HEXAGON

Q-DAS Product Line

Unbalance measurements

Data format, applications and possibilities

CAS
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	30.08.2023	GA	Initial release
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CONTENTS

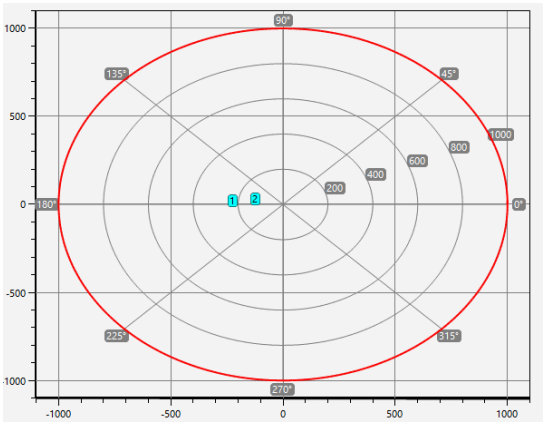
1 Foreword

Unbalance measurements are very specific applications with a variety of possibilities depending on the production AND measurement process. In this document we will go a little bit into the possible variants of the different unbalance measurement types and how measuring instrument manufacturers could write the file format accordingly. These are only suggestions, which always have to be worked out in a project in cooperation with the end customer, the measuring device manufacturer and the Q-DAS project team.

Due to the complexity of the topic, it is necessary to explain some chapters in advance and to explain the interrelationships only in the later chapters. It may therefore be necessary to read this document several times and iteratively.

2 General consideration

An unbalance is basically a simultaneous consideration of magnitude and angle. Optimally written in polar notation as an unbalance group. (the notation of the DFQ file will be explained later). This is then shown accordingly in the graphic "Positional tolerances". For the sake of simplicity, here are only 2 measurements.



But this view is not quite correct either. We can see the angle in the polar notation in the picture. Measurement 2 is somewhat closer to the zero point with approximately the same angle, i.e. less "amount".

But is this representation correct?

The representation in the coordinate system would only be correct if the clamping of the components was the same. For example, in one set-up 2 measurements in a row after a correction. Or, if there is a marking on the components which then specifies "0°", so that each produced component is inserted in the measuring device in the same way (for example, a groove which then reflects the 0°).

Considerations of unbalances in the graphic "Positional tolerances", i.e. also their writing as polar data, therefore only make sense if repeat measurements are carried out in the same clamping or if the "0°" is given by a component geometry. Otherwise, the pure consideration of the amount as a completely normal characteristic is preferable.

3 Different types of measurement for unbalances

The list of possible procedures shown here does not claim to be exhaustive. The author of this document is always prepared to include deviations from this list.

3.1 Measure and if necessary discard the component

The simplest form of unbalance analysis. Sometimes the 100% measured components are so inexpensive to produce that after the measurement, the only thing that is checked is whether the amount of unbalance is within the specifications. If within, the component is delivered, if outside, the component is disposed of.

But even in this simple case, the question must be asked whether one keeps the measurements of the bad components in order to get an evaluation afterwards why. (Unless the reject rate is already being tracked in other systems.

Also the consideration is, despite the first simple consideration of the amount to separate good parts and scrap parts, to write the angle anyway, as long as a clear 0° - point can be defined on the part.

3.2 Measuring and reworking

One of the most common types of measurement. After production, the component is measured. If the amount is too large, then reworking is carried out (removal or application of material). Then measured again.

Here, too, it is important to record all data. Not only the last measurement. How good were the corrections? How many corrections had to be made? Were there over-regulations due to the corrections?

3.3 Measuring in the production plant and subsequently with higher-quality measuring equipment after production.

Sometimes there are systems in which a component is measured directly in the production line. An unbalance measurement in the clamping of the production and correction system. Here, the component is measured, corrected (removal or application), measured again, etc. Only after this process is the component measured again on a higher-quality measuring device outside the correction system. And corrected again if necessary.

In addition to the questions as in the previous example, there are further questions here: Do you separate the data sets, one data set for the inline measurements, one for the downstream measurement? In order to be able to evaluate the quality of the corrections on the one hand, and with the offline data set the quality that goes to the customer, as well as in the comparison of the two (related to the repeated reworking after the offline measurement), to improve the inline system?

3.4 Measuring with different speeds / levels / oil fillings

The last measurement technique known to the author is measurement at multiple speeds, or deviating oil fillings, or other levels, as well as combinations of both. This means that many measurements are taken. All measurements must be "passed", in each speed range, with each oil fill. These are unbalance groups written in parallel.

It is recommended to use the polar notation in order to see if the component behaves differently with the same clamping but different speeds/oil fillings.

4 Coding

Since all measurements, including those that are repeated, are important, the measurements in additional data fields should receive various additional data information.

Roughly listed in prose what information might be of interest:

- Component already OK after first measurement
- Component OK after corrections
- Component already NOK after first measurement, no reworking possible
- Component after x maximum permitted corrections NOK
- Measurement is repeated
- Sequence number of the repeat measurement/corrections
- Calibration measurement carried out before test item measurement
- Part ID of the component

This information is given to each measured value. For the OK/NOK information as well as the information whether this measurement will be repeated (important: not this measurement was repeated, but this measurement WILL be repeated), this is optimally done in the events catalogue. The codes of these events and their contents (here the entries 501 to 505) are communicated to the manufacturer of the measuring device and written to ALL measured values of a test object, as status information for the test object, regardless of the individual measured value.

