SCALEXIO

- Modular real-time platform for hardware-in-the-loop (HIL) and rapid control prototyping (RCP) applications
- High-performance processor and FGPA technology for the most demanding real-time requirements
- Comprehensive, precise, and fast I/O capabilities, and bus support

SCALEXIO

SCALEXIO

Modular real-time platform

Highlights

- High-performance processor technology for the most demanding real-time requirements
- Best-in-class closed-loop performance
- Comprehensive bus support and I/O capabilities
- Scalable system with various software-based configuration options

Application Areas

The dSPACE SCALEXIO product line comprises highly flexible and modular systems in several form factors for hardware-in-the-loop (HIL) and rapid control prototyping (RCP) applications for various industries such as automotive, automation, aerospace, medical, transportation, or research. Its powerful real-time technology and comprehensive bus support are ideally suited for the most demanding applications of today and tomorrow, which include highly automated and autonomous driving, electromobility, and increasing network communication driven by modern E/E architectures.

Key Benefits

- Scalable to any computation and I/O requirements
- For laboratory as well as in-vehicle applications
- High-performance processor technology for real-time calculation of large and complex simulation models
- Comprehensive, precise, and fast I/O capabilities based on FPGA technology
- IOCNET real-time backbone with very low jitter and high bandwidth for best-in-class closed-loop performance
- Openess for several third-party simulation environments via Functional Mock-up Interface (FMI) support

SCALEXIO Systems

SCALEXIO systems cover a wide range of application areas, such as rapid control prototyping (RCP), data acquisition (DAQ) and monitoring, hardware-in-the-loop (HIL) testing, and test benches.

To address the specific project requirements, the systems are available in different form factors.

Laboratory System

SCALEXIO LabBox is ideally suited for a wide range of applications, such as RCP, function testing, test bench control, and as a base system for customized HIL setups. The compact chassis fits on an office desk and offers space for up to 18 SCALEXIO I/O boards, which you can easily exchange in order to adapt the real-time system to various projects. As processing hardware, you can install the DS6001 Processor Board directly into SCALEXIO LabBox to profit from its small size. If more computing power is required, you can connect the SCALEXIO Processing Unit to the SCALEXIO LabBox via IOCNET. For an additional increase in performance as well as additional I/O, memory or IOCNET bandwidth, multiple LabBoxes can be combined.

In addition to the desktop version, SCALEXIO LabBox is available as a rack version for installation in a SCALEXIO customized rack system.

SCALEXIO LabBox (19-slot) and SCALEXIO LabBox (8-slot)

SCALEXIO Processing Unit

In-Vehicle System

The SCALEXIO AutoBox with its shock and vibration resistance brings the power of SCALEXIO into vehicles such as passenger cars, trucks, trains, and agricultural as well as construction machinery. Optimized for in-vehicle use, it is ideal for test drives when developing components such as electric powertrains and chassis control as well as functions for assisted, highly automated, and autonomous driving (AD). The SCALEXIO AutoBox chassis provides up to seven slots for SCALEXIO I/O boards and one system slot which is intended for the DS6001 Processor Board. The compact system setup can easily be installed in your test vehicle and can be supplied directly from the vehicle's 12V, 24V, or 48V battery. To increase performance or the number of interfaces, multiple SCALEXIO AutoBoxes can be combined.

SCALEXIO AutoBox

Off-the-Shelf Systems for HIL Tests

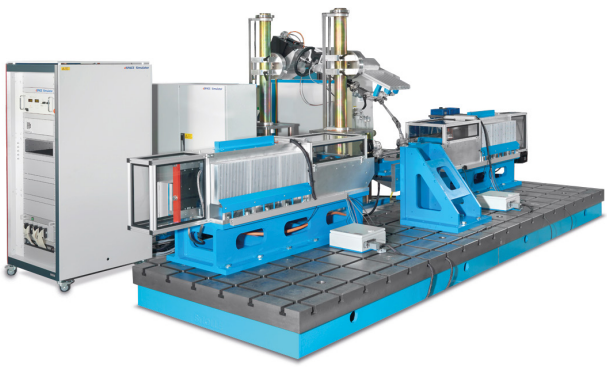
For ECU tests, the SCALEXIO off-the shelf rack systems provide sufficient space for MultiCompact I/O units, HighFlex boards, and SCALEXIO I/O boards.

In contrast to a SCALEXIO laboratory system, the SCALEXIO off-the-shelf system for HIL testing comprises onboard fault insertion and current measurement with comprehensive software support.

The SCALEXIO off-the-shelf system for HIL applications comes in variants with 9 height units (U) and 12 U and is ideal for testing single ECUs.

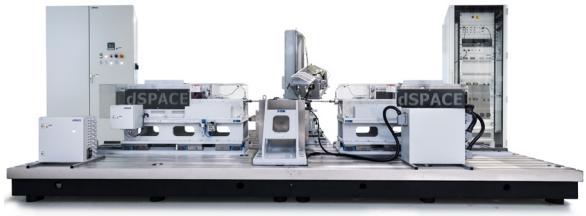
Customized Systems

dSPACE Enigineering Services provide systems that are tailored to customer-specific requirements. These customized SCALEXIO rack system provides maximum flexibility and can be expanded easily. Its typical fields of application include large tests of networked ECUs as well as tests including electronic loads and complete virtual vehicles.



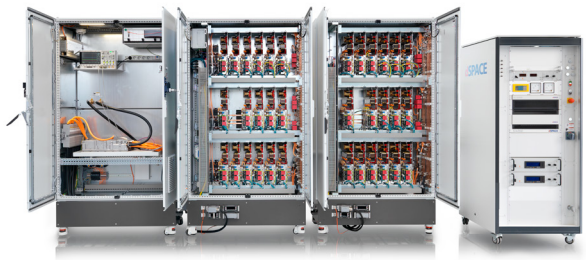
Mechanical Test Benches

dSPACE offers highly dynamic test benches for testing complex mechatronic systems. To achieve a realistic behavior of the components to be tested, the test bench uses real parts, such as an electric motor or mechanical loads that match those in the real vehicle.



Power Hardware-in-the-Loop Systems

For motor controllers and power electronics control units for non-rotating applications like DC/DC converters and chargers, dSPACE also offers turn-key projects using electronic load modules from dSPACE that provide high voltages and hundreds of kVA.



