Introduction

This document explains how to install Furse Electronic Systems Protectors for mains power supplies:

Single phase	ESP 120 M1
Three phase	ESP 208 M1
Single phase	ESP 240 M1
Three phase	ESP 415 M1

WARNING: Incorrect installation will impair the effectiveness of the ESP units

These instructions are prefaced by a summary of the *Key points of installation*. Each key point is explained in detail in the section entitled *Installation*.

Contents

Key points of installation

1 Install protectors very close to the power supply to be protected, either within the distribution panel or directly alongside it.

2 Mount units within a panel or WBX enclosure.

3 Units are installed in parallel.

4 Connect to phase(s), neutral and earth.
NOTE: Units must have a neutral connection.

5 Units installed at power distribution boards can be installed either:
(i) on the load side of the incoming isolator, or
(ii) on the closest available outgoing way to the incoming supply.

6 Provide a means of isolation for the ESP unit.

7 On power supplies rated at over 100 amps, the connecting leads to phase/live terminals should be fused with 63 amp high rupture capacity (HRC) fuses, switchfuse, MCCB or type 'C' MCB.

8 Connecting leads should be 10 mm^2 multi stranded cable.

9 Keep the connecting leads as short as possible and ideally less than 25 cm (10 inches) in length.

10 Bind the connecting leads tightly over their entire length.

Before installation

1 Check that the voltage between neutral and earth does not exceed 10 volts. If this voltage does exceed 10 volts, the installation is unsafe. Find and rectify the cause of this fault before proceeding.

2 Make sure that the supply voltage is suitable for the unit.

	Supply *Rated Voltage* (V rms)	*Unit Voltage Range* (V rms)
ESP 120 M1 *Phase to Neutral/Earth*	110/120/127	90-150
ESP 208 M1 *Phase to Phase*	190/208/220	156-260
ESP 240 M1 *Phase to Neutral/Earth*	220/230/240	200-280
ESP 415 M1 *Phase to Phase*	380/400/415	346-484

Installation

1 **Location**
Protectors need to be installed very close to the power supply to be protected. Usually the protector will be installed at a power distribution panel either inside it *(Figure 1)* or right next to it *(Figure 2)*.

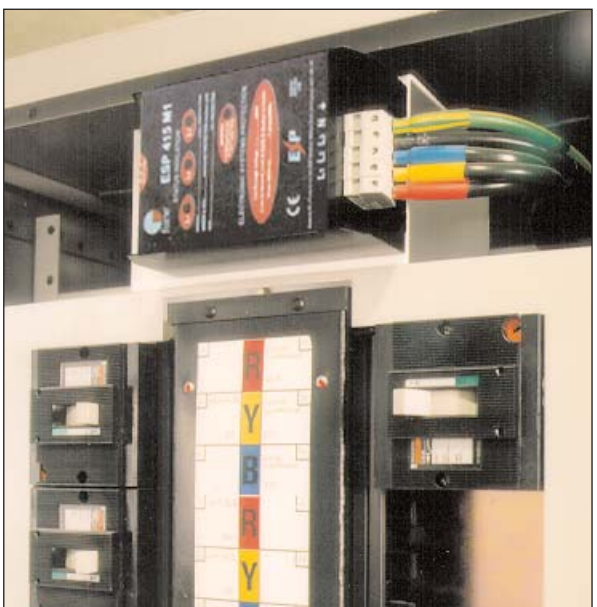

Figure 1 - ESP 415 M1 installed inside a power distribution panel.

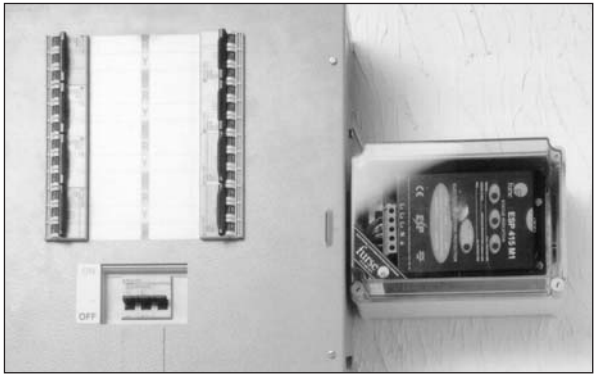

Figure 2 - ESP 415 M1 installed next to a power distribution panel.