Catalogue

Events Catalogue

cons. no.	Number	Description	Remarl
23	E0023	Resistance too high	
24	E0024	Short circuit	
25	E0025	Fuse triggered	
26	E0026	Resistance too low	
27	E0027	Tastes bad	
28	E0028	Saline	
29	E0029	Too cold	
30	E0030	Too spicy	
31	E0031	Too sweet	
32	E0032	Too hot	
501	1	Component already OK after first measurement	
502	2	Component OK after corrections	
503	3	Component after first measurement already NOK, no rework possible	
504	4	Component after x maximum allowed corrections NOK	
505	5	Repeated measurement	

5 Ordinal characteristic at the beginning of the data set

The use of an ordinal characteristic at the beginning of the data set is not obligatory, but facilitates the evaluation afterwards.

An ordinal characteristic contains catalogue-based "status indications" instead of measured values, which are also indicated as OK, not OK or without evaluation. Best practice could also be that the ordinal classes catalogue entries get the same code as the events, also the same text.

Ordinal Classes Catalogue

Catalogue

Ordinal Classes Catalogue

cons. no.	Number	Description	Ev	Rank	O.K./n.O.K.	Validity
18	4	Rank 4		4	O.K.	valid
19	5	Rank 5		5	O.K.	valid
20	6	Rank 6		6	O.K.	valid
21	7	Rank 7		7	O.K.	valid
22	8	Rank 8		8	O.K.	valid
23	9	Rank 9		9	O.K.	valid
24	10	Rank 10		10	O.K.	valid
501	1	Component already OK after first measurement		11	O.K.	valid
502	2	Component OK after corrections		12	O.K.	valid
503	3	Component after first measurement already NOK, no rework possible		13	n.O.K.	valid
504	4	Component after x maximum allowed corrections NOK		14	n.O.K.	valid
505	5	Repeated measurement		15		valid

These are also summarised in a sub-catalogue.

Sub-catalogues

2.0 3.0 5.0 Nominal Kendall Unbalance

cons. no.	Number	Description
501	1	Component already OK after first measuremer
502	2	Component OK after corrections
503	3	Component after first measurement already N
504	4	Component after x maximum allowed correctio
505	5	Repeated measurement

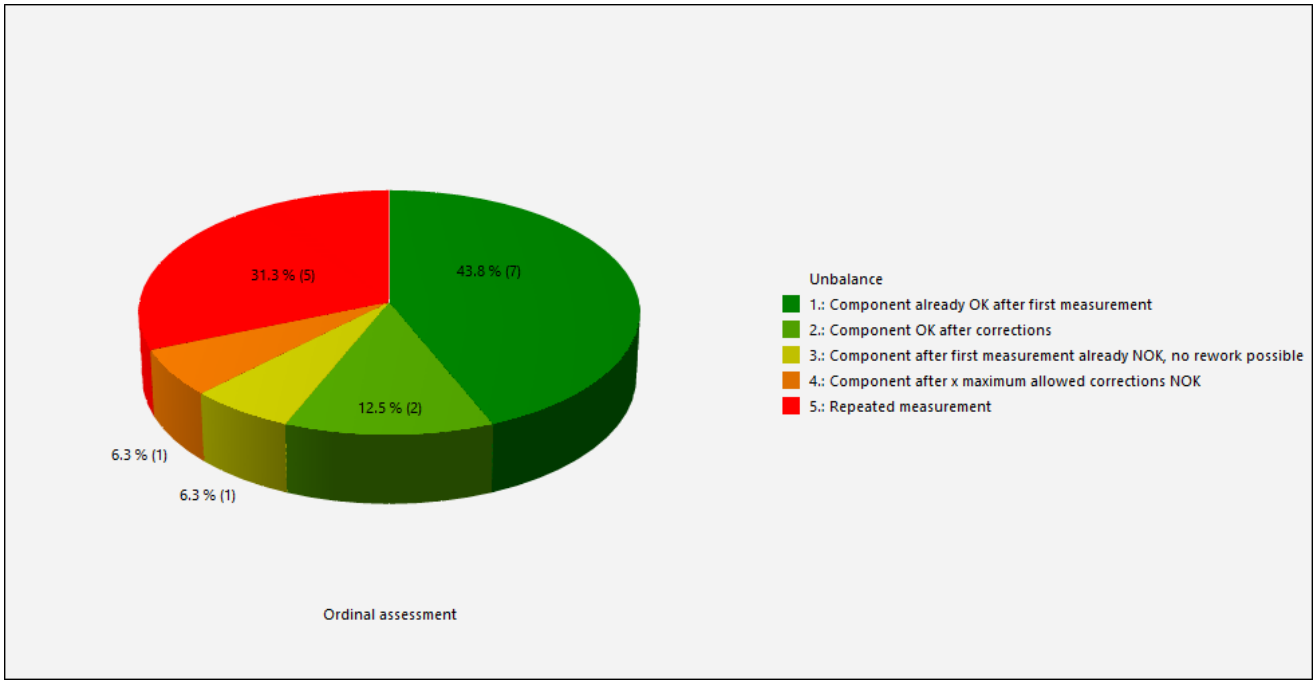
Why the double work in writing event and ordinal characteristic?

The ordinal characteristic is used for the overall evaluation. The quick overview of mass data, as described in later chapters. The marking in the events for each measured value, regardless of its individual quality, serves to see that the individual value, the individual unbalance may have been good, but the overall component was rejected for other reasons.

In the values mask, such information would look as follows:

Ordinal assessment
Component already OK after first measurement
Component already OK after first measurement
Component already OK after first measurement
Component already OK after first measurement
Component already OK after first measurement
Component already OK after first measurement
Component after first measurement already NOK, no rework possible
Repeated measurement
Repeated measurement
Component after x maximum allowed corrections NOK
Component already OK after first measurement
Repeated measurement
Component OK after corrections
Repeated measurement
Repeated measurement
Component OK after corrections

In the pie chart



6 Calibration measurements

Calibration measurements are often carried out. These should contain other information in the key fields of the header data, if they are written out as a DFQ file at all. These data should not be mixed with the measurements of the test objects.

