Quality Tool

Statistical Service Software

Measurement System Analysis
Validation, Qualification and Reporting
Test Station Data

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Introduction

- The purpose of this application is to give a statistical **MSA** tool for the practising test engineers in idustrial mass production environment, who needed to make **GR&R** and **SPC** studies for complex test system, which are built from many test stations and their testing process contains numerous measurement sequence steps.

- The program allows users to perform fast, easy and practical test data analysis with customizable add-in input logfile converters, filtering options and extensive mathematical functions, furthermore it stores the measurements in **XML** files as well as makes convenient and userfriendly graphical reporting in **Excel** worksheets.

Applications

- General Test Measurement System Qualification
- Gage Repeatability and Reproducibility Studies (ANOVA Analysis of Variance methods are used)
- Statistical Process Control (Capability and Performance Investigations)
- Attribute Agreement Analysis (Accuracy and Consistency, Fleiss' kappa statistic)
- Standard Six Sigma (**6σ**) Methods
- Automotive Industry
- On-the-spot Validation of Tester Setups and Testing Procedures

RIM CFT & BLT Test Stations

Combined Functional and Board Level Measurement Systems at the Elcoteq's Product Line PL12 for Testing of BlackBerry Mobile Phones

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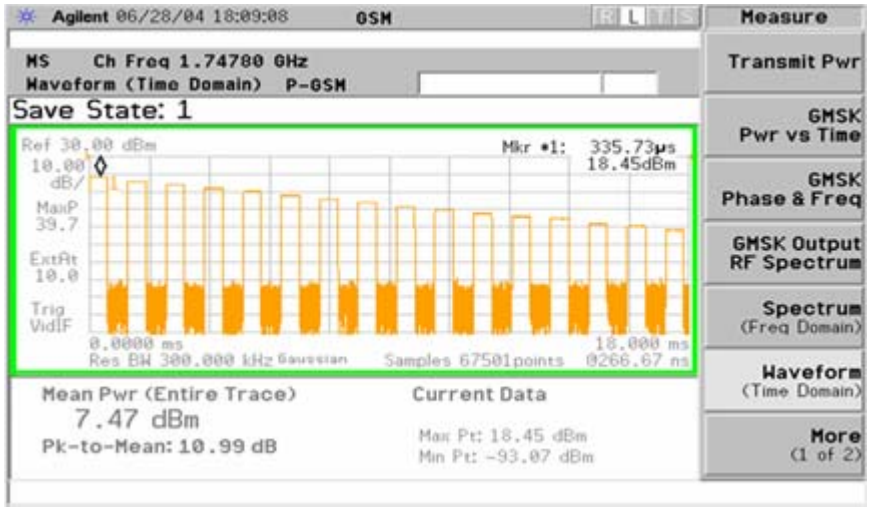
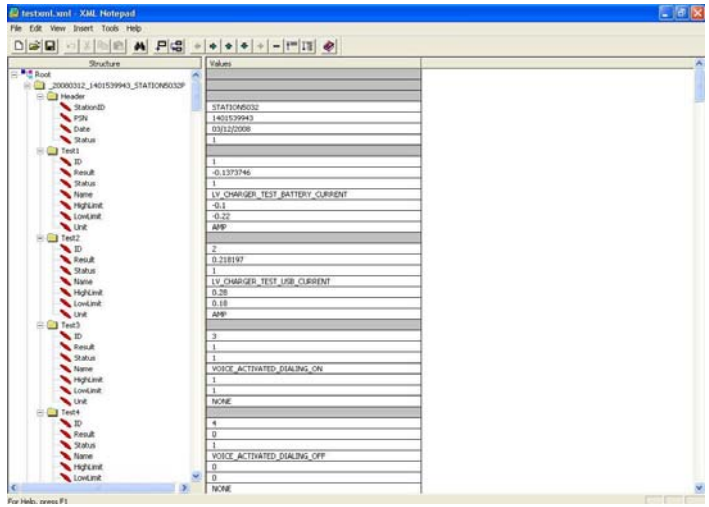
Measurement Procedures





- Radio Frequency Test
- Audio Test
- GSM (850/900/1800/1900) Measurements
- GPS Test
- WLAN Test
- Bluetooth Test
- Visual Testing by Image Processing

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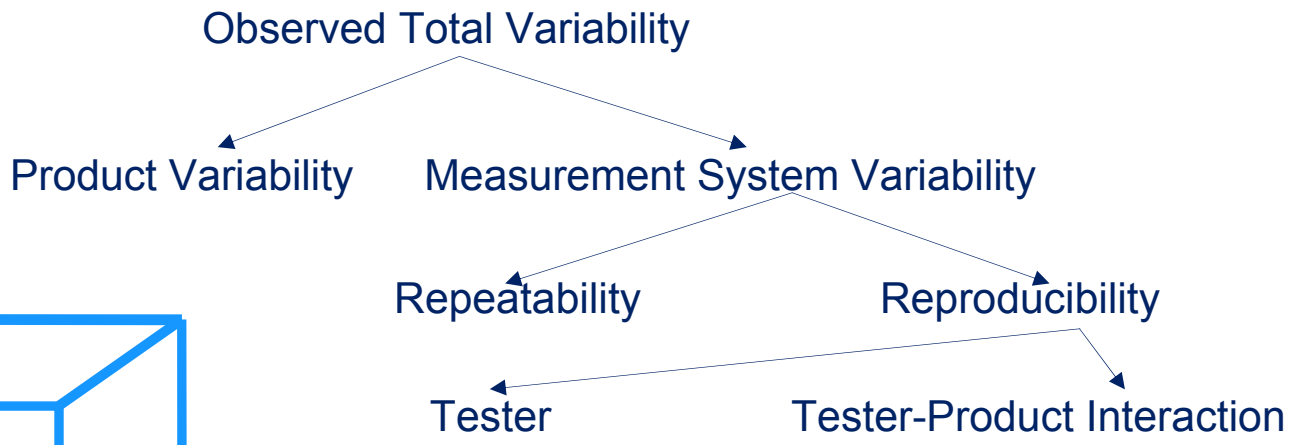
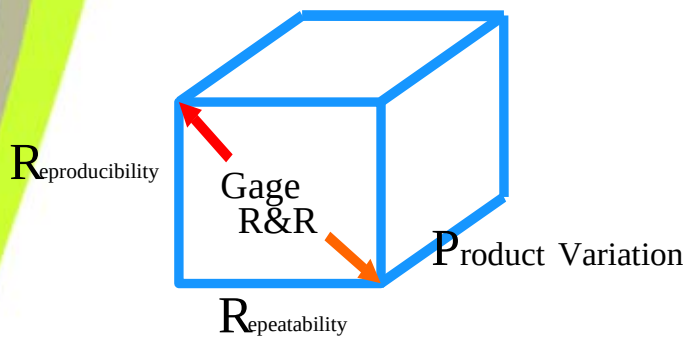
Measurement System Analysis





$$\sigma^2_{Total} = \sigma^2_{Product} + \sigma^2_{Measurement\ System} = \sigma^2_{Product} + \sigma^2_{GageR\&R}$$

$$\sigma^2_{Total} = \sigma^2_{Product} + \sigma^2_{Repeatability} + \sigma^2_{Tester} + \sigma^2_{Tester-Product\ Interaction}$$

Input	*Activity*	*Output*
• Customer specifications • Measurement equipment • Measurement methods • Testers Acceptance criterias	**Gage R&R**	• Information about the measurement system Info about variation sources

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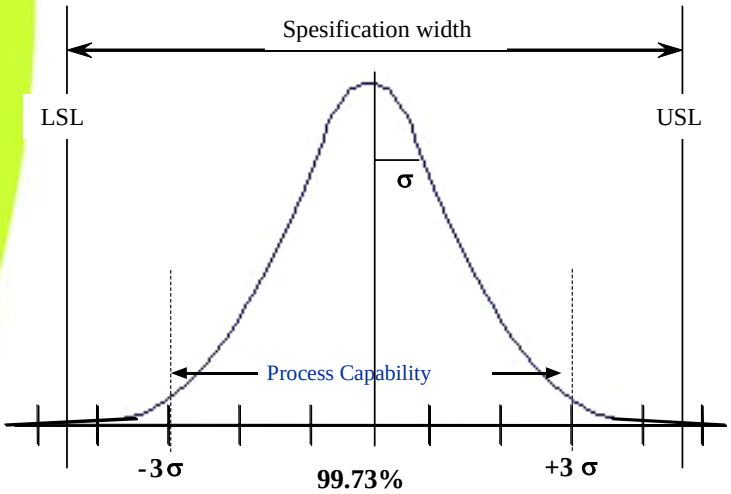
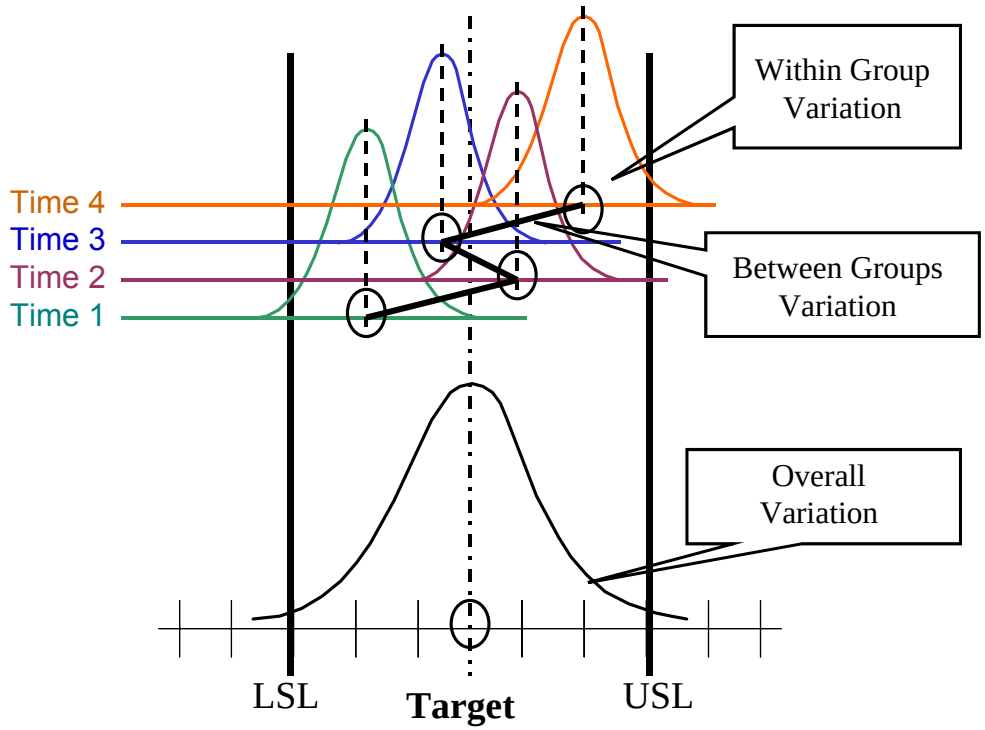
Statistical Process Control





Capability Index

$$Cpk = \min\left\{\frac{\overline{X} - LSL}{3\sigma}; \frac{USL - \overline{X}}{3\sigma}\right\}$$

Input *Activity* *Output*

- Customer specifications
- Control chart

Capability studies

- Information about the process capability

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Features

- **File handling**

  Quality Tool rapidly and directly parses the tester log files as input data by using special built-in file format converters. External converter can also to be added to the application with the help of a *Quality Manager* dialog box in DLL code.

