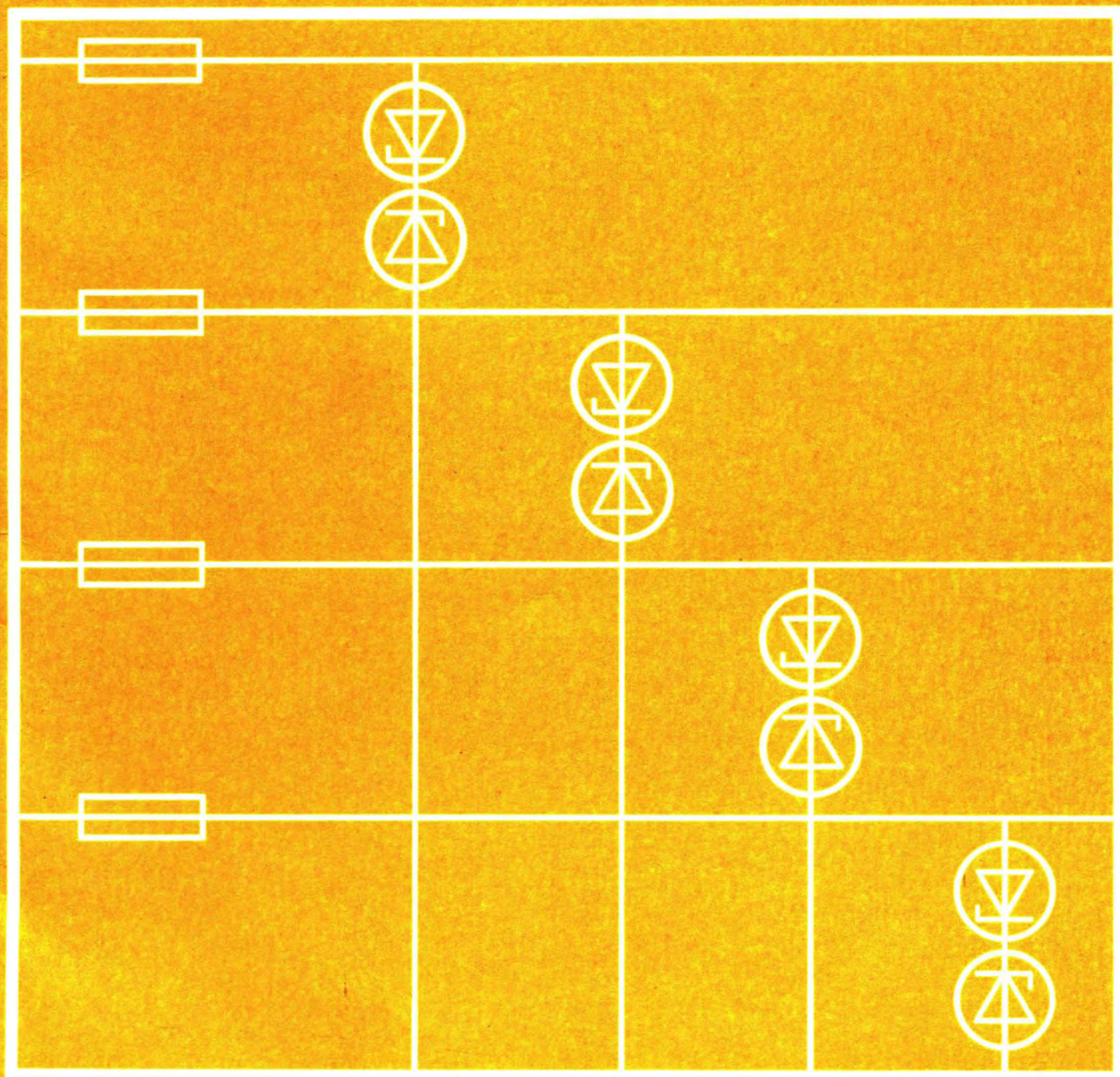


Post Office Telecommunications

Technical Guide No. 26

Requirements for the electrical protection
of Post Office maintained plant from
privately supplied and maintained apparatus.



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NOTE:

Suppliers of private attachments should note that when significant amendments to Technical Guides are necessary the information will be contained in a Suppliers Information Note (SIN) which will be sent to all companies with Post Office agreements to supply attachments concerned. Such information is incorporated in revised editions of the Technical Guides which are not automatically distributed.

Completely new Technical Guides are automatically distributed as appropriate when new services are introduced.

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Technical Guide No. 26

Requirements for the electrical protection
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FOREWORD

This guide details the electrical protection requirements to which privately owned and maintained equipment (referred to as 'the attachment' throughout this guide) must conform if supplied for attachment to Post Office maintained plant.

The private attachment will also need to comply with certain operational and technical requirements depending on its function and use. These are described in the Technical Guide appropriate to the particular Post Office service with which the attachment will be associated.

The conditions under which private attachments may be used in conjunction with a Post Office provided and maintained telecommunication service are given in the relevant Post Office Telecommunication Scheme made under Section 28 of the Post Office Act 1969.

Private attachments must not be connected to or used with installations without prior Post Office consent. No consent to the use of private equipment is given without prior evaluation by the Post Office to ensure that it meets policy, technical and operational requirements.

In many cases the use of a private attachment connected to Post Office maintained plant requires a Post Office licence under Section 27 of the Post Office Act 1969. Where such a licence is necessary the written consent of the Post Office may bring the system within the coverage of the relevant Post Office General Licence for Private Attachments to Post Office Telecommunication Installations and/or the Post Office General Licence for Message Conveying Computers. In some cases however, an individual licence may be required. Where a private mobile radio or radio telephone system is to be associated with Post Office plant a Wireless Telegraphy licence under the Wireless Telegraphy Act 1949 will be required from the Home Office and a licence under the Post Office Act may also be required from the Post Office.

Enquiries about radio licences should be made to:

The Home Office
Radio Regulatory Department
Waterloo Bridge House
Waterloo Road
LONDON
SE1 8UA

APPLICATIONS FROM SUPPLIERS FOR THE EVALUATION OF PRIVATE ATTACHMENTS

Applications for the evaluation of private attachments to be supplied for connection to Post Office maintained plant should be made to the Post Office when the supplier is satisfied that it meets the requirements detailed herein and any other relevant Technical Guide.

Written applications should be made to Post Office Telecommunications Headquarters at the address given in the Technical Guide relevant to the PO service with which the attachment will be used.

Technical Guides are obtainable from:

Telecommunications Headquarters
Marketing Executive
Residential and Customer Services Department
Customer Service Policy Division ME/RCS 1.2.1.4.
Tenter House
45 Moorfields
LONDON EC2Y 9TH
Telephone No:- 01-432 9347

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Applications must state the function of the equipment and its unique title or code. Documentation included with the application should include the following:

- a. All relevant circuit and block schematic diagrams showing clearly the points of connection of the attachment to the Post Office Service.
- b. Details of the output signals.
- c. A statement showing the components that form the protection barriers.
- d. Specifications for the components in c. to show compliance with the relevant section of this guide. Results of testing a limited number of samples is not adequate.
- e. Drawings, a sketch or a photograph showing the physical construction of the barrier, the layout of components and wiring.
- f. Such other information as may be requested in the Technical Guides or application forms for the particular Post Office service involved. The address and telephone number of the applicant's engineering representative to whom technical enquiries may be directed are also required.