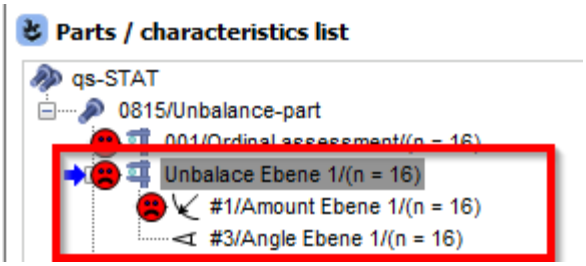
It makes sense to save the historical calibration measurements (for the same calibration piece) in order to record the ongoing corrections, if this is not offered by the measuring software itself. This would make overregulations visible, or perhaps also the need to carry out more calibration measurements.

As mentioned in the chapter "Coding", this information can also be added AFTER a calibration measurement as an event (K0005) of the measurement. This makes it possible to see in the data history when the calibration was carried out.

7 Notation of unbalances in polar notation

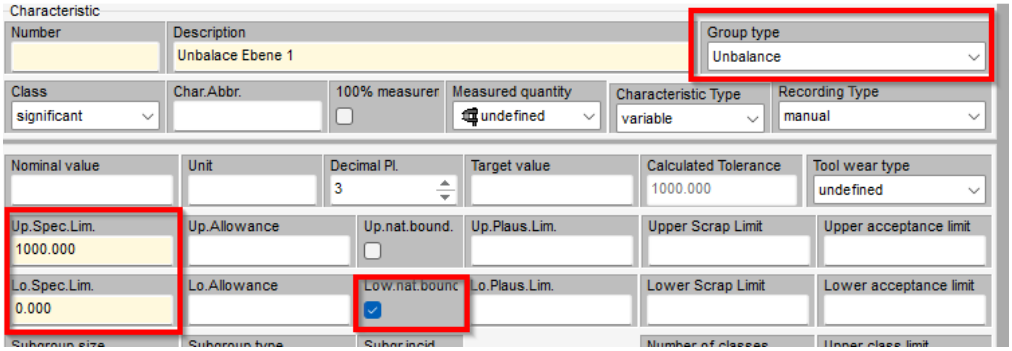
Measuring instrument manufacturers who would like to learn how to write files in polar notation can contact the Q-DAS company. The format is explained here for the Q-DAS user in the software interface.

The unbalance is written as a group structure like a positional tolerances. One superordinate characteristic, 2 subordinate characteristics:



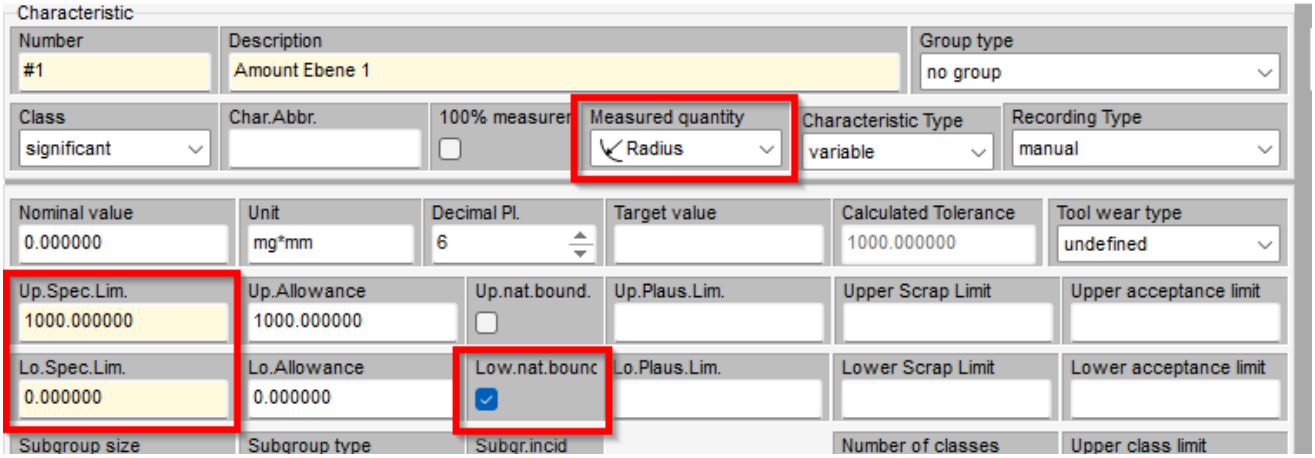
In addition to the information such as feature number / feature description, the following fields are elementary:

For the parent characteristic, the following information must be written in the K fields:



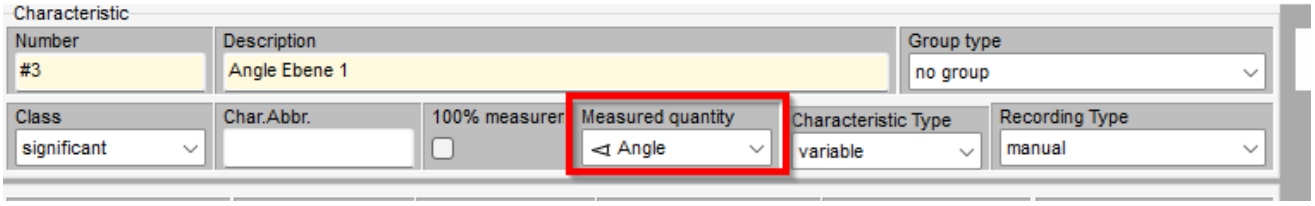
Name	K-field	Content
Group type	K2008	18
Upper specification	K2111	Limit value of the amount
Lower specification	K2110	0
lower natural boundary	K2120	2

