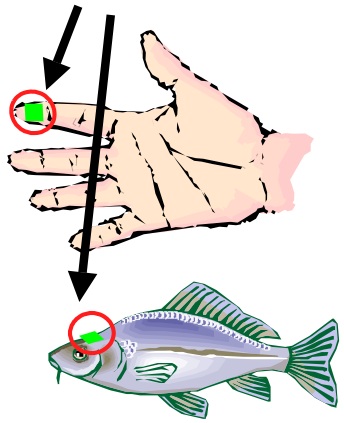
Neural-Sensing LSI with Wireless Interface

T.Yoshida, T. Mashimo, M. Akagi and A. Iwata

Graduate School of Advanced Sciences of Matter, Hiroshima Univ.
E-mail:{tyoshida, takayuki, miho, iwa}@dsl.hiroshima-u.ac.jp

1. Introduction

Neural-Sensing LSI → Applying to experiment on Physiology and Neuroscience, …

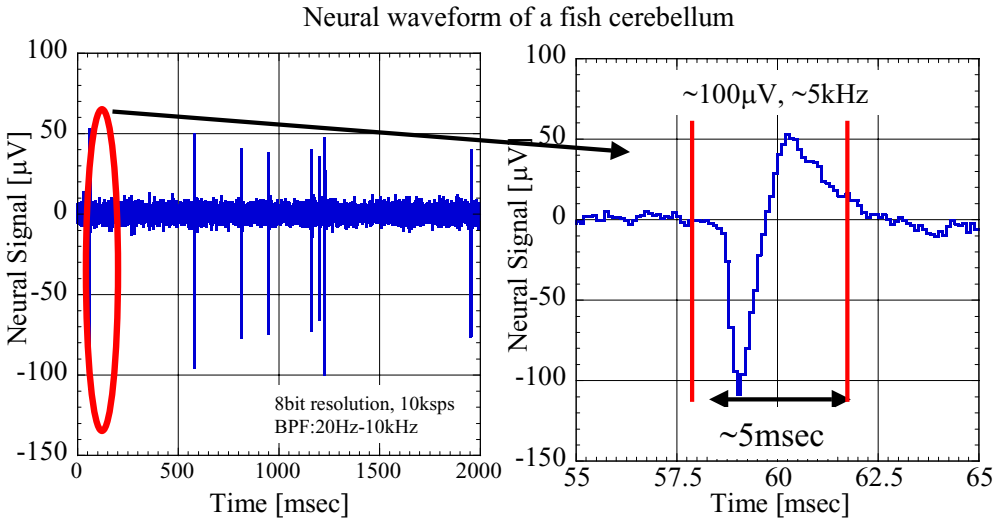


Challenge

Sensing LSI has to achieve:
- High-speed wireless data transmission
- Reduction of a flicker noise
- Decrease in a offset voltage
- Multi-channel observation

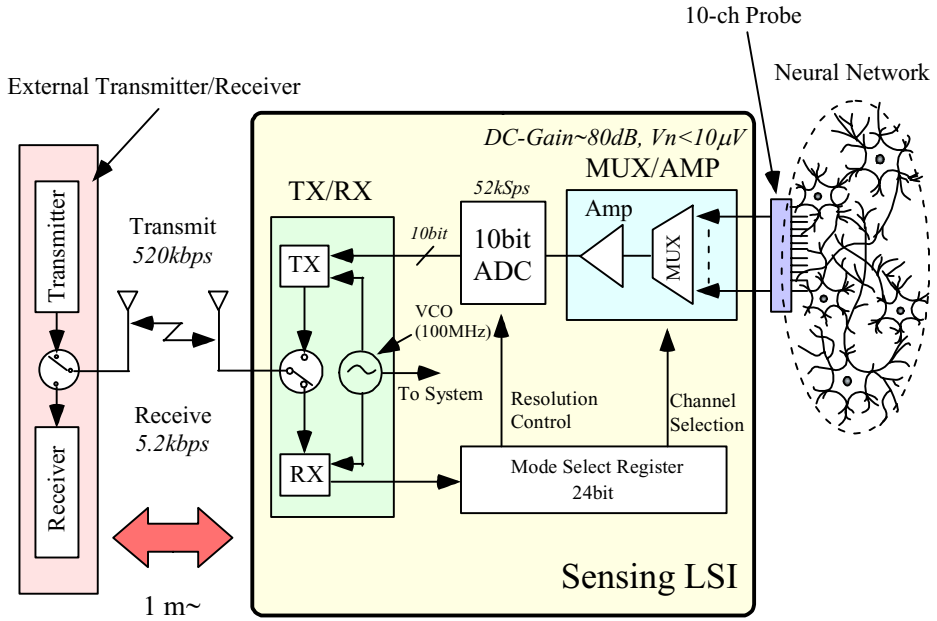
We propose the architecture of wireless neural-sensing system with multi-input-channels.

