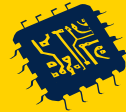# Biosensors for well-being and healthcare

Challenges for sensors in well-being and healthcare

- Multiple parameters & non-invasive sensing
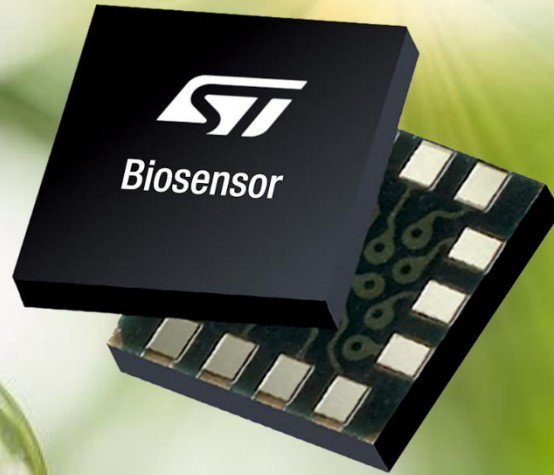- Small size, reliable, and low cost
- Accuracy and precision
- Low power consumption
- Data security

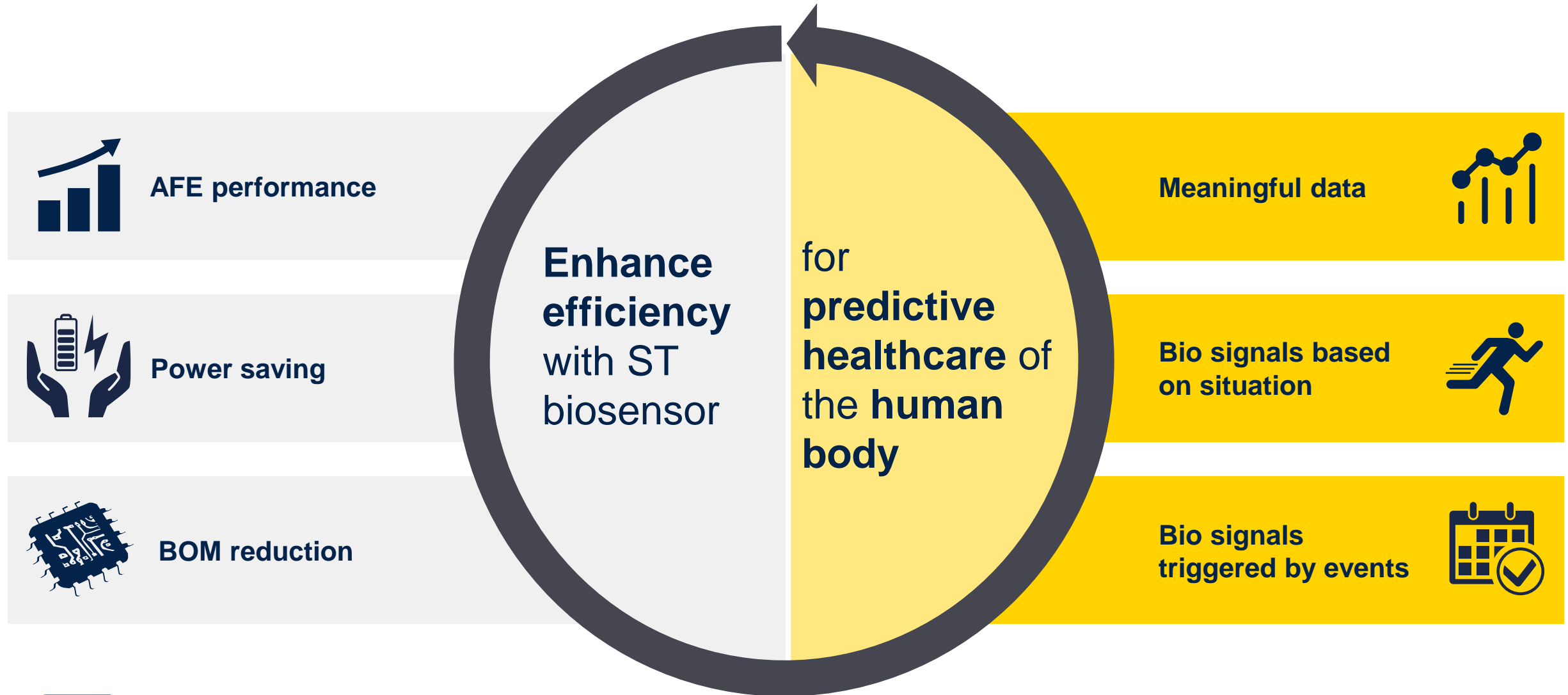# A novel class of MEMS sensors
The biosensors