2 **Enclose the ESP unit**

The ESP unit has exposed terminals. For electrical safety, the unit must be installed within a panel or enclosure. Where possible, install the unit within the power distribution panel behind a suitable viewing window.

When mounting the units in existing metal panels or enclosures, ensure that the enclosure is securely bonded to the earth bar to which the ESP unit will be connected.

If it is not possible to install the unit within the distribution panel it should be mounted in a separate enclosure, *see Figure 2*, as close as possible to the distribution panel *(see 9 - Length of connecting leads)*. Gland the enclosure onto the power distribution panel. Suitable enclosures are available from Furse.

3 **Parallel connection**

The Electronic Systems Protectors (ESP 120 M1, ESP 208 M1, ESP 240 M1, ESP 415 M1) are connected in parallel with the supply to be protected. *See Figure 3*. The connecting leads do not carry the load current of the supply, only the current associated with suppressing the transient overvoltage. *Figures 3 & 4* show connection diagrams for single phase and three phase star power supplies.

Figure 3 - Parallel connection for single phase supplies.

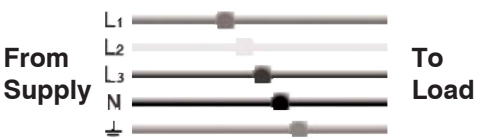

Figure 4 - Parallel connection for three phase star (4 wire and earth) supplies.

4 **Connection to phase, neutral and earth**
Connections are made to each supply conductor including earth. Terminals marked L, N, ⏚ (single phase units) or L_1, L_2, L_3, N, ⏚ (three phase units) must be connected to phase/live, neutral and earth respectively.

Under no circumstances must the ESP unit be installed without connection to its neutral.

Where no neutral is present (eg delta supplies) the neutral (N) terminal on the ESP unit must be connected to earth. This will result in a greatly increased earth leakage current. On some delta supplies the voltage between phase and earth/neutral may exceed the rating of the ESP unit. Consequently, the supplies phase to earth voltage must be checked before installing the ESP unit. **We recommend that you consult Furse ESP before installing ESP units on delta supplies.**

5 **Connection point**
(a) Protecting supplies feeding equipment in the building
The ESP unit is typically connected to the power supply at a power distribution board/panel, either:

(i) *on the load side of the incoming isolator (Figure 5).*

(ii) *on the closest available outgoing way to the incoming supply (ie the incoming isolator).*

The ESP unit can be connected via one of the distribution board's outgoing fuseways or circuit breakers. **Ideally, the ESP unit should be connected to the outgoing way which is nearest to the incoming supply (or isolator).** *See Figure 6.* On small, compact, metal cased distribution boards, (such as small MCB boards) the first way is preferable, although any outgoing way is suitable. On a large board such as a cubicle switchboard, it is better to install the protector on the load side of the incoming isolator (eg in the metering section). Fitting the protector in any other position could affect the protectors performance.

(iii) *directly to the busbars (supplies rated at 100 amps or less, only).*

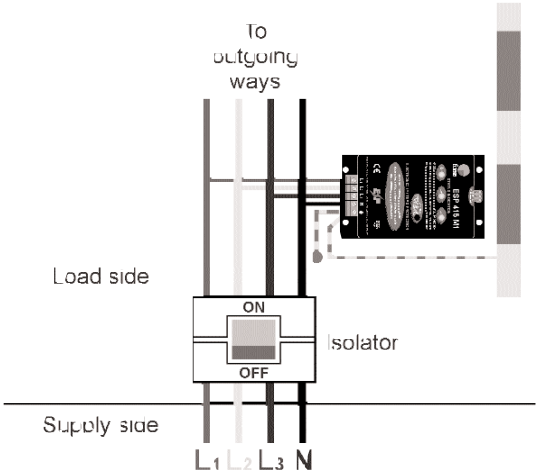

Figure 5 - ESP unit mounted within a distribution board connected to the incoming supply on the load side (ie downstream) of the isolator. (Note the additional earth bond to the metal work of the distribution board. This technique is explained in 9(iii).)