For more information about the dSPACE test benches and application examples, please see *www.dspace.com/go/test-bench*.
You can also contact dSPACE at info@dspace.de.

Overview and Technical Details for SCALEXIO Systems

Features	Off-the-Shelf System			Customized System
	SCALEXIO LabBox	SCALEXIO AutoBox	Rack Version	Rack Version
Application area	■ Function development and testing	■ Function development	■ All test domains	
SCALEXIO I/O hardware	■ SCALEXIO I/O boards		■ MultiCompact I/O units ■ HighFlex boards ■ SCALEXIO I/O boards	
	■ Up to 18 I/O boards	■ Up to 7 I/O boards	■ Up to 20 I/O and/or HighFlex boards	■ Variable number of boards
	■ Dedicated slots for the DS6051 IOCNET Router and the DS6001 Processor Board			
	■ Board exchange via front access			
Processing hardware	One of the following ■ Integrated DS6001 Processor Board ■ External SCALEXIO Processing Unit	■ Integrated DS6001 Processor Board	■ Integrated SCALEXIO Processing Unit	
Additional functions for rack versions	■ Not applicable		■ Failure Insertion Unit ■ Lambda Genesys power supply for external devices	■ Failure Insertion Unit ■ Electronic load modules ■ Customer-specific power supply
Connectors	■ Sub-D (majority)		■ Hypertac	■ Hypertac ■ Customer-specific
Communication backbone	■ IOCNET for internal communication and coupling with other SCALEXIO systems ■ Multiprocessor extension by coupling two or more Processing Units or processor boards			
Environment	■ Laboratory	■ In-vehicle	■ Laboratory	■ Laboratory

dSPACE Engineering Services

You can avail of dSPACE Engineering Services in any project phase. Whether you need engineering support for an entire project or only for system installation or first use, you can rely on our years of experience and comprehensive know-how. Experienced engineers support you in small projects and with complete turn-key solutions alike. We can help you use our systems' versatility to make to most of your project.

Customized Solutions

For hardware-in-the-loop, projects dSPACE Engineering Services can provide customized solutions (e.g., I/O interfaces and I/O drivers) that extend the standard range of dSPACE products. dSPACE services include, for example, software adaptations, interface extensions, hardware modification and expansion, and model adaptation.

Turn-Key Solutions

dSPACE Engineering Services offer complete ready-to-use solutions even for complex application scenarios. If required, dSPACE assists you throughout the entire dSPACE tool chain, including in requirements analysis, from specification to implementation, system delivery, on-site commissioning, and more.

On-Site Support

dSPACE engineers can also help you on site – even as residents. dSPACE Engineering Services enable you to soon work independently with our tools and quickly learn the required product know-how from the dSPACE specialists. For global projects, the internationally networked team of dSPACE specialists as well as our central project coordination guarantee smooth and rapid project progress towards successful project completion.