2. System Requirements

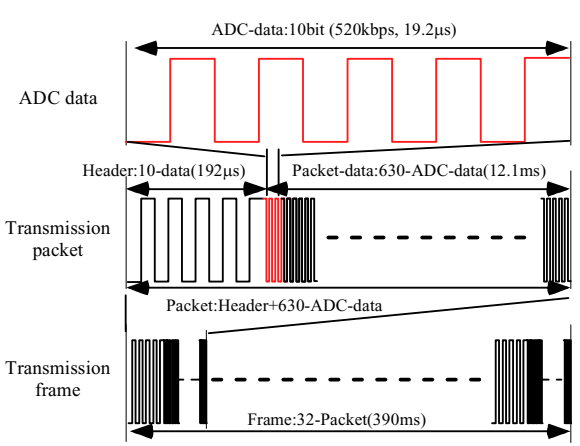


Amplifier:~80dB DC-gain, ~10μV in-band noise.
ADC:More than 8bit accuracy and a sampling rate of 10ksps/channel.
Transmitter:More than 100kbps/channel transmission rate.

3. Neural-Sensing LSI Architecture

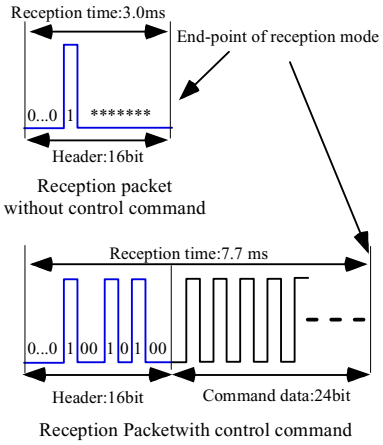


4. Data format of TX/RX



(a)Transmission data format

Transmission packet length > pulse-width of neural signal

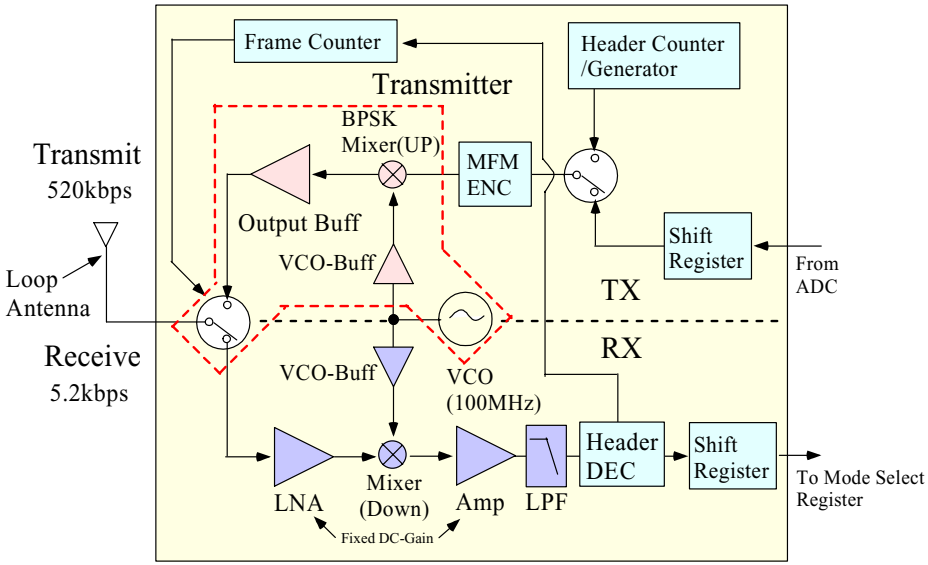


(b)Reception data form

Command data:channel selection, gain control, resolution…

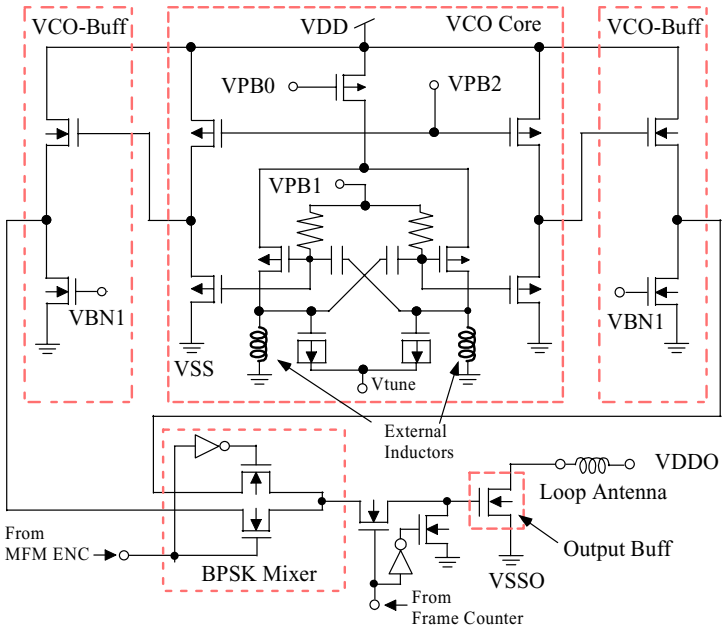
Achievement of the efficiency neural measurement