- **Selecting**

  All those test steps can be selected for what analysis will be carried out.

- **Filtering**

  Test data files are often „not perfect”. The program provides powerful filtering options that help you easily identify and eliminate unwanted data (e.g. Pass/Fail, Parts, Test Steps, Stations, Outliers).
  The comprehensive *Station*, *Product* and *Test Data* moduls even allow you to ignore the most common mismatches among datasets (e.g. Part Count, Test Count, Test Numbers, Test Limits).

Features

- **Capacity**

  Supports up to *128 Test Stations* (Operators), *64 Products* (Parts) and *32 Replicates* (Trials) for GR&R as well as *4096 Samples* for SPC calculations, respectively.

  Processes measured data up to *1500 Numeric Limit Test* Steps per Sequence and stores these in well defined and structured XML output file.

- **Table and Graphical Reports**

  The numerical and graphical results of the analysis for all selected test steps are displayed in separated and high quality Excel tables or color charts. The graphs (control charts and histograms) give useful and quick visual informations about the characteristic of measurement process.

Features

- **Flexibility**

  There is possibility of many level preference settings which are belonging to the application environment variables and the parameters of statistical methods. The user defined attributes are saved to *registry* or *settings.ini* file, so those will be available next time.

- **Reference**

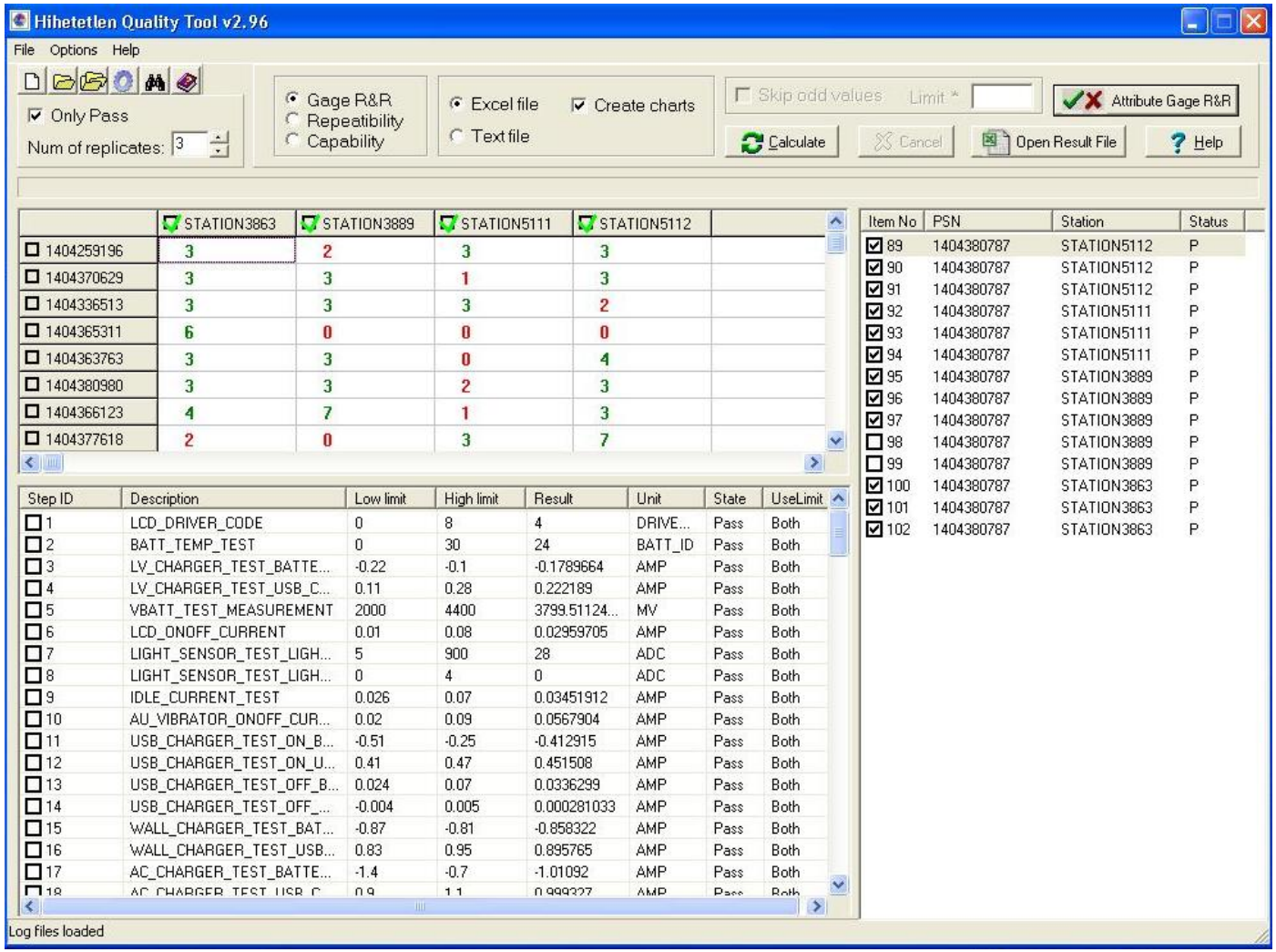
  On-line help and documentation (User Guide, Analysis Theory). Since, for efficient data analysis you need not only a good tool, but also a clear understanding how to use the tool. The reference documentation explains the all important items.

  Quality Tool is developed from the engineering point of view instead of a theoretical software package.

Steps to Perform GR&R Study

- Load the testers' *log files* from the File menu (multiple files or a group of subdirectories can be selected) choosing the correct log type in the appearing dialog box. Wait for the end of converting and parsering processes.
- Select the *test stations* that will be included in the analysis by clicking to the suitable checkboxes.
- Select the *products* in a similar way that are distinguished by their PSNs and will be used for the calculations.
- Specify the *number of replicates* by using the updown counter.
- Select the name of the *test steps* for which the study will be made.
- Select the *Gage R&R* radio button from the radio-group list of methods.
- Click to the *Calculate* button to starting calculating and reporting processes. An information message will appeare after these are successfully completed.

Example for GR&R Study



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GR&R Summary Report

On the output Excel *Summary Worksheet* the following data can be found ordering by line in test steps:

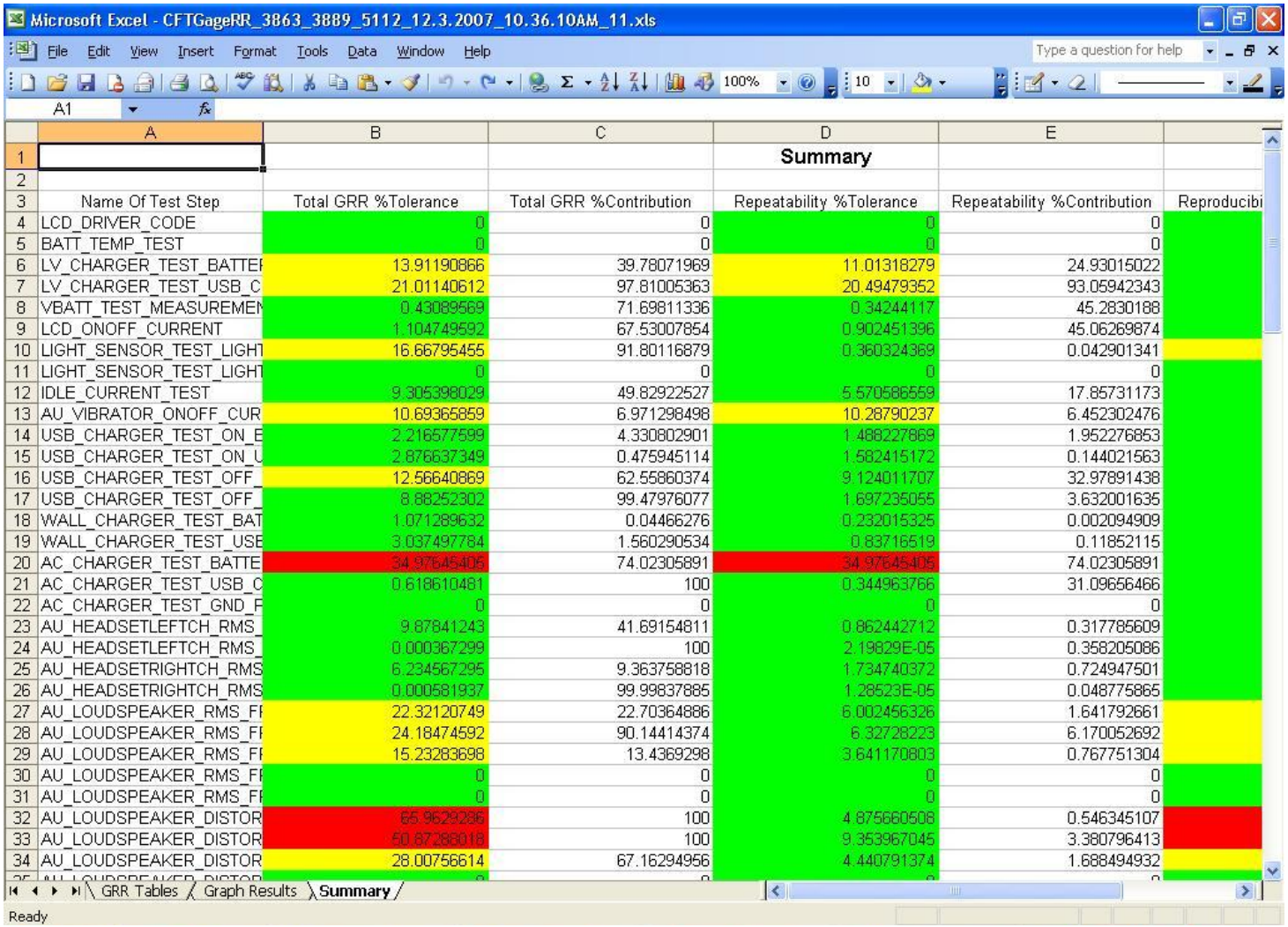
- Name of Test Step

- Total GR&R %Tolerance
- Total GR&R %Contribution

- Repeatability %Tolerance
- Repeatability %Contribution

- Reproducibility %Tolerance
- Reproducibility %Contribution

GR&R Summary Report



	A	B	C	D	E	
1				Summary		
2						
3	Name Of Test Step	Total GRR %Tolerance	Total GRR %Contribution	Repeatability %Tolerance	Repeatability %Contribution	Reproducibi
4	LCD_DRIVER_CODE	0	0	0	0	
5	BATT_TEMP_TEST	0	0	0	0	
6	LV_CHARGER_TEST_BATTEI	13.91190866	39.78071969	11.01318279	24.93015022	
7	LV_CHARGER_TEST_USB_C	21.01140612	97.81005363	20.49479352	93.05942343	
8	VBATT_TEST_MEASUREMEN	0.43089569	71.69811336	0.34244117	45.2830188	
9	LCD_ONOFF_CURRENT	1.104749592	67.53007854	0.902451396	45.06269874	
10	LIGHT_SENSOR_TEST_LIGHT	16.66795455	91.80116879	0.360324369	0.042901341	
11	LIGHT_SENSOR_TEST_LIGHT	0	0	0	0	
12	IDLE_CURRENT_TEST	9.305398029	49.82922527	5.570586559	17.85731173	
13	AU_VIBRATOR_ONOFF_CUR	10.69365859	6.971298498	10.28790237	6.452302476	
14	USB_CHARGER_TEST_ON_E	2.216577599	4.330802901	1.488227869	1.952276853	
15	USB_CHARGER_TEST_ON_U	2.876637349	0.475945114	1.582415172	0.144021563	
16	USB_CHARGER_TEST_OFF_	12.56640869	62.55860374	9.124011707	32.97891438	
17	USB_CHARGER_TEST_OFF_	8.88252302	99.47976077	1.697235055	3.632001635	
18	WALL_CHARGER_TEST_BAT	1.071289632	0.04466276	0.232015325	0.002094909	
19	WALL_CHARGER_TEST_USE	3.037497784	1.560290534	0.83716519	0.11852115	
20	AC_CHARGER_TEST_BATTE	34.97645405	74.02305891	34.97645405	74.02305891	
21	AC_CHARGER_TEST_USB_C	0.618610481	100	0.344963766	31.09656466	
22	AC_CHARGER_TEST_GND_F	0	0	0	0	
23	AU_HEADSETLEFTCH_RMS_	9.87841243	41.69154811	0.862442712	0.317785609	
24	AU_HEADSETLEFTCH_RMS_	0.000367299	100	2.19829E-05	0.358205086	
25	AU_HEADSETRIGHTCH_RMS	6.234567295	9.363758818	1.734740372	0.724947501	
26	AU_HEADSETRIGHTCH_RMS	0.000581937	99.99837885	1.28523E-05	0.048775865	
27	AU_LOUDSPEAKER_RMS_FI	22.32120749	22.70364886	6.002456326	1.641792661	
28	AU_LOUDSPEAKER_RMS_FI	24.18474592	90.14414374	6.32728223	6.170052692	
29	AU_LOUDSPEAKER_RMS_FI	15.23283698	13.4369298	3.641170803	0.767751304	
30	AU_LOUDSPEAKER_RMS_FI	0	0	0	0	
31	AU_LOUDSPEAKER_RMS_FI	0	0	0	0	
32	AU_LOUDSPEAKER_DISTOR	65.9629286	100	4.875660508	0.546345107	
33	AU_LOUDSPEAKER_DISTOR	50.87288018	100	9.353967045	3.380796413	
34	AU_LOUDSPEAKER_DISTOR	28.00756614	67.16294956	4.440791374	1.688494932	

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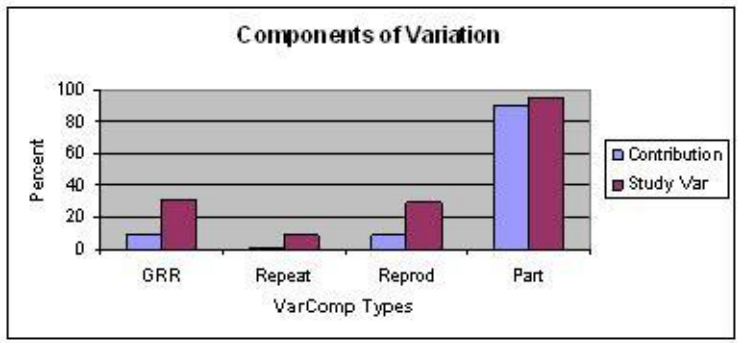
GR&R Graphical Report

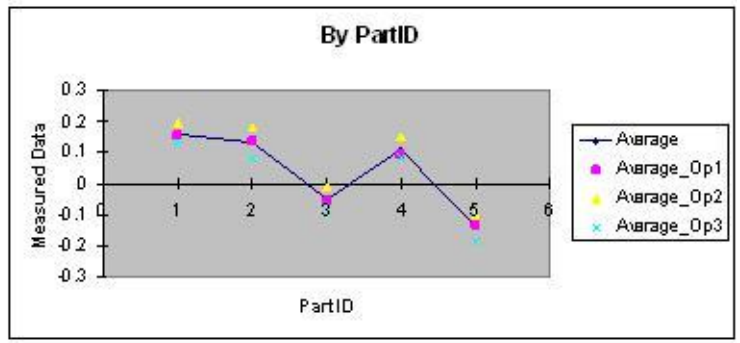
The results of the advanced charts analysis are shown in the Excel *Graph Results Worksheet* for each test steps:

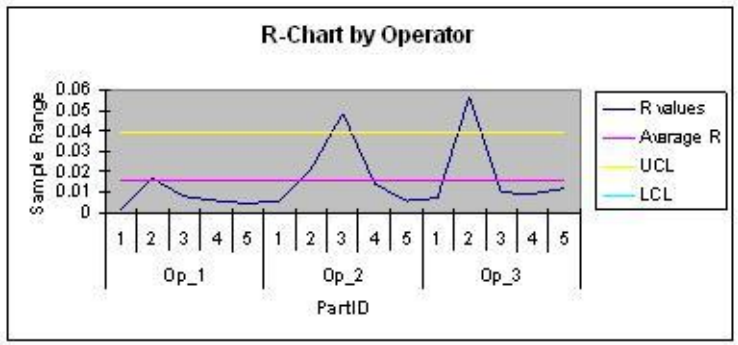
- Contribution Chart
- Avarage R-Chart
- Avarage Xbar-Chart

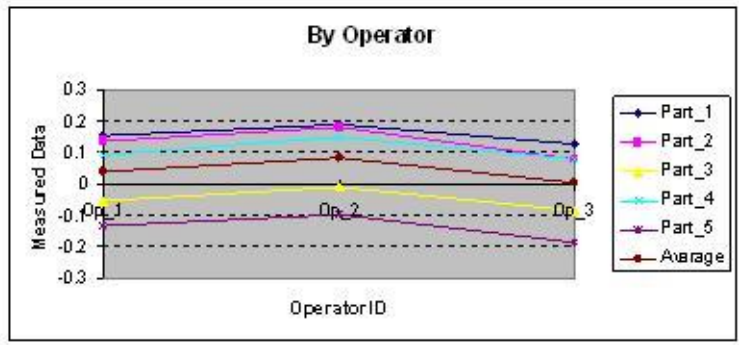
- Interaction Plot: Scatter plot by Opeartor-by-Part
- Run Chart: Measurement by Operator
- Run Chart: Measurement by Part

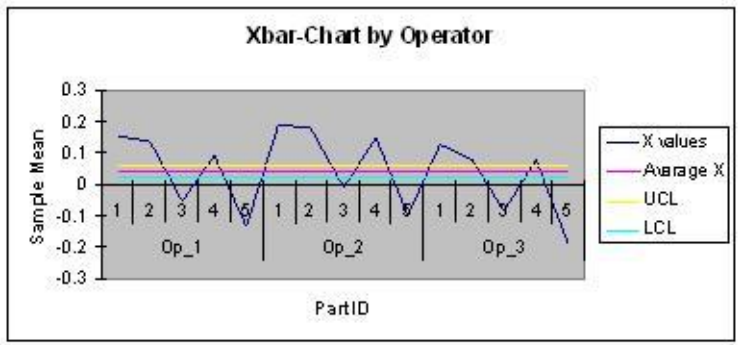
GR&R Graphical Report

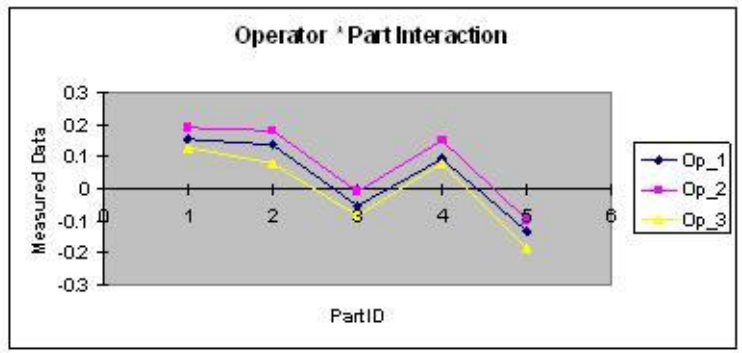












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GR&R Table Report

The Excel *GRR Tables Worksheet* contains the calculated values of the elements of ANOVA and GR&R tables for all selected test steps:

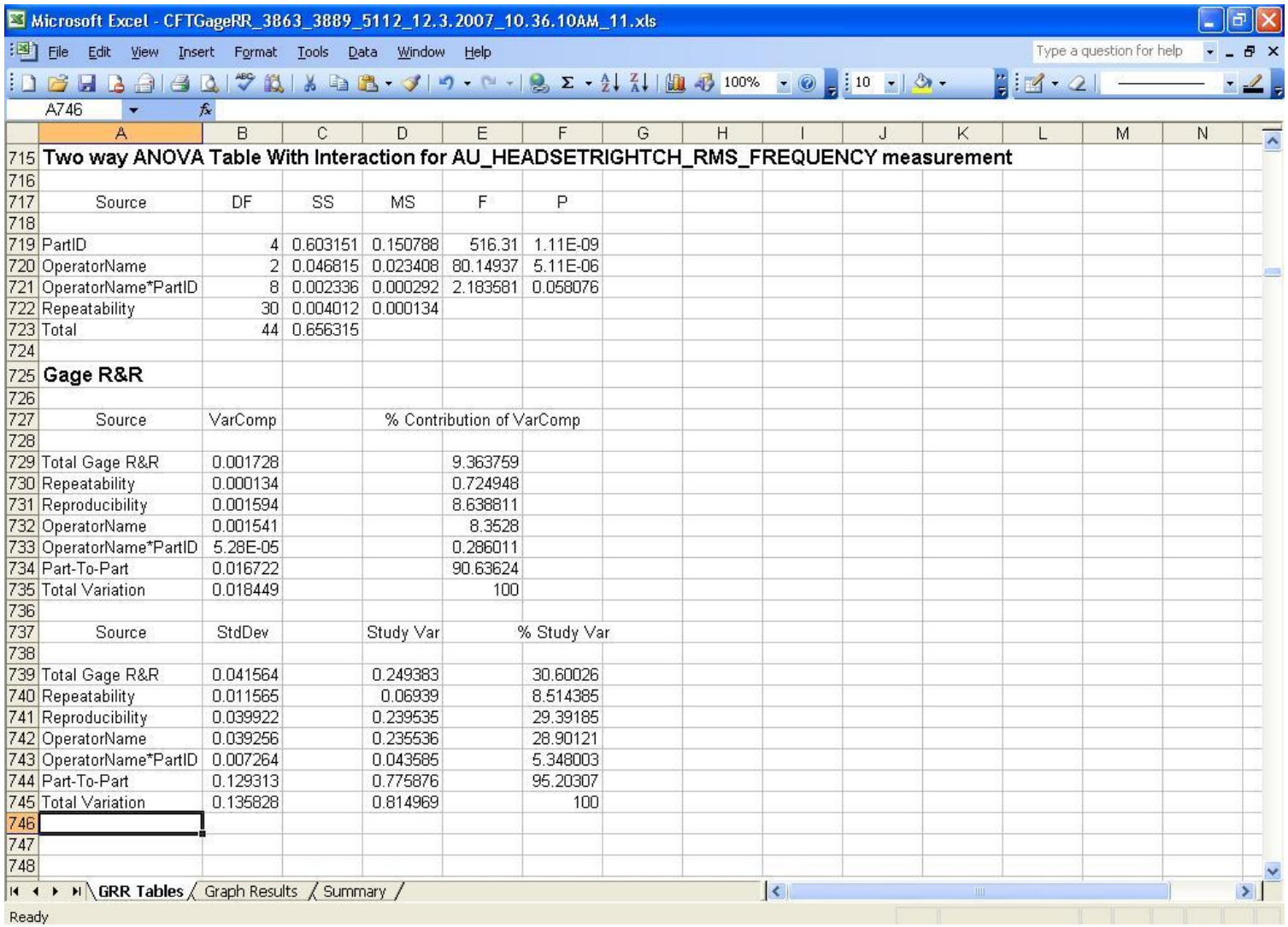
- **ANOVA Table**

  Includes the main effects of Parts and Operators, plus the Part by Operators interaction terms.