(b) Protecting supplies going out of the building

The connection methods 5a (i to iii) are not suitable for protecting a power distribution board which provides a supply to outside the building - either to a separate building or some other external load (eg site lighting). To protect the equipment inside the building, from transient overvoltages entering the board on the outgoing feed, protection should be installed close to the external load. *See Figure 7.*

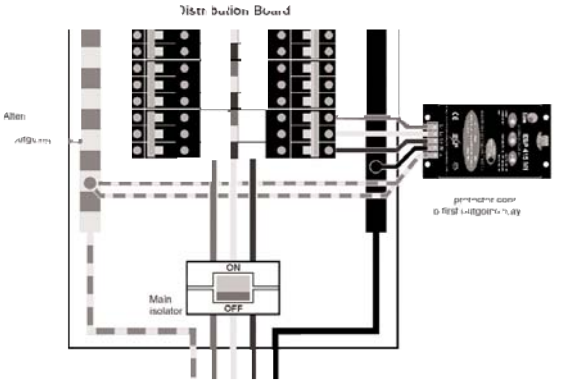

Figure 6 - Three phase ESP protector connected to the nearest available outgoing (MCB) way to the incoming supply. The MCB also provides the means of isolation. Since there is insufficient space within the distribution board the ESP unit has been mounted within a separate enclosure, directly alongside the board. Note the double connection to earth, in order to compensate for the long connecting leads. (See 9 Length of connecting leads - this also gives an alternative technique in 9(iii).)

6 **Isolation**

It is good practice to be able to isolate or disconnect the ESP unit from the supply.

The supply to the entire distribution board should not be switched off on many computer power supplies and other critical loads. The means of isolation should therefore be installed in the connection to the ESP unit. *Figures 8 & 9* show example connection schematics. Where it is also necessary to fuse the connection to the ESP unit *(see 7 Fuse connecting leads on supplies over 100 amps)* this

can be achieved through use of a switchfuse, MCCB or type ‘C’ MCB.

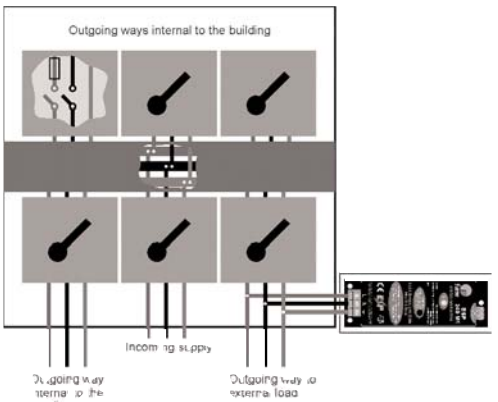

Figure 7 - Connection for supplies continuing external to the building.

7 **Fuse connecting leads on supplies over 100 amps**
If the ESP unit is to be connected to a power supply rated at over 100 amps the connecting leads to the phase/live terminals of the ESP units should be fused. This is to protect the connecting leads in the event of a short circuit, it is not to protect the ESP unit.

Live/phase connecting leads can be fused by either:

(a) installing 63 or 100 amp high rupture capacity (HRC) fuses or switchfuses in the connecting leads at the supply end of the lead *(See Figure 10)*, or

(b) installing a 63 amp circuit breaker (MCCB or type ‘C’ MCB).

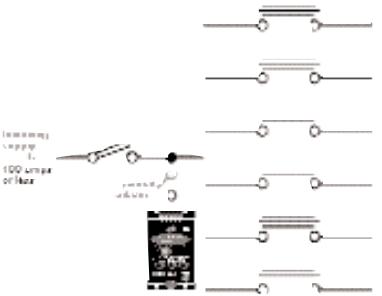

Figure 8 - ESP unit installed on incoming side of distribution board on supply rated at 100 amps or less.

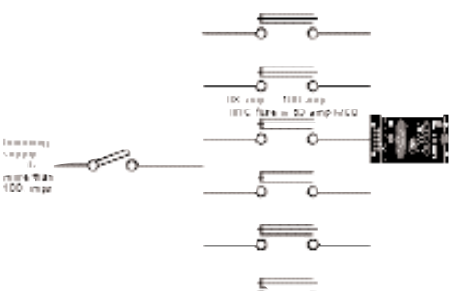

Figure 9 - Installation of ESP unit on first outgoing way of distribution board on supply rated at greater than 100 amps.

Where the ESP unit is installed via an outgoing way *(5b earlier)* this should incorporate a 63 amp HRC fuse or circuit breaker.