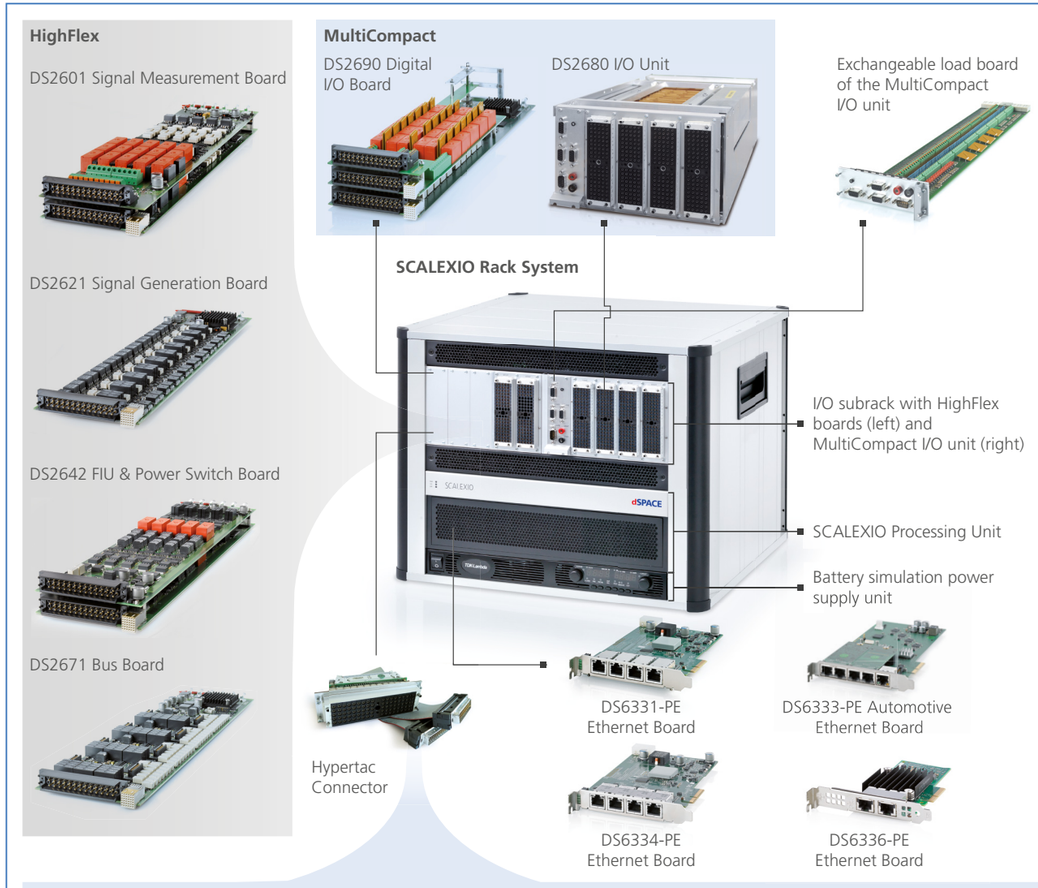
Training

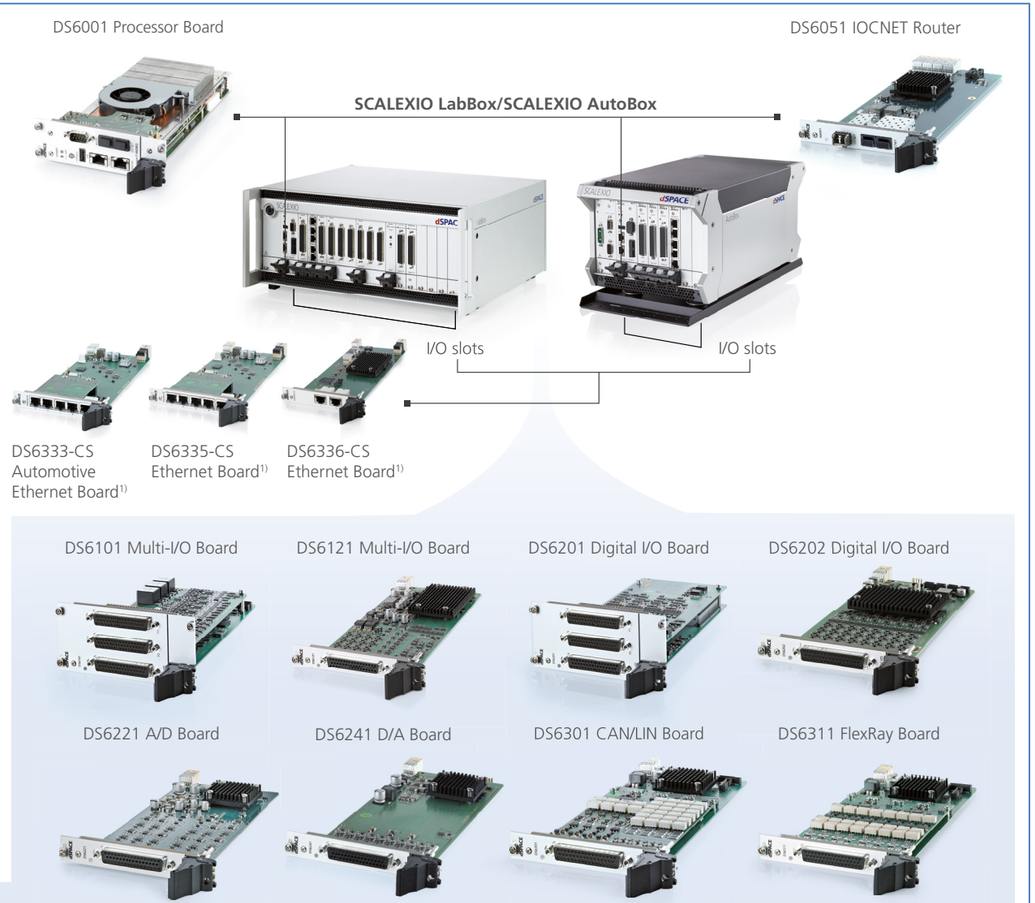
Additionally, dSPACE specialists provide standard training courses as well as customer-specific courses. On-site courses are available on request.

For more information, please see *www.dspace.com/go/engineering*.

System Setup

A SCALEXIO system consists of hardware and software, combined according to project requirements. You can easily expand your system to fit almost any requirements. The portfolio includes standard hardware that covers development and testing, an extensive FPGA-based portfolio for highly dynamic applications, and specialized boards for ECU HIL tests with onboard signal conditioning and fault simulation, among other things. For dedicated application areas, such as aerospace applications, additional interfaces can be integrated by dSPACE Engineering Services.





SCALEXIO I/O Boards

FPGA Portfolio

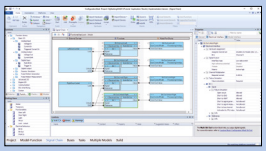
[1)] *In combination with DS6001 Processor Board*

Software

A SCALEXIO system is complemented by a wide range of software, e.g., for configuration, FPGA projects, test automation, and simulation models.

For more information, please visit the dSPACE website: *www.dspace.com*

Implementation Software



ConfigurationDesk

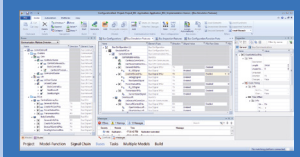
SIMULINK Enabled

fmi Functional Mock-Up Interface

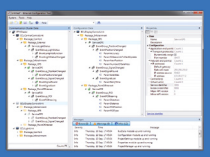
RTMaps

Additional solutions available, e.g., for electric drive applications.

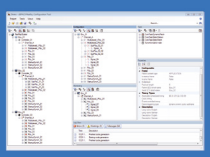
Bus and Network Applications



Bus Manager

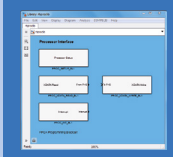


Ethernet Configuration Package

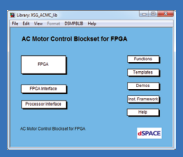


FlexRay Configuration Package

FPGA Applications

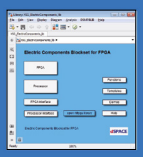


RTI FPGA Programming Blockset



XSG AC Motor Control Library

XSG Advanced Engine Control Library



XSG Electric Component Model

Experiment and Visualization Software

MotionDesk

ControlDesk

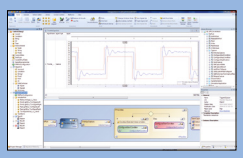
ModelDesk

Simulation Software

Automotive Simulation Models

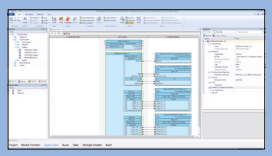
Sensor Simulation

Test Automation Software

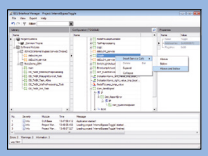


AutomationDesk

ECU Interface Software

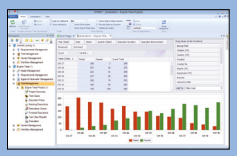


SCALEXIO Fieldbus Solution



ECU Interface Manager

Data Management Software



SYNECT

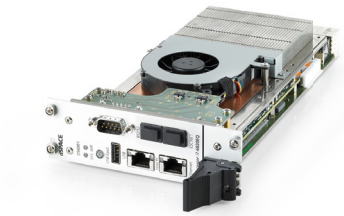
SCALEXIO Processing Hardware

Two product types are available for the SCALEXIO processing hardware – the computing core: the DS6001 Processor Board and the SCALEXIO Processing Unit.

Both hardware components are regularly updated to enable real-world testing.

DS6001 Processor Board

- Real-time platform for a very compact system size
- For applications that require fast closed-loop rates or high I/O bandwidth



SCALEXIO Processing Unit

- Real-time platform for applications with high performance requirements
- Two product types:
  - High core performance for applications that require strong computation performance per core
  - High parallel performance for applications that require the parallel computation of very large simulation models

SCALEXIO I/O Hardware

The SCALEXIO I/O hardware provides a wide range of external interfaces. The hardware can be devided into four groups.

