



HEXAGON

Basic Q-DAS examples

Introduction

FAQ
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Document History

Version	Date	Author(s)	Modifications / Remarks
	31.05.2023	BA	Initial release

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1 Foreword

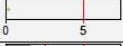
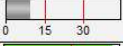

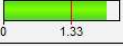

This documentation is briefly describing the example data sets located in the folder “Basic_Q-DAS_examples”. When the files are opened, users might get different results and graphics then the ones presented in this document, depending on the product used and evaluation strategy used.

Please, get familiar with evaluation strategy in your system, to be able to understand what evaluation results users can see.

2 MSA examples





2.1 MSA Type 1 study

This example is showing classical MSA Type 1 study – gage capability C_g and C_{gk} . The goal of this study is to find out if the measuring gage is capable or not. The study is done with 1 reference part and 50 measurements.

Drawing Values		Collected Values		Statistics	
$X_m + 0.1 \times T$	= 20.33200	$X_{max,g}$	= 20.313	$\bar{X}_g + 3s_g$	= 20.31745
X_m	= 20.30200	$X_{min,g}$	= 20.294	\bar{X}_g	= 20.30348
$X_m - 0.1 \times T$	= 20.27200	R_g	= 0.019	$\bar{X}_g - 3s_g$	= 20.28951
$0.2 \times T$	= 0.06000	n_{tot}	= 50	$6s_g$	= 0.02794
T	= 0.300			s_g	= 0.00466
Unit	= mm			$ Bi $	= 0.0014800
				n_{eff}	= 50
Test for Bias				Test results : significant ($\alpha \leq 5\%$)	
Bias = 0.49%					
Minimum reference figure for capable measuring system					
Resolution	%RE = 0.33%			$T_{min}(\%RE)$	= 0.0200
%EV = $\frac{EV}{T}$	= 9.31%			$T_{min}(\%EV)$	= 0.186
$C_g = \frac{0.2 \times T}{6 \times s_g}$	= $1.72 \leq 2.15 \leq 2.57$			$T_{min}(C_g)$	= 0.186
$C_{gk} = \frac{0.1 \times T - \bar{X}_g - X_m }{3 \times s_g}$	= $1.63 \leq 2.04 \leq 2.46$			$T_{min}(C_{gk})$	= 0.201
Measurement system capable (%RE, min, C_g , C_{gk})					
© Q-DAS Measurement Process Qualification (04/2022): Type 1 - (C_g/C_{gk} study)					

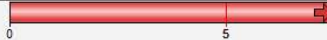



2.2 MSA Type 2 study – Tolerance

This example is showing classical MSA Type 2 study – Gage repeatability and reproducibility. The goal of this study is to find out if the measurement system (as a whole) is good enough or not for measurement process. The study is done on real parts with multiple operators. The reference figure used is tolerance range.

Variance		Standard dev.		Confidence level 1- α = 95.000%	
Repeatability	0.000072361	0.0085065	EV = 0.0070938	$\leq 0.0085065 \leq 0.010627$	%EV = 12.76%
Reproducibility	0.000011632	0.0034106	AV = 0.00045433	$\leq 0.0034106 \leq 0.024462$	%AV = 5.12%
Interaction	[pooling]	[pooling]	IA =		%IA = ---
Repeatability & Reproducibility	0.000083993	0.0091648	GRR = 0.0085368	$\leq 0.0091648 \leq 0.025905$	%GRR = 13.75%
Part Variation	0.00000	0.00000	PV = 0.00000	$\leq 0.00000 \leq 0.0037157$	%PV = 0.00%
Total Variation	0.000083993	0.0091648	TV =	0.01	
Design			Reference Figure		
No. of Trials	= 2		Process Variation	= 0.06	
Number of operators	= 3		Tolerance	= 0.40	
Number of Parts	= 10		required Cp value	=	
Resolution	%RE = 2.50%				
number of distinct categories	ndc = 1				
Repeatability & Reproducibility	%GRR = 13.75%				
Minimum reference figure for capable measuring system =			$T_{min}(\%GRR)$	= 0.367	
Minimum reference figure for measuring system of limited c=			$T_{min}(\%GRR)$	= 0.183	
Measurement system capable (%RE, min, %GRR)					
© Q-DAS Measurement Process Qualification (04/2022): Type 2 - ANOVA (tolerance)					


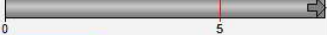


2.3 MSA Type 2 study – Total variation

This example is showing classical MSA Type 2 study – Gage repeatability and reproducibility. The goal of this study is to find out if the measurement system (as a whole) is good enough or not for measurement process. The study is done on real parts with multiple operators. The reference figure used is total variation.

Form sheet - Design 3					
	Variance	Standard dev.	Confidence level	1- α = 95.000%	
Repeatability	0.000072361	0.0085065	EV = 0.0070938 \pm 0.0085065	\pm 0.010627	%EV = 92.82%
Reproducibility	0.000011632	0.0034106	AV = 0.00045433 \pm 0.0034106	\pm 0.024462	%AV = 37.21%
Interaction	[pooling]	[pooling]	IA =		%IA = ---
Repeatability & Reproducibility	0.000083993	0.0091648	GRR = 0.0085368 \pm 0.0091648	\pm 0.025905	%GRR = 100.00%
Part Variation	0.00000	0.00000	PV = 0.00000 \pm 0.00000	\pm 0.0037157	%PV = 0.00%
Total Variation	0.000083993	0.0091648	TV =	0.00916	
Design			Reference Figure		
No. of Trials	=	2	Process Variation	=	0.06
Number of operators	=	3	Tolerance	=	0.40
Number of Parts	=	10	required Cp value	=	
Resolution	%RE	=	109.11%		
number of distinct categories	ndc	=	1		
Repeatability & Reproducibility	%GRR	=	100.00%		
Minimum reference figure for capable measuring system =			TV _{min} (%GRR)	=	0.0611
Minimum reference figure for measuring system of limited c=			TV _{min} (%GRR)	=	---
The requirements were not met (%RE,min,%GRR)					
© Q-DAS Measurement Process Qualification - Total Va: Total variation					

2.4 MSA Type 3 study – Tolerance

This example is showing classical MSA Type 3 study – Gage repeatability and reproducibility. The goal of this study is to find out if the measurement system (as a whole) is good enough or not for measurement process. The study is done on real parts without the operator. The reference figure used is tolerance range.

