Aimtec in the Medical Power Supply Industry

With the advancements in medicinal sciences, we have enhanced our understanding of the human body. Diseases such as chickenpox, smallpox, and polio were once considered fatal, but we now have the means to treat and eradicate them.

Modern medicine uses a wide range of equipment to detect and treat diseases. These equipment are critical to the health care professional and often could be the deciding factor in saving lives. These tools and equipment are used by the modern doctor, which benefits from the most rigorous testing and stringent standards. The power supplies that power these devices are also subject to strict standards to ensure the safety of both the operators and their patients.

To qualify as a medical power supplies compliance to IEC 60601-1 standard along with any country-specific deviations are mandatory. The 60601-1 standard was introduced in 1977. Since then, there have been many revisions and updates to ensure the safe operation of medical equipment. Below are some of the key points of the 60601-1 standard:

Means of Protection (MOP)
To protect patients and operators from the risk of electrical shock, IEC60601-1 introduces the concept of Means of Protection (MOP). There are two types of MOP: Means of Operator Protection (MOOP) and Means of Patient Protection (MOPP).
As patients may not be able to react to electrical shock, stricter protection requirements are applied for Means of Patient Protection (MOPP). Means of protection can be achieved by creepage, clearance, and protective earth connection (ground).
Based on the working voltage of the medical equipment and devices, different distances of creepage, clearance, or tests are defined. For certain medical devices, 2xMOPP or 2xMOOP may be required.

Applied parts (AP)
Depending on the type of medical device, physical connections between the patients and the medical devices may be required. Such connections can carry leakage currents and can cause potential danger to the patients. To determine the required level of protection, the applied parts which are the parts that will have contact with the patients under normal use are categorized into three different types:

Type CF (Cardiac Float)
Applied parts that are physically connected to the patient’s heart. Example: artificial pacemaker, automated external defibrillator (AED), etc.

Type BF (Body Float)
Applied parts that are physically connected to the patient. Examples: medical ventilator, ECG monitor, etc.

Type B (Body)
Applied parts that are not physically connected to the patient. Examples: intensive care bed, medical X-ray, etc.

Low leakage currents
Even a small amount of current flowing through the body can be extremely dangerous. According to IEC60479-1, 0.5mA to 5mA of AC current flowing through the body can cause involuntary muscle spasms. If exposed to 5mA to 40mA of AC current, strong involuntary muscle spasms, immobilization and heart arrhythmias may occur. If more than 40mA flows from the left hand to both feet for more than 3 seconds, cardiac arrest, breath arrest, and other cell injuries may occur. Preventing such current is especially important when it comes to patients as they might not be conscious or have the ability to let-go.

To protect patients from being hurt by the leakage currents, strict patient leakage current regulations are defined in

IEC60601-1.

Patient leakage current a.c.(µA)	Type B		Type BF		Type CF	
	Normal condition	Single fault condition	Normal condition	Single fault condition	Normal condition	Single fault condition
	100	500	100	500	10	50

Below are some block diagrams of medical equipment and how they are powered:

1] Automatic nucleic acid extraction instrument:

Nucleic acid extraction is the starting point of most of the biomedical experiments. A perfect extraction can ensure the quality of the following experiments. As the nucleic acid extraction device is not placed in the patient environment, the Information and Communication Technology Equipment (ICT) grade of electrical systems is sufficient.

However, high EMC performance and strong interference immunity are needed to prevent interference to the data acquisition device. The device shown below consists of a communication module, industrial PC, HMI, motor, motor drive, ultraviolet disinfection module and two heating devices. The main AC/DC source is an Aimtec AMESP-NZ series converter with PFC function to increase grid interference immunity. Three isolated DC/DC modules provide the required voltage level to each component and isolate the interference.

