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METHODS OF ELIMINATING FAULTS IN MEDICAL EQUIPMENT AND ELECTRICAL SAFETY

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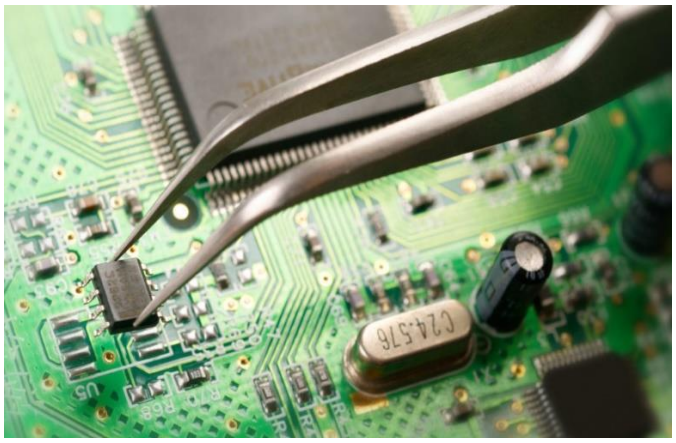
Abstract: One of the most important issues related to the use and elimination of electronic medical equipment for a medical worker is its electrical safety. The patient, due to various reasons (detoxification of the body, the effects of anesthesia, weakness, the presence of electricity in the body, i.e. direct connection of the patient to the electrical circuit, etc.), is in a particularly dangerous electrical environment compared to a healthy person. To prevent electrical hazards, it is necessary to observe safety precautions.

Keywords: Electrical hazard, electrical circuit, electrical network, insulation, electrical medical devices, electrodes, resistance.

Medical workers working with electronic medical equipment are also exposed to electrical hazards. Electrical networks and technical systems usually provide electrical voltage. Troubleshooting is the key to identifying problems and implementing the correct maintenance, which will return the device in question to service as soon as possible. Troubleshooting requires knowledge of troubleshooting techniques and a thorough understanding of the theory of operation, structure, and proper use of the device in question. In general, troubleshooting has moved from component-level diagnostics to broader or assembly-level diagnostics. Circuit designs are using fewer and more discrete components, and replacing individual ICs is often difficult or impossible.

Manufacturers' service information often does not include component-level diagrams, descriptions, or parts lists, which makes it difficult to get down to the component level. Some electronic systems can still be repaired and repaired at the component level, so these skills should not be neglected. Step zero can be used to determine whether the device is covered under any warranty or service agreement.



The first step in troubleshooting is to gather as much information about the problem as possible. This includes asking anyone who is using the device about the conditions that existed when the error occurred. Is the device making noises, smells, or smoke? Are there

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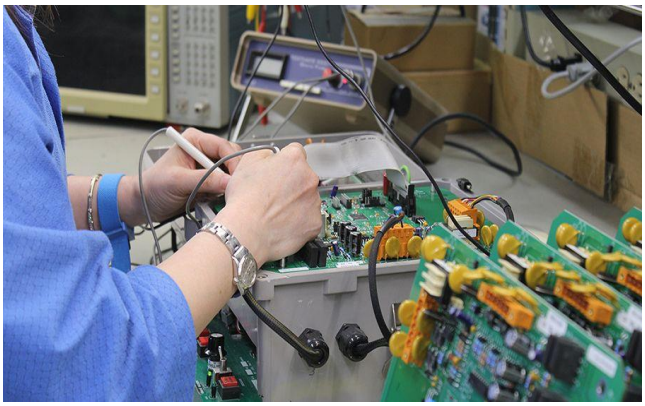
any codes or error lights? What accessories were used with the equipment? If possible, get the accessories!

Was there anything else unusual before the malfunction occurred? What other equipment was being used at the time?

The second step involves reviewing the device's information. This may be something that you know almost automatically about common problems, or it may be something you've never seen before. If there is a service manual, you can consult it. On the other hand, service manuals may contain very little useful information for troubleshooting.

