**Overview of Tools (Selection)**

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
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<tr>
<td><strong>MicroAutoBox</strong></td>
<td>Compact real-time prototyping system with various I/O interfaces and functional safety mechanisms for use in aircraft.</td>
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<td><strong>MicroLabBox</strong></td>
<td>All-in-one development system for the laboratory.</td>
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<td>Modular real-time system that can be used for hardware-in-the-loop (HIL) and rapid control prototyping (RCP) projects.</td>
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<td><strong>ConfigurationDesk</strong></td>
<td>Configuration and implementation software for dSPACE SCALEXIO hardware.</td>
</tr>
<tr>
<td><strong>Real-Time Interface</strong></td>
<td>Automatic implementation of MATLAB®/Simulink®/Stateflow® models on dSPACE hardware.</td>
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<tr>
<td><strong>AutomationDesk</strong></td>
<td>Translation, module export and instrumentation software.</td>
</tr>
<tr>
<td><strong>ControlDesk</strong></td>
<td>Graphical description of test creation.</td>
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<tr>
<td><strong>TargetLink</strong></td>
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**Aerospace Solutions**

Aerospace Solutions are designed to meet the specific needs of the aerospace industry, providing solutions for flight control, avionics, and mission critical applications. These solutions are built on the experience and expertise of dSPACE, a leading provider of software and hardware solutions for real-time control and simulation.

- **MicroAutoBox**: A compact real-time prototyping system with various I/O interfaces and functional safety mechanisms. It is ideal for use in aircraft, featuring shock- and vibration-resistant hardware according to DO-160.
- **MicroLabBox**: An all-in-one development system for the laboratory, combining compact size and low system costs with high performance and versatility.
- **SCALEXIO**: A modular real-time system that can be used for hardware-in-the-loop (HIL) and rapid control prototyping (RCP) projects. It supports high-performance real-time processors for demanding applications and provides high-performance real-time processors for demanding applications.
- **ConfigurationDesk**: Software for configuration and implementation of dSPACE hardware, allowing for easy and safe use due to automatic consistency checks.
- **Real-Time Interface**: Automatic implementation of MATLAB®/Simulink®/Stateflow® models on dSPACE hardware.
- **AutomationDesk**: A graphical description of test creation, allowing for efficient test creation.
- **ControlDesk**: Essential for flight control, avionics, and mission critical applications.
- **TargetLink**: Automatic generation of high-quality, easy to read, and maintainable C code directly from Simulink®/Stateflow® models, significantly reducing coding and development time.

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The Challenges of Control System Development

The size and complexity of software for aerospace systems is growing significantly. The aeronautics industry faces the need to master the exponential growth for commercial and military aircraft, for instance. The many requirements for commercial aircraft have driven the demand for efficient fuel consumption, low noise emission, flight range and economic efficiency. On top of all this, aerospace developers and manufacturers must adhere to a variety of demanding standards and norms.

To rise to these challenges, aerospace companies are pushing forward with groundbreaking developments in many different fields. Throughout the entire development process for electronic control systems, dSPACE systems play a vital role, giving aerospace engineers the required tools to set up high-performance development environments.

Tools for a Wide Spectrum of Use Cases

dSPACE testing systems offer multiple benefits for a large variety of development activities in aerospace applications. Typical use cases range from function design via rapid prototyping and software verification on embedded platforms for embedded software as well as integrated systems. The SCALEXIO system can also serve as an integrated part of an actual test rig for testing high lift surface control in the lab, for example. It achieves a scalable closed-loop environment by providing control, measurement, monitoring, and data acquisition capabilities for the driving as well as the landing side of the test rig. Real as well as simulated pilot controls for repeatable testing can be used as input. In addition, the SCALEXIO system offers flexible capabilities for software verification by idle simulation as well as for testing the integrated systems including fault scenarios, achieved by enabling simulation of the entire system, individual components such as power electronics, or the physical environment only.

Verification of Networked Aircraft Systems

dSPACE testing systems offer multiple benefits for a large variety of development activities in aerospace applications. Typical use cases range from function design via rapid prototyping and software verification on embedded platforms for embedded software as well as integrated systems.