Form sheet - Design 3					
	Variance	Standard dev.	Confidence level	1- α = 95.000%	
Repeatability	0.0000021600	0.0014697	EV = 0.0011526 \pm 0.0014697	\pm 0.0020288	%EV = 14.70%
Repeatability & Reproducibility	0.0000021600	0.0014697	GRR = 0.0011526 \pm 0.0014697	\pm 0.0020288	%GRR = 14.70%
Part Variation	0.00031332	0.017701	PV = 0.011796 \pm 0.017701	\pm 0.026620	%PV = 177.01%
Total Variation	0.00031548	0.017762	TV =	0.018	
Design			Reference Figure		
No. of Trials	=	2	Process Variation	=	0
Number of Parts	=	25	Tolerance	=	0.060
			required Cp value	=	
Resolution	%RE	=	1.67%		
number of distinct categories	ndc	=	17		
Repeatability & Reproducibility	%GRR	=	14.70%		
Minimum reference figure for capable measuring system =			T _{min} (%GRR)	=	0.0588
Minimum reference figure for measuring system of limited c=			T _{min} (%GRR)	=	0.0294
Measurement system capable (%RE,min,%GRR)					
© Q-DAS Measurement Process Qualification (04/2022); Type 3 - ANOVA (tolerance)					

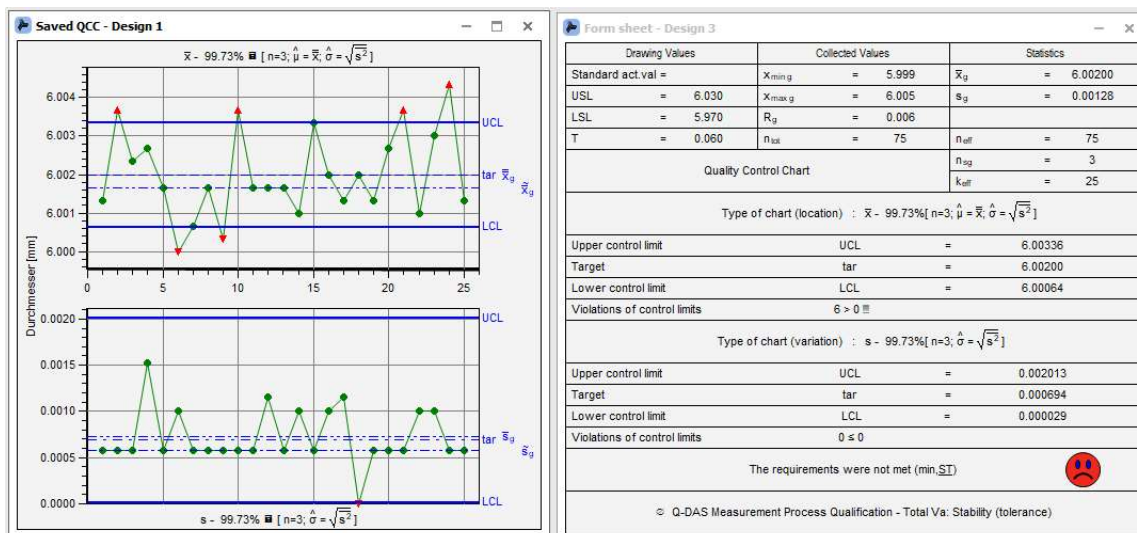
2.5 MSA Type 3 study – Total variation

This example is showing classical MSA Type 3 study – Gage repeatability and reproducibility. The goal of this study is to find out if the measurement system (as a whole) is good enough or not for measurement process. The study is done on real parts without the operator. The reference figure used is total variation.

Form sheet - Design 3					
	Variance	Standard dev.	Confidence level	1- α = 95.000%	
Repeatability	0.0000021600	0.0014697	EV = 0.0011526 \pm 0.0014697	\leq 0.0020288	%EV = 8.27%
Repeatability & Reproducibility	0.0000021600	0.0014697	GRR = 0.0011526 \pm 0.0014697	\leq 0.0020288	%GRR = 8.27%
Part Variation	0.00031332	0.017701	PV = 0.011796 \pm 0.017701	\leq 0.026620	%PV = 99.66%
Total Variation	0.00031548	0.017762	TV =	0.0178	
Design			Reference Figure		
No. of Trials	=	2	Process Variation	=	0
Number of Parts	=	25	Tolerance	=	---
			required Cp value =		
Resolution	%RE	=	5.63%		
number of distinct categories	ndc	=	17		
Repeatability & Reproducibility	%GRR	=	8.27%		
Minimum reference figure for capable measuring system =			TV _{min} (%GRR)	=	0.00980
Minimum reference figure for measuring system of limited c=			TV _{min} (%GRR)	=	---
The requirements were not met (%RE,min,%GRR)					
© Q-DAS Measurement Process Qualification - Total Va: Total variation - Type 3					

2.6 MSA Stability study

Stability study is often used regularly to check if the measuring gage is stable or not after time. It is sometimes used in combination with procella module (more information can be found on help site <https://help.hexagonmi.com/bundle/q-das/page/gc.html> in the document “Stability-cards”). The calibrated standard is used during the study.





2.7 MSA Linearity study

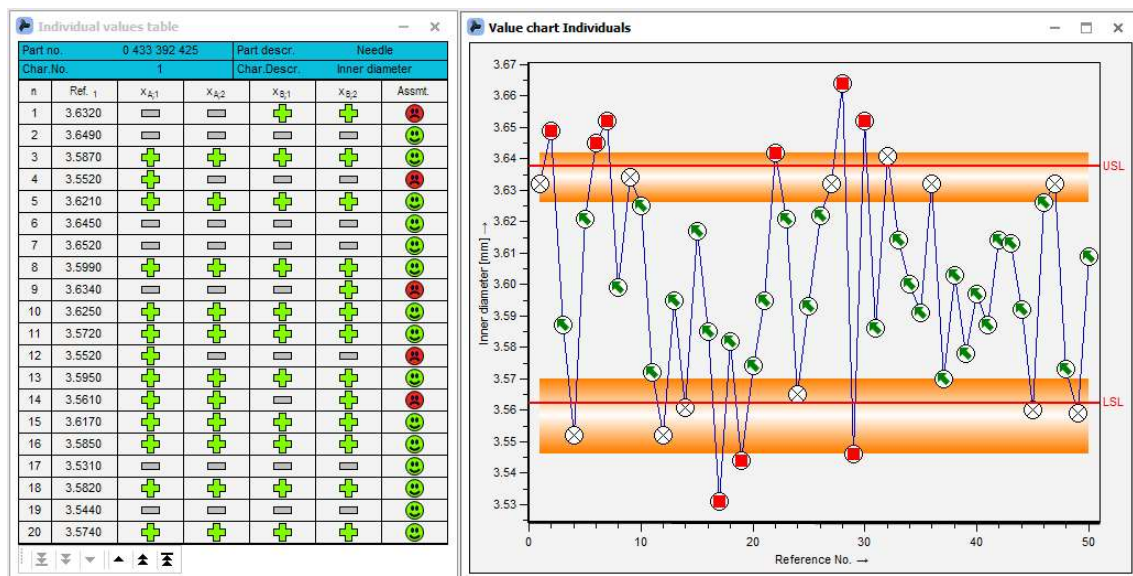
This study is used to find out whether or not the gage is measuring in the same linear way across the whole tolerance range. Multiple standards are used during the study.