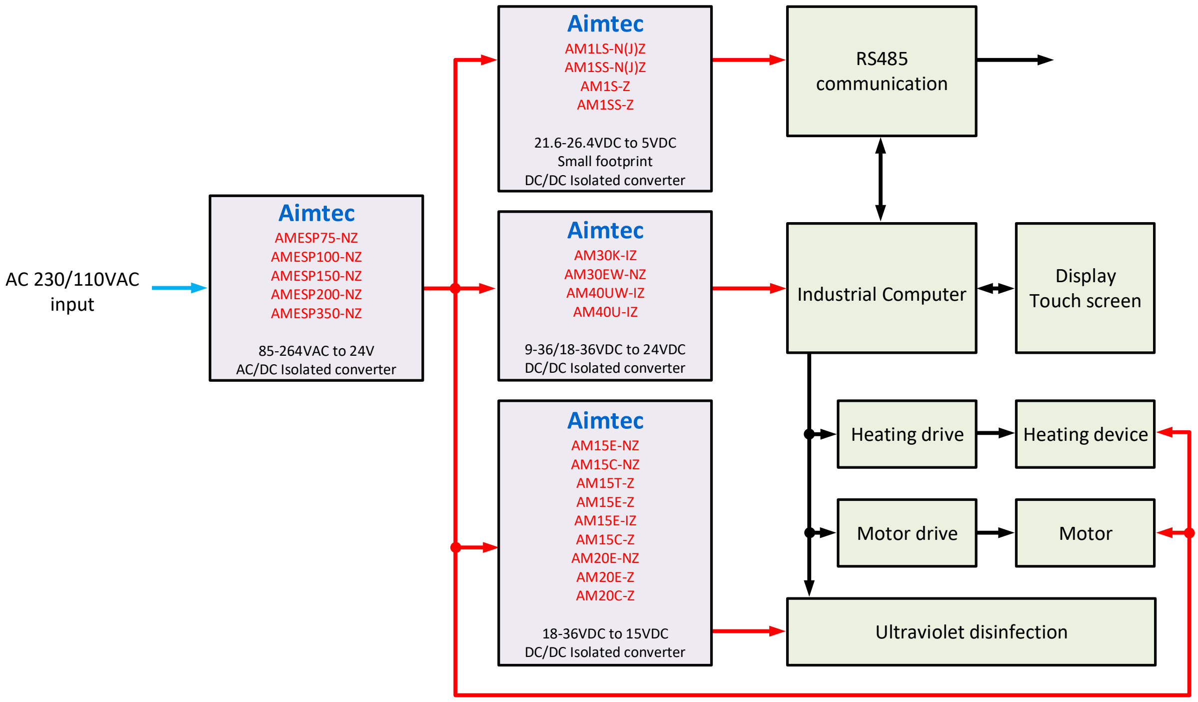

Figure 1. Automatic nucleic acid extraction instrument

2] Medical X-ray machine:

Medical X-ray machines are crucial in clinical diagnosis. There are three types of medical X-ray machines: Computed tomography (CT), fluoroscopy, and conventional X-ray. They are all used to help diagnose different medical conditions.

As the X-ray machine is within the patient environment but not electrically connected to patients, the machine is required to meet type B applied parts standards. Below is an example of the control system of a C-arm X-ray machine. The machine consists of an MCU, X-ray module, displacement detection module and image intensifier. The example below uses an ITE grade AMESP-NZ AC/DC converter to provide the 24V to the system. Three medical-grade converters with 2xMOPP convert the voltage to power the other modules. Customers can choose the AM6TW-NZ with 6KVDC isolation or the AM20EWM-NZ with 5KVAC isolation to satisfy the required creepage and isolation protection requirements.

