Modular Power for Medical Equipment

What should be considered when choose a *proper* power supply?

- ✓ Safety
- ✓ Medical Standards
- ✓ Design flexibility

Safety & Medical Standards

When it comes to medical equipment, nothing is more important than the ***human safety***, for the patients and health care personnel.

To ensure that devices and equipment are not hazardous, strict ***standards*** are in place to help guarantee global compliance.

For ***power supplies***, one of the most important is ***IEC 60601-1***, Medical Electrical Equipment, Part I:General Requirements for Basic Safety and Essential Performance.
This standard covers essential safety-related specifications and values, such as isolation voltage, leakage current and creepage/clearance distances that ***must be*** met to protect people from ***electrical shock.***

The latest version of 60601-1 is the 3rd edition which was first published in December 2005.
the standard has been adopted in the major countries/regions of the world and published as the following versions:
EU: EN60601-1/A12:2006
USA: ANSI/AAMI ES 60601-1:2005 Ed. 2
Canada: CSA-C22.2 NO. 60601-1:08

Isolation

Compared to industrial power supplies, the levels required for medical power supplies are much stricter.

As an example of what IEC 60601-1 codifies, isolation is required between the ac input, internal high-voltage stages and dc output in order to prevent electrical shock to the operator or patient.
To ensure correct and sufficient isolation, either *double insulation* or *reinforced insulation* should be used in medical power supplies instead of a protective earth (Class II isolation). Class I electrical equipment only calls for basic insulation and uses a protective earth to avoid electrical shock, and is suitable for certain equipment.

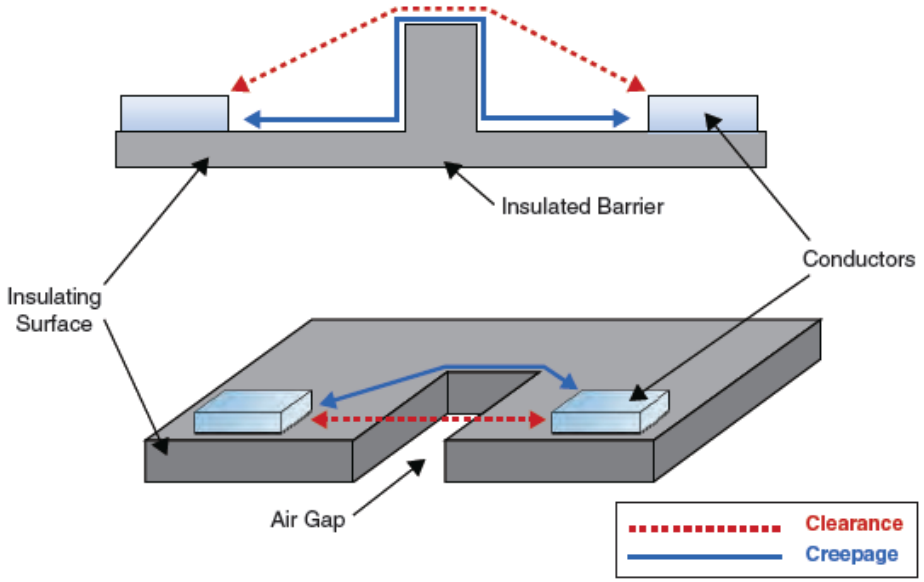
MOOP and MOPP

Other terms within IEC 60601-1 to be familiar with include the means of protection used, describing the isolation protection between the electrical circuits and equipment that may contact the device.

Isolation protection includes creepage/clearance distances, insulation, and protective earths.

Subcategories for this term include *MOOP (means of operator protection) and MOPP (means of patient protection).*

3rd Edition requirement by classification			
Classifications	Isolation	Creepage	Insulation
One MOOP	1500 VAC	2.5mm	**Basic**
Two MOOP	3000 VAC	5mm	**Double/Reinforced**
One MOPP	1500VAC	4mm	**Basic**
Two MOPP	4000 VAC	8mm	**Double/Reinforced**



*Insulation test voltages based on 240 VAC working voltage.