Automated tests with scalable equipment

Moreover, test systems from dSPACE also support automated test cases that require real-time simulation of multiple systems interacting with real parts of the aircraft. The close-loop environment provides an effective verification platform for embedded software as well as integrated systems. This approach allows for performing efficient and automated integration tests 24 hours a day. In addition, the open and scalable architecture enables scalability tests from large to small setups depending on the application, thus contributing to a flexible and cost-effective test environment adaptable for different test scenarios.

Test Rig for Electric Actuation Systems

Testing Embedded Components

To test a flight control computer in the laboratory, the real flight conditions must be simulated. In this example a SCALEXIO system is used for real-time flight simulation of the entire mission for a high-altitude research rocket. The objective is to verify the correct behavior of the navigation computer in the lab. In the first step, the HIL simulator is connected to the navigation computer since the navigation devices are not available yet. Therefore, they are emulated on the SCALEXIO, which provides the sensor data for the navigation computer. Later, the navigation devices replace the virtual counterparts. In this case, the SCALEXIO system continues to simulate the environment, thus enabling the navigation devices to provide the relevant sensor data to the navigation computer.

For testing multiple networked aircraft systems you might require a test bench that corresponds to the aircraft in size and dimensions and includes the actual cable harness. The setup shown in this case also consists of various mechanical components, for example, control surface actuators. The networked aircraft hardware, such as the electrical power system, is connected to multiple SCALEXIO systems that simulate missing aircraft systems in real time. For example, these simulated systems include engines or avionics systems that are interconnected with the systems under test in the real aircraft. The SCALEXIO systems also provide navigation and environmental data including aerodynamics representative of the flight scenario.

The objective of this use case consists in the fast and easy verification of new control algorithms in an användet served for research. A validated flight simulation environment lays the foundation for the model-based design of specific control functions whose role is to maintain a safe flight envelope during operation. The code generated from the controller models transferred directly to MicroAutoBox installed in the UAV to perform real flight tests. Multiple sensors are connected to a common data bus required for transmitting variables such as speed, altitude, position, angle of attack, and slip angle. The communication between the flight control system and MicroAutoBox is achieved by means of pulse width modulation.

Function Design via Rapid Control Prototyping

Realistic testing of flight scenarios in the lab

By providing a seamless and easy integration of simulation models, dSPACE products make it possible to frontend tests of aircraft components or systems with the support of a comprehensive workflow and easy test system configuration. Therefore, even critical flight scenarios can be fully reproduced in a safe laboratory environment for early testing in the ground. The flexible and scalable test environment enables detailed and fault isolation tests at every development stage in almost all conceivable flight situations.

Components by means of hardware-in-the-loop simulation to the measurement and control of integration tests bench for networked systems.

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The Challenges of Control System Development

The size and complexity of software for aerospace systems is growing significantly. The aeronautics industry faces the need to master the exponential growth for commercial and military aircraft, for instance. The many requirements for commercial aircraft have now driven by rising demands concerning efficiency, such as noise, fuel consumption, flight range and economic efficiency. On top of all this, aerospace manufacturers must adhere to a variety of demanding standards and norms. Therefore, even critical flight scenarios are achieved by means of pulse width modulation.

Testing Embedded Components

To test a flight control computer in the laboratory, the real flight conditions must be simulated. In this example a SCALEXIO system is used for real-time flight simulation of the entire mission for a high-altitude research aircraft. The objective is to verify the correct behavior of the navigation computer in the lab. The first step, the HIL simulator is connected to the navigation computer, which is not yet available in the real aircraft. Therefore, they are simulated on a special simulation machine, which provides the sensor data for the navigation computer. Later, the navigation computer replaces their virtual counterpart. In this case, the SCALEXIO system continues to simulate the environment, thus enabling the navigation computer to provide the relevant sensor data to the navigation computer.

Tools for a Wide Spectrum of Use Cases

dSPACE testing systems offer multiple benefits for a large variety of development activities in aerospace applications. The SCALEXIO system can also serve as an integrated part of an actual test rig for testing high-lift surfact control in the lab, for example. It achieves a scalable closed-loop environment by providing control, measurement, monitoring, and data acquisition capabilities for the driver as well as the loading side of the test rig. Real as well as simulated pilot controls for repeatable testing can be used as input. In addition, the SCALEXIO system offers flexible capabilities for software verifications by HIL simulation as well as for testing the integrated systems (including fault scenarios) by system behavior enabling evaluation of the entire system, individual components such as power electronics, or the physical environment.

