

Remote Human Health Monitoring System

Abstract

The system is intended for monitoring of organism state of diseased individuals, persons which are located in dangerous environment (firemen, rescuers), sportsmen during training and automobile/train drivers. The portable small autonomous system is proposed, which can be used for on-line and off-line human organism state monitoring. The following sensor types are supported by the developed system: the electrocardiogram sensors, the two way light pulsometer sensor and accelerometer. The used sensor combination allows analyzing of human heart state, respiratory activity, blood oxygen saturation level and individual movement activity. The sensor data can be used for prediction of various dangerous states, for example, detection of human consciousness losing, heart infarct. The other sensor types will be supported in the next system releases.

The wireless data link allows organizing a centralized monitoring center. The bidirectional data link possibility allows sending commands or other information to consumer. Besides of real-time health state monitoring, the proposed system can be used for collection of sensor data in internal nonvolatile data memory and its transmission to PC for following processing. This operation mode is intended for diagnose of some kinds of cardiac diseases or collection of data during sportsmen training.

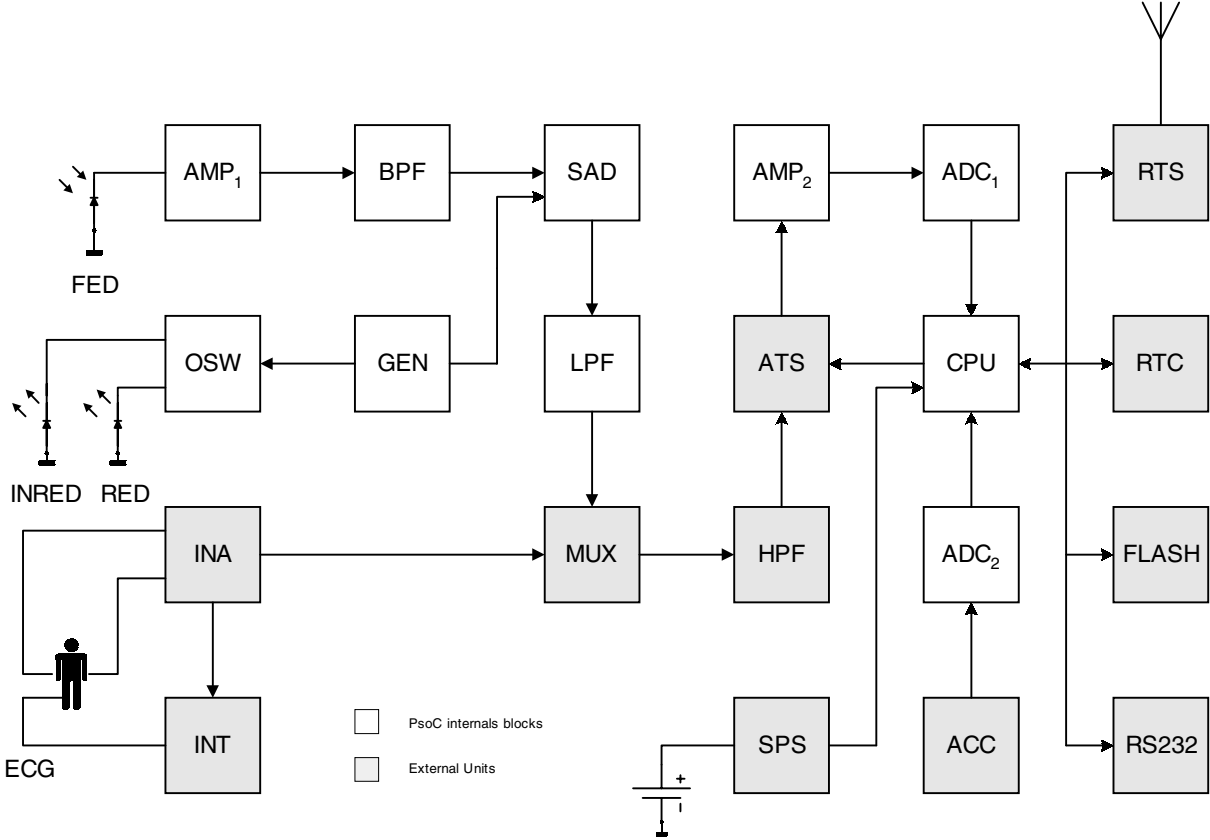
The system consists of two main units: the portable autonomous unit, which is carried by an individual, and data communication unit, which plays the role of radio transceiver for receiving the data collected by autonomous unit and transmitting it to the PC for analysis. The data communication unit is also used for sending the control commands to autonomous unit. For uploading the collected data in offline operational mode the autonomous unit can perform data exchange with PC directly via high-speed serial interface. The system operates in the following way.

