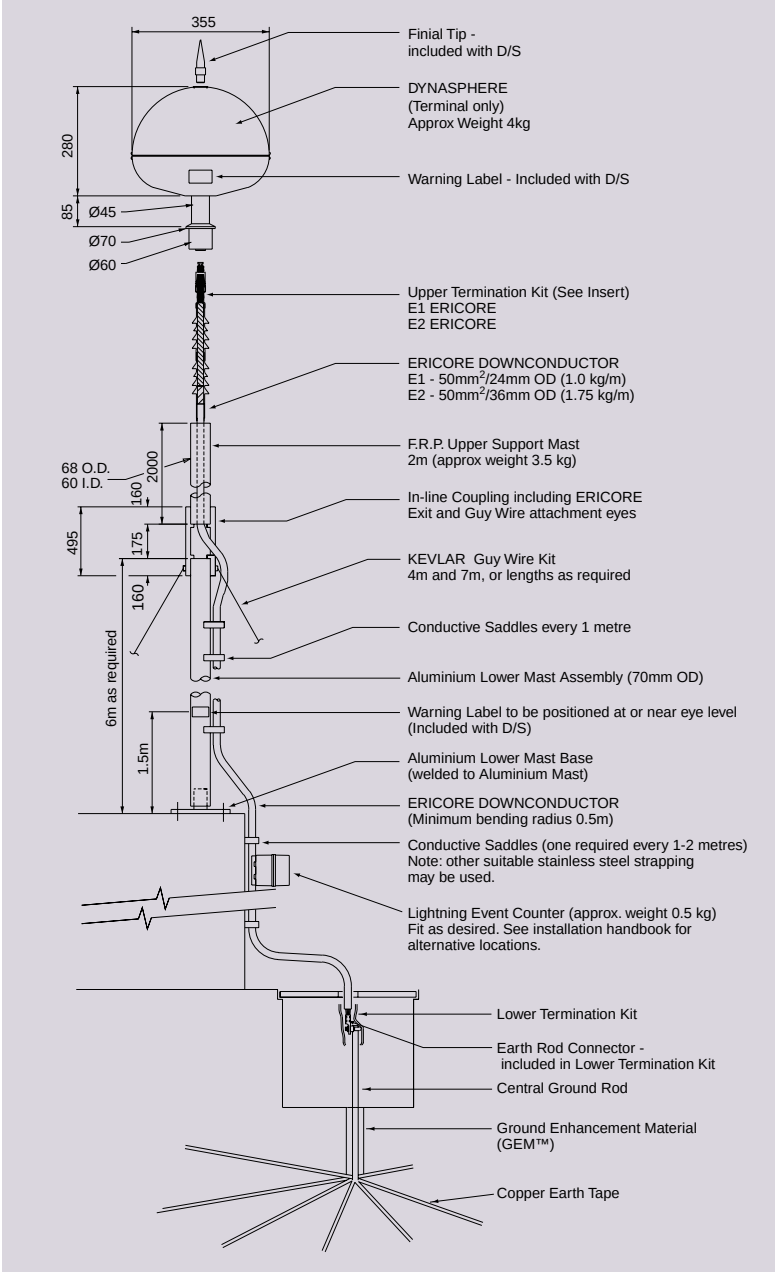


Figure 17.
System 3000™ Component Diagram.

AIR TERMINAL

How it works

In the "static" thunderstorm phase, the electric fields are only slowly varying, with magnitudes in the range 5-15 kV/m. During this time, and even in the early stages of leader approach, the sphere remains effectively grounded via the high impedance static drain unit. It presents a surface of sufficiently low field intensification in order to minimise corona and, hence, prevent the inhibiting effects of a space charge volume.