The first subordinate element must be the amount. The following information must be stored in the K fields:



Name	K-field	Content
measurement quantity	K2009	201
Upper specification	K2111	Limit value of the amount
Lower specification	K2110	0
lower natural boundary	K2120	2

The second subordinate element must be the angle. The following information must be stored in the K fields:

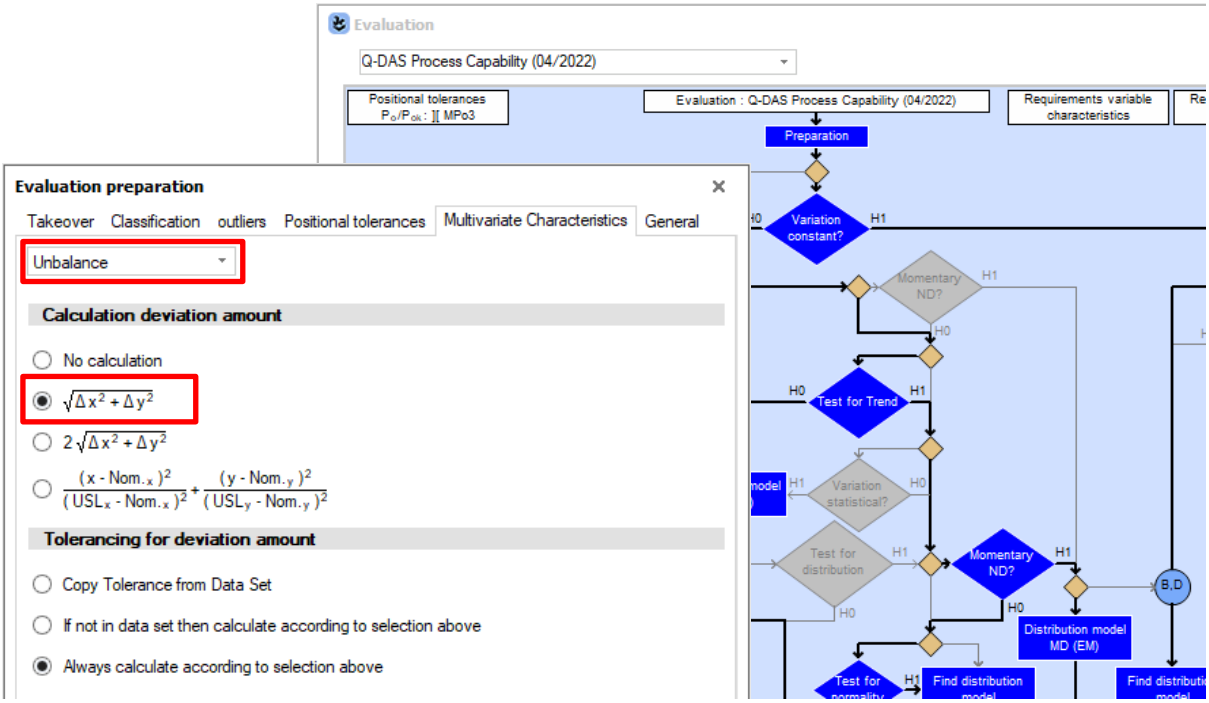


Note: the angle has no specification limits.

Name	K-field	Content
measurement quantity	K2009	203

8 Evaluation strategy for unbalances

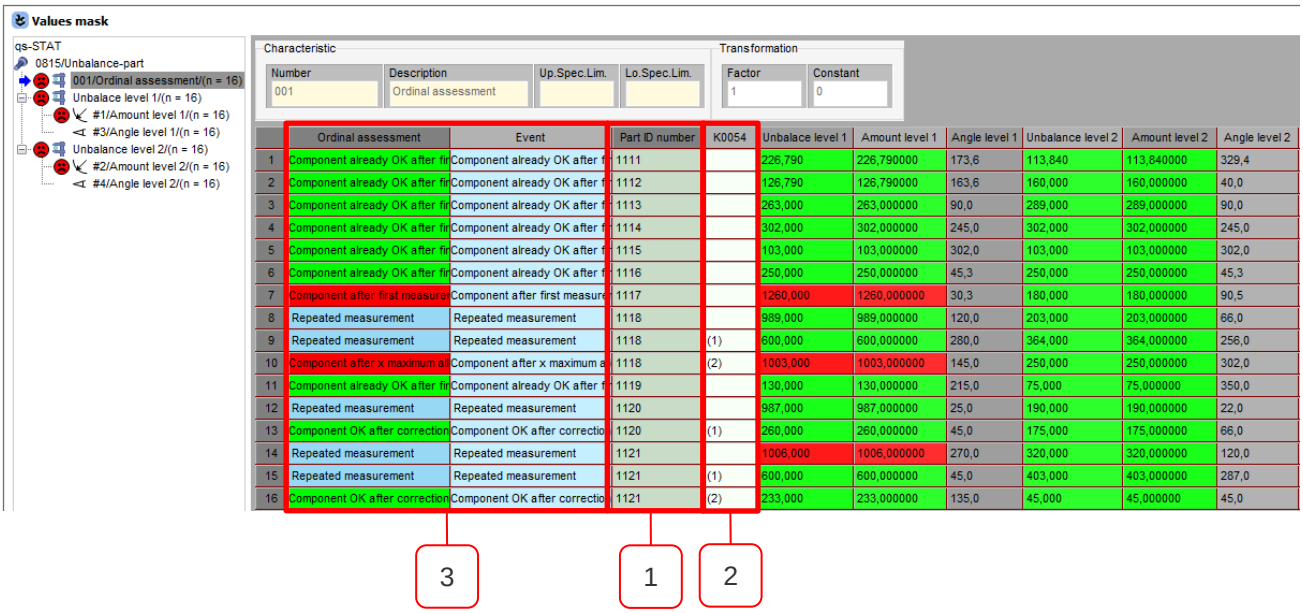
For the multivariate groups, a separate calculation of the superordinate amount is available in the evaluation strategy. Unbalances entered with the correct Group type in K2008 are considered radius observations.
<Evaluation strategy> | <Preparation> | <Multivariate characteristics>.



