

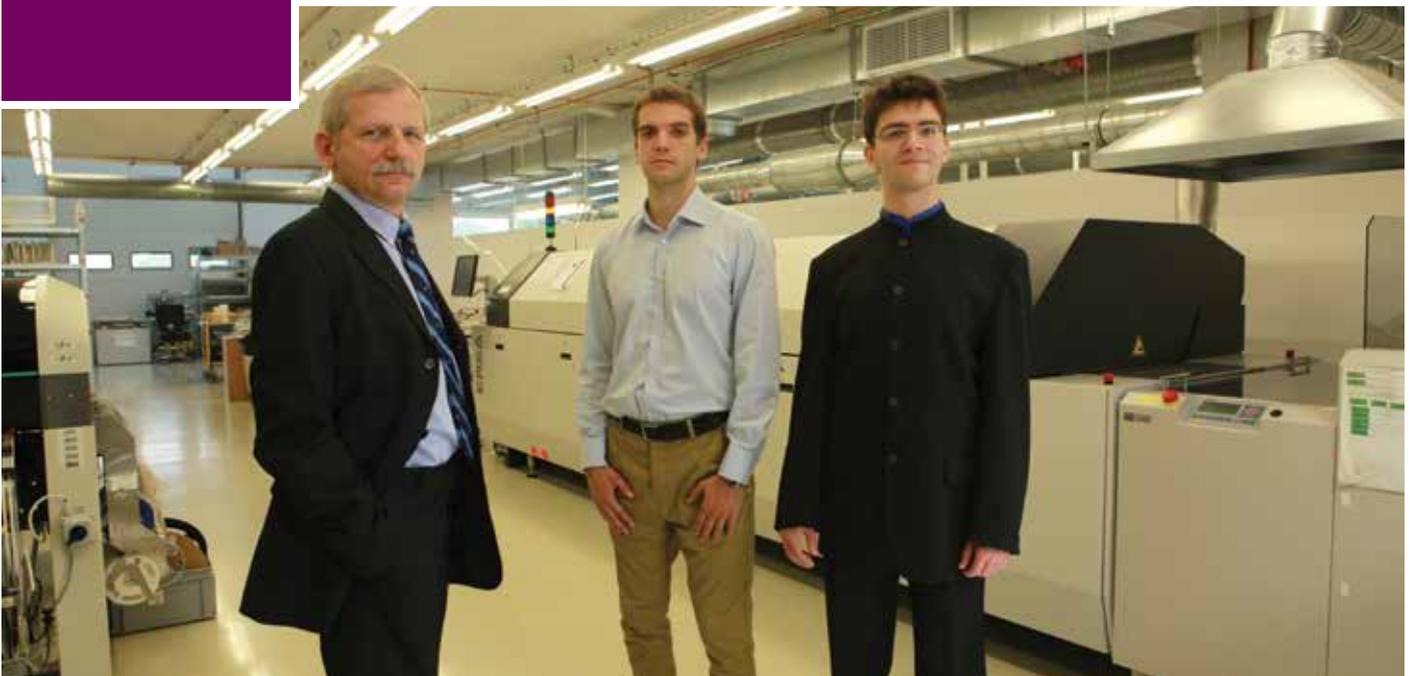
# INTELLIGENT ADAPTIVE ELECTRONICS



for Pressure Differential Systems (PDS) protecting  
escape and rescue routes



**Saving human lives - Intelligent Automatics for PDS**  
Adaptive Automatics for Pressure Differential Systems



## RESEARCH AND DEVELOPMENT

- Area of special expertise – adaptive algorithms and their innovative use in the ventilation industry, with the scientific support of Ph.D. Maciej Szumski, leading specialist in this field and PLUM CEO
- Research facilities – Company's own 5 research and measurement laboratories for testing devices in development phases
- R&D Department – a team of 50 specialist engineers with long-term experience in the development of electronic heating and ventilation systems
- Research co-operation – with independent experts of Polish and foreign universities and institutes, including the Institute of Industrial Aerodynamics (I.F.I) at the Aachen University, Germany and the Warsaw University of Technology, Poland

## INNOVATION

- Algorithms developed by PLUM for specific projects
- Products protected by patent, registered trademarks and brand names as well as copyrights to industrial designs
- Participation in EU strategic innovation programs
- Plum Ltd. as an established innovation pioneer, several times awarded with the first prize in the category "Company and Product of the Highest Quality" in the competition "Quality International", organized by the Polish Ministry of Regional Development" and the Forum ISO 9000

