

PromethION 2 Solo Technical Specification

FOR RESEARCH USE ONLY

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Device part number

Device name

Short description

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Device part number

PRO-SEQ002

Device name

PromethION 2 Solo

Short description

The PromethION 2 Solo is a small benchtop device designed to run up to two PromethION flow cells. Each flow cell is independently addressable, meaning that experiments can be run concurrently or individually. The PromethION 2 Solo plugs into a GridION Mk1 or user compute for real-time data streaming and analysis.

Product overview

PromethION 2 Solo is a modular nanopore sequencing device using the same technology found in the MinION and GridION devices. It allows up to two sequencing experiments to be run concurrently or individually. PromethION 2 Solo also allows users to offer nanopore sequencing as a service.

The PromethION 2 Solo contains two sequencing ports where PromethION flow cells can be inserted. The device has no integrated compute, but can be plugged into a GridION Mk1 or a stand-alone computer that meets the minimum spec. This allows the device to basecall, in real-time, the data generated by two flow cells. The current chemistry and software enables generation of up to 290 Gbases* of data from a single PromethION flow cell (*theoretical max output based on sequencing at 420 bps for 72 hours).

The device has a USB Type-C port for connecting to external compute (e.g. a GridION device) - as such, setting up a PromethION 2 Solo requires no facility upgrades.



Technical specifications

Component	Specification
Size and weight	152 x 110 x 87 mm, 1.5 kg
Installation ports	1x USB Type-C (3.0 at 5 Gbps) 1x 12 VDC barrel power connector
Software installed	P2 Solo device driver
Compute specification	N/A
Environmental conditions	Designed to sequence at +18°C to +25°C*

*Functional range of electronics +5°C to +40°C

Shipping and logistics

The Oxford Nanopore Technologies PromethION 2 Solo device is stored and shipped at ambient temperature (15–25°C).

Please note that the PromethION 2 Solo is shipped separately to the kits and flow cells.

IT requirements

[PromethION 2 Solo IT requirements](#)

Safety and legal information

Intended use of the PromethION 2 Solo device

Oxford Nanopore Technologies® PromethION 2 Solo device is an electronic analysis system for use in scientific research. The core technology is built around a nanopore that is able to detect single molecule events including nucleic acids (DNA/RNA), proteins and small molecules.

This product is for research use only

The safety information below provides you with the details needed to install and use the system safely.

Electrical information

Mains supply voltage	100-240 VAC (50/60 Hz)
Maximum rated current	1.8 A
Peak power consumption	60 W

Emergency procedures

In case of emergency, switch the PromethION 2 Solo off at the power switch and unplug the power cables from the back of the device.

Declaration of conformity

The PromethION 2 Solo conforms to the EMC and Electrical Safety directives as outlined in the EC Declaration of Conformity.

CE DECLARATION OF CONFORMITY

(1) Product

Model name(s): PromethION 2 Sequencing Unit Solo

Model part number(s): PRO-SEQ002/ ONT-00-00233-00

Equipment type: Laboratory Equipment

(2) Manufacturer

Name: Oxford Nanopore Technologies plc

Address: Gosling Building, Edmund Halley Road,
Oxford Science Park, Oxford,
OX4 4DQ
United Kingdom

(3) We, Oxford Nanopore Technologies plc, hereby declare under our sole responsibility that the above specified products conform to the following European Directives and applied harmonised standards:

EMC 2014/30/EU Electromagnetic Compatibility

LVD 2014/35/EU Low Voltage Directive

RoHS 2011/65/EU Restriction of the use of certain hazardous substances in electrical and electronic equipment. Amended by 2015/863

(4) Harmonised standards applied:

EMC EN 61326-1:2013

LVD EN 61010-1:2010+A1:2019

RoHS EN IEC 63000:2018

(5) Signed for and on behalf of Oxford Nanopore Technologies plc.

Signature:



Date: 28 Nov 2022

Full Name:

Rajeev Uppal

Position:

Director, Quality Assurance

Place of Issue:

Oxford, UK

License and Warranty

The license and warranty contract ensures your instrument is performing optimally by providing the latest up-to-date hardware and software. The contract guarantees that Oxford Nanopore Technologies support obligations are delivered during the contract period as laid out in sections 4 and 7 of the [Nanopore Product Terms and Conditions](#).

For more information, see the [Device Warranty](#) page on the Oxford Nanopore Store.