After details have been studied the Post Office may require to inspect and/or test the prototype, subsequent production models and the equipment on site.

If the applicant is in any doubt about the acceptability from policy or technical points of view of the facilities offered by the private attachment, early enquiries should be made to ME/RCS 1.2.1 (policy) or ME/RCS 1.2.2 (technical) at the contact point given in the Technical Guide for the relevant PO service with which it is proposed to use the attachment before the supplier is too committed commercially.

CHARGES FOR THE EVALUATION OF PRIVATE ATTACHMENTS

A charge will be raised for the evaluation of the attachment and will vary with the amount of Post Office resources required; charges will normally range from £50 to £950 (plus VAT). In particularly complex cases however a specially assessed charge exceeding £950 may be made.

Applicants will be notified of the charge following receipt of the application. Evaluation will not commence until a form of undertaking accepting the charge has been signed and the form received by the Post Office. The Post Office reserves the right to charge a deposit before commencing evaluation. The full charge will be payable whether or not the attachment is found to be technically acceptable. A charge will be payable if an application is withdrawn at any stage subsequent to the acceptance of the charge.

The basic charge allows for a limited degree of retesting after new equipment has been modified during the evaluation stage. It will nevertheless be in the interest of the applicant to ensure the private attachment is likely to meet Post Office requirements before being submitted for evaluation. Significant periods of prior consultation will however be taken into account when the individual charge is assessed. It should be noted that payment will not necessarily ensure Post Office consent to the use of the equipment in question.

AGREEMENT TO SUPPLY PRIVATE ATTACHMENTS

When evaluation of the attachment is completed the Post Office proceeds in one of two ways:

Where the attachment is to be supplied generally for use in association with Post Office maintained equipment the supplier will be required to accept terms contained in an Agreement. When the Agreement is concluded, the name and address of the authorised company and the unique title of the equipment will be entered in a List of Permissible Attachments held by all local Post Office Telephone Area Offices (Sales Division). Subsequent reference to Telecommunications Headquarters, Residential and Customer Services Department when customers apply for the connection of listed equipment, will not normally be necessary.

Where the attachment, or configuration in which it is to be used, is not covered by an Agreement with the equipment supplier each application will be dealt with by Telecommunications Headquarters on a one-off basis.

In both the above instances the customers will be required to accept conditions appertaining to the use of the attachment and charges will be raised on the customer's bill for the Post Office services provided.

The Agreement with the supplier of the attachment concerns the applicant company only. If any other company wishes to supply the same equipment it must make separate application to the Post Office. A copy of a standard Agreement is obtainable from the address shown above.

PERFORMANCE OF ATTACHMENTS

The Post Office accepts no responsibility for the satisfactory performance of the attachment. It is not normally evaluated against performance, reliability or quality of service parameters and hence permissible equipment should not be described as 'Post Office Approved'.

MODIFICATION OF PRIVATE EQUIPMENT

Once evaluated, private attachments must not be modified from the equipment submitted for evaluation without the Post Office agreeing in writing to such modification.

The Post Office reserves the right to revise its requirements at any time and gives notice regarding such changes. No new private attachment will be permitted connection to Post Office maintained plant after the expiry date of such notice unless it complies with the new requirements. The supplier shall carry out modification to new attachments arising from such changes at his own expense.

The technical content of this Guide has been prepared by:

Telecommunications Headquarters
Marketing Executive
Residential and Customer Services Department
Customer Service Policy Division ME/RCS 1.2.2
Tenter House
45 Moorfields
LONDON EC2Y 9TH

Any technical queries should be addressed to the contact point given in the specific Technical Guide for the PO service with which it is intended that the attachment be used.

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1 PRINCIPLES OF PROTECTION

In order to safeguard Post Office personnel, customers and equipment, it is essential to prevent the transmission of dangerous voltages from the attachment into Post Office maintained equipment or the Post Office telecommunications network.

Post Office plant must be isolated from these dangerous voltages by means of an identifiable barrier contained within the attachment, or, except for portable test equipment, interposed between the attachment and its point of connection to Post Office plant. Suitable barrier designs are considered in Section 5 of this guide. Provision of these barriers is the responsibility of the supplier as part of the attachment.

2 DANGEROUS VOLTAGES

Voltages exceeding 75 volts a.c. (rms) or 150 volts d.c. are considered dangerous. Ringing voltages of nominally 75 volts a.c. (rms) and ± 80 volt d.c. telegraph signalling voltages are acceptable provided they are satisfactorily isolated from dangerous voltages.

3 SPECIAL PRECAUTIONS

The majority of attachments do not contain voltages exceeding 1000 volts and suitable protection barriers and isolation methods for such devices are detailed in Section 5. However special precautions are necessary where the attachment is operated from, contains, or is associated with, voltages exceeding 1000 volts a.c. (rms) or d.c., or where the attachment is located at sites such as power stations where a high rise of earth potential may exist.

1000 volts is a somewhat arbitrary limit and represents the maximum voltage that most practical barriers can withstand consistent with economical design.

The particular precautions that need to be taken will depend on the type and design of the attachment and/or its location. Every case will be the subject of special consideration by the Post Office.

Devices containing high voltage low current supplies eg extra high tension (EHT) voltages within visual display units, may offer protection against such voltages by any of the methods detailed in Section 6.

4 INTERCONNECTION OF SYSTEMS

Where a multi-port attachment which is transparent to dangerous voltages is to be connected to other privately maintained equipment, or the attachment forms the point of interconnection between a privately maintained system or network, and the Post Office network, then all associated private equipment must be separately evaluated for safety by the Post Office. Alternatively the complete system configuration must be isolated from the Post Office network by a barrier. Examples are data modems, radio transmitter/receivers with shared aerial systems, computer systems connected to Post Office data circuit terminating equipment, private exchanges (PXs) connected to Post Office maintained private circuits or private branch exchanges (PBXs).

5 ISOLATION AGAINST VOLTAGES UP TO 1000 VOLTS AC (RMS) OR DC

5.1 Method of Protection against Dangerous Voltages.

Isolation methods or barriers as specified in Section 5.2 are required to protect the Post Office maintained equipment associated with the attachment from each dangerous voltage source connected to, or generated within, the attachment. Barriers must not be by-passed by wiring or components unless the by-pass path itself contains a barrier. Barriers may be located within the attachment or interposed between the attachment and the Post Office maintained equipment.

In practice protection is best afforded in one of two ways:

a. By isolating the source of dangerous voltage close to its entry into the attachment by use of the existing supply transformer; the attachment is then considered to be inherently safe. The supply transformer must meet the requirements of Sections 5.2.2.2 and 5.2.2.3 for isolating transformers.

b. By isolating the Post Office maintained equipment from the attachment and its dangerous voltages by a barrier located within the attachment but adjacent to the terminals connected to the Post Office maintained equipment, or by a separate barrier interposed between the attachment and the Post Office maintained equipment.