- **GR&R Tables**

  Show, how the total variability is divided among the following sources: Total GR&R (broken into Repeatability and Reproducibility) as well as Part-to-Part variabilities.

GR&R Table Report



Microsoft Excel - CFTGageRR_3863_3889_5112_12.3.2007_10.36.10AM_11.xls

File Edit View Insert Format Tools Data Window Help

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	A	B	C	D	E	F
715	**Two way ANOVA Table With Interaction for AU_HEADSETRIGHTCH_RMS_FREQUENCY measurement**					
716						
717	Source	DF	SS	MS	F	P
718						
719	PartID	4	0.603151	0.150788	516.31	1.11E-09
720	OperatorName	2	0.046815	0.023408	80.14937	5.11E-06
721	OperatorName*PartID	8	0.002336	0.000292	2.183581	0.058076
722	Repeatability	30	0.004012	0.000134		
723	Total	44	0.656315			
724						
725	**Gage R&R**					
726						
727	Source	VarComp		% Contribution of VarComp		
728						
729	Total Gage R&R	0.001728			9.363759	
730	Repeatability	0.000134			0.724948	
731	Reproducibility	0.001594			8.638811	
732	OperatorName	0.001541			8.3528	
733	OperatorName*PartID	5.28E-05			0.286011	
734	Part-To-Part	0.016722			90.63624	
735	Total Variation	0.018449			100	
736						
737	Source	StdDev		Study Var	% Study Var	
738						
739	Total Gage R&R	0.041564		0.249383		30.60026
740	Repeatability	0.011565		0.06939		8.514385
741	Reproducibility	0.039922		0.239535		29.39185
742	OperatorName	0.039256		0.235536		28.90121
743	OperatorName*PartID	0.007264		0.043585		5.348003
744	Part-To-Part	0.129313		0.775876		95.20307
745	Total Variation	0.135828		0.814969		100
746						
747						
748						

GRR Tables / Graph Results / Summary

Ready

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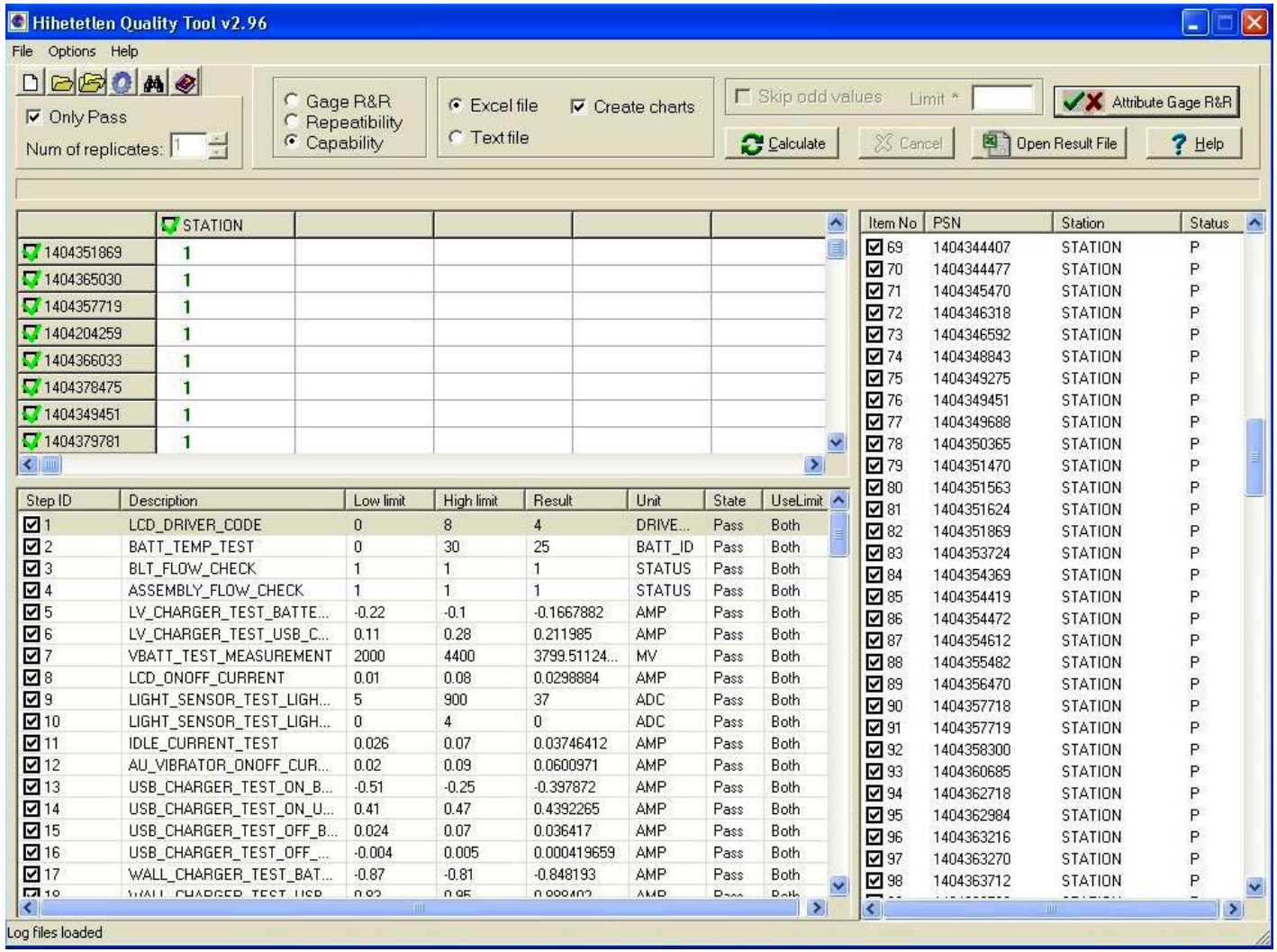
Steps to Perform SPC Study

- Load the testers' *log files* from the File menu (multiple files or a group of subdirectories can be selected) choosing the correct log type in the appearing dialog box. Wait for the end of converting and parsering processes.
- Select one *test station* that will be included in the analysis by clicking to the suitable checkboxes. (This station name may be a logical identifier of more investigated testers)
- Select the *products* in a similar way that are distinguished by their PSNs and and will be used for the calculation.
- The *number of replicates* should be one.
- Select the name of the *test steps* for which the study will be made.
- Select the *Capability* radio button from the radio-group list of methods.
- Click to the *Calculate* button to starting calculating and reporting processes. An information message will appeare after these are successfully completed.

Example for SPC Study



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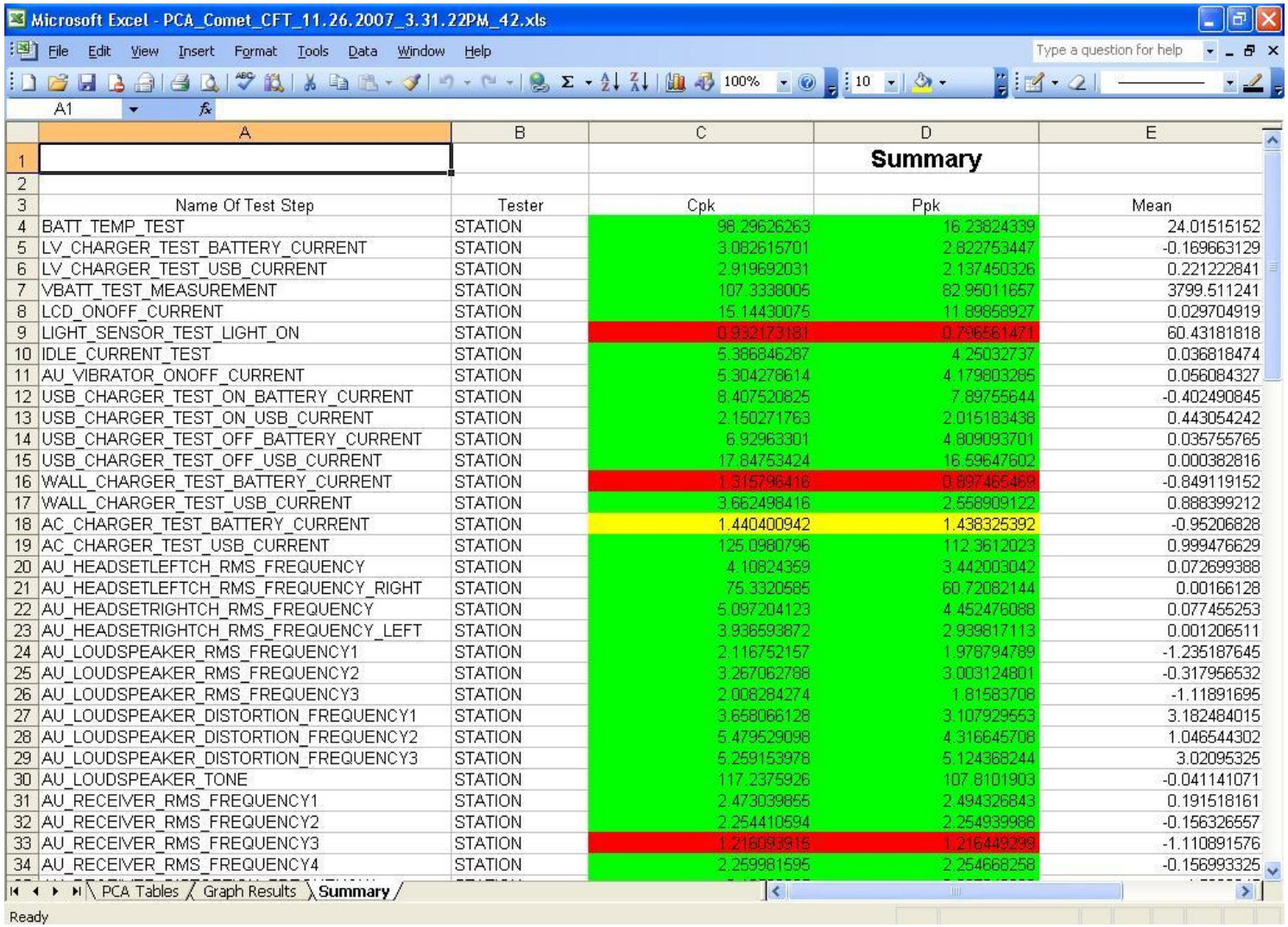
SPC Summary Report

On the output Excel *Summary Worksheet* the following data can be found ordering by line in test steps:

- Name of Test Step
- Tester(s) Identification
- Cpk
- Ppk
- Process Mean
- Process Standard Deviation
- PPM