- Standard I/O hardware that covers development and testing of highly dynamic applications
- Programmable FPGA subsystems including various I/O modules for very fast, high-resolution signal-processing applications
- HighFlex boards, e.g., for ECU HIL tests including signal conditioning and fault simulation
- MultiCompact Units with a high number of I/O channels as well as integrated signal conditioning and onboard Failure Insertion Unit

All the SCALEXIO I/O hardware shares the following characteristics:

- Task-synchronous signal preprocessing on I/O boards to take some of the load off the real-time processor to ensure highest real-time performance of the SCALEXIO systems
- Connection to the processing hardware via an IOCNET interface
- Fully software-configurable
- Easy installation and configuration processes, so very little training effort is necessary

I/O Overview of SCALEXIO Hardware

I/O Channels				I/O Function																			
				In																			
Board	Channel	Failure Insertion Unit integrated	Number of channels	Current In	Triggered Current In	Voltage In	Multi Bit In	Trigger In	Digital Pulse Capture	PWM/PFM In	Current Signal Capture	Voltage Signal Capture	Digital Incremental Encoder In	Sine Encoder In	Hall Encoder In	Resolver In	EnDat Master	SSI Master	Injection/Ignition Current In	Extension[1]	Injection/Ignition Voltage In	Extension[1]	SENT In
DS6101 Multi-I/O Board	Analog In 4	No	10			✓						✓										✓	
	Analog In 5		1			✓																	
	Digital In 3		12				✓	✓	✓	✓													✓
	Flexible In 3		10			✓	✓	✓	✓	✓		✓									✓	✓	✓
	Analog Out 6		8																				
	Analog Out 7		1																				
	Analog Out 8		3																				
	Analog Out 9		4																				
	Digital Out 3		14																				
	Resistance Out 2		6																				
DS6121 Multi-I/O Board	Analog In 16	No	6			✓						✓											
	Resolver In 2		1													✓							
	Flexible In/Out 1		6										✓	✓	✓		✓	✓					
	Digital In/Out 9		4				✓	✓		✓			✓		✓			✓					
	Digital Out 8		12																				
DS6201 Digital I/O Board	Digital In/Out 3	No	96				✓			✓													
DS6202 Digital I/O Board[2]	Digital In/Out 5	No	32				✓	✓	✓	✓			✓										✓
DS6221 A/D Board	Analog In 6	No	16			✓						✓											
	Trigger In 1		8					✓															
DS6241 D/A Board	Analog Out 10	No	20																				
	Trigger In 2		4					✓															

I/O Channels		I/O Function																									
		Out																									
Board	Channel	Current Sink	Voltage Out	Multi Bit Out	Digital Pulse Out	Potentiometer Out	Resistance Out	PWM/PFM Out	Multi-Channel PWM Out	Block Commutated PWM Out	Wavetable Current Sink	Wavetable Digital Out	Wavetable Voltage Out	Angular Wavetable Digital Out	Angular Wavetable Voltage Out	Digital Incremental Encoder Out	Wheelspeed Out	Waveform Current Sink	Waveform Voltage Out	Waveform Digital Out	Crank/Cam Current Sink	Crank/Cam Digital Out	Crank/Cam Voltage Out	Knock Signal Out	Lambda DCR[3]	Lambda NCCR[3]	SENT Out
DS6101 Multi-I/O Board	Analog In 4																										
	Analog In 5																									✓	
	Digital In 3																										
	Flexible In 3																										
	Analog Out 6		✓										✓		✓				✓				✓				
	Analog Out 7		✓																✓						✓	✓	
	Analog Out 8												✓		✓				✓				✓	✓			
	Analog Out 9	✓	✓								✓		✓		✓		✓	✓	✓		✓		✓				
	Digital Out 3			✓	✓			✓				✓		✓		✓				✓		✓					✓
	Resistance Out 2					✓	✓																		✓	✓	
DS6121 Multi-I/O Board	Analog In 16																										
	Resolver In 2																										
	Flexible In/Out 1																										
	Digital In/Out 9			✓	✓			✓	✓																		
	Digital Out 8			✓	✓			✓	✓	✓																	
DS6201 Digital I/O Board	Digital In/Out 3			✓				✓																			
DS6202 Digital I/O Board[2]	Digital In/Out 5			✓	✓			✓	✓			✓		✓		✓				✓							✓
DS6221 A/D Board	Analog In 6																										
	Trigger In 1																										
DS6241 D/A Board	Analog Out 10		✓										✓		✓				✓								
	Trigger In 2																										

1) Extension for using extended signal analysis. Additional channels are required.
2) The number of function instances is limited for selected functions.
3) Several channel types are required for this function.

I/O Overview of SCALEXIO Hardware

I/O Channels		Failure Insertion Unit integrated	Number of channels	Current In	Triggered Current In	Voltage In	Multi Bit In	Trigger In	Digital Pulse Capture	PWM/PFM In	Current Signal Capture	Voltage Signal Capture	Digital Incremental Encoder In	Sine Encoder In	Hall Encoder In	Resolver In	EnDat Master	SSI Master	Injection/Ignition Current In	Extension[1]	Injection/Ignition Voltage In	Extension[1]	SENT In
				I/O Function – In																			
DS2655 FPGA Base Board DS6601 FPGA Base Board DS6602 FPGA Base Board		No		DS2655M1 I/O Module: 5 A/D channels, 5 D/A channels, 10 digital I/O channels DS2655M2 I/O Module: 32 digital I/O channels (RS232 or RS485 communication) DS6651 Multi-I/O Module: 6 A/D channels, 6 D/A channels, 16 digital I/O channels																			
DS2601 Signal Measurement Board	Flexible In 1	Yes	10	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓
DS2621 Signal Generation Board	Flexible Out 1	Yes	10																				
DS2642 FIU & Power Switch Board			10	Power Switch, Central FIU																			
DS2680 I/O Unit	Analog In 1	Yes	20			✓						✓								✓		✓	
	Analog In 2		2			✓																	
	Digital In 1		30				✓	✓	✓	✓													✓
	Flexible In 2		18	✓	✓		✓	✓	✓	✓	✓								✓	✓	✓	✓	✓
	Analog Out 1		15																				
	Analog Out 2		2																				
	Analog Out 3		7																				
	Analog Out 4		8																				
	Digital Out 1		28																				
	Resistance Out 1		12																				
			6	Power Switch, Central FIU																			
DS2690 Digital I/O Board	Digital In 2	Yes	10				✓			✓													
	Digital Out 2		10																				
	Digital In/Out 1		10				✓			✓													