Leakage current

Touch currents are defined as the leakage paths from an enclosure that may contact a patient or operator. Because medical patients are often in a weak state, even a small amount of leakage current can have an adverse health effect.

Closely related to the leakage current concept is the test that measures it: The total patient leakage current test measures the leakage current when all “applied parts” required to operate the medical device are in contact with the patient.

Leakage Current	Type B		Type BF		Type CF	
	NC	SFC	NC	SFC	NC	SFC
Earth Leakage Current	500µA	1mA	500µA	1mA	500µA	1mA
Enclosure Leakage Current	100µA	500µA	100µA	500µA	100µA	500µA
Patient Leakage Current	100µA	500µA	100µA	500µA	100µA	50µA

Classification Types of Applied Parts (clause 2.1.24-2.1.28, 5.2 of IEC60601

Type B – No electrical contact with Patient and maybe earthed

Type BF – Electrically connected to Patient but not directly to heart

Type CF – Electrically connected to the heart of the Patient.

Earth leakage = Current flowing in the earth conductor
Enclosure leakage = Current flowing to earth via the patient from the enclosure.
Patient leakage = Current flowing to earth via the patient from an applied part.
Patient auxiliary = Current flowing between two applied parts

Design Flexibility

In addition to safety concerns, medical equipment designers also must consider a host of other factors when choosing the best power supply for the application. Some of these include *input range, output voltage and power, standby power, temperature and altitude constraints, and product warranties.*
Understanding how various power supplies compare to one another in terms of each of these factors will enable equipment designers to make the right design decision for the project at hand.

Performance Factors to be considered

**Input voltage range:* such as a 4:1 input range of 18~75V. Having a wider input range translates to much greater flexibility for unforeseen design iterations requiring higher input voltages or the need to develop several versions of the same basic equipment model.

**Standby power:* Some medical power supplies use standby power as low as 0.15W,whereas similarly sized devices consume as much as 0.48W.

Environmental factors:* **Operating temperatures of -40℃~70 ℃ at full load operation than -40 ℃~60 ℃ at offering a substantial improvement in design flexibility.

Operating altitude. Some power supplies are designed for altitudes of 3000 m or less, others can function to 5000m, this value can limit where the medical equipment can reliably operate.

**Electromagnetic interference (EMI) :* Devices such as patient monitors operate with low-level signals within hospital settings, this type of equipment is more sensitive to EMI than typical industrial equipment. Due to this reality, electromagnetic compatibility is another area that is regulated by standards and tested for performance.

