

# 1536 CHANNEL NEUROPIXELS 2.0 QB MULTISHANK

High resolution fully integrated silicon neural probe for small animal recording

## Key Features

- 5120 reliable, low-impedance TiN<sup>1</sup> electrodes
- Dense 2 row linear electrode layout along four 10-mm long shanks
- 70 x 24  $\mu\text{m}$  shank cross-section
- Maximal shank bending  $\leq 200 \mu\text{m}$
- 1536 parallel, full-band (AP<sup>2</sup>, LFP<sup>3</sup>), low-noise recording channels
- On-chip amplification, signal conditioning and digitization
- Channel-independent reference selection (internal or external)
- Small, flexible and light-weight package (0.51-0.55 g)
- Systematic quality control process to ensure low variability in performance
- Fully characterized and qualified
- Compatible with SpikeGLX and Open Ephys software
- Compatible with PXIe system or OneBox

<sup>1</sup> Titanium Nitride Electrode, US9384990 B2

<sup>2</sup> Action potentials

<sup>3</sup> Local field potentials

### Important Information

The NeuroPixels probes are intended for RESEARCH USE ONLY ("RUO") in non-human subjects such as small animals\*. These NeuroPixels probes should not be used in humans and are not manufactured or approved for human use. They have no proven human efficacy and are not indicated for human use or any form of clinical use. The NeuroPixels probes are provided and delivered for use only under the imec general terms and conditions of sale of NeuroPixels probes ("GTC"). [The GTC is available for download on [www.neuropixels.org](http://www.neuropixels.org)]

## Description



The Neuropixels 2.0 QB multishank neural probe is the most advanced CMOS digital integrated microsystems platform. With four times the number of channels ( $n=1536$ ) of the standard Neuropixels 2.0 probe<sup>4</sup>, the spatial coverage of the recorded area can be quadrupled, allowing single unit recording at an unprecedented scale. The probe features 5120 low-impedance TiN recording sites densely tiled along four thin, 10 mm-long, straight shanks. The 1536 parallel low-noise recording channels integrated in the base enable simultaneous full band recording of hundreds of neurons. On-chip circuitry for signal conditioning and digitization results in a small and light-weight package allowing the implantation and simultaneous use of multiple probes in close proximity.

Neuropixels probes enable long-term monitoring and dense sampling of single cell activity as well as larger neuron populations in awake and anaesthetized animals. The probes connect to the custom-made recording system via a miniature and light-weight headstage, which is an essential interface board for reliable power supply, probe configuration, data streaming and system/probe diagnostics. Each headstage can connect two probes simultaneously. A dedicated cable streams the data to a PXIe based Card and Control System or OneBox, and the probes are supported by the SpikeGLX and Open Ephys software.

<sup>4</sup> Steinmetz et al, Science 2021, Vol 372, Issue 6539

## Key Applications

- High-density in vivo recording of neural activity in small animal models.
- Recording of large neuron populations from several brain regions at high spatiotemporal resolution and large volume coverage.



## Ordering information

| ORDER CODE    | DESCRIPTION  |
|---------------|--|
| NP2020        | Box of 5 Neuropixels 2.0 QB multishank probes                |
| NP2021        | Box of 5 Neuropixels 2.0 QB multishank probes with cap       |
| DNP2020       | Box of 6 Neuropixels 2.0 QB dummy multishank probes          |
| DNP2021       | Box of 6 Neuropixels 2.0 QB dummy multishank probes with cap |
| HS_2020       | Neuropixels 2.0 QB head stage                                |
| CBL_2020      | Neuropixels 2.0 QB cable                                     |
| HOLDER_2000_C | Neuropixels 2.0 metal cap probe holder pair                  |

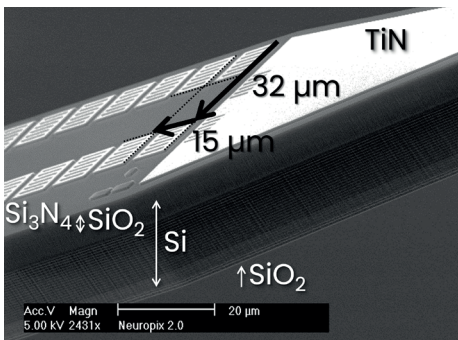


Figure 1: SEM image of the shank tip. Indicated are the electrode pitch and exposed materials.

