



Olink NPX™ Signature for Olink® Focus

Software User Manual

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Part 1: Introduction

1. About this manual

This user manual provides you with the instructions needed for processing the raw data and performing quality control on the data from Olink® Focus panels with the Olink® NPX Signature software.

This manual contains step-by-step instructions for analysis in Olink® NPX Signature and troubleshooting.



NOTE: *This Olink® NPX Signature for Olink® Focus User Manual is provided for informational purposes. Although we aim to maintain accurate and up to date information, aspects of the software may at times vary from the description in this manual. Without limitation, displayed screenshots may differ from actual user interface and should be considered as examples. For any questions, guidance or support concerning the software, please contact Olink Support at support@olink.com.*

1.1 Intended use

Olink NPX Signature is a data analysis software that is designed for the use with the qPCR-based kits from Olink, including Olink® Target 48, Olink® Target 96, Olink® Focus as well as for Olink® Flex panels. It allows for importing run data, validating data quality, and normalizing Olink data for subsequent statistical analysis.

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1.2 Intended target group

Olink NPX Signature is intended to be used by trained users of the Olink Focus analysis platform. Quality control should be performed by trained users that determine whether data from a run can be approved for further analysis.

2. List of abbreviations

%CV	Coefficient of Variation
IFC	Integrated Fluidic Circuit (also called "chip" in this document)
LLOQ	Lower Limit of Quantification
LOD	Limit of Detection
LOQ	Limit of Quantification
LQL	Lowest Quantifiable Level
NPX	Normalized Protein eXpression
PCR	Polymerase Chain Reaction
QC	Quality Control
ULOQ	Upper Limit of Quantification

3. Safety

This chapter contains important safety information.

3.1 Definition of alert levels

The following alert levels are used in the Olink Explore manuals:

 **IMPORTANT:** Indicates an important action that may impair the results if not performed correctly.

 **NOTE:** Contains information that can make it easier to understand or perform a certain task.

4. Associated documentation

- Olink® Signature Q100 User Manual, doc no 1172
- Olink® Focus User Manual, doc no 1231

All relevant Olink documentation is available from the Olink website:

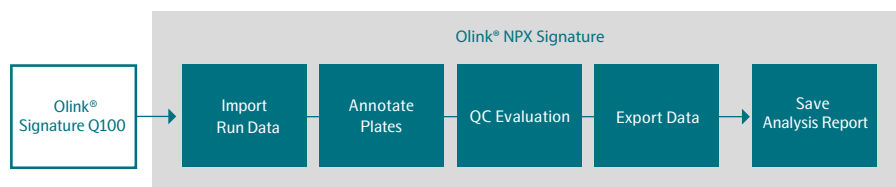
<https://www.olink.com/downloads>.

5. Technical support

For questions, guidance, and support, contact Olink Proteomics at support@olink.com.

6. Process

Olink NPX Signature is a standalone Windows software application that lets you import data from Olink® Signature Q100, validate its quality, and normalize it. The data is not required to be annotated or processed before importing it into Olink NPX Signature. The software can also process Fluidigm® Biomark™ data.



7. Software and file requirements

Components	Minimum	Recommended
Operating System	Windows® 10 or higher	
Processor	Intel® Core™ i5	Intel® Core™ i7 or higher
Memory	8 GB RAM	16 GB RAM or more
Disk Space	500 MB	500 MB

7.1 Files and information

7.1.1 Olink® NPX Signature Study File (.npx)

IMPORTANT: To enable Olink NPX Signature's remote data functions to Olink Signature Q100, ensure that the instrument is connected to the network and TCP port 8085 (enabled by default) is not blocked. For instructions on how to securely connect the Olink Signature Q100 to a network, refer to the Olink® Signature Q100 User manual.

Olink NPX Signature stores all study data in a file with the extension .npx. This file is the single repository for all study-related data required by Olink NPX Signature to display, review, and export data for a study.

7.1.2 Files and Information Needed for Analysis

Q100 Run Data

This is the Olink Signature Q100 run data that can be imported into Olink NPX Signature without the need for annotation or processing in advance. The file types and information accessible for analysis are:

- Olink Signature Q100 export file (.q100 or .zip);
- Olink Signature Q100 instrument with enabled remote connectivity;
- Olink NPX Manager project file (.oaf); or
- Fluidigm realtime PCR analysis software exported heatmap or table file (.csv). A csv file is needed to be able to analyze Biomark runs in Olink NPX Signature

See the tutorials and help sections in Olink NPX Signature for more information.

Plate Manifest File

Microsoft Excel file (.xlsx) that can be used to define the sample plate layout.

Panel Data File

File needed to properly process and quality control your data. This file is unique to your panel and kit lot. The file is provided by Olink.



NOTE: The size of the .zip file that is transferred via USB from Olink Signature Q100 might be larger than 20 MB. An Olink NPX Signature study that includes run data in the .npx archive might be too large to email to Olink Support. If possible, email only the Olink NPX Signature with the .npx extension.

8. Installation

8.1 License agreement

You are required to accept the end-user license agreement when installing Olink NPX Signature or before using an updated version for the first time.

8.2 Install software

The installer performs a first-time installation or an update to the current installation if it is already installed on your local computer. Any updates to the software retain all existing user settings and custom data.

1. Download the latest version of Olink NPX Signature software to your computer from olink.com/software/
2. Open the zip folder.
3. Double-click the installer (.msi) file.
4. Follow the on-screen instructions.

Olink NPX Signature will be displayed in the Windows Start menu for future use. To open the application, double-click on the icon.

8.3 Uninstall software

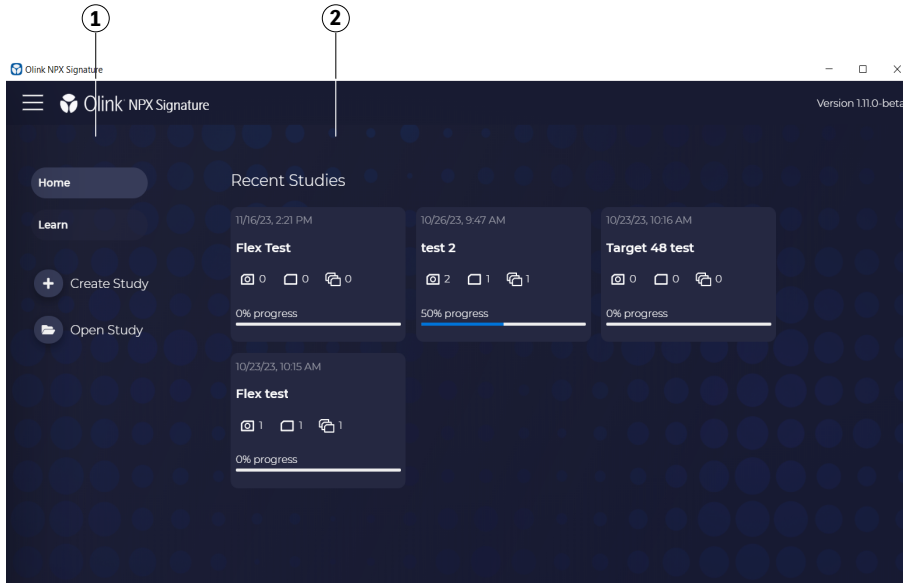
If you need to uninstall Olink NPX Signature, use the Windows Add found in Windows Settings, or Remove Programs in the Control panel. Select Olink NPX Signature from the program list and click **Uninstall**.

All user data is retained where it was saved before the application was uninstalled, and your custom Olink NPX Signature settings are retained on the system.

Part 2: User Interface

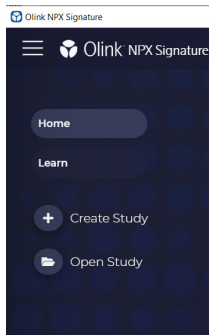
9.General

9.1 Start view



No	Function	Description
1	Main menu	Access main functions. Click on the three lines in the top left corner to expand the main menu.
2	Recent studies	Show recent opened studies. Click on a project to get to the Study Overview.

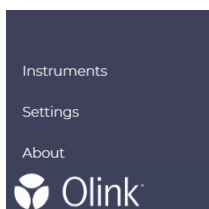
9.2 Main menu



Function	Description
Home	Access the main level of the application, where you see your most recently opened studies.
Learn	Access all the integrated tutorials. Refer to 11. Tutorials and in-line help for more information.
Create Study	Create a new study.
Open Study	Open an existing study.