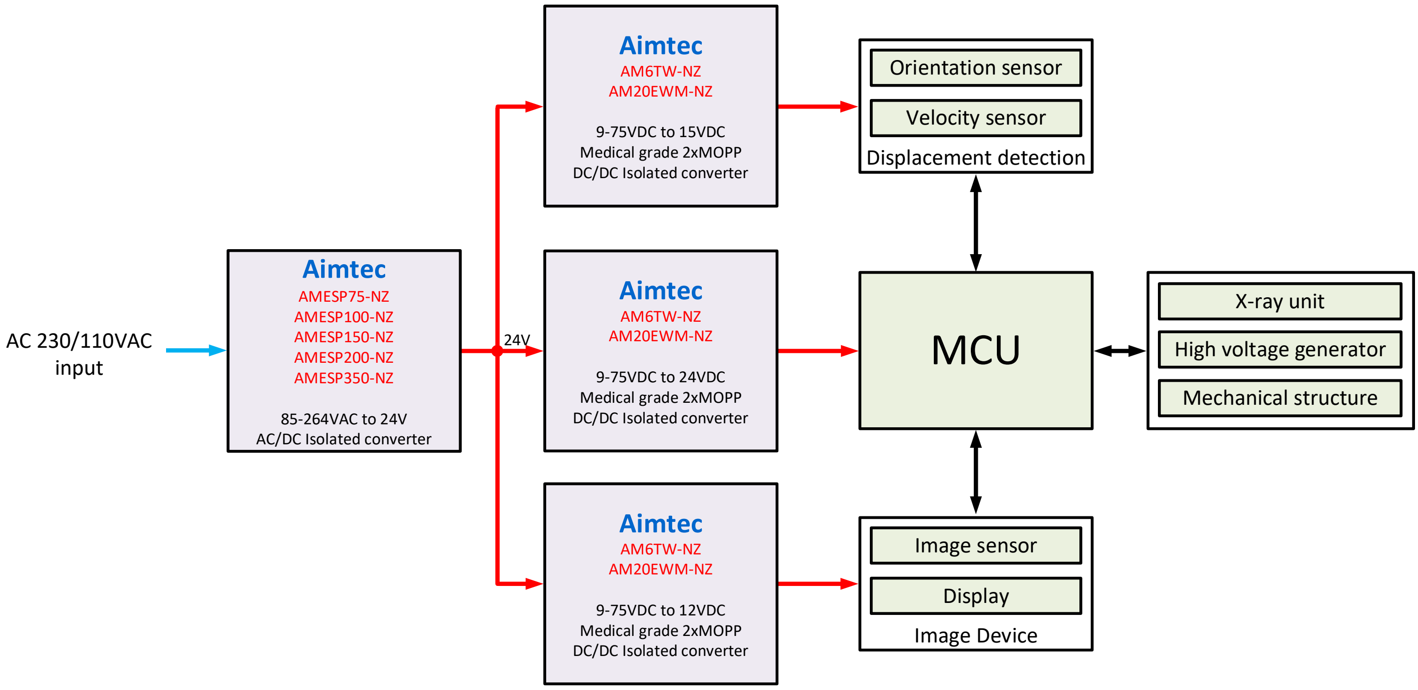

Figure 2. Medical X-ray machine

3] Immunoassay analyzer:

An Immunoassay analyzer is used to identify different substances of interest in a given sample. The basic concept is to use labeled molecules that are coated with an antibody to target substances of interest and highlight them. The labeled molecules will emit light under certain wavelengths which are then captured by the photosensor. This captured data is then analyzed to produce the test results.

Similar to the nucleic acid extraction instrument, an immunoassay analyzer is also not placed in the patient environment hence the example below uses Information and Communication Technology Equipment (ICT) grade converters.

The analyzer consists of an inspection unit, a cuvette loading system, a sample loading system and a control communication module. Aimtec's AMESP-NZ provides the 24V required to power the HV generator, heating device, and valve directly. Three isolated DC/DC converters converter the 24V to 5V and 12V to power the sensitive communication module and high EMI motors. Other modules are powered by 3 cost-effective non-isolated switching regulators.

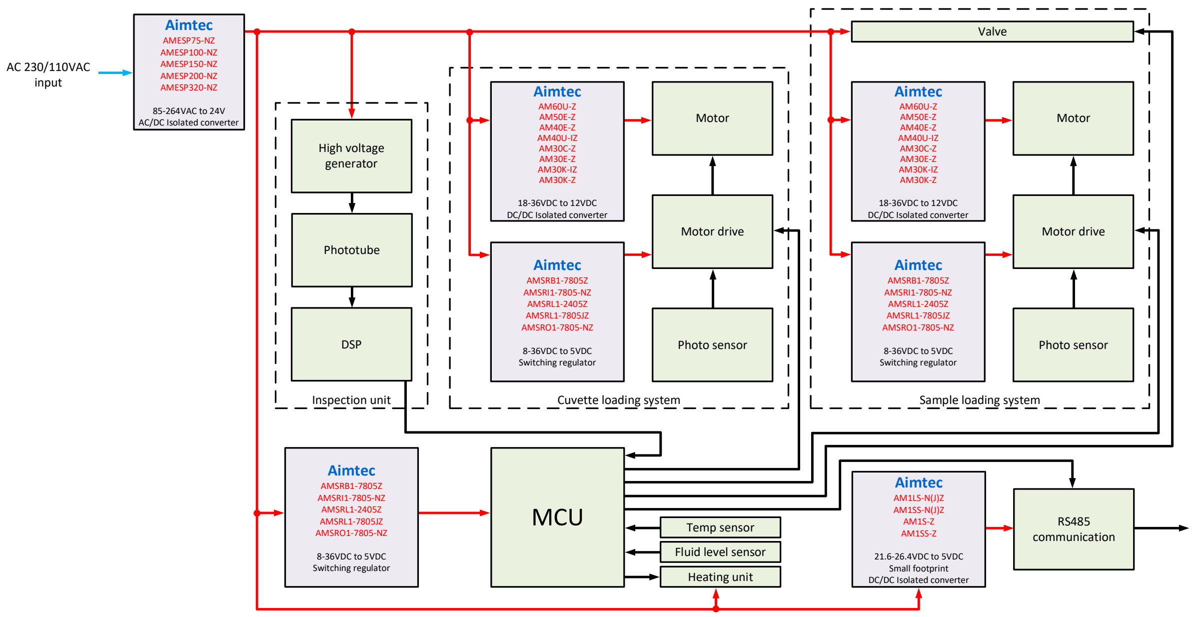

Figure 3. Immunoassay analyzer

4] Ventilators

Ventilators are designed to aid patients who cannot breathe effectively or are unable to breathe by themselves. This life-saving equipment consists of a pump or blower that can transfer breathable air in and remove carbon dioxide out of the lungs. Depending on the way it delivers the breathable air into patients' lungs, a ventilator can be divided into two types: non-invasive and invasive.