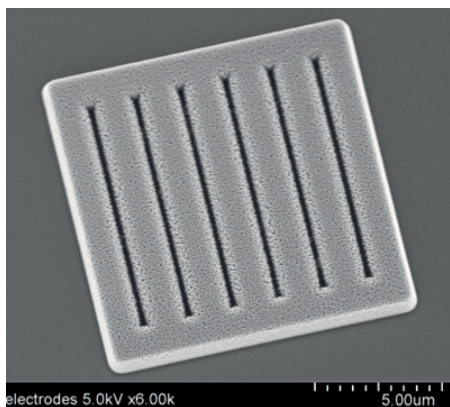


Figure 2: SEM image of a 12 x 12 μm TiN electrode.

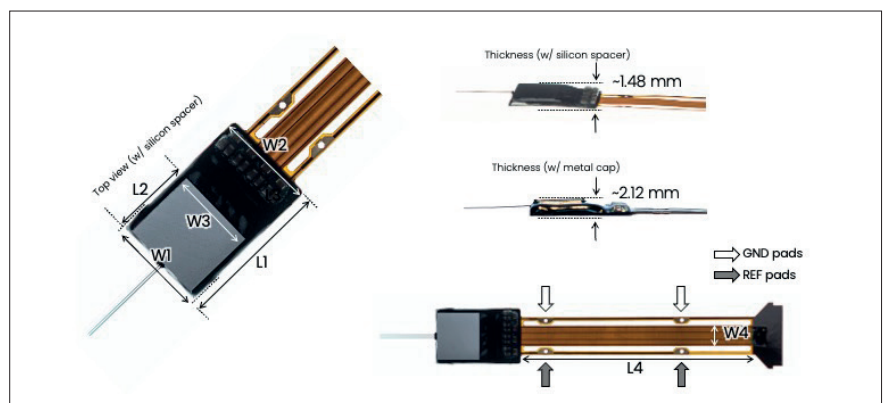


Figure 3: Dimensions of the different probe packages and locations of REF/GND input pads.

## ELECTRODES

|             |  |
|-------------|--|
| NUMBER      | 5120   |
| PATTERN     | linear, two rows   |
| PITCH       | 15 $\mu\text{m}$ (column), 32 $\mu\text{m}$ (row) (Figure 1) |
| MATERIAL    | Porous TiN <sup>1</sup> (Figure 2)                           |
| SIZE        | 12 x 12 $\mu\text{m}$  |
| IMPEDANCE   | ~150 k $\Omega$ (at 1 kHz in PBS <sup>5</sup> )              |
| SELECTIVITY | Local switch under each electrode                            |

## SHANK PROPERTIES AND MATERIALS

|                    |  |
|--------------------|--|
| NUMBER             | 4  |
| SHANK PITCH        | 250 $\mu\text{m}$                                      |
| WIDTH              | 70 $\mu\text{m}$                                       |
| LENGTH             | 10 mm  |
| THICKNESS          | 24 $\mu\text{m}$                                       |
| BENDING            | $\leq 200 \mu\text{m}$ (base to tip)                   |
| TIP LENGTH         | 175 $\mu\text{m}$                                      |
| TIP SHAPE          | Chisel   |
| TIP ANGLE          | ~20°   |
| FRONTSIDE MATERIAL | Silicon nitride ( $\text{Si}_3\text{N}_4$ ) (Figure 1) |
| BACKSIDE MATERIAL  | Silicon dioxide ( $\text{SiO}_2$ )                     |
| SIDEWALL MATERIALS | Silicon (Si), silicon dioxide ( $\text{SiO}_2$ )       |

