

Consultation

R&D Collaboration

Semiconductor
Design and Manufacturing

Nemesis

Precise, Customizable and Intelligent Biosignal
Processing Semiconductor Solutions Provider

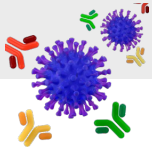
Optimize

We help biotechnologists and healthcare device manufactures to make the most optimized sensors and medical devices.



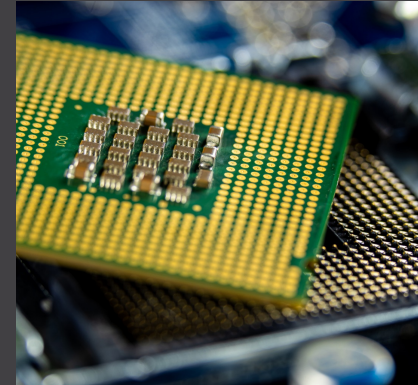
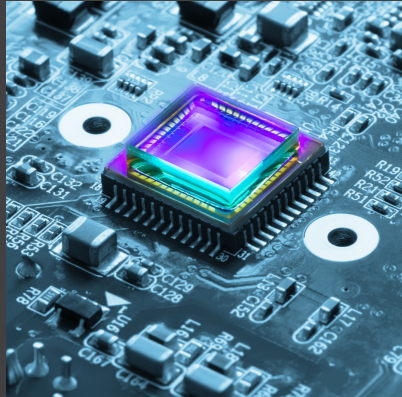
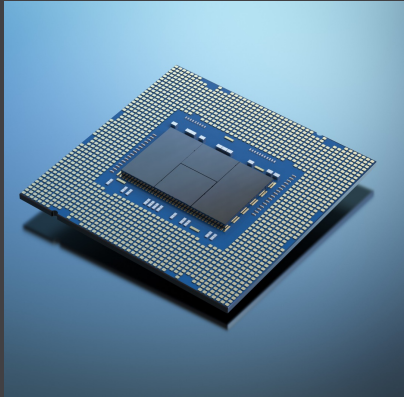
Consult

We consult and solve problems together with our clients when developing biosensors and medical devices so that they can improve and innovate their sensors with best performance and succeed in the market.



Collaborate R&D

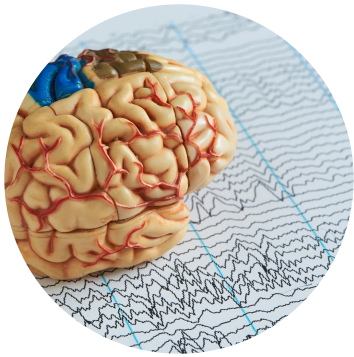
After a comprehensive consultation, we collaborate on Research and Development with our clients leveraging our biosensor development and integrated circuit design expertise.



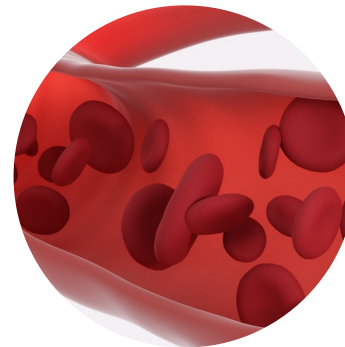
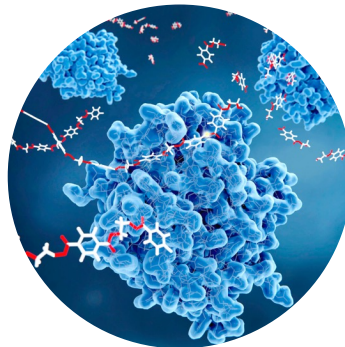
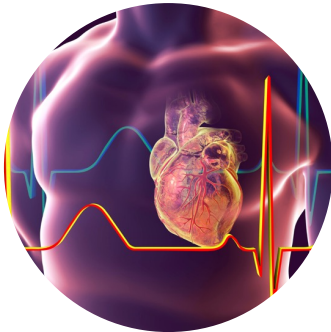
What could be the best chip for your biosensor?

We can help you find the best solution.

Biosensors capture **biosignals** from various vital signs and biomarkers.



Convert to meaningful data



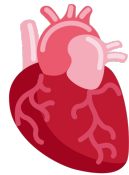
Biosignals are difficult to capture because they are alive and complex.

