Choosing the correct Furse ESP Lightning Barrier for your application

Introduction

This guide is intended to help you choose the correct ESP Lightning Barrier for a particular application, focusing on the long established D and E lightning barrier range.

However, the electrical selection process is the same for all ESP lightning barriers, which come in a variety of formats to allow, easy, cost effective, flexible adaptation to installations:

- New SL series – slim line, removable module
- New SLX series – as SL but ATEX approved for use in hazardous areas
- D series – 'standard' barrier
- E series – high performance
- H series – high current handling, ultra low in-line resistance
- Q series – space saving (4 barriers in one)
- KS series – for LSA-Plus disconnection frames (PBX)
- PCB – mounted directly onto circuit board

The D and E Series Lightning Barriers are most usually available in the form of a module.

The D series can also be purchased in a ready boxed form (D/BX or 4 wire D/2BX variants).

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The 6 steps to choosing the correct Lightning Barrier

By following the steps below it should be a simple task to choose the correct barrier for a particular application.

Step 1: How many Barriers do you need?

Identify how many wires, excluding screen and shields, your system uses.

A Lightning Barrier is able to handle two wires, or one pair.

- If there are three wires, you will need two Lightning Barriers at each end
- If there are four wires, you will need two Lightning Barriers at each end
- If there are five wires, you will need three Lightning Barriers at each end, and so on..

Where the number of lines is odd, one channel at each end will be unused.

If one line is 0 Volts or earth/ground it may be possible to route it via the 'S' (screen) terminal of the Barrier. *See hints and tips later on in this document.*

The 'S' or screen terminal is also used to terminate the screen. See *'Hints and tips"*.

Some systems involve looped wiring; Again, see *"Hints and tips"*.

If some of the wires are paired, then group the pairs together, e.g. TX+ and TX-.

Note: The ESP SL an ESP Q series are designed for applications where there are a high number of lines requiring protection – their slim format saves critical space.

Slim Line ESP SL & SLX Series

Step 2: Choose the correct voltage

In general, the Lightning Barrier must have a let-through voltage that is low enough to ensure damage does not occur.

Its working voltage must also be high enough so it does not treat the signal as a transient, and hence interfere with signalling.

If the damage threshold of the system is known, which is rarely the case, the Lightning Barrier can be chosen based on its let-through voltage, as given on the Datasheet.

The operating voltage requirements detailed below still need to be met, e.g. if you have to protect a system with a 52 Volts damage threshold, that has a working voltage of 5 Volts, then an ESP 30D or ESP 30E are possible choices, as their let-through voltages of 43.4 Volts and 44.3 Volts respectively are below 52 Volts, and their working voltages of 30 Volts are above the 5 Volts system voltage.

As the damage threshold of systems is rarely known, Lightning Barriers are most usually chosen based on the system working voltage.

The Barriers normal working voltage is chosen so that it is equal to or just higher than the system's normal working voltage, for example:

- A 6 Volt system would be protected with an ESP 06D or ESP 06E
- A 12 Volt system would be protected with an ESP 15D or ESP 15E
- A 15 Volt system would be protected with an ESP 15D or ESP 15E

The Lightning Barrier has a maximum working voltage that is higher than the normal working voltage.

This is to allow for system tolerances.

Hence if the actual voltage present is a little higher than expected then signalling will not be disrupted.

You should be able to find out the operating voltage of the system, from its manufacturer, a manual, or a standard.

At their normal working voltage, and at their maximum working voltage, Barriers leak less than a specified current.

This is rarely a consideration, but this data, when required, is given in the footnotes to the performance table on the Datasheet.