Form sheet - Design 3

Linear equation	=	f_x	=	$-0.4670 + 0.0477 x$	%R ²	=	62.249%
Test of slope							
α	=	5%	H ₀	Regression line gradient equals 0			
			H ₁	Regression line gradient unequal to 0			
upper critical value ($\alpha = 5\%$)			2.05	Test results - significant ($\alpha \leq 0.1\%$)			
upper critical value ($\alpha = 1\%$)			2.76	6.79491***			
upper critical value ($\alpha = 0.1\%$)			3.67				
H ₁ *** : Regression line gradient unequal to 0							
Test of intercept							
α	=	5%	H ₀	Regression line intercept equals 0			
			H ₁	Regression line intercept unequal 0			
upper critical value ($\alpha = 5\%$)			2.05	Test results - significant ($\alpha \leq 0.1\%$)			
upper critical value ($\alpha = 1\%$)			2.76	6.60738***			
upper critical value ($\alpha = 0.1\%$)			3.67				
H ₁ *** : Regression line intercept unequal 0							
Process Variation	=	Process Var.	=	0			
Repeatability	=	EV	=	$0.0085734 \pm 0.013411 \pm 0.014760$			
Repeatability	=	%EV	=	8.05%			
B	=	0.039000	% B	=	3.90%	B target = 5.00%	
Measurement system capable (Bi)							
Q-DAS Measurement Process Qualification - Total Va: Linearity (tolerance)							

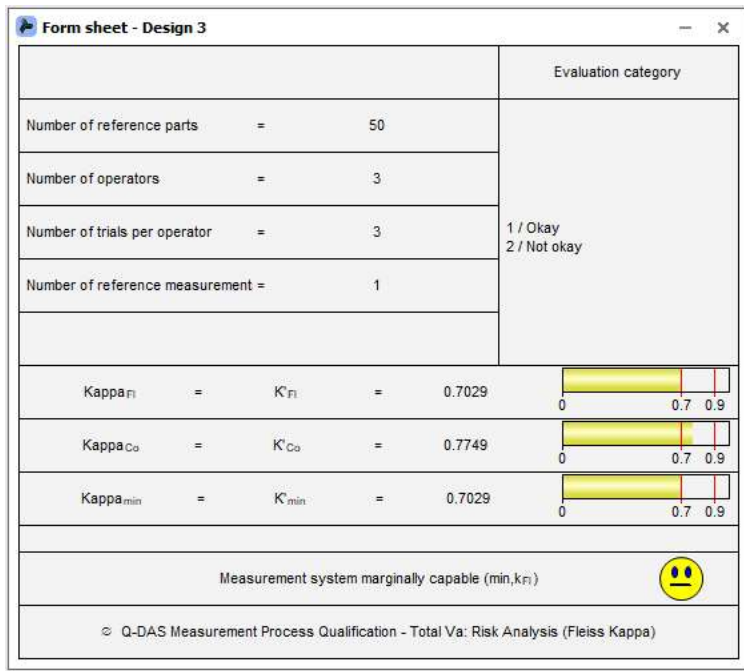
2.8 MSA Attributive signal detection





This study is used for attributive testing systems (OK/NOK) where reference measurement can be done.



2.9 MSA Nominal / Ordinal kappa study

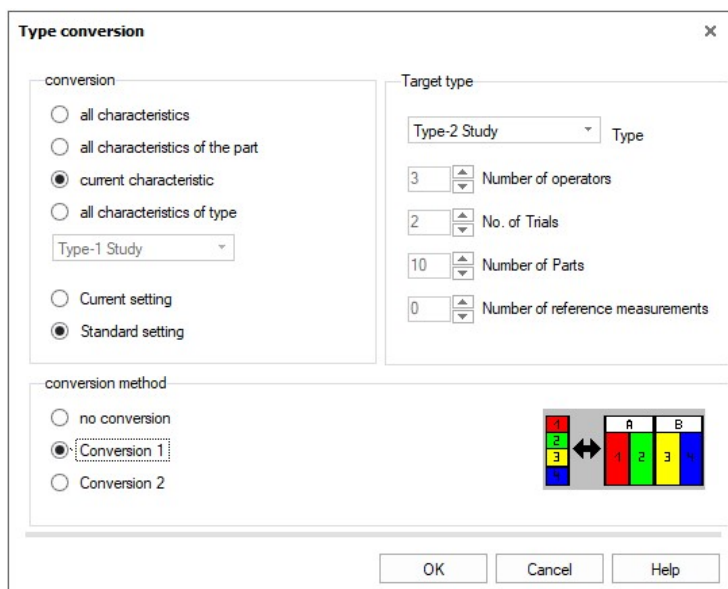
This study is used for attributive testing systems (two or more possible states of the real parts) with or without reference measurement. The main requirement is the kappa. With the same dataset, different studies can be evaluated (Effectiveness, Fleiss kappa, Cohen kappa etc..).



