AN IMPLANTABLE TELEMETRY SYSTEM POWERED BY A CAPACITOR HAVING HIGH CAPACITANCE

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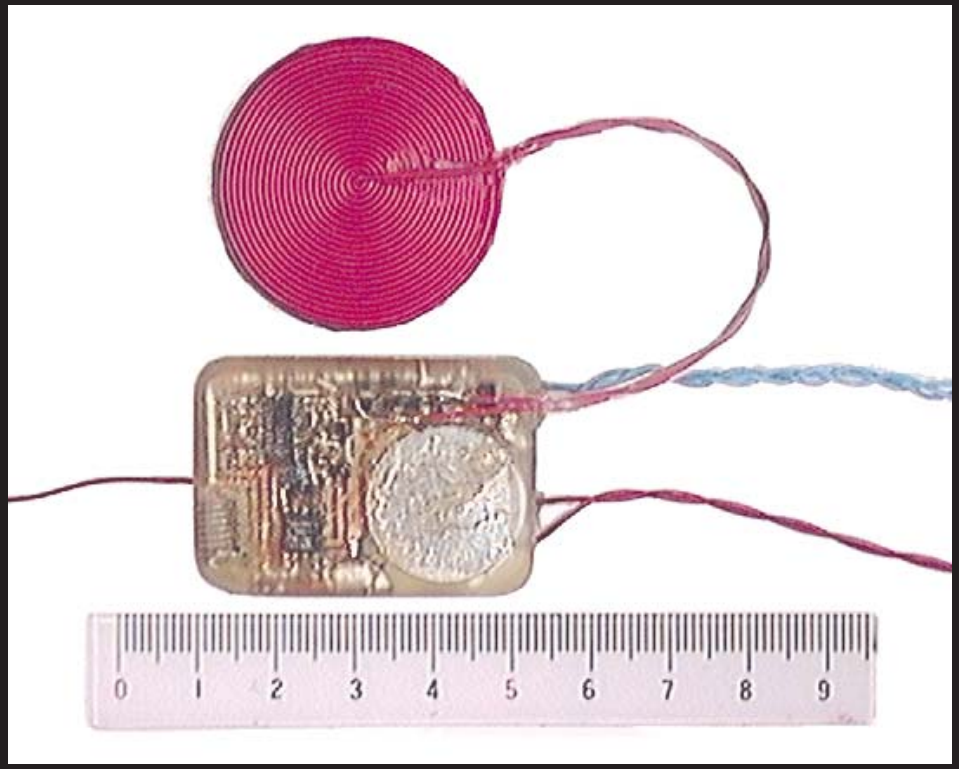

Fig.1 The implantable telemeter designed with a capacitor having high capacitance. The size is 40mm x 30mm x 10mm, and weight is 23g. The power for the telemeter is inductively coupled by a spiral coil, and then the power charges the 2.5 faraday capacitor.