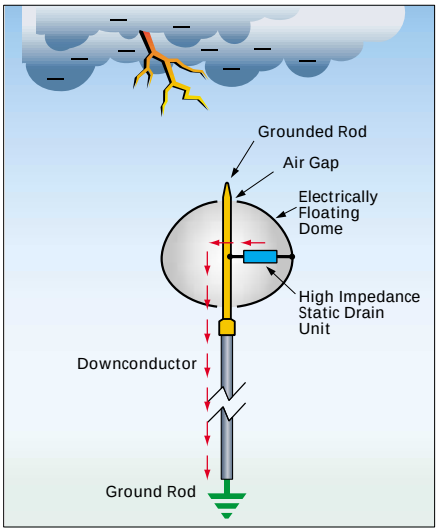


Figure 18. Static Thunderstorm Phase.

On the closer approach of the downward leader, the sphere rises in voltage via capacitive coupling. When the voltage is high enough, a triggering arc is created across the air gap between the sphere and grounded rod.

The triggering arc has two effects, namely: (i) it produces the large number of free electrons needed to initiate an upward streamer, and (ii) it causes a sudden increase in the electric field above the air terminal, which provides additional energy to initiate and convert a streamer. This guarantees stable leader propagation, and hence ensures reliable lightning capture. The size of the air gap is optimised so that a triggering arc only occurs when the electric field is high enough to ensure a stable upward leader can be developed to successfully intercept the downward leader.

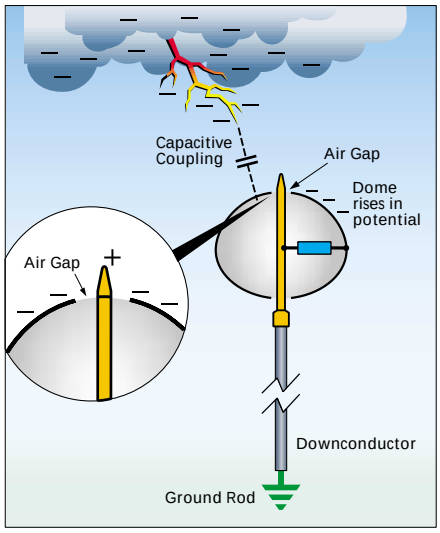


Figure 19. Dynamic Thunderstorm Phase.

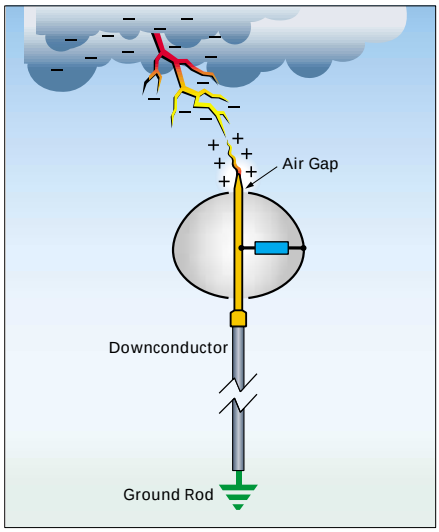


Figure 20. Controlled Triggering Streamer Phase.

The Dynasphere™ has been designed to meet all of the criteria necessary for the controlled emission of a streamer. The concept of "controlled" is important because there is no point launching a streamer too early - the ambient field will not be large enough to convert the streamer to a leader and so the streamer will cease to propagate. This will leave a space charge behind which can inhibit future initiation attempts.

Leading scientists agree that the electric field required to initiate and sustain stable upward leader propagation is in the range 300 - 500 kV/m for a positive upward leader and approximately 1 MV/m for a negative upward leader. The triggering of the Dynasphere™ at the correct time in relation to the descent of the downward leader is the key to its more reliable performance.

Characteristics of an optimum air terminal

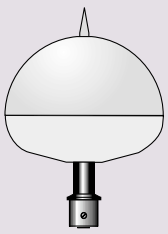
- Minimal pre-strike corona/space charge
- Streamers released only when the ambient field can sustain leader initiation and propagation

Both of these characteristics require a blunt configuration.



Dynasphere shown here under test conditions - generated down leader triggers upward leader.