## RECORDING CHANNELS AND DIGITAL INTERFACE

|                          |   |
|--------------------------|---|
| NUMBER                   | 1536 (full-band)                                      |
| BANDWIDTH                | 0.5 Hz - 10 kHz                                       |
| AP INPUT-REFERRED NOISE  | ~7 $\mu\text{V}_{\text{rms}}$ (typical <sup>6</sup> ) |
| LFP INPUT-REFERRED NOISE | ~5 $\mu\text{V}_{\text{rms}}$ (typical)               |
| SAMPLING FREQUENCY       | 30 kHz  |
| GAIN                     | 100   |
| CROSSTALK                | 1.51% (at 1 kHz; typical)                             |
| INPUT VOLTAGE RANGE      | 10 mVpp   |
| ADC RESOLUTION           | 12 bits   |
| DATA RATE                | 576 Mb/s  |
| POWER CONSUMPTION        | ~88 mW (in recording mode; typical)                   |
| SHANK HEATING            | <1°C (in the brain)                                   |

## REFERENCE SELECTION

|        |  |
|--------|--|
| INPUTS | Large tip electrode on each shank (Figure 1)<br>External reference input on the probe package (Figure 3) |
|--------|--|

<sup>5</sup> Phosphate buffered saline  
<sup>6</sup> Process corner

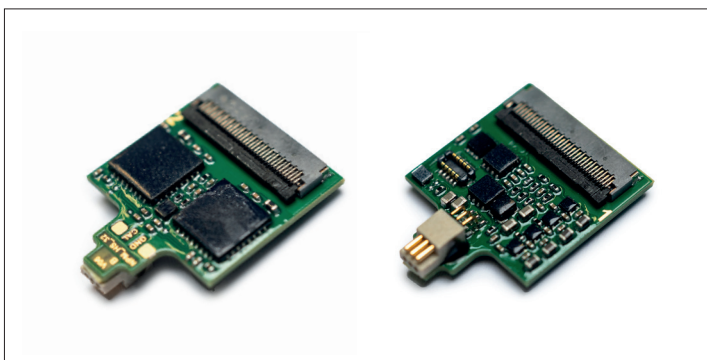


Figure 4: Headstage for Neuropixels 2.0 QB multishank probe. One headstage can connect to 2 probes.

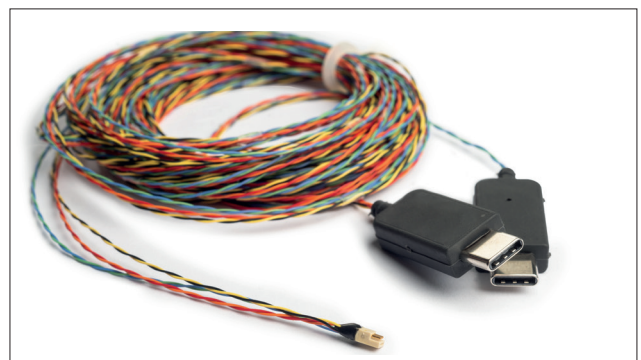


Figure 5: Triple twisted pair cable for the Neuropixels 2.0 QB multishank probe.