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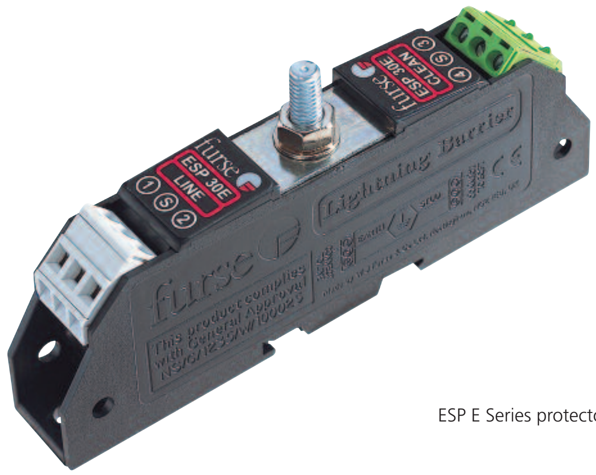
Note that it is the loaded voltage, i.e. the voltage present when the system is fully connected up, not the open circuit voltage, that you need.

The voltages given for the ESP D and E Series Lightning Barriers apply between the two lines, and between each line and earth, in either polarity.



ESP E Series protector

Step 3: Is the line resistance of the Barrier going to be a problem?

Lightning Barriers insert resistance into the circuit they protect.

If this resistance is too high, the signal level is reduced to a point where function is disrupted.

ESP D Series

A D Series Lightning Barrier inserts 9.40 Ω into each line.

As a Barrier has two channels, it will introduce double this resistance into a circuit.

When protection is required at both ends of a circuit, Barriers are necessary at both ends, and resistance is added at both ends.

Thus, with a Barrier at each end of a circuit the overall circuit loop resistance will be 37.60 Ω.

ESP E Series

An E Series Lightning Barrier inserts 1.00 Ω into each line.

As a Barrier has two channels, it will introduce double this resistance into a circuit.

When protection is required at both ends of a circuit, Barriers are necessary at both ends, and resistance is added at both ends.

Thus, for a Barrier at each end of a circuit, the overall circuit loop resistance will be 4.00 Ω.

You can find out if the resistance is acceptable in a number of ways.

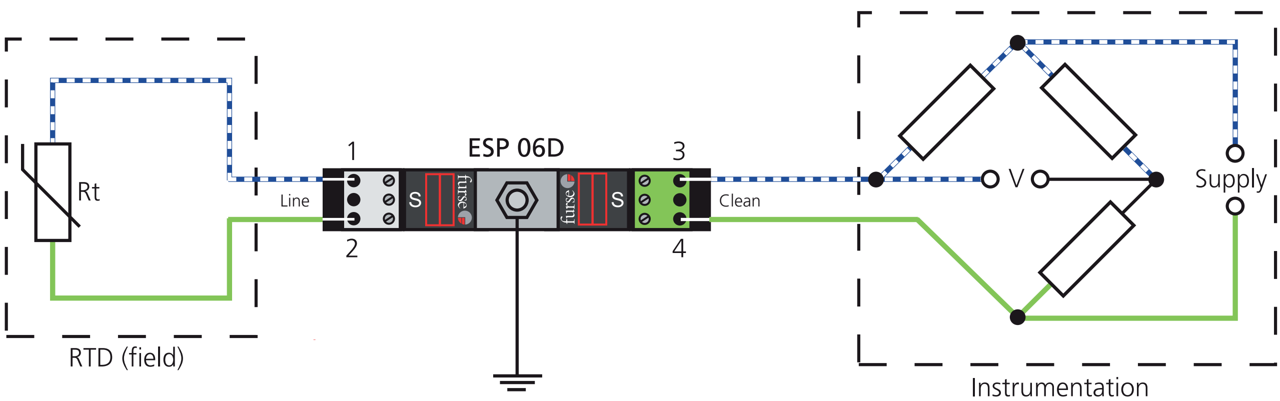
- Ask the manufacturer of the system.

  The system may have an acceptable loop resistance value in its documentation.
- Perform an 'ohms law' voltage drop calculation (V=IR) based on the current present, and the resistance introduced into the circuit as a result of introducing the Barrier.

  If the volt drop is small compared to the signal level, the resistance is acceptable.
- Compare the resistance to cable resistance in the system.

  If the resistance of the Barrier is small compared to the cable resistance that is present, then introducing the Barrier is unlikely to make any difference to the system.

Generally, resistance becomes an issue in power supplies, and in some higher frequency systems.