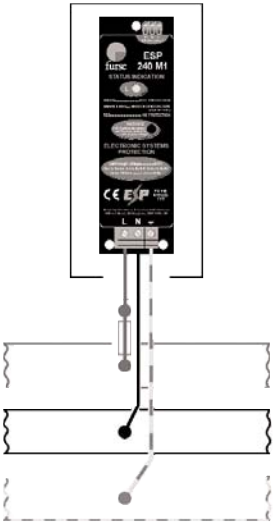

Figure 10 - Busbar mounted 63 or 100 amp HRC fuse at the end of the live connecting lead.

8 **Size of connecting leads**

The connecting leads between the terminals of the ESP unit and the power supply, should be 10 mm² multi stranded conductor. On supplies rated at 63 amps or less 4 mm² multi stranded conductor can be used. If required, the terminals on the ESP unit will accept connecting leads of up to 16 mm².

9 **Length of connecting leads**

The connecting leads should be kept as short as possible and ideally should not exceed 25 cm (10 inches) from the busbars to the units terminals.

ESP units can be mounted upside down or on their side if this facilitates shorter connecting leads.

WARNING: The longer the connecting leads (between the mains cable or busbars and the terminals of the ESP unit) the greater the voltage let-through the protector. If the resultant let-through voltage is higher than the susceptibility level of the equipment to be protected, damage will result.

Connecting leads up to 50 cm (20 inches) can be used when:

(i) Two sets of 4 mm² cables are used (ie two sets of live, neutral and earth conductors).

Each set of conductors is tightly bound together, using tie-wraps, tape or spiral wrap. This should be done for the entire length of the cable or as far as is possible.

The two sets of bound conductors should be separated in their routeing. Ideally a distance of 10 cm (4 inches) should be maintained between the two sets of conductors as far as possible. *See Figure 11.*

(ii) Alternatively, if only one conductor needs to be longer than 25 cm then use a pair of separated (as above) conductors to make that connection. *See Figure 6.*

Figure 11 - For connecting leads of up to 50 cm use two sets of conductors (L1, L2, L3, N, ⏚). Each set of conductors has been tightly bound and separated in their routeing.

(iii) For metal distribution boards, if only the earth connection needs to be longer than 25 cm, the following procedure is suggested (*see Figure 5)*:

(a) Using 4 mm² cable make one connection from the ESP unit to the earth bar.

(b) A second short and direct connection, again using 4 mm² cable, should be taken from the ESP unit to the metal work of the distribution board.

(c) Bond the earth bar to the metal work of the distribution board.

The techniques outlined above (i-iii) are designed to minimise the inductance associated with the connecting leads.

10 **Bind connecting leads**

Connecting leads should be tightly bound together using tie-wraps, tape or spiral wrap. This should be done for the entire length of the cable or as far as is possible. *See Figure 11*.

Installation check

The ESP unit should now be correctly installed. Switch the power supply on. Check that a green LED per phase is lit. *See Figure 12.*

The unit is now fully operational.

Watch the WARNING light for 30 seconds. If it is flashing or lit there is a problem with your installation *(see page 19)*.

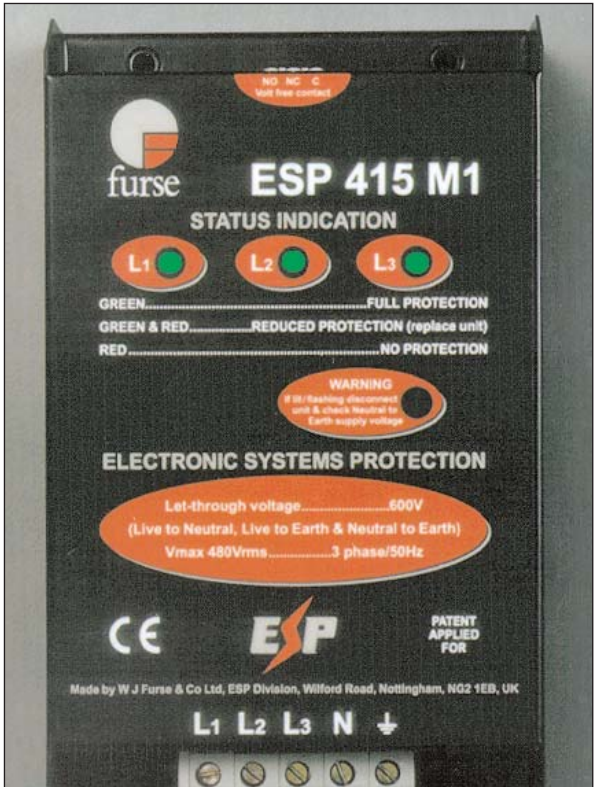

Figure 12 - Status indication lights showing full protection on all phases.

