

# GAGE REPEATABILITY AND REPRODUCIBILITY REPORT

According to AIAG - Measurement Systems Analysis 4<sup>th</sup> Edition

Date : 19-05-2021

Performed by : Tiago Marques

Operator A: Tiago

Operator B: Mafalda

Operator C: Sara

|                           |                                      |                                         |
|---------------------------|--------------------------------------|-----------------------------------------|
| ES Part number : S002816B | Dimensional Report Number : 164/2021 | Gage name : <i>Profile Projector</i>    |
| Characteristic : Distance | Specification : 8,3± 0,2 mm          | Gage number : PPF Resolution : 0,001 mm |
| USL = 8,50                | LSL= 8,10                            | Tolerance= TI= USL-LSL = 0,40           |

| Appraiser | A: TIAGO  |           |           |       | B: MAFALDA |           |           |       | C: SARA   |           |           |       | Xp (part) |
|-----------|-----------|-----------|-----------|-------|------------|-----------|-----------|-------|-----------|-----------|-----------|-------|-----------|
| Parts #   | 1st trial | 2nd trial | 3rd trial | Range | 1st trial  | 2nd trial | 3rd trial | Range | 1st trial | 2nd trial | 3rd trial | Range |           |
| 1         | 8,233     | 8,223     | 8,230     | 0,010 | 8,234      | 8,231     | 8,234     | 0,003 | 8,224     | 8,228     | 8,227     | 0,004 | 8,229     |
| 2         | 8,242     | 8,246     | 8,242     | 0,004 | 8,237      | 8,235     | 8,238     | 0,003 | 8,244     | 8,237     | 8,240     | 0,007 | 8,240     |
| 3         | 8,192     | 8,196     | 8,201     | 0,009 | 8,202      | 8,196     | 8,201     | 0,006 | 8,196     | 8,198     | 8,203     | 0,007 | 8,198     |
| 4         | 8,212     | 8,219     | 8,210     | 0,009 | 8,209      | 8,209     | 8,215     | 0,006 | 8,213     | 8,213     | 8,214     | 0,001 | 8,213     |
| 5         | 8,259     | 8,251     | 8,256     | 0,008 | 8,257      | 8,251     | 8,259     | 0,008 | 8,254     | 8,256     | 8,255     | 0,002 | 8,255     |
| 6         | 8,271     | 8,275     | 8,270     | 0,005 | 8,272      | 8,270     | 8,268     | 0,004 | 8,273     | 8,269     | 8,267     | 0,006 | 8,271     |
| 7         | 8,274     | 8,269     | 8,270     | 0,005 | 8,267      | 8,267     | 8,264     | 0,003 | 8,273     | 8,273     | 8,274     | 0,001 | 8,270     |
| 8         | 8,155     | 8,161     | 8,162     | 0,007 | 8,152      | 8,155     | 8,161     | 0,009 | 8,153     | 8,155     | 8,163     | 0,010 | 8,157     |
| 9         | 8,226     | 8,228     | 8,226     | 0,002 | 8,220      | 8,230     | 8,220     | 0,010 | 8,224     | 8,229     | 8,226     | 0,005 | 8,225     |
| 10        | 8,126     | 8,121     | 8,123     | 0,005 | 8,127      | 8,119     | 8,120     | 0,008 | 8,124     | 8,119     | 8,126     | 0,007 | 8,123     |

|                  |        |       |       |                  |        |       |       |                  |        |       |       |       |       |
|------------------|--------|-------|-------|------------------|--------|-------|-------|------------------|--------|-------|-------|-------|-------|
| <b>Average</b>   | 8,219  | 8,219 | 8,219 | 0,006            | 8,218  | 8,216 | 8,218 | 0,006            | 8,218  | 8,218 | 8,220 | 0,005 | 0,148 |
| X <sub>A</sub> = | 8,2190 | RA=   | 0,006 | X <sub>B</sub> = | 8,2173 | RB=   | 0,006 | X <sub>C</sub> = | 8,2183 | RC=   | 0,005 | RP=   |       |

| CONSTANTS      |        |        |        |        |        |        |        |        |        |
|----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Parts          | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     |
| K <sub>3</sub> | 0,7071 | 0,5231 | 0,4467 | 0,4030 | 0,3742 | 0,3534 | 0,3375 | 0,3249 | 0,3146 |

|                                                                                                           |                          |
|-----------------------------------------------------------------------------------------------------------|--------------------------|
| $\bar{R} = (\bar{RA} + \bar{RB} + \bar{RC}) / 3$                                                          | $\bar{R} = 0,0058$       |
| $\bar{X}_{dif} = \text{Max. } \bar{X}_{(A,B \text{ ou } C)} - \text{Min. } \bar{X}_{(A,B \text{ ou } C)}$ | $\bar{X}_{dif} = 0,0016$ |
| $L_{SCR} = \bar{R} \times D_4$                                                                            | $L_{SCR} = 0,0150$       |
| $L_{ICR} = \bar{R} \times D_3$                                                                            | $L_{ICR} = 0$            |

| Appraiser s | K <sub>2</sub> | Trials | D <sub>3</sub> | D <sub>4</sub> | K <sub>1</sub> |
|-------------|----------------|--------|----------------|----------------|----------------|
| 2           | 0,7071         | 2      | 0              | 3,27           | 0,8862         |
| 3           | 0,5231         | 3      | 0              | 2,58           | 0,5908         |

| Results (R&R)                       |          |                                                        |
|-------------------------------------|----------|--------------------------------------------------------|
| <input checked="" type="checkbox"/> | ≤ 10%    | Measurement system is acceptable                       |
| <input type="checkbox"/>            | 10 - 30% | May be acceptable based upon importance of application |
| <input type="checkbox"/>            | ≥ 30%    | Needs improvement                                      |

| Measurement analysis                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Tolerance analysis (%)                                                                                                                                                                                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Repeatability</b> → Equipment Variation (EV)<br>$E.V = R \times K_1 = 0,00343$ <b>K<sub>1</sub>=</b> 0,5908<br><b>Reproducibility</b> → Appraiser Variation (AV)<br>$A.V = \sqrt{(\bar{X}_{dif} \times K_2)^2 - (E.V^2 / jn)} = 0,00058$<br><b>K<sub>2</sub>=</b> 0,5231 <b>n=</b> 10 <b>r=</b> 3<br><b>Repeatability and Reproducibility (R &amp; R)</b><br>$R\&R = \sqrt{(E.V^2 + AV^2)} = 0,00348$<br><b>Part Variation (PV)</b><br>$PV = RP \times K_3 = 0,04649$ <b>K<sub>3</sub>=</b> 0,3146<br><b>Total Variation (TV)</b><br>$T.V = \sqrt{(R\&R^2 + PV^2)} = 0,04662$ | <b>% E.V = 100 (EV / TV) = 7,35%</b><br><b>% A.V = 100 (AV / TV) = 1,25%</b><br><b>% R &amp; R = 100 (R &amp; R / TV) = 7,46%</b><br><b>% PV = 100 (PV / TV) = 99,72%</b><br><b>ndc = 1,41(PV/R&amp;R) = 18,860</b> |