Function Design via Rapid Control Prototyping

The SCALEXIO system can offer an extensive use case for testing high-lift surface control in the lab, for example. It achieves a scalable closed-loop environment by providing control, measurement, monitoring, and data acquisition capabilities for the driver as well as the loading side of the test rig. Real as well as simulated pilot controls for repeatable testing can be used as input. In addition, the SCALEXIO system offers flexible capabilities for software verifications by HIL simulation as well as for testing the integrated systems (including fault scenarios) by system behavior enabling evaluation of the entire system, individual components such as power electronics, or the physical environment.

Verification of Networked Aircraft Systems

For testing multiple networked aircraft systems you might require a test bench that corresponds to the aircraft in size and dimensions and includes the actual cable harness. The setup shown in this use case also consists of various mechanical components, for example, control surface actuators. The networked aircraft hardware, such as the electrical power system, is connected to multiple SCALEXIO systems that simulate missing aircraft systems in real-time. For example, these simulated systems include engines or avionics systems that are interconnected with the networked aircraft. The HIL simulation also provides navigation and environmental data including aerodynamics representa-
The Challenges of Control System Development

The size and complexity of software for aerospace systems is growing significantly. The aeronautics industry faces the need to master the exponential growth for commercial and military aircraft, for instance. The many requirements for commercial aircraft now extend beyond just noise concerns concerning efficient fuel consumption, low noise emission, flight range and economic efficiency. On top of all this, aerospace developers and manufacturers must adhere to a variety of demanding standards and norms.

To rise to these challenges, aerospace companies are pushing forward with groundbreaking developments in many different fields. Throughout the entire development process for electronic control systems, dSPACE systems play a vital role, giving aerospace engineers the required tools to set up high-performance development environments.

Testing Embedded Components

To test a flight control computer in the laboratory, the real flight conditions must be simulated. In this example a SCALEXIO system is used for a real-time flight simulation of the entire mission for a high-altitude research rocket. The objective is to verify the correct behavior of the navigation computer in the lab. In the first step, the HIL simulator is connected only to the navigation computer since the navigation devices are not available yet. Therefore, they are emulated on the HIL simulator, which provides the sensor data for the navigation computer. Later, the navigation device replaces its virtual counterpart. In this case, the SCALEXIO system continues to simulate the environment, thus enabling the navigation devices to provide the relevant sensor data to the navigation computer.

Verification of Networked Aircraft Systems

For testing multiple networked aircraft systems you might require a test bench that corresponds to the aircraft in size and dimensions and includes the actual cable harness. The setup shown in this use case also consists of various mechanical components, for example, control surface actuators. The networked aircraft hardware, such as the electrical power system, is connected to multiple SCALEXIO systems that simulate missing aircraft systems in real-time. For example, these simulated systems include engines or avionics systems that are interconnected with the systems under test in the real aircraft. The HIL simulation also provides navigation and environmental data including aerodynamics representative of the flight scenario.

Tools for a Wide Spectrum of Use Cases

dSPACE testing systems offer multiple benefits for a large variety of development activities in aerospace applications. Typical use cases range from function design via rapid control prototyping and software verification on embedded platforms to exhaust testing of aircraft systems. The SCALEXIO platform can be used as a test bench for real-time simulation of an entire network. Later, real navigation devices replace their virtual counterparts, and the networked aircraft system hardware is connected to the SCALEXIO HIL system.

Function Design via Rapid Control Prototyping

The objective of this use case consists in the fast and easy evaluation of new control algorithms in an unmanned aerial vehicle (UAV). A validated flight simulation environment lays the foundation for the model-based design of specific control functions whose role is to maintain a safe flight envelope during operation. The code generated from the control models is then directly transferred to an flight computer installed in the UAV to perform real flight tests. Multiple sensors are connected via a common data bus required for transmitting variables such as speed, altitude, position, angle of attack, and sideslip angle. The communication between the flight control system and MicroAutoBox is achieved by means of pulse width modulation.