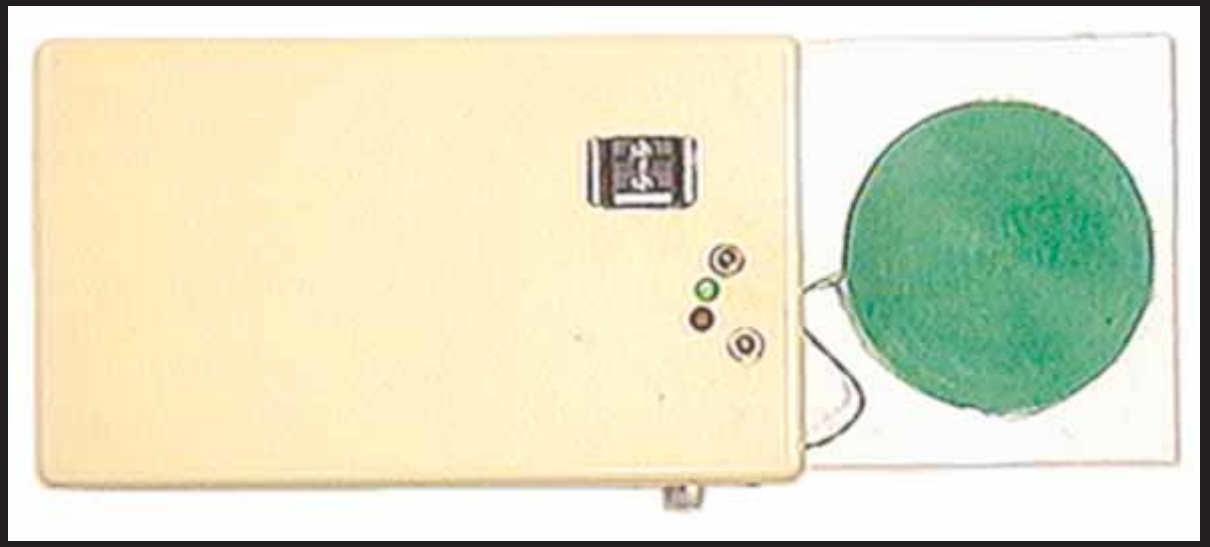

Fig. The external energy microcontroller system. The system generates a 45 Vp-p pulse wave at 1 MHz to drive a primary spiral coil. The microcontroller controls the capacitor charge and sets the gain of the NS amplifier in the implantable telemeter. Switch SW1 starts the microcontroller-timed 5 minutes capacitor charge period. Switch SW2 enables the gain control code as set by digital thumbwheel switches. The gain control code is sent by on-off-keying of transmitted power modulated at 144 bps. The size is 18cm x 7.5cm x 4.5cm, and weight is 510g.