- The non-invasive ventilator delivers air into the patient's lungs through a face mask that covers the patient's nose and mouth.
- An invasive type ventilator delivers air into the patient's lungs by an endotracheal tube that goes through the patient's nose or mouth into their windpipe.

Modern ventilators are usually computerized equipment consisting of a blower, several sensors and valves. The blower pushes the air from the gas source which can be just air or mix with oxygen through the inspiratory valve and multiple sensors, and eventually into the patient's lungs. At the same time, the MCU monitors the reading from the sensors and controls the blower speed or valve opening to achieve the desired pressure, flow rate, and oxygen level.

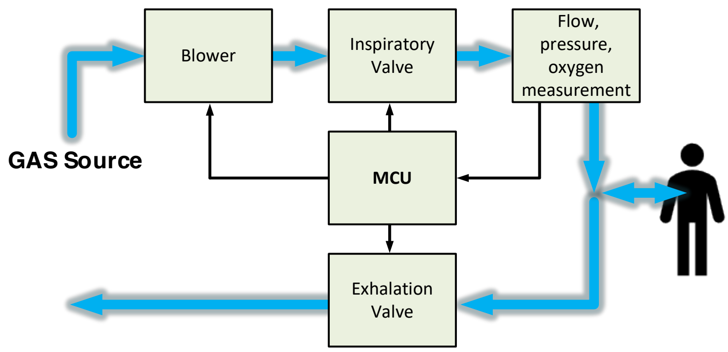

Figure 4. 3D body scanner

5] Intensive care ventilator:

An intensive care ventilator is designed to be used in Intensive Care Units. It features a wide range of flow rates and pressure settings and is often bulkier than other types of ventilators as size restrictions are not the primary design constraint.

These ventilators require physical connection with the patient, hence it needs to meet the type BF applied part standard. As the device is usually capable of a higher flow rate and pressure, a more powerful medical grade AC/DC converter of 200 to 300W is required as the main power source. In this example, the 24V provided by the Aimtec's AC/DC converters power the display unit and the pump motor directly. Four isolated DC/DC converters convert the 24V into 12V, 5V, and -12V. As the valves usually generate more electromagnetic noise, customers can use our AM10TWM-YZ or AM20EWM-NZ dedicated to the valves to isolate the interference. The 5V level which is also provided by our AM10TWM-YZ or AM20EWM-NZ series powers the electronic control circuits and the communication module. To ensure the RS232 signal quality, customers can use our AM1DM-NZ or AM2DM-NZ which provide 6000KVDC isolation to power the signal line. The -12V provides by the AM2DM-NZ offers the necessary reference voltage to the OPA and DAC.