				Evaluation category	
Number of reference parts	=	50		1 / Okay 2 / Not okay	
Number of operators	=	3			
Number of trials per operator	=	3			
Number of reference measurement	=	1			
Kappa _{F1}	=	K' _{F1}	=	0.7029	
Kappa _{C0}	=	K' _{C0}	=	0.7749	
Kappa _{min}	=	K' _{min}	=	0.7029	
Measurement system marginally capable (min, K _{F1}) 					
© Q-DAS Measurement Process Qualification - Total Va: Risk Analysis (Fleiss Kappa)					

2.10 MSA FAQ type conversion

This example only explains the principle of conversion from one type of study to another. Detailed information about conversion can be found on the help platform https://help.hexagonmi.com/bundle/q-das/page/menu_file.html under "Type conversion".



conversion

- ☐ all characteristics
- ☐ all characteristics of the part
- ☒ current characteristic
- ☐ all characteristics of type

Type-1 Study

- ☐ Current setting
- ☒ Standard setting

Target type

Type-2 Study

Type

3
Number of operators

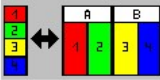
2
No. of Trials

10
Number of Parts

0
Number of reference measurements

conversion method

- ☐ no conversion
- ☒ Conversion 1
- ☐ Conversion 2



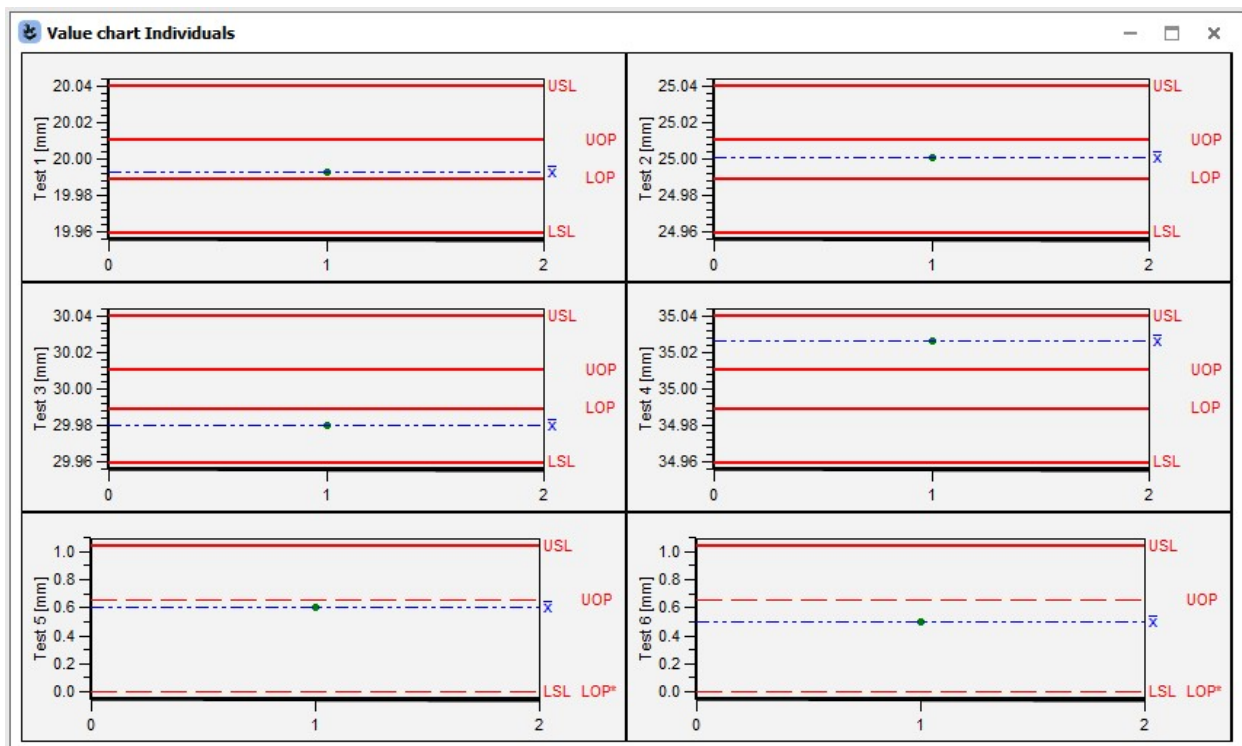
OK
Cancel
Help

3 Sample analysis examples

3.1 Sample analysis 1 part study

This study is used often for setup of a production machine, using 1 part analysis.

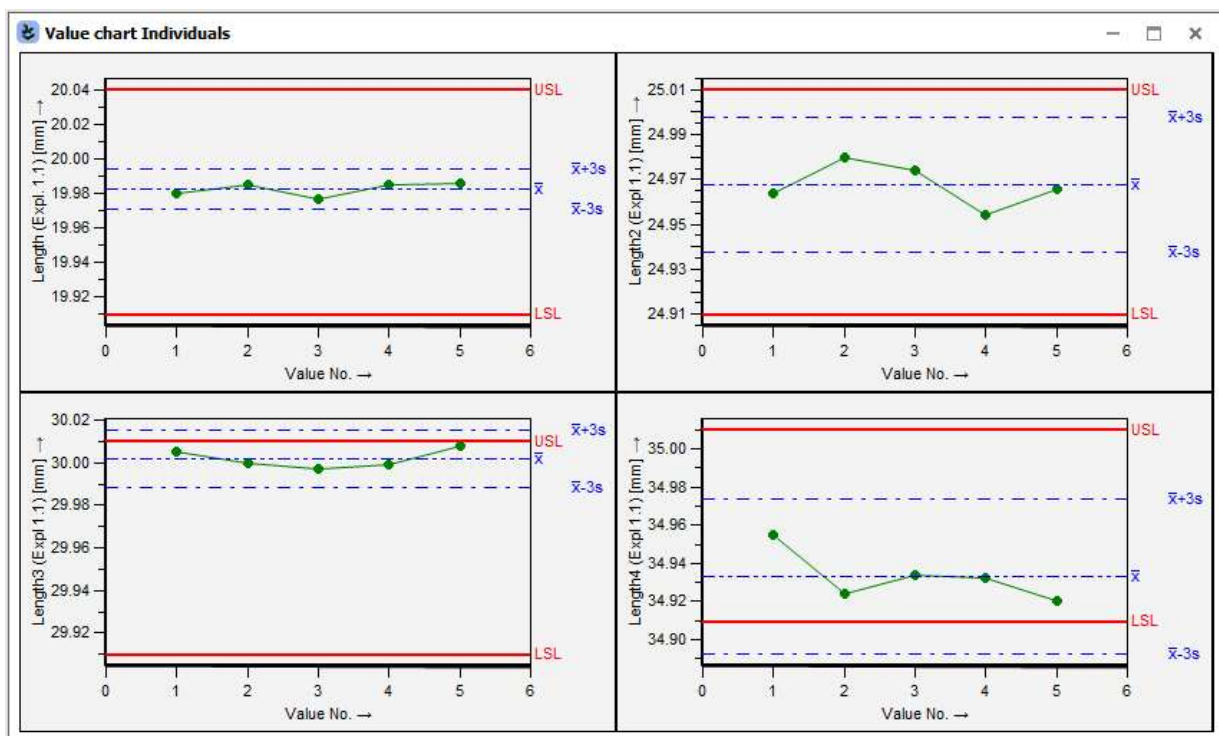
1 Part Report						
Char.No.	Char.Descr.	LSL	USL	x	$x - T_m$	Requirement
1.1	Test 1	19.960	20.040	19.993	-0.00700	😊
1.2	Test 2	24.960	25.040	25.001	0.00100	😊
1.3	Test 3	29.960	30.040	29.980	-0.0200	😞
1.4	Test 4	34.960	35.040	35.026	0.0260	😞
1.5	Test 5	0.000	1.040	0.600	0.600	😊
1.6	Test 6	0.000	1.040	0.500	0.500	😊