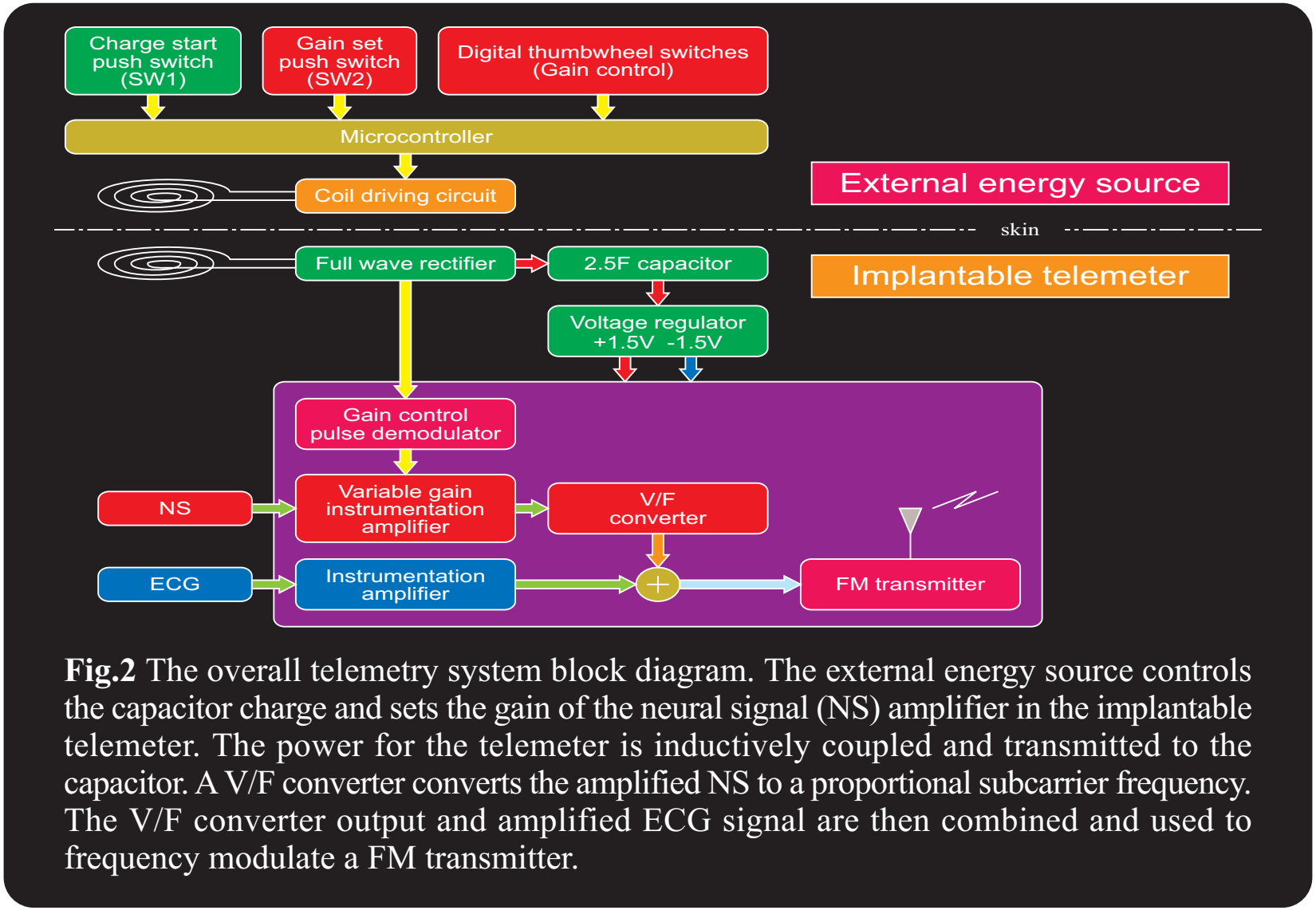

Fig.2 The overall telemetry system block diagram. The external energy source controls the capacitor charge and sets the gain of the neural signal (NS) amplifier in the implantable telemeter. The power for the telemeter is inductively coupled and transmitted to the capacitor. A V/F converter converts the amplified NS to a proportional subcarrier frequency. The V/F converter output and amplified ECG signal are then combined and used to frequency modulate a FM transmitter.