## Plum Ltd. – Experience, Research, Solution, Product

Plum Ltd. is a manufacturer of sophisticated and specifically developed systems for strategic economic sectors, such as gas, heating and ventilation technology. The Company was established by couple Maciej and Dorota Szumski, and since then it has been run by the founders as a family business. The company's performance potential is based on four pillars: 25-year experience in the development and production of state-of-the-art equipment, a team of highly motivated engineers, an ultra-modern production complex and a variety of on-site research laboratories. PLUM products are designed and manufactured in accordance with the guidelines of the integrated management system. Both developed and finished devices are examined in the following company's own testing laboratories.

- **Accredited Measurement Laboratory** for the calibration of electricity, temperature, pressure, humidity and pressure measurement devices
- **Fire Ventilation Laboratory** for testing and visualizing algorithms of different airflows in multi-storey buildings
- **Heating Technology Laboratory**
- **Electromagnetic Compatibility Laboratory (EMC)**

The basis for the Company's success is formed by a close connection between applied research and professional experience. This bond has been supplemented by the consequent use of the latest technologies and management methods. From the very beginning, PLUM CEO Ph.D. Maciej Szumski has been implementing a user-friendly and innovative strategy to company's business activities. Back in the eighties, Ph.D. M. Szumski used to develop complex equipment for the gas sector. Currently, Ph.D. Szumski along with his colleagues of the R&D Department designs and constructs technically advanced equipment to solve specific problems of businesses from HVAC technology sectors. The PLUM high-tech "forge" produces up-to-date systems that combine and deploy the latest achievements of mathematics, mechanics, electronics and information technology.



### TECHNOLOGY

- Purpose-built complex with manufacturing facilities, storage space and laboratory rooms (total area of 4601 m<sup>2</sup>)
- Assembly lines equipped with first-class equipment
- Production and storage processes protected from ESD by special devices
- Components delivered exclusively by renowned and reliable partners, including Samsung, AVX, Epcos, Panasonic, Honeywell, Phoenix Contact and Texas Instruments

### QUALITY AND ENVIRONMENT PROTECTION

- PLUM has implemented the following integrated management systems: Quality Management System (QMS) ISO 9001 regularly certified by BSI, Health and Safety Management System OHSAS 18001 and Environmental Management System ISO 14001
- Applied technologies and procedures are environmentally friendly
- The Company is located in a unique part of Poland. The vicinity is mainly a conservation area. Nearby, there is the Bialowieza National Park, the last primeval forest of Europe

