Plastic-core fibre optic cables

Features and instructions for mounting

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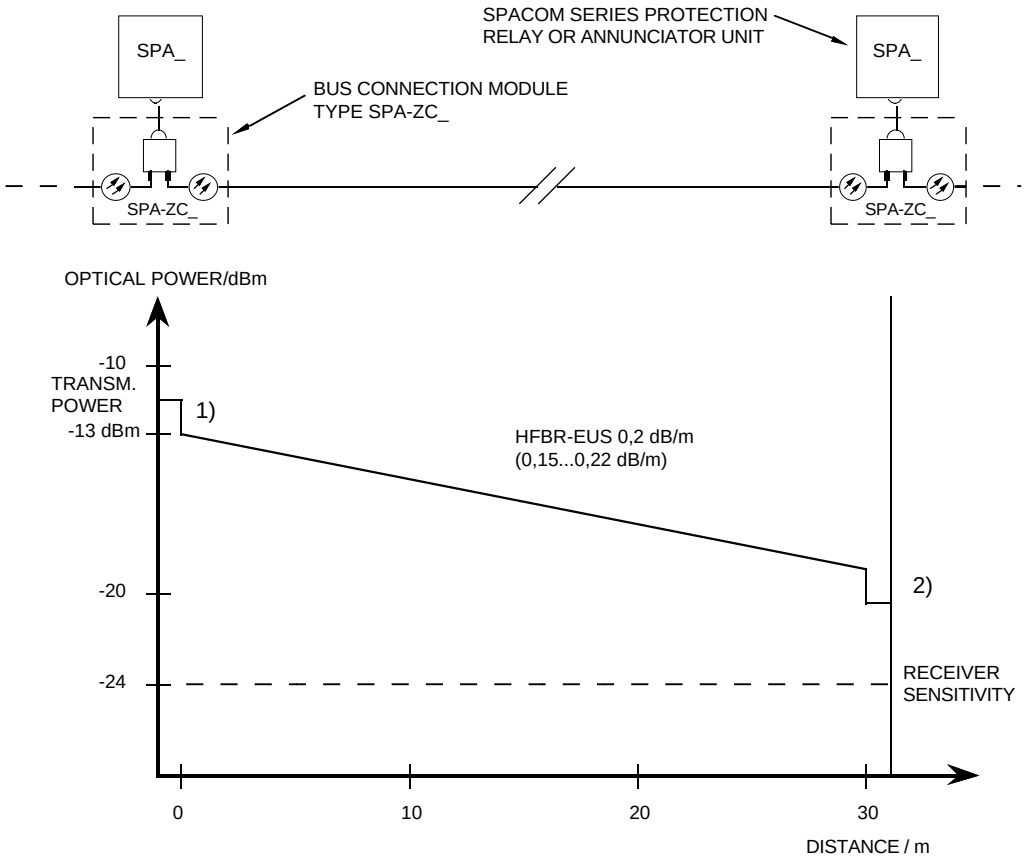
General

Plastic-fibre optic cables are recommended to be used when the advantages of optical fibres, e.g. galvanic isolation and EMI immunity, are required, but the excellent transmission capacity of glass-fibre cables is not needed. Plastic-fibre cables are recommended for high frequencies, short transmission distances and narrow frequency ranges. They allow a large numerical opening and core diameter, thus facilitating connection and feeding of light into the cable.

The transmission distances of plastic-fibre cables are limited in the first place by the attenuation in the cables and connectors.



1) The transmission is attenuated by about 1.5 dBm, which is normal in a properly made connection. Impurities, scratches, damage etc. on the connector surface increase the attenuation, thus reducing the transmission capacity.

2) The signal strength at the fibre end must be greater than the sensitivity of the receiver.

Fig. 1. Attenuation in cables and connectors.

The plastic-fibre optic cable (Hewlett Packard HFBR-EUS) is provided with connectors on both ends. The basic connectors used are type HFBR-4501 and type 4511. The connectors have the same structure but different colours: HFBR-4501 is grey and HFBR-4511 is blue.

When the transmitter, receiver and the plastic-fibre optic cable are used at the worst values of the tolerance ranges and environmental conditions the maximum cable length is about 34 m. When the components are used at their typical values the cable length will be approximately 50 m. The calculations are based on the assumption that the cables have no joints.

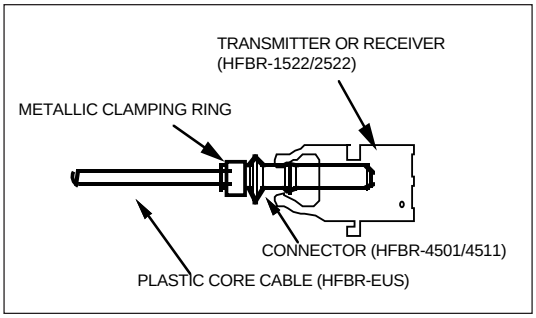


Fig. 2. Connection of the plastic-fibre optic cable to the bus connection module.