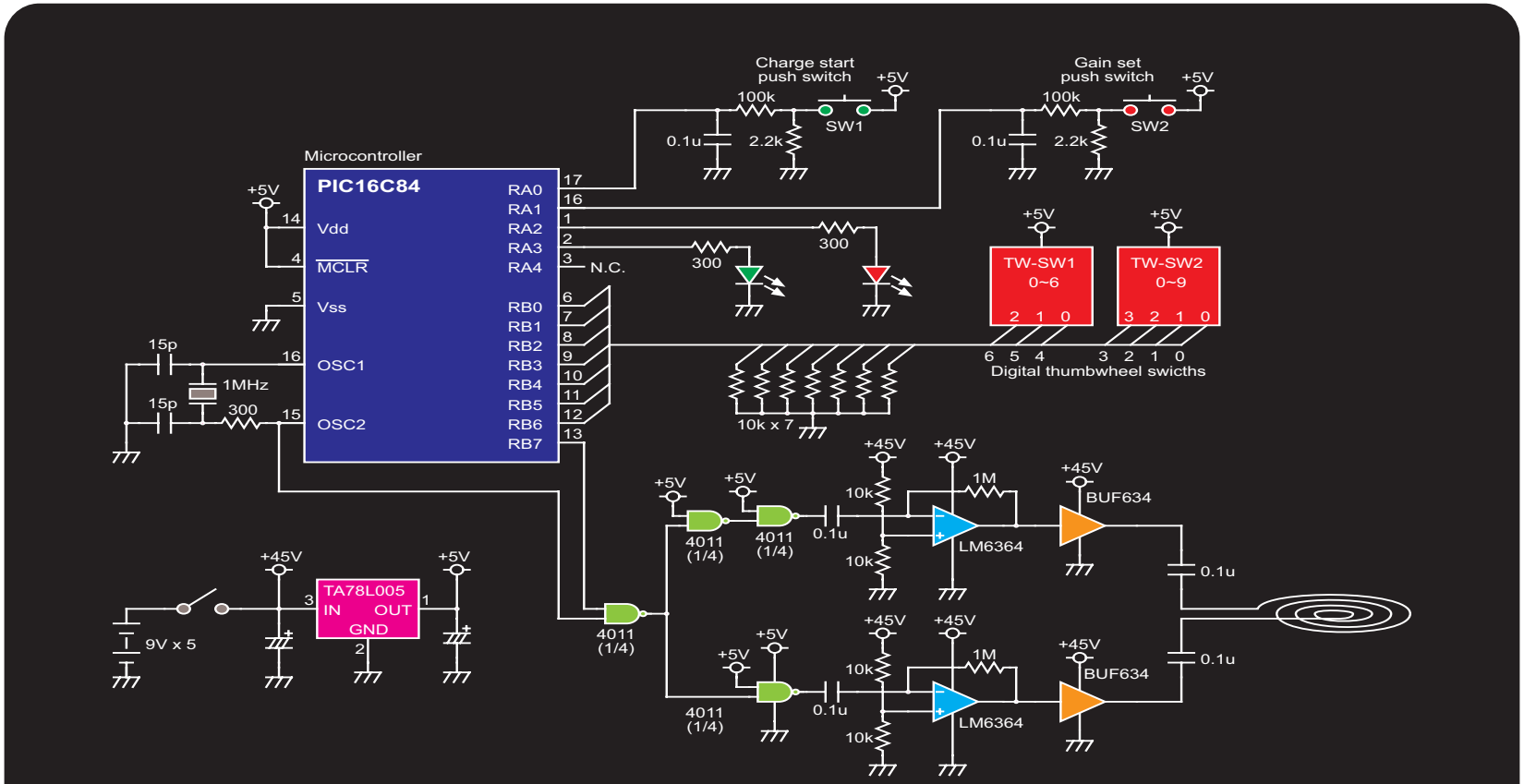

Fig.3 The detailed circuit diagram of the capacitor charging and gain control external unit. The external energy source generates a 45Vp-p pulse wave at 1MHz to driver a primary spiral coil. The microcontroller (PIC16C84) controls the capacitor charge and sets the gain of the NS amplifier in the implantable telemeter. The gain control code is sent by on-off-keying of transmitted power modulated at 144bps.