3.2 Sample analysis 5 part study

This study is often used for setup of a production machine, using 5 part analysis.

5 Part Report							
Char.No.	Char.Descr.	LSL	USL	\bar{x}	R/T	$\bar{x}-T_m$	Requirement
1.1	Length (Expl. 1.1)	19.910	20.040	19.98260	6.92%	0.00760	😊
1.1	Length2 (Expl 1.1)	24.910	25.010	24.96760	26.00%	0.00760	😡
1.1	Length3 (Expl 1.1)	29.910	30.010	30.00180	11.00%	0.0418	😡
1.1	Length4 (Expl 1.1)	34.910	35.010	34.93300	35.00%	-0.0270	😡



3.3 Sample analysis machine capability study

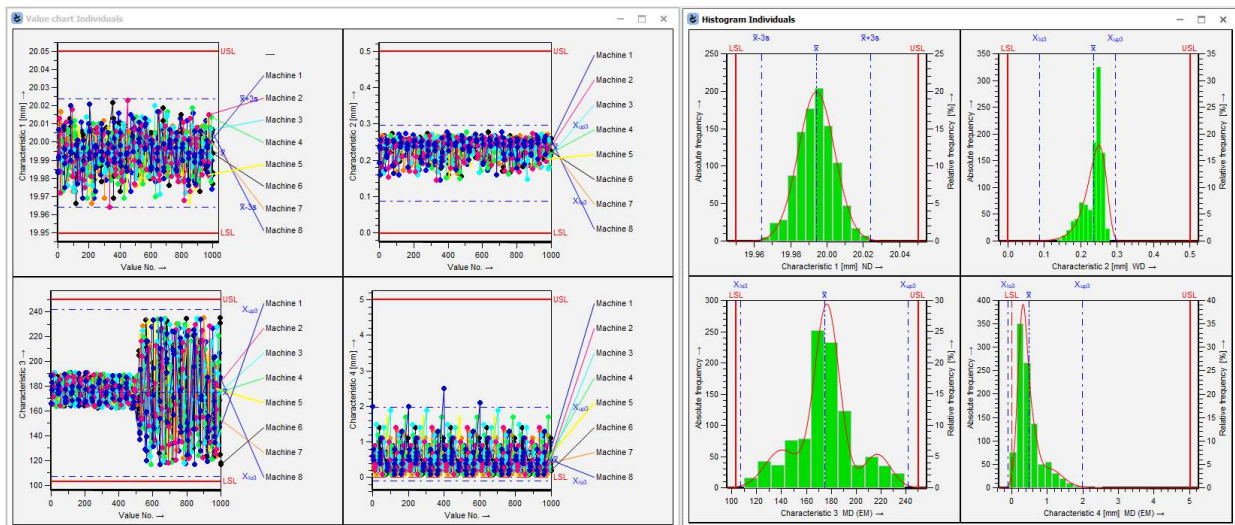
This study is used to determine capability of production machine. The study is conducted on multiple parts produced in the short period of time with the same conditions.

Characteristics Statistics - Design 9							
Part no. 25052023				Part descr. Machine capability analysis - Example			
Char.No.	Char.Descr.	\bar{x}	s	pot. Index	crit. Index	Overall evalua	
1	Width - Machine 1	12.00845	0.00361	$P_m = 2.49$	$P_{mk} = 1.71$	↑	
2	Width - Machine 2	12.00798	0.00381	$P_m = 2.36$	$P_{mk} = 1.66$	↓	
3	Width - Machine 3	12.00827	0.00395	$P_m = 2.28$	$P_{mk} = 1.58$	↓	
Value chart Individuals				Histogram Individuals			
Form sheet - Design 3				Form sheet - Design 4			

4 Process analysis examples

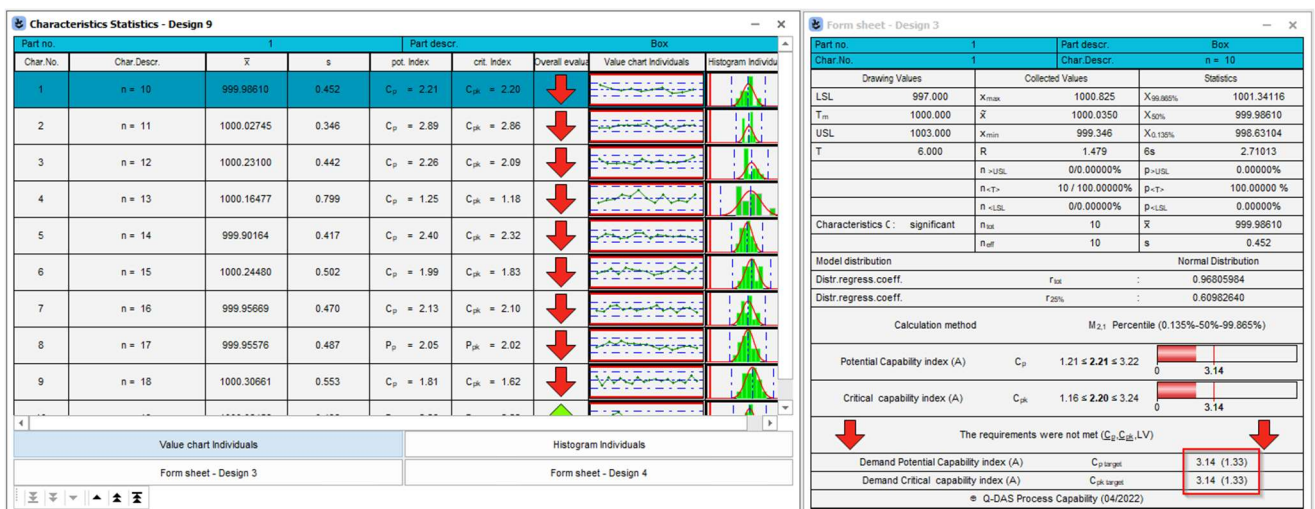
4.1 Process analysis additional data

Dataset contains 4 characteristics with different distributions and additional data (machine, operator, batch number and order number). The intended use is to demonstrate filtration options in read from database dialog as well as graphic option in the software, and to demonstrate the ability of the software to determine different distribution models and capability calculations.