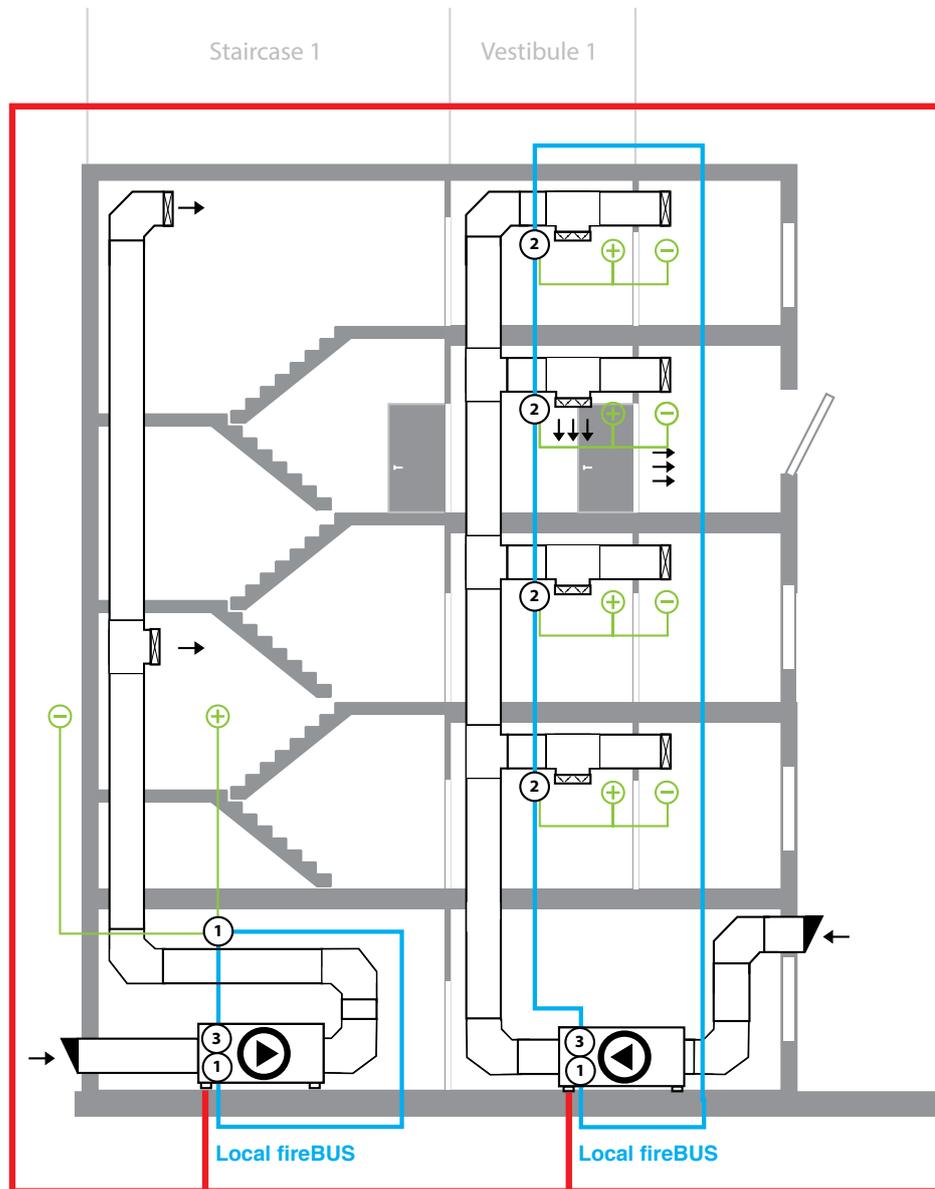


**UNIQUE FIRE PROTECTION SOLUTION**

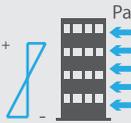
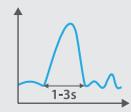
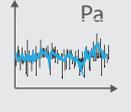
Active system to safeguard evacuations of people

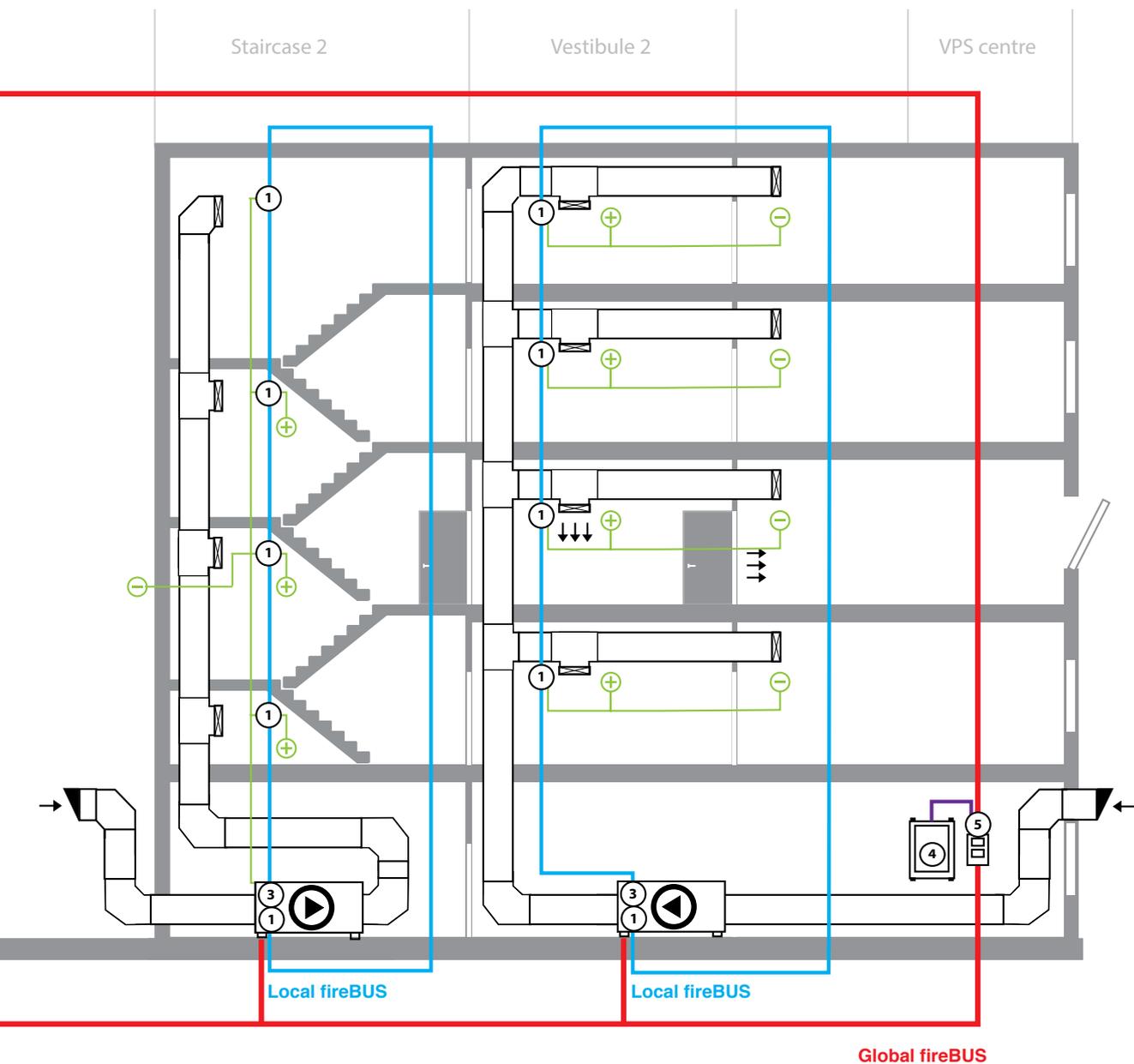
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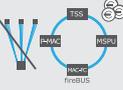
- 1. Digital pressure difference transducer with a differential sensor (PDC-DS)
- 2. Digital controller of an individual damper (DC-D)
- 3. Controller of pressure differential systems (CPDS)
- 4. Visual panel system centre
- 5. Switch board / switch and indicator board (SB/SIB)
- Communication bus - global fireBUS
- Communication bus - local fireBUS