In this instruction Hewlett Packard's own HFBR type designations have been used for the optical fibres, transmitters/receivers and connectors. The cables and connectors should, however, be ordered under their SPA-ZF BB type designations, which may be expressed as follows:

SPA-ZF BB 3

Fibre optic cable
Type of connector
Length of cable in metres

The plastic-fibre optic cables are delivered in standard lengths of 1, 3, 5, 10, 20 and 30 m, but on request other lengths are available, too.

Mounting instructions for plastic-fibre optic cables

The specific features of the plastic-fibre technique and the mechanical properties, above all bending characteristics, of optical fibres must be considered, when plastic-fibre optic cables are handled, mounted and connected. Too sharp bends cause tensile and compression stress to the cables, and eventually fatigue of the material. Too many bends reduce the transmission capabilities even though the transmission capacity generally returns to normal when the bends are removed, unless the bending radius has been too small for too long a time. The attenuation, for instance, increases considerably when the minimum bending radius of the cables is below the manufacturer's recommendations.

The cable designers have aimed at constructing cables not too sensitive to handling, but still the special features of optical fibre cables in contrast to electric cables have to be considered. To ensure proper performance the following factors should be allowed for when plastic-fibre cables are handled:

- minimum bending radius (temporarily and permanently)
- compressions
- twists
- vibration
- humidity
- temperature
- sharp edges and other mechanical things

To avoid too sharp bends and deformation, the optical fibres have to be protected against mechanical stress, for instance, by using a rigid or flexible protection tube.

N.B.
Cables mounted in doors must be protected by a flexible tube at the hinges. Furthermore, the cables should be fitted so as to avert tension and compression and too small bending radii in any position of the door.

To avoid permanent damage to the plastic optical fibre cable the bending radius must never be less than 25 mm. The cables are permitted to be bent at a radius of 25 mm for one hour maximum. The smallest permanent bending radius is 35 mm.

Plastic-fibre cables must not be grouped together with other cables. Unless the weight of the cable itself causes to sharp bends, the cable may run freely without support at short distances. It is also important to protect the cable against sharp edges.

Special attention should be paid to the bending radius of the cable close to the connector. To prevent tensile stress on the connector the cable has to be supported at the bus connection module.

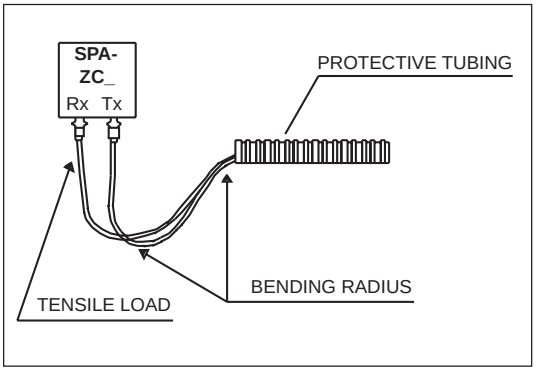


Fig. 3. Mounting of plastic-fibre cables

If the optical fibre cable is too long, the extra cable can be arranged as a coil, the minimum diameter of which is 20 cm. The coil may be tied, for instance, with a bundle tie, but loosely to prevent deformation of the optical fibres.

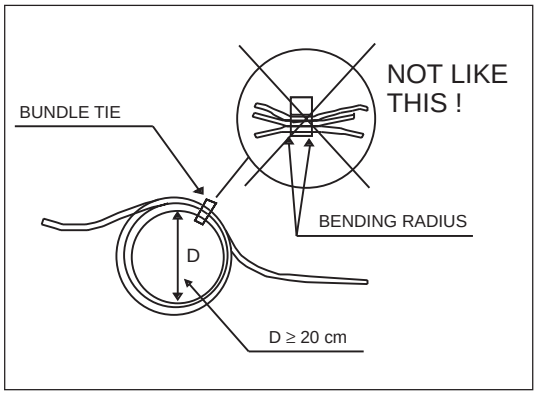


Fig. 4. Arrangement of excess cable

It is to be noted that plastic optical fibre cables cannot be repaired but temporarily, for instance by straightening bends.

N.B. When unplugging the connector from the bus connection module, pull at the connector body (Fig. 5). Pulling on the cable may cause the fastening tie of the cable to move out of its position and the end of the plastic-fibre to slide into the connector. In such a case the light effect is abruptly decreased and the transmission is attenuated. In certain cases, at long cables (>10 m) or a great displacement (>0.5 mm) the transmission may even be interrupted.