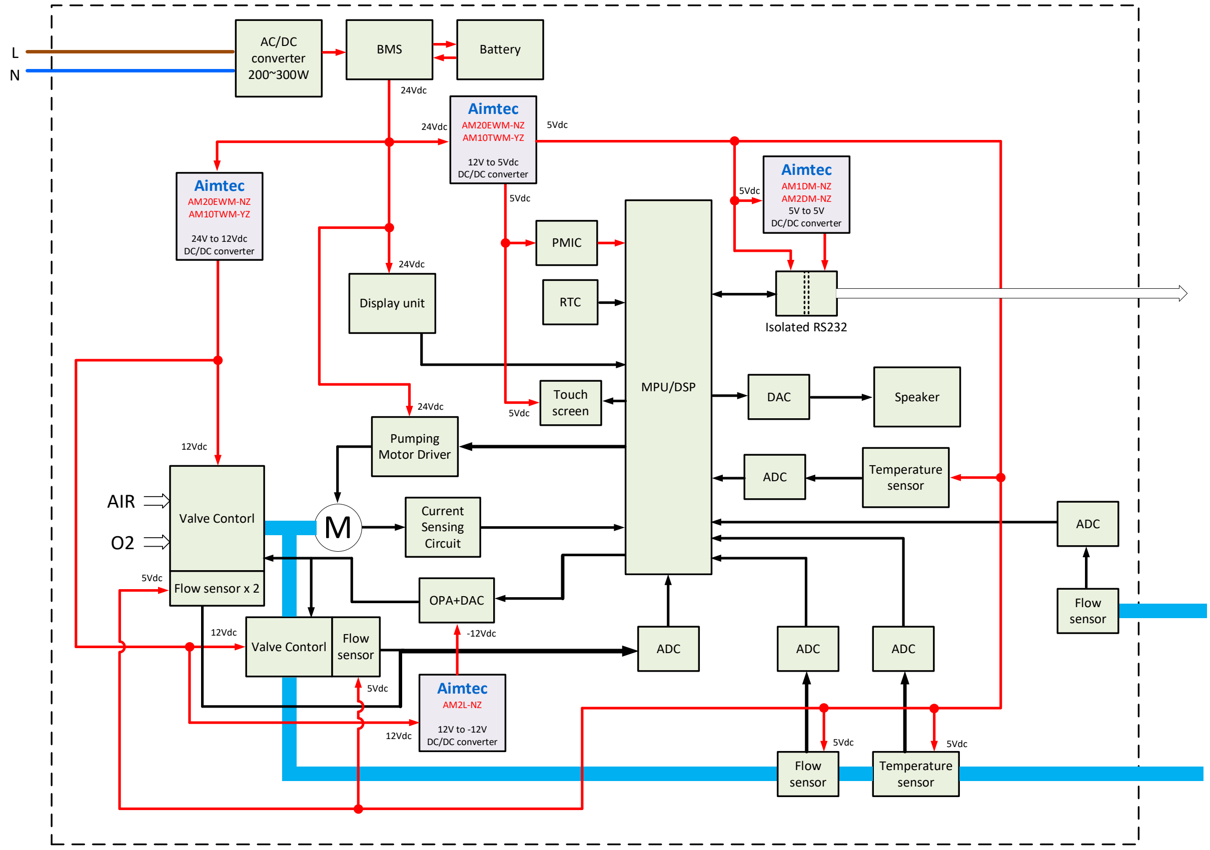

Figure 5. Intensive care ventilator

6] Transport ventilator:

As size and weight are the primary constraints for transport ventilators, it is often designed with fewer features or a smaller range of flow rates and pressure settings when compared to an intensive care ventilator.

As this device has a smaller setting range and fewer features, the device usually requires lower power of around 80 to 150W. In the below block diagram the device can be powered by the onboard medical grade AC/DC or an external 24V medical-grade adapter.

The 24V from the onboard AC/DC or external adapter powers the motor and the valve directly. To isolate the interference from the motor and valves, an Aimtec AM20EWM-NZ isolated DC/DC converter with 5000VAC isolation is used to convert the 24V to 5V and provide power to the control circuits, sensors, and the display unit. AM1DM-NZ or AM2DM-NZ are also used in this example to ensure the signal integrity to the RS232 communication module.