5. TX/RX Block

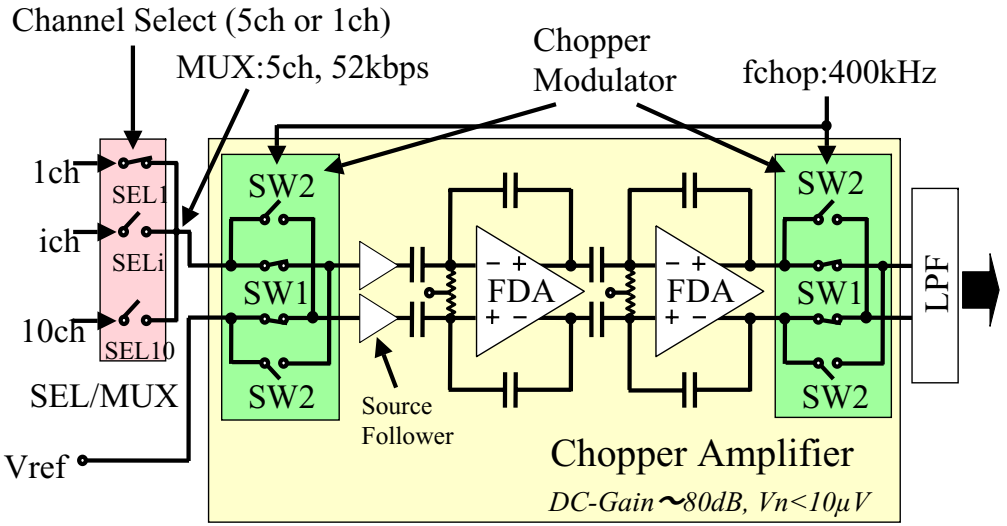


Simplified System → BPSK Modulation, Direct Conversion, Fixed-Gain Amplifier

6. Schematic of transmitter

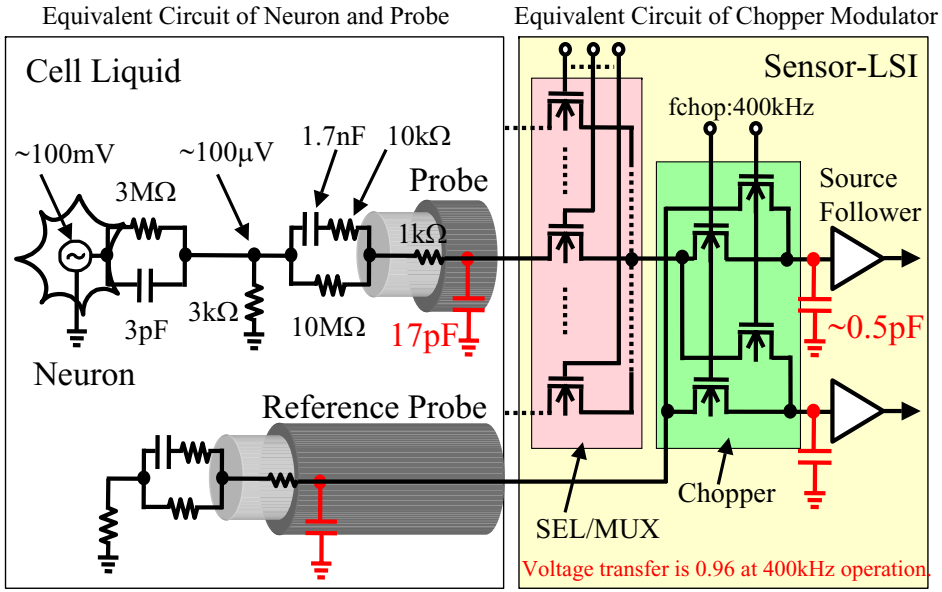


7. MUX/AMP Block



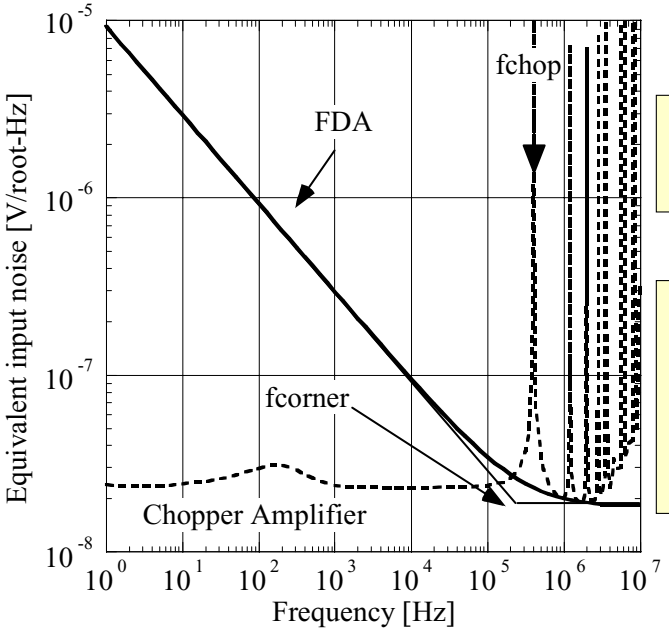
FDA:Fully Differential Amplifier

8. Direct-Chopper-Input Scheme



The chopper amplifier is able to detect a neural signal using this scheme.