During optical-based pulse measuring, the infrared or red **LED** is powered by modulation signal generator **GEN** via output switch **OSW** for switching between two LEDs. The light beam is passed through human tissue and reaches the photodiode **FED**. Note, the pulsometer sensor (two LEDs and photodiode) is located on arm finger, or as ear clips. The **FED** signal is amplified by **AMP₁** and passed via band-pass filter **BPF** to synchronous amplitude detector **SAD**. The filter output is connected to input of synchronous amplitude demodulator that consists of **SAD** and low-pass filter **LPF**. The low-pass filter **LPF** suppresses high-frequency products in demodulator output signal. The suggested signal processing scheme is characterized by excellent immunity to light noise from diverse sources: AC powered or fluorescent lamps, sun-light.

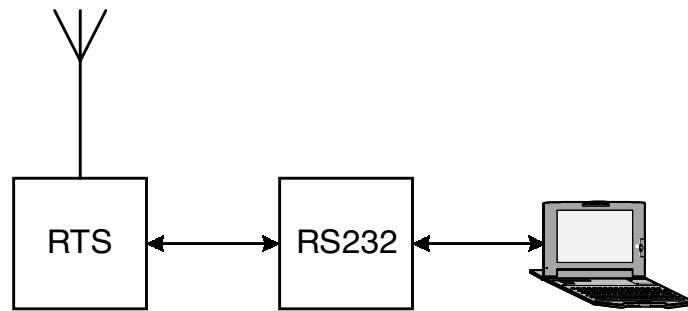
During electrocardiogram measuring, the signal from the instrumentation amplifier **INA** is being brought via multiplexer to high-pass filter and then to programmable gain amplifier and is sampled by **ADC**.

During measuring of accelerometer information the signal is passed to **ADC₂** and processed by the **CPU**. The two independent **ADCs** allow transmitting the pulse or electrocardiogram waveforms and accelerometer signal simultaneously, which allows to analyze the dynamic characteristics and to discover various parameters' correlations.

The other possible system applications have been studied too. The measurement examples are presented in the project as well. For data analyzing and for diagnostic purposes the dedicated software is currently under development.