The third step is to try to reproduce the problem. Some problems occur from time to time, and just as your car never makes that funny noise when you take it in for repair, so too will failures occur from time to time when testing a device in a lab. You should try to recreate the conditions under which the failure occurred, as they are known to occur. Patience and a methodical approach will help achieve this goal, and some techniques come only with experience. It may not be possible to reproduce the problem. The device may not work at all, or it may continue to work without apparent problems. In the second case, you can decide whether to return the device to service or not without doing anything further.

Step four is to inspect the inside of the unit for damage, which can be a good indication that it has been damaged (even if the end user denies this possibility), and then you should look



for internal damage. Carefully inspect the exterior of the unit for signs of damage, liquid ingress, overheating, or deterioration. Physical shock can cause heavy components such as transformers to be pulled out of their normal positions, and liquids entering the unit can leave obvious signs of corrosion or shrinkage. Some units may have internal fuses that can be checked for continuity.

Replacing a blown component may solve the problem, but it is often only a symptom of an underlying problem. Sometimes replacing the component and turning the unit on can provide additional information if the bad component is not actually the problem. Service manuals can have good troubleshooting guides that take you methodically through the system, checking for various things like voltage or waveforms at test points, or looking for specific answers from the device.

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If there is no useful troubleshooting information available, you may need to work through your own circuit. If possible, identify the power source and power supply. Check the voltages - these may be marked on the circuit boards, or you can make an educated guess as to what voltages should be at various points in the circuit. Check the continuity of the switches, as well as the power supply transformer. If it is not getting power from the power supply, it will need to be replaced.

Sometimes simple component failures can be identified using a multimeter or component analyzer. If spare parts are available, the faulty component can be replaced, but this may be a symptom of another problem. On the other hand, replacing a diode can be a miracle cure. If no component failures are found, the next step can be called.

In the fifth step, you should check the device for spare boards or other assemblies, and if all other troubleshooting does not find the problem, try replacing them one by one, starting with the board you can find.

In the sixth step, if after performing all available actions, the device still does not work, it can be sent to the manufacturer or an approved repair facility. For large devices that are not suitable for sending, an on-site service call is required.

According to electrical safety regulations, a single failure should not pose an immediate danger to a person. Possible leakage currents are divided into types of electromedical devices and the degree of protection against electric shock of these products. At the end of the last century, the Russian engineer M.O. Dolivo-Dobrolosky proposed a three-phase current system (three-phase current) to technically solve the problem of sparingly transmitting alternating current through wires. Not all electrical medical equipment is reliably protected by grounding or neutral. According to additional protective measures against electric shock of the supply network, the equipment is divided into four classes: 1) products in which, in addition to the main insulation, it is provided to connect the voltage supply to the ground (neutral) on easily accessible metal parts. This can be done, for example, using a three-pronged mains cord and a three-pin plug. Two wires of the cord serve to create voltage, and the third serves as a grounding conductor. When you insert a plug into a socket, it first connects to the ground, and then to the power supply.

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Above, only the main issues of electrical safety when working with electrical medical devices were considered. Since it is difficult to give an electrical explanation of various situations that can lead to accidents, we will limit ourselves to a few general instructions.

- Do not touch the devices with both hands and body parts at the same time;
- Do not work on a wet floor or ground;
- When working with electrical devices, do not touch pipes (gas, water heating), metal structures;
- Do not touch metal parts of two devices at the same time.

When performing treatment using electrodes connected to the patient, it is difficult to foresee many variants that create an electrical safety situation (touching the patient with heating batteries, gas and water pipes and taps, contact through the body of an adjacent device, etc.), therefore, when performing treatment, it is necessary to follow the instructions and not deviate from them.

Troubleshooting methods and electrical safety in medical equipment are very important aspects. For medical equipment to function effectively, it is necessary to regularly check and adjust them. If malfunctions occur, diagnostics and repairs should be carried out by qualified specialists. Regarding electrical safety, proper insulation of electrical circuits, grounding and special protection systems should be installed to prevent errors such as device failures, short circuits or overloads. It is also necessary to conduct safety checks before using medical equipment and provide users with appropriate knowledge and skills. Implementing electrical safety measures and adhering to standards developed by qualified specialists when troubleshooting play an important role in ensuring the safety of medical equipment.

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