9. Equivalent Input Noise (Simulation)



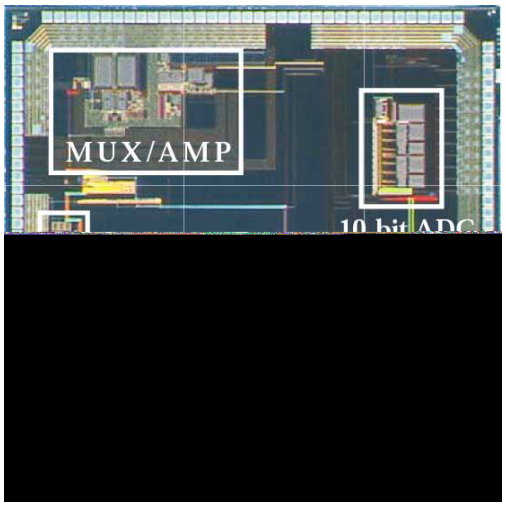
In-band Noise(~100kHz)

FDA
Vnoise=32.9μV

Chopper Amplifier
Vnoise=7.2μV

Equivalent Input Noise
Veq=23nV/root-Hz

10. Microphotograph of a Test-Chip



Technology:0.35-μm mixed-signal CMOS
2-poly 3-metal

Chip Area:4.9 x 4.9 mm^2

Supply Voltage:3.0V

Power Dissipation:6.0mW(MUX/AMP)
1.5mW(TX)