No Standardized Signal

From Human Body



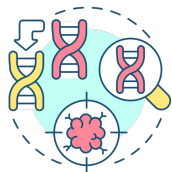
Brainwaves



Heart Rate



Other Vital Signs



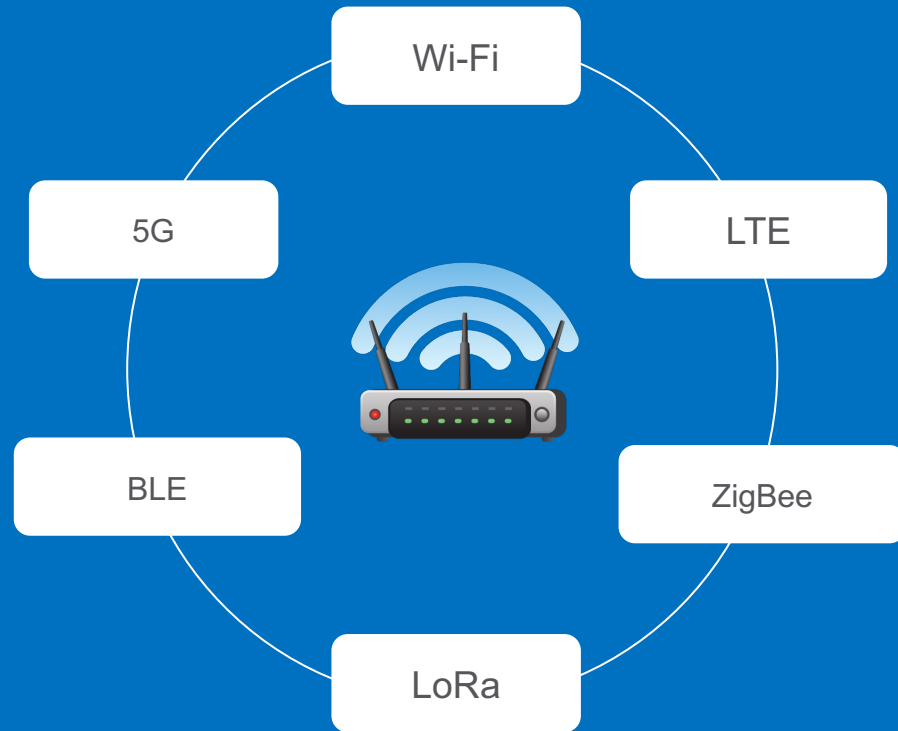
Biomarkers

VS

Wireless signals are easier to capture because of its predictability

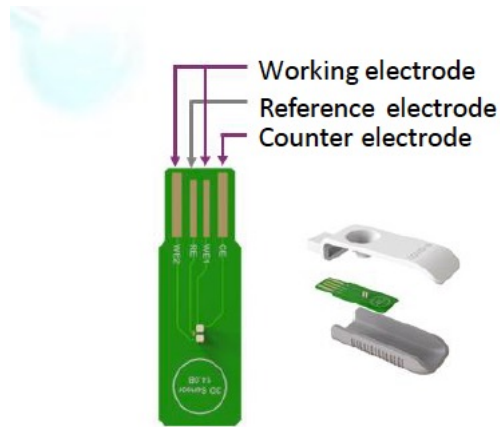
Standardized Signal

Man-made



Translating biosignal into electrical data requires cumulative experience with expert knowledge.