SPC Summary Report


Microsoft Excel - PCA_Comet_CFT_11.26.2007_3.31.22PM_42.xls

File Edit View Insert Format Tools Data Window Help

Type a question for help

A1

	A	B	C	D	E
1				Summary	
2					
3	Name Of Test Step	Tester	Cpk	Ppk	Mean
4	BATT_TEMP_TEST	STATION	98.29626263	16.23824339	24.01515152
5	LV_CHARGER_TEST_BATTERY_CURRENT	STATION	3.082615701	2.822753447	-0.169663129
6	LV_CHARGER_TEST_USB_CURRENT	STATION	2.919692031	2.137450326	0.221222841
7	VBATT_TEST_MEASUREMENT	STATION	107.3338005	82.95011657	3799.511241
8	LCD_ONOFF_CURRENT	STATION	15.14430075	11.89658927	0.029704919
9	LIGHT_SENSOR_TEST_LIGHT_ON	STATION	0.932173181	0.796561471	60.43181818
10	IDLE_CURRENT_TEST	STATION	5.386846287	4.25032737	0.036818474
11	AU_VIBRATOR_ONOFF_CURRENT	STATION	5.304278614	4.179803285	0.056084327
12	USB_CHARGER_TEST_ON_BATTERY_CURRENT	STATION	8.407520825	7.89755644	-0.402490845
13	USB_CHARGER_TEST_ON_USB_CURRENT	STATION	2.150271763	2.015183438	0.443054242
14	USB_CHARGER_TEST_OFF_BATTERY_CURRENT	STATION	6.92963301	4.809093701	0.035755765
15	USB_CHARGER_TEST_OFF_USB_CURRENT	STATION	17.84753424	16.59647602	0.000382816
16	WALL_CHARGER_TEST_BATTERY_CURRENT	STATION	1.315796416	0.897465469	-0.849119152
17	WALL_CHARGER_TEST_USB_CURRENT	STATION	3.662498416	2.558909122	0.888399212
18	AC_CHARGER_TEST_BATTERY_CURRENT	STATION	1.440400942	1.438325392	-0.95206828
19	AC_CHARGER_TEST_USB_CURRENT	STATION	125.0980796	112.3612023	0.999476629
20	AU_HEADSETLEFTCH_RMS_FREQUENCY	STATION	4.10824359	3.442003042	0.072699388
21	AU_HEADSETLEFTCH_RMS_FREQUENCY_RIGHT	STATION	75.3320585	60.72082144	0.00166128
22	AU_HEADSETRIGHTCH_RMS_FREQUENCY	STATION	5.097204123	4.452476088	0.077455253
23	AU_HEADSETRIGHTCH_RMS_FREQUENCY_LEFT	STATION	3.936593872	2.939817113	0.001206511
24	AU_LOUDSPEAKER_RMS_FREQUENCY1	STATION	2.116752157	1.978794789	-1.235187645
25	AU_LOUDSPEAKER_RMS_FREQUENCY2	STATION	3.267062788	3.003124801	-0.317956532
26	AU_LOUDSPEAKER_RMS_FREQUENCY3	STATION	2.008284274	1.81583708	-1.11891695
27	AU_LOUDSPEAKER_DISTORTION_FREQUENCY1	STATION	3.658066128	3.107929553	3.182484015
28	AU_LOUDSPEAKER_DISTORTION_FREQUENCY2	STATION	5.479529098	4.316645708	1.046544302
29	AU_LOUDSPEAKER_DISTORTION_FREQUENCY3	STATION	5.259153978	5.124368244	3.02095325
30	AU_LOUDSPEAKER_TONE	STATION	117.2375926	107.8101903	-0.041141071
31	AU_RECEIVER_RMS_FREQUENCY1	STATION	2.473039855	2.494326843	0.191518161
32	AU_RECEIVER_RMS_FREQUENCY2	STATION	2.254410594	2.254939988	-0.156326557
33	AU_RECEIVER_RMS_FREQUENCY3	STATION	1.216093915	1.216449299	-1.110891576
34	AU_RECEIVER_RMS_FREQUENCY4	STATION	2.259981595	2.254668258	-0.156993325

PCA Tables | Graph Results | Summary

Ready

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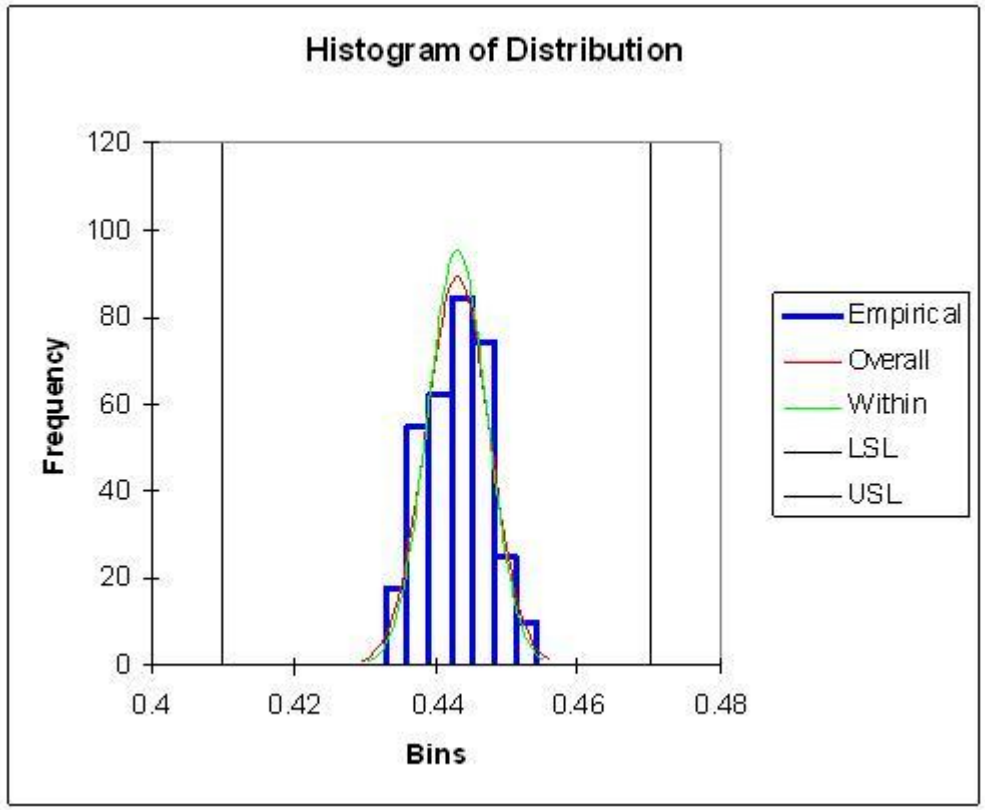
SPC Graphical Report

The results of the charts analysis are shown in the Excel *Graph Results Worksheet* for each test steps:

- Histogram of the empirical relative frequency density
- Overall Gaussian distribution curve
- Within Gaussian distribution curve

SPC Graphical Report



Histograms provide a display of data set and show where the values fall. This helps in understanding of the data in terms of shape, spread and location.

SPC Table Report

The Excel *SPC Tables Worksheet* contains the calculated values of the elements of PCA and PPA tables for all selected test steps:

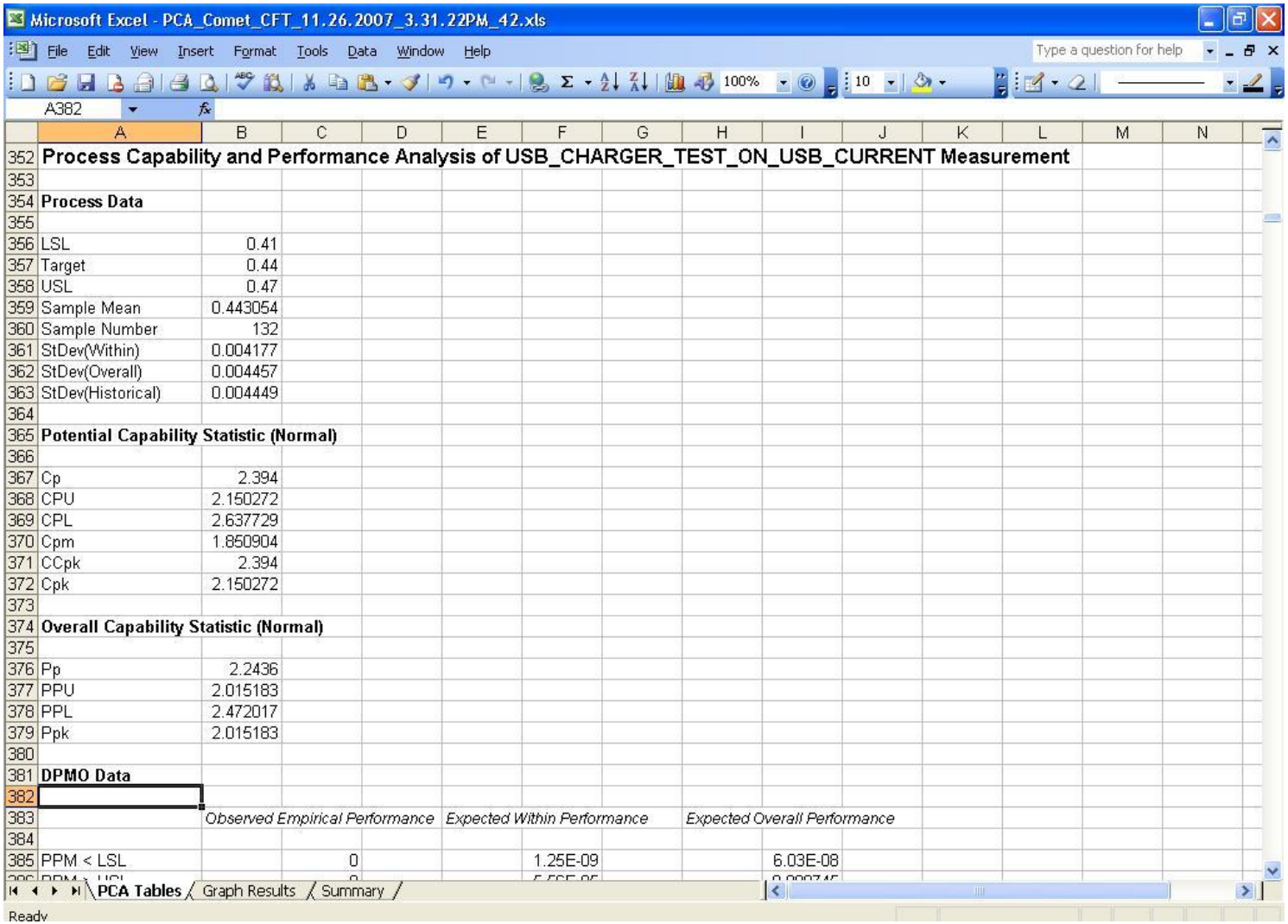
- **PCA Table**

  Includes the process data and process capability indexes.

- **PPA Table**

  Shows the process performance indexes and the predicted DPMO values.