ESP D Series protecting an RTD system

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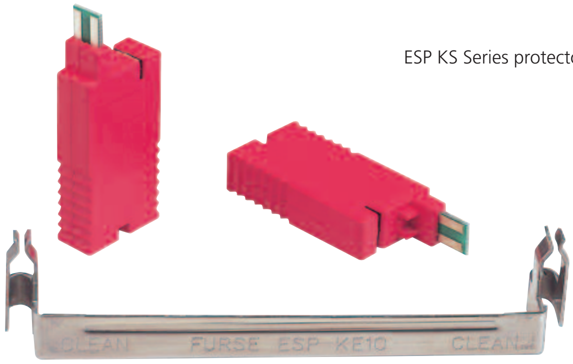
Step 4: Am I exceeding the maximum operating current of the Barrier?

When current flows through the resistance of the Barrier, heating occurs.

The maximum operating current of the Barrier is based on a conservatively acceptable amount of heating taking place.

This value should not be exceeded.



ESP KS Series protectors

Step 5: Am I exceeding the bandwidth of the Barrier?

Lightning Barriers insert series resistance and shunt capacitance into a circuit.

As such they form a low pass filter.

Beyond its bandwidth, such a filter will stop signalling.

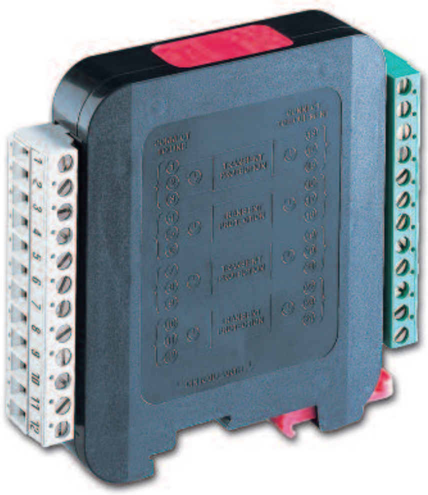
We specify the -3 dB bandwidth for our Barriers in a 50 Ω system for a sinusoidal signal.

If the bandwidth of the protector exceeds the maximum signal frequency by at least a factor of ten, then there should be no problems.

If the factor is less than ten, then we have to be a little more careful.

If the Barrier is inserted into a system that is not 50 Ω then its actual bandwidth will change.

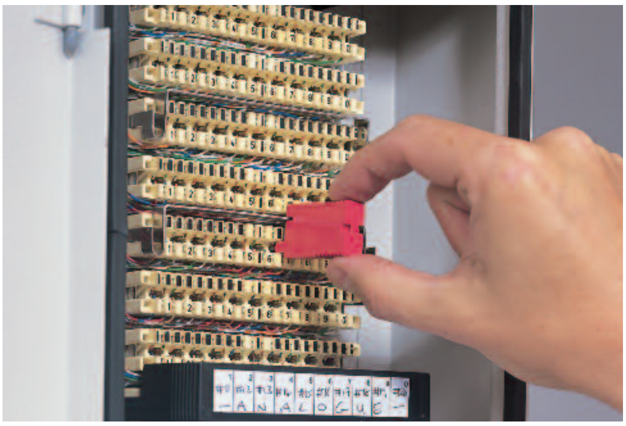
Also if the signal is not sinusoidal it may contain frequencies higher than expected.



ESP Q/UL Series protector

Step 6: Choose correct termination, enclosure and approvals.

Screw terminals are most common, though some data lines terminate on a PBX type LSA-plus disconnection frame hence the ESP KS Series should be considered for easy plug-in cost effective protection.



Simple plug-in connection of ESP KS Series protector

The ESP PCB protectors could be used where there is an opportunity to protect directly on the circuit board to have discrete protection – typically used for military applications.

Also choose the correct enclosure, if required – lightning barriers have exposed terminals and therefore have to be enclosed within the panel or via an ESP WBX enclosure.

Finally, check the environment in which the lightning barrier is fitted – for example is ATEX certification needed?

