NEOXA 3 – Research & Technology Scouting Report

**Last Updated:** 16/07/2025  
**Version:** 1.0

**1. Document Objective**

This report compiles technical findings, product references, datasheets, and evaluations related to the development of the NEOXA 3 system. The goal is to support internal tracking, component selection, design validation, and communication with future collaborators or design teams.

**2. System Overview**

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AI-generated content may be incorrect.

**Key Modules:**

* EEG Acquisition (8-channel, low-noise AFE)
* PPG (Red/IR/Green photoplethysmography)
* Audio (bone conduction)\*\*
* SoC with BLE and onboard processing
* Local data storage
* Power management unit (PMIC)

**3. Component Scouting Summary**

**3.1 EEG Analog Front Ends (AFE)**

| **AFE** | **Supplier** | **Channels** | **ADC** | **Notes** |
| --- | --- | --- | --- | --- |
| ADS1299 | TI | 8 | 24-bit | Low noise, used in EEG research |
| ADS1298 | TI | 8 | 24-bit | Similar to 1299, ECG compatible |
| RHD2000 | Intan | 16–64 | 16-bit | Advanced, higher complexity |
| ADAS1000 | Analog Devices | 5 ECG/EEG | 24-bit | Multi-biosignal option |

→ **Selected candidate:** TI ADS1299 (low-noise, multi-channel EEG)

**3.2 PPG AFE Options**

| **AFE** | **Supplier** | **Notes** |
| --- | --- | --- |
| MAX30101 | Maxim | Integrated LEDs & ADC |
| AFE4404 | TI | Very low power, full control |
| MAX86140 / 86176 | Maxim / AD | High accuracy, motion-resistant |
| SFH7072 | Osram | Red, IR, Green LEDs (optical module) |

→ **PPG LED Layout:** RED + IR (SpO2) + optional GREEN (motion tracking)  
→ **Photodiode candidate:** Vishay VEMD8080

**3.3 SoC Evaluation**

| **SoC** | **CPU** | **ADC** | **RAM/Flash** | **BLE** | **Notes** |
| --- | --- | --- | --- | --- | --- |
| Nordic nRF5340 | Dual M33 | 12-bit | 512 KB / 1 MB | 5.2 | Balanced |
| STM32WB55 | M4+M0 | 12-bit, 5MSPS | 64 KB / 1 MB | 5.0 | High ADC rate |
| NXP NHS52504 | M33 | integrated | ? | 5.3 | Ultra low power, medical-grade |

→ **Candidate:** NXP NHS52504 (BLE 5.3, I2C/SPI/UART, battery-friendly)Neoxa-3

**3.4 Memory & OS**

* **Storage**: SPI Flash or FAT-compatible memory
* **RTOS**: FreeRTOS proposed (supports deterministic tasks and priority control)

**4. Electrode & Textile Materials**

**4.1 Electrode Types**

| **Material** | **Coating** | **Notes** |
| --- | --- | --- |
| Nylon | Silver | High conductivity (e.g. Shieldex) |
| Spandex | Silver | Soft, stretchable |
| Kapton | Silver ink | For printed electrodes |
| Gold leaf | Au | Optional for coating copper electrodes |

→ **Chosen for testing:** Shieldex MedTex (silver-coated, <0.1 Ω/sq, biocompatible)

*Shieldex® Med-tex Coated Variants*

* *P70 + B: 21% elastomer, lightweight, antimicrobial, nitrile-coated*
* *P130 + B: 22% elastomer, bi-elastic, for skin disease applications*
* *P180 + B: 6% Dorlastan, mono-elastic, good for direct skin contact*

*All include nitrile rubber coating for protection, silver-based biocide (EU Regulation §67).*

**Evaluation Criteria:**

* Surface resistivity (Ω/sq)
* Durability (washing, wear)
* Comfort / biocompatibility
* Thickness and flexibility
* Ease of manufacturing

**Fabric Comparison Table**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Fabric | Conductivity (Ω/sq) | Thickness | Elasticity | Notes |
| EeonTex Ag/AgCl | <0.5 | Low | High | Skin-friendly |
| Shieldex MedTex | <0.1 | Low | Medium | Excellent EEG performance |
| Adafruit Lame | 1–10 | Medium | Low | Prototyping only |
| Statex Silverell | ~0.5 | Low | High | Soft, durable |

**4.2 Wiring & Assembly**

**Conductive Thread**

* **SilverTech 117/17** (Statex): ~15 Ω/m, high durability
* **316L Stainless Steel Thread**: ~16–40 Ω/m, robust, more affordable
* **Bekaert Bekinox**: Strong, used in smart textile manufacturing

**Flexible Conductive Tape / Strips**

* Flat copper adhesive tape or flex-PCBs for streamlined headband routing.

**Conductive Snaps**

* **Metal Snap Fasteners**: (Adafruit, 7 mm)
* **SnapSense Connectors**: Medical-grade EEG-ready
* **PLUX Leads**: EEG-specific, high quality

**5. Physical Layout & Design Ideas**

* Headband or glasses-mounted electrodes
* Frontal and occipital placement (Fp1, Fp2, O1, O2)
* Reference in forehead (Fpz or common mode front)
* Electrode pressure: spring-loaded or conductive fabric
* Local timestamping and data alignment (EEG + PPG + IMU)

**6. Additional Features & Considerations**

* **Bone conduction audio**: Piezoelectric + amplifier (TI DAC3101 proposed)
* **Motion artifact filtering**: 6-DoF IMU (ICM-42688 or BMI160)
* **Sampling Rates**: 500–250 Hz (EEG/PPG sync)
* **BLE Stack**: Secure data transmission (v5.0+)
* **Battery Management**: BQ series or MAX77650 PMIC

**7. Reference Products Analyzed**

|  |  |  |  |
| --- | --- | --- | --- |
| **Device** | **EEG Layout** | **Notes** | LINK |
| Muse S | Fp1, Fp2, T9, T10 | Silver ink electrodes, BLE 4.2 | https://choosemuse.com/pages/muse-s?srsltid=AfmBOoqcO5ZuzNO\_dFIvY\_lBrhQUk1HAWDCQ1JjDlvATrkVYyBqfk3kw |
| QEIOS Orbit | AF7, AF8 | PPG + motion, BLE 5.4 | <https://www.qeios.com/read/HDMEQ5>  <https://www.neuro-stellar.com/> |
| Dreem | T3, T4, O1, O2 | Audio via DAC, advanced firmware | <https://beacon.bio/dreem-3s> |
| Brainbit | T3, T4, O1, O2 | Spring-loaded gold-plated electrodes | <https://brainbit.com/media/1053/brainbit-specification.pdf> |

**8. Next Steps**

* Confirm AFE-SoC compatibility (SPI/I2C bus alignment)
* Prototype flexible PCB with routing for EEG, PPG, PMIC
* Test conductive fabric + electrode interface
* Benchmark BLE data throughput for EEG + PPG
* Prepare integration proposal with Sofiatech