Mornsun Modular Power for Medical Equipment

AC-DC converter

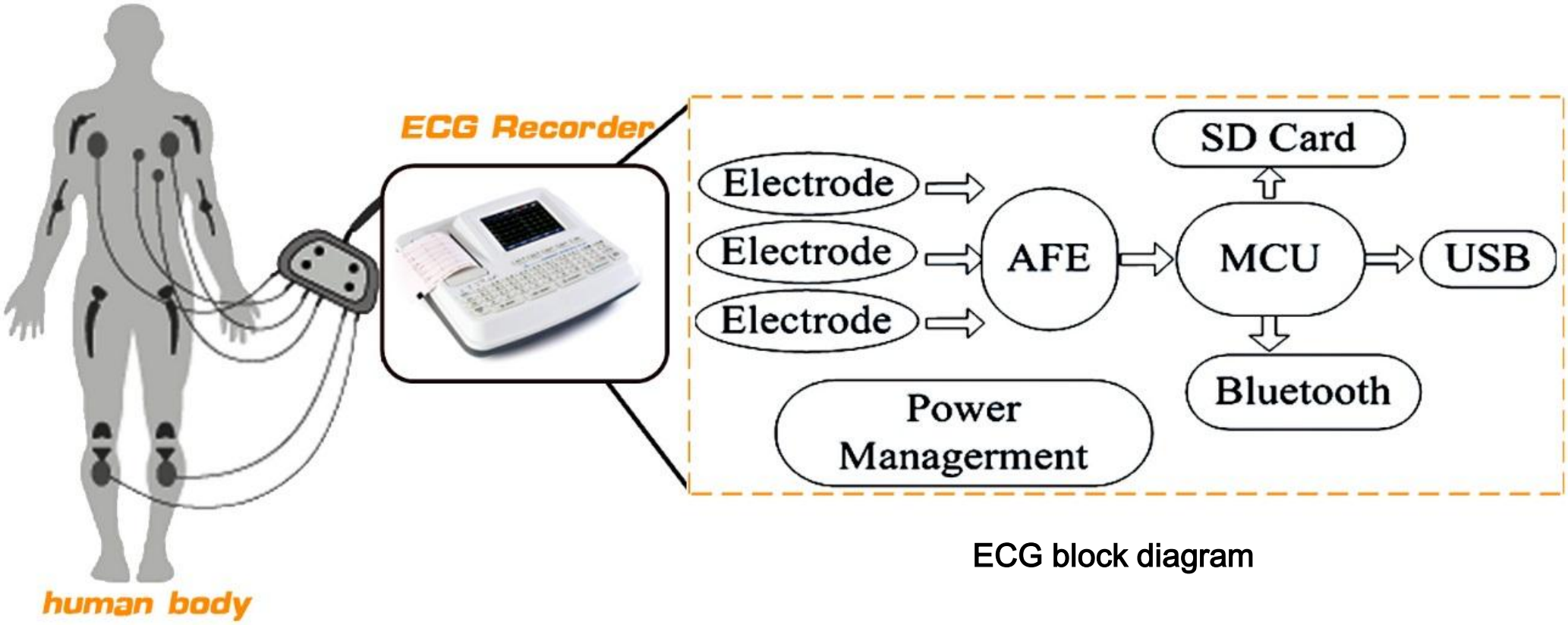
85-264VAC/85-305VAC input available
Operating temperature: -40℃~+70℃
Low Standby power consumption
Isolation voltage:3000VAC/4000VDC
IEC/EN/UL60950 certified

DC-DC converter

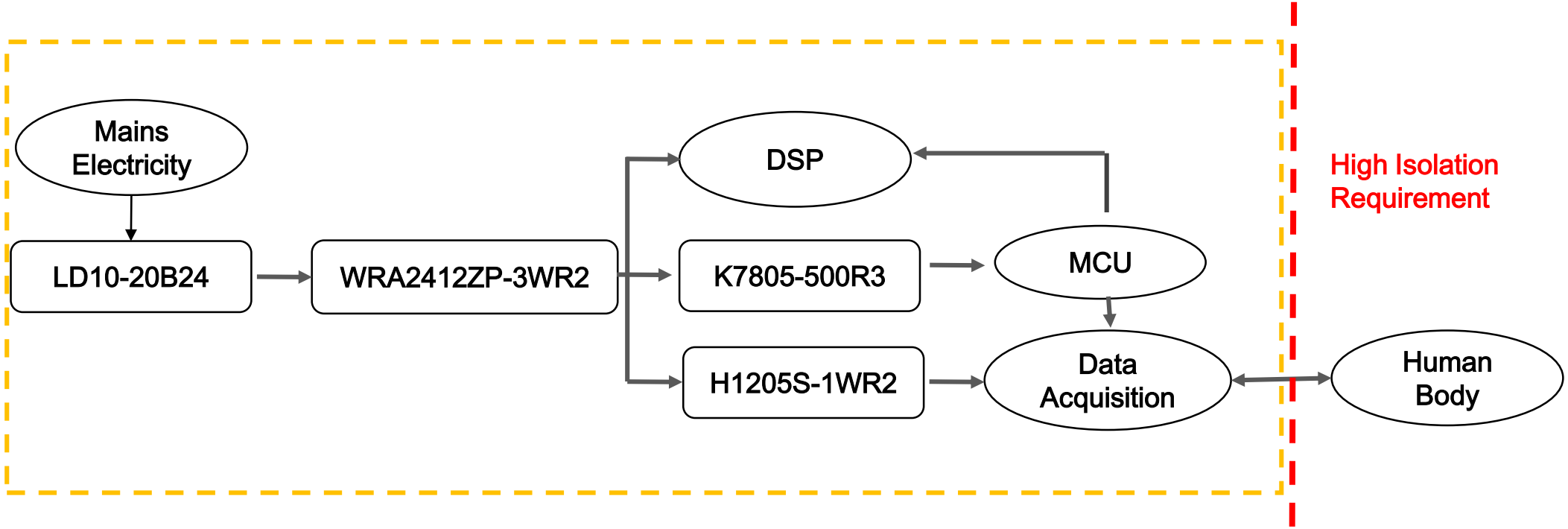
EN60601-1,ANSI/AAMI ES60601-1 certified
Reinforced insulation
Patient leakage current : ≤2μA
Isolation voltage:4200VAC/6000VDC
Standby power as low as 0.12W
Operating temperature: -40℃~+85 ℃
5V/12V/24V/9-36V/18-75V input available