SPC Table Report



	A	B	C	D	E	F	G	H	I	J	K	L	M	N
352	**Process Capability and Performance Analysis of USB_CHARGER_TEST_ON_USB_CURRENT Measurement**													
353														
354	**Process Data**													
355														
356	LSL	0.41												
357	Target	0.44												
358	USL	0.47												
359	Sample Mean	0.443054												
360	Sample Number	132												
361	StDev(Within)	0.004177												
362	StDev(Overall)	0.004457												
363	StDev(Historical)	0.004449												
364														
365	**Potential Capability Statistic (Normal)**													
366														
367	Cp	2.394												
368	CPU	2.150272												
369	CPL	2.637729												
370	Cpm	1.850904												
371	CCpk	2.394												
372	Cpk	2.150272												
373														
374	**Overall Capability Statistic (Normal)**													
375														
376	Pp	2.2436												
377	PPU	2.015183												
378	PPL	2.472017												
379	Ppk	2.015183												
380														
381	**DPMO Data**													
382														
383		*Observed Empirical Performance*			*Expected Within Performance*			*Expected Overall Performance*						
384														
385	PPM < LSL		0			1.25E-09			6.03E-08					

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Steps to Perform Attribute Agreement Analysis

- Click on the button labeled as *Attribute Gage R&R*
  A dialog box will be appeared on the screen, which has the following items:

- Number of Parts: Type the number of samples.
- Number of Ops: Type the number of appraisers.
- Number of Trials: Type the number of trails.

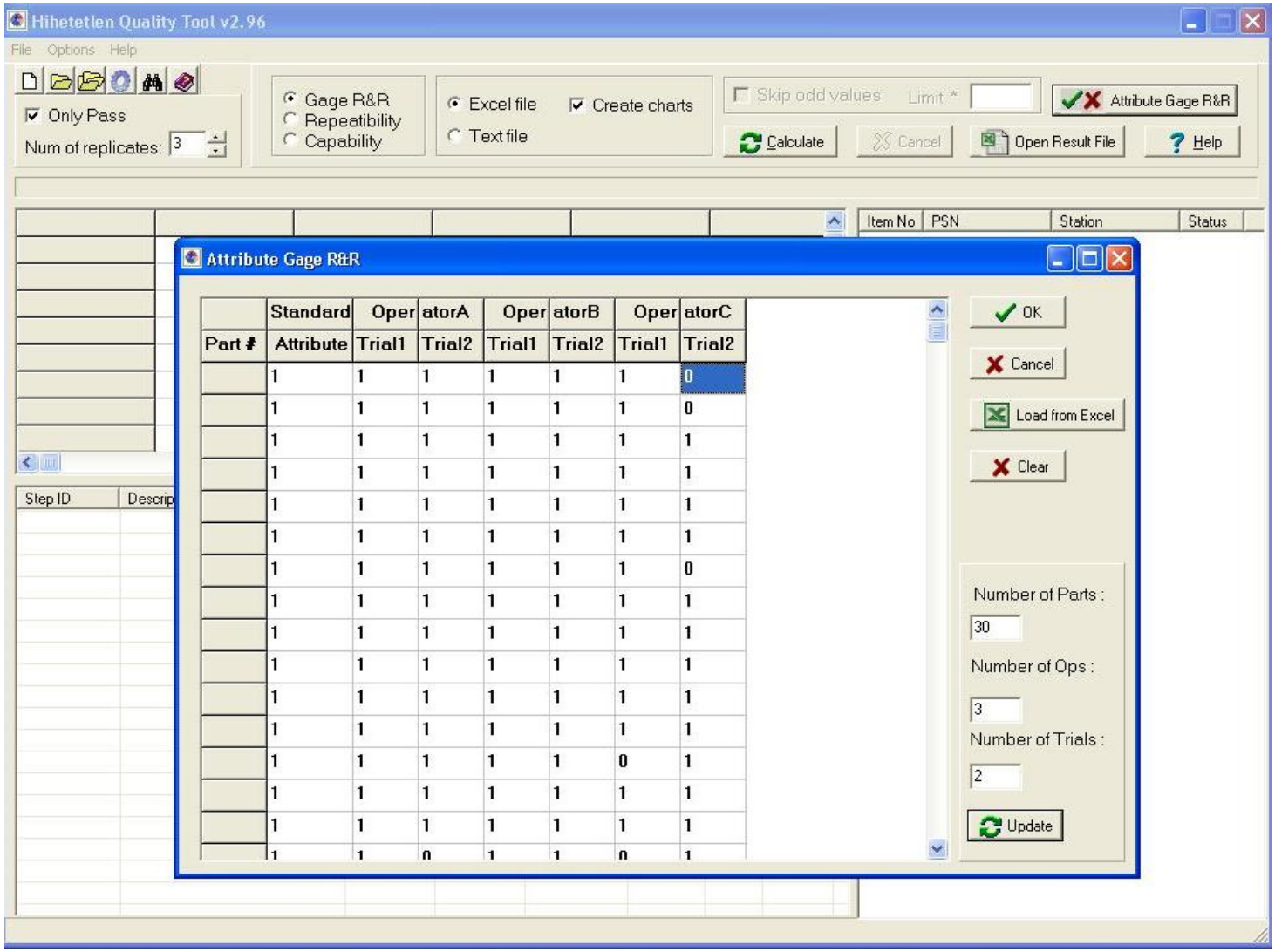
- Click on the button labeled as *Update*
  Corresponding to the above parameters a new table will be shown and you can use it to enter the standards and the responses of each appraisers:

- Attribute Column: Enter a column containing the attribute or known standards for each samples.

- Multiple columns : Enter the columns containing the responses of appraisers for all trials together. Keep the trials for each appraisers in adjoining columns.

- Click to the *OK* button to starting calculating and reporting processes. An information message will appeare after these are successfully completed.

Example for Attribute Agreement Analysis



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Attribute Agreement Summary Report

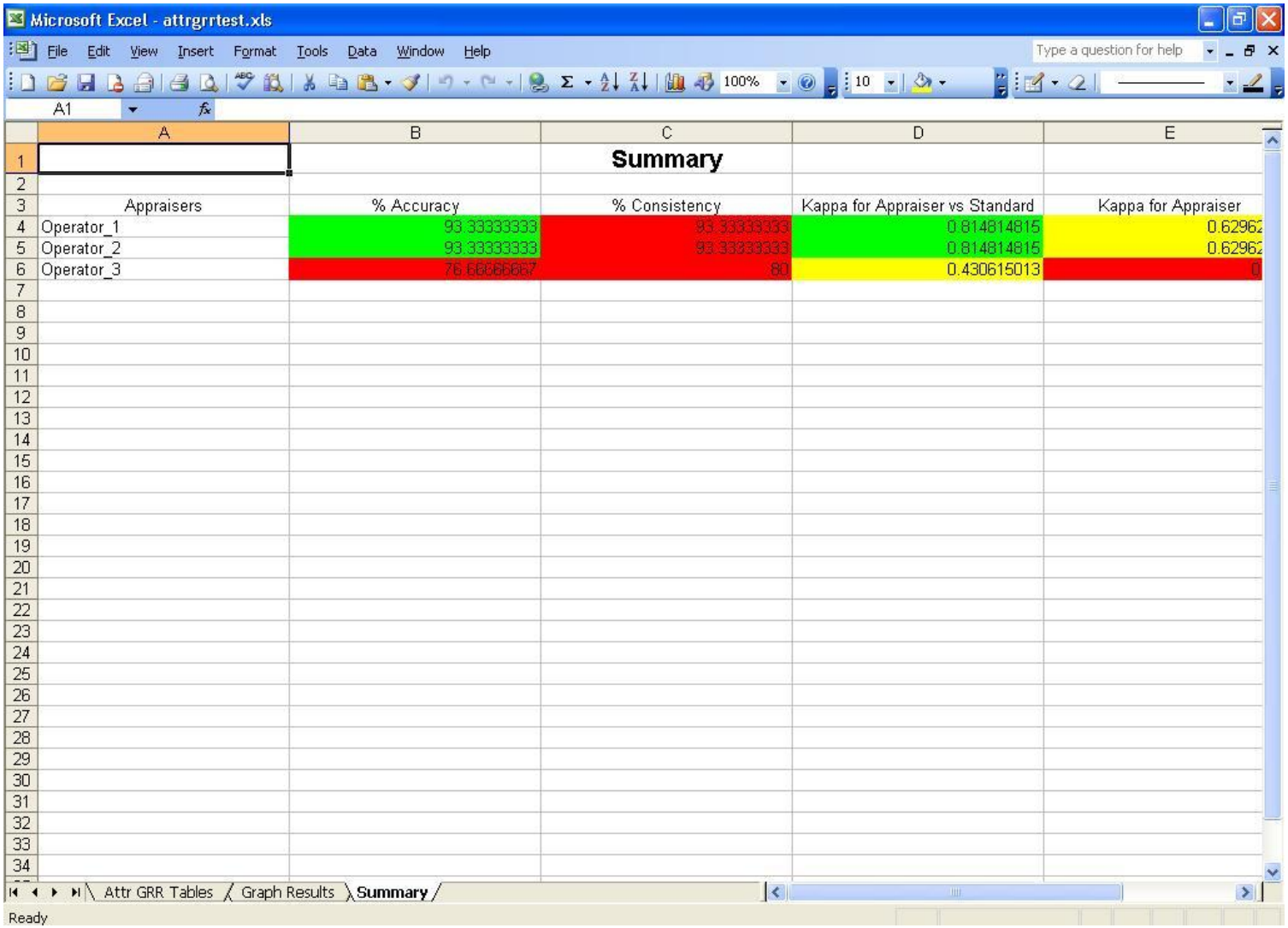
On the output Excel *Summary Worksheet* the report includes the below-mentoinded calculated results ordering by line in appraisers:

- Identification of Appraiser

- % Accuracy value
- % Consistency value

- Fleiss' kappa coefficinet for Appraiser vs Standard
- Fleiss' kappa coefficient for Appraiser

Attribute Agreement Summary Report

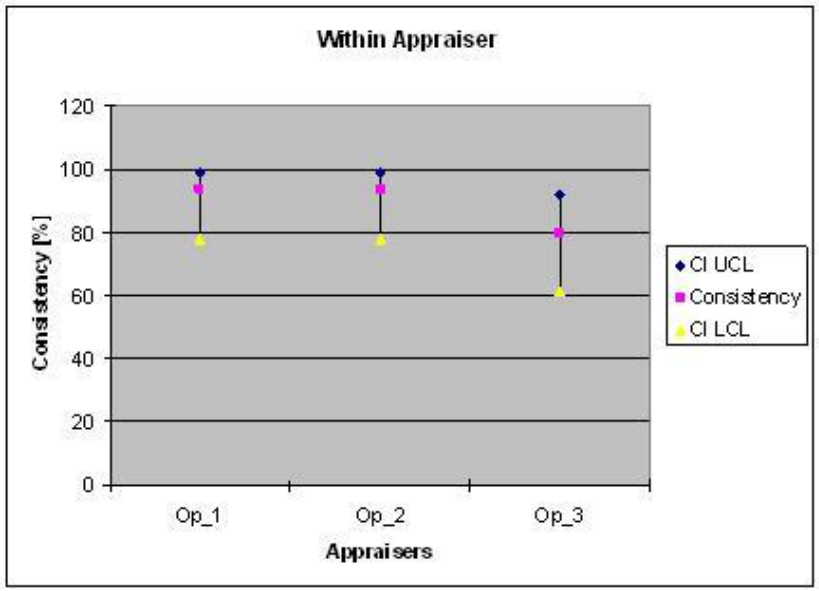


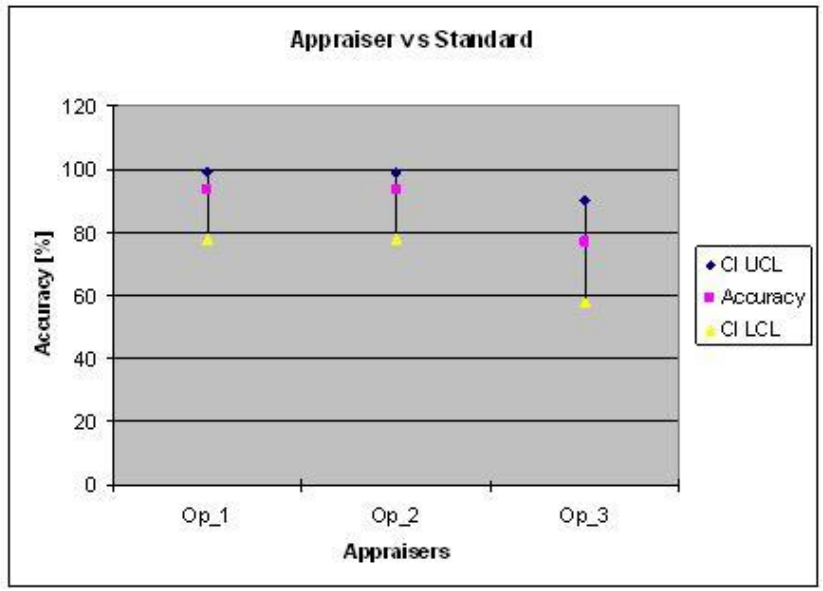
Attribute Agreement Graphical Report

On the Excel *Graph Results Worksheet* the percentage plots of agreed responses can be seen:

- Within Appraiser (% Consistency): Graph of the matched proportions for each appraisers.
- Appraiser vs Standard (% Accuracy): Graph of the matched proportions between the ratings of each appraisers and the attribute.
- The lower and upper confidence limits (CI LCL, CI UCL) are also displayed as error bars.

Attribute Agreement Graphical Report





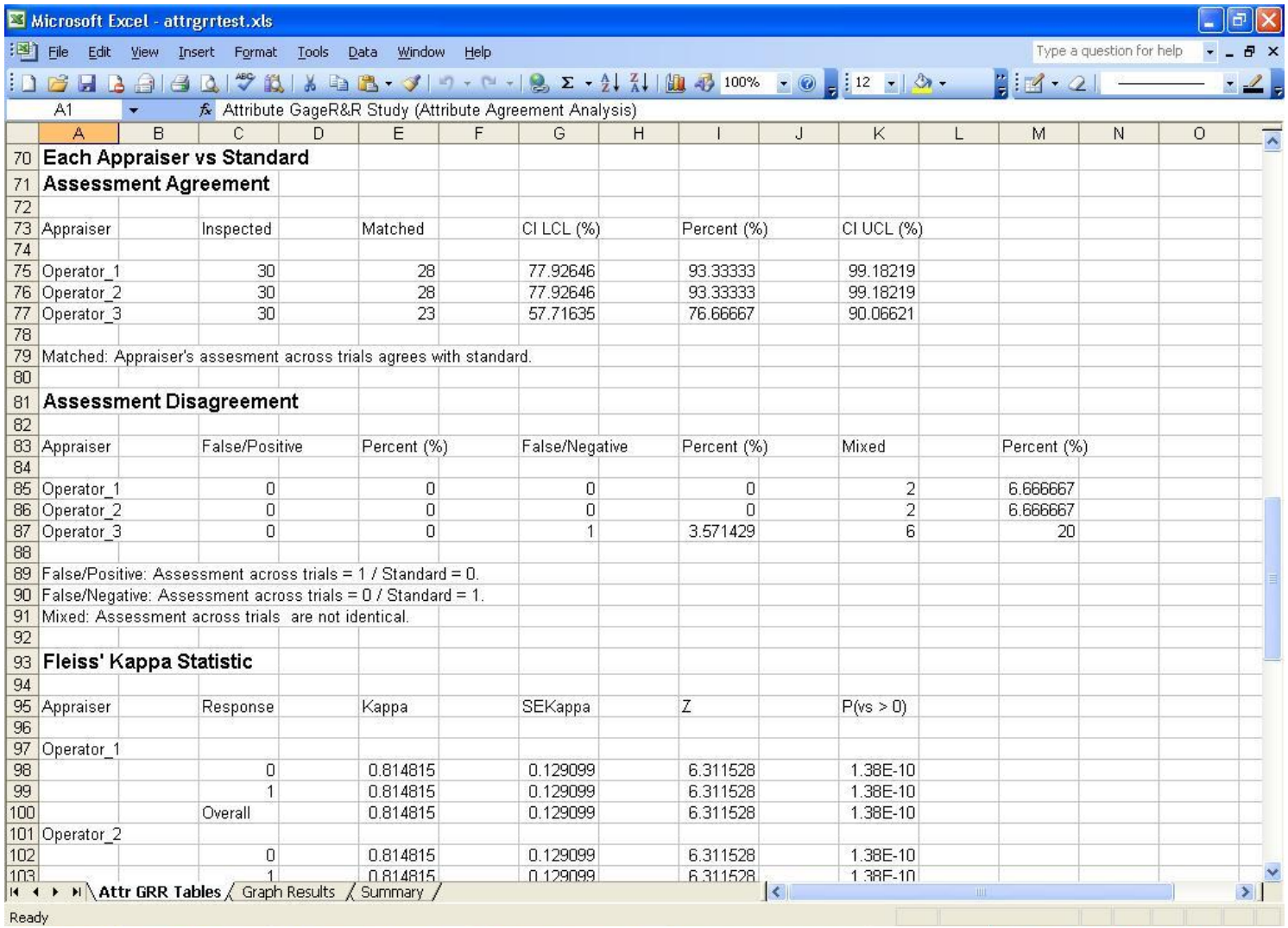
Consistency: Operator agrees with himself/herself on both trials
Accuracy: Operator agrees on both trials with the known standard

Attribute Agreement Table Report

On the Excel *ATTR GRR Tables Worksheet* the output data of „Cross Tab Method” can be found:

- Appraiser to appraiser cross tabulation
- Appraiser to reference cross tabulation
- Computed values of effectiveness of the measurement system with given α confidence interval, results of miss rate and false alarm rate analysis
- Fleiss’ kappa statistic for multiple raters using categorical classifications

Attribute Agreement Table Report



Microsoft Excel - attrgrrtest.xls

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A1 Attribute GageR&R Study (Attribute Agreement Analysis)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
70	**Each Appraiser vs Standard**														
71	**Assessment Agreement**														
72															
73	Appraiser		Inspected		Matched		CI LCL (%)		Percent (%)		CI UCL (%)				
74															
75	Operator_1		30		28		77.92646		93.33333		99.18219				
76	Operator_2		30		28		77.92646		93.33333		99.18219				
77	Operator_3		30		23		57.71635		76.66667		90.06621				
78															
79	Matched: Appraiser's assesment across trials agrees with standard.														
80															
81	**Assessment Disagreement**														
82															
83	Appraiser		False/Positive		Percent (%)		False/Negative		Percent (%)		Mixed		Percent (%)		
84															
85	Operator_1		0		0		0		0		2		6.666667		
86	Operator_2		0		0		0		0		2		6.666667		
87	Operator_3		0		0		1		3.571429		6		20		
88															
89	False/Positive: Assessment across trials = 1 / Standard = 0.														
90	False/Negative: Assessment across trials = 0 / Standard = 1.														
91	Mixed: Assessment across trials are not identical.														
92															
93	**Fleiss' Kappa Statistic**														
94															
95	Appraiser		Response		Kappa		SEKappa		Z		P(vs > 0)				
96															
97	Operator_1														
98			0		0.814815		0.129099		6.311528		1.38E-10				
99			1		0.814815		0.129099		6.311528		1.38E-10				
100			Overall		0.814815		0.129099		6.311528		1.38E-10				
101	Operator_2														
102			0		0.814815		0.129099		6.311528		1.38E-10				
103			1		0.814815		0.129099		6.311528		1.38E-10				

Attr GRR Tables | Graph Results | Summary

Ready

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Simplified Repeatability Study

The program allows the user to apply a more appropriate approach to evaluating the level of measurement error between repeated values.

There are three accessible reporting modes:

- **Standard** (**S**)

  All measured data, specification limits and maximum differences for the selected test steps will be stored on distinct worksheets for each stations .

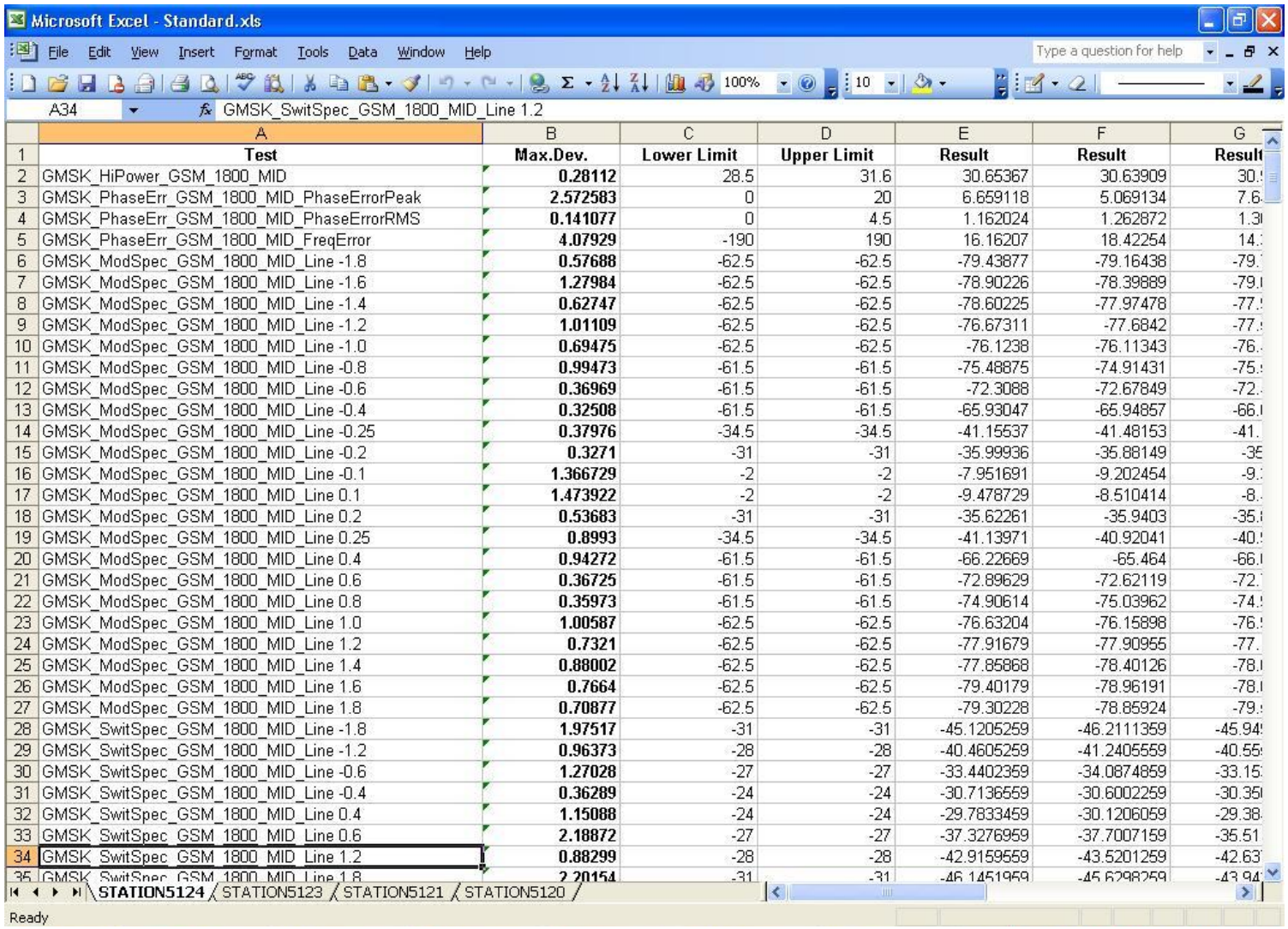
- **Same Station** (**SS**)

  Measured values are belonging to a given station and different PSNs will be compared by calculating the maximum differences for selected test steps.