Test Rig for Electric Actuation Systems

The SCALEXIO system can also serve as an integrated part of an actuator test rig for testing high-lift surface control in the lab. For example, it achieves a scalable closed-loop environment by providing control, measurement, monitoring, and data acquisition capabilities for the driving as well as the loading side of the test rig. Real as well as simulated pilot controls for repeatable testing can be used as input. In addition, the SCALEXIO system offers flexible capabilities for software verification by HIL simulation as well as for testing the integrated systems including fault scenarios. The SCALEXIO framework enables simulation of the entire system, individual components such as power electronics, or the physical environment only.
## Overview of Tools (Selection)

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| MicroAutoBox Hardware | - Compact real-time prototyping system with various I/O interfaces and functional safety mechanisms for use in aircraft  
- Shock- and vibration-resistant hardware according to DO-160  
- Intuitive software environment with smooth Simulink® integration  
- Available in several standard variants (each with different interfaces and I/O). All variants can integrate an additional embedded PC |
| MicroLabBox        | - All-in-one development system for the laboratory  
- Combines compact size and low system costs with high performance and versatility  
- Quick and easy setup of control, test or measurement applications |
| SCALEXIO           | - Modular solution: system I/O box can be used for hardware-in-the-loop (HIL) and rapid control prototyping (RCP) projects  
- High scalability  
- Provides high-performance hardware for demanding applications as well as comprehensive power, and Fail-Safe capabilities |
| ConfigurationDesk  | - Configuration and implementation software for SCALEXIO hardware  
- Advanced configuration of hardware and application parameters  
- Hardware configuration independently of the Simulink®/Stateflow® behavior model |
| Real-Time Interface | - Automatic implementation of Simulink®/Stateflow® models on SCALEXIO hardware  
- Code generation  
- Graphical configuration via comprehensive Simulink block libraries  
- Easy to use due to automatic consistency checks |
| ControlDesk        | - Universal, modular experiment and instrumentation software  
- Powerful experimental interface for measurement and preprocessing  
- Wide range of instrument drivers, graphic, look-up tables, plotters, etc.  
- High-speed data capture from different sources |
| AutomationDesk      | - Graphical description of test routines:  
- Advanced automation library concept  
- Remote control of calibration, measurement and diagnostic tools, such as ControlsDesk |
| TargetLink         | - Automatic generation of high-quality, easy to read, and maintainable C code directly from Simulink®/Stateflow® models  
- Significant reduction in coding and development time  
- Automated code compliance according to DO-178B |
Aerospace Solutions

MicroAutoBox Hardware
- Compact real-time prototyping system with various I/O interfaces and functional safety mechanisms for use in aircraft
- Shock- and vibration-resistant hardware according to DO-160
- Intuitive software environment with smooth Simulink® integration
- Available in several standard variants (each with different interfaces and I/O). All variants can integrate an additional embedded PC

MicroLabBox
- All-in-one development system for the laboratory
- Combines compact size and low system costs with high performance and versatility
- Quick and easy setup of control, test or measurement applications

SCALEXIO
- Modular real-time system that can be used for hardware-in-the-loop (HIL) and rapid control prototyping (RCP) projects
- Highly scalable system architecture
- Provides high-performance real-time processors for demanding applications as well as comprehensive, precise, and fast I/O capabilities
- Diverse interfaces for aerospace communication buses, like MIL-STD-1553, ARINC429, and ARINC664/AFDX® (AFDX® is a registered trademark of AIRBUS)

Confi gurationDesk
- Configuration and implementation software for dSPACE SCALEXIO hardware
- Graphical configuration of hardware and application specifics
- Hardware configuration independently of the MATLAB®/Simulink® behavior model

Real-Time Interface
- Automatic implementation of MATLAB®/Simulink®/Stateflow® models on dSPACE hardware
- Complete libraries for all Simulink I/O signals
- Easy and safe to use due to automatic consistency checks

ControlDesk
- Universal, modular experiment and instrumentation software
- Powerful experimental interface for measurement and post-processing
- Wide range of user-friendly blocks, like look-up tables, plots, etc.
- High-speed data capture from different sources

AutomationDesk
- Advanced automation library concept
- Remote control of calibration, measurement and diagnostic tasks, such as ControlDesk

TargetLink
- Automatic generation of high-quality, easy-to-read, and traceable C code directly from Simulink®/Stateflow® models
- Significant reduction in coding and development time
- Automated code certificated according to DO-178B