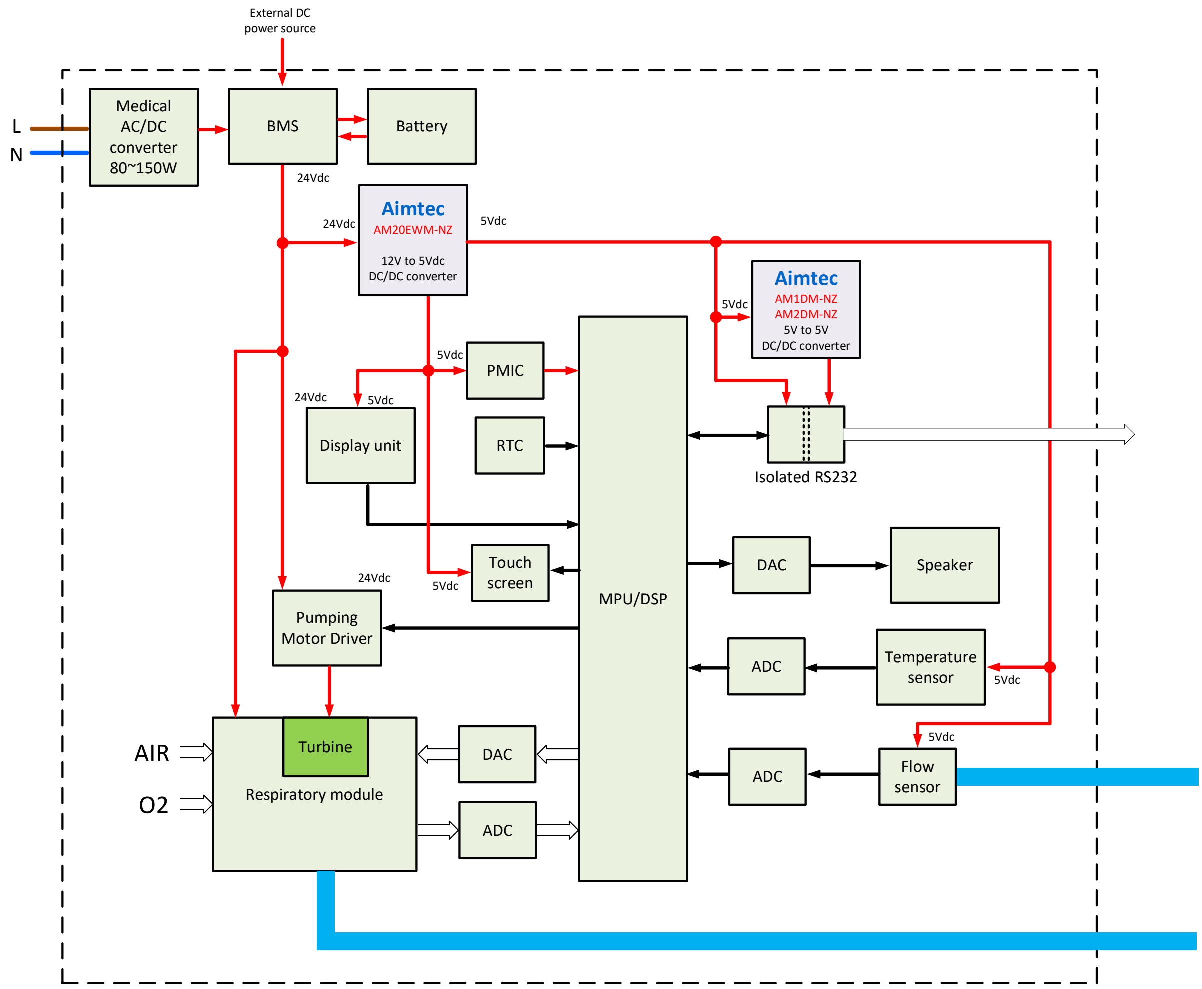

Figure 6. Transport ventilator

7] Mechanical ventilator:

The mechanical ventilator has the smallest size and least number of available features when compare with the other two ventilators. The sacrifice in features enables it to run with lower power. Similar to the transport ventilator, the example below can accept either AC or DC input.

Aimtec's medical-grade DC/DC converter, the AM20EWM-NZ with 4:1 input range is built into the device to enable a flexible external DC power source. The input power is converted to 24V and powers the valve, blower, and system fan. Switching regulators can also be used to convert 24V to 9V and 5V to power the sensors and the microcontroller units.

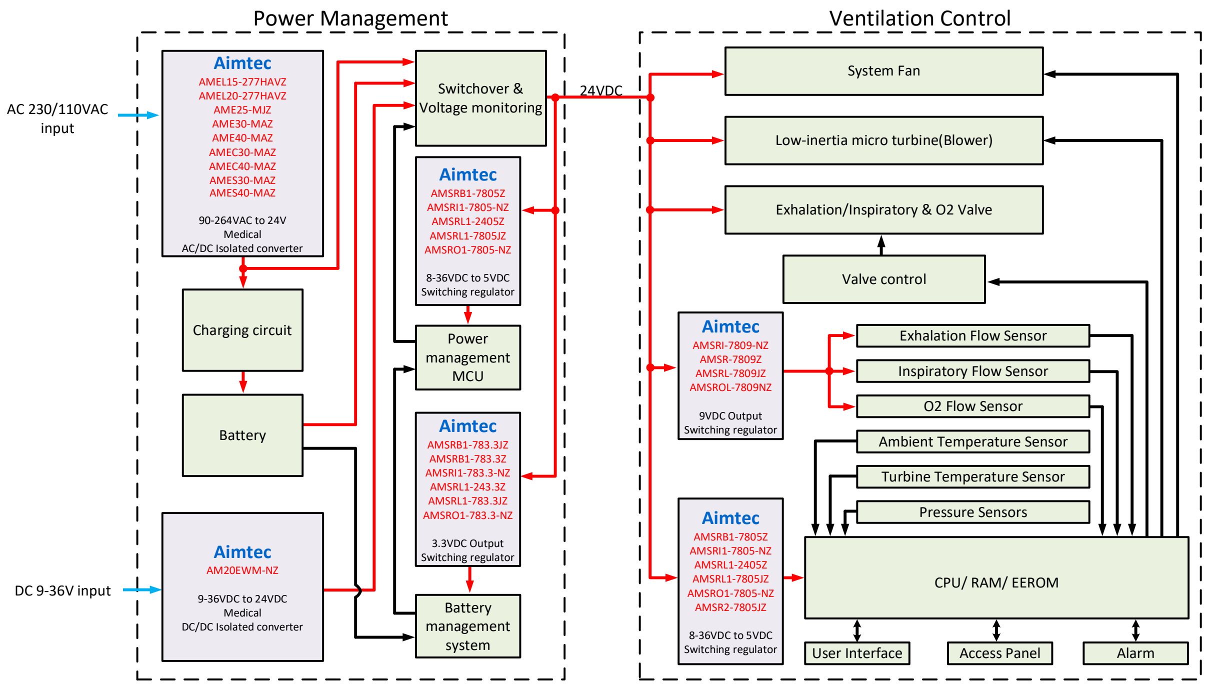

Figure 7. Mechanical ventilator

8] UV-C cabinet drawer:

Most surface disinfection methods consist of using chemicals, the efficacy of these methods depends on the selected agent, manner of use (immersion vs. contact), and the treatment time. Electronic devices such as phones, tablets, and computers cannot be exposed to these strong chemicals that are used to combat viruses and superbugs. Using surface disinfecting chemicals can often result in corrosion of the materials and can damage the devices (in some cases can also void the warranty). The UV-C cabinet drawer provides an alternative method of surface disinfection for all materials that can withstand non-ionizing UV-C radiation.