9 Evaluations and observations

Depending on the filtering of the data when reading from database, a different view can be generated. This is because users are assigned different filters and views depending on their position. In the following, a data set is used as an example, which is attached to the documentation.

A total of 16 measurements were taken. All measured values have the same additional data, which are only shown here for characteristic 1, the ordinal "overview characteristic":

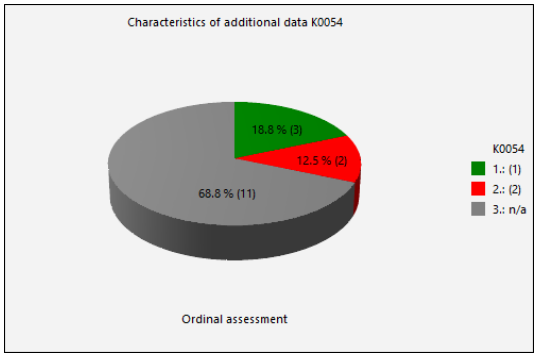


1	The part ID (K0014) to identify the test object.
2	K0054 as field to indicate the repeat measurement
3	In the event as well as in the ordinal characteristic at the beginning, the "Superordinate evaluation over the measurement series".

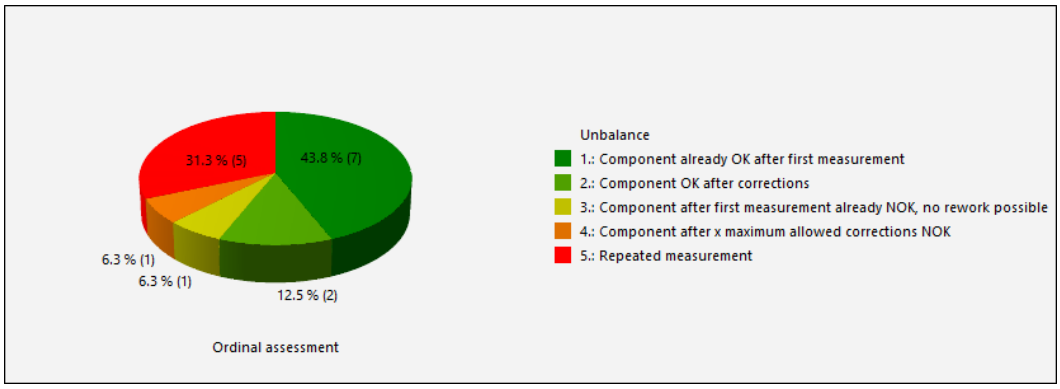
9.1 Loading all data

The frequency of corrections can be seen when all data is loaded without filtering. Users who use loading all data include, for example, employees and persons responsible for production.

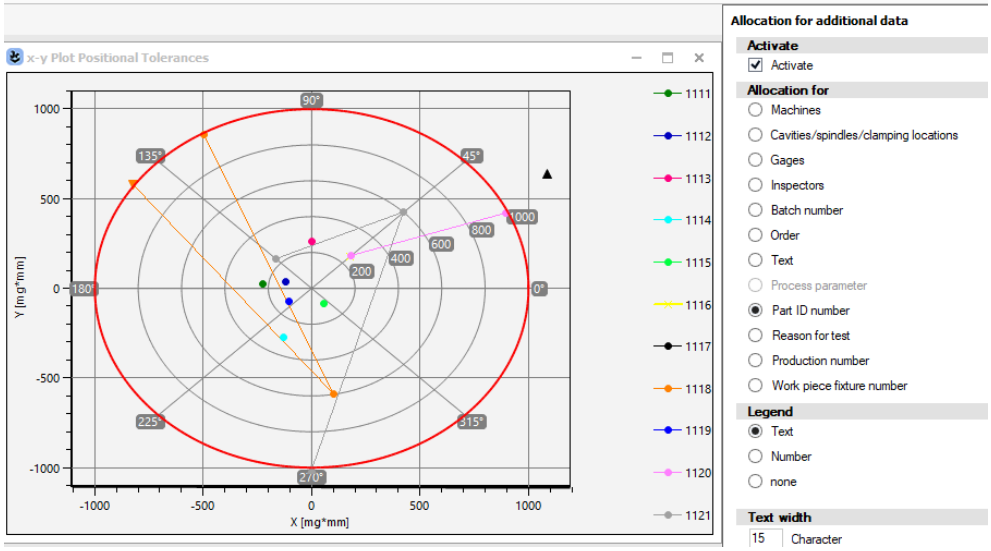
How often corrections were made can be seen after loading all the data. For example, in the pie chart of the additional data for K0054.