SPECIFICATIONS



Dynasphere™ Enhanced Air Terminal

Capture point of the ERITECH® System 3000. Initiates an upward leader during storm conditions to capture lightning discharges over a greater radius than conventional protection.

Height:	460mm (18 3/4in.)
Diameter:	354mm (14 7/16in.)
Weight:	3.7kg (8lbs.)
Colours:	Gold and Silver

DOWNCONDUCTOR

The ERICORE™ Downconductor

As part of the ERITECH System 3000, the screened, insulated ERICORE™ downconductor conveys the lightning discharge current to ground with minimal danger of sideflashing. A unique semi-conductive outer sheath allows electrostatic bonding of the building through cable securing saddles.

The ERICORE™ downconductor evolved after extensive studies of potential voltage rise in structures due to lightning injection. This cable comprises carefully selected dielectric materials, as shown in Figure 22, which create capacitive balance and ensure insulation integrity under high impulse conditions.

The unique ability of ERICORE™ to confine a discharge current and simultaneously support electrical bonding ensures minimal risk to building, occupants and sensitive electronics.

Lightning parameters			Cable voltage developed at injection point (kV)	
Peak current (kA)	% of larger currents	Max. dI/dt (GA/s)	Conventional downconductor	ERICORE downconductor
10	92	12	580	13
30	55	40	1900	44
50	25	77	3700	85
90	5	160	7700	180

Table 3. Example of the difference in reliability between a conventional downconductor and a screened, insulated downconductor. Based on the ERICORE E2.

To understand the technical value of the cable, it is first necessary to review the problems associated with normal down conductors. Figure 21 shows how the self-inductance of a normal conductor causes very high voltages to be developed.

A value of inductance of 1.6 microhenries/metre is normally regarded as quite small. However, when a current is impressed which is rising at the rate of 10^{10} Amperes per second, the effect of this inductance becomes dominant. As an example, a single 60 metre downconductor will rise to a value in excess of 1,000,000 volts with the application of an average discharge. It is for this reason that the ERICORE downconductor has a significant advantage over conventional downconductors.

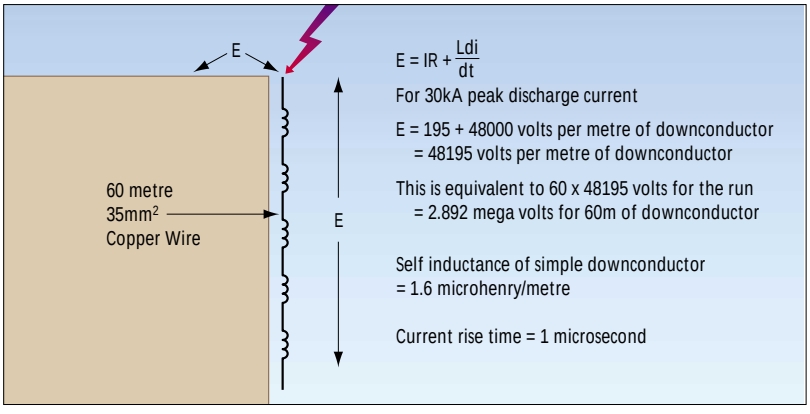


Figure 21. The effect of self inductance in a single downconductor.