Patient Care Equipment- Electrocardiography(ECG/EKG) Recorder

An ECG/EKG Recorder interprets and records the electrical impulses to create an electrocardiograph, a reading that helps physicians learn more about the heart for diagnostic purposes.



ECG block diagram



Power Management

AC-DC converter： LD10-20B24 converts the mains power to isolated 24V and supply to WRA2415ZP-2W;

DC-DC converter: WRA2412ZP-3WR2 provides 12V voltage to DSP, K7805-500R3 and H1205S-1WR2;

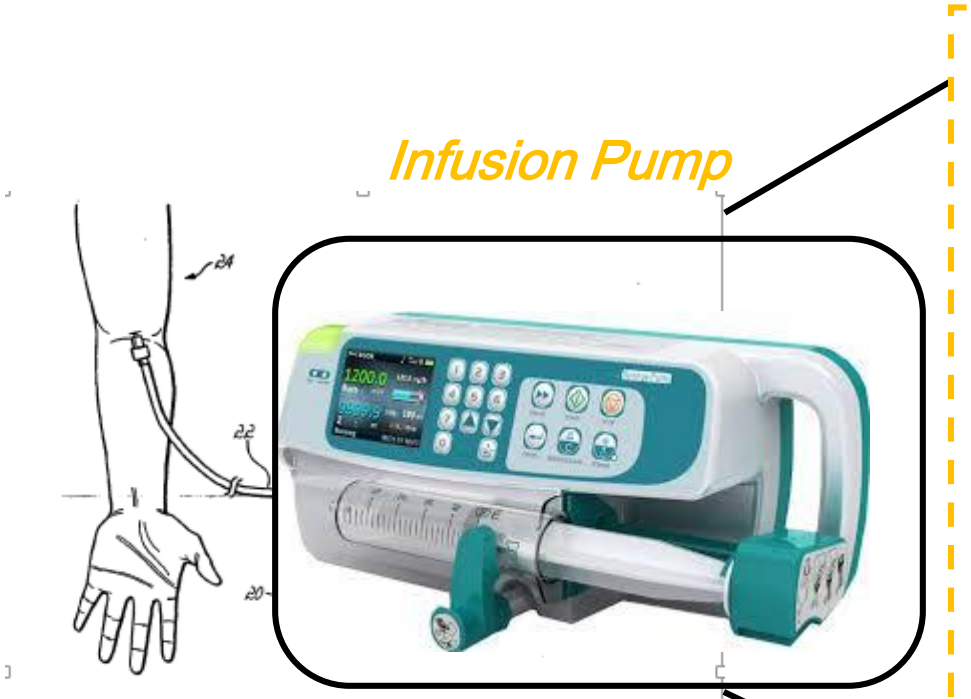
K7805-500R3 converts 12V into 5V to power MCU, and offers output short circuit protection.