Biosensors featured with vertical analog front end

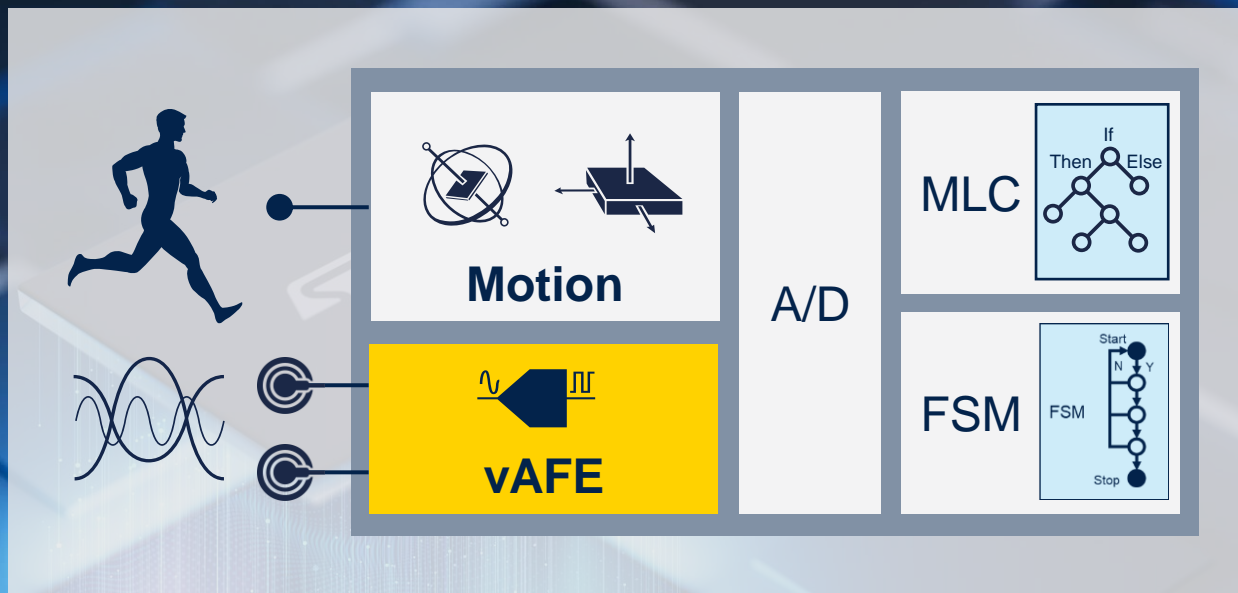The first MEMS sensor embedding a **vertical analog front end** (vAFE) and a **motion MEMS**

Expanding the range of applications **beyond the usual target market segments**

A new sensor technology for digital healthcare and vital signs monitoring

vAFE, a specific analog circuit implemented into the MEMS sensor and capable to detect **bio-signals** through connected electrodes

Full synchronization of **analog** input channel with **motion** MEMS sensing channels. Data available to **FSM*** and **MLC*** embedded resources

*FSM = finite state machine

*MLC = machine learning core

Comparison: vertical AFE vs general purpose AFE

vertical AFE

Enabling interaction with the external analog world for fitness and wellness, and medical applications

- Optimized for a dedicated task
- Unique blending of analog signals & motion information
- Embedded processing in MEMS sensor offloading the microcontroller
- Leverage MEMS sensor embedded ecosystem, including MLC
- Simple to use

Suitable for portable and wearable devices

VS

General purpose AFE

Standalone analog device for medical applications

- Multi-purpose applications
- Standalone device
- Need for an external microcontroller
- Complex to use
- Costly device

Suitable for medical devices and applications

Which attributes for biosensors?

