Switch Mode Power Supplies (SMPS)

Many modern medical devices consume only small amounts of power. In many cases this power comes from rechargeable batteries. Nevertheless, the mains power supply needed to either power the device or recharge the batteries ends up being quite large and heavy because of the need to include the mains transformer and smoothing capacitors, and to provide some means of getting rid of the heat that is generated.

Most of the small medical devices commonly in use now use switch mode power supplies (SMPS) which are smaller, lighter, and generate much less heat than conventional transformers, and can also give very accurate control of output voltage. There are, however, some disadvantages in using SMPSs, particularly in large establishments where there may be a very large number of these devices in use. The SMPS only draws current close to the peak of the input sine wave. This tends to generate high frequency interference, unless efficient input filters are incorporated into the design.

The simplest types of SMPS do not include power factor correction, which will also result in harmonic distortion, which can cause problems where a large number of these devices are in use.

The design of many SMPSs does not include an earth connection, so that any equipment supplied by the SMPS will be floating. Stray capacitance will result in the outputs being at about 50% of the mains input voltage. The amount of current that can flow to earth will be low, since it is due to the stray capacitance, but in some cases it can be sufficient to give a noticeable ‘buzz’ if the exposed conductive surfaces of any connected equipment are touched. Figure 1 shows an example of a USB hub that has a touch voltage of 71.3V on the metal enclosure. This would not be a problem, except where the touch voltage could be applied to a patient.

Figure 1

Any item of electrical equipment, even devices that are not classed as medical devices such as a radio, MP3 player, phone charger, laptop, television, etc., that have accessible conductive parts may be touched by a patient could present a hazard, particularly where the patient has a conductor, for example a catheter, pacing lead, or any other conductor, positioned in the central circulatory system, which is accessible outside of the patient.

There are SMPSs that conform to IEC60601, in which case the earth leakage current will be below 10µA. If a SMPS that does not conform to IEC60601 is used to power a medical

device, the CE marking of the medical device will be compromised. As one might expect SMPSs that are IEC60601 compliant will be more expensive than the basic version.

A quick check for floating output lines can be done using a 'Voltstick' or similar device (Figure 2). If the Voltstick indicates the presence of a voltage on any conductive surface then the source of the voltage should be investigated, and action taken to improve the earthing.

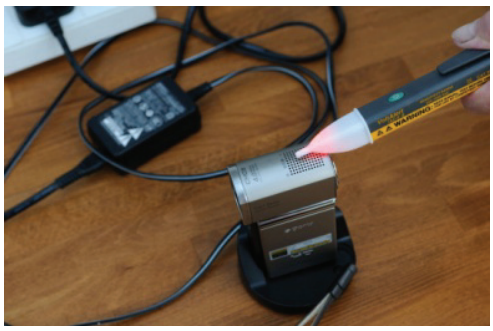

Figure 2

The small size of a low power SMPS means that it can be incorporated into a plug-top, which is only a little larger than a standard mains plug. However, mains plugs and sockets are intended to be used only on mobile or portable equipment. This means that if the equipment is not on wheels, or you cannot pick it up and carry it, then it should be hard wired. SMPSs that are supplying power to a part of an installed unit should therefore be designed to be hard wired, rather than plugged in.

Some manufacturers are supplying SMPSs that are built into continental two-pin plugs (Figure 3). These should **not** be used in the UK. Some installations have been seen where the two-pin plug has been forced into a 13A socket by moving the shutters out of the way using a screwdriver pushed into the earth socket. This is clearly unacceptable, so it is advisable to check that there are no examples of this practice in any installations that come under your control.

Figure 3

The way in which the mains supply to the two-pin continental socket is normally installed uses a 10A miniature circuit breaker, which will trip out if the current drawn by the plug-top SMPS rises above 10A. If the SMPS is supplied from a standard UK mains supply, the only protection will most likely be a 32A fuse. The device will not be protected by the usual plug-top fuse, and so if a fault develops, the SMPS can overheat.

Exercise caution when purchasing a replacement SMPS and only buy from a reputable supplier. There are a huge number of SMPSs available, some of which claim to be

manufactured by well known companies, when in fact they are counterfeits of unknown origin. Some of these products are available at less than half the manufacturer's list price. Figure 4 shows a laptop supply from a reputable manufacturer (top), together with a replacement unit, apparently from the same source. The accompanying radiograph shows that the original unit is much more complex than the replacement. Further examination showed that the replacement contained an iron bar, included to increase the weight to something closer to that of the original.

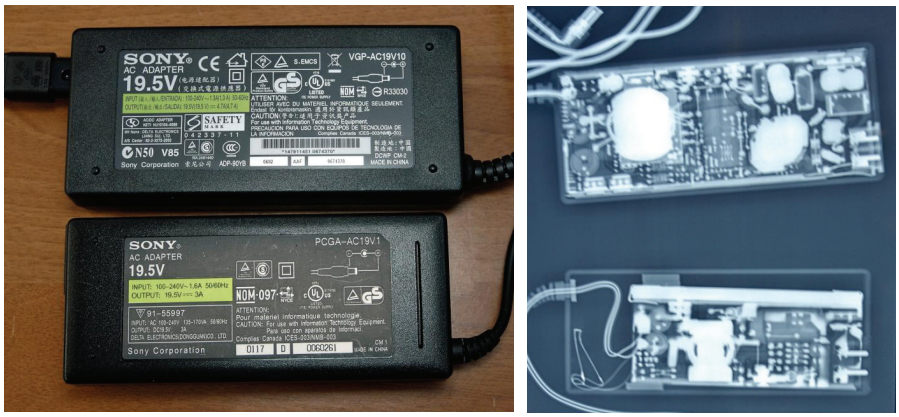

Figure 4

Key points

- Check that there are no significant voltages on any accessible conductive surfaces of devices connected to a SMPS.
- If a high touch voltage is discovered, measure the earth leakage current. In order to comply with IEC 60601 it should be less than 10μA.
- Ensure that any SMPS used with a medical device complies with IEC 60601.
- Ensure that plug-top power supplies are not used with permanently installed equipment. If it is not on wheels, or you cannot pick it up and carry it away, it should be hard wired, not plugged into a 13A socket.
- If the SMPS is fitted with a three core mains lead or has a three pin connector, then it must be earthed.
- A continental two pin plug-top SMPS must **not** be used in the UK. 13A sockets are protected by a 30A fuse, so that a device intended to be used on a continental 10A mains supply will overheat under certain fault conditions.
- Ensure that the correct power supply is used. There is no universal standard for SMPSs. Polarity of output connectors, output voltage and current, and input and output filters can be different even when power supplies look identical. To avoid confusion, each power supply should be labelled, so that the device that it is intended to be used with can be identified.