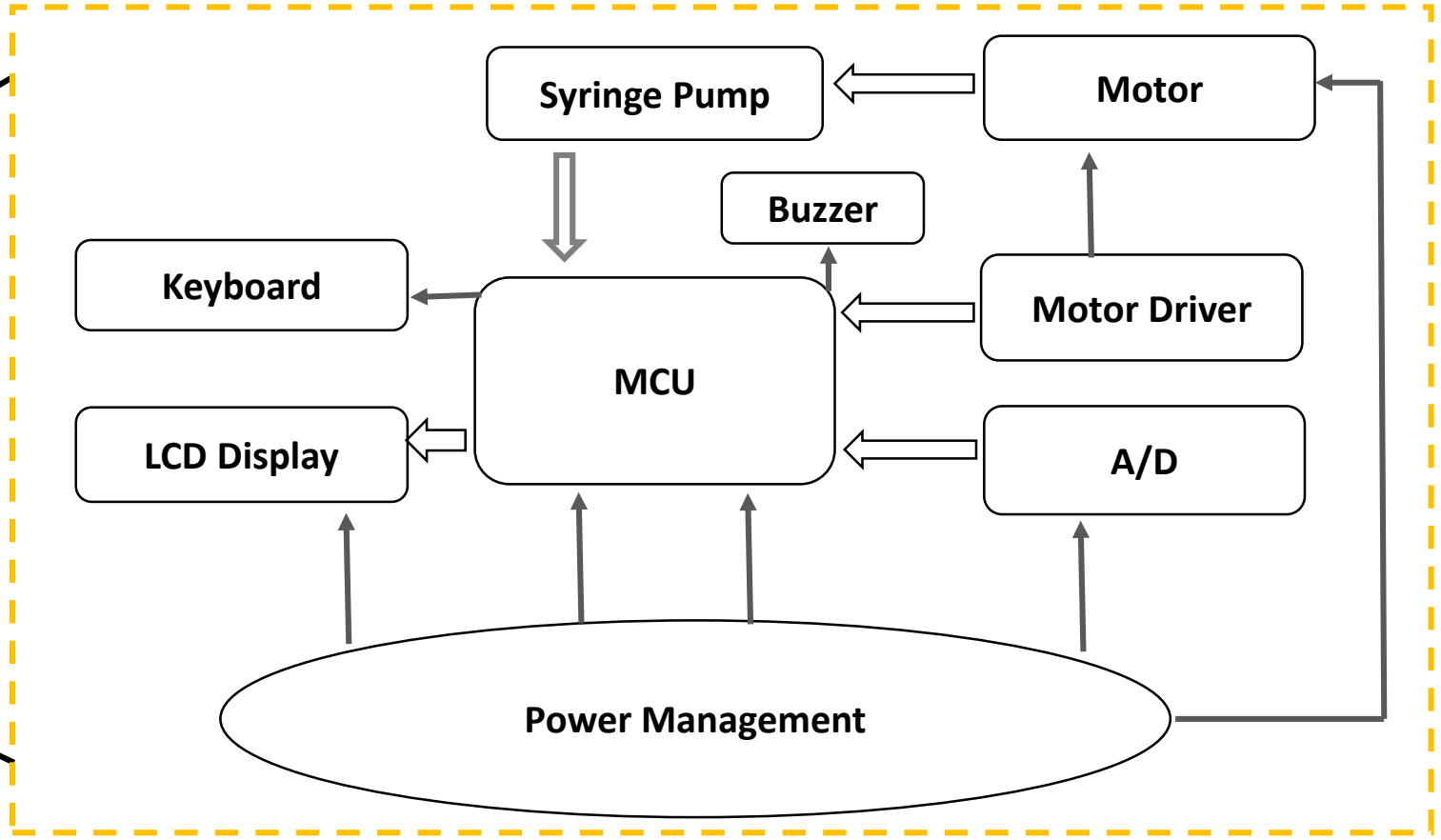
H1205S-1WR2 converts and supply an isolated 5V voltage to the touch switch circuit.