Global fireBUS

Benefits of the PDS Adaptive Automatics	Application advantages of the PDS Adaptive Automatics
 <p>High resistance against negative phenomena caused by wind loading and the stack effect</p>	<p><b>Security regardless of changing external conditions</b></p> <p>The adaptive algorithm of the latest generation (based on neural networks) ensures the resistance of the PLUM Automatics against all adverse effects connected with wind loading on buildings; eliminates the negative impact of the stack effect on the pressure distribution in escape and rescue routes; does not react to any daily and annual temperature fluctuations.</p>
 <p>Independent of fluctuations in air leakage in evacuation routes</p>	<p><b>Low start-up and adaptation costs</b></p> <p>The PDS Automatics continuously monitor a protected building and recognize the actual conditions inside. This allows constant adaptation to the actual fluctuations in air leakage. The fluctuations may be caused by structural modifications or deviations from construction plans. The intelligent system does not require any ongoing adjustment - neither in different construction phases of a building nor in completed objects.</p>
 <p>Swift adaptation to dynamic changes in environmental parameters</p>	<p><b>Swift adaptation to changes taking place in a building</b></p> <p>The PDS Automatics quickly adapt to dynamic changes in their environment. The Adaptive Automatics detect and analyse problematic situations to react appropriately. Data from a monitored building are collected and stored by the PLUM Automatics 20 times per second.</p>
 <p>Stable operation in chaotic circumstances during evacuations. The PDS Adaptive Automatics flexibly fulfil the criteria for airflow and pressure</p>	<p><b>Excellent operation in case of evacuation</b></p> <p>The PDS Intelligent Automatics work extremely stable in chaotic circumstances during evacuations, when doors are constantly being opened and closed. In such extreme cases, the system components do not begin to oscillate.</p>