The UV-C cabinet drawer is not placed in the patient environment, therefore Information and Communication Technology Equipment (ICT) grade electrical power supplies can be used to power these devices. In the below example, a UV-C LED array is used to achieve surface disinfection. Aimtec offers 30~60W AC/DC LED drivers to convert the AC source to DC output that able to drive the UV-C LED array directly. The MCU, LCD display, touch screen, sensors also need a DC power source which can be achieved via Aimtec's compact AC/DC power solutions like AME3-CJZ, AME3-HAVZ, AME3-VZ series.

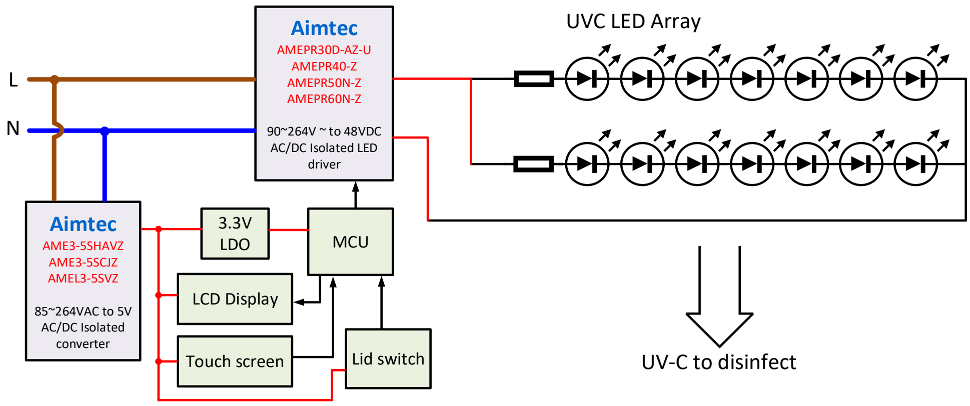

Figure 8. UV-C cabinet drawer

9] UV-C disinfection robot:

A UVC Disinfection Robot is an Autonomous Mobile Robot (AMR) base coupled with an Ultraviolet (UV) light emitter top module that can clear and disinfect environments from bacteria and viruses. The UVC Disinfection Robot System provides excellent germicidal efficiency by treating the environment with UV-C light. When coupled with a cloud-based application the hospital's infection control department can regularly track and record the implementation of their sanitation protocols and thus reduce the Healthcare-associated Infections (HAI) and improve the quality of health care.

The power source for this device is a 48VDC battery which drives the motors, laser sensors, camera, computing device, and the UV-C lamps or UV-C LED array. Aimtec's AMSROL10-NZ can convert the 48V to 24V which mainly supplies the power to the brain of the robot, the computing platform. The AMSRI-NZ converts the 24V to 12V which powers the camera and sensors to give the robot abilities to recognize and see the object or obstacles. Isolated DC/DC converters, such as theAM6C-NZ and AM6G-Z offer an isolated 5V that can supply the power to the sub-control system and peripheral sensor. The AMLDV-NZ direct converts 48V to 5V from the battery to power the UV-C LED arrays that disinfects the environment.