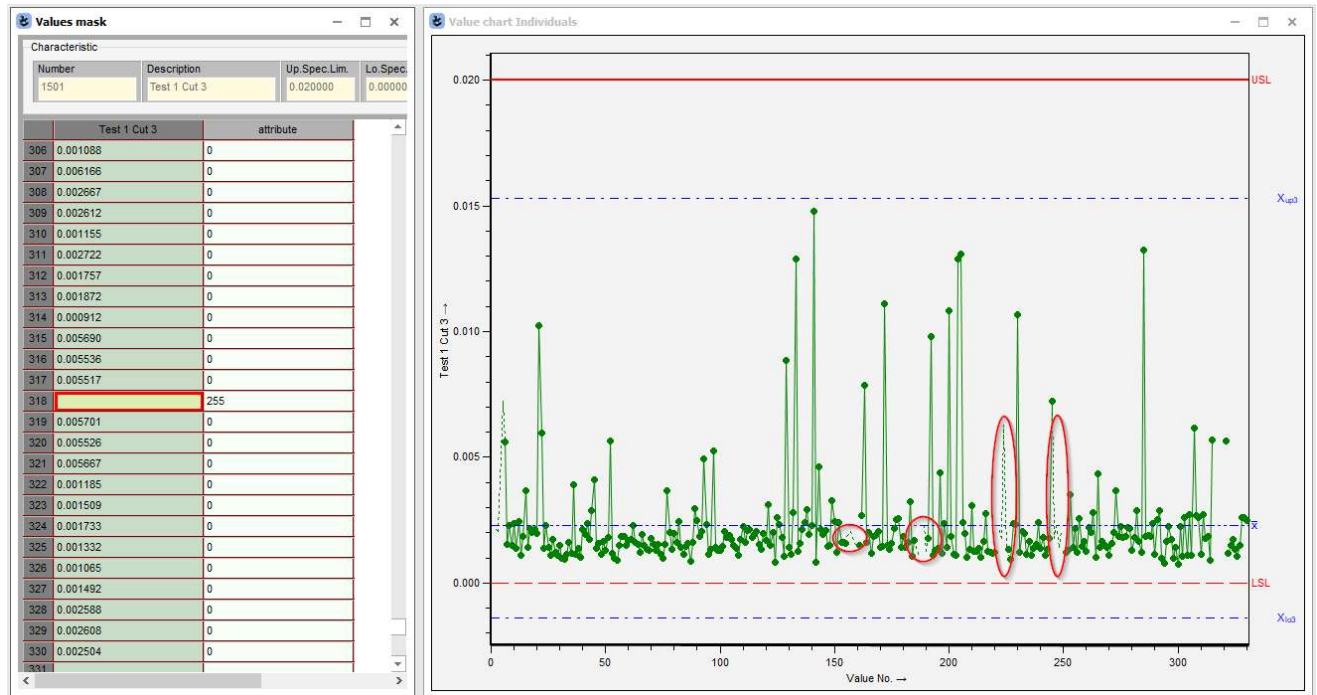
4.2 Process analysis capability by number of values

The dataset demonstrates the capability of the evaluation strategy to change automatically the target for capability indices based on number of values used for evaluation.









4.3 Process analysis invalid values attribute 255

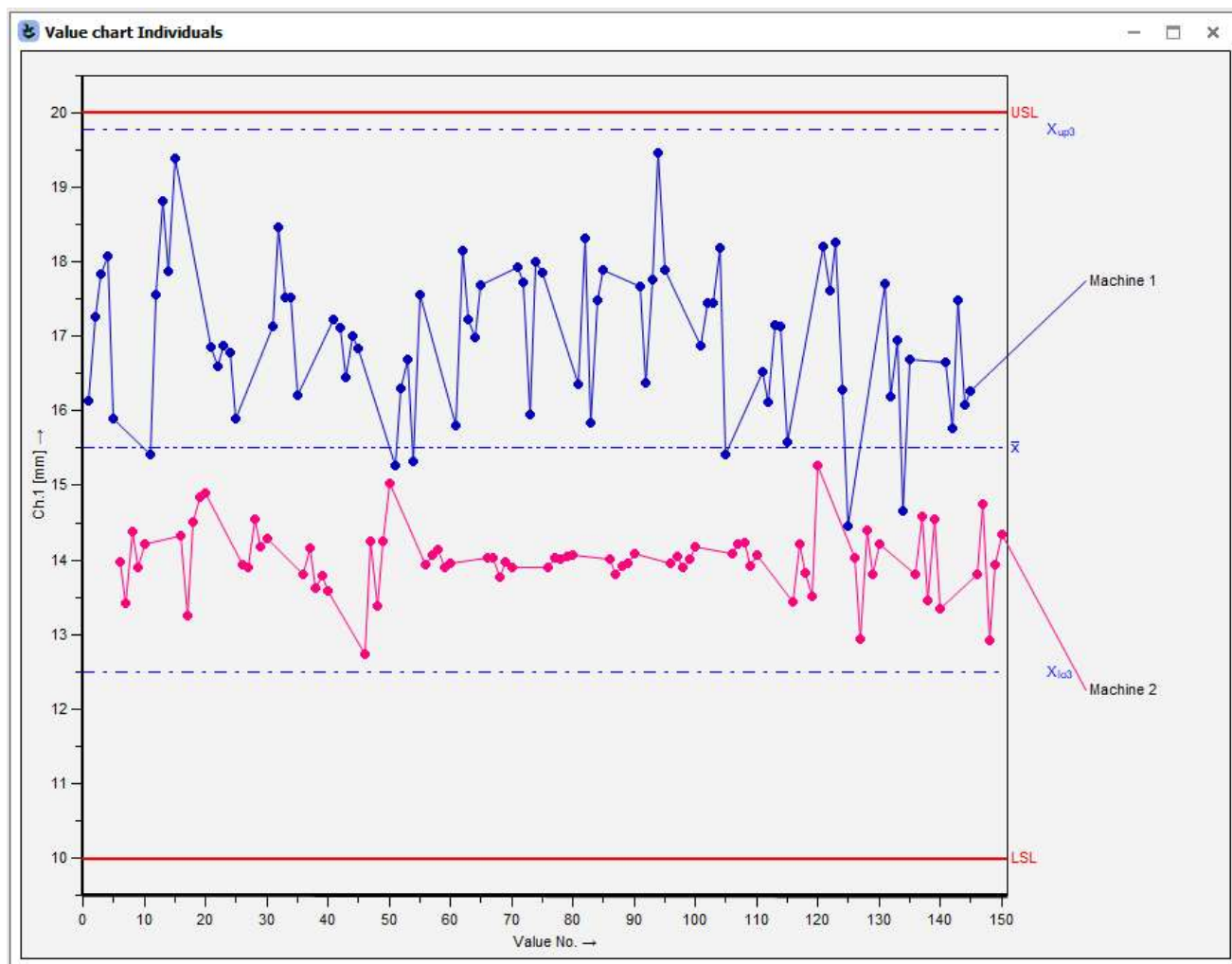
The dataset demonstrates how the software treats the invalid values marked with attribute 255. The gaps can be observed in the value charts and the values are not taken into consideration during the analysis.