The expanded menu lists three functions in the lower part of the menu.

9.2.1 Lower part of main menu



Function	Description
Instruments	Show a list of Olink Signature Q100 instruments available to the Olink NPX Signature software over the network.
Settings	Access the application settings. Refer to 10. Settings for more information.
About	For instructions on how to securely connect the Olink Signature Q100 to a network, refer to the Olink® Signature Q100 User Manual.

10.Settings

Click **Settings** on the main menu to customize the view.

General

- Change the color theme of the application and charts.
- Enable or disable the advanced user features.
- Customize the Analysis Report by adding a company name and logo.

Layout Templates

Review or create new sample plate layouts to define the sample types for each well.

Panels

- Review all Panel Data Files in the application.
- Import or remove Olink Flex Panel Data Files.

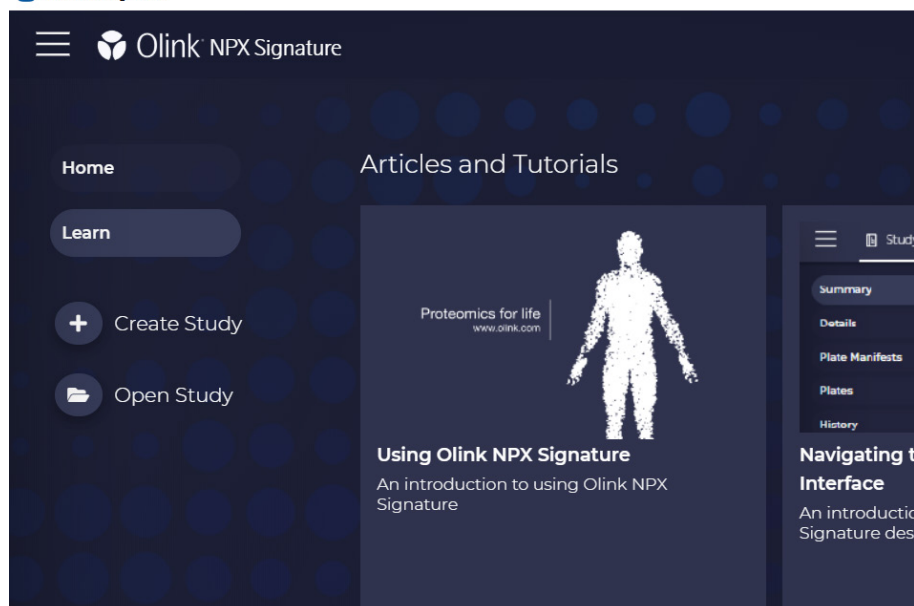
11.Tutorials and in-line help

Olink NPX Signature contains integrated tutorials and in-line help.

11.1 Tutorials


Click **Learn** on the main menu to access integrated tutorials meant to assist you in learning the various features of Olink NPX Signature. Click a tutorial and navigate through the pages using **Next** or **Previous**.

Olink NPX Signature



You can also launch a tutorial by clicking **TUTORIAL** in the end of the in-line help content.

11.2 In-Line help

Click the  icon in the upper-right corner of a view to access the in-line help, which contains information about the usage of the current view. If the contextual help is longer than the allowed space, a scroll bar appears that lets you read the full text.

Part 3: Operation

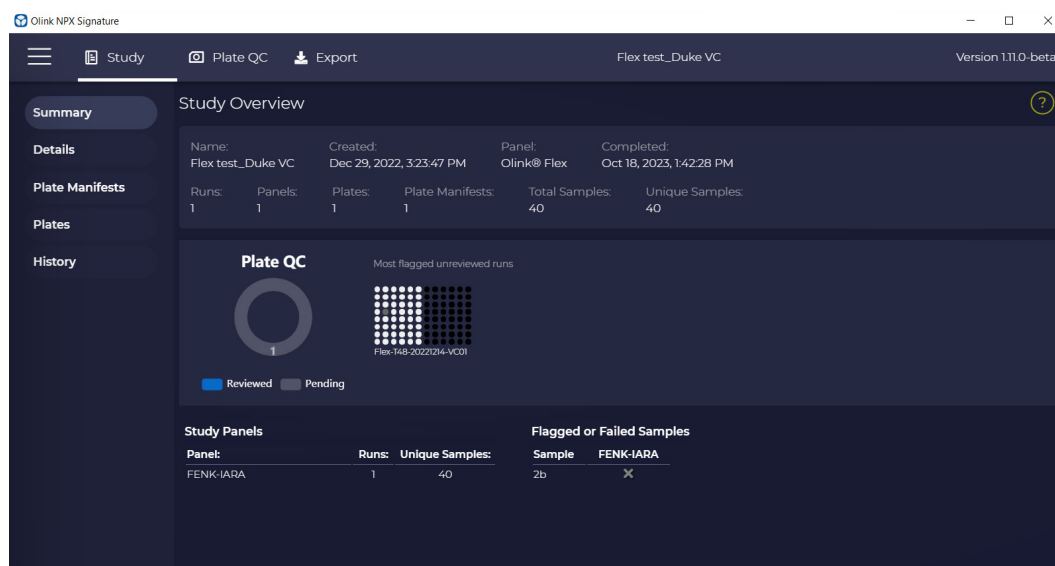
12. Introduction

Input data for Olink NPX Signature are run files from Olink Signature Q100 in .q100 format, Signature Q100 or Biomark runs exported as csv files from Fluidigm realtime PCR analysis software, either heatmap or table format, NPX Manager .oaf project files and Olink NPX Signature .npx study files. After quality control and normalization against the Extension Control, and a bridging factor, the output data are obtained in NPX values.

Further normalization against the Calibrators produces data in standard concentration units (pg/mL), for the panels where absolute quantification is included.

This section describes how you analyze data step-by-step in Olink NPX Signature, divided into the following steps:

1. Start or open a project
2. Perform quality controls
3. Export file data



13. Start or open a project

This section describes how you analyze data step-by-step in Olink NPX Signature, divided into the following steps:

1. Import panel data files.
2. Create a study.
3. Import run data.
4. Enter study information.
5. Verify panel and plate layout information.

13.1 Import Panel Data Files

Every Focus panel has its own Panel Data File, which is provided by Olink. This panel data file needs to be imported to Olink NPX Signature before setting up your first study of this particular panel.

To import the Panel Data File to Olink NPX Signature, perform the following steps:

1. Expand the main menu by clicking the three horizontal lines in the top left corner. Select Settings -> Panels.
2. Click **Import**. Select the correct panel data files (.xml) as outlined in the Lot Configuration document.
3. Click **Open**. Ensure that no error messages are shown and that the file is added to the list of Panel Data Files.

13.2 Create a study

To create a study, perform the following steps:

1. Click **Create Study**.
2. Select Product.
3. Enter Study Name (required information), Sample Type and Notes.
4. Click Create.

13.3 Import run data

13.3.1 Add run data to a new study

When prompted, select your Run Data Source:

- To import run data directly from an Olink Signature Q100 instrument, select **Olink Q100 Connect**. Select the desired run(s) and press **Next**.



NOTE: Run data cannot be saved in the npx folder. Please make sure that the data is securely saved on disk, server or computer.

- Click **Next** and verify panel, data file version and plate layout information.
- Click **Add**. The Study Overview will appear.
- To import run data files from your computer or a local server, select **Run Data Files**.
 - Select the desired run data file(s). Valid options are Olink Signature Q100 export files, .q100 or .zip, exported heatmap or table results files in .csv format from Fluidigm Real-time PCR analysis software.
- Add plate name for Plates 1 and 2.
- Select **Sample Plate Dispensing**: Left & Right or Even & Odd.



NOTE: A study cannot include different panel types at the same time. It can consist of only runs from one of the following panels: Olink Target 48, Olink Target 96, Olink Focus, or from Olink Flex.

If duplicate sample names are found, Olink NPX Signature prompts an alert message box. During data import, unique sample and assay names are necessary for proper handling of the data. Change sample names if needed. Sample names can be changed directly in Olink NPX Signature by importing a manifest in the Plate Manifests view. Refer to the built-in help for more information.

When the selected runs have been validated, click **Next**. Select the correct Panel and Panel Data File for each of the imported runs, and select if the plate should have the default plate layout or if the layout should be mapped based on a plate manifest. Click **Add**.