What's in the box

The PromethION 2 Solo is shipped together with the necessary cables and Configuration Test Cells to confirm your hardware is functioning as expected.

Configuration is the process of testing that communication between the PromethION 2 Solo device and the control software is operational prior to experimental work being performed. This is carried out in the absence of any chemistry and uses a specific flow cell known as the Configuration Test Cell (CTC).

The PromethION 2 Solo is packed into a box that contains everything needed for installing the device. The shipping weight is ~2 kg, meaning no special equipment is required for installing the device in your laboratory.

Product cross-compatibility

Flow cells

- FLO-PRO114M
- FLO-PRO004RA
- FLO-PRO002

Kits FLO-PRO114M flow cells are suitable for V14 Sequencing kits:

- Ligation Sequencing Kit V14 (SQK-LSK114)
- Ligation Sequencing Kit XL V14 (SQK-LSK114-XL)
- Ultra-Long DNA Sequencing Kit V14 (SQK-ULK114)
- Multiplex Ligation Sequencing Kit XL V14 (SQK-MLK114.96-XL)
- Rapid Sequencing Kit V14 (SQK-RAD114)
- Rapid Barcoding Kit 24 V14 (SQK-RBK114.24)
- Rapid Barcoding Kit 96 V14 (SQK-RBK114.96)
- Rapid PCR Barcoding Kit 24 V14 (SQK-RPB114.24)
- Native Barcoding Kit 24 V14 (SQK-NBD114.24)
- Native Barcoding Kit 96 V14 (SQK-NBD114.96)
- 16S Barcoding Kit 24 V14 (SQK-16S114.24)
- cDNA-PCR Sequencing Kit V14 (SQK-PCS114)
- cDNA-PCR Barcoding Kit V14 (SQK-PCB114.24)

FLO-PRO004RA flow cells are suitable for the Direct RNA Sequencing Kit:

- Direct RNA Sequencing Kit (SQK-RNA004)

FLO-PRO002 flow cells are suitable for:

- Ligation Sequencing Kit (SQK-LSK110)
- Ligation Sequencing Kit (SQK-LSK109)
- PCR-cDNA Sequencing Kit (SQK-PCS111)

- PCR-cDNA Sequencing Kit (SQK-PCS109)
- PCR-cDNA Barcoding Kit (SQK-PCB109)
- Direct cDNA Sequencing Kit (SQK-DCS109)
- Direct RNA Sequencing Kit (SQK-RNA002)

Software Basecalling:

- MinKNOW
- Dorado

Downstream analysis:

- EPI2ME
- Oxford Nanopore-developed tools and pipelines
- Customer-developed tools and pipelines

Change log

Date	Version	Changes made
24th April 2024	V4	<ul style="list-style-type: none"> - In "Technical specifications", updated the environmental conditions to "Designed to sequence at +18°C to +25°C" - Added a Declaration of Conformity - Updated the License and Warranty information - Updated product cross-compatibility
20th February 2024	V3	<ul style="list-style-type: none"> - In "Electrical information", the mains supply voltage has been updated to 100-240 VAC (50/60 Hz); rated current has been removed; and maximum rated power has been changed to peak power consumption - In "Product cross-compatibility", the Guppy compatibility has been replaced with Dorado
12th December 2022	V2	<ul style="list-style-type: none"> - The theoretical maximum output has been updated to say "theoretical max output based on sequencing at 420 bps for 72 hours" - Updated PromethION Flow Cell compatibilities with recently-released V14 kits
21st September 2022	V1	Initial document publication

PromethION 2 Solo IT requirements

FOR RESEARCH USE ONLY

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PromethION 2 Solo IT requirements

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PromethION 2 Solo IT requirements

Overview

The PromethION 2 (P2) Solo device maintains the flexibility associated with PromethION 24 and PromethION 48 devices but in a compact, accessible form. It is designed for small- to medium-sized academic and research labs, as well as core labs and commercial service providers. The P2 Solo delivers the benefits of high-coverage nanopore sequencing to users with lower sample processing requirements (i.e. up to four full-length sequencing runs per week or 200 flow cells per year). Each flow cell has the capacity to deliver hundreds of gigabases of nanopore sequencing data and presents a convenient way to rapidly enable the coverage required for sequencing larger genomes. Additionally, P2 devices allow you to explore applications and projects enabled by high-output nanopore sequencing, before committing to a P24 or P48 device.