I/O Channels		Failure Insertion Unit integrated	Number of channels	Current Sink	Voltage Out	Multi Bit Out	Digital Pulse Out	Potentiometer Out	Resistance Out	PWM/PFM Out	Multi-Channel PWM Out	Block Commutated PWM Out	Wavetable Current Sink	Wavetable Digital Out	Wavetable Voltage Out	Angular Wavetable Digital Out	Angular Wavetable Voltage Out	Digital Incremental Encoder Out	Wheelspeed Out	Waveform Current Sink	Waveform Voltage Out	Waveform Digital Out	Crank/Cam Current Sink	Crank/Cam Digital Out	Crank/Cam Voltage Out	Knock Signal Out	Lambda DCR[3]	Lambda NCCR[3]	SENT Out
				I/O Function – Out																									
DS2655 FPGA Base Board DS6601 FPGA Base Board DS6602 FPGA Base Board		No		DS2655M1 I/O Module: 5 A/D channels, 5 D/A channels, 10 digital I/O channels DS2655M2 I/O Module: 32 digital I/O channels (RS232 or RS485 communication) DS6651 Multi-I/O Module: 6 A/D channels, 6 D/A channels, 16 digital I/O channels																									
DS2601 Signal Measurement Board	Flexible In 1	Yes	10																										
DS2621 Signal Generation Board	Flexible Out 1	Yes	10	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓
DS2642 FIU & Power Switch Board			10	Power Switch, Central FIU																									
DS2680 I/O Unit	Analog In 1	Yes	20																										
	Analog In 2		2																									✓	
	Digital In 1		30																										
	Flexible In 2		18																										
	Analog Out 1		15		✓										✓		✓				✓				✓				
	Analog Out 2		2		✓																✓						✓	✓	
	Analog Out 3		7												✓		✓				✓				✓	✓			
	Analog Out 4		8	✓	✓								✓		✓		✓		✓	✓	✓		✓		✓				
	Digital Out 1		28			✓	✓			✓				✓		✓		✓				✓		✓					✓
	Resistance Out 1		12					✓	✓																		✓	✓	
			6	Power Switch, Central FIU																									
DS2690 Digital I/O Board	Digital In 2	Yes	10																										
	Digital Out 2		10			✓				✓																			
	Digital In/Out 1		10			✓				✓																			

[1] Extension for using extended signal analysis. Additional channels are required.
[2] The number of function instances is limited for selected functions.
[3] Several channel types are required for this function.

SCALEXIO Support for Buses and Networks

			Failure Insertion Unit integrated	Number of channels	CAN/CAN FD	LIN	FlexRay	RS-232	RS-422	RS-485	Standard Ethernet (Physical Layer)	Automotive Ethernet (Physical Layer)	UDP	TCP	SOME/IP
SCALEXIO Bus Boards	SCALEXIO Processing Unit	Ethernet Adapter 1	No	1							✓		✓	✓	✓
		UART 5		1				✓							
	DS6001 Processor Board	Ethernet Adapter 1	No	1							✓		✓	✓	✓
		UART 6		1				✓							
	DS6301 CAN/LIN Board	CAN 2	No	4	✓										
		LIN 2		4		✓									
	DS6311 FlexRay Board	FlexRay 2	No	4			✓								
	DS6321 UART Board	UART 1	No	4				✓	✓	✓					
	DS6331-PE Ethernet Board	Ethernet Adapter 1	No	4							✓		✓	✓	✓
	DS6333-CS Automotive Ethernet Board	Ethernet Adapter 2	No	4							✓	✓	✓	✓	✓
	DS6333-PE Automotive Ethernet Board	Ethernet Adapter 2	No	4							✓	✓	✓	✓	✓
	DS6334-PE Ethernet Board	Ethernet Adapter 1	No	4							✓		✓	✓	
	DS6335-CS Ethernet Board	Ethernet Adapter 2	No	4							✓	✓	✓	✓	
	SCALEXIO Processing Unit	Ethernet Adapter 1	No	1							✓		✓	✓	✓
	DS6336-CS Ethernet Board	Ethernet Adapter 1	No	2							✓		✓	✓	✓
	DS6336-PE Ethernet Board	Ethernet Adapter 1	No	2							✓		✓	✓	✓
	DS6341 CAN Board	CAN 2	No	4	✓										
	DS6342 CAN Board	CAN 2	No	8	✓										
	DS6351 LIN Board	LIN 2	No	8		✓									
	DS2671 Bus Board	Bus 1	Yes	4	✓	✓	✓	✓	✓	✓					
	DS2672 Bus Module (Add-on for DS2680)	CAN 1	Yes	2	✓										
		LIN 1		2		✓									
		FlexRay 1		2			✓								

SCALEXIO Solutions for Dedicated Applications

In addition to the SCALEXIO products, such as processing hardware and SCALEXIO I/O boards, special solutions are available for dedicated applications. Solutions typically consist of hardware and software parts. They add specific features to the SCALEXIO systems to cover requirements from application fields such as aerospace, electric drives, as well as power electronics and industrial fieldbus systems.

Application Field	dSPACE Solution	Can be used with	
		SCALEXIO Rack System	SCALEXIO LabBox / AutoBox
Electric drives	■ SCALEXIO EMH Solution	✓	✓
	■ SCALEXIO TWINsync Solution	✓	✓
Power electronics	■ Electrical Power Systems Simulation Package	✓	✓
Bus and network communication	■ SCALEXIO Fieldbus Solution	✓	✓
	■ SCALEXIO Serial Interface Solution	✓	✓
	■ PGI PSI5 Master/Slave Solution	✓	✓
Aerospace	■ SCALEXIO Interface Solution for ARINC 429	✓	✓
	■ SCALEXIO Interface Solution for ARINC 664 and AFDX®	✓	✓
	■ SCALEXIO Interface Solution for MIL-STD-1553	✓	–

Please contact dSPACE if you require other solutions for a project.