4.4 Process analysis machine comparison






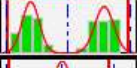
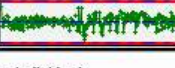

The dataset demonstrates how the calculation of capability can be influenced by multiple machines in 1 dataset and how to differentiate between them.

Characteristics Statistics - Design 9											
Part no. 1450				Part descr.		Machine comparison					
Char.No.	Char.Descr.	\bar{x}	s	pot. Index	crit. Index	Overall evalu.	Value chart Individuals	Histogram Individuals			
1	Ch.1 (M001)	17.00617	1.017	$C_p = 1.64$	$C_{pk} = 0.98$						
1	Ch.1 (M002)	14.00728	0.439	$C_p = 3.79$	$C_{pk} = 2.95$						
Value chart Individuals					Histogram Individuals						
Form sheet - Design 3					Form sheet - Design 4						



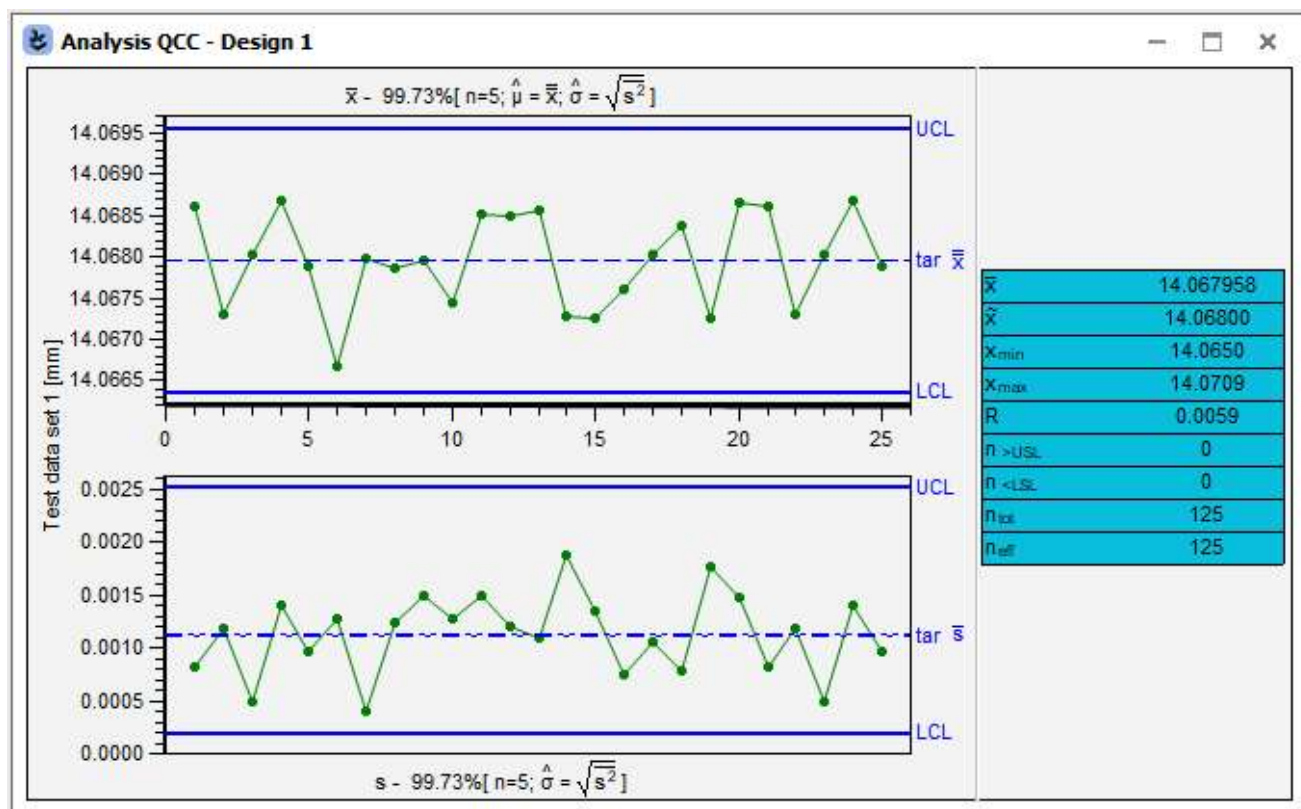
4.5 Process analysis problematic datasets

The dataset demonstrates potential problems in the datasets (outliers, resolution, different cavities, time axis).