For instructions on how to securely connect the Olink Signature Q100 to a network, please refer to the Olink® Signature Q100 User Manual.

13.3.2 Add run data to existing study

Open your already saved study. Expand the main menu by clicking the three horizontal lines in the top left corner. Select **Import Run Data**, and follow the above instructions to add data directly from a Olink Signature Q100 instrument or from run data files on your computer.

13.4 Enter study information

Study information can be entered in the **Study -> Details**. Adding study details is optional but can be used to e.g., add information to the Analysis Report.

Enter information in some or all the following fields to be displayed in the Analysis Report:

- Sample Type
- Customer Info
- Business Development Manager
- Lab Info
- Report Notes
- QC Notes for Analysis Report

13.5 Verify plate layout and sample annotation

1. Select **Plate QC -> Plate Layout** to display the plate layout for each Olink panel and plate.
2. Under **Plate Details**, verify that the correct panel data file version is selected in the drop-down menu. The same data file version will be used for all runs of the same Olink panel in the study.
3. Verify that the plate layout is correct. To change the plate layout, select one or several wells and click preferred Sample Type in the list above the plate layout.

Available types are:

- Sample (S)
- Negative Control (NEG)
- Sample Control (SC)
- Calibrator (CAL)
- Not Used (N/A)

Calibrator, Negative Control, and Sample Control must be annotated for calibration normalization and QC to be performed.

4. Repeat step 2 and 3 for all imported plates before continuing.


14. Perform quality controls

This section describes how you perform quality control including additional quality assessment, divided into the following steps:

1. Perform the QC for each plate separately using the Sample QC tab.
2. Perform quality assessment for all plates using the other views and then make an overall assessment.


The acceptance criteria for passing QC are described below.

Olink NPX Signature acceptance criteria	Value
Run QC	
Controls Std. Dev. of Incubation Control	< 0.5 NPX
Samples Std. Dev. of Incubation Control	< 0.2 NPX
Controls Std. Dev. of Detection Control	< 0.5 NPX
Samples Std. Dev. of Detection Control	< 0.2 NPX
Number of flagged samples	≤ 1/6 of total number of samples on plate (8 samples on a full plate, or 12 samples for a total of 72 samples on a plate, or 13 samples for a total of 80 samples on a plate)
Number of flagged Sample Controls	≤ 2
Number of flagged Calibrators	≤ 2
Sample QC	
Incubation Control deviation	< ±0.3 NPX from plate median
Detection Control deviation	< ±0.3 NPX from plate median
Assay QC	
Precision Sample Control	Intra CV <30%
Accuracy Sample Control	Recommended expected value will be read from file
Calibrator or Control replicates outside LOQ	≤ 1/3 of the Sample Control- and/or Calibrator replicates are outside of LOQ
Precision Calibrator	Recommended Intra CV will be read from file

 **TIP:** If Std. Dev. is higher than the recommended value for the controls, evaluate the Control signal deviation from median/sample QC graph to identify any extreme outlier samples. Exclude these samples from the QC analysis (click on the sample in the graph and select QC analysis: Excluded) and re-evaluate the run QC again.

14.5.1 Perform a quality assessment

Parameters that need to be evaluated for each run are listed in the table below. The corresponding information in NPX Signature can be found in the lower left corner under Plate Metrics. If all plates pass quality control and assessment, the Quality Control is finished, and the data is ready for export and reporting.

Information	Recommended value	Comment
Plate ANOVA	≤ 10 (number of assays)	No warning.
	> 10 (number of assays)	May be caused by insufficient randomization or other issues. If samples were not randomized, this warning can be disregarded.  NOTE: These guidelines are based on a two-plate study. The larger a study is, the smaller the detectable differences become.
Row/Column ANOVA	< 7 (number of assays)	No warning.
	7 – 14 (number of assays)	Possible randomization issue. Refer to section 21 .
	14 – 21 (number of assays)	Re-run plate or verify that this is not the result of a poorly executed run. For high values, investigate the Assay QC view.
%CV Intra	< 15%	Refer to section 19 .
%CV Inter	< 25%	Refer to section 19 .

14.5.2 Additional quality assessment



NOTE: Switch between Ct, NPX and, where applicable, quantified values, in each view e.g. to evaluate the effect of normalization or to search for position effects in internal controls and assays.

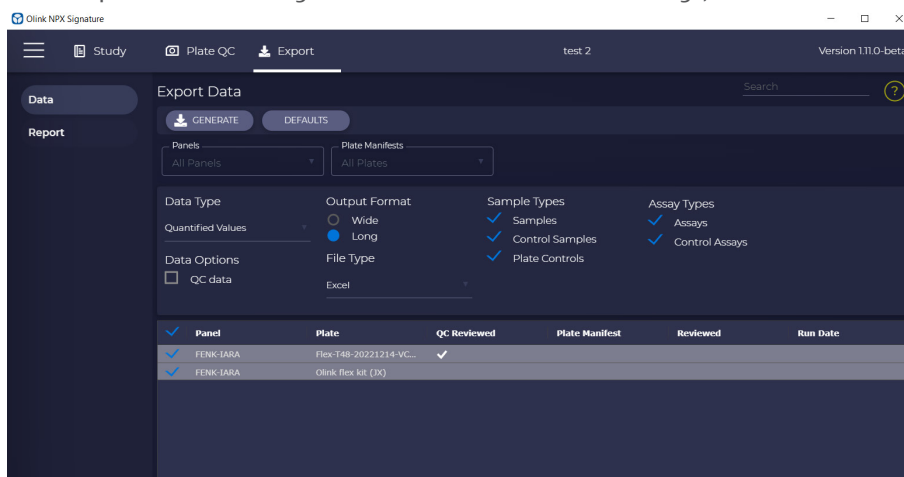
To perform additional quality assessment, follow these steps:


- On the **Assay QC** tab, view the values of internal controls and assays (change assay in the drop-down menu above the plate layout) for each sample. For example, search for specific patterns that may indicate technical errors.
- On the **Table** tab, evaluate patterns of data below LOD between sample plates in a study and/or remove specific assays or single datapoints from a study/sample plate.
- On the **Heatmap** tab, search for outlier samples and/or visualize homogeneity of Negative Controls, Sample Control or Calibrators (change sample type in the drop-down menu).
Use the Quantified Value setting to provide an overview of failed assays which will be marked in black.
- On the **Detectability** tab, evaluate the detection limit for each assay and sample plate. Assess if deviating LOD for an assay affects detectability for that assay.
When evaluation LOD values while looking at NPX data, LOD values above 2.5 NPX and below -2.5 NPX are highlighted. Some assays can be expected to have LOD values above 2.5 NPX or below -2.5 NPX, and this should not affect the number of samples that can be quantified above the plate LOD. The Detectability view can be used to assess if such assays have a high number of samples outside LOQ.
- The **Z-scores** tab displays differences in data distribution between sample plates as well as within plates.

15. Export data


In the **Export -> Data tab**, Data can be exported for use in preferred applications.

1. Under Panels, select from which panels in the study data should be exported.
2. To export data according to the recommended default settings, click **Defaults**.



 **NOTE:** The settings in the **Export Data** view may be adjusted to change the format, layout, or to add additional data to the export. Refer to [14.5.1 Perform a quality assessment](#) for more information.

3. When the desired options have been selected, click **Generate**.
4. Enter a filename and location in the **Save** dialog, select an export format (Microsoft Excel or Text files) and click the **Save** button.

Setting	Description
Data Options: QC data	Export deviation from plate median for Incubation Control and Detection Control. Deviation from median for Incubation Control and Detection Control is exported in NPX values. Data for the controls cannot be calculated in pg/mL and will be blank in the results file for quantified values.
Data Options: Plate LOD	Will export plate LOD for each plate.
Output format	Wide format or Long format. Wide is the default matrix format and Long format will output one line per datapoint.  NOTE: In Excel, there is a number of rows limit of 1 048 576. If this number is exceeded, Excel export will not work. Select Text format instead.
File Type	Microsoft Excel (.xlsx) or Text (.csv) For CSV format, column separator and decimal separator can be configured
Sample types: Samples	Export data for customer samples.
Sample types: Sample Control	Export results from the Sample Controls.
Sample types: Plate Controls	Export results from Negative Control and Calibrators.
Assay types: Assay	Export results for assays.
Assay types: Control Assay	Export results for internal control assays.