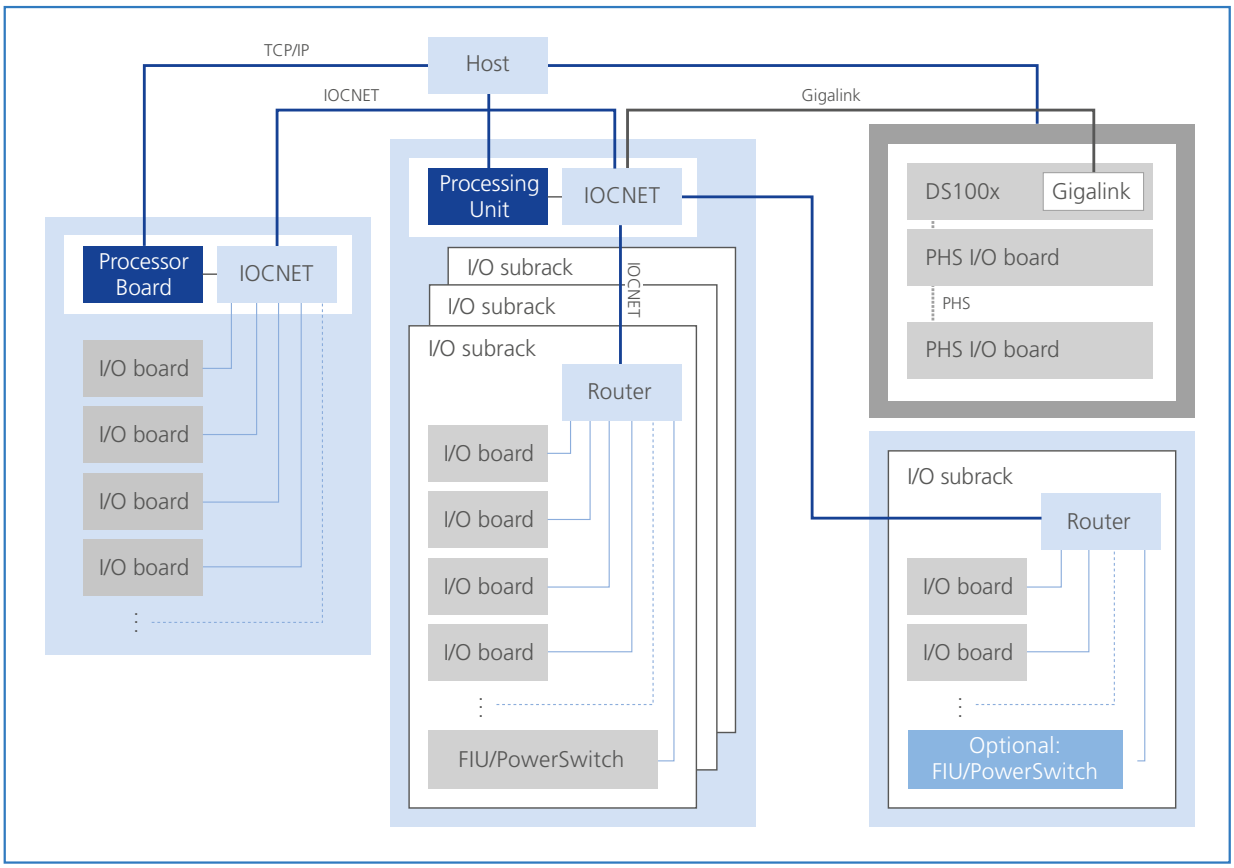
IOCNET (I/O Carrier Network)

IOCNET (I/O Carrier Network) is a network technology optimized for demanding real-time requirements in terms of latencies and bandwidth. It has been developed by dSPACE for SCALEXIO, providing high-bandwidth communication and enabling low jitter/latencies for best closed-loop performance. Communication via IOCNET lets you use decentralized I/O functions with full performance.
The network also makes it easy to scale SCALEXIO systems. The setups can include more than 100 device nodes, and the I/O and processing hardware can be located up to 100 m apart. SCALEXIO is therefore ideal for spatially distributed test systems, which can also be extended later on.

Coupling Possibilities with IOCNET

- Multiple processing hardware components can be combined to a multiprocessor system.
- By using IOCNET, you can add several I/O subracks to your system. These decentralized I/O units do not need their own processing hardware.
- Existing dSPACE systems, such as dSPACE Simulator Full-Size and dSPACE Simulator Mid-Size can be coupled as well.

For information about further coupling options, please contact dSPACE.



SCALEXIO LabBox

Modular real-time system

Highlights

- Compact size for desktop and rack use
- Small version for up to 7 SCALEXIO I/O boards
- 19" version for up to 18 SCALEXIO I/O boards
- Easy system setup and modification
- Low noise emission

Application Areas

SCALEXIO LabBox is a compact real-time system for function development and testing. Its compact footprint and low noise emission make it ideal for use in the laboratory. SCALEXIO LabBox is available in two chassis variants:

- SCALEXIO LabBox 8-slot for up to 7 SCALEXIO I/O boards
- SCALEXIO LabBox 19-slot where you can install up to 18 SCALEXIO I/O boards

Key Benefits

Its compact footprint and low noise emission make SCALEXIO LabBox a powerful real-time system for the desk. The mechanical concept for an easy setup and modifications allows quick adaptations of the system to changing project requirements. Due to different options for processing hardware, the computation power of LabBox-based systems can be scaled to match a wide range of applications. SCALEXIO LabBox is also available as rack-mount and covered rack-mount version.

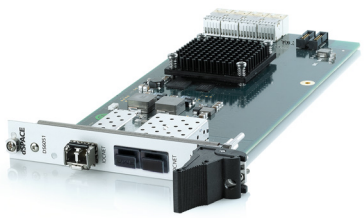
Options for Processing Hardware

For both chassis variants, you have two options regarding the processing hardware:

- The dual-slot DS6001 Processor Board can be installed in the SCALEXIO LabBox, which results in a very compact setup.
- Alternatively, SCALEXIO Processing Units can be connected externally using the DS6051 IOCNET Router to provide more computation performance, e.g., for complex and computationally intensive simulation models.

Coupling Options with DS6051 IOCNET Router

The DS6051 IOCNET Router is used to connect SCALEXIO LabBox with an external processing hardware, e.g., a SCALEXIO Processing Unit or existing SCALEXIO real-time systems as I/O extensions.