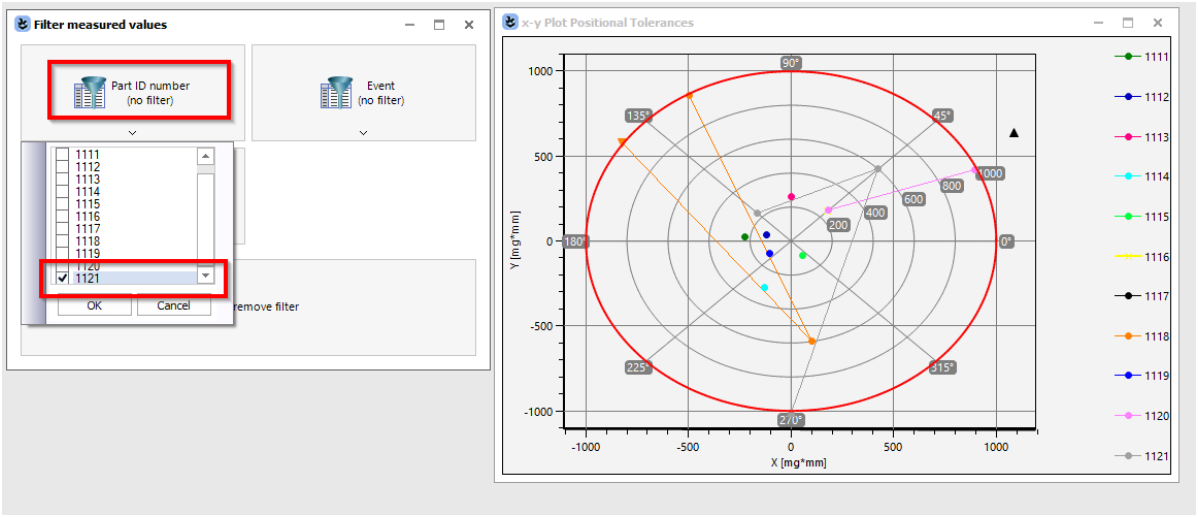
The pie chart for the ordinal characteristic shows the frequency of corrections with OK or NOK.



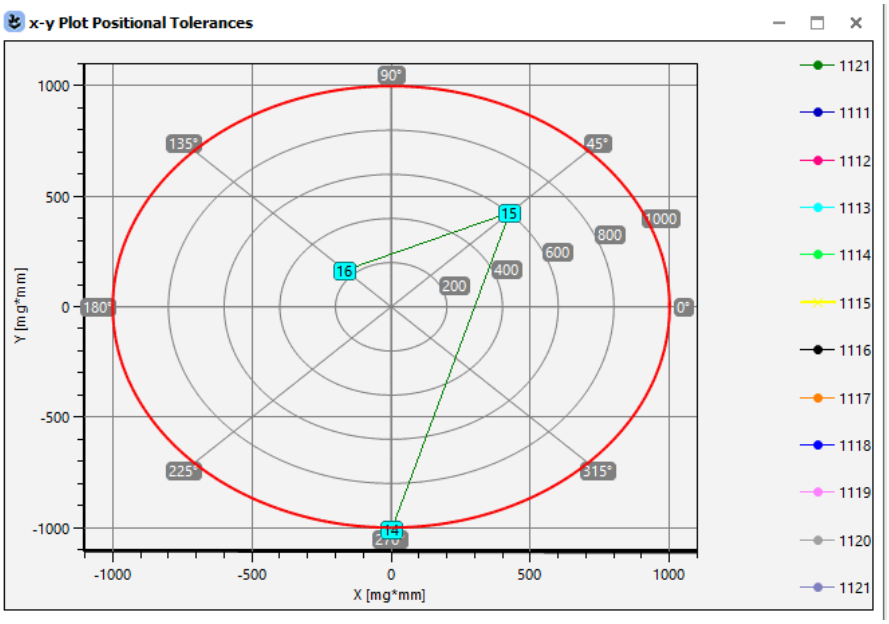
For those responsible for the corrections (i.e. how much must be removed / applied), the XY plot can be viewed with allocation for additional data:



If a particular part ID is noticeable, it can be filtered out for closer inspection using the options for filtering the measurements. Based on the loaded data, the option lists the part IDs for selection:

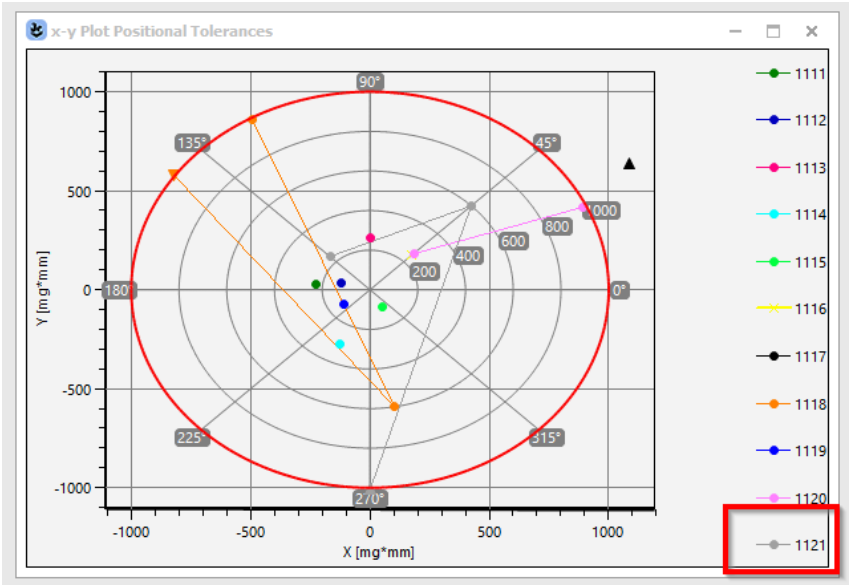


The view is reduced. By filtering a part ID, the result of the corrections can be viewed. As here in the example: after the first measurement of the test object, an overcontrol past the target.