15.1 Considerations

- Samples that have not passed the sample QC are reported in red text.
- Samples, assays, or data points that have been marked as failed in the software show reported as No Data.

For panels with absolute quantification, the data are given in standard units (pg/mL) and presented as follows:

- Data between LQL and ULOQ is reported as pg/mL value in white cells.



NOTE: Lowest Quantifiable Level (LQL) is defined as the value used as the lower limit, LLOQ (default) or plate LOD (when plate LOD > LLOQ)

- Data > ULOQ is indicated as > ULOQ in red cells.
- Data below LQL is presented in pg/mL value in red cells.
- Data below lowest fitting parameter in the 4PL curve fit model cannot be calculated and is indicated as NaN in red cells.
- Failed data points (either because of assay failure, sample failure or chip failure) are indicated as No data in grey cells.
- For samples and assays with QC warning, values are indicated as described above but marked in red text. Data from samples and assays that do not pass QC should be treated with caution.
- For each plate and assay, values for LQL, LOD, LLOQ and ULOQ, as well as results for assay QC in **Assay warning** are presented on separate rows below the data for the samples.
- Missing data frequency is reported for each assay and indicates the percentage of samples with values < LQL, > ULOQ as well as failed data.

Result and QC results					In Data report			
Sample QC	Calibrator QC precision	Sample Control QC precision and/ or accuracy	Calibrator and/or Sample Control QC replicates within LOQ	Data between LQL and ULOQ	Data Output Format	Sample QC	Assay QC	Notes
Pass	Pass	Pass	Pass	Yes	pg/mL	Pass	Pass	
Fail	Pass	Pass	Pass	Yes	pg/mL	Warning	Pass	Treat with caution
Pass	Fail	Pass	Pass	Yes	pg/mL	Pass	Warning	Treat with caution
Pass	Pass	Fail	Pass	Yes	pg/mL	Pass	Fail	
Pass	Pass	Pass	Fail	Yes	pg/mL	Pass	Fail	
Pass	Pass	Pass	Pass	No; < curve fitting	NaN	Pass	Pass	
Pass	Pass	Pass	Pass	No; < LQL	pg/mL	Pass	Pass	Treat with caution
Pass	Pass	Pass	Pass	No;	> ULOQ	Pass	Pass	

15.2 NPX files

The NPX results can be exported as an XLSX file. The NPX data are presented as follows:

- As NPX values.
- Values below LQL have a red cell background.
- Data for samples with a QC warning are indicated in red text. Data from samples that do not pass QC should be treated with caution.
- The LOD value for each assay is presented on a separate row below the data for the samples and is indicated as LOD.
- Missing data frequency is presented for each assay and indicates the percentage of samples with values below plate LOD.

15.2.1 Wide format

Study Name	Olink® NPX Signature version																													
NPX data or Quantified data																														
Panel	Panel 1 (version xxxx)					...					Panel x					Panel 1		...		Panel x		Panel 1		...		Panel x				
Assay	1	2	3	...	21						1	2	3	...	21	Plate ID			Plate ID		QC Warning			QC Warning						
Uniprot ID	1	2	3	...	21						1	2	3	...	21															
Olink ID	1	2	3	...	21						1	2	3	...	21															
Unit																														
Sample #1	1	2	3	...	21						1	2	3	...	21	plate_1. csv			plate_x. csv		Pass / Warning			Pass / Warning						
Sample #2	1	2	3	...	21						1	2	3	...	21	plate_1. csv			plate_x. csv		Pass / Warning			Pass / Warning						
Sample #x	1	2	3	...	21						1	2	3	...	21	plate_1. csv		...	plate_x. csv		Pass / Warning			Pass / Warning						
...																														
[Assay warning] (Pass / Fail / Warning)	1	2	3	...	21						1	2	3	...	21	plate_1. csv			plate_x. csv											
Plate LOD	1	2	3	...	21						1	2	3	...	21	[plate_1. csv]			[plate_x. csv]											
[ULOQ]	1	2	3	...	21						1	2	3	...	21															
[LLOQ]	1	2	3	...	21						1	2	3	...	21															
Missing Data freq. (%)	1	2	3	...	21						1	2	3	...	21															
Normalization	1	2	3	...	21						1	2	3	...	21															

15.2.2 Long format

Column	Description	Type	Table format
SampleID	The annotated sample ID	String	Ct, NPX, Quant
Index	Well index in 96 plate	Integer	Ct, NPX, Quant
OlinkID	OlinkID for assay	String	Ct, NPX, Quant
UniProt	UniProt ID for assay	String	Ct, NPX, Quant
Assay	Short name for assay	String	Ct, NPX, Quant
MissingFreq.	Frequency of missing data (below LOD or NaN)	Float	NPX, Quant
Panel	Panel name assay belongs to	String	Ct, NPX, Quant
Panel_Version	Data file version for the panel	Integer	Ct, NPX, Quant
PlateID	Name of the plate the sample was run on	String	Ct, NPX, Quant
QC_Warning	Indicates whether the sample passed QC or not	String PASS, WARN or FAIL	NPX, Quant
Plate_LQL			Quant
Plate_LOD	LOD value for assay	Float	NPX, Quant
LLOQ			Quant
ULOQ			Quant
Quantified value			Quant
Unit			Quant
Assay_Warning	Indicates whether the assay passed QC or not	String PASS or WARN	NPX, Quant
NPX			NPX
Normalization	Type of normalization used in study	String Plate control or Intensity	NPX, Quant
Ct			Ct
QC Deviation Inc Ctrl			NPX, Quant
QC Deviation Det Ctrl			NPX, Quant
Olink NPX Signature version	Software version of the module in Olink NPX Signature used for panel calculations and normalization		Ct, NPX, Quant

15.3 Analysis Report

The analysis report is a pdf-file that can be generated from Olink NPX Signature. The analysis report summarizes the quality analysis of the project. It contains basic information and descriptions of the project. It also contains a summary of the Quality control including sample passed QC.

Go to **Export -> Report** and select all panels to be included in the Analysis Report. Click Create to save the Analysis Report as a PDF document. A preview of the document will appear.

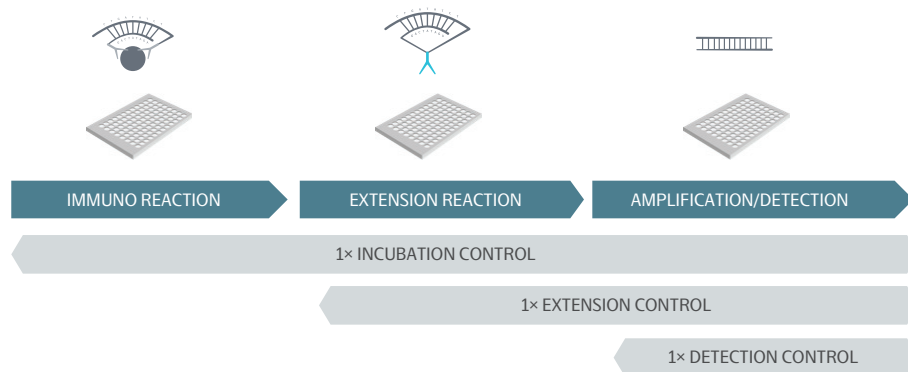
The Analysis Report contains the following:

- Study information
- Quality control
 - Summary of Quality Control of samples
 - Summary of Quality Control of assays
 - Intra- and Inter-Assay Coefficient of Variance (%CV)
 - o Average %CV
 - o Intra-Assay %CV Distribution
 - o Inter-Assay %CV Distribution
 - Protein detection results
 - Number of proteins detected
 - Data output
 - o Data output for absolute quantification
- Samples that did not pass QC
- Observed deviations

Part 4: Quality control

16. Overview

Olink has built-in quality controls in all multiplex panels. Each Olink Focus panel contains up to 24 assays, including three internal controls. The internal controls allow for an in-process quality control designed to monitor different steps of the protocol: immuno reaction, extension and amplification/detection. The controls included are illustrated in the figure below:



- The Incubation Control consists of a non-human antigen measured with PEA assays. This control monitors potential variation in all three steps of the reaction.
- The Extension Control is an antibody coupled to both DNA-tags (hence always in proximity). This control monitors the extension/pre-amplification and amplification/detection step and is used for normalization of the data.
- The Detection Control is a complete double stranded DNA amplicon which does not require any proximity binding or extension step. This control monitors the amplification/detection step.

