

## GAUGE REPEATABILITY AND REPRODUCIBILITY DATA SHEET VARIABLE DATA RESULTS

Part Number	23461-K0NA-D010	Gauge Name	OBD MICROMETER	Appraiser A	MANJUNATH
Part Name	C3 K0NA	Gauge Number	C07L01BR0012-001	Appraiser B	ISMILE
Characteristic	Specification	Gauge Type	VARIABLE	Appraiser C	SHRINIVAS
OBD	54.150-54.180				
Characteristic Classification	CRITICAL	Trials	3	Parts	10
				Appraisers	3
				Date Performed	18/06/2019 ✓

APPRAISER/ TRIAL #	PART										AVERAGE
	1	2	3	4	5	6	7	8	9	10	
1. A 1	54.151	54.152	54.153	54.155	54.158	54.162	54.168	54.171	54.175	54.179	54.162
2. 2	54.150	54.152	54.154	54.155	54.158	54.163	54.169	54.172	54.176	54.178	54.163
3. 3	54.151	54.152	54.153	54.156	54.159	54.163	54.169	54.173	54.175	54.177	54.163
4. AVE	54.151	54.152	54.153	54.155	54.158	54.163	54.169	54.172	54.175	54.178	$\bar{X}_a =$ 54.163
5. R	0.001	0.000	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.002	$r_a =$ 0.001
6. B 1	54.151	54.152	54.153	54.155	54.158	54.162	54.168	54.171	54.175	54.179	54.162
7. 2	54.152	54.151	54.154	54.157	54.157	54.163	54.169	54.172	54.176	54.178	54.163
8. 3	54.151	54.152	54.154	54.156	54.159	54.163	54.169	54.173	54.177	54.179	54.163
9. AVE	54.151	54.152	54.154	54.156	54.158	54.163	54.169	54.172	54.176	54.179	$\bar{X}_b =$ 54.163
10. R	0.001	0.001	0.001	0.002	0.002	0.001	0.001	0.002	0.002	0.001	$r_b =$ 0.001
11. C 1	54.151	54.152	54.153	54.156	54.158	54.162	54.168	54.171	54.175	54.179	54.163
12. 2	54.153	54.153	54.152	54.155	54.157	54.164	54.168	54.174	54.176	54.179	54.163
13. 3	54.151	54.152	54.153	54.156	54.159	54.163	54.169	54.173	54.175	54.177	54.163
14. AVE	54.152	54.152	54.153	54.156	54.158	54.163	54.168	54.173	54.175	54.178	$\bar{X}_c =$ 54.163
15. R	0.002	0.001	0.001	0.001	0.002	0.002	0.001	0.003	0.001	0.002	$r_c =$ 0.002
16. PART AVE ( $\bar{X}_p$ )	54.151	54.152	54.153	54.156	54.158	54.163	54.169	54.172	54.176	54.178	$\bar{X} =$ 54.163 $R_p =$ 0.027
17. ( $r_a + r_b + r_c$ ) / (# OF APPRAISERS) =											R = 0.0014
18. (Max $\bar{X}$ - Min $\bar{X}$ ) =											$X_{DIFF} =$ 0.0002
19. $R \times D_4^* =$											$UCL_R =$ 0.0035
20. $R \times D_3^* =$											$LCL_R =$ 0.0000
Reference Values	54.151	54.152	54.153	54.156	54.158	54.163	54.169	54.172	54.176	54.178	

\*  $D_4^* = 3.27$  for 2 trials and 2.58 for 3 trials;  $D_3^* = 0$  for up to 7 trials.  $UCL_R$  represents the 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 re-average and recompute R and the limiting value from the remaining observations.

Notes:

PREPARED BY  
ISF-QA-016

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APPROVED BY

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Part Name	C3 K0NA	Gage Number	C07L01BR0012-001	Appraiser B	ISMILE
Characteristic	OBD	Gage Type	VARIABLE	Appraiser C	SHRINIVAS
Characteristic Classification		Trial	3	Parts	10
		Appraisers	3	Date Performed	18/06/2019

Measurement Unit Analysis				% Total Variation (TV)	
<b>Repeatability - Equipment Variation (EV)</b>					
EV	=	$R \times K_1$	<b>Trials</b>	<b>K1</b>	% EV = 100 (EV/TV)
	=	0.001 x 0.5908	2	0.8862	= 100(0.0008/0.0086)
	=	0.0008	3	0.5908	= 9.42
<b>Reproducibility - Appraiser Variation (AV)</b>					
AV	=	$\{(X_{DIFF} \times K_2)^2 - (EV^2/nr)\}^{1/2}$			% AV = 100 (AV/TV)
	=	$\{(0.000 \times 0.5231)^2 - (0.001^2/(10 \times 3))\}^{1/2}$			= 100(0.0000/0.0086)
	=	0.0000	<b>Appraisers</b>	<b>2</b>	= 0.00
			<b>K2</b>	<b>0.7071</b>	n = number of parts
				<b>0.5231</b>	r = number of trials
<b>Repeatability &amp; Reproducibility (R &amp; R)</b>					
R & R	=	$\{(EV^2 + AV^2)\}^{1/2}$	<b>Parts</b>	<b>K3</b>	% R&R = 100 (R&R/TV)
	=	$\{(0.001^2 + 0.000^2)\}^{1/2}$	2	0.7071	= 100(0.0008/0.0086)
	=	0.0008	3	0.5231	= 9.42
<b>Part Variation (PV)</b>					
PV	=	$R_p \times K_3$	4	0.4467	Gage system O.K ✓
	=	0.027 x 0.3146	5	0.4030	
	=	0.0085	6	0.3742	
<b>Total Variation (TV)</b>					
TV	=	$\{(R\&R^2 + PV^2)\}^{1/2}$	7	0.3534	% PV = 100 (PV/TV)
	=	$\{(0.001^2 + 0.009^2)\}^{1/2}$	8	0.3375	= 100(0.0085/0.0086)
	=	0.0086	9	0.3249	= 99.55
			10	0.3146	ndc = 14.9 ✓

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

$K_1$  is  $5.15/d_2$ , where  $d_2$  is dependent on the number of trials (m) and the number of parts times the number of operators (g) which is assumed to be greater than 15.

AV - If a negative value is calculated under the square root sign, the appraiser variation (AV) defaults to zero (0).

$K_2$  is  $5.15/d_2$ , where  $d_2$  is dependent on the number of operators (m) and (g) is 1, since there is only one range calculation.

$K_3$  is  $5.15/d_2$ , where  $d_2$  is dependent on the number of parts (m) and (g) is 1, since there is only one range calculation.

$d_2$  is obtained from Table D3, "Quality Control and Industrial Statistics", A.J. Duncan.