Benefits of the PDS Adaptive Automatics	Application advantages of the PDS Adaptive Automatics
 <p>Minimal wiring costs</p>	<p><b>Minimal wiring costs</b></p> <p>The communication protocol fireBUS secures data transfer among the modules of the PDS Automatics via a single communication loop. As a result of this, the wiring costs are minimal.</p>
 <p>Expandable and upgradable system Flexible and adaptable to individual needs</p>	<p><b>Easy customizing to needs of investors, planners and engineers</b></p> <p>Due to their modular design, the existing Adaptive Automatics for PDS can be expanded or customised to individual needs.</p>
 <p>Monitoring system components Test recording: hard copy printout, checking the correct operation of the system</p>	<p><b>Operational safety</b></p> <p>The monitoring function of the Adaptive Automatics for PDS allow examining connection circuits and current performance parameters. The Adaptive Automatics can store and then print test results. They may be connected to the Internet and mobile phones for remote diagnostics.</p>
 <p>Wide range of application</p>	<p><b>Adaptable to all building types and sizes</b></p> <p>The PDS Automatics can be installed in all types of buildings, such as residential houses, office buildings, industrial facilities and commercial centres of any size and design.</p>
 <p>No adjustment needed</p>	<p><b>Low costs of system setting in new and existing objects</b></p> <p>The adaptive algorithm automatically improves its performance parameters. Hence, the PDS Adaptive Automatics do not require any fine tuning after installation or change in air leakage rate (calculating deviations of actual values).</p>

## Application of the Adaptive Automatics for PDS

### Regulation and monitoring

The Adaptive Automatics for PDS ensure the highest level of protection against heavy smoke in horizontal and vertical escape and rescue routes of multi-storey buildings. The Intelligent Automatics monitor and regulate pressure differential systems (PDS) in residential houses, office buildings, industrial facilities, shopping malls, student hostels, hotels etc. The PDS Adaptive Automatics allow to freely set the desired pressure inside the monitored area and can be used in buildings of any size and design. All the time, the Intelligent Automatics keep exchanging data with the fire alarm control panel (FACP) without any need to regulate or monitor this process.

The fast acting Automatics for PDS guarantee a reaction time of 1-2 s after door opening **in all circumstances inside and outside of the protected area**. Regulation results for both tight and leaky structures are excellent and vary between 1 and 3 s. The PLUM Intelligent Automatics identify the object of regulation and dynamically respond to the changeable demands resulting from the actual state of evaluation. This maintains the highest level of security at minimal cost.

#### Reference objects with the Intelligent Automatics for PDS to monitor smoke spreading and ventilation units:



- **The University of Physical Education in Cracow** – 13-storey student hostel for 1,300 occupants, a renovated building, 2 Adaptive Automatics (basic and auxiliary) used for security reasons, system devices are interconnected with a communication fireBUS. This solution may be installed in any object to control fire ventilation systems in the following areas:
  - Small and large-scale staircases up to several floors
  - Lift shafts of any size.



- **Ikea (Wroclaw)** – Shopping mall with the total floor area of 37,705 m<sup>2</sup>, 6 spacious staircases with high tightness. The following components of the Intelligent Automatics have been installed: 6 x CPDS, 6 x PDC-DS, 6 x PSCC, 1 x SB and 1 x VPS.



- **Malta (Poznan)** – 5 storey building with the office area of 15,000 m<sup>2</sup>, 2 separate ventilation systems for 2 large/-scale staircases with high tightness. After closing the door, time figures for pressure stabilization of 1.5 to 2.5 sec. have been reached.

## Adaptive Automatics for PDS

### Intelligent Automatics for Pressure Differential Systems

The PDS Automatics are one of the latest solutions for monitoring fire ventilation equipment. In the event of fire, the Adaptive Automatics for PDS ensure precise and stable overpressure in escape and rescue routes. In this process, all requirements of the European standard EN 12101-6:2005 are met.

The Intelligent Automatics for PDS have a modular structure; i.e. all system components are interconnected with one transmission cable forming a closed loop (fireBUS).

## ADAPTIVE ALGORITHM

### Based on a neural network

The PLUM Automatics for PDS are based on predictive algorithms. Using stored data, the Intelligent Automatics recognize the actual conditions in the escape and rescue routes of a monitored building. This way, an exact pattern of the current object state is established. The fast acting PLUM Automatics employ this pattern for the adaptive regulation of pressure differential systems. The algorithm ensures the resistance against all adverse effects caused by wind loading. Moreover, it eliminates the negative impact of the stack effect on the pressure distribution in escape and rescue routes. Algorithm functions are not affected by daily or annual temperature fluctuations.

Over 5,000 hours of testing have confirmed the reliability and precision of the algorithm for differential systems in escape and rescue routes. The fire protection system currently used are mainly based on mechanical devices or PID controllers. Compared to conventional methods, the adaptive model of the PLUM Automatics provides a higher standard of security for protected areas.