The internal controls are used for both sample and run QC as described below. The quality control of data is performed separately for each sample plate.

Each Olink Focus panel also contains three types of external controls that are added in triplicate or duplicate on each sample plate.

16.1 Sample QC

Each of the internal controls are spiked into all samples at a set concentration. The signals for these are therefore expected to be the same over the entire plate. Sample QC is performed using Detection Control and Incubation Control. Within each run, the levels of these controls are monitored for each sample and compared against the plate median of all samples. If either of the controls deviate more than the acceptance criteria allow (see below), the sample gets a QC Warning and the sample is flagged in Olink NPX Signature. The Extension Control is used in the normalization step and in generation of NPX, and hence is not included in the quality control of data.

For acceptance criteria for passing a sample, refer to [14. Perform quality controls](#).

Deviating values for the internal controls can be caused by, for example, errors in pipetting or pre-analytical factors in the samples that affect the performance of the controls. For more information on troubleshooting samples that do not pass QC, refer to [19. Deviating controls](#).

16.2 Run QC

The internal controls are also used in the run QC. This QC assesses the variation over the plate for the Incubation Controls and the Detection Control. If the variation for one of the controls is too large (see below) the entire run is considered unreliable.

If a too large variation is observed for either of the controls, go to the Plate QC -> Assay QC tab to evaluate the data. For example, if individual samples show extreme values or if a certain sample column is affected, these samples can be marked as failed, and the QC redone and re-evaluated. For more information on troubleshooting of this step, refer to [19. Deviating controls](#).

In addition to passing or failing individual plates, ensure that no systematic bias is present in the data. The Plate metrics view in the bottom left corner alerts you to such issues.

%CV is calculated using the Sample Controls on each sample plate. The reported %CV in the Plate Metrics field is the mean %CV over all assays and all sample controls, and this is only calculated using data in pg/mL for Focus panels with absolute quantification and linear NPX data for panels with relative quantification, from panels with absolute quantification, or with linear NPX values if the panel only provides NPX results, non-flagged replicates within LOQ. A high %CV does not fail a run automatically but should be a cause for further investigation.

%CV calculated for the replicates of each specific sample control is reported in the analysis report, while the %CV in NPX Signature is a mean of all sample controls.

For acceptance criteria for passing a run, refer to [14. Perform quality controls](#) and for reference values for %CV, refer to [14.5.1 Perform a quality assessment](#).

16.3 Assay QC

Quality control of assays is performed for Olink Focus panels. For Focus panels with absolute quantification, an expected concentration value for the Sample Controls for each assay is defined during the validation of the panels. The accuracy and precision for the calculated concentration values are evaluated for each assay.

For Focus panels with relative quantification only precision is calculated and evaluated.

For acceptance criteria for passing an assay, refer to [14. Perform quality controls](#).

17. Normalization methods

Olink uses an arbitrary, relative quantification unit called Normalized Protein eXpression (NPX). In qPCR, the x-axis value of the point where the reaction curve intersects the threshold line is called the Cycle threshold (Ct). This indicates the number of cycles needed for the signal to surpass the fluorescent signal threshold line.

17.1 Calibrator normalization

Calibrator normalization is used for Olink Focus panels. The calibrators are used to determine the protein concentration in the panel. The calibrators consist of a buffer with a spike-in of recombinant antigen for each assay. Randomization of samples across and within plates is recommended but not mandatory.

For the Olink Focus panels, the Extension Control, the Calibrators and the bridging factor are used for the normalization calculation. NPX is derived from the Ct values obtained from the qPCR using the following equations:

Each sample is normalized with the Extension Control:

$$Ct_{\text{Sample } i, \text{ Assay } j} - Ct_{\text{Sample } i, \text{ Assay Ext ctrl}} = dCt_{\text{Sample } i, \text{ Assay } j}$$

Each plate is normalized with its Calibrators to generate NPX levels and is adjusted against a pre-determined bridging factor:

$$\text{Bridging factor}_{\text{Assay } j} - (dCt_{\text{Sample } i, \text{ Assay } j} - \text{Median}(\text{Calibrators}_{\text{Sample } i, \text{ Assay } j})) = NPX_{\text{Sample } i, \text{ Assay } j}$$

The NPX unit is unique to each protein assay, meaning that even if two different proteins have the same NPX values, their concentrations in pg/mL may differ.

The bridging factor is determined by Olink during the validation of the panels, and for each new kit lot, a lot-specific bridging factor is defined.

17.1.1 Results in standard unit (pg/mL)

The method for quantification of data in standard units (pg/mL) is described in this section.

Method overview

The method requires fewer sample wells in each plate/run for controls compared to e.g. running a full calibration curve on each plate, allowing more wells to be used for customer samples.

Before the run (during product development at Olink):

1. A precise pre-defined standard curve is established for each protein.
2. A bridging factor, utilized to ensure accuracy between production batches, is calculated.
3. A four parameter logistic (4PL) model fit is performed to define the standard curve mathematically within the measurement range for each protein in the panel.

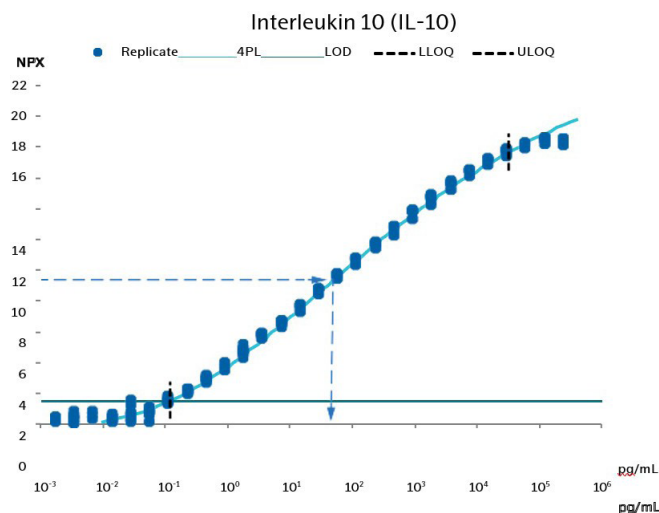
After each run:

1. The median value of each Calibrator triplicate is used to adjust the measured samples along the y-axis (NPX) to normalize between plates. In other words, the samples are normalized in the same way as the standard curve is during development. The samples are also adjusted against the bridging factor, see formula above.
2. The adjusted standard curve model, is used to convert the measured NPX value to the protein concentration in pg/mL.

Standard curve

During development, a thorough fine-tuned 32-point standard curve is developed for each protein biomarker simultaneously, including all 21 assays. Multichannel pipetting and numerous replicates of the curves are used to minimize errors and establish an accurate immunoassay curve fitting. Due to the wide dynamic range of the PEA assays in the panel, a large spread of measurement points is required to cover the entire range. Eight measurement points, which are commonly used in many technologies, would not suffice for Olink's multiplex measurement of max 21 assays. The predefined standard curves avoid operator- dependent reconstitution and pipetting of standard curves at each lab and for each run. The figure below shows an example of a point standard curve defined for one assay during development.

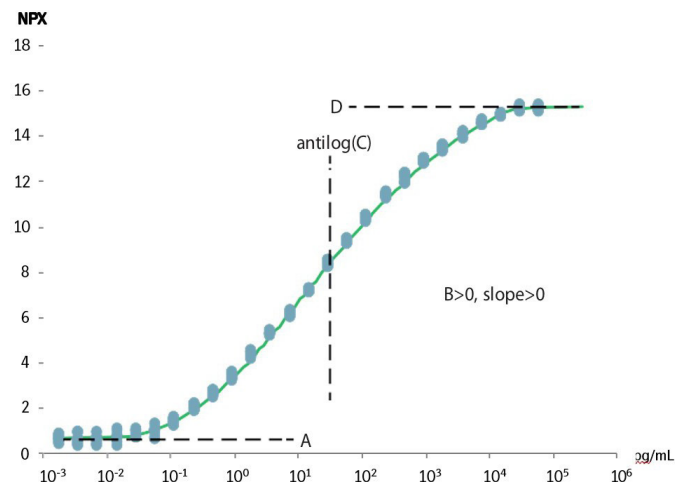
For standard curves for each assay, refer to the Panel validation report provided by Olink.



A 32-point standard curve defined for each assay during development.