G/H-S-1WR2 G/H-S-2WR2	• *IEC 60601-1 3rd Edition (1xMOPP/2xMOOP)* • *Patient leakage current : ≤2μA* • *High efficiency up to 84%* • *Isolation voltage : 4200VAC(6000VDC)*

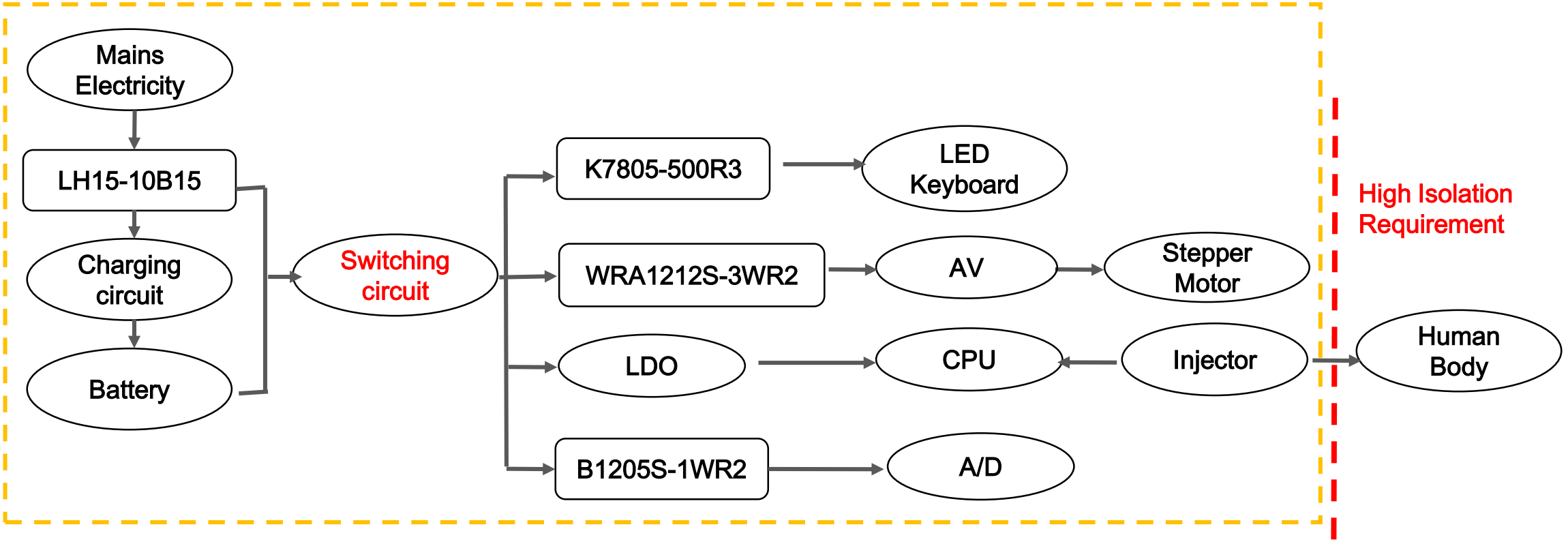
Patient Care Equipment- Infusion Pump

An **infusion pump** is a medical device that delivers fluids, such as nutrients and medications, into a patient's body in controlled amounts. **Infusion pumps** are in widespread use in clinical settings such as hospitals, nursing homes, and in the home.