Technical Details SCALEXIO LabBox

Parameters	SCALEXIO LabBox 8-Slot	SCALEXIO LabBox 19-Slot
General	■ Chassis with 8 slots ■ 7 slots for SCALEXIO I/O boards ■ 5 extended I/O slots[1)] ■ 1 system slot reserved for a DS6001 Processor Board or DS6051 IOCNET Router	■ Chassis with 19 slots ■ 18 slots for SCALEXIO I/O boards ■ 5 extended I/O slots[1)] ■ 1 system slot reserved for a DS6001 Processor Board or DS6051 IOCNET Router
	■ Temperature-controlled active cooling ■ I/O boards software-configurable via ConfigurationDesk ■ Board exchange via front flap using an ejection lever ■ Status LED and Kensington® Security Slot	
Ambient temperature	■ 0 °C … 50 °C (32 °F … 122 °F)	
Operating humidity	■ 5% … 95% (non-condensing environment)	
Size (width x height x depth)	■ Desktop version: 224 x 193 x 394 mm (8.8 x 7.6 x 15.5. in) ■ Rack-mount version: 483 x 178 x 355 mm (19 x 7 x 14 in) ■ Covered rack-mount version: 483 mm x 178 mm x 493 mm (19 in x 7 in x 19.4 in)	■ Desktop version: 447 x 193 x 394 mm (17.6 x 7.6 x 15.5 in) ■ Rack-mount version: 483 x 178 x 355 mm (19 x 7 x 14 in) ■ Covered rack-mount version: 483 mm x 178 mm x 493 mm (19 in x 7 in x 19.4 in)
Mass	■ 7.25 kg (without boards)	■ 11.5 kg (without boards)
Power supply	■ 100 … 240 V AC, 50 … 60 Hz; 350 W	

[1)] *The PCI Express interfaces of the DS6001 are provided in dedicated I/O slots.*

Versatile Utilization

Three chassis versions are available for each variant of SCALEXIO LabBox: The desktop version, rack-mount version, and covered rack-mount version.

- Desktop version: Features carrying handles and plastic feet.

SCALEXIO LabBox (19-slot, desktop)

SCALEXIO LabBox (8-slot, desktop)

- Rack-mount version: For installation in a 19" rack system.

SCALEXIO LabBox (19-slot, rack-mount)

SCALEXIO LabBox (2x8-slot, rack-mount)

- Covered rack-mount version: This version is mounted deeper inside the rack, behind an additional front cover that lets you keep the entire wiring on the inside.

SCALEXIO LabBox (19-slot, covered rack-mount)

SCALEXIO LabBox (2x8-slot, covered rack-mount)

High-Performance System for Function Testing

To form a powerful real-time system for function testing, the SCALEXIO Processing Units have to be extended by the required I/O and bus interfaces. Therefore, a SCALEXIO LabBox can be connected to the processing hardware via IOCNET.

Technical Details DS6051 IOCNET Router

Parameters	Specification
IOCNET router	■ 1 optical IOCNET uplink port ■ 2 optical IOCNET downlink ports[1)] ■ Support of up to 18 electrical IOCNET downlink ports (via backplane) ■ Up to 2.5 Gbit/s link speed
Typical power consumption	■ 7.2 W (typ. 300 mA, at +24 V)
Size	■ 238 × 100 × 19 mm (9.4 x 3.9 x 0.7 in) without fastening bracket
Mass	■ 300 g

1) *SFP transceiver modules have to be ordered separately.*

Order Information

Product	Order Number	
	8-Slot Version	19-Slot Version
SCALEXIO LabBox desktop version	■ SCLX_LBX8_D	■ SCLX_LBX19_D
SCALEXIO LabBox rack-mount version	■ SCLX_LBX2X8_R	■ SCLX_LBX19_R
SCALEXIO LabBox covered rack-mount version	■ SCLX_LBX2X8_CR	■ SCLX_LBX19_CR
DS6051 IOCNET Router	■ DS6051	

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk

Hardware	Product
Required	■ DS6001 Processor Board or
	■ DS6051 IOCNET Router and SCALEXIO Processing Unit
Optional	■ SCALEXIO I/O Boards

SCALEXIO AutoBox

Modular real-time system for in-vehicle use

Highlights

- Up to 7 slots for SCALEXIO I/O boards
- Integrated power supply for 12 V, 24 V, and 48 V electrical systems
- Improved shock and vibration resistance
- Extended temperature range

Application Areas

The SCALEXIO AutoBox is a very powerful in-vehicle system that offers tremendous processing power, excellent real-time properties, and comprehensive support for automotive bus systems. With its increased resistance to shock and vibration, an integrated DC power supply, and its extended temperature range, it is the ideal choice for testing new functions at an early stage in real test drives. Based on its wide variety of I/O, bus, and network interfaces, SCALEXIO addresses a wide range of application areas from A as in 'autonomous driving' to Z as in 'zero emissions'.

Key Benefits

The SCALEXIO AutoBox is a robust chassis for in-vehicle use. It provides up to seven slots for SCALEXIO I/O boards and one system slot intended for the DS6001 Processor Board. The SCALEXIO AutoBox offers a wide-range power supply to operate with 12 V, 24 V, and 48 V electrical systems, and it also supports operation at cranking conditions, such as temporary voltage drops. The chassis is equipped with shock and vibration dampers and an optimized cooling system. Remote power-up and -down is provided via different interfaces, e.g., terminal 15 or wake-up on CAN. The modular concept of the SCALEXIO AutoBox and the many I/O, bus, and network connections allow for use-case-optimized system setups. Furthermore, programmable FPGA subsystems let you implement user-specific hardware accelerators or interfaces. To increase the computation performance or the number of interfaces, you can combine several SCALEXIO AutoBoxes to one real-time system.