The P2 Solo is a sequencing device that requires external compute to run the MinKNOW software. You can plug a P2 Solo either into a GridION or stand-alone computer.



Specifications - GridION

The P2 Solo can use the GridION device as a convenient compute resource – offering plug-and-play compatibility taking advantage of the GPU contained within the GridION to basecall data generated

from the P2 Solo. Furthermore, the operating system, SSD and memory are all compatible with the P2 solo out-of-the-box, and engineered to have the optimum amount of compute resources for sequencing.

Item	Specification
1x GridION (GXB02xxx or greater)	<p>GridION is used by the P2 Solo as the compute resource.</p> <p>A GridION Mk1 with serial number GXB02xxx or greater is required to use all basecalling models with a PromethION Flow Cell.</p>
1 Gb/s RJ45 port with DHCP service	Internet connection and long-term data transfer. Details on using networked storage can be found in the GridION data transfer section below.
Networked storage	See below for detailed instructions for additional storage.
1x RJ45 Ethernet cable (cat5e or higher recommended for 1 Gbps)	Internet connection is required to use MinKNOW. Customers require Ethernet connection for data transfer to remote storage (NFS/SMB).
Telemetry feedback	<p>HTTPS/port 443 to 52.17.110.146, 52.31.111.95, 79.125.100.3 (outbound-only access)</p> <p>or DNS rule for ping.oxfordnanoportal.com</p>
EPI2ME analysis	<p>Ethernet: HTTPS/port: 443</p> <p>TCP access to AWS eu-west-1 IP ranges: http://docs.aws.amazon.com/general/latest/gr/aws-ip-ranges.html</p>
Software updates	<p>HTTPS/port 443 to 178.79.175.200 and 96.126.99.215 (outbound-only access)</p> <p>or DNS rule for cdn.oxfordnanoportal.com</p>
100-240 V 50/60 Hz AC power outlet	AC Mains power required for both P2 Solo and GridION.
1x USB keyboard	USB Type-A keyboard is needed to operate the GridION (I/O on rear of device).
1x USB mouse	USB Type-A mouse is needed to operate the GridION (I/O on rear of device).
1x HDMI or Display Port cable	A Display Port or HDMI cable is required to view the MinION user interface.
1x monitor	GridION currently supports output with a Display Port-compatible monitor. Additionally, a DP-to-HDMI adapter is provided with the original

Item	Specification
	GridION.

Configuring a new computer

Consumer workstations can include desktop towers and high-performance laptops. Workstations can be used if you are comfortable installing the MinKNOW software and do not already have a GridION. The basecalling performance of your setup will depend heavily on your work station and PC specifications.

Item	Specification
Operating System (OS)	Windows – 11 and 10 macOS – Sonoma (14), Ventura (13), Monterey (12) Linux – Ubuntu 22.04 and 20.04
Storage	<p>Recommended specification</p> <p>8 TB*+ of useable, internal fast SSD storage. *Note if using 2x 4 TB internal SSDs, they need to appear as a single drive to the OS (e.g. using RAID 0).</p> <p>For more information on data sizes, see the information above about storage required for data generated by the P2 Solo.</p>
GPU	<p>Recommended specification</p> <p>NVIDIA GPU with at least 12GB of GPU memory</p> <p>Note: High-end NVIDIA GPUs (RTX 4090 recommended) are recommended for real-time high accuracy basecalling (HAC). MacOS - Mac Studio is recommended for real-time basecalling using the fast model.</p>
Memory	<p>Recommended specification</p> <p>64 GB of DDR4+ RAM</p>
CPU	<p>Recommended specification</p> <p>12-core/24-thread Intel i7/i9 10th gen or newer processor / AMD Ryzen processor</p>
Electrical	<p>Consult your workstation/desktop computer manufacturer for electrical specifications. The P2 Solo is powered by a mains supply voltage of 100-240 V 50/60 Hz AC, with a 60 W maximum power draw. Power draw will depend on the sequencing run conditions (e.g. temperature, number of flow cells, etc.)</p> <p>Note: Do not use an extension cord to connect the P2 Solo and the computer.</p>
1x USB-C port	<p>For transferring sequencing data for up to two PromethION flow cells. Designed for a maximum data transfer rate of 5 Gb/s (USB 3.0 or higher).</p> <p>Note: If using a workstation/desktop computer, please ensure you are:</p> <ul style="list-style-type: none"> - Plugging your P2 Solo directly into the workstation computer's motherboard. - Not using a PCIe to USB-C adapter card (this is known to cause USB communication errors). <p>Failure to plug the P2 Solo directly into the computer motherboard will cause device</p>

Item	Specification
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issues.