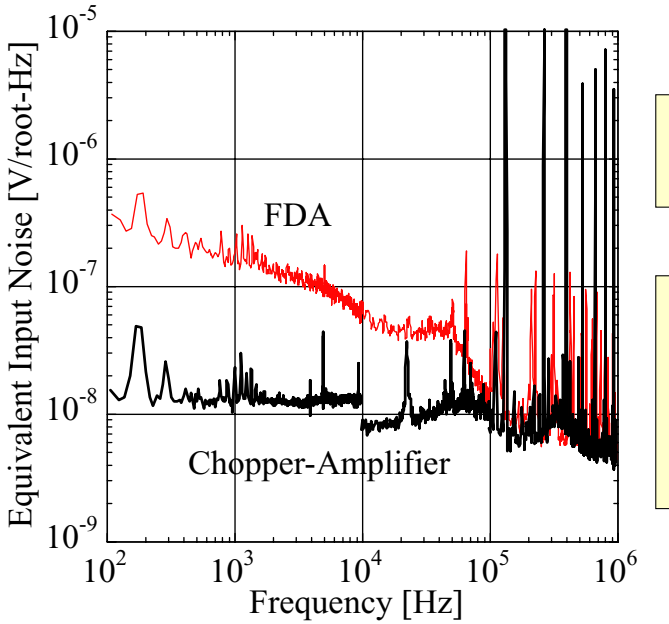
MUX/AMP Block

DC-Gain:66dB
Chopper Frequency:400kHz
Equivalent Input Noise:10nV/root-Hz

Tx Block

Carrier Frequency: 110.6MHz
Transmission Rate:1Mbps

11. Measured Equivalent Input Noise



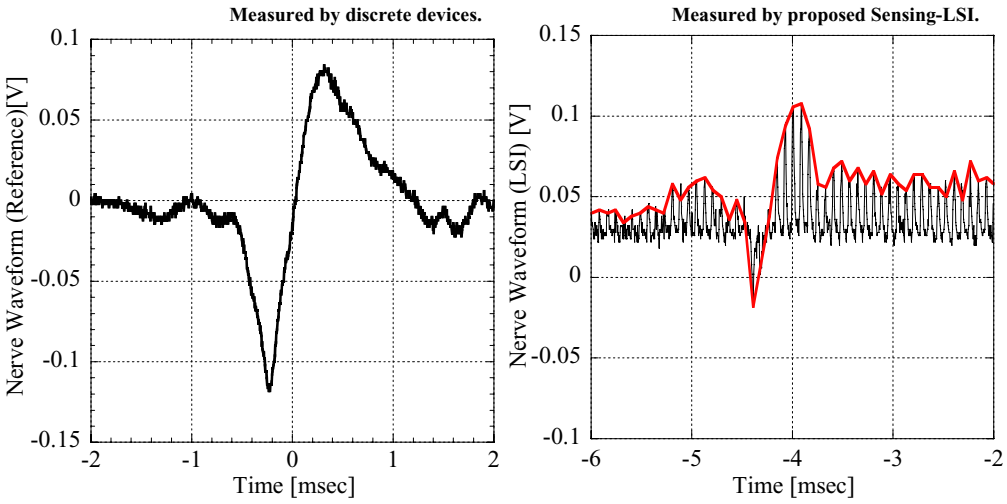
In-band Noise(~100kHz)

FDA
Vnoise=17μV

Chopper Amplifier
Vnoise=3.2μV

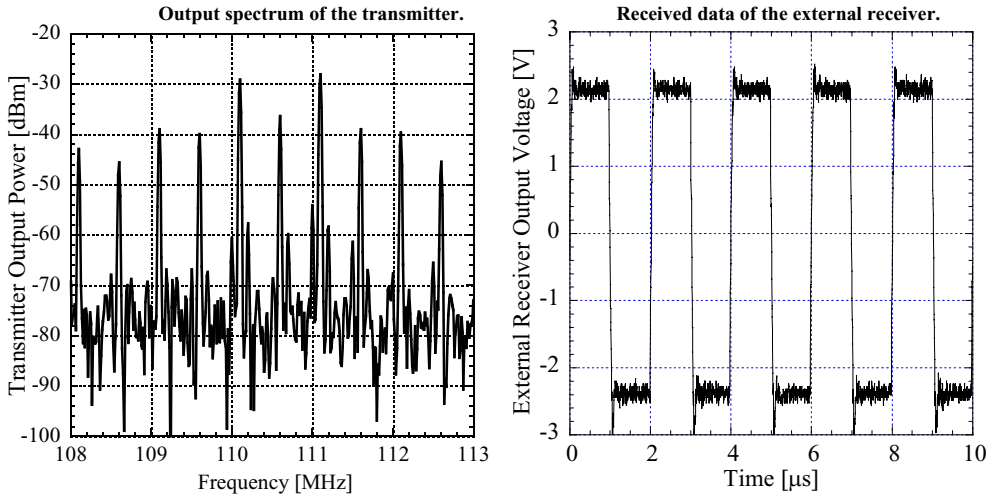
Equivalent Input Noise
Veq=10nV/root-Hz

12. Measured Nerve Fascicle Waveform



Sensing-LSI achieved a detection of real neural signals.

13. Measured Nerve Fascicle Waveform



Sensing-LSI achieved a transmission rate of 1Mbps using the BPSK modulation.

14. Conclusion

The architecture of the wireless neural-sensing LSI with selectable multi-input-channels is proposed.

The chopper-amplifier accomplished with a 3.2μV in-band noise and a measurement of real nerve signal.

The transmitter achieved 1Mbps wireless data transmission with BPSK modulation at a carrier frequency of 110MHz.