In the first case the attachment circuitry on the same side of the barrier as the Post Office maintained equipment is isolated and in the second only the Post Office maintained equipment is isolated. See Figure 1 for these and other methods.

The following types of attachments do not require barriers:

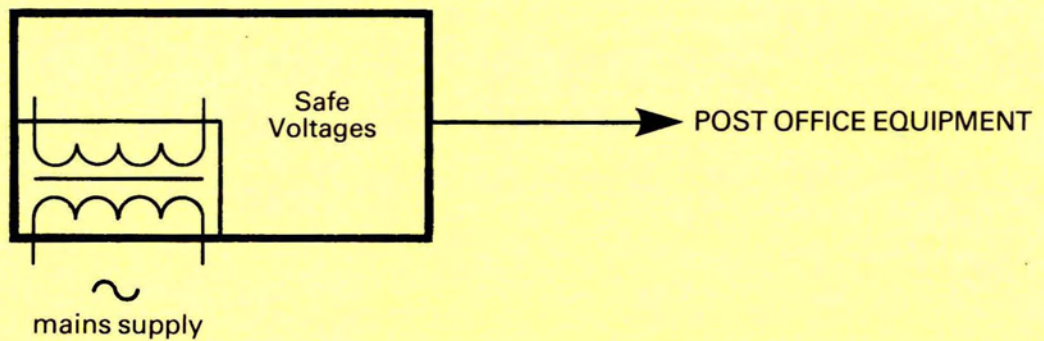
i. Attachments powered by batteries of less than 150 volts d.c. which do not generate a dangerous voltage internally and are not re-charged from a source of dangerous voltage such as the mains supply. Where a charger is used it must meet the requirements of this technical guide.

ii. Attachments such as passive filters or transducers requiring no operating power.

iii. Attachments powered by a voltage transmitted over a Post Office service which do not generate a dangerous voltage internally. The far end attachment must be a permitted attachment to ensure that the voltage that it transmits to line is below the dangerous value.

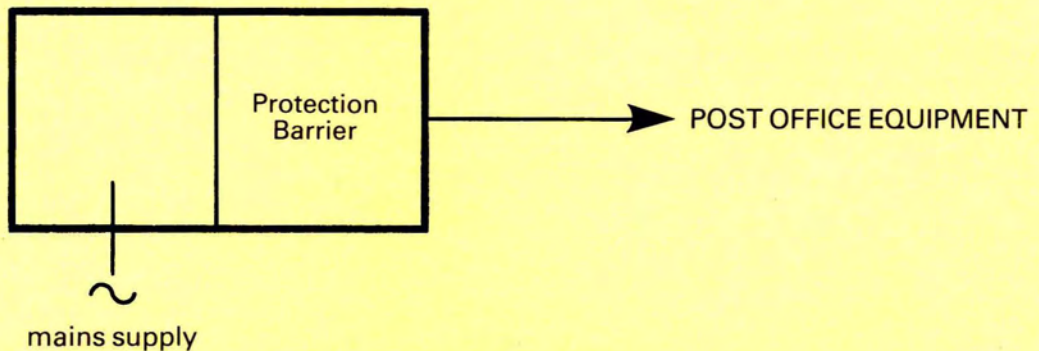
iv. Attachments where the only dangerous voltage is the supply to a motor which merely performs a mechanical function within the attachment and where the supply connections are fully shrouded. The motor case must be connected to a protection earth and there must be no other electrical connections to the motor. The Post Office will also consider all insulated or double insulated construction.

a.



The supply transformer(s) must meet Post Office requirements (see 5.2.2). If there is associated equipment that is separately powered, this must either meet Post Office protection requirements or must be isolated by means of a protection barrier. (See c. and d. below).

b.

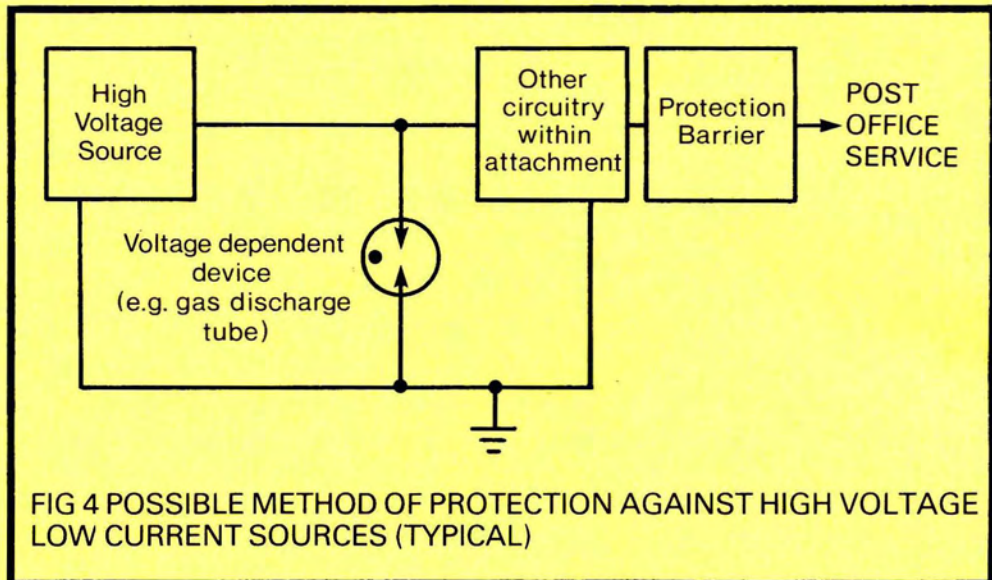


The protection barrier must meet Post Office protection requirements and may be any of the following types:

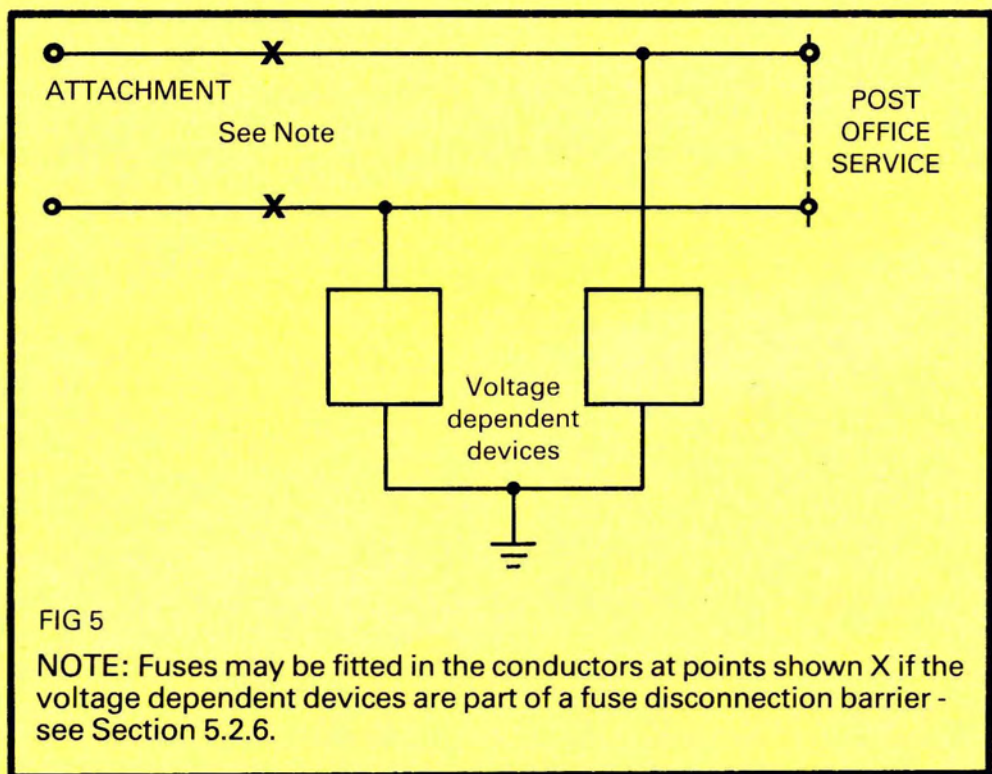
- i. Isolating transformer - see Section 5.2.2.
- ii. Isolating relay - see Section 5.2.3.
- iii. Optical isolator - see Section 5.2.4.
- iv. Isolating capacitor - see Section 5.2.5.
- v. Fuse disconnection barrier - See Section 5.2.6.
- vi. Acoustic coupler - see Section 5.2.1.

A barrier may consist of a combination of the above; for example a barrier may consist of a line transformer and relays in order that both a.c. and d.c. signals may pass through the barrier.

See Figure 4 for typical example.



c. Voltage dependent device(s) may be fitted to conductors connected to the Post Office service. The voltage dependent device(s) may be part of a fuse disconnection barrier. A typical arrangement is shown below in Figure 5:



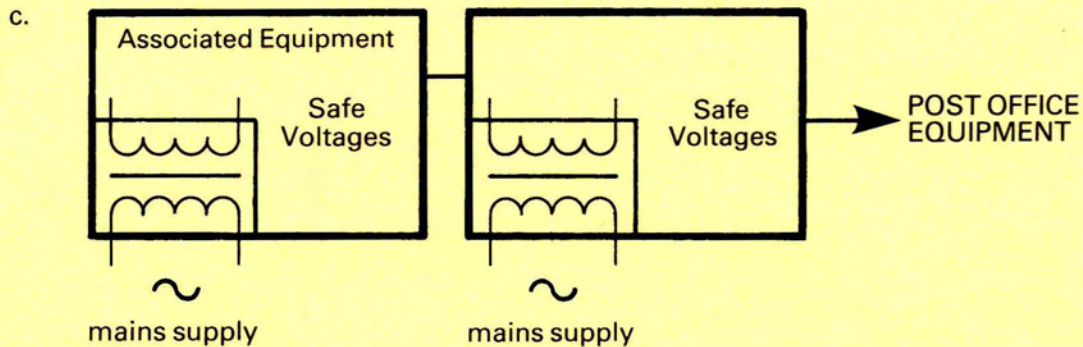
The voltage dependent device(s) must meet the following requirements:

- conduct at voltages not exceeding 75 volts;

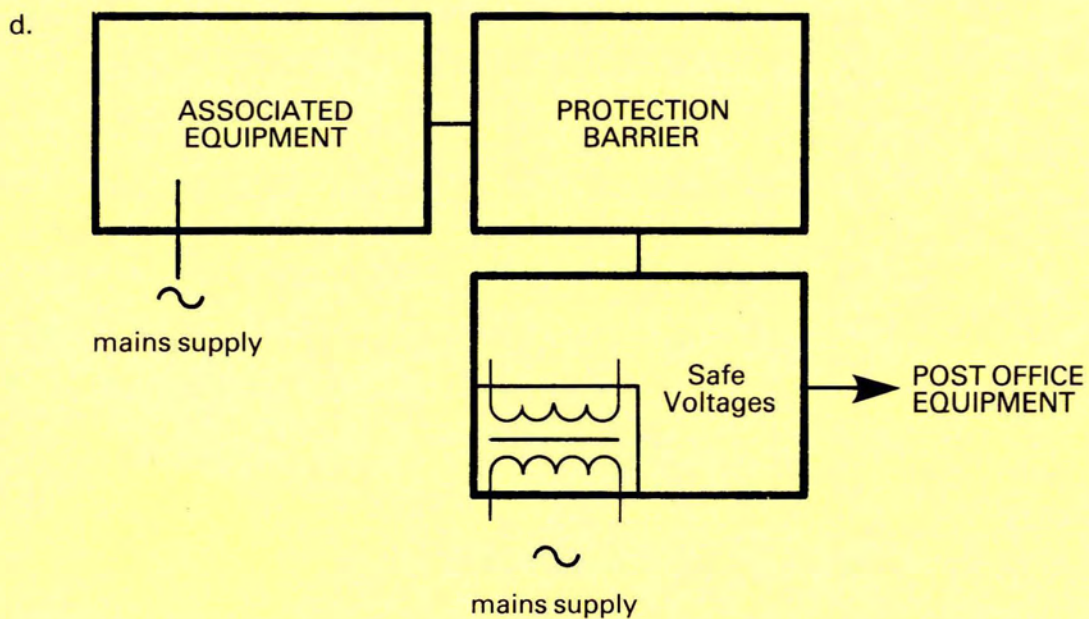
- be capable of carrying without failure:

- i. the pulse power, including that discharged from any capacitance, that may be dissipated should the high voltage source come into contact with the barrier.

- ii. the steady current that the high voltage source is capable of supplying.



All supply transformers must meet Post Office protection requirements (see 5.2.2).



Both the supply transformer shown and the protection barrier must meet Post Office protection requirements; see 5.2. The protection barrier may be any of the types listed in b. above.

FIG 1 TYPICAL METHODS OF PROTECTION, Figs. a, b, c & d.

5.2 Isolation Methods and Protection Barriers

The following includes requirements for components used as protection barriers. Additionally consideration will be given to components shown to meet nationally or internationally recognised standards eg British Standards Institution Specifications.

5.2.1 Isolation of Acoustically Coupled Devices

The mechanical arrangements of the attachment must ensure that separation as defined in Table 1 will exist between the metal-work of the transducers in the Post Office handset and the metal-work of the transducers in the attachment.

TABLE 1 MINIMUM SEPARATION FOR ACOUSTICALLY COUPLED DEVICES		
Maximum Peak Voltage in Attachment	Minimum Separation mm	
up to and incl 500	3	
over 500 up to and incl 800	3.5	
over 800 up to 1000	4	
over 1000 up to and incl 1250	} a.c. only	4.5
over 1250 up to and incl 1414		5.5

5.2.2 Isolating Transformers

An isolating transformer comprises windings as follows:

Non-Isolated Windings - those windings connected to or generating a dangerous voltage, or connected to components not isolated from dangerous voltages. These windings may not be connected to Post Office maintained equipment.