Infusion pump block diagram



Power Management

AC-DC converter：LH15-10B15 converts the mains power to isolated 15V and supply to Charging circuit and Switching circuit;

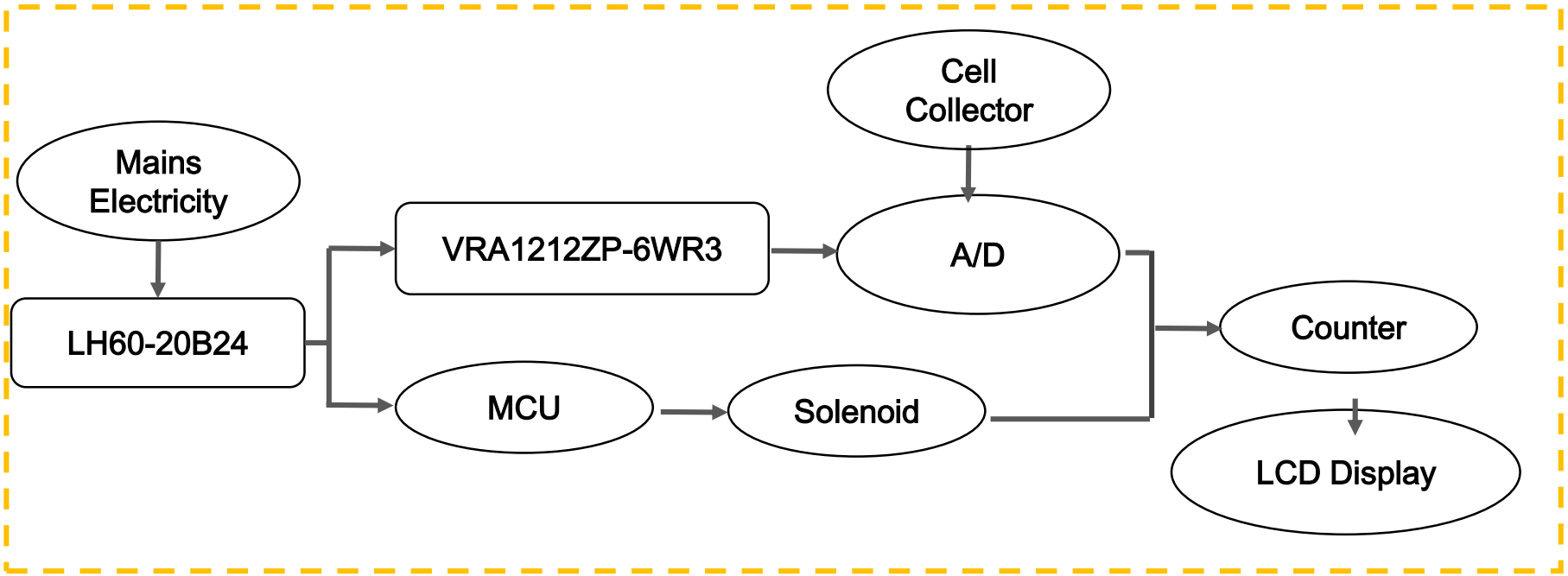
DC-DC converter: K7805-500R3 converts and supplies 5V voltage to LED, Keyboard and etc.

WRA1212S-3WR2 provides Isolated 12V voltage to AV;

B1205S-1WR2 converts and supply an isolated 5V voltage to A/D.

Non-Patient Care Equipment- hematology analyzer/Blood analyzer

Hematology analyzers are computerized, highly specialized and automated machines used in the medical field that count the number of different kinds of white and red blood cells in a blood sample.



Circuit of the controller

Power Management

AC-DC converter：LH60-20B24 converts the mains power to isolated 12V and supply to VRA1212ZP-6WR3;

DC-DC converter: VRA1212ZP-6WR3 supply an isolated 12V voltage to A/D。

More information please visit
www.mornsun-power.com