

GAGE REPEATABILITY AND REPRODUCIBILITY DATA SHEET (Long Method)
VisionMaster AP212 Measurement System

	1	2	3	4	5	6	7	8	9	10	11	12
Operator	A - Owen B.				B - Mike R.				C - Steve A.			
Sample #	1st Trail	2nd Trial	3rd Trial	Range	1st Trail	2nd Trial	3rd Trial	Range	1st Trail	2nd Trial	3rd Trial	Range
1	198.18	197.98	199.27	1.29	196.6	197.91	198.46	1.86	197.78	197.95	197	0.95
2	205.36	205.29	205.65	0.36	205.26	205.22	205.85	0.63	206.32	205.29	205.06	1.26
3	206.35	209.23	205.08	4.15	204.3	205.04	205.21	0.91	206.88	206.08	205.49	1.39
4	210.46	210.89	210.33	0.56	208.78	209.68	209.36	0.9	211.64	209.39	209.22	2.42
5	179.95	181.24	180.96	1.29	180.39	180.6	179.62	0.98	182.94	180.39	180.28	2.66
6	199.36	198.57	196.6	2.76	197.15	196.86	196.79	0.36	199.87	196.3	196.82	3.57
7	203.6	203.94	202	1.94	200.99	201.99	202.19	1.2	203.77	201.72	202.62	2.05
8	203.38	202.72	204.58	1.86	203.79	202.7	202.44	1.35	200.19	203.22	199.98	3.24
9	200.93	201.45	197.06	4.39	201.22	197.85	199.76	3.37	196.81	201.45	195.94	5.51
10	118.42	119.84	120.03	1.61	120.65	119.68	119.5	1.15	118.97	120.15	120.17	1.2
Totals	1925.99	1931.15	1921.56	20.21	1919.13	1917.53	1919.18	12.71	1925.17	1921.94	1912.58	24.25
		1925.99		2.021		1919.13		1.271		1925.17		2.425
		1921.56		Ave Ra		1919.18		Ave Rb		1912.58		Ave Rc
Sum		5778.7			Sum	5755.84			Sum	5759.69		
Ave Xa		192.62			Ave Xb	191.86			Ave Xc	191.99		

Ave Ra	2.021
Ave Rb	1.271
Ave Rc	2.425
Sum	5.717
R	1.91

# Trials	D4
2	3.27
3	2.58

$(R) \times (D4) = \text{UCLR}^*$ $(0.09) \times (2.58) = \underline{0.23}$
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Max X(ave)	192.62
Min X(ave)	191.86
X(ave) Diff.	0.76

* Limit of individual R's. Circle those that are beyond this limit. Identify the cause and correct. Repeat these readings using the same appraiser and unit as originally used or discard values and reaverage and recompute R and the limiting value. UCLR from the remaining observations.

Reference: The D4 constant is obtained from, Table of Factors For Xbar & R Charts. Figure 9. Pg 12 -- Western Electric (AT&T) Statistical Quality.

Notes:

Gage Repeatability and Reproducibility Report

Part No. & Name VisionMaster
 Characteristic: Solder Paste Thickness
 Specification: 50 micron

Gage Name: LaserVision Tech.
 Gage No.: 2
 Gage Type: Automated

Date: 12/8/1998
 Performed By: ASC

From Data Sheet: R = **1.91** X(diff) = **0.76**

MEASUREMENT UNIT ANALYSIS

% TOLERANCE ANALYSIS

Repeatability - Equipment Variation (E.V.)

No. Trials(m)	2	3
K1	4.56	3.05

E.V. = (R) x (K1)

=

=

5.83

% E.V. = 100[(E.V.)/(Tolerance)]

=

=

11.65%

Reproducibility - Appraiser Variation (A.V.)

Operators	2.00	3
K2	3.65	2.7

A.V. = sqrt(((x(diff)x(k2) - ((E.V.)sq/(nxm)))

=

=

0.96

0.4

% A.V. = 100[(A.V.)/(Tolerance)]

=

=

1.90%

10

n = number of parts

m = number of trials

Repeatability and Reproducibility (R&R)

R&R = sqrt((E.V.)sq. + (A.V.)sq.)

=

=

5.91

0.23

% R&R = (100((R&R)/(Tolerance))

=

=

11.82%

2.4

All calculations are based upon predicting 5.15 sigma (99.0% of the area under the normal distribution curve).