Neutral-earth warning light

If the WARNING light is illuminated there is an excessive voltage present between neutral and earth. **The WARNING light should never be illuminated.**

(a) *Illumination at time of installation*

If the WARNING light flashes as soon as the mains supply to the ESP unit is turned on, one of the phase/live cables may have been connected to neutral and the neutral to phase/live. **Isolate or disconnect the ESP unit immediately.** Check the phase/live and neutral connections and if a mistake has been made, correct it. If all the phase/live and neutral connections are correct, there is a fault with the mains supply *(see (b) - below)*.
Note: The ESP unit may have suffered damage - check the status indication *(see page 20)*.

(b) *Illumination at any time*

The WARNING light will flash when the neutral to earth voltage exceeds 30 volts. The faster the flashing, the higher the voltage between neutral and earth (at very high voltages the WARNING light may appear to be permanently illuminated). **Disconnect the ESP protector immediately and check the mains supply.** The ESP protector should not be reconnected until the cause of the fault has been identified and rectified.
Note: The ESP unit may have suffered damage - check the status indication *(see page 20)*.

Status indication

ESP units give a continuous visual display of their status. They have a two colour indicator light, for each phase:

Green only = Full protection, power on.

Green + Red = WARNING: Reduced protection, replace unit as soon as possible.

Red only = NO PROTECTION. Replace ESP unit immediately.

No lights = No power connection or system fault. Check external fuses and connections.

Remote indication

A remote indication of the reduced protection state is provided for linking the protector to a building management system, remote telemetry, PLC or directly to an indication light or buzzer. The unit has both a normally open and a normally closed volt free contact. The terminal for the volt free contact accepts 2.5 mm^2 cable and is located on the top of the ESP unit. It has three terminals, marked:

NO = Normally Open
NC = Normally Closed
C = Common

The normally open (NO) contact is open when the ESP unit is healthy and power is present.

The normally closed (NC) contact is closed when the unit is healthy and power is present.

As well as providing warning of the reduced protection state, the normally closed volt free contact can also be used to signal power loss on one or more phases, eliminating the need for special relays. *See Figure 13.*

The ESP units remote indication is rated at 1 amp, 250 volts (ac).

	Unit healthy		*Reduced or No protection*	
	NO	*NC*	***NO***	*NC*
Power present	**OPEN**	CLOSED	**CLOSED**	OPEN
Power absent	**CLOSED**	OPEN	**CLOSED**	OPEN

*Figure 13. Operation of normally closed (NC) and **normally open (NO)** volt free contact.*

Maintenance

Maintenance should be conducted at least once a year and also following lightning activity. Visually check:

(i) Visual status indication lights *(see Status indication, above, for interpretation).*

(ii) Condition of connecting leads and terminations.

Application notes

1 **RCD units**
ESP units should ideally be installed before (or upstream of) residual current devices (RCDs) and not on the load side. ESP units should only be installed on the load side of the RCDs if the load in question is external to the building. This should help to reduce any spurious tripping of such devices due to transient overvoltages. Special transient hardened RCDs (type 'S') can be obtained from a number of manufacturers.

2 **Insulation tests (flash testing)**
The ESP unit should be fully disconnected from the circuit before testing. Otherwise the ESP unit will treat the insulation test as a transient overvoltage and control the voltage to a low level - thereby defeating the object of the test.

3 **Duplex configuration**
For systems demanding extremely high reliability ESP units can be connected in duplex format. The use of two units will achieve an improvement in performance and increased lifetime over a single ESP unit at high discharge current levels. Each unit should have its own (separate) wiring and its own isolation. If possible the two units should be connected to the power supply a short distance apart either:

(a) onto the first two outgoing ways

(b) up to a metre apart on the incoming power supply.

4 **Installing three phase units on single phase supplies**
If a three phase unit is installed on a single phase mains supply (or a supply in which one or two phases are not in use), the ESP units spare (or unused) live terminal(s) should be connected to live, otherwise its indication lights and volt free contact will not work correctly. The preferred approach is to take a connecting lead from each spare terminal to the supply live. However, it is also possible to connect the ESP units spare terminal(s) to whichever live terminal is in use at the unit.

5 **Use of powered screwdrivers**
The use of powered screwdrivers is not recommended unless measures are taken to ensure screws are tightened correctly and not damaged.