If your workstation does not have a USB-C port on the motherboard, a USB-C to USB-A cable can be provided upon request. This USB-A port must be a USB 3.0 speed or greater.

If your P2 Solo does not appear in MinKNOW, this could be due to an antivirus or endpoint detection and response package. If your IT security policies require such third party software please contact your IT department to ensure the below codes are whitelisted in the peripheral controls of the third party software. Users will be responsible for validating the sufficiency of the applied codes on P2 Solo performance. For more information please visit: [How do I connect my P2 Solo?](#)

Telemetry feedback	HTTPS/port 443 to 52.17.110.146, 52.31.111.95, 79.125.100.3 (outbound-only access) or DNS rule for ping.oxfordnanoportal.com
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EPI2ME analysis	Ethernet: HTTPS/port: 443 TCP access to AWS eu-west-1 IP ranges: http://docs.aws.amazon.com/general/latest/gr/aws-ip-ranges.html
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Software updates	HTTPS/port 443 to 178.79.175.200 and 96.126.99.215 (outbound-only access) or DNS rule for cdn.oxfordnanoportal.com
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Operating environment	Consult your computer documentation on operating temperatures. Vents should not be obstructed, otherwise basecalling performance will be affected.
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Here is a non-exhaustive list of example models/workstations that meet or can be configured to meet the recommended specification for the P2 Solo. We have not extensively tested any of these computers, so purchasing is at your own risk. Ensure that you have configured the computer to meet the specification in the table above. Other manufacturers are available; check the availability for your region.

Example computers (available as of July 2024)

- [Dell Precision 7960 with 2x A6000 GPUs](#)
- [Dell Precision 7770](#)
- [Dell Precision 3660](#)
- [Lenovo - ThinkStation P520/P620 Tower](#)
- [Alienware Aurora R16 Desk with RTX 4090 GPU](#)

Telemetry

MinKNOW collects telemetry information during sequencing runs as per the Terms and Conditions to allow monitoring of device performance and enable remote troubleshooting. Some of this information

comes from free-form text entry fields, therefore no personally-identifiable information should be included. We do not collect any sequence data.

The EPI2ME platform is hosted within AWS and provides cloud-based analysis solutions for multiple applications. Users upload sequence data in FASTQ format via the EPI2ME Agent, which processes the data through defined pipelines within the EPI2ME Portal. Downloads from EPI2ME are either in Data+Telemetry or Telemetry form. The EPI2ME portal uses telemetry information to populate reports.

Software updates

The IP address from which you receive software updates will depend on your geographical location. You can update through the software UI or through **apt** on the terminal, so you require outbound-only access. We notify users about software updates through the Nanopore Community and provide full instructions for updating in each release note.

Storage

File types

Nanopore sequencing data is stored in three file types: POD5, FASTQ and BAM. Basecalling summary information is stored in a `sequencing_summary.txt` file:

- POD5 is an Oxford Nanopore-developed file format which stores nanopore data in an accessible way and replaces the legacy `.fast5` format. This output also reads and writes data faster, uses less compute and has smaller raw data file size than `.fast5`. POD5 files are generated in batches every 10 minutes. The files can be split by barcode if barcoding is used, but splitting by barcode is off by default.
- `.fast5` is a legacy file format based upon the `.hdf5` file type, which contains all information needed for analysing nanopore sequencing data and tracking it back to its source. A `.fast5` file contains data from multiple reads (4000 reads as default), and is several hundred Mb in size.
- FASTQ is a text-based sequence storage format, containing both the sequence of DNA/RNA and its quality scores. FASTQ files are generated in batches by time, with a default of one file generated every 10 minutes. However, you can configure this frequency to 10 minutes, one hour, or one file generated at the end of the run. You can also batch the reads based on the number of reads per file.
- BAM files are output if you perform alignment or modified base calling on the basecalled dataset. BAM file generation options are the same as for FASTQ files. BAM files are off by default and switched on automatically if alignment or modified base calling is used.
- `sequencing_summary.txt` contains metadata about all basecalled reads from an individual run. Information includes read ID, sequence length, per-read q-score, duration etc. The size of a sequence summary file will depend on the number of reads sequenced.