Biosignal processing is complex and delicate

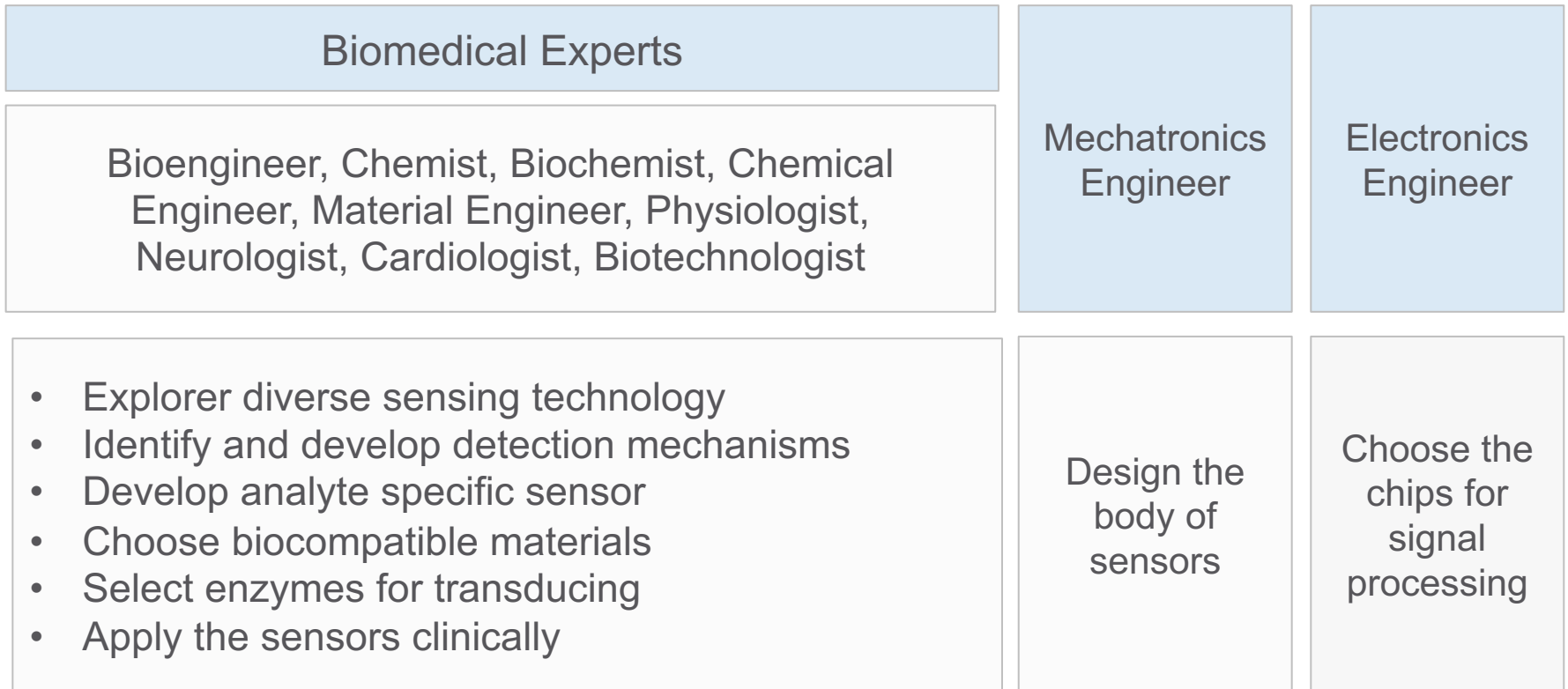


6.5 Electrical Characteristics

minimum and maximum specifications apply from -40°C to $+85^{\circ}\text{C}$; typical specifications are at $+25^{\circ}\text{C}$; all specifications are at $\text{DVDD} = 1.8\text{ V}$, $\text{AVDD} - \text{AVSS} = 3\text{ V}^{(1)}$, $V_{\text{REF}} = 2.42\text{ V}$, external $f_{\text{CLK}} = 512\text{ kHz}$, data rate = 500 SPS, $C_{\text{FILTER}} = 4.7\text{ nF}^{(2)}$, and gain = 6 (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
ANALOG INPUTS					
Full-scale differential input voltage (AINP – AINN)		$\pm V_{\text{REF}} / \text{gain}$			V
Input common-mode range		See the Input Common-Mode Range subsection of the PGA Settings and Input Range section			
Input capacitance		20			pF
Input bias current (PGA chop = 8 kHz)	$T_A = +25^{\circ}\text{C}$, input = 1.5 V			± 200	pA
	$T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$, input = 1.5 V			± 1	nA
DC input impedance	Chop rates other than 8 kHz	See Pace Detect section			
	No pull-up or pull-down current source	1000			M Ω
	Current source lead-off detection (nA), $\text{AVSS} + 0.3\text{ V} < \text{AIN} < \text{AVDD} - 0.3\text{ V}$	500			M Ω
	Current source lead-off detection (μA), $\text{AVSS} + 0.6\text{ V} < \text{AIN} < \text{AVDD} - 0.6\text{ V}$	100			M Ω
PGA PERFORMANCE					
Gain settings		1, 2, 3, 4, 6, 8, 12			
Bandwidth	With a 4.7-nF capacitor on PGA output (see PGA Settings and Input Range section for details)	8.5			kHz
ADC PERFORMANCE					
Resolution		24			Bits
Data rate	$f_{\text{CLK}} = 512\text{ kHz}$	125		8000	SPS
CHANNEL PERFORMANCE (DC Performance)					
Input-referred noise	Gain = 6 ⁽³⁾ , 10 seconds of data	8			μV_{PP}
	Gain = 6, 256 points, 0.5 seconds of data	8		11	μV_{PP}
	Gain settings other than 6, data rates other than 500 SPS	See Noise Measurements section			
Integral nonlinearity	Full-scale with gain = 6, best fit	2			ppm
Offset error		± 100			μV
Offset error drift		2			$\mu\text{V}/^{\circ}\text{C}$
Offset error with calibration		15			μV
Gain error	Excluding voltage reference error	± 0.1		± 0.2	% of FS
Gain drift	Excluding voltage reference drift	2			ppm/ $^{\circ}\text{C}$
Gain match between channels		0.2			% of FS
CHANNEL PERFORMANCE (AC performance)					
CMRR	Common-mode rejection ratio	$f_{\text{CM}} = 50\text{ Hz}$ and $60\text{ Hz}^{(4)}$	105	120	dB
PSRR	Power-supply rejection ratio	$f_{\text{PS}} = 50\text{ Hz}$ and 60 Hz	90		dB
	Crosstalk	$f_{\text{N}} = 50\text{ Hz}$ and 60 Hz	-120		dB
SNR	Signal-to-noise ratio	$f_{\text{N}} = 10\text{ Hz}$ input, gain = 6	107		dB
		10 Hz, -0.5 dBFS, $C_{\text{FILTER}} = 4.7\text{ nF}$	-104		dB