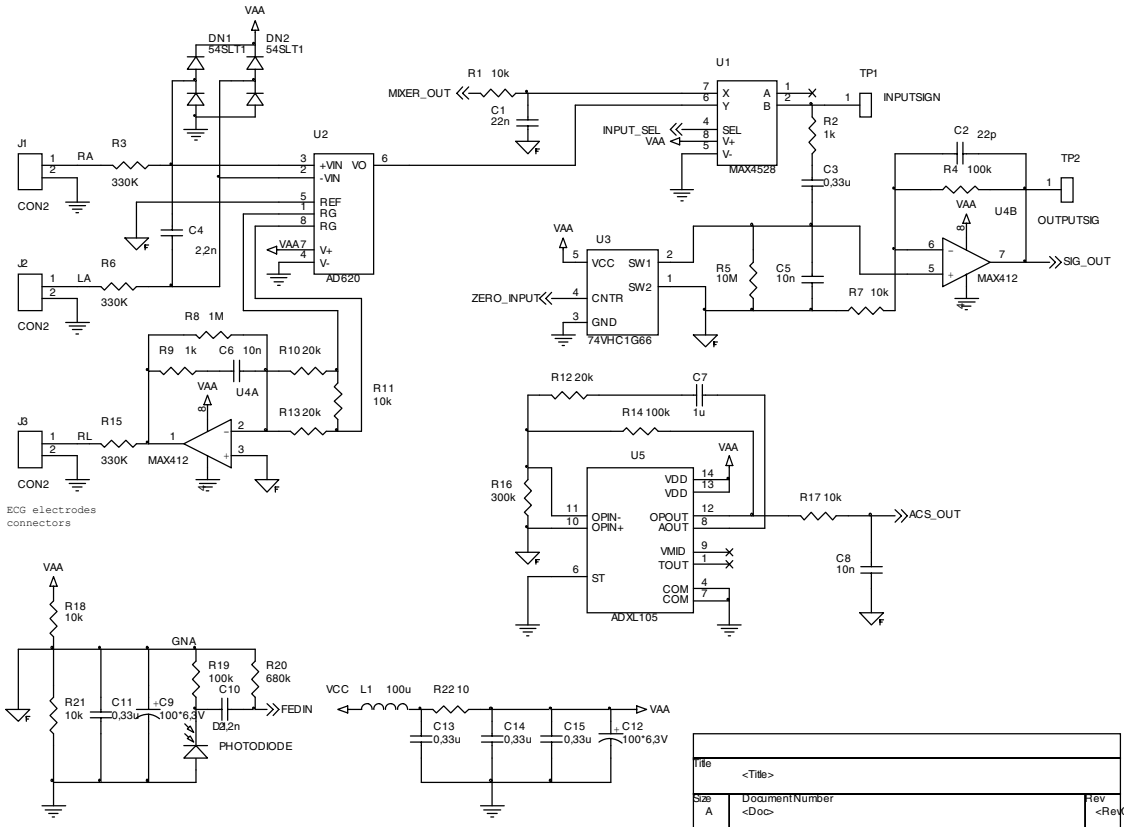
The autonomous unit flowchart.



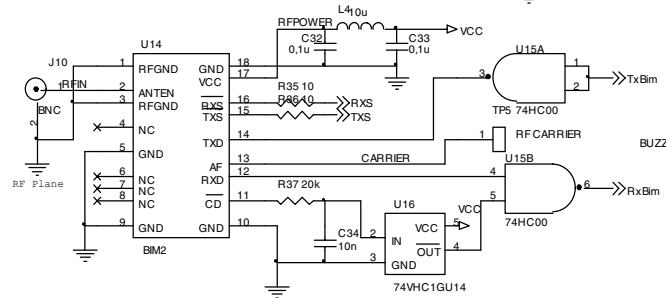
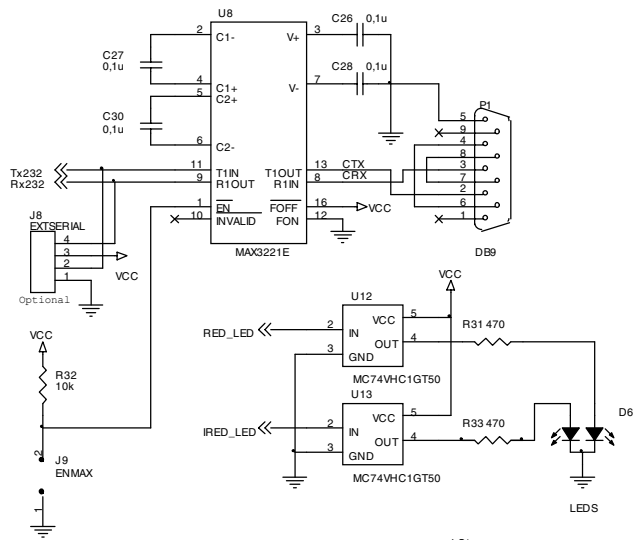
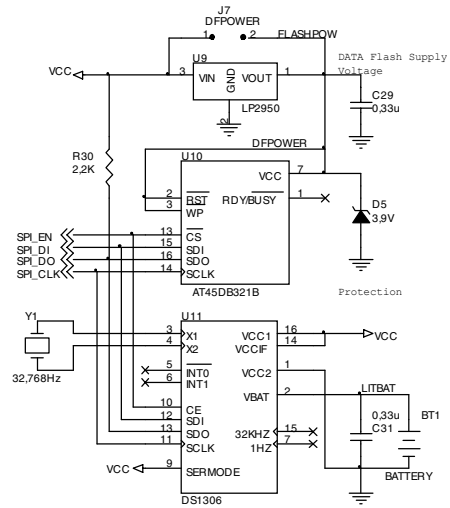
The data interface unit flowchart.