Characteristics Statistics - Design 9								
Part no. 1				Part descr. Quality data				
Char.No.	Char.Descr.	\bar{x}	s	pot. Index	crit. Index	Overall evalua	Value chart Individuals	Histogram Individuals
1	Outliers	0.03421	0.245	$P_{pk} = 0.17$	$P_{pk} = 0.09$	↓		
2	Resolution	11.110	0.0903	$C_p = 0.74$	$C_{pk} = 0.33$	↓		
3	Cavity No.	12.1492	0.411	$P_p = 0.97$	$P_{pk} = 0.95$	↓		
4	Time Axis	0.0206	0.0780	$P_p = 0.92$	$P_{pk} = 0.87$	↓		
Value chart Individuals				Histogram Individuals				
Form sheet - Design 3				Form sheet - Design 4				

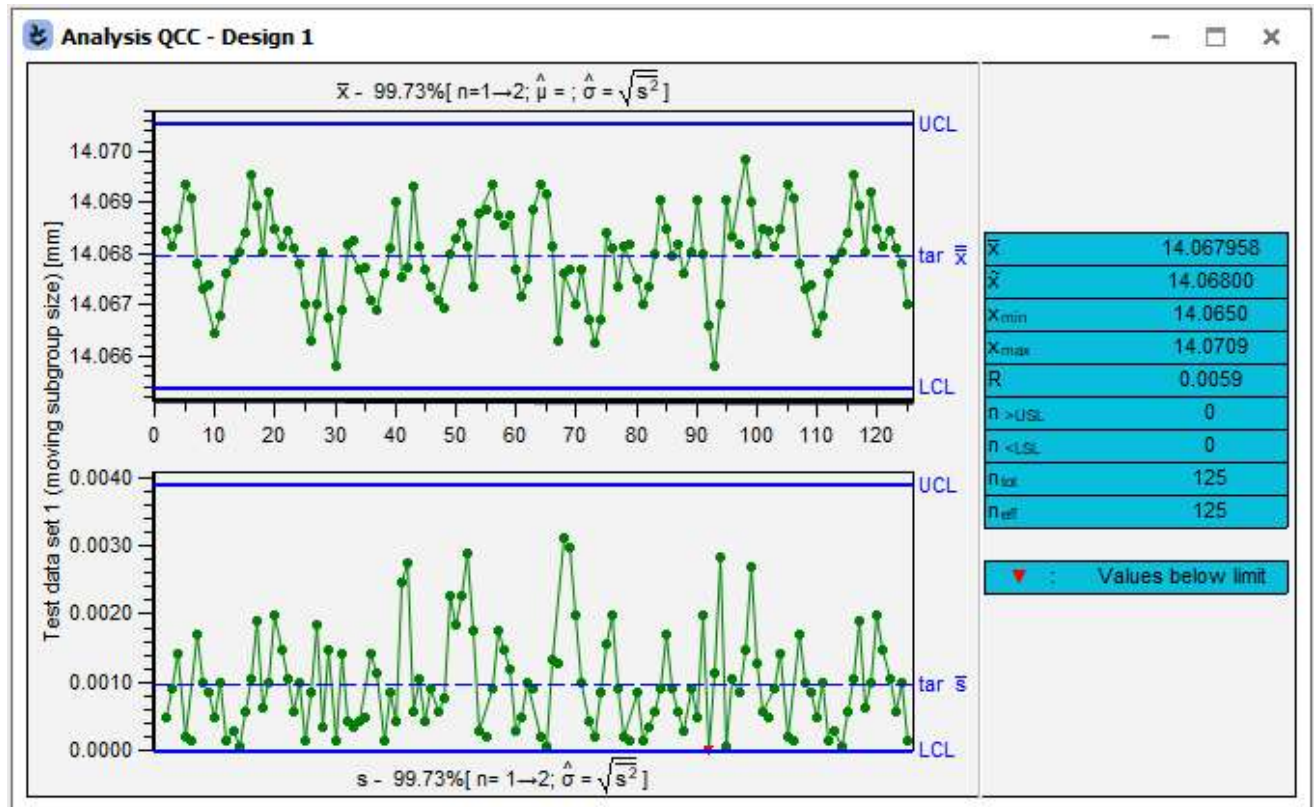
4.6 Process analysis QCC test data fixed subgroup size

The dataset demonstrates analysis and QCC with fixed subgroup size.



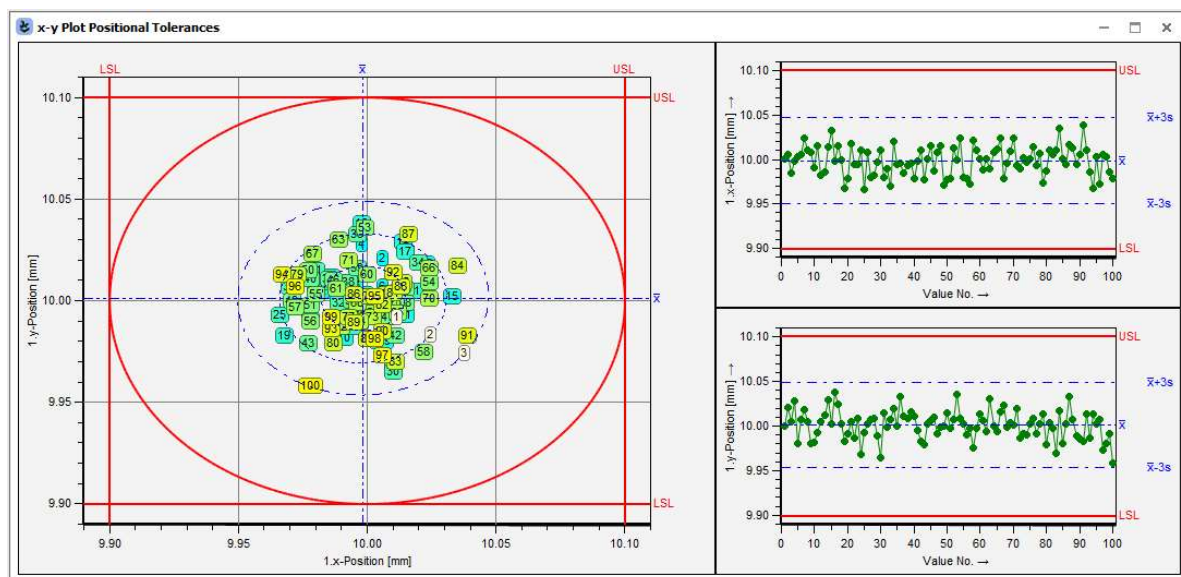
4.7 Process analysis QCC test data moving subgroup size

The dataset demonstrates analysis and QCC with moving subgroup size.



4.8 Process analysis True position

The dataset demonstrates and explains the analysis of 2D and 3D true position features.



4.9 Process analysis attributive characteristics

The dataset demonstrates different types of attributive characteristics and its evaluation.