Example file sizes below are based on different throughputs from an individual flow cell, with a run saving POD5, FASTQ, and BAM files with a read N50 of 23 kb. TMO = theoretical maximum output.

Flow cell output (Gbases)	POD5 storage (Gbytes)	FASTQ.gz storage (Gbytes)	Unaligned BAM with modifications (Gbytes)
100	700	65	60
200	1,400	130	120
290 (TMO)	2,030	188.5	174

As an experiment progresses, POD5 files are produced for all reads. If you choose to basecall your data, these reads are used by the MinKNOW software to generate sequence data which is then stored in FASTQ files and/or BAM files.

Data transfer and long-term storage

It is essential that data is streamed from the device in real-time to prevent runs from terminating due to lack of storage space (this is common for high specification laptops). For this, a customer site must ensure that connectivity to the local infrastructure/external SSD is of sufficient bandwidth to prevent data backing up. We recommend storage presented as NFS or CIFS. To stream data to storage in real-time, SSD is required due to its high write speed compared to HDD. After initial writing to networked SSD drives, data can be moved to storage with a slower write speed for long-term storage.

The form and volume of data to be stored will depend on customer requirements and whether you wish to basecall your sequencing data in the future when more advanced basecalling algorithms are available:

- Storing POD5 files with raw read data in will permit re-basecalling of data when new algorithms are released by Oxford Nanopore Technologies. In such cases, new releases of basecallers have enabled significant improvements in basecalling accuracy of existing datasets through re-basecalling. Further, selected Oxford Nanopore and third-party tools use the raw signal information contained within the POD5 to extract additional information from the raw signal, e.g. calling modified bases, reference-guided SNP calling, or polishing of data.
- Retaining only FASTQ files will allow use of standard downstream analysis tools using the DNA/RNA sequence, but no further sequence data can be generated when improvements in basecalling become available.

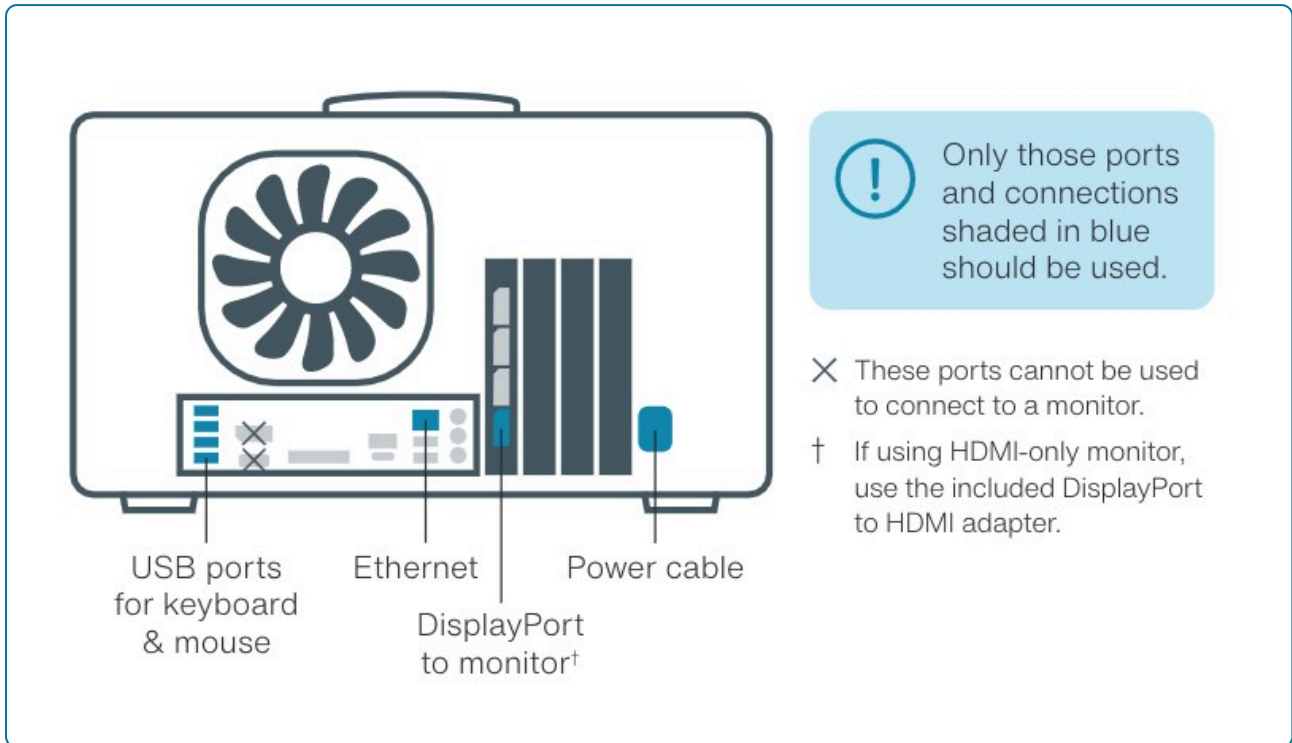
Oxford Nanopore is unable to provide exact recommendations for storage, as these will be site-specific. The requirements below should be taken into consideration.