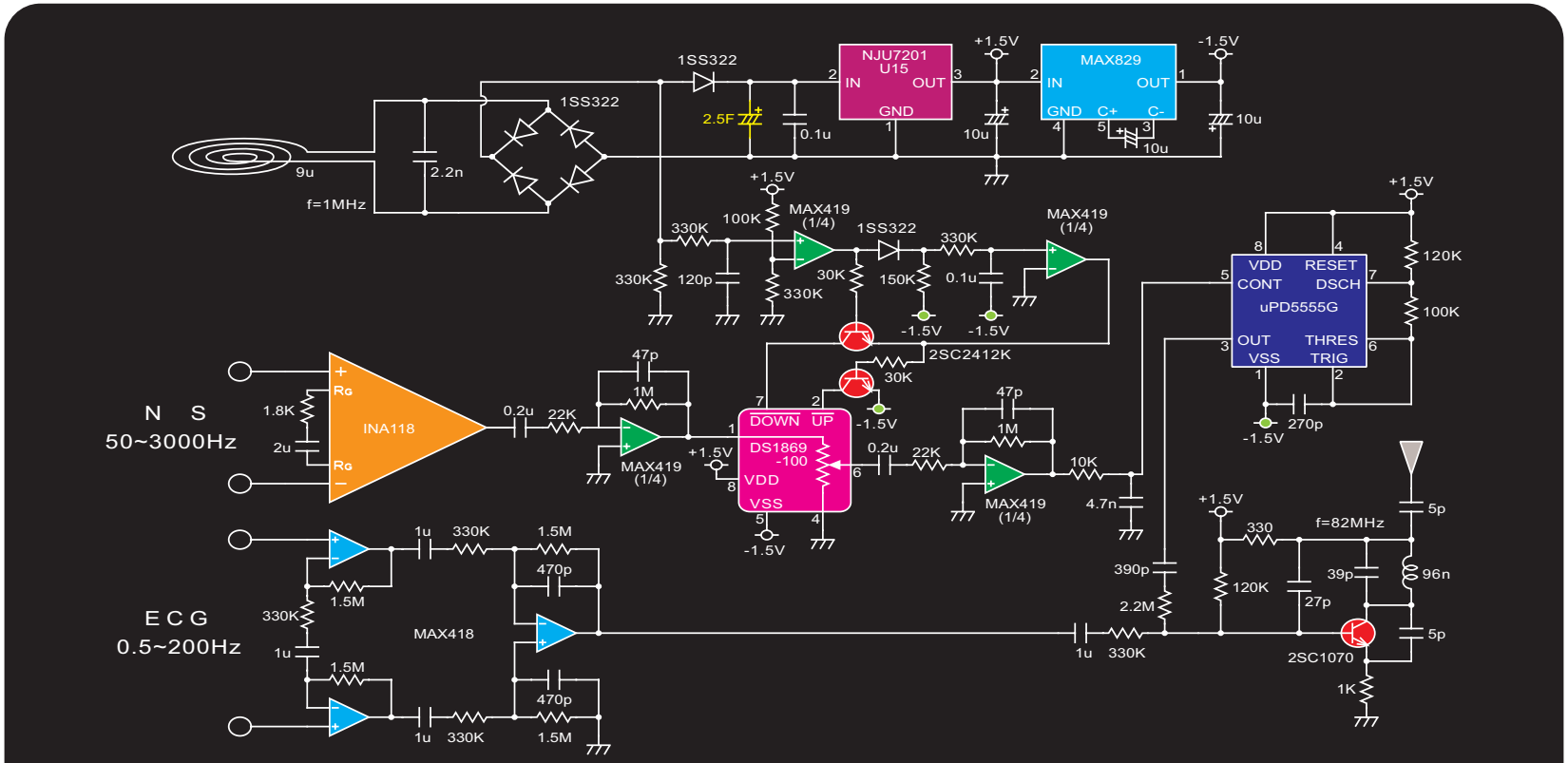

Fig.4 The detailed circuit diagram of the implantable telemeter. The transmitted power charges the 2.5 faraday capacitor. The NS amplifier gain is set by the potentiometer (DS1869) , which is controlled by external on-off-keying of power. A low power V/F converter (uPD5555G) converts the amplified NS to a proportional subcarrier frequency. The V/F converter output and amplified ECG signal are then combined and used to frequency modulate a low power FM transmitter. The power consumption is 3.75mW.

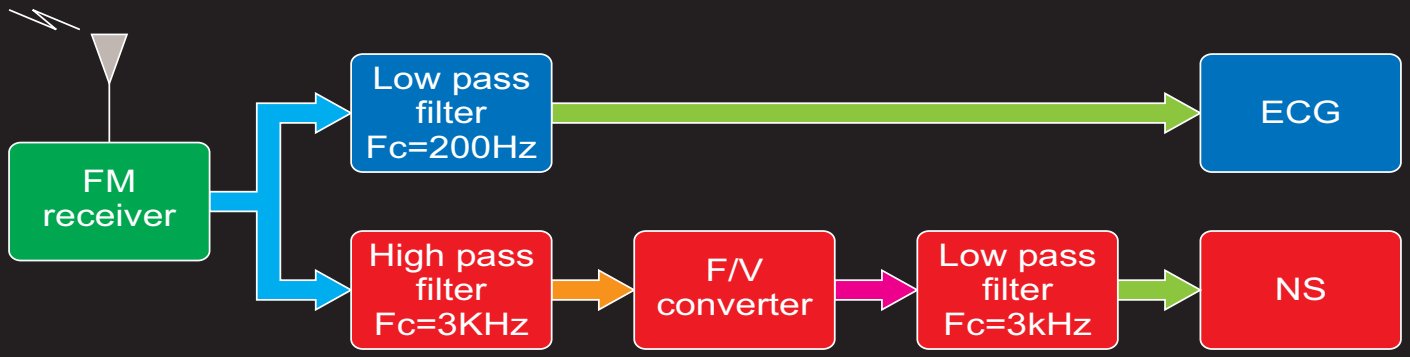

Fig.5 The receiver and demodulator block diagram. The transmitted V/F converter output and ECG signals are received by a modified consumer FM receiver. The ECG signal is separated from 18kHz cardiac sympathetic nerve signal by a low-pass filter. The V/F converter signal is separated by a high-pass filter. A F/V converter, generates a voltage level proportional to the V/F converter frequency. The converted cardiac sympathetic nerve signal is applied to low-pass filter for smoothing.