If so the ESP SLX series should be considered.

If UL certification is required, the ESP Q/UL series should be considered.

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Worked examples

Protecting a 1 amp 6 Volt floating DC power supply:

Step 1: This has two wires + and -, hence one Barrier at each end is appropriate.

No real need for slim formats, PCB or PBX LSA-plus type protectors.

Step 2: Either ESP 06D, ESP 06E or ESP 06H could be used, as their normal working voltages correspond to the power supply voltage.

The maximum working voltages, which are just under 30% higher in these cases should account for any tolerance in the power supply voltage.

Step 3: If a D Series were used, the loop volt drop would be 1 amp multiplied by 37.60 Ω (4 x 9.4 Ω), that is 37.6 Volts, more than the power supply voltage!

A D Series device is inappropriate.

If an E Series device were used, the loop volt drop would be 1 amp multiplied by 4.00 Ω, which is 4.0 Volts, a significant part of the power supply voltage!

An E Series device is also inappropriate.

The ESP H series has an ultra low in-line resistance of 0.05 Ω. So 1 amp multiplied by 0.2 Ω loop resistance (4 x 0.05 Ω) would mean a loop volt drop would only be 0.2 V.

The ESP H Series is therefore only suitable.

Step 4: Just to illustrate, the D Series cannot be used as 1 amp exceeds its maximum running current parameter.

Whilst 1 amp falls within the running current parameters of the E Series, the volt drop in Step 3 means it cannot be used anyway.

The ESP 06H has a maximum running current of 4A so is suitable.

Step 5: DC is a frequency of 0 Hz, and as such bandwidth is not a problem for the ESP 06H.

Step 6: There is space in the cabinet to mount the ESP 06H barriers conveniently on the DIN rail so there is no need for a additional WBX enclosure.

Example: Protecting RS-232

Step 1: The number of wires in an RS-232 varies, with shorter links using more wires and operating faster and longer links using fewer wires and operating at slower speeds.

In most situations there will be three or four wires, requiring two Lightning Barriers at each end.

The simple way to find out how many wires there are is to look and count them.

Step 2: Whilst RS-232 has a 25 Volt open circuit voltage, the voltage with everything connected lies between 5 and 14 Volts.

Hence an ESP 15D or ESP 15E could be used.

Tests at Furse show that some RS-232 systems are able to tolerate around 50 Volts without damage.

ESP 30D or ESP 30E could protect these, but other versions of RS-232 hardware may be less robust, so the ESP 15D or ESP15E are the safer choice.

Step 3: The transmitter source resistance for RS-232 is always greater than 300 Ω, and the receiver resistance lies between 3,000 Ω and 7,000 Ω.

The 37.60 Ω introduced by a ESP 15D is insignificant compared to these values.

There is no benefit in using an ESP 15E.

Step 4: Based on a 25 Volt open circuit voltage, and 300 plus 3,000 Ω resistance, the current flowing can be shown to be less than 8 mA, well within the capabilities of the D Series.

Step 5: The maximum speed RS-232 runs at is 20,000 bits per second.

The bandwidth of an ESP 15 is 2.5 MHz, many times this.

There will be no bandwidth problems.

Hence ESP 15D is the optimum choice as it is more cost effective solution than the enhanced ESP 15E.

Step 6: The units are to be mounted externally.

Furse conveniently offer the ESP 15D Series in a ready boxed 4 wire variant – the ESP 15D/2BX.

This is the most cost effective, easy to install, compact option.

Note: Furse technical are more than happy to help you select the right product – just simply provide the details of the system (detailed in the 6 steps above) you are trying to protect.

Many systems have standard industry names – e.g. RS 485 which requires no detailed calculations as Furse have already determined that the ESP 06E for example is already suitable.

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Hints and tips

Unbalanced lines

A balanced line uses pairs of wires, with identical physical and electrical characteristics where one wire is electrically identical to the other.

They will often be labelled A & B, TX+ & TX- etc. An unbalanced or single ended line uses wires, where one of the wires is 0 volts or earth at both ends of the system.