Synchronization

Biopotential and **motion** signals are intrinsically **synchronous.**

Unique **context-aware analysis and artifact removal** with **in-sensor AI.**

Miniaturization

Integrates biopotential & motion information measurement system in a **compact form factor.**

Vital signs monitoring, healthcare, and gesture detection **in any wearable device.**

Efficiency

Ultralow power consumption: few µA to record and process information.

Analysis **at the edge**, leveraging in-sensor AI features, **offloading the microcontroller**

Enhance efficiency with ST dual-function biosensor that **monitors movement and bio signals**, paving the way for **predictive healthcare of the human body**

Human-centered biosensors in applications

- Electrocardiography (ECG)
- Electroneurography (ENG)
- Electroencephalography (EEG)
- Seismocardiography (SCG)

Smartwatch		Chest band
TWS		AR / VR
Headphone		Smart glasses
Smart ring		Helmet

Embedding a low noise vAFE + ultralow power accelerometer

Product status

Mass market ready

LGA-12L
2.0 x 2.0 x 0.74 mm

Applications

- Heart monitoring
- Cognitive status
- Gesture recognition

Ultralow power consumption ~ 50 µA

Adjustable amplifier gain 2x / 4x / 8x / 16x

Low input noise 10 µV @ 20 Hz – 400 Hz (gain 16x)

Processing in the edge **Embedded FSM, MLC & ASC**

Ultralow power 3-axis smart accelerometer

Embedding a vAFE* + low power IMU

Product status

Mass market ready

LGA-14L
2.5 x 3.0 x 0.71 mm

Applications

- Heart Rate Monitoring (HRM)
- ECG & SCG

Low power vAFE	15 µA on top of IMU consumption
Configurable input impedance	from 235 MΩ to 2.4 GΩ
Wide input range	±460 mV
Processing in the edge	Embedded FSM, MLC & ASC, SFLP
Low power, low noise 6x IMU	

(*) Pre-amplification needed for low level biopotential signals

Biosensors for heart analysis and monitoring (ECG)

**Healthy status indicators can be derived by ECG measurements**

User healthy classification based on ECG

ECG interpretation based on user activity

ECG is used for triggering other measurements

Biosensing platform for cardio monitoring (ECG & SCG)

ST & DuPont reference design platform for intelligent and context-aware electrocardiography and seismocardiography
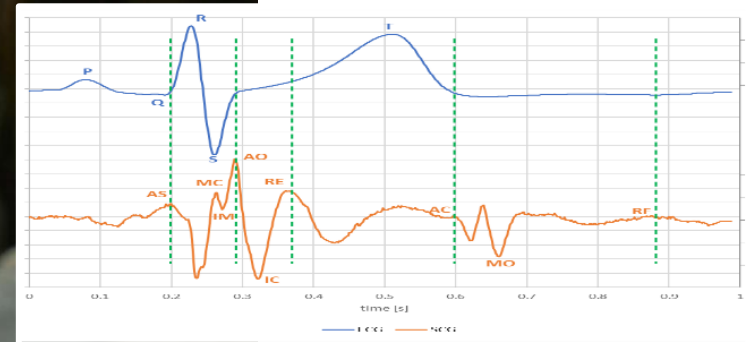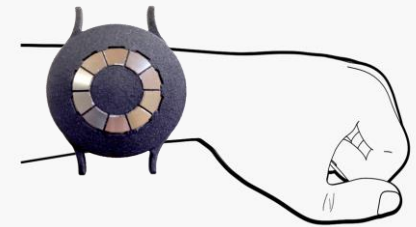
Biosensor for electroneurography (ENG)

Introducing the next generation of user interface experience

Biosensor and patented **electroneurography** (**ENG**) techniques by Pison to create a touchless, gesture-based HMI

In addition to gesture recognition, **cognitive readiness and mental agility** can be evaluated through ENG signal

Any smartwatch or wearable can be infused with the power of biosensor giving users virtually unlimited and effortless command of their environments

PISON

Biosensor for electroencephalography (EEG)

Real-time, accurate, cognitive, and emotional information, using wearable devices and sensors

Mental healthcare and wellness

Real-time emotional response

Attention and cognitive status

ST's biosensors: the breakthrough for digital health

Biosensor's key benefits

Unique blending of vital signs & motion signals in a very compact form-factor
Integration in a standard small package of a fully synchronized biopotential & motion information measurement system, for a unique context-aware vital signs monitoring in any wearable device