Isolated Windings - those windings separated from non-isolated windings. These windings may be connected to Post Office maintained equipment.

5.2.2.1 A transformer may be used to isolate dangerous d.c. voltages and a.c. voltages provided one of the requirements a. to c. below is met:

a. The transformer is of step down ratio such that no voltage in excess of 75 volts a.c. rms can be induced into the isolated winding(s) when the maximum a.c. voltage against which protection is required is applied across the non-isolated winding(s).

or

b. The transformer saturates at a flux value insufficient to induce a voltage in excess of 75 volts a.c. rms into the isolated winding(s). In this case a specification provided by the transformer manufacturer must be supplied to the Post Office clearly showing that the transformer meets this requirement.

or

c. A fuse and voltage dependent device are fitted on the isolated winding side as shown in Fig 2. The fuse and voltage dependent device must meet the requirements detailed in 5.2.6.

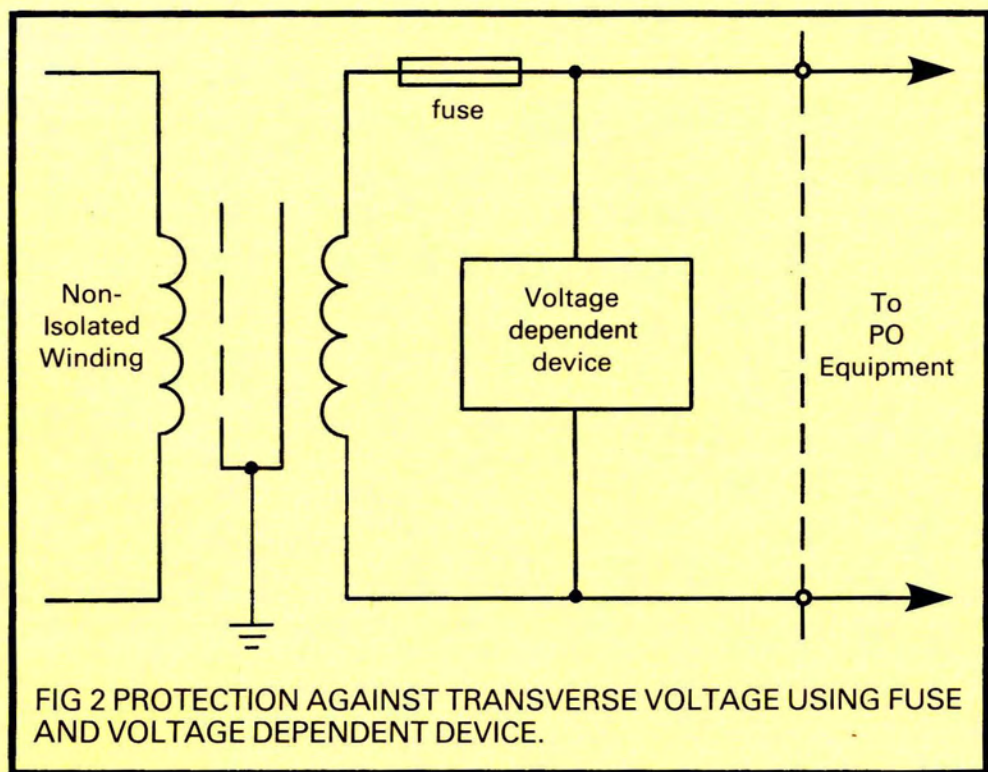


FIG 2 PROTECTION AGAINST TRANSVERSE VOLTAGE USING FUSE AND VOLTAGE DEPENDENT DEVICE.

5.2.2.2 The windings of an isolating transformer must be arranged such that non-isolated windings and isolated windings are either:

a. On separate limbs of the core.

or

b. Adjacent to each other on separate spools provided that each spool:

i. Is manufactured from an insulating material acceptable to the Post Office.

ii. Separates the non-isolated windings from the isolated windings.

iii. Has partition walls such that winding spillage from one partition to another is prevented. The partition wall and spool must be moulded or pressed in one piece.

or

c. Overlapping each other provided that a foil screen is inserted between them. Each foil must:

i. Surround the winding around which it is wrapped such that the ends overlap by not less than 5 mm.

ii. Extend sufficiently beyond the coils being screened so as to prevent direct contact between the coils.

iii. Be capable of carrying the circuit prospective current from a point source until the rupture of a fuse provided specifically to remove the dangerous condition or for an indefinite time. (The circuit prospective current is the maximum current which flows from a specified point in a circuit as the result of the connection of that point to any other point in the equipment.)

- iv. Be directly connected to a safety earth terminal via a conductor of adequate size to carry any fault current that may occur.

Unless all insulated or double insulated construction is used, all structural metal-work such as metallic magnetic cores and protective casings, must be directly connected to a safety earth. Transformers certified as meeting the requirements of BS 3535 for class II transformers are acceptable and additional certification concerning proof voltage testing and insulation standards as stated below in 5.2.2.3 is not required.

Toroidal transformers must comply with the above requirements and additionally any lead out wires passing through any foil screen must be double insulated with an outer covering of a heat resistant sleeving of a type acceptable to the Post Office. Sleeving complying with BS 2757 Class H is a type considered acceptable.

The isolation obtained between the two sets of windings must not be by-passed in any way by components or wiring associated with the attachment.

5.2.2.3 An isolating transformer must be shown by the manufacturers specification to meet the following requirements:

The insulation of the transformer must withstand a 50 Hz proof-test voltage of $(1500 + 2E)$ or 2200 volts peak a.c. (whichever is the greater) for a full minute. 'E' is the peak a.c. or d.c. value of the voltage to be isolated. DC voltages equivalent to the peak a.c. values may be used for the proof-test voltages. The test voltage is applied between the isolated set of windings and the non-isolated set of windings with:-

firstly

a. the transformer core, case and interwinding screen(s) (if fitted) connected to the non-isolated set of windings;

and secondly

b. the transformer core, case and interwinding screen(s) (if fitted) connected to the isolated set of windings.

Immediately following these tests, the insulation resistance between the two points of application of the proof-test voltage must be greater than 100 megohms when measured at 500 volts d.c. minimum. The insulation resistance may be determined by measuring the current flowing at the end of the proof voltage test.

It must not be possible, under any circumstances, to connect the two sets of windings together by accidental bridging between their respective terminals. Insulating material or earthed metal separators may be interposed between the two sets of terminals, but flying leads or separate shrouded terminal blocks are preferred.

5.2.3 Isolating Relays

Relays may be used as barriers provided that they meet the following conditions.

5.2.3.1 The connections must be made in one of three ways:

a. The dangerous voltage may be connected to the coil winding if the Post Office maintained equipment is connected to the contact-set.

b. The dangerous voltage may be connected to the contact-set if the Post Office maintained equipment is connected to the coil winding.

c. Both the dangerous voltage and the Post Office maintained equipment may be connected to separate contact-sets provided that these are isolated from each other by a barrier of insulating material or a metal screen connected to the protection earth.