## PACKAGE DESCRIPTION

|  |  |
|--|--|
| WIDTH AT PROBE BASE (W1)                     | 10.2 mm  |
| WIDTH AT SMD <sup>7</sup> BASE (W2)          | 10 mm  |
| WIDTH OF SILICON SPACER (W3)                 | 8.5 mm   |
| WIDTH OF METAL CAP (W3')                     | 1.8 mm   |
| WIDTH OF FLEX (W4)                           | 3.75 mm  |
| LENGTH OF PROBE + BASE SMD <sup>7</sup> (L1) | 15.7 mm  |
| LENGTH OF SILICON SPACER (L3)                | 7.8 mm   |
| LENGTH OF METAL CAP (L3')                    | 8 mm   |
| LENGTH OF FLEX (L4)                          | 42 mm  |
| THICKNESS AT PROBE BASE                      | ~1.48 mm (with Si spacer)<br>~2.12 mm (with metal cap) |
| THICKNESS OF FLEX                            | 80 µm  |
| EXTERNAL REFERENCE INPUT                     | REF (multiple pads along flex)                         |
| GROUND INPUT                                 | GND (multiple pads along flex)                         |
| BLACK EPOXY                                  | EPO-TEK / H70E   |
| CONFORMAL COATING OF SMD <sup>7</sup>        | ELPEGUARD / SL I307 FLZ-T                              |
| WEIGHT                                       | ~510 mg (with Si spacer)<br>~546 mg (with metal cap)   |

## HEADSTAGE

|                                       |                           |
|---------------------------------------|---------------------------|
| SIZE                                  | 14 mm x 18 mm x 3.5 mm    |
| WEIGHT                                | 815 mg                    |
| ZIF CONNECTOR                         | 2 x 35-pin                |
| SOLDER PADS                           | GND (CAL_SIG)             |
| CABLE CONNECTOR                       | 6-pin (Omnetics)          |
| CONFORMAL COATING OF SMD <sup>7</sup> | ELPEGUARD / SL I307 FLZ-T |

## TRIPLE TWISTED-PAIR DATA POWER CABLE

|                     |                                 |
|---------------------|---------------------------------|
| LENGTH              | 5 m                             |
| WEIGHT              | 22 g (incl. 2 USB-C connectors) |
| DIAMETER            | 6 x 0.41 mm                     |
| HEADSTAGE CONNECTOR | 6-pin (Omnetics)                |
| PXIE CARD CONNECTOR | USB-C                           |
| WIRE STRANDS        | 3 twisted pairs                 |

## METAL CAP HOLDER

|          |                |
|----------|----------------|
| LENGTH   | 7.5 cm         |
| DIAMETER | 4 mm           |
| MATERIAL | Aluminium 6061 |

<sup>7</sup> Surface-mount devices: Biasing resistors, decoupling capacitors, EEPROM with probe ID, low-noise reference supply IC

### About Neuropixels

The Neuropixels 2.0 neural probe is an advanced silicon CMOS digital integrated microsystem and a tool for neuroscience research. It was developed through a collaboration funded by Howard Hughes Medical Institute (HHMI), University college London (UCL), The Flemish Institute for Biotechnology (VIB), the Catholic University of Leuven (KUL), The Norwegian University for Science and Technology (NTNU), and the Champalimaud Centre for the Unknown. Probes were designed, developed and fabricated at imec, Leuven, Belgium in collaboration with Howard Hughes Medical Institute (HHMI), University college London (UCL), The Flemish Institute for Biotechnology (VIB), the Catholic University of Leuven (KUL), The Norwegian University for Science and Technology (NTNU), and the Champalimaud Centre for the Unknown.

### Legal Disclaimer

The contents of this document are provided by imec, 'as is'. Imec makes no representations nor warranties with respect to the accuracy or completeness of the contents of this publication and reserves the right to make changes to the specifications at any time without notice. All trademarks are the property of their respective owners. The Neuropixels probes are ONLY distributed to the Neuroscience Research Community under the "IMEC GENERAL TERMS AND CONDITIONS OF SALE OF NEUROPIXELS PROBES". Imec is a registered trademark for the activities of IMEC International (a legal entity set up under Belgian law as a "stichting van openbaar nut"), imec Belgium (IMEC vzw supported by the Flemish Government), imec the Netherlands (Stichting IMEC Nederland, part of Holst Centre which is supported by the Dutch Government), imec India (Imec India Private Limited), and imec Florida (IMEC USA nanoelectronics design center).

\* Small animals like rodents and non-human primates