

# Gauge Capability Analysis

Before using a gauge it must be ensured that any requirements for the gauge are fulfilled when it is under continuous usage. This is accomplished by performing complex capability analysis procedures that go far beyond simple calibration. Possible weaknesses in the context of the working environment, the influence of individual workers or the continuous usage of the gauge need to be excluded by several different methods. The following standards are considered in iQ-PMF: DIN EN ISO 9001, DIN EN ISO 10012, QS9000, and VDA 6.1. The development of the module itself has been based on the Series 10 papers (introduced by Bosch):

- Procedure 1 Calculation of the dispersion and the average of the measured values
- Procedure 2 Determination of the complete range of dispersion under the influence of users
- Procedure 3 Determination of the complete range of dispersion without user influence
- Procedure 4 Linearity
- Procedure 5 Measurement stability
- Procedure 6 Inspection process for qualitative characteristics

## Workflow

A capability analysis can include multiple characteristics. The data belonging to each characteristic builds the foundation for every procedure that is to be applied for the corresponding characteristic. Procedures 2 and 3 have procedure 1 as prerequisite. The capability analysis results are assigned to the single gauge. The worst result of all gauges of a type is assigned to the gauge type. This way it becomes a very easy task to find the appropriate gauge for a specific measuring job.

## Important Features at a Glance

- Overview of every capability analysis that has been performed for a gauge or gauge type
- Multiple procedures per characteristic and work piece
- Optional review after each analysis of a characteristic
- Creation of appropriate forms for each procedure
- Total result and use decision are part of the overview.
- Every analysis is documented in the gauge's history.

### The gauge capability analysis considers:

- Measurement of serial production parts
- Usage of multiple workers
- Work places with integrated measuring devices
- Environmental conditions of the work place
- Automated measuring devices

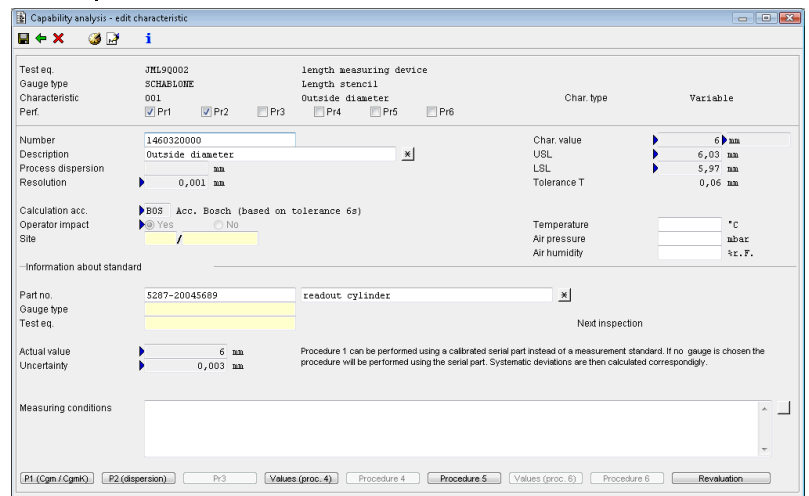
### Defaults for capability analysis

- For each gauge type a time limit can be specified for repeating the capability analysis. It is up to the user which specific gauge of this type will be taken as subject of the analysis.
- In the master data of a gauge defaults can be specified for performing a capability analysis after using the gauge for measuring. Possible values are 'not necessary', 'recommended' or 'necessary after purchase and repair'.

### Characteristic-related data

- Work piece including part no. and name
- Value of the characteristic including unit and tolerances
- Process dispersion (procedure 1)
- Resolution

- Calculation method (4s, 6s or process-related)
- Measuring conditions such as temperature, air pressure, and humidity
- Reference standard as part no. with name or gauge
- Actual value of the standard including uncertainty



### Procedure 1

Determining the capability as Cgm and CgmK

- Repeated measurements of (at least) 50 values using a calibrated reference or serial part
- Measurement at the location of usage
- Specification of the worker
- Absolute and relative measurements
- Calculation of average, standard deviation, and capability indices Cgm and CgmK
- Use decision based on minimal values
- Specification of the decider including the cost centre
- Comments