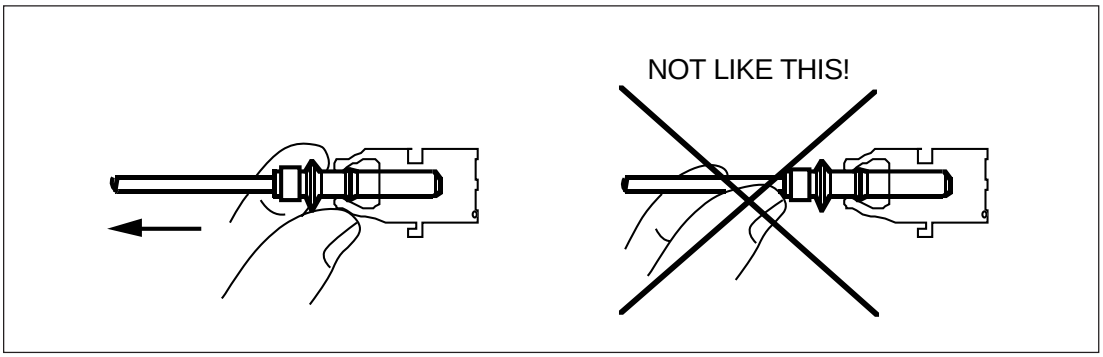


Fig. 5. Unplugging the plastic optical fibre cable from the transmitter/receiver.

The ends of the plastic-fibre cables have to be protected from dirt and must not be touched with the fingers. Lens paper, available in photo shops, is recommended for cleaning a dirty cable end. Solvents are prohibited.

Installing the connectors on the cable ends

Where a connection has to be easily opened and closed without special tools, connectors are used. Fitting the connector onto the optical fibres requires accuracy and special tools. For the sake of attenuation, repeatability and lifetime of the connectors, special care should be taken to keep the connectors clean. Unconnected connectors should be provided with a protective cap. Before the connectors are fitted the connector ends have to be carefully cleaned.

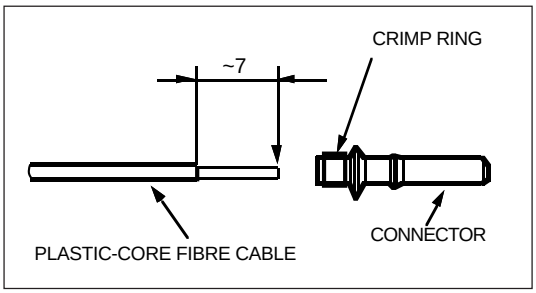
Accessories needed for mounting the connectors:

1) Plastic-fibre cable
2) HFBR-4595 or HFBR-4596 type polishing kit including a polishing fixture, 600 grit abrasive paper and 3m lapping film (3M Company, OC3-14)
3) HFBR-450 type grey connector and crimp ring
4) HFBR-4511 type blue connector and crimp ring
5) Cutting pliers
6) 16 gauge stripping pliers
7) Crimp tool AMP 90364-2

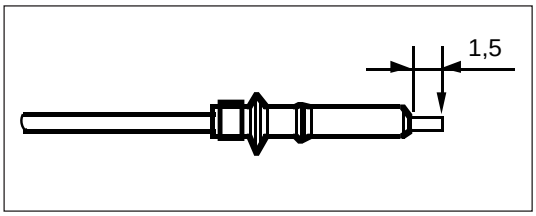
Cut the plastic-fibre cable to the desired length.

Strip the cable to a length of about 7 mm, using the stripping pliers mentioned above. Be careful not to damage the optical fibres.

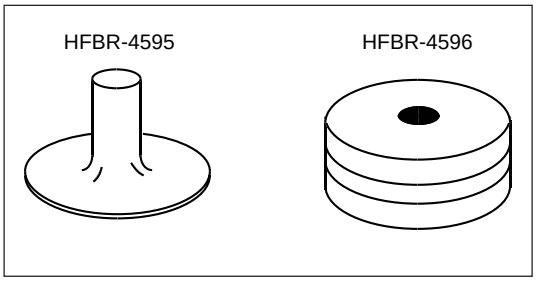
Place the crimp ring over the connector and press the cable into the connector so that about 3 mm of the optical fibre protrudes. Crimp the ring in place with the crimp tool AMP 90364-2. Other types of crimp tools must not be used.