Hi-Fi biopotential sensing
The embedded high performance analog front end (AFE) measures the weakest body signals with high fidelity
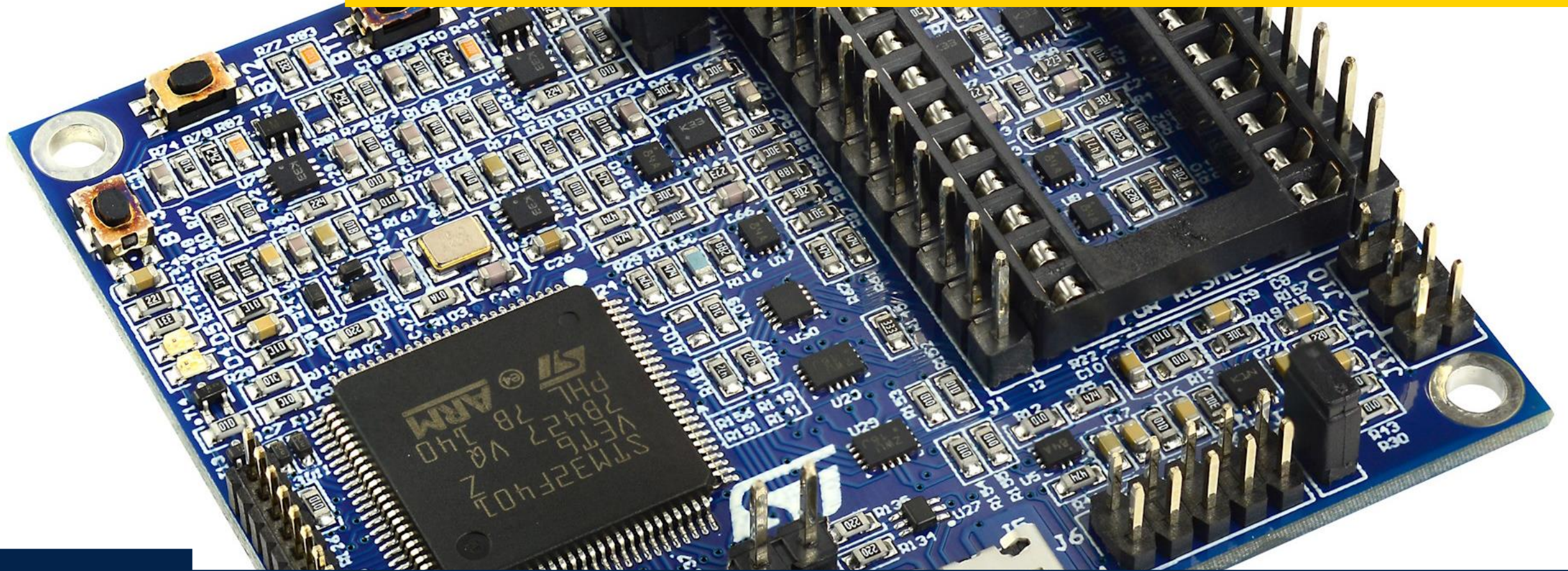
Ultralow power consumption
Few µA to record and process biopotential signals & motion information enabling continuous monitoring in daily life

Edge AI
Preprocessing data, reducing system-level power consumption and data transfers

MEMS ecosystem offer for biosensors

ST ecosystem supporting learning and prototyping for biosensors

Biosensor's ecosystem deliverables for a ready-to-go solution

Hardware

Professional MEMS tool	DIL24 adapter boards

Application example

ECG & HBR by chest

ECG & HBR by fingers

Development tools

MEMS Studio & BIO_VSM library

Professional MEMS tool
(STEVAL-MKI109V3 or STEVAL-MKI109D)

ECG through chest

Custom adapter for chest leads
(3.5 jack connection)

ST1VAFE6AX	ST1VAFE3BX
STEVAL-MKI242A (jack connection)	STEVAL-MKI250KA (kit for both jack connection and fingers)
STEVAL-MKI249KA (for fingers)	

ECG through fingers

Additional adapters for fingers electrodes (direct fingers contact)

Our technology starts with You

🌐 Find out more at st.com/biosensors

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