Procedure 2

Total range of dispersion in multi-worker situations

- No limitation regarding the number of workers (usually 2)
- No limitation regarding the number of parts (usually 10)
- Calculation of the percentage range of dispersion
- Support of the ARM and differences based method
- Use decisions: capable (0-10%), conditionally capable (10-30%), not capable (>30%)

Procedure 3

Total range of dispersion without user influence

- Absolute and relative measurements
- No limitation regarding the number of parts (usually 25)
- Determination of the range of dispersion for all measuring series
- Support of the ARM and differences based method
- Use decision as in procedure 2

Procedure 4

Determination of linearity

- Important for measuring ranges with characteristic curves
- Variable number of sampling points over the entire workspace
- Measuring using reference standards
- Multiple measurements per sampling point
- Graphical representation of the result
- Single values and average per sampling point
- Over a measuring range a curve progression for a 95% measuring range
- Point of origin check in relation to the confidence interval

Procedure 5

Measuring stability

- Long term monitoring of usage
- Multiple measuring of each part (standard)
- Measuring using a common inspection order from production
- Report containing any data related to measuring stability

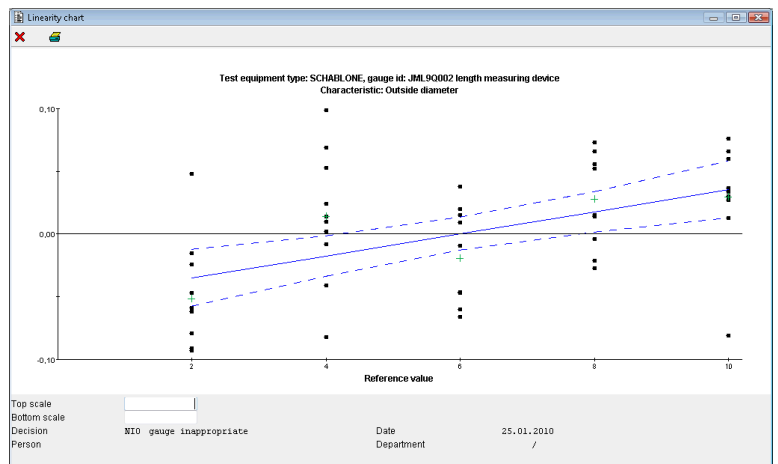
Procedure 6

Qualitative inspections of parts that have been measured exactly

- Specification of the number of inspectors
- Selection of parts from production to examine the entire tolerance range
- Exact measurement of parts to determine the number of parts within and outside of the tolerance limits
- Following the measurement a qualitative inspection of each part and a statement if the part was within or outside of the specific tolerance limit
- Statistical value %GRR depending on the number of conformities
- Use decision as in procedure 2

Import interface

- Procedure 1, 2, and 3 support importing from the Q-DAS interface.



AHP		Procedure 5: measurement reliability		Equipart	length measuring device	Plant / work shop	0001 / 5009
				Work step	measurement stability	Control chart created by Supervisor	
				Characteristic	Outside diameter	Date 03.02.2010	
				Page no.			
x1	2	4	3	2	0	1	1
x2	1	4	2	1	1	1	2
x3	1	3	2	1	2	1	2
x4							
x5							
s	1.3	3.7	2.3	2.3	0.8	0.3	1.7
s	0.6	0.6	0.6	1.6	0.6	0.6	0.6
				Deviation from	0.0000 mm		
				Unit	µm		
				Cvg	1.84		
				Amount of samples	3		
				Inspection interval	4 hour		
				Characteristic name	Outside diameter		
				Target value	6.000 mm		
				UL	6.030 mm		
				LL	5.970 mm		
				Tolerance T	0.0600 mm		
				Action limits	UAL = sm + 0.043 * T 6.0045 mm		
					Central position + sm 6.0020 mm		
					LAL = sm - 0.043 * T 5.9954 mm		
					UALs = 2.302 * T * SD 0.0035 mm		
					LALs = 0.071 * T * SD 0.0001 mm		
				Evaluation	Distribution		
					Uncertainty U of measuring process		
					Evaluated		
					Valid		

**Interfaces to Other iQ-BASIS Modules**

- iQ-PMV for gauge management
- iQ-PMÜ for gauge monitoring
- iQ-GL for a centralized maintenance of all master data that is relevant in other modules, too
- iQ-DOKU to store documents such as the protocols accompanying a capability analysis