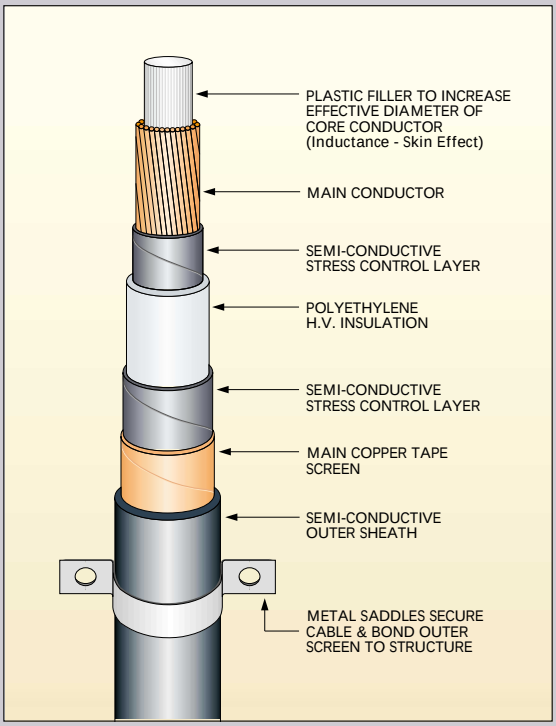


Figure 22. Cutaway diagram showing the composite layers of ERICORE™ downconductor.

Technical and Design Characteristics of ERICORE™

The ERICORE™ downconductors have been designed to meet all of the criteria for an effective and reliable downconductor, with the following key characteristics:

- a low inductance per unit length
- a low surge impedance
- a carefully controlled internal electric field distribution to minimise field stresses under current impulse conditions
- carefully designed, stress reducing upper termination



The System 3000 ERICORE™ downconductor is easily retro-fited to existing structures. Inset: Lightning Event Counted (LEC IV) installed to register strikes to System 3000.

DOWNCONDUCTOR

ERICORE™ Sizes

ERICO offers two different sizes of ERICORE™ screened/insulated downconductors, the "E1" and the "E2". The central conductor of each cable has the same cross-sectional area but other key electrical and physical characteristics vary. Table 4 summarises the key characteristics of each of these cables.

ERICO representatives should be contacted to determine the size of cable that best suits specific applications.

Characteristic	E1	E2
Characteristic impedance (Ω)	6.7	4.5
Inductance (nH/m)	33	22
Capacitance (pF/m)	750	1100
Cross Sectional Area of Conductor - mm^2	50	50
Resistance (mΩ/m)	0.4	0.5
Upper Termination Voltage withstand (kV)	200	200

Table 4. Characteristics of ERICORE™ E1 and E2 downconductor.

Why Use ERICORE™?

The ERICORE™ downconductor cables are purpose-designed low inductance, low impedance, cables designed to minimise voltage build-up due to lightning impulses. This cable provides significantly higher performance than any normal HV cable and is specially designed for the control of lightning impulses.

The main danger in controlling lightning impulses is the very fast voltage and current rise times following the capture of the lightning strike.

To further understand the technical value of the cable, it is necessary to review the lightning mechanism and resulting voltage buildup. The voltage between inner conductor and outer sheath is determined by three different parameters. These are dominant at different stages during the operation of the cable in conveying lightning energy to ground (as shown in Figure 23 and summarised in Table 5).

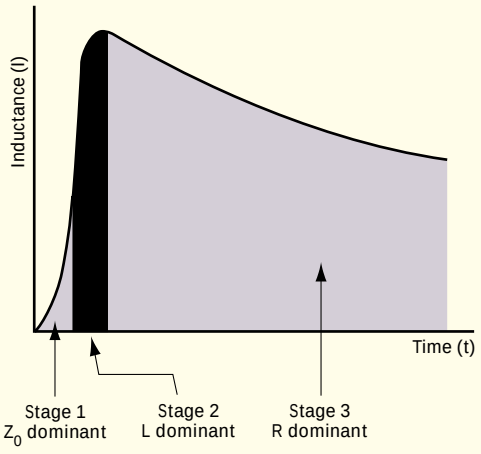


Figure 23. Typical lightning waveform.

Stage 1 - Impedance (Z)	
$Z_0 = \sqrt{\frac{L}{C}}$	Cable voltage determined by Z_0
Stage 2 - Inductance (L)	
$V \propto L \frac{dI}{dt}$	Cable voltage determined by inductance and its rate of change
Stage 3 - Resistance (R)	
IR.	Cable voltage determined by L&R but L is small or negative due to small dI/dt.