In the above a conductor not isolated to Post Office standards from a dangerous voltage is itself considered as carrying a dangerous voltage.

5.2.3.2 The insulation between:

firstly any part connected to the Post Office maintained equipment and all other parts connected together,
and secondly any part carrying a dangerous voltage, or not isolated from a dangerous voltage, and all other parts connected together, must withstand the application of a 50 Hz proof-test voltage of $(1500 + 2E)$ or 2200 volts peak a.c. (whichever is the greater) for a full minute. 'E' is the peak a.c. or d.c. value of the voltage to be isolated. DC voltages equivalent to the peak a.c. values may be used for the proof-test voltages.

Immediately following this test, the insulation resistance between the two points of application of the proof-test voltage must be greater than 100 megohms when measured at 500 volts d.c. minimum. The insulation resistance may be determined by measuring the current flowing at the end of the proof voltage test.

5.2.3.3 The core and any metal-work associated with the relay must be connected to the protection earth. The Post Office will also consider the use of all insulated or double insulated construction. It must not be possible, under any circumstances, to connect the dangerous voltage to Post Office maintained equipment by accidental bridging between contact-sets or between contact-sets and the coil connections. It is imperative that all connections to isolating relays are fully sleeved.

5.2.4 Optical Isolators

Optical isolators may be used as barriers provided that, after the application of a proof test voltage for one minute of $(1500 + 2E)$ or 2200 volts peak a.c. (whichever is greater) between the two sides of the barrier, the insulation resistance between those two points is greater than 100 megohms when measured at 500 volts d.c. minimum. 'E' is the peak a.c. or d.c. value of the voltages to be isolated. A d.c. voltage equivalent to the peak a.c. value may be used for the proof-test voltage. The insulation resistance may be determined by measuring the current flowing at the end of the proof voltage test.

5.2.5 Isolating Capacitors

Capacitors may be used as barriers against d.c. voltages (not a.c. voltages) provided they meet the following conditions:

a. The dielectric material of isolating capacitors shall be of mica, ceramic, polystyrene or any other such material that is acceptable to the Post Office.

b. Capacitors must be of a type which are not polarity conscious.

c. Capacitors shall be of such a value that the energy stored by the capacitor does not exceed 4 joules when it is fully charged to the unsafe voltage against which protection is required.

d. Capacitors must withstand for one minute without break-down or flashover the application of a test voltage of $(1500 + 2E)$ or 2200 volts whichever is the greater. (E) is the value of the voltage to be isolated. The test voltage may be d.c. or a.c. of an equivalent peak value.

The test voltage is applied across the capacitor and, in the case of the capacitor is metallic, also between the capacitor connections and its metallic case.

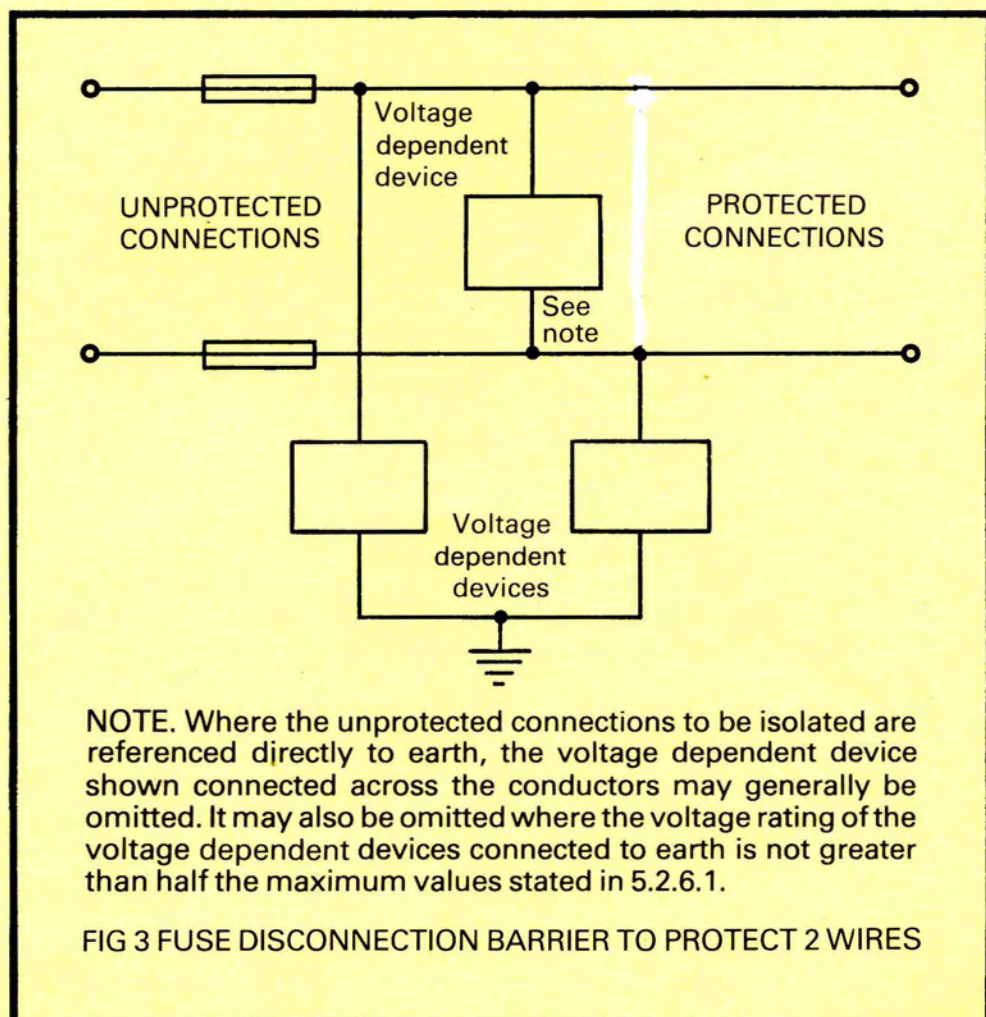
Immediately following this test, the insulation resistance between the two points of application of the proof-test voltage must be greater than 100 megohms when measured at 500 volts d.c. minimum. The insulation resistance may be determined by measuring the current flowing at the end of the proof test if d.c. is used for this test.

e. In the case of any isolating capacitor is metallic the case must be directly connected to a safety earth terminal.

5.2.6 Fuse Disconnection Barriers

These barriers must prevent the transmission of dangerous voltages to Post Office maintained equipment within 250 ms of the appearance of a dangerous voltage at the unprotected connections. These barriers are generally interposed between the attachment and the Post Office maintained equipment.

A typical arrangement is shown in Fig 3. The rating of components used will depend upon the voltages and currents that the barrier must normally pass without disconnection. A barrier may be constructed to protect one or more wires depending upon its intended application.