4PL model

A 4PL model curve fit is used to describe the immunoassay standard curve, indicated by the turquoise line in the figure above. When running a study, the measured sample value (represented by the dotted blue arrows) is related back to the adjusted standard curve model which translates the measured value to the protein concentration in pg/mL using the equation below. Where A = asymptote (a constant value) at low doses, B = slope factor, C = EC50 (mid-range concentration) and D = asymptote at high doses. These parameters are indicated in the figure below. An example of a point standard curve defined for each assay during development.



An example of a point standard curve defined for each assay during development.

$$\text{Concentration (pg/mL)}_{\text{Sample I, Assay J}} = \frac{10^{\left(10^{\left(\frac{\log_{10}\left(\frac{(A-D)}{(\text{NPXvalue}_{\text{Sample I, Assay J}} - D)} - 1\right)} + \log_{10}(C)\right)}\right)}}{1000}$$

Repeated testing and validation show that the 4PL curve fitting describes the standard curve well and can be used to correctly estimate the protein concentration in analyzed samples within the limits of quantification. The approximate lower and upper limits of quantification (ULOQ and LLOQ) are defined during the development of the panel, and specifications for LLOQ and ULOQ are established for each lot. This information is available in the individual Panel Validation Reports provided by Olink.

Results reported in pg/mL

The figures and list below provide an overview of how data in pg/mL is reported in the results file.

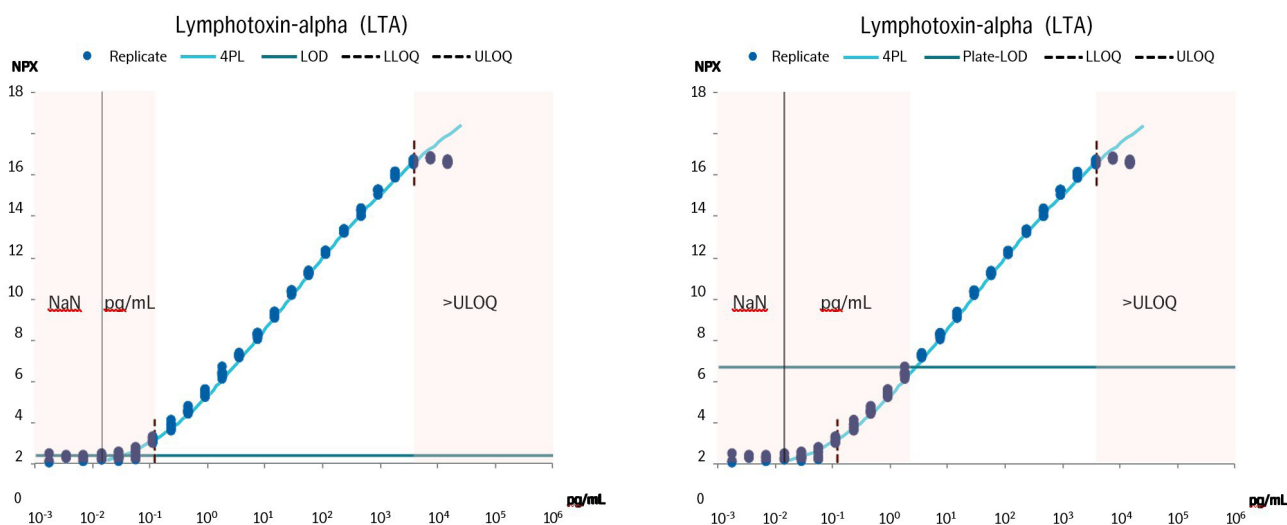
- Data between LQL and ULOQ is reported as a pg/mL value and shown in the white areas of the graphs.



NOTE: Lowest Quantifiable Level (LQL) is defined as the value used as the lower limit, LLOQ (default) or plate LOD (when plate LOD > LLOQ).

- Data below the lowest fitting parameter in the 4PL curve fit model cannot be calculated and is indicated as NaN in the red areas of the graphs.
- Data >ULOQ is indicated as >ULOQ in the red areas of the graphs. Values above ULOQ are not reported in pg/mL due to high risk of misinterpretation of hooking data.
- Data below LQL is presented in pg/mL value in the red areas of the graphs. Values below LQL should be treated with caution due to decreased precision and accuracy in the lower range and should not be used for individual comparison to reference values.

For a more detailed list describing the results file, refer to [15. Export data](#).



Overview of how data in pg/mL is reported in the exported results file depending on if LLOQ > plate LOD (left) or if plate LOD > LLOQ (right).

17.1.2 LOD and CV calculation

LOD is defined as being three standard deviations (SDs) above the median NPX of Negative Controls. The median is set using all samples annotated as Negative Controls per plate. A predefined SD is used (fixSD). Detectability is calculated per assay and plate and is defined by the percentage of samples in which the assay was detected above the LQL threshold. The overall detectability of the project is generated and reported in the Analysis Report.

The CV is calculated per assay (i) using the assumption of a log-normal distribution. The average CV is then calculated across the panel and included in the Analysis Report output.

$$CV_i = 100 \sqrt{e^{S\ln_i^2} - 1}, \text{ where } S\ln_i = \ln(2) \times SD_i$$

Part 5: Troubleshooting

18. Introduction

This chapter describes issues that may arise during use of Olink NPX Signature, or data issues during analysis of Olink Focus studies, and how to solve these issues.



NOTE: The figures in troubleshooting are schematic only and do not reflect the current interface of Olink NPX Signature for Olink Focus.

18.1 Warning messages

The following warnings can be displayed:

1. Opening Study
 - a. Could not identify the panel
 - The panel data file associated to plates in the study cannot be located and thus not identified. Navigate to Settings -> Panels and import the required panel data file (.xml file format). Refer to [13. Start or open a project](#).
2. Importing Run Data
 - a. Quality Threshold does not meet specified criteria 0.5.
 - The Quality Threshold defined for analysis was not set to 0.5. Open *Run data* in Fluidigm Realtime PCR Analysis software and export the data after analyzing with a quality threshold of 0.5.
 - b. Baseline Correction method is not set to Linear.
 - The Baseline Correction method defined for analysis was not set to Linear. Open run data in Standard Bio Tools and export the data after analyzing with a baseline correction method of Linear.
 - c. Unsupported plate format
 - The run data was not acquired with a supported chip type.
 - d. Unsupported probe-type count, expected 1.
 - The run data was not acquired with a supported protocol
 - e. Panel types must match in study
 - The study already contains a plate for one panel type (Olink Target 96, Olink Target 48, etc.). All plates in the study must be run for the same panel type.
 - f. Run barcode already exists in a study for the panel
 - The run data for this chip has already been imported to the study.
 - g. Data integrity file not found in the archive
 - The run data checksum file was not found in the Olink Q100 Signature export. The run data must be analyzed and exported from Fluidigm Realtime PCR Analysis software before importing.

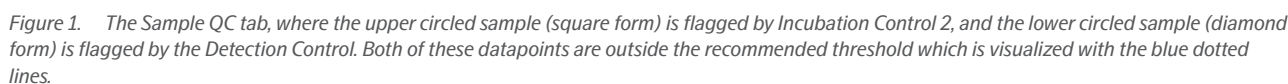
- h. Could not locate data file in file
 - The run data analysis export was not located in the Olink Q100 Signature export file. This may be due to a corner finding error during analysis, due to:
 - o Insufficient amount of ROX dye in corner wells
 - o Contrast not optimal
 - o Edge sample or assay is not loaded (e.g. air bubbles or particle clogging of the chip)

Unzip the run data archive and open the ChipRun.bml in Fluidigm Realtime PCR Analysis software to analyze and export data. Manually set the corners using Fluidigm Realtime PCR Analysis software, export in CSV format and import in Olink NPX Signature.

Make sure to zoom in to clearly see where the wells should be (if empty). All wells will not fit optimally, the important ones are the four corner wells.