GridION data transfer

If you are using a P2 Solo in combination with a GridION and require additional SSD storage, ensure you are using the correct USB port/Ethernet on the rear of the device. Do NOT use either the USB port with a white, rectangular centre or those at the front of the device (if your GridION has front-facing USB ports).

Instead, use the blue USB Type-A ports on the rear of the GridION (see the image below for reference). Alternatively if using Ethernet, ensure that you are using a cable capable of at least 1

Gbps (CAT5e) and the minimum length for reduced latency.



Support

For more information and FAQs about the PromethION 2 Solo, refer to the [P2 Solo self-service page](#).

Change log

Date	Version	Changes made
31st July 2024	V10	<ul style="list-style-type: none"> - Renamed "Specifications - workstation/laptop" section to "Configuring a new computer." - Removed minimum specifications for Storage, Memory, GPU and CPU. - Updated recommended GPU to "NVIDIA GPU with at least 12GB of GPU memory." - Added note on GPU recommendations for real-time high accuracy basecalling. - Removed Apple silicon (M1, M2) GPU recommendation. - Added note on P2 Solo not appearing in MinKNOW due to antivirus/endpoint detection packages and how to resolve. - Merged "Example laptops" and "Example desktop" workstation lists to "Example computers" and updated items in list. - Renamed item "100-240 V 50/60 Hz AC power outlet" to "Electrical"; added recommendation to consult manufacturer electrical specifications - Added note not to use extension cord to connect P2 solo and computer. - Added note on operating temperatures of computer - In "File types", updated information about data generation for POD5, FASTQ and BAM files.
24th April 2024	V9	<ul style="list-style-type: none"> - In "Specifications - workstation/laptop", updated operating system recommendations for Windows, macOS and Linux. - Updated CPU and GPU recommendations to include Apple silicon (M1 and M2)
20th February 2024	V8	<ul style="list-style-type: none"> - In "Specifications - workstation/laptop", more information has been added about USB-C port requirements. - Minor corrections and clarifications throughout the document
28th September 2023	V7	<ul style="list-style-type: none"> - A file size table has been added to "File types" - The required operating system for Mac has been updated in "Specifications - workstation/laptop" - Minor corrections and clarifications throughout the document
4th August 2023	V6	<p>A disclaimer has been added to "Specifications - workstation/laptop": "Do not use a USB-C to USB-A adapter to plug the device into your computer, as this can cause issues with connectivity."</p>
28th June 2023	V5	<ul style="list-style-type: none"> - In "Specifications - GridION" and "Specifications - workstation/laptop", the specs for telemetry feedback, EPI2ME analysis, and software updates have been changed. - In "Specifications - workstation/laptop", the minimum storage recommendations have been updated. - "Networking explanations" has been removed. - In "File types", information has been added about POD5 files and BAM

Date	Version	Changes made
		<p>files. The file size comparison table has been temporarily removed.</p> <ul style="list-style-type: none"> - The "Included software" section has been removed. - A "Support" section has been added - Minor corrections and clarifications throughout the document.
27th February 2023	V4	In "Specifications - workstation/laptop", "1x Type-C port" has been changed to "1x USB-C port"
12th December 2022	V3	- Ubuntu 18.04 has been removed from the workstation/laptop specification table
1st November 2022	V2	<ul style="list-style-type: none"> - A list of compatible workstations/laptops has been included after "Specifications - workstation/laptop" - In "Specifications - workstation/laptop", the requirements have been updated from 1 x USB TypeA/Type C port to 1 x USB Type-C port.
May 2022	V1	Initial publication