5.2.6.1 Component Requirements.

i. Voltage Dependent Device

This is normally a pair of zener diodes but the use of other devices will be considered by the Post Office. The voltage dependent device must conduct at a voltage (inclusive of tolerances) not exceeding:

- a. The limits specified in any Post Office Technical Guide for the particular Post Office service involved (eg 15 volts for Post Office Datel Services).
- b. 75 volts if protection is required against one or more sources of alternating voltage. Exceptionally with circuits carrying ringing voltages of nominally 75 volts a.c. (rms) or ± 80 volt d.c. telegraph signals the voltage rating may be up to 150 volts.
- c. 150 volts if protection is required against one or more sources of direct voltage only.

It must have a pulse power rating such that ten connections of any unsafe voltage source against which protection is required does not cause failure of the device when applied to the unprotected connections of the barrier ie via the fuses. (The fuse is replaced with a new one after each application of the unsafe voltage source).

It must be capable of continuously carrying without failure a current of three times the rated current of the fuses used in the barrier.

ii. Fuses

The fuses must have:

- a. a current rating not exceeding 250 mA or a lower value if specified in the relevant Technical Guide for a particular Post Office service (eg 60 mA for the Datel Service). Special consideration will be given by the Post Office to any fuse with a larger rated breaking current than this value if required in any particular application.
- b. prospective breaking currents not less than the circuit prospective current. (NB The circuit prospective current is the maximum current which flows from a specified point in a circuit as the result of the connection of that point to any other point in the equipment - a 13 amp mains socket outlet is considered to have a prospective current of 6000 Amperes). It is permissible to assume that the circuit prospective current will be limited by the resistance of the fuse in the barrier if the fuse manufacturer specifies a minimum fuse resistance. Alternatively resistors may be fitted in series with the fuses to limit the fault current to a value not greater than the prospective breaking current of the fuses. Any resistors used must either be carbon film or metal oxide type or another type acceptable to the Post Office.
- c. voltage ratings not less than the highest unsafe voltage for which isolation is required.
- d. Fuses must also be of a type that rupture within 250 ms when a current of 3 times the rated current flows. 'Slow-blow' or 'surge resistant' types are not acceptable.

iii. Layout of Components and Wiring etc.

a. Wiring and terminals must be insulated in order to prevent accidental connection of the 'attachment' side of the barrier to the Post Office maintained equipment side.

b. With the fuse(s) removed and the earth connected for test purposes to the Post Office maintained equipment connections, the insulation between the attachment connections and the earth connection must withstand a 50 Hz proof-test voltage of $(1500 + 2E)$ or 2200 volts peak a.c. (whichever is the greater) for a full minute.

'E' is the peak a.c. or d.c. value of the voltage, whichever is the greater, against which the barrier offers protection. DC voltages equivalent to the peak a.c. may be used for the proof test voltages.

A breakdown to another conductor at a point remote from the area of the fuses is permissible providing that the current is passed to earth without any risk of it by-passing the fuse connections.

Immediately following the above test the insulation resistance between the two points of application of the proof test voltage must be greater than 100 megohms when measured at 500 volts d.c. minimum. The insulation resistance may be determined by measuring the current flowing at the end of the proof voltage test.

c. If printed board circuitry is used for the fuse disconnection barrier, the tracks connected to the Post Office maintained equipment terminals, the voltage sensing devices and the earth must be spaced from all other tracks by a minimum of 1 mm per 100 volts (d.c. or peak a.c. whichever is greater) against which the barrier offers protection. Exceptionally where the provisions of b. above permit the earth track to approach other tracks more closely at points remote from the area of the fuses this requirement need not be met at these remote points.

d. Clip-in fuse holders are not acceptable unless either:

i. The holders are provided with a suitable fuse carrier which facilitates easy removal without possible accidental bridging of the fuse.

or

ii. The units are constructed in such a way as to prevent access to the device whilst connected to the Post Office maintained equipment (eg socket fitted in lid of unit).

e. A durable label must be fitted adjacent to any fuse holder stating the precise type and current rating of the fuse.

f. The earth connection to and within the barrier must be capable of continuously carrying without damage a current of 3 x current rating of fuse x number of fuses in unit, or 3 amperes, whichever is the greater.

g. The barrier may be placed within the case of the attachment or, except for portable test equipment, mounted externally in a closed box: if the box is of metal construction it must be earthed. Where the barrier is built into the attachment it must be located as close as possible to the terminals connected to the Post Office maintained equipment and must be separated from the attachment circuitry by a fully enclosing cover of insulating material or earthed metal.

h. The use of shrouded terminal blocks is recommended for the barrier connections.

5.2.6.2 Documentation and Hardware Required for Technical Evaluation Purposes.

The following documentation must be submitted:

- i. A circuit diagram of the barrier.
- ii. A copy of the specification for the fuses.
- iii. A copy of the specification for the voltage sensing devices.
- iv. A drawing showing the physical layout of the barrier.

The following hardware is also required:

- i. Barrier unit(s) with at least 4 voltage sensing devices.
- ii. An additional 20 fuses to those included in the complete barrier devices.

A separate barrier unit must have a unique title or code.

5.3 Layout of Components and Wiring

Wiring and terminals carrying, or not isolated to Post Office standards from, dangerous voltages must be fully insulated in order to prevent accidental connection to other circuitry by metallic objects dropped into the attachment during operation or maintenance.

The clearance and creepage distances between conductors connected to opposite sides of an isolating barrier must meet the requirements of Table 2 to avoid failure due to deposited dust or moisture impairing the insulation.

TABLE 2 MINIMUM CLEARANCES AND CREEPAGE DISTANCES		
Peak value of the voltage to be isolated	Minimum clearance	Minimum creepage distance in air
V	mm	mm
up to and incl 354	3	3
over 354 up to and incl 500	3	4
over 500 up to and incl 630	3.5	4.5
over 630 up to and incl 800	3.5	5
over 800 up to and incl 1000	4	6
over 1000 up to and incl 1100	4.5	7
over 1100 up to and incl 1250	4.5	8
over 1250 up to and incl 1414	5.5	9

Wiring on the Post Office side of a protection barrier must not be in the same wiring form as wiring carrying, or not isolated to Post Office standards from, dangerous voltages.

The attachment connections to the Post Office maintained equipment must be clearly marked and must not be contained within the same terminal block, or the same multiway plug, as a dangerous voltage or any circuitry not isolated to Post Office standards from a dangerous voltage.

5.4 Design Requirements for Printed Circuit Boards

Tracks associated with the isolated circuitry must be separated from other tracks by a distance of at least 1 mm for every 100 volts d.c. or peak a.c. against which the barrier offers protection.

Where a plug-in board carries a protection earth track, either:

- a. the earth track must be brought out to both ends of the plug connector;
- or
- b. the plug connection carrying the earth track must be longer than the other plug connections such that the earth contact will always make first upon insertion of the board and break last upon withdrawal of the board, in order to ensure that the earth connection is made before any other connection to the board. The earth track must be of sufficient current-carrying capacity to ensure that, under fault conditions, the supply fuse will rupture before the track is damaged.

Where the board carries an isolating barrier, the board must be fully enclosed on both sides by insulating material or earth metal, to prevent accidental bridging of the barrier. It is permitted in these cases for the multiway plug connector to contain connections to isolated and non-isolated blocks of circuitry.