Sensor Designing Process and Roles



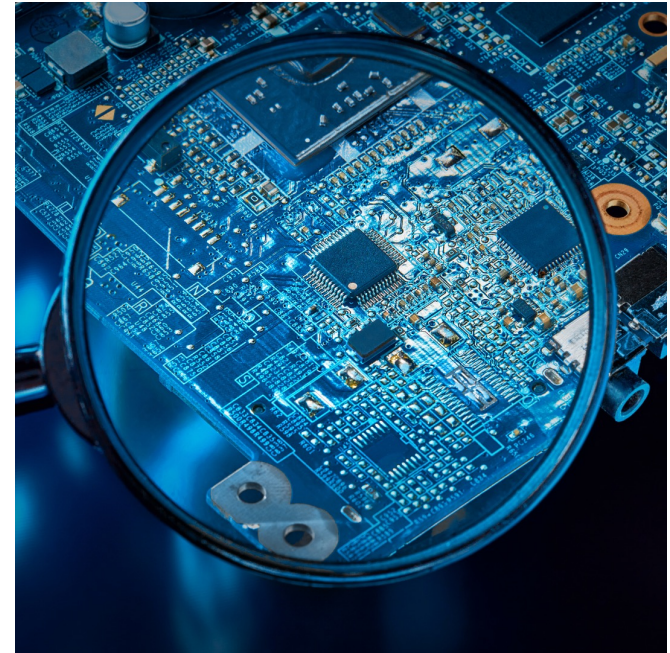
Nemesis Expertise Coverage Area

Other chipmakers operating area →

Nemesis approach is holistic and sequential encompassing both biomedical and semiconductor.



Nemesis is knowledgeable in both biotechnology and semiconductor domains.



Nemesis is an unrivaled semiconductor company that is specialized in biosensor technologies. Our unique approach simplifies chip complexities in the field of bio, allowing us to collaboratively solve problems with our clients.

Here is why

We are seasoned experts in semiconductor and biosensor technologies.

20+ years of accumulated experience in designing and manufacturing chips

100+ mil units supplied to Samsung, SK and LG

Top-notch experts of biosensors and biochips

1st in the world, developed and manufactured Wireless One-chip SoC (Korean Presidential Award Recipient)

Ex-Samsung, LG and SK Hynix semiconductor engineers

Sold RadioPulse, a semiconductor company founded by the current team to a US Nasdaq listed company.

Our Founders' History



Founded
RadioPulse

Achieved +30
Mil Sales only
from RadioPulse



Founded
Nemesis for
biosensors

Until
2002

2003

2006

Until
2014

2015

2017

Team acquired
Ph.Ds and worked
for LG, Samsung,
SK Hynix

Manufactured
Wireless One-chip
SoC, Received
Presidential Award

Sold RadioPulse
to a Nasdaq
Listed Company

Received +5 Mil
Investment

Received +1.5
Mil Private
Research Fund

Other projects
on-going

2019

Until
2022

2022

2022

Until
2023

Biosensor Chip
Launched

Sold
Biosensor Unit

Received
Government
R&D Fund



11



Our Leadership



Sung Ho Wang

CEO, Founder
Ph.D EE, KAIST
20 Years in
Semiconductor
Former CEO,
RadioPulse (Exit)