- i. Datafile checksum not verified
 - The run data contained in the Olink Signature Q100 export file failed to validate using the checksum values generated when the analysis was performed. This may indicate that the run data has been modified after it was initially analyzed when the run was going to be completed. Unzip the run data archive and import the results_all.csv, results_all.csvx, or results_heatmap.csv file directly.
3. Importing Panel Data Files
- a. Data file already exists
 - A panel definition with the same name and version is already imported in the application. If importing an updated version of an existing panel, the old version must first be removed.
4. Importing Sample Manifest Files
- a. Unrecognized file extension for sample plate manifest
 - The file format could not be processed. Supported formats are .csv file with comma value separated plate definitions and Olink NPX Signature XLSX format.
 - b. No Sample-ID defined in input data
 - The sample manifest import file does not define the Sample-ID column
 - c. No Plate-ID defined in input data
 - The sample manifest import file does not define the Plate-ID column

Issue	Explanation	Reason	Action
A sample is flagged.	A sample is flagged when one or several internal controls deviate from the plate median for that specific sample.	All flagged samples in a study are shown under Study -> Summary in the table Flagged or failed samples.	The behavior of the internal controls makes it possible to understand why the sample is flagged. See the rest of this section for more information. For more detailed information about flagged samples, click the Plate QC -> Sample QC tab (Figure 5) and the Assay QC tab (Figure 8).



20. Sample flagged by Detection Control

Issue	Explanation	Reason	Action
A sample is flagged by Detection Control.	The NPX value of the Detection Control for this specific sample deviates more than 0.3 NPX from the plate median.	One example can be seen in Figure 1 and Figure 2 . Data is normalized using the Extension Control. Since both Incubation Control and the Extension Control display decreased Ct-values, the normalization step will adjust the data. The Detection Control that did not show decreased Ct-values will be overcompensated by normalization against the Extension Control and thereby deviate from the rest of the sample set after normalization.	This type of flag is generally caused by the same reasons as flagged Incubation Control. It is not uncommon that both the Incubation Control and Detection Control flag simultaneously, but with opposite “direction” in the Sample QC. This is seen when the flagged sample affects both the extension and immunoassay step, but to different extent. See examples in section 19.1.1 .

20.1 Deviating external controls


Issue	Explanation	Reason	Action
High Intra-CV value	Intra-CV value is larger than 15%.	The Sample Control replicates differ within the sample plate.	Check sample annotation of the Sample Controls and that they pass QC. Check the row pattern for rows containing sample control replicates to make sure that none of the rows is an outlier (e.g. issue with a channel on one of the multichannel pipettes). For panels with sample controls in triplicate, one Sample Control replicate deviates from the other two and this pattern can be confirmed for several assays, this could indicate a manual issue with this replicate. In such case, that replicate can be failed and the remaining replicates used for CV calculation. Please contact support@olink.com for further guidance.

High Inter-CV value	Inter-CV value is larger than 25%.	The Sample Control replicates differ between sample plates.	Check sample annotation of the control samples and that they pass QC. For panels with controls in triplicate, if one Sample Control replicate deviates from the other two and this pattern can be confirmed for several assays, this could indicate a manual issue with this replicate. In such case that replicate can be failed and the remaining used for CV calculation. Please support@olink.com for further guidance.
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Issue	Explanation	Reason	Action
High LODs affect the number of samples that can be quantified above LOD.	Calculated LODs are out of expected range.	<ul style="list-style-type: none"> • Wrong data file version. • Wrong panel. • Contamination of Negative Controls. • Wrong annotation of Negative Controls, Sample Controls or Calibrators. 	<ul style="list-style-type: none"> • Confirm annotation of Negative Controls, Sample Controls and Calibrators. • Confirm data file version: reanalyze data. • Please contact support@olink.com for further guidance.
Sample Control intra CV > 30% and/or accuracy > ±30% causing many failed assays.	Sample Control intra CV > 30% and/or accuracy > ±30%.		Check sample annotation of the Sample Controls and that they pass QC. Check the row pattern for rows containing sample controls to make sure that none of the rows is an outlier (e.g. issue with a channel on one of the multichannel pipettes). For panels containing controls in triplicate, if one Sample Control replicate deviates from the other two and this pattern can be confirmed for several assays, this could indicate a manual issue with this replicate. In such case that replicate can be failed and the remaining used for CV and accuracy calculation. Please contact support@olink.com for further guidance.

Calibrator intra CV > 30% resulting in many assays with warning.	Calibrator CV > 30%.	Calibrator replicates differ within the same plate.	Check sample annotation of the Calibrators and that they pass QC. Check the row pattern for rows containing calibrator replicates to make sure that none of the rows is an outlier (e.g. issue with a channel on one of the multichannel pipettes). If one Calibrator replicate deviates from the other two and this pattern can be confirmed for several assays, this could indicate a manual issue with this replicate. In such case that replicate can be failed and the remaining used for CV calculation. Please contact support@olink.com for further guidance.
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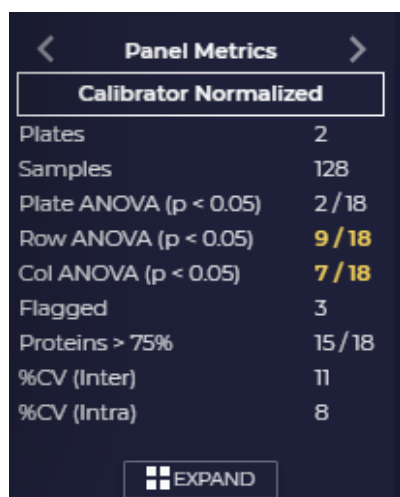
20.2 Missing sample data

Issue	Explanation	Reason	Action
Missing sample data in exported results file.	Data for some samples are not exported.	This can be caused by not using unique sample names.	<p>Ensure that sample names are unique by checking Plate QC -> Samples tab or change sample type to Control for non-unique samples to force export of data for these samples.</p> <p> NOTE: <i>this will probably affect the %CVs significantly.</i></p>

21. Inconsistent results

21.1 Variation between plates - common reasons


Issue	Explanation	Reason	Action
The "Plate ANOVA" value in the Panel metrics box (Figure 3) shows a high value. The variation is also shown on the Plate QC -> Z-scores tab.	The total NPX and/or quantified values vary between plates.	May be caused by insufficient randomization, meaning that the distribution of samples from different groups is not the same for all plates in the study.	<p>If the samples are not randomized, the result shows natural differences between the plates.</p> <p>If the samples are completely randomized, and no variation between plates are expected, further investigation is needed.</p>
High Inter CV value	Inter CV value is larger than 25%.	The Sample Controls differ between sample plates.	Check sample annotation of the Sample Controls and that they pass QC.



Panel Metrics	
Calibrator Normalized	
Plates	2
Samples	128
Plate ANOVA (p < 0.05)	2 / 18
Row ANOVA (p < 0.05)	9 / 18
Col ANOVA (p < 0.05)	7 / 18
Flagged	3
Proteins > 75%	15 / 18
%CV (Inter)	11
%CV (Intra)	8
EXPAND	

Figure 3. The Panel metrics field, with a Plate ANOVA value that indicates variation between plates.


21.2 Variation within a plate - common reasons

Issue	Explanation	Reason	Action
The columns or rows ANOVA in the Plate Metrics or Panel Metrics box show high values. The effects are visualized in the Assay QC tab.	Areas of a plate (columns and/or rows) have systematically higher or lower values (Ct and/or NPX) than the rest of the plate.	The variation is caused by the sample position on the plate. Within-plate effects are often caused by laboratory mistakes.	See examples in section 21.2.1 .  NOTE: Make sure that the deviation cannot be explained with biological variation, i.e. that a unique sample group is placed on one column/row.
Position effects/patterns: visible only for Internal controls			
All internal controls are affected on Ct-level in a similar manner (all increased or decreased.)	One sample column or row consistently show deviating values.	Pipetting error, e.g. pipette not pre- conditioned.	Exclude data from analysis and/or rerun.
		Mistake during pipetting of the incubation solution, extension solution, detection solution or samples.	Refer to Figure 4 .
		Evaporation due to incomplete sealing of plate during incubation or PCR steps.	Exclude data from analysis and/or rerun.
		Different sample matrices.	QC matrices separately.
Incubation Control and Extension Control differ from Detection Control on Ct-level.	Incubation and Extension Controls show the same pattern, Detection Control shows another pattern.	PCR instrument not good at keeping 50 °C, Detection Control not affected by extension step.	Rerun from immuno reaction step.
		May be pre-analytical (interfering factors may affect all controls but the Detection Control).	Contact support@olink.com for further guidance.
Incubation Control differ from Extension and Detection Controls.	Incubation Control shows deviating pattern.	Pre-analytical factors in samples that interfere with the immuno reaction.	Few deviating samples: Exclude samples from subsequent statistical data analysis. > 1/6th of samples deviating: Contact support@olink.com for further guidance.
Position effects/patterns: visible for samples and Internal controls			
Columns/rows/parts of sample plate.	Patterning that follows sample naming/sample matrices.	Different sample matrices.	QC different sample matrices separately.
Gradient over the sample plate.	Upper or lower part or left and right part of the plate affected with clearly deviating values.	Chip issue. Poor vortexing in extension step. Poor mixing of detection mix. Uneven temperature in PCR block.	Rerun. Contact support@olink.com for further guidance.