5.5 Mains Supply Plugs, Fuses, Control Switches and Mains Noise Suppression

Where the mains supply is directly wired into the attachment or connected by way of a terminal block, the EARTH, LIVE and NEUTRAL connections must be clearly marked.

All supply plugs, sockets and cables must comply with the current British Standard. Where plugs carry the protection earth, the earth pin must be the longest in order that the earth connection is made first on plugging in.

Flexible mains cables must be fitted with an adequate cord grip.

A fuse of rating no larger than necessary to operate the attachment satisfactorily must be connected in the LIVE power supply conductor only. The fuse rating should be clearly marked at a point close to the fuse holder. Existing fuses or non-linked switches in the EARTH or NEUTRAL conductors must be replaced by a permanent connection. The fusing of the attachment must not rely on the use of a fused supply plug.

Capacitors connected between the mains conductors and the protection earth, usually for the suppression of noise, cause a leakage current to flow in the earth and must meet the requirements of BS 613 with regard to safety.

Where a supply transformer is used to isolate the mains voltage it is imperative that all wiring and components carrying the mains voltage ie plugs, sockets, fuses, switches and transformer terminations are fully insulated to prevent accidental bridging between the safe and unsafe sides of the barrier. Transformer secondaries of isolating supply transformers should be adequately fused to prevent accidental overloading of transformers.

5.6 Earthing

5.6.1 Protection Earth

The protection earth must comply with Section D of the current issue of IEE 'Regulations for the Electrical Equipment of Buildings' when it forms part of the customer's a.c. mains supply.

Where a.c. mains is supplied to the equipment via a plug or socket, access to the protection earth may be gained by way of a third pin. Where the a.c. mains is supplied directly from a fused distribution point, the attachment must be earthed by a direct connection to a protection earth. To ensure an efficient path within the attachment, discrete wiring should be used to connect the barrier device to the protection earth input. Alternatively an earth path via one solid piece of metal work is acceptable but otherwise bolted or screwed connections via the chassis are not permitted.

Metalwork mating with the screws or bolts should be carefully cleaned and serrated washers should be used.

If a protective earth is required for two or more items of equipment, it must not be possible to remove the protective earth while any one item of equipment remains connected to the a.c. mains supply.

5.6.2 Functional Earth

If an attachment applies an earth condition or potential with respect to earth to the Post Office maintained equipment, or to equipment or conductors not isolated from Post Office maintained equipment then:

- a. Where practical a mains earth should not be used for this purpose and a separate earth should be provided.
- b. Where a. is not practical the attachment supplier must show how adequate checks will be carried out to test the integrity of the mains earthing system at the users premises.

With some Post Office services (eg certain PBX interfaces) a Post Office signalling earth will be available for signalling but not protection purposes.

The point of connection of any signalling earth must be clearly marked.

6 ISOLATION AGAINST HIGH VOLTAGE LOW CURRENT SOURCES

Devices incorporating high voltage low current supplies, eg EHT voltages in visual display units, may offer protection against such voltages by any one of the following methods:

- a. Ensuring that all components, terminations and conductors carrying high voltages are insulated and segregated in such manner and to such extent as is reasonably necessary to minimise the risk of accidental establishment of a conducting path between the high voltage points and any other points which could cause either:
 - i. A dangerous voltage as defined in Section 2 of this guide to be impressed on the connections to Post Office Services, *or*
 - ii. A protection barrier to be stressed by a voltage above that for which it provides protection as defined in Section 5.2 of this guide.

When this method of protection is adopted the above must be certified by a competent authority in writing.

Alternatively, where the supplier can clearly identify all points of such insulation or segregation, consideration may be given to verification that the above requirements are met at each point. If the failure of such insulation or segregation could cause either (i) or (ii) above to occur, the insulation or segregation must be capable of withstanding without failure a proof test voltage of $(1500 + 2E)$ volts for one minute. ('E' is the peak a.c. rms or d.c. voltage that normally exists across the insulation in working conditions).

- b. Voltage dependent device(s) may be incorporated on the side of an interface protection barrier remote from the Post Office connections such that should the high voltage make contact with the barrier, the voltage would be clamped to a level for which the barrier provides satisfactory protection as defined in Section 5.2 of this guide.

The voltage dependent device(s) must:

- i. not conduct at a voltage (inclusive of tolerances) less than 360 volts;
- ii. conduct at a voltage not greater than that for which the protection barrier provides satisfactory protection as defined in Section 5.2 of this guide;
- iii. be capable of continuously carrying a current of 5 amperes;
- iv. be of a type that upon failure exhibits a short circuit between its terminals;
- v. prevent the transmission of dangerous voltages to the Post Office connections for any period exceeding 250 m secs.

If a high voltage low current source is contained within a device, separate from but associated with the attachment, the steady current from that high voltage source will generally be assumed not to exceed 180 mA: in this case the pulse power will generally be considered as being adequately limited by the inter-connecting circuitry.

If a supplier intends to adopt this method of protection information and specifications must be provided to show the above requirements are met.

d. By means of a high voltage protection barrier. Details of requirements for these barriers will be supplied separately on request to the Post Office, the basic principle being that all barriers must be able to withstand a 50 Hz proof test voltage of $(1500 + 2E)$ for a full minute where 'E' is the peak a.c. or d.c. value of the voltage against which protection is offered.

All other devices operated from, containing or associated with, voltages in excess of 1000 volts a.c. (rms) or d.c. will be the subject of special consideration by the Post Office.

7 CONNECTION OF PRIVATE CABLES TO POST OFFICE MAINTAINED EQUIPMENT

Each application to connect customer owned cable to Post Office maintained equipment is subject to special consideration by the Post Office. Initially the Post Office will require the following information:

- a. Whether the cables are used exclusively for the attachment.
- b. Whether the cables are contained exclusively within physically secure enclosures.
- c. Whether the cables are routed in the vicinity of high voltage (ie above 650 a.c. rms or d.c.) power lines or cables and the segregation standards that have been applied.
- d. Whether the cables are installed to any particular documented standard eg IEE Regulations for the Electrical Wiring of Buildings or British Standards Institution Code of Practice No. 1022.

8 WARNINGS

8.1 Protection against Damage to the Attachment

Users and suppliers are advised to consider the need to protect the attachment from voltages which may be impressed on Post Office maintained equipment by lightning or other extraneous sources. These voltages may be unidirectional or alternating and of a transient nature. Transient and prolonged voltages are also present on many Post Office circuits as normal functional characteristics. They may reach a peak value of the order of several hundred volts. Prolonged voltages of at least 100 volts peak may be encountered (eg ringing current). Surges may also be present due to lightning.

Equipment containing semi-conductors is particularly vulnerable to damage by comparatively small excess voltages even of a short duration.

The Post Office does not accept any responsibility for damage caused to attachments by any of the above conditions unless such damage is attributable to the negligence or wilful act of any person engaged in the business of the Post Office.

8.2 Transmission Considerations

Account should be taken of any effect the barrier may have on transmission performance of an attachment eg loss or impedance mismatch.

END