The system consists of the following main modules:

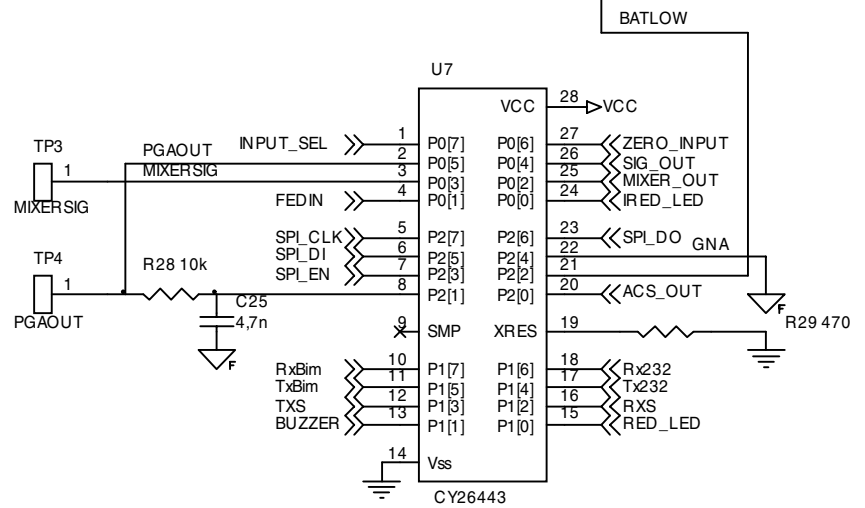
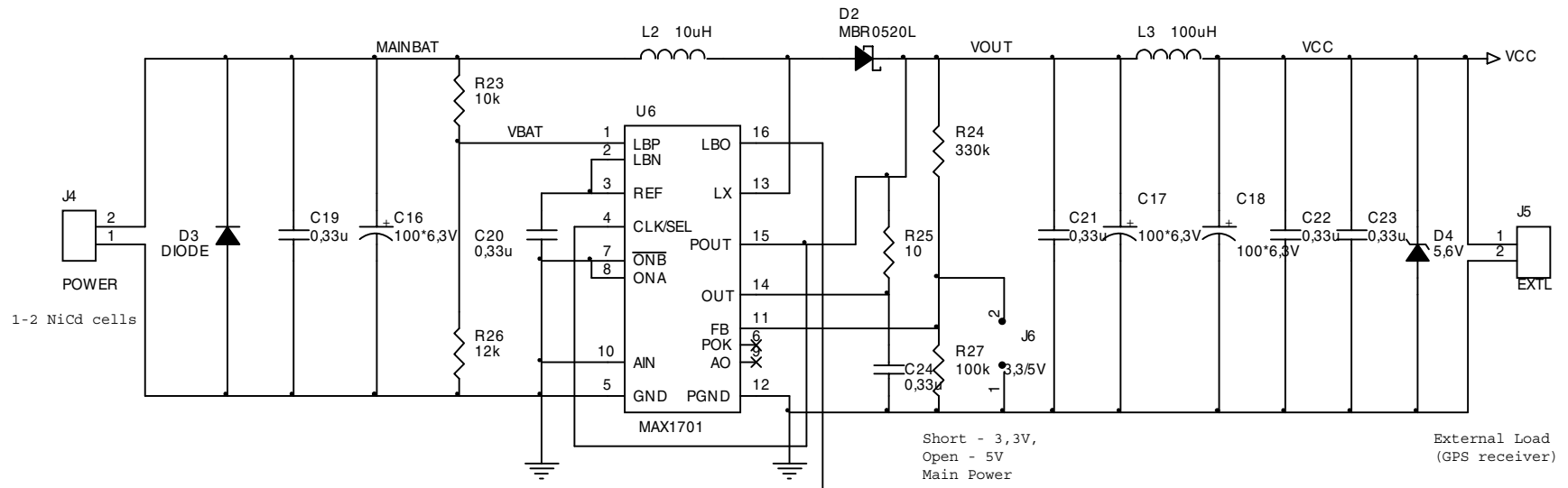
1. **AMP₁** and **AMP₂** – signal amplifiers.
2. **BPF** – band-pass filter.
3. **SAD** – synchronous amplitude detector.
4. **LPF** – low-pass filter.
5. **GEN** – signal generator.
6. **OSW** – output LED signal switch.
7. **INA** – instrumentation amplifier.
8. **INT** – integrator.
9. **MUX** – signal multiplexer.
10. **HPF** – high-pass filter.
11. **ATS** – active transient suppressor.
12. **SPS** – switching step-up power supply.
13. **CPU** – central processing unit.
14. **ADC₁**, **ADC₂** – analog-to-digital converters.
15. **ACC** – accelerometer.
16. **RTS** – radio transceiver.
17. **RTC** - real-time clock.
18. **FLASH**- data Flash memory.
19. **RS232** – RS232 level translator.