Luke Kim

CTO, CSO Co-Founder
Ph.D EE, Yonsei Univ.
20 Years in AFE and
semiconductor
Former CTO,
RadioPulse (Exit)



Minkyu Je

Co-Founder
Ph.D EE, KAIST
Biochip, Biosensor,
SoC World-Renowned
Expert



Eric Choi

VP, Sales & Marketing
Former Samsung
Former Cisco

Nemesis's team is a powerhouse in semiconductor and biosensor expertise, making them the go-to specialists in biosignal processing.

Nemesis employees total 26. professionals and 20 R&D Engineers and 3 Sales and Marketing Experts.

We have 9 Ph.Ds and 3 Masters.'

Experts Team

Biotechnology

In Suk Han, Ph.D.

- Chief Advisor
- Ph.D in Biochemistry, Washington State Univ.
- Researched biosensor at Univ. of Michigan
- Faculty, Chemical Engineering and Material Science, Univ. of Utah
- Developed Glucose biosensor, CEO, M-biotech

Hyuckhan Kim, Ph.D.

- Biosensor Expert
- Developed sensing materials
- Prof. of Chemistry at Dankuk University
- Ph.D in Chemistry, UC Davis, USA

Jaeha Kung, Ph.D.

- Advisor
- Machine Learning Algorithms Development
- Professor of Electrical Engineering, Korea Univ.
- Ph.D in Eletronics Engineering, Georgia Institute of Technology

Semiconductor

Luke Kim, Ph.D.

- CTO, Co-Founder
- System on Chip Design Expert (+20 Years)
- Ph.D. in Electrical Engineering, Yonsei University

Minkyu Je, Ph.D.

- Technical Advisor
- Biochips, Biosensor, System on Chip Design Expert
- Integrated Microsystems Powered with Advanced Circuit Technologies Lab
- Ph.D. in Electrical and Electronics Engineering, KAIST

Joonho Gil, Ph.D.

- Co-Founder
- Biosignal Processing Chip and System on Chip Design Expert
- Ph.D. in Electrical and Electronics Engineering

Team's Relevant Papers and Patents

- Impedance-Readout Integrated Circuits for Electrical Impedance Spectroscopy: Methodological Review, SI Cheon, H Choi, H Kang, JH Suh, S Park, SJ Kweon, M Je, S Ha, IEEE Transactions on Biomedical Circuits and Systems, 2023
- Wireless power and data transmission and reception apparatus, JE Minkyu, P Yechan, C Kim, ST Koh, LEE Jeongeun, H Kim, C Jaesuk, US Patent App. 17/673,164, 2023
- A 15.4-ENOB, Fourth-Order Truncation-Error-Shaping NS-SAR-Nested Modulator With Boosted Input Impedance and Range for Biosignal Acquisition, K Jeong, S Ha, M Je, IEEE Journal of Solid-State Circuits, 2023
- A Wireless and Wearable Body-Pressure-Monitoring System for the Prevention of Pressure-Induced Skin Injuries, H Park, K Kim, SJ Kweon, O Gul, J Choi, YS Oh, I Park, M Je, IEEE Transactions on Biomedical Circuits and Systems, 2023
- A Wide-Bandwidth Ultrasound Receiver and On-Chip Ultrasound Transmitter for Ultrasound Capsule Endoscopy, K Jeong, G Yun, J Choi, I Choi, J Son, JY Hwang, S Ha, M Je, IEEE Journal of Solid-State Circuits, 2023
- Trend Investigation of Biopotential Recording Front-End Channels for Invasive and Non-Invasive Applications, T Lee, M Je, arXiv preprint arXiv:2305.13463, 2023
- An Energy-Efficient, Scalable Neural Stimulation IC with Adaptive Dynamic Voltage Switching for Cochlear Implant System, W Ahn, KH Nguyen, J Lim, KS Min, H Lee, S Ha, M Je, 2023 IEEE International Symposium on Circuits and Systems (ISCAS), 1-5
- A Batteryless Electrochemical Sensing System IC Based on Intra-Body Power and Data Transfer Towards Miniaturized Wearable Sensor Nodes, JH Suh, H Cho, Y Jeon, M Je, 2023 IEEE International Symposium on Circuits and Systems (ISCAS), 1-5
- Battery-Free, Wireless, Cuff-Type, Multimodal Physical Sensor for Continuous Temperature and Strain Monitoring of Nerve, S Kim, YS Oh, K Lee, S Kim, WY Maeng, KS Kim, GB Kim, S Cho, H Han, Small, 2206839, 2023