In an unbalanced system, providing the 0 Volts or earth lines are directly connected to electrical earth in the equipment, it is permissible to route them via the 'S' terminal of the Barrier.

This terminal connects directly to earth at both ends of the Lightning Barrier.

If it is unclear if the 0 Volts or earth line is connected directly to electrical earth in the equipment, then it should be routed via a channel in the Lightning Barrier.

Shields and screens

Advice on bonding of shields and screens varies from system to system, probably due to lack of understanding of the topic, rather than requirement.

To avoid disputes and arguments, we suggest the shielding method that would have been employed without Barriers present, still be employed when Barriers are employed.

E.g. If shields are to be bonded at both ends, do so.

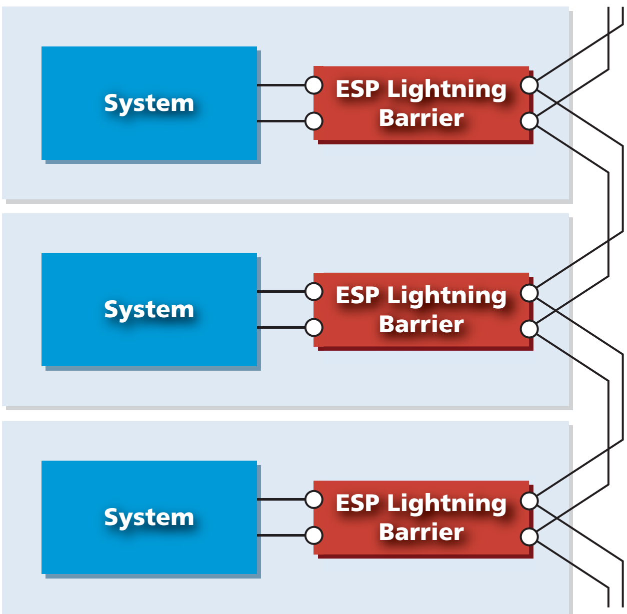
In a typical system this will have to be done on three lengths of cable.

If shields are to be bonded at one end only, they should be bonded at one end only, on three lengths of cable.

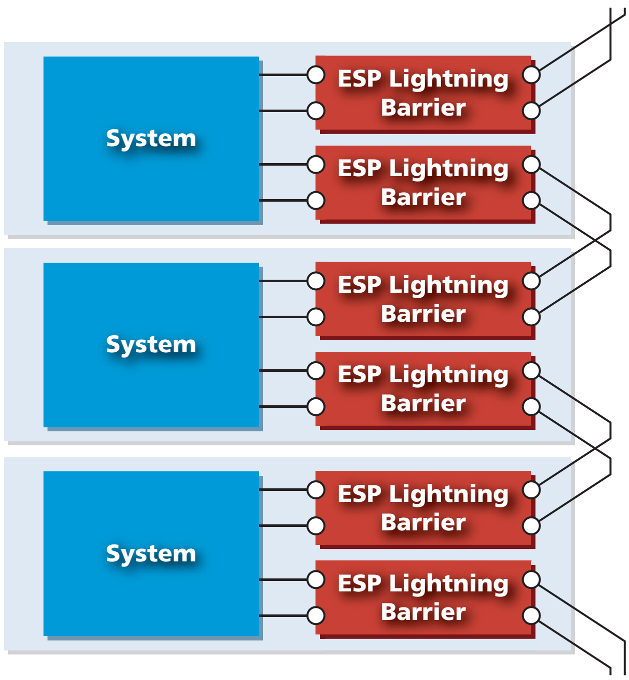
Note that the ESP SL series come with an option (/I) to isolate the screen from the earth which is particularly useful for preventing earth loop problems, common in certain systems such as fire alarms.

Daisy chain and in out wiring

Where wires are run between a series of buildings, you may require either one Lightning Barrier per pair of wires, per building, if the system uses daisy chain wiring or if the system uses in out wiring, double this number of Barriers. This is illustrated below.



Two wire "daisy chain" connection for three buildings



Two wire "in out" connection for three buildings

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