



# Fraunhofer

## TESTED<sup>®</sup> DEVICE

igus GmbH  
chainflex CF11.D  
**Report No. IG 2405-1526**

DUPLICATE

Statement of  
Qualification

Product series  
**Particle Emission  
in Dry-Cleanroom**

|                  |                                                                                                                                                                                                                                                                                                                                                                 |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Customer         | igus GmbH<br>Spicher Strasse 1a<br>51147 Cologne<br>Germany                                                                                                                                                                                                                                                                                                     |
| Component tested |                                                                                                                                                                                                                                                                                                                                                                 |
| Category:        | Energy Supply                                                                                                                                                                                                                                                                                                                                                   |
| Subcategory:     | Cable Systems                                                                                                                                                                                                                                                                                                                                                   |
| Product name:    | chainflex measuring system cable CF11.D<br>Tested Products: <ul style="list-style-type: none"><li>CF11.001.D (manufacturing date: first quarter of 2023)</li><li>CF11.007.D (manufacturing date: third quarter of 2021)</li><li>CF11.014.D (manufacturing date: first quarter of 2017)</li><li>CF11.019.D (manufacturing date: third quarter of 2022)</li></ul> |

Random sampling of particle emissions (airborne) at representative sites in dry-cleanroom

|                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Standards/Guidelines:        | ISO 14644-1, -14<br>The norms stated generally refer to the version valid at the time of the tests.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Test devices:                | Optical particle counter:<br>LasAir II 110 and LasAir III 110 with measuring ranges $\geq 0.1\text{ }\mu\text{m}$ , $\geq 0.2\text{ }\mu\text{m}$ , $\geq 0.3\text{ }\mu\text{m}$ , $\geq 0.5\text{ }\mu\text{m}$ , $\geq 1.0\text{ }\mu\text{m}$ and $\geq 5.0\text{ }\mu\text{m}$                                                                                                                                                                                                                                                                                                        |
| Test environment parameters: | <ul style="list-style-type: none"><li>Dry-Cleanroom Air Cleanliness Class (according to ISO 14644-1): ..... ISO 3</li><li>Airflow velocity: ..... <math>0.1\text{ m/s} \pm 0.05\text{ m/s}</math></li><li>Airflow pattern: ..... displacement flow</li><li>Temperature: ..... <math>22\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}</math></li><li>Relative humidity/dew point: ..... <math>-40\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}</math></li></ul>                                                                                                            |
| Test procedure parameters:   | <ul style="list-style-type: none"><li>Energy chain: ..... igus E61.29.02.075 or igus E61.29.02.150</li><li>Chain bending radius: ..... <math>r = 75\text{ mm}</math> or <math>150\text{ mm}</math></li><li>Stroke length: ..... <math>s = 820\text{ mm}</math></li><li>Parameter Set 1: ..... <math>v_1 = 0.5\text{ m/s}</math>; <math>a_1 = 1.0\text{ m/s}^2</math></li><li>Parameter Set 2: ..... <math>v_2 = 1.0\text{ m/s}</math>; <math>a_2 = 2.0\text{ m/s}^2</math></li><li>Parameter Set 3: ..... <math>v_3 = 2.0\text{ m/s}</math>; <math>a_3 = 4.0\text{ m/s}^2</math></li></ul> |

|                              |                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Test result / Classification | When operated under the specified test conditions, the series chainflex measuring system cable CF11.D is suitable for use in Dry-Cleanrooms (with a room temperature of $22\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$ and dew point of $-40\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ ) fulfilling the specifications of the following Air Cleanliness Classes according to ISO 14644-1: |
|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

| Test parameter(s)                                 | Air Cleanlines Class |
|---------------------------------------------------|----------------------|
| $v_1 = 0.5\text{ m/s}$ ; $a_1 = 1.0\text{ m/s}^2$ | 4                    |
| $v_2 = 1.0\text{ m/s}$ ; $a_2 = 2.0\text{ m/s}^2$ | 4                    |
| $v_3 = 2.0\text{ m/s}$ ; $a_3 = 4.0\text{ m/s}^2$ | 4                    |
| Overall result                                    | 4                    |

Please note: Transport damages, incorrect installation, aging behavior, etc. can influence the test result.

The measuring devices used for the qualification tests are calibrated at regular intervals; their results can be traced back to national and international standards. In cases where no national standards exist, the test procedure implemented complies with the technical regulations and norms applicable at the time of the test. The relevant documentation can be viewed on request at any time.

Detailed information and parameters of the test environment can be found in the Fraunhofer IPA test report.

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|-----------------------------------------------------------------------|-----------------------------------------------------------------------|-------------------------------------------------------------------|
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| Department of Ultraclean Technology and Micromanufacturing            | --<br>Report No. current document                                     | --<br>Place, current date                                         |
| Nobelstrasse 12<br>70569 Stuttgart<br>Germany                         | on behalf of<br>Dr.-Ing. Frank Bürger, Project Manager Fraunhofer IPA |                                                                   |