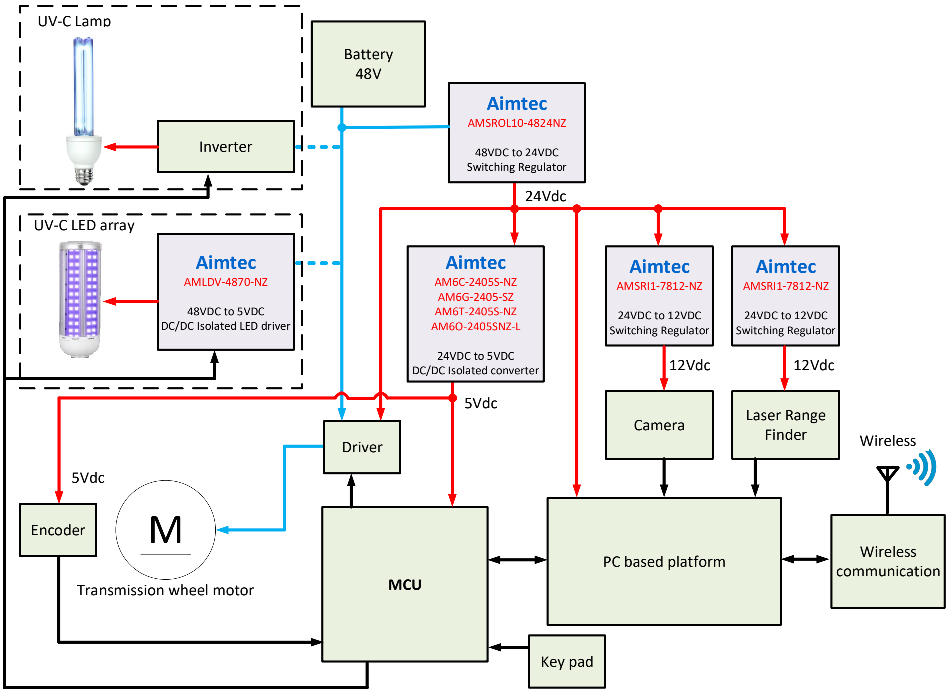

Figure 9. UV-C disinfection robot

Medical devices are constantly improving and are being made safer for use. The power supplies used to power these devices are also constantly evolving and offer larger creepage, clearances, and isolation to meet the safety and EMC requirements. Aimtec has a wide range of Medical grade converters that can help power a variety of medical equipment and help reduce time to market. Listed below are some of the Aimtec's medical-grade power supplies:

Aimtec medical converter offerings

Series	Power (W)	Input	Output	MOP	Safety
AM1DM-NZ	1	2.97-26.4	3.3, 5, 12, 15, ±5, ±9, ±12, ±15	1xMOPP/2xMOOP	UL60601-1
AM2DM-NZ	2	2.97-26.4	3.3, 5, 12, 15, ±5, ±9, ±12, ±15	1xMOPP/2xMOOP	UL60601-1
AM6TW-NZ	6	9-75	5, 6, 9, 12, 15, 24	2xMOPP	Meet EN60601-1 3rd
AM10TWM-YZ	10	9-75	3.3, 5, 12, 15, ±5, ±12, ±15		Meet EN60601-1 3rd
AM20EWM-NZ	20	9-75	3.3, 5, 12, 15, 24	2xMOPP	Meet EN60601-1 3rd
AMEL15-277HAVZ	15	85-305	3.3, 5, 9, 12, 15, 24	2xMOPP	Meet EN62368, EN60335, EN61558, EN60601-1, ES60601-1
AMEL20-277HAVZ	20	85-305	3.3, 5, 9, 12, 15, 24	2xMOPP	Meet EN62368, EN60335, EN61558, EN60601-1, ES60601-1

AMEL5-MJZ	5	85-264	5, 12, 15, 24	2xMOPP	Meet EN60601-1 3rd
AMEL10-MJZ	10	85-264	3.3, 5, 9, 12, 15, 24	2xMOPP	Meet EN60601-1 3rd
AME15-MJZ	15	85-264	5, 12, 15, 18, 24	2xMOPP	Meet EN60601-1 3rd
AME25-MJZ	25	85-264	5, 12, 15, 18, 24	2xMOPP	Meet EN60601-1 3rd
AMEL20-MAZ	20	90-264	3.3, 5, 12,15, 24, ±3.3/5, ±3.3/12, ±3.3/15, 3.3/24, ±5, ±5/12, ±5/15, 5/24, ±12, ±12/15, 12/24, 15/24	2xMOOP	UL60601-1
AME30-MAZ	30	90-264	3.3, 5, 12,15, 24, ±5, ±12, ±15, ±24	2xMOOP	UL60601-1
AME40-MAZ	40	90-264	3.3, 5, 12,15, 24, ±5, ±12, ±15, ±24	2xMOOP	UL60601-1
AMEC30-MAZ	30	90-264	3.3, 5, 12,15, 24, ±5, ±12, ±15, ±24	2xMOOP	UL60601-1
AMEC40-MAZ	40	90-264	3.3, 5, 12,15, 24, ±5, ±12, ±15, ±24	2xMOOP	UL60601-1
AMES30-MAZ	30	90-264	3.3, 5, 12,15, 24, ±5, ±12, ±15, ±24	2xMOOP	UL60601-1
AMES40-MAZ	40	90-264	3.3, 5, 12,15, 24, ±5, ±12, ±15, ±24	2xMOOP	UL60601-1

About Aimtec:

Founded in 2002, Aimtec is a global designer and manufacturer of modular AC/DC and DC/DC switching power supplies. The company's standard products include DC/DC converters up to 200 W, AC/DC converters, and LED drivers reaching 250 W.

Aimtec converters assist customers worldwide in reducing engineering design time and expenses while facilitating miniaturization and performance enhancements of their end products.

For more information, please visit Aimtec at www.Aimtec.com