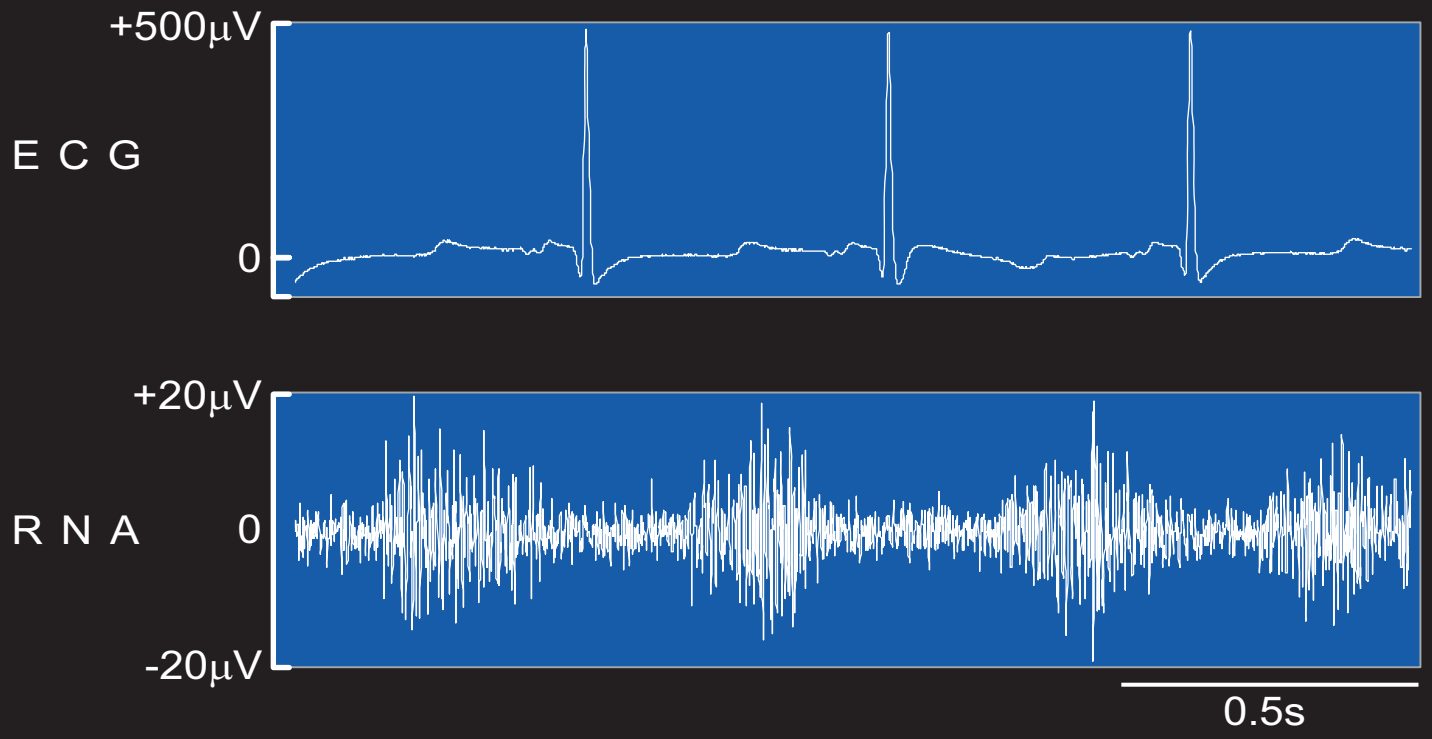

Fig.6 The renal nerve activity (RNA) and ECG recorded from swine. The telemeter package was placed and implanted into the subcutaneous tissue under the back. After power charging in 5 minutes, the RNA and ECG were recorded simultaneously by the developed telemetry system. Discharge patterns of RNA were regular and showed a grouped activity synchronous with cardiac cycle.