# TESTS AT RWTH AACHEN UNIVERSITY

I.F.I. Institute for Industrial Aerodynamics



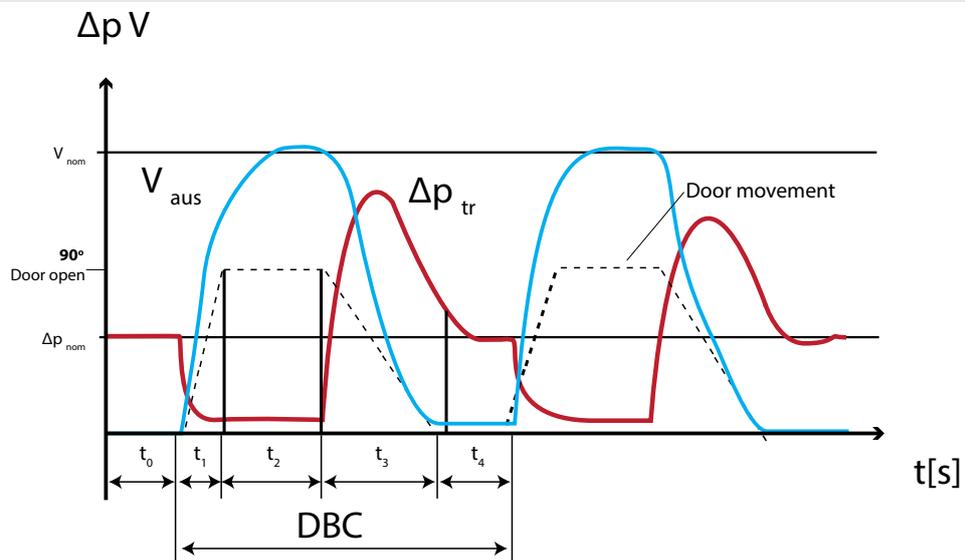
The uniqueness and reliability of the Intelligent Automatics for PDS have been explicitly confirmed by the independent Institute for Industrial Aerodynamics at the Aachen University. For that, the Aachen Institute conducted the following tests:

- Dynamic behaviour test
- Functionality test (Fu) consisting of 20 full cycles of opening and closing of doors
- Reliability test (Re) repeated 10,000 times
- Durability test (Du) consisting of 20 full cycles of opening and closing of doors
- Resonance test (Res) consisting of 10 individual series of tests of 20 cycles each, all of them with open and closed air release opening
- Dynamic behaviour test: 20 cycles of dynamic behaviour



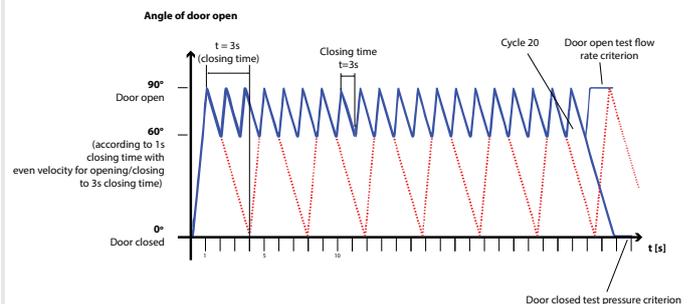
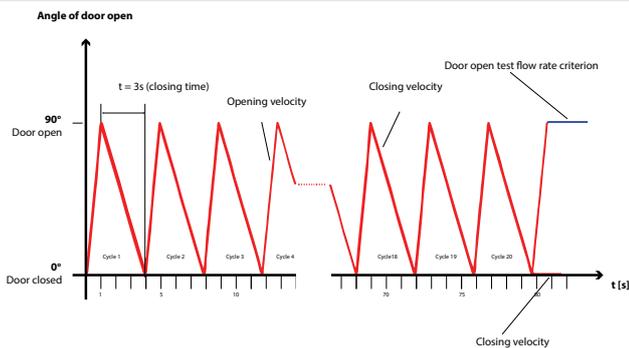
## Test results at I.F.I. Aachen

Dynamic Behaviour Cycle



Resonance cycle with 1s opening time and 3s closing time - alternative endings with open or closed door after 20 cycles

Resonance cycle with 3s and 1s closing time - alternative endings with open or closed door after 20 cycles - opening and closing velocities are kept constant between various closing times





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