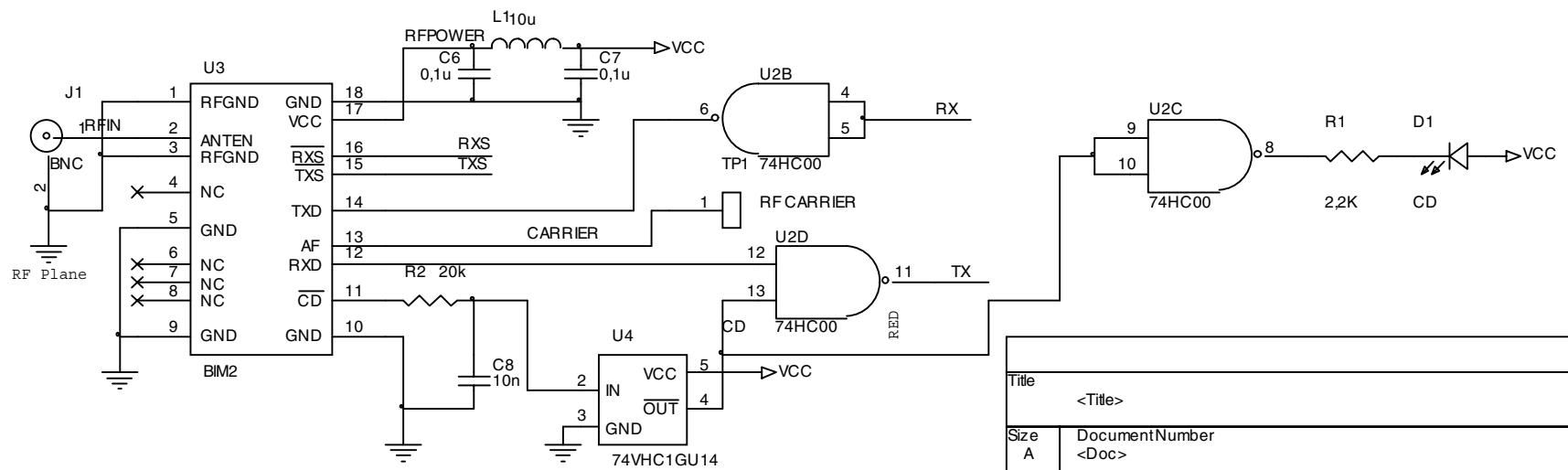
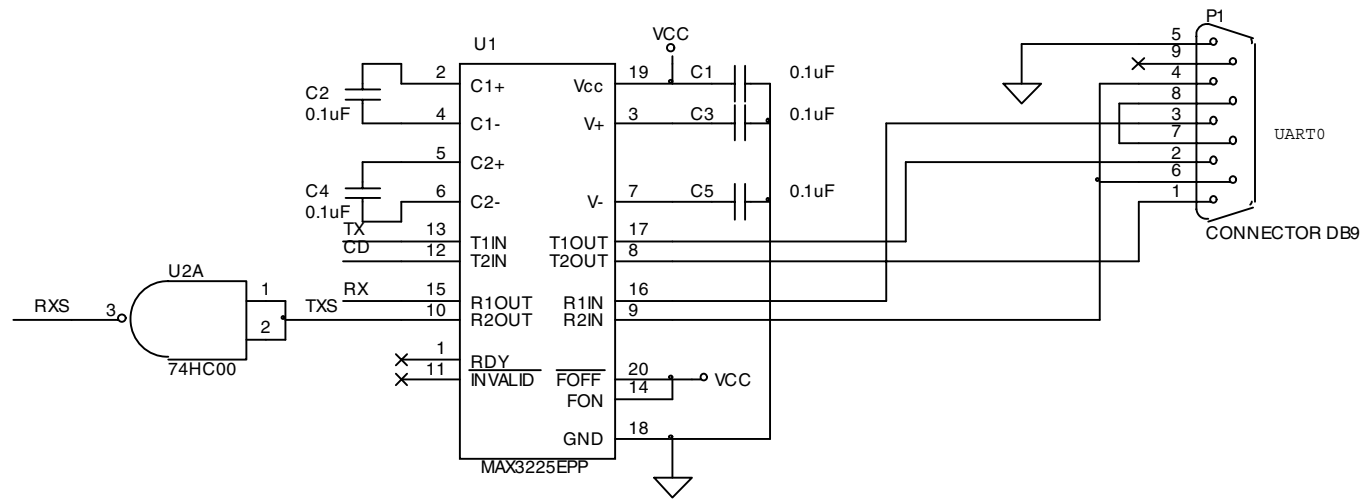
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