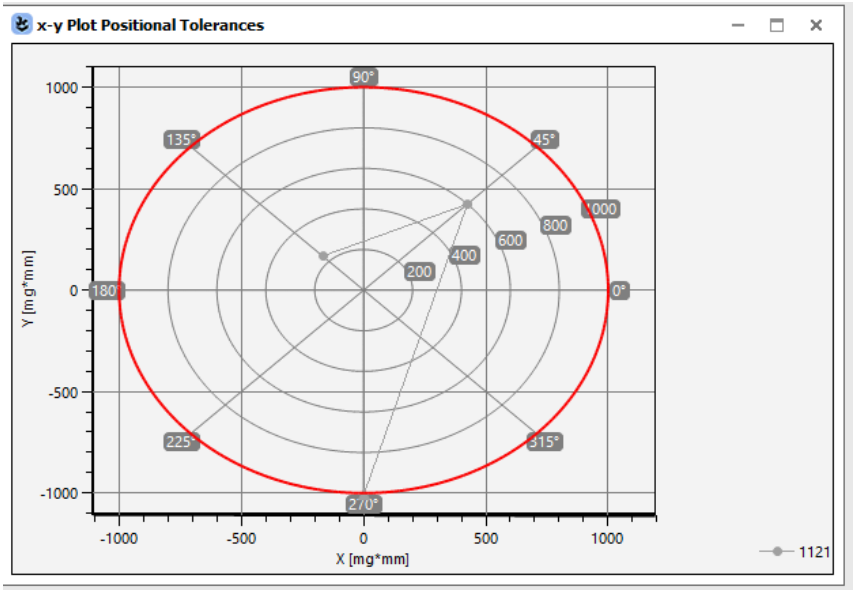


From version 15, a new option will be available to simplify this:

With a click on the displayed additional data field:



the graphical view is immediately reduced to these selected additional data.

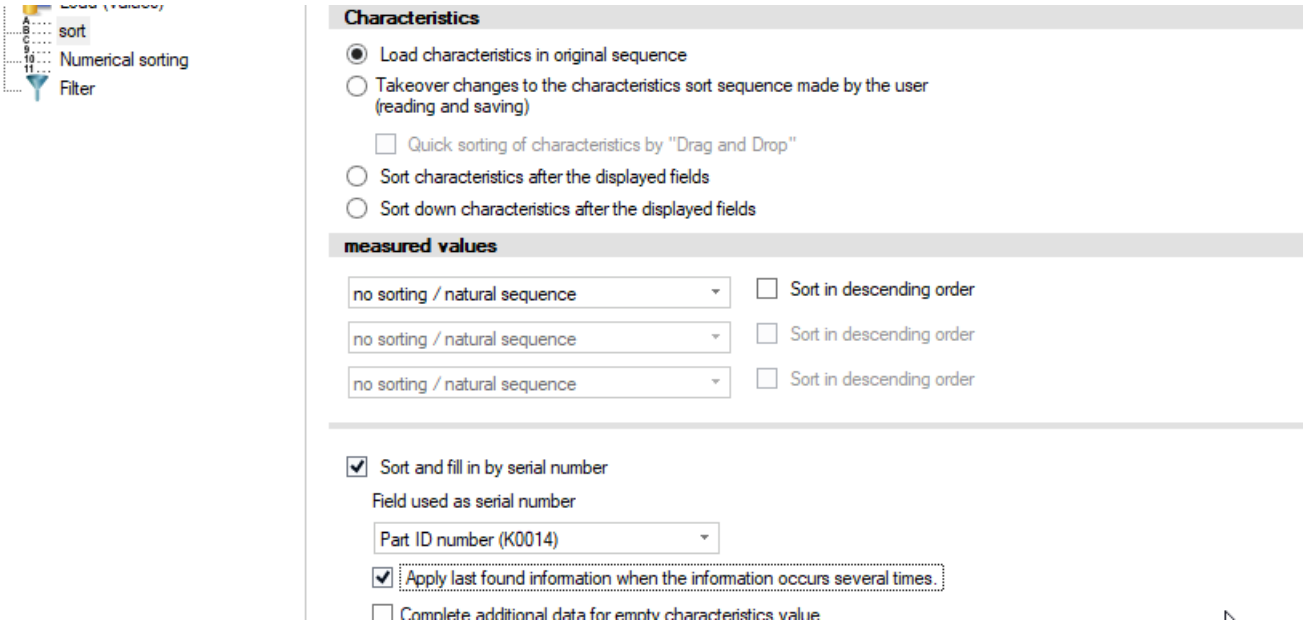


9.2 Loading the "last" measurements

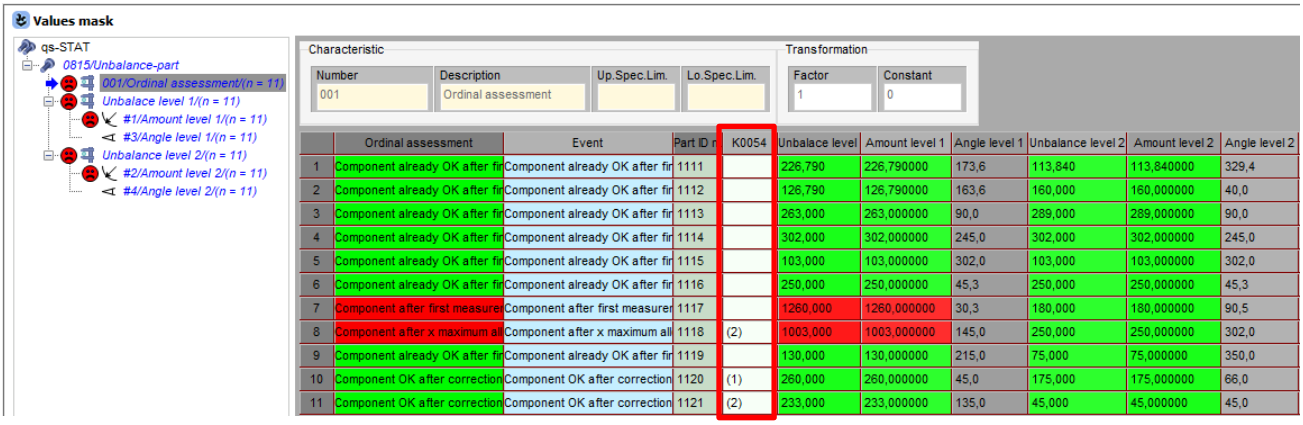
There are use cases where repeat measurements are not taken into account. This is the case, for example, when a user creates reports for parts that are discarded during repeat measurements.