Table 5. Summary of the three main stages of ERICORE operation.

ERICORE™ offers purpose-designed performance in each phase of the lightning control process to convey the energy safely to the grounding system.

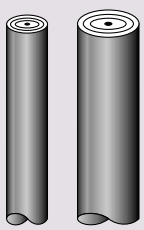
As an example, consider the following comparison between the same 50 m length of conventional downconductor (25mm x 3mm copper tape) and ERICORE™ downconductor, using the air breakdown electric field (nominally 3 MV/m) and cable termination voltage (200 kV) as the criterion for "failure" of the downconductors.

The conventional downconductor will, conservatively, cause a flashover or structure dielectric breakdown when carrying lightning currents of only ~ 30 kA. On the other hand, the ERICORE™ screened/insulated downconductor can easily deal with lightning currents of 90 kA. This magnitude of lightning current is exceeded in only ~ 5 % of lightning events or approximately once every 30 years in a region with a ground flash density of 5 strikes/km^2/yr (approximately 80 thunder days/yr).

Main Benefits

- Lightning impulse is contained within the cable and the semiconductive outer sheath is bonded to the structure via metallic saddles which means that the risk of sideflashing is negligible
- The low characteristic impedance of the cable minimises internal dielectric failure
- The cable is able to be routed away from sensitive equipment, electrical wiring, structural steel and human work areas
- Use of a single downconductor as opposed to multiple downconductors
- Ease of installation
- Minimal maintenance

SPECIFICATIONS

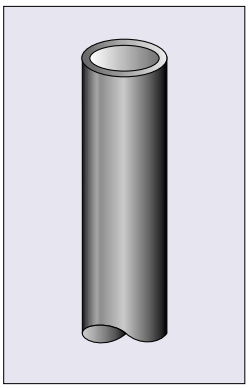


ERICORE Downconductor

Purpose designed cables, using a copper 50mm^2 (1/0 AWG) main conductor to safely convey the lightning energy to ground, while minimising side flashing.

Downconductor:	E1	E2
Diameter:	24mm (1")	36mm ($1^7/_{16}$")
Weight:	1.0kg / metre	1.8kg / metre
	10.3oz / ft.	19oz / ft.

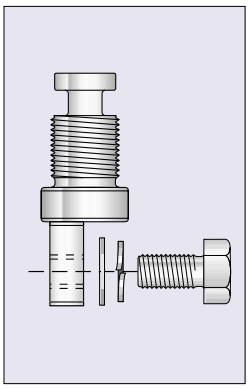
OTHER COMPONENTS



FRP Mast

Purpose-designed Fibreglass Reinforced Plastic, manufactured from non-hydroscopic epoxy and glass laminate, provides an insulated mast for mounting the Dynasphere™.

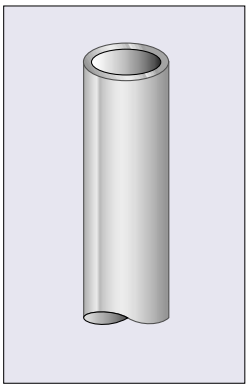
Lengths:	2m (811/2in.) & 4.6m (1873/4in.)
Inside Diameter:	60mm (23/8in.)
Outside Diameter:	68mm (211/16in.)
Weight:	2m = 3.3kg (71/4lbs.) 4.6m = 7.6kg (163/4lbs.)
Colours:	White or Black



Terminal Lug Coupling

The Terminal Lug Coupling allows for connection of a conventional downconductor such as 25mm x 3mm copper tape/bar to the Mark III Dynasphere™. See Upper Termination Instructions for fixing of coupling to Dynasphere™.

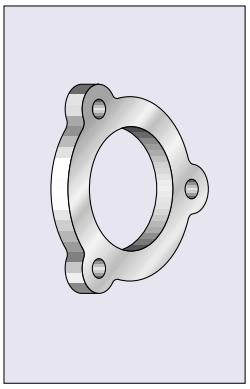
Material:	Brass Alloy 384D
Length:	68.75mm (211/16in.)
Weight:	181 grams (6.38 oz.)
Diameter:	25.4mm (1in.)