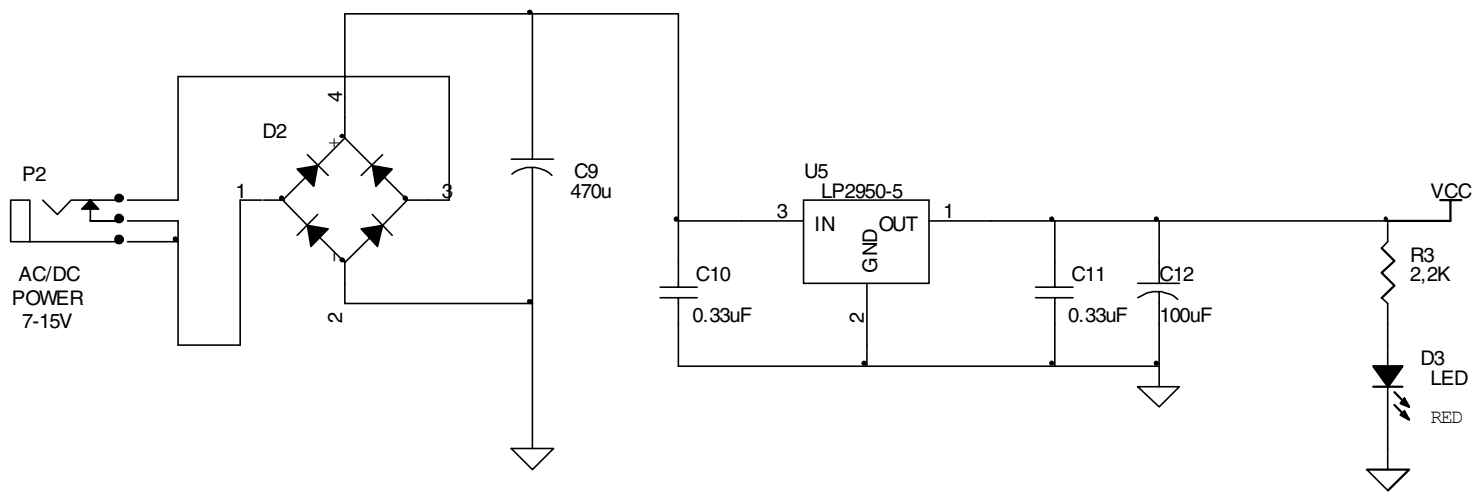
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