Here, only the measured values of the LAST measurement are of interest to the user, as this reflects the inventory of components to be delivered.

This would be a filter and sort by part ID with the takeover of the last occurrence of a field:

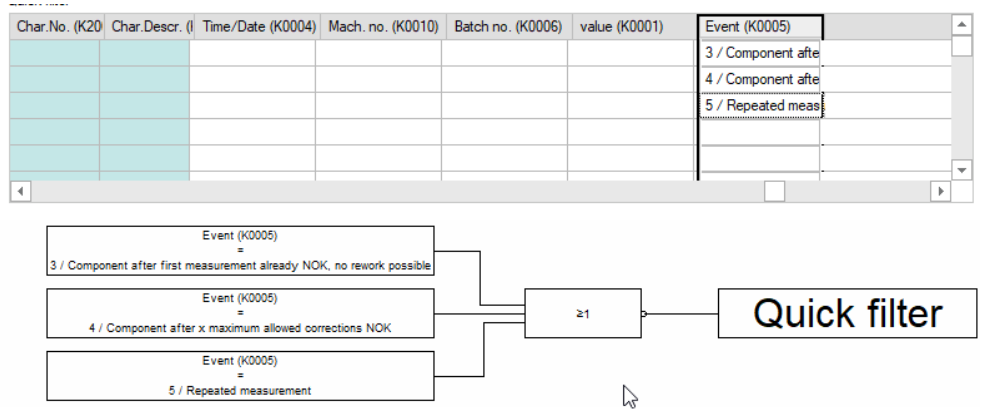


By activating the loading filter, only the last 11 measurements are loaded instead of the 16 measurements actually recorded. As can be seen from field K0054, the repeat measurements are not taken into account when loading.



	Ordinal assessment	Event	Part ID n	K0054	Unbalace level	Amount level 1	Angle level 1	Unbalance level 2	Amount level 2	Angle level 2
1	Component already OK after fir	Component already OK after fir	1111		226,790	226,790000	173,6	113,840	113,840000	329,4
2	Component already OK after fir	Component already OK after fir	1112		126,790	126,790000	163,6	160,000	160,000000	40,0
3	Component already OK after fir	Component already OK after fir	1113		263,000	263,000000	90,0	289,000	289,000000	90,0
4	Component already OK after fir	Component already OK after fir	1114		302,000	302,000000	245,0	302,000	302,000000	245,0
5	Component already OK after fir	Component already OK after fir	1115		103,000	103,000000	302,0	103,000	103,000000	302,0
6	Component already OK after fir	Component already OK after fir	1116		250,000	250,000000	45,3	250,000	250,000000	45,3
7	Component after first measurer	Component after first measurer	1117		1260,000	1260,000000	30,3	180,000	180,000000	90,5
8	Component after x maximum all	Component after x maximum all	1118	(2)	1003,000	1003,000000	145,0	250,000	250,000000	302,0
9	Component already OK after fir	Component already OK after fir	1119		130,000	130,000000	215,0	75,000	75,000000	350,0
10	Component OK after correction	Component OK after correction	1120	(1)	260,000	260,000000	45,0	175,000	175,000000	66,0
11	Component OK after correction	Component OK after correction	1121	(2)	233,000	233,000000	135,0	45,000	45,000000	45,0

Assuming a 100% measurement, the measured values with the events "NOK" and "repeat measurement" can still be excluded:



This way, only the components that will ultimately be delivered to the customer are loaded:

Component already OK after fir	Component already OK after first measurement	1111		226.790	226.790000	173.6	113.840	113.840000	329.4
Component already OK after f	Component already OK after first measurement	1112		126.790	126.790000	163.6	160.000	160.000000	40.0
Component already OK after fir	Component already OK after first measurement	1113		263.000	263.000000	90.0	289.000	289.000000	90.0
Component already OK after fir	Component already OK after first measurement	1114		302.000	302.000000	245.0	302.000	302.000000	245.0
Component already OK after fir	Component already OK after first measurement	1115		103.000	103.000000	302.0	103.000	103.000000	302.0
Component already OK after fir	Component already OK after first measurement	1116		250.000	250.000000	45.3	250.000	250.000000	45.3
Component already OK after fir	Component already OK after first measurement	1119		130.000	130.000000	215.0	75.000	75.000000	350.0
Component OK after correction	Component OK after corrections	1120	(1)	260.000	260.000000	45.0	175.000	175.000000	66.0
Component OK after correction	Component OK after corrections	1121	(2)	233.000	233.000000	135.0	45.000	45.000000	45.0

9.3 Load only the ordinal characteristic s

If no detailed analysis is necessary, but only an overview of the measurements of possibly many unbalance systems and the components balanced on them, the loading of the data can be reduced to the ordinal characteristic. This way, an overview can be created of many balancing systems in parallel with their components to be balanced there.