Team's Relevant Papers and Patents

- A 16-channel Impedance-Readout IC with Synchronous Sampling and Baseline Cancellation for Fast Neural Electrical Impedance Tomography, JH Suh, H Choi, Y Jung, S Oh, H Cho, N Koo, SJ Kim, C Bae, S Ha, M Je, IEEE Solid-State Circuits Letters, 2023
- Battery-Free, Wireless, Ionic Liquid Sensor Arrays to Monitor Pressure and Temperature of Patients in Bed and Wheelchair, H Han, YS Oh, S Cho, H Park, SU Lee, K Ko, JM Park, J Choi, JH Ha, Small 19 (9), 2205048, 2023
- Wireless, multimodal sensors for continuous measurement of pressure, temperature, and hydration of patients in wheelchair, S Cho, H Han, H Park, SU Lee, JH Kim, SW Jeon, M Wang, R Avila, Z Xi, npj Flexible Electronics 7 (1), 8, 2023
- Impedance measuring apparatus, W Lee, SUH Ji-Hoon, JE Minkyu, SJ Kim, US Patent 11,543,443, 2023
- A High-Efficiency Single-Mode Dual-Path Buck-Boost Converter With Reduced Inductor Current, D Cho, H Cho, S Oh, Y Jung, S Ha, C Kim, M Je, IEEE Journal of Solid-State Circuits 58 (3), 720-731
- Magnetic component connector, circuit boards for use therewith, and kits for building and designing circuits, IS Han, DK Lim, I Park, US Patent 7,611,357, 2009
- Separation of the effects of pH and polymer concentration on the swelling pressure and elastic modulus of a pH-responsive hydrogel, F Horkay, MH Han, IS Han, IS Bang, JJ Magda, Polymer 47 (21), 7335-7338, 2006
- Polymer matrix containing catalase co-immobilized with analytic enzyme that generates hydrogen peroxide, IS Han, DY Jung, US Patent 6,858,403, 2005
- Methods and compositions for use of catalase in hydrogels and biosensors, IS Han, DY Jung, US Patent App. 09/824,552, 2005
- Photometric glucose measurement system using glucose-sensitive hydrogel, IS Han, S Lew, MH Han - US Patent 6,835,553, 2004

Team's Relevant Papers and Patents

- Temperature-dependent transparency of poly (HPMA-co-DMA) hydrogels: effect of synthesis parameters, MH Han, JW Kim, J Kim, JY Ko, JJ Magda, IS Han, Polymer 44 (16), 4541-4546, 2003
- Hydrogel biosensor, IS Han, JJ Magda, SL Lew, Y San Jean - US Patent 6,514,689, 2003
- Glucose biosensor, IS Han, YH Bae, JJ Magda - US Patent 6,475,750, 2002
- Biosensor, IS Han, YH Bae, JJ Magda, SG Baek - US Patent 6,268,161, 2001
- Constant-volume hydrogel osmometer: a new device concept for miniature biosensors, IS Han, MH Han, J Kim, S Lew, YJ Lee, F Horkay, JJ Magda, Biomacromolecules 3 (6), 1271-1275, 2002
- ReplaceNet: real-time replacement of a biological neural circuit with a hardware-assisted spiking neural networkS Hwang, Y, Hwang, D Kim, J Lee, HK Choe, J Lee, H Kang, J Kung, Frontiers in Neuroscience 17, 1161592, 2023
- Hardware accelerator for performing computations of deep neural network and electronic device including the sameSH Noh, JH Kung, JH Koo, US Patent App. 18/155,863
- DBPS: Dynamic Block Size and Precision Scaling for Efficient DNN Training Supported by RISC-V ISA ExtensionsS Lee, J Choi, S Noh, J Koo, J Kung, 2023 60th ACM/IEEE Design Automation Conference (DAC), 1-6, 2023
- FlexBlock: A flexible DNN training accelerator with multi-mode block floating point support, SH Noh, J Koo, S Lee, J Park, J Kung, IEEE Transactions on Computers, 2023
- LightNorm: Area and Energy-Efficient Batch Normalization Hardware for On-Device DNN Training, SH Noh, J Park, D Park, J Koo, J Choi, J Kung, 2022 IEEE 40th International Conference on Computer Design (ICCD), 443-450, 2022

Technical Excellence I

Impedance Boosting

By increasing the input impedance, vital signs can be measured without direct skin contact.