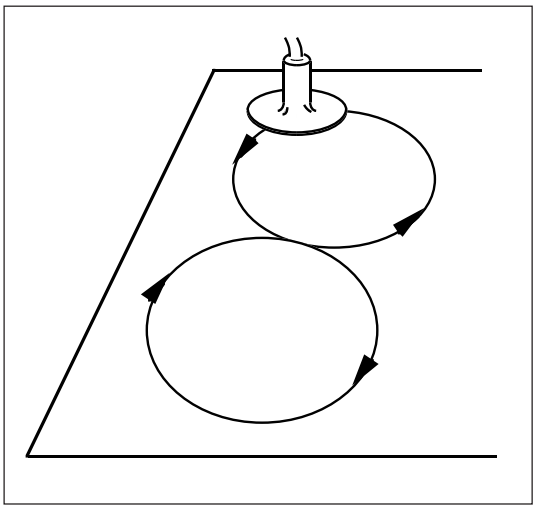
Cut the middle fibre of the cable so that it protrudes about 1.5 mm from the connector. After cutting, check that the fibre is intact, i.e. that there are no cracks extending to the connector surface. In the event of cracks, start the procedure from beginning.



Insert the connector into the polishing fixture, either a plastic type HFBR-4595 or a steel type HFBR-4596. Note: The four dots on the bottom of the polishing fixture are wear indicators. Replace the polishing fixture when any dot is no longer the visible.



Place the fibre onto the abrasive paper 600 and polish the fibre until it is in a level with the connector. Keep the fibre vertical to the surface and polish using a figure-of-eight pattern of motion. The surface must be smooth and horizontal, for instance, a table. A moderate polishing speed should be used to prevent the fibre from melting. Fragments from the abrasive paper or other impurities easily get into melting fibre. Finally polish the surface smooth using a 3μ lapping film.



It is recommended to check the optical fibre cable and the connector with a measuring gauge specially designed for the purpose. Then the attenuation of the cable should be in accordance with the values stated in the table below.

Cable length	Attenuation
1 2 3	< 3 dB
10	< 5 dB
20	< 8 dB
30	< 9 dB

A visual inspection can be made with a magnifying glass (8 x). One end of the cable is directed towards a bright source of light and by using a magnifying glass it is checked at the other end of the cable that the light is evenly distributed over the fibre cross section and that there are no deep scratches, cracks or impurities in the fibre. Seen against the light a crack shows as a dark area.

Note.
During polishing, too, the permitted bending radii of the cable should be observed.

Technical data

	HFBR-EUS
Storage temperature	-55...+85°C
Mounting temperature	-20...+70°C
Min. bending radius, temporarily	25 mm
Min. bending radius, permanently	35 mm
Core diameter	1.0 mm
External diameter	2.2 mm
Weight	5.3 g/m
Tensile strength, max. time	50 N
Typical attenuation	0.19 dB/m (0.15...0.22)
Numerical aperture	0.47

Trouble shooting

Trouble shooting is performed systematically from unit to unit, starting from the protection relay unit next to the host equipment. Submenu 2 of register A of the function module includes a bus communication monitor (that one of the control module SPTO_ is found in register C). When the communication is operating, the monitor shows the value 0. Should the communications be interrupted the numbers from 1 to 255 are continuously scrolling, incrementing one step a second. When the communication of the unit is in order, the next unit is tested, and so on.

When there are communication problems with a relay module, check:

- that the blue connector of the optical fibre cable is connected to the blue receiver connector and the grey connector of the cable is connected to the grey transmitter connector of the bus connection module
- the connector of the fibre optic cable is properly seated in the transmitter/receiver
- the optical fibre cable is not jammed or bent too sharply. In such a case the cable has to be replaced, because it is not possible to repair it.
- the ends of fibre has no signs of cracks or scratches, impurities, etc.
- the end of the fibre is in level with the connector end

When a bus connection module connected to the relay module over an electric cable is used, for instance, a module type SPA-ZC17, the following additional things should be checked:

- the auxiliary voltage of the bus connection module is connected, LED indication on the front panel
- the cable connecting the relay module and the bus connection module, including earthing, is in order
- the switches on the bus connection module are properly set (TTL/RS 485, slave/master)

If nothing seems to be wrong, but there is still no contact with the host system the reason might be that:

- two relay modules of the same system has the same address code
- the module has been given the wrong serial data transfer rate
- the necessary modifications to the bus connection module of the master have not been made

Inspection of fibre optic cable

Put a light source, for instance a flash light, at one end of the cable and check at the other end that the light is properly transmitted through the cable. The cable can also be tested by connecting the transmitting end to a bus connection module sending information and checking the light arriving at the other end. The light transmitted by a bus connection module is red. If no light is transmitted through the cable, or it is weak compared with the light transmitted through another cable of the same length, the cable may have broke or have to sharp bends.

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