- **Station to Station** (**S2S**)

  Measured values for a given PSN and various stations will be similarly compared as well as graphical displaying of a selected group of measurements be also possible.

Simplified Repeatability Study



	A	B	C	D	E	F	G
1	Test	Max.Dev.	Lower Limit	Upper Limit	Result	Result	Result
2	GMSK_HiPower_GSM_1800_MID	0.28112	28.5	31.6	30.65367	30.63909	30.5
3	GMSK_PhaseErr_GSM_1800_MID_PhaseErrorPeak	2.572583	0	20	6.659118	5.069134	7.6
4	GMSK_PhaseErr_GSM_1800_MID_PhaseErrorRMS	0.141077	0	4.5	1.162024	1.262872	1.3
5	GMSK_PhaseErr_GSM_1800_MID_FreqError	4.07929	-190	190	16.16207	18.42254	14.
6	GMSK_ModSpec_GSM_1800_MID_Line -1.8	0.57688	-62.5	-62.5	-79.43877	-79.16438	-79.
7	GMSK_ModSpec_GSM_1800_MID_Line -1.6	1.27984	-62.5	-62.5	-78.90226	-78.39889	-79.
8	GMSK_ModSpec_GSM_1800_MID_Line -1.4	0.62747	-62.5	-62.5	-78.60225	-77.97478	-77.
9	GMSK_ModSpec_GSM_1800_MID_Line -1.2	1.01109	-62.5	-62.5	-76.67311	-77.6842	-77.
10	GMSK_ModSpec_GSM_1800_MID_Line -1.0	0.69475	-62.5	-62.5	-76.1238	-76.11343	-76.
11	GMSK_ModSpec_GSM_1800_MID_Line -0.8	0.99473	-61.5	-61.5	-75.48875	-74.91431	-75.
12	GMSK_ModSpec_GSM_1800_MID_Line -0.6	0.36969	-61.5	-61.5	-72.3088	-72.67849	-72.
13	GMSK_ModSpec_GSM_1800_MID_Line -0.4	0.32508	-61.5	-61.5	-65.93047	-65.94857	-66.
14	GMSK_ModSpec_GSM_1800_MID_Line -0.25	0.37976	-34.5	-34.5	-41.15537	-41.48153	-41.
15	GMSK_ModSpec_GSM_1800_MID_Line -0.2	0.3271	-31	-31	-35.99936	-35.88149	-3
16	GMSK_ModSpec_GSM_1800_MID_Line -0.1	1.366729	-2	-2	-7.951691	-9.202454	-9.
17	GMSK_ModSpec_GSM_1800_MID_Line 0.1	1.473922	-2	-2	-9.478729	-8.510414	-8.
18	GMSK_ModSpec_GSM_1800_MID_Line 0.2	0.53683	-31	-31	-35.62261	-35.9403	-35.
19	GMSK_ModSpec_GSM_1800_MID_Line 0.25	0.8993	-34.5	-34.5	-41.13971	-40.92041	-40.
20	GMSK_ModSpec_GSM_1800_MID_Line 0.4	0.94272	-61.5	-61.5	-66.22669	-65.464	-66.
21	GMSK_ModSpec_GSM_1800_MID_Line 0.6	0.36725	-61.5	-61.5	-72.89629	-72.62119	-72.
22	GMSK_ModSpec_GSM_1800_MID_Line 0.8	0.35973	-61.5	-61.5	-74.90614	-75.03962	-74.
23	GMSK_ModSpec_GSM_1800_MID_Line 1.0	1.00587	-62.5	-62.5	-76.63204	-76.15898	-76.
24	GMSK_ModSpec_GSM_1800_MID_Line 1.2	0.7321	-62.5	-62.5	-77.91679	-77.90955	-77.
25	GMSK_ModSpec_GSM_1800_MID_Line 1.4	0.88002	-62.5	-62.5	-77.85868	-78.40126	-78.
26	GMSK_ModSpec_GSM_1800_MID_Line 1.6	0.7664	-62.5	-62.5	-79.40179	-78.96191	-78.
27	GMSK_ModSpec_GSM_1800_MID_Line 1.8	0.70877	-62.5	-62.5	-79.30228	-78.85924	-79.
28	GMSK_SwitSpec_GSM_1800_MID_Line -1.8	1.97517	-31	-31	-45.1205259	-46.2111359	-45.94
29	GMSK_SwitSpec_GSM_1800_MID_Line -1.2	0.96373	-28	-28	-40.4605259	-41.2405559	-40.55
30	GMSK_SwitSpec_GSM_1800_MID_Line -0.6	1.27028	-27	-27	-33.4402359	-34.0874859	-33.15
31	GMSK_SwitSpec_GSM_1800_MID_Line -0.4	0.36289	-24	-24	-30.7136559	-30.6002259	-30.35
32	GMSK_SwitSpec_GSM_1800_MID_Line 0.4	1.15088	-24	-24	-29.7833459	-30.1206059	-29.38
33	GMSK_SwitSpec_GSM_1800_MID_Line 0.6	2.18872	-27	-27	-37.3276959	-37.7007159	-35.51
34	GMSK_SwitSpec_GSM_1800_MID_Line 1.2	0.88299	-28	-28	-42.9159559	-43.5201259	-42.63
35	GMSK_SwitSpec_GSM_1800_MID_Line 1.8	2.20154	-31	-31	-46.1451959	-45.6298259	-43.94

STATION5124 STATION5123 STATION5121 STATION5120

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Simplified Repeatability Study

Microsoft Excel - REPS2S.xls

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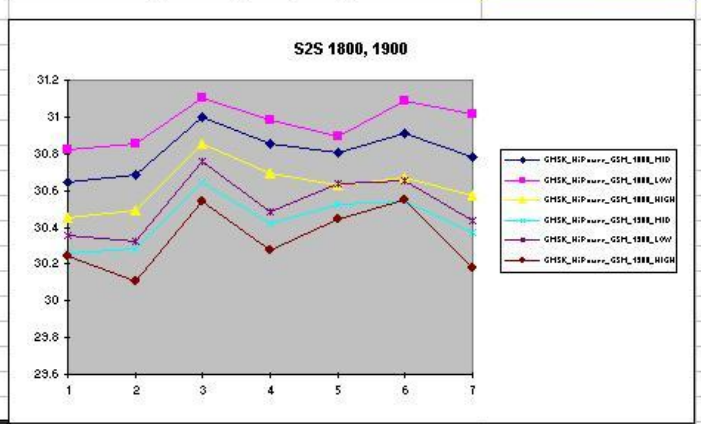
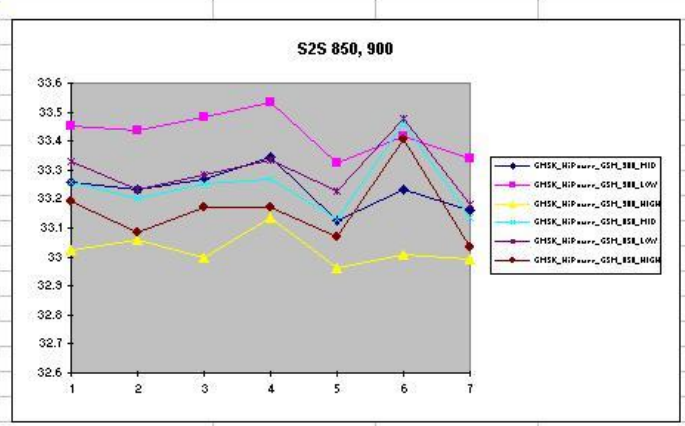
A34

	A	B	C	D	E	F	G
1							
2		Station To Station Repeatability					
3		BSN			1404465358	1404465358	1404465358
4		Measurement	**Delta accross stations**	**Average**	STATION5124	STATION5123	STATION5121
5		GMSK_HiPower_GSM_1800_MID	**0.354395**	30.81740917	30.64638	30.68554	31.000775
6		GMSK_HiPower_GSM_1800_LOW	**0.27554**	30.95736	30.82492	30.85461	31.10046
7		GMSK_HiPower_GSM_1800_HIGH	**0.40289**	30.63232083	30.451235	30.49282	30.854125
8		GMSK_HiPower_GSM_900_MID	**0.2203**	33.24390417	33.26025	33.23214	33.270085
9		GMSK_HiPower_GSM_900_LOW	**0.20863**	33.44087	33.453235	33.435145	33.4844
10		GMSK_HiPower_GSM_900_HIGH	**0.17254**	33.03000833	33.021	33.05891	32.996185
11		GMSK_HiPower_GSM_850_MID	**0.33319**	33.26185667	33.256595	33.20063	33.252965
12		GMSK_HiPower_GSM_850_LOW	**0.25193**	33.3142775	33.330995	33.232235	33.28447
13		GMSK_HiPower_GSM_850_HIGH	**0.33803**	33.18198833	33.19126	33.08566	33.17066
14		GMSK_HiPower_GSM_1900_MID	**0.38215**	30.44382667	30.25914	30.28318	30.64129
15		GMSK_HiPower_GSM_1900_LOW	**0.438745**	30.53515417	30.3542	30.32156	30.760305
16		GMSK_HiPower_GSM_1900_HIGH	**0.437495**	30.36078333	30.245955	30.108985	30.543085
17							





CFT_StationToStation

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General Informations

- **Minimum PC-platform requirements**

  Computer: IBM compatible PC
  Operating System: MS Windows NT/2000/XP
  Processor: 32-bit Intel Pentium III/IV 1GHz CPU or equivalent
  System Memory: 512 MByte of RAM
  Screen resolution: Super VGA 1024x768 pixels
  Software environment: MS Office Excel 2000 or later
  Hard disk: High Data Rate drive is recommended with 20 MByte of free space for installing

- **Technical Support**

  If you have any questions regarding to the software or need technical support please write or call. Contact technical support is available by telephone or e-mail during normal business hours.

Typical Running Times

Test Computer: Fujitsu Siemens Laptop (1GB RAM, 1.7GHz CPU)

Number of Testers: 4
Number of Test Steps: 130
Number of PSNs: 10 (GRR), 130 (SPC)
Number of Replicates: 3 (GRR), 1 (SPC)
Number of Log Files: 120 (GRR), 130 (SPC) LogType: 450 kByte txt

- **Coverting & Parsering:**
  GRR(~15sec), SPC(~15sec)
- **Filtering (manual):**
  Max ~1 min (in case of a beginner user)
- **Calculating & Reporting:**
  GRR (~2 min), SPC(~45sec)
- **Total Test Process Time:**
  GRR(~3min 15sec), SPC(~2 min)

If the log files are already loded and saved templates used for report settings, the total time of further analysies can strongly be reduced (now it is only ~2min).

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