Wide Dynamic Range

Accuracy increases as the accepted range of input signals is wide.

Multi-modal Interface

Several biosensor signals can be processed with one chip.

High Fidelity

Resolution is increased with our unique analog signal processing technology.

EEG, ECG, EMG, Bio-Z, Electro-chemical

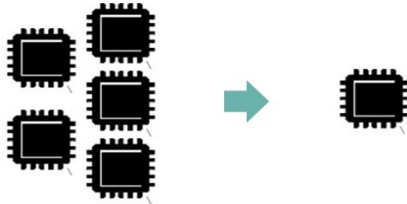
Various biomarkers and vital signs can be processed.

Tiny Machine Learning

Intelligence functions can be enabled with our machine learning algorithms built on the chip.

Technical Excellence II

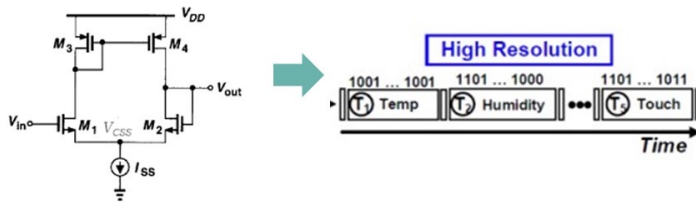
High Quality Low Power Analog Circuit Design Skills



Multi-modal Sensing: achieve smaller chip size



Wide Input Signal Range: achieve high resolution



Time Based Circuit: achieve low power and high resolution

In Addition
Creative Problem Solving Skills

Nemesis Patents

	Issue Date	Application #	Registration #	Patent Title
1	2018.07.27	10-2018-0087841	10-2081155	Sensor interface device with low power and high precision
2	2018.10.29	10-2018-0129766	10-2128811	Photo sensor having wide dynamic range
3	2018.11.16	10-2018-0141418	10-2098700	Photo sensing device with having improved dynamic range and noise resistant property
4	2020.01.16	10-2020-0005957	Pending	Reference voltage-current generating circuit
5	2020.02.07	10-2020-0014800	10-2301722	Time-digital convertor having low power consumption and high precision
6	2020.03.10	10-2020-0029785	10-2323135	Digital temperature sensor capable of reducing size
7	2020.05.22	10-2020-0061298	10-2312597	Glucose sensing device for reducing noise effect
8	2020.10.15	10-2020-0133124	10-2435495	Capacitance sensing device for improving sensing accuracy
9	2020.10.30	10-2020-0142625	Pending	Band pass modulator capable of controlling passing frequency band
10	2021.07.17	10-2021-0093838	10-2391015	Glucose sensing device for having wide sensing range and low noise effect
11	2021.08.03	10-2021-0101839	Pending	Method for manufacturing biosensor and biofuel cell including working electrode
12	2021.11.30	10-2021-0168043	Pending	Pre-charge circuit employing the Pre-charge method
13	2021.12.28	10-2021-0189924	Pending	Impedance measuring apparatus and impedance measuring method
14	2022.05.03	PCT/KR2022/005898	Pending	Pre-charge circuit employing the Pre-charge method

Our Projects I

Client A:

- They are developing continuous blood glucose monitoring device (CGMS) as the next product.

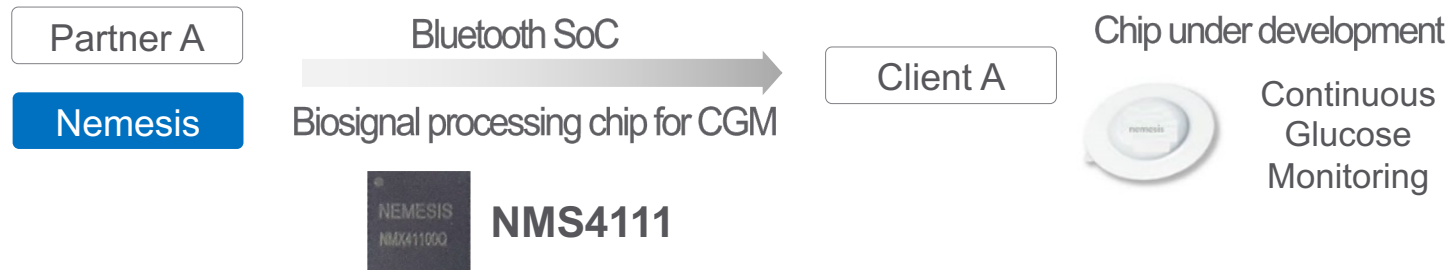
General Challenges:

For a competitive CGMS, the following challenges must be addressed:

- Small size less than the size of a quarter coin in diameter
- Increasing usage time with low power consumption
- Lower cost
- Enhancing blood sugar sensing accuracy by increasing chip resolution
- Convenience of calibration with intelligent functions
- Multi-sensing to monitor multiple biomarkers
- Secure new intellectual property rights

Our Projects I

Healthcare device manufacturers do not have semiconductor solutions, and semiconductor companies are not familiar with biosensors. Nemesis is the only semiconductor company that knows both blood sugar sensors and semiconductors well. It was selected after several months of verification and provides consulting and customization services.



Solutions:

- After verification of the glucose biosensor developed by Nemesis, Client A acquired the technology through the acquisition of the Nemesis sensor team.
- The first generation product currently developed uses other major chipmaker's chips and existing issues have not been resolved.
- The 2nd generation product is scheduled to use the Nemesis chip, and a chip that solves issues is being developed.
- Nemesis develops and supplies a dedicated chip for Client A, and is currently in process after completing the prototype design.

Our Projects II

Client B:

Low power bioimage processing chip solution



Our Projects III

Client C:

ECG and multi-vital sign monitoring chip solution

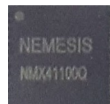
Multi vital sign monitoring chip
for smart watch and TWS

Nemesis



Client C

Development under discussion



NMS1111



Smart Watch,
TWS, Smart Band

Other Clients:

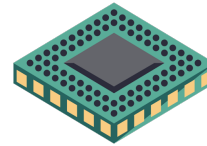
Innovative PCR Sensor Solution, Innovative ECG Sensor, CGMS Patch

Benefits of Nemesis Solutions

Long Battery Life



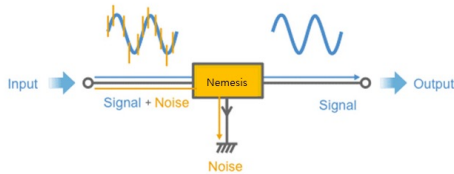
Smaller Size



Lower Costs



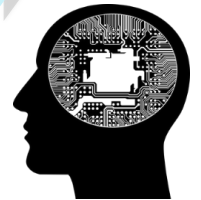
Optimized Bio-signal Processing



Consultation Customization



Accurate Data Processing



Applications



CGM Patch



ECG Patch



EEG Band



TWS

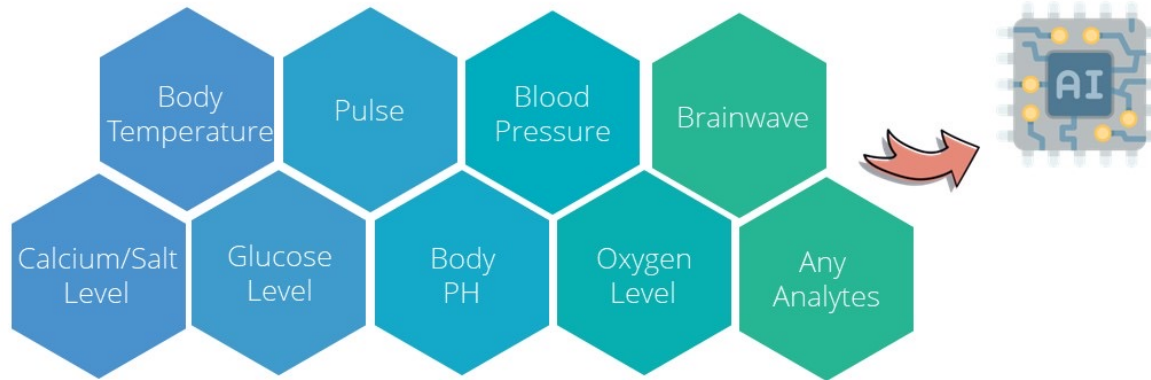


Smart Watch



Smart Band

Long-term digital healthcare solution application areas



Consultation

Customization
R&D

Chips Design and
Manufacturing

Optimize

Contact us
At Our Korea Office

Nemesis

Your Trusted Intelligent Bio-Signal Processing Solutions Partner

If you are interested in learning more about our products and technology, contact us at

sophie.lee@nemesis.kr

Thank you.



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