Aluminium Mast

Light weight lower mast material.

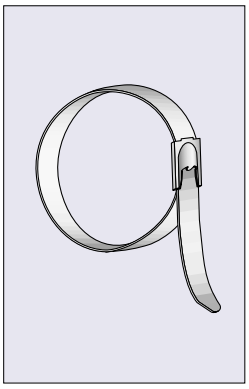
Lengths:	3, 4, 5 & 6m (1221/2, 1631/4, 204 & 245in.)
Inside diameter:	61.9mm (27/16in)
Outside diameter:	69.9mm (21/4in.)
Weight:	2.4kg / metre



Guy Ring

Purpose-designed Guy Ring, providing 3 guy anchoring points from the neck of the Dynasphere™.

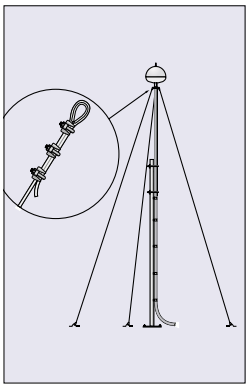
Height:	105.25mm (42/16in.)
Inside Diameter:	60mm (26/16in.)
Outside Diameter:	91mm (31/2in.)
Material:	Cast Aluminium
Guy Hole Diameter:	10mm (6/16in.)



Stainless Steel Cable Tie

Purpose-designed cable tie for securing of ERICORE™ down-conductor to structures.

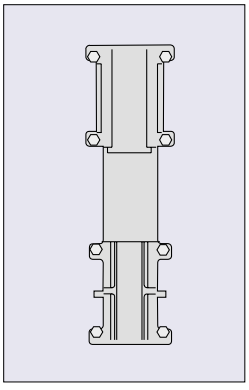
Length:	521mm (201/2in.)
Width:	7.9mm (5/16 in.)
Material:	Stainless Steel
Maximum Bundle Diameter:	152mm (6 in.)
Minimum Loop Tensile Strength:	250lbs.



Guy Kit

Purpose-designed guying Kits for anchoring from a Guy Ring or Inline Coupling. Each kit comes complete with six stainless steel thimbles, plus 18 guying grips per kit.

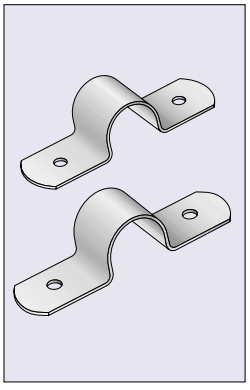
	4m Guy Kit	7m Guy Kit
Guy Diameter:	4mm (5/32 in.)	5mm (3/16 in.)
Actual Guy Length:	6m (201/2 ft.)	10m (34 ft.)
Guy Tensile Strength:	430kg (946lb.)	560kg (1232lb.)



Inline Coupling

Purpose-designed coupling to clamp FRP to aluminium lower mast, providing 3 guy anchoring points and downconductor exit point.

Max. Clamping diameter:	70mm (27/8in.)
Max. Clamping torque:	55kg/cm (45in.lb)
Weight:	2.4kg (51/4lbs.)
Height added to mast:	200mm (77/8in.)



ERICORE Downconductor Saddles

Purpose-designed saddles for securing of downconductor to structure.

	Saddle E1	Saddle E2
Pack Size:	5	5
Material:	Stainless Steel 316	Stainless Steel 316
Length:	103mm (4 in.)	114.5mm(41/2in.)
Thickness:	1.2mm (1/16 in.)	1.2mm (1/16 in.)
Fixing Hole Diameter:	6mm (4/16 in.)	6mm (4/16 in.)
Width:	25.5mm (1 in.)	25.5mm (1 in.)