21.2.1 Common problems and reasons for within-plate effects.

Problem	Possible cause	Figure reference
First column different than the rest of the plate (observed for internal controls).	The pipette was not preconditioned.	
A specific column or columns is/are different than for the rest of the plate (observed for internal controls).	A mistake when the incubation solution, extension solution, detection solution or samples were pipetted.	Figure 5.
One row consistently different from the rest of the plate (observed for internal controls and/or samples).	The pipette tip in that specific position was not tight enough.	
A gradient from row A to row H.	Pipetting was done at an angle. The plates were not sufficiently vortexed.	Figure 8.
Deviating Z-score distribution for single assays on one plate.	Primer contamination. NB! Primer contamination on Focus chips would affect both plates that are run on the same chip"	Figure 7.

21.3 Extreme outliers - common reasons

Issue	Explanation	Reason	Action
Extreme blue or red lines in heatmap (when only selecting "samples" in the drop-down menu) or outlier dots in z-score view.  NOTE: Extreme outliers can be discovered in different views (Plate QC -> Z-scores, Assay QC, Heatmap). In Figure 4 , two types of outliers are illustrated.	Sample with extremely low or high protein quantification.	Incorrect dilution of sample. Sample with low/no protein conten.	Fail sample. If it can be determined that the deviating results from the sample has not been caused by the handling of the sample but rather is a result of the sample itself, do not fail the sample.

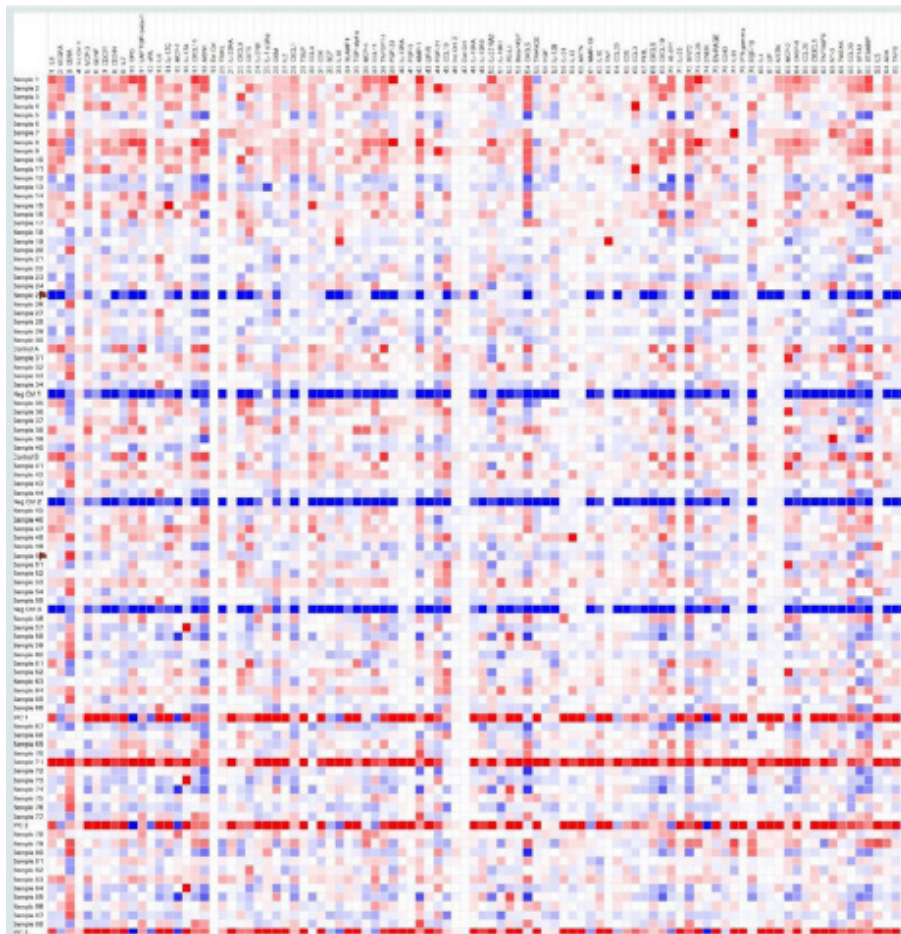


Figure 4. Heatmap with data display type Delta with NPX values from a single plate run which contains two outliers. Sample 25 has the lowest NPX values for all assays and Sample 71 has the highest NPX values for all assays.

For Sample 25 in the figure above, most NPX values are below LOD and one conclusion for this outlier is that there is no biological sample present in that well.

For Sample 71 in the figure above, the NPX values are higher than for the rest of the samples. This can e.g. arise from poor dilution of a sample.



Figure 5. Ct-values that show results of laboratory mistakes. Refer to table below for description of errors performed on this run.



Figure 6. NPX values that show results of laboratory mistakes. Refer to table below for description of errors performed on this run.

Explanation of columns in Figure 5 and Figure 6. Red numbers indicate laboratory mistakes.

	Column 4 (correct)	Column 7	Column 8	Column 9	Column 10	Column 11	Column 12
Incubation mix (µL)	3	3	3	3	3	6	3
Sample volume (µL)	1	1	1	0	2	1	1
Extension mix (µL)	96	96	192	96	96	96	96
Detection mix (µL)	7.2	14.4	7.2	7.2	7.2	7.2	7.2
PCR product (µL)	2.8	2.8	2.8	2.8	2.8	2.8	5.6



Figure 7. Ct values that show primer contamination of Incubation Control 2.

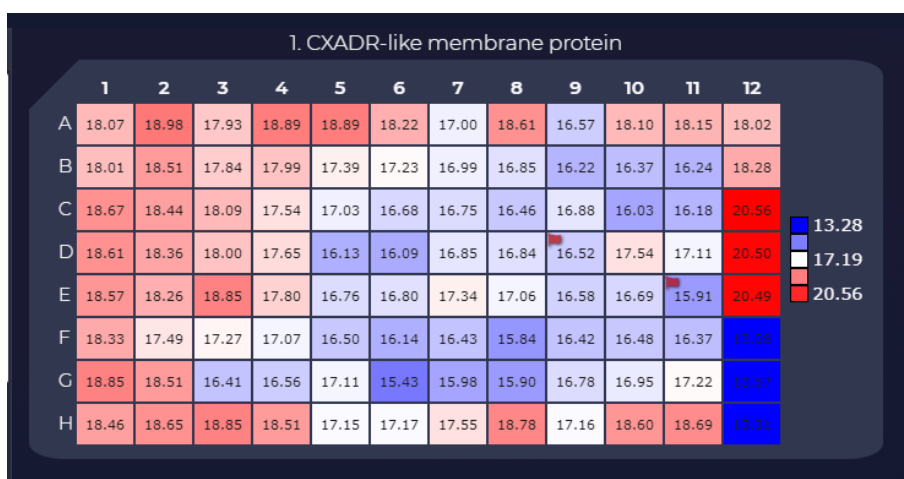


Figure 8. Within plate effects due to incorrect or insufficient vortexing of the sample plate during sample dilution. Note that column 11 and 12 does not exist in an Olink Focus project.

21.4 High NPX signals - common reasons

Issue	Explanation	Reason	Action
Unexpectedly high NPX signals in diluted panel for the majority of samples.	Low variation between samples Saturated assays (may be visualized in Z-scores tab).	Samples were not diluted.	Rerun from sample dilution step.

22.Revision history

Version	Software version	Date	Description
1.12	1.12	2024-02-16	14 : table updated. 15.2.2 : updated. 15.3 updated. Figure 1 updated.
1.11	1.11	2023-11-21	6 , flowchart updated and statistical analysis removed. 13.3 Note added. Screenshots updated.
–	1.10	–	No user manual updates.
1.9	1.9	2023-10-26	14 : first table updated Changed version number to correspond the software version (version 1.2–1.8 does not exist) Added Software version column to revision history Editorial changes
1.1		2023-02-15	8.1 updated. Editorial changes.
1.0		2022-11-15	New

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1300, v1.12, 2024-02-16