Technical Details

Parameters		SCALEXIO AutoBox 8-Slot
General		■ Enclosure with 8 slots ■ 7 slots for SCALEXIO I/O boards (5 slots equipped with additional PCIe interfaces[1]) ■ 1 system slot reserved for a DS6001 Processor Board ■ Compact chassis, shock mounts with rubber shoes ■ Temperature-controlled active cooling ■ Overvoltage-protected remote on/off input ■ I/O boards software-configurable via ConfigurationDesk ■ Board exchange via front flap using an ejection lever ■ Status LED and Kensington® security slot
Shock and vibration resistance	ISO 16750 – 3:2012/4.2.2	■ Mechanical test of shock resistance
		■ Test conditions: ■ Shock direction: six spatial directions ■ Acceleration: 50 g/6 ms; half-sinusoidal ■ Number of shocks: 10 per direction ■ Operating
	ISO 16750 – 3:2012/4.1.2.4 Test IV	■ Mechanical test of vibration resistance
		■ Test conditions (-3 dB): ■ Broadband noise, 1 h per axis/3 spatial axes ■ RMS acceleration 19.2 m/s^2 ■ Operating
Ambient temperature		■ 0 °C ... 55 °C (32 °F ... 131 °F)
Operating humidity		■ 5% … 95% (non-condensing environment)
Size (width x height x depth)		■ 224 x 205 x 434 mm (8.8 x 8.1 x 17.1 in)
Mass		■ 10 kg (without boards)
Power supply	Input voltage	■ 10 V ... 54 V (± 10%) DC normal operating range ■ 6 V ... 10 V DC undervoltage crank condition, time-limited (> 10 s at 6 V DC, measured at input connector)
	Start-up current	■ Max. 6 A ■ Soft start ■ 300 ms at 12 V DC start-up time
	Quiescent current	■ < 20 mA with remote off at 12 V
	Max. output power	■ 170 W
	Input/output isolation[2]	■ 100 V

[1] *Only dSPACE products and dSPACE qualified products can be used with the PCI and PCIe slots. Please contact dSPACE for more information.*
[2] *The maximum voltage between any input pins or any input pins and output ground must not exceed 100 V.*

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk

Hardware	Product
Required	■ DS6001 Processor Board
	■ DS6051 IOCNET Router
Optional	■ SCALEXIO I/O Boards

Order Information

Product	Order Number
SCALEXIO AutoBox	■ SCLX_ABX8

SCALEXIO Rack System

Off-the-shelf HIL simulator with up to 12 height units

Highlights

- HIL simulator for a wide range of applications
- Expandable system from 9 to 12 height units (U)
- Integrated Failure Insertion Unit
- Integrated signal conditioning
- Software-configurable with dSPACE ConfigurationDesk

Application Areas

The SCALEXIO rack system is an off-the-shelf hardware-in-the-loop simulator for comprehensive ECU tests, covering a broad range of test scenarios and domains.

Typical fields of application include:

- Autonomous driving
- Electric motor simulation for hybrid and electric powertrains
- Engine, powertrain, chassis
- Truck applications
- Racing applications

Key Benefits

The SCALEXIO rack system can be equipped with boards providing onboard signal conditioning and integrated fault simulation, thus making it ideal for ECU testing. You can use the whole range of SCALEXIO boards, such as SCALEXIO I/O boards, MultiCompact units, HighFlex boards, and FPGA subsystems. All hardware is software-configurable, which makes it easy for you to adapt the system to changing project requirements.

The SCALEXIO Processing Unit acts as the computation node and is also integrated in the system.

Programmable Power Supplies

The programmable power supply unit feeds the components to be tested and allows for simulating real voltages, such as the vehicle battery voltage during start-up. The power supply unit is remotely controlled from the real-time model. Various power supplies are available for different applications, for example:

- 0 ... 20 V
- 0 ... 60 V

Technical Details

Parameters		Specification
General		■ HIL simulator system for up to 20 SCALEXIO boards of any type ■ Integrated SCALEXIO Processing Unit (p. 19) ■ Failure Insertion Unit (p. 102) ■ Integrated signal conditioning ■ Software-configurable via ConfigurationDesk ■ Connection to host PC via Ethernet ■ Board exchange via front access
Connecting with other systems		■ I/O extension via additional I/O subracks using an IOCNET connection
Ambient temperature		■ 0 °C ... +40 °C (32 … 104 °F)
Operating humidity		■ 80% max. if < 31 °C (87.8 °F) (non-condensing environment)
Size		■ 19'' rack system ■ 9 or 12 U
Mass		■ Up to 80 kg
Power supply[1)]	Internal	■ 100 … 240 V AC, 50 … 60 Hz ■ 300 W for 9 U rack ■ 600 W for 12 U rack
	For external devices	■ Lambda Genesys power supply unit

[1)] *Without a SCALEXIO Processing Unit.*

Order Information

Product	Order Number
SCALEXIO 9 U rack system	■ Please inquire
SCALEXIO 12 U rack system	■ Please inquire

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk

Hardware	Product
Required	■ SCALEXIO Processing Unit
Optional	■ SCALEXIO boards

SCALEXIO Customized System

Application-ready HIL system

Highlights

- HIL system adapted to customer-specific applications and requirements
- Applications can range from single ECUs up to large ECU networks
- ECU harness and connector pinouts with different integration options, e.g., for real loads
- High-current and high-voltage options, e.g., for electric propulsion, battery management, electric power steering

Application Areas

The SCALEXIO customized system is usually installed in one or more 19" cabinets. Its height can be tailored to your requirements. The system can be used for any application, including complex simulations of a complete virtual vehicle.

Typical fields of application include:

- Autonomous driving
- Electromobility
  - Electric motor simulation for hybrid or electric powertrains and electric steering systems
  - Battery management systems
  - Electric motor emulation at power level (power hardware-in-the-loop) or high-voltage capable for battery management testing
- Engine, powertrain, chassis, and body
- Truck applications (24 V/36 V)
- Racing applications (Formula One, Ralley)
- Mechanical test benches
- Comprehensive closed-loop testing on ECUs, release/acceptance tests
- Networked ECUs
- Special requirements, e.g., for high system flexibility and high-current or high-voltage applications

Key Benefits

The SCALEXIO customized system utilizes a highly scalable, modular rack concept that is flexible and open enough to meet any of your requirements. The I/O hardware offers extensive I/O features and is largely software-configurable, which facilitates adapting the system to changing project requirements. Adapted to your specific application and requirements, the system is fully commissioned, documented, quality-assured and put into operation directly at the customer's site. This way, it is ready for operational use right from the time of delivery. Adaptations and extensions are possible whenever required.

Coupling Options

To increase computational power and I/O interfaces, you can combine as many SCALEXIO customized systems as required. Based on dSPACE IOCNET backbone technology, SCALEXIO systems are very scalable and flexible, e.g., multiprocessing-unit, multi-rack setups, or decentralized I/O extensions are possible. You can also easily combine multiple customized rack systems to a virtual vehicle.
All software for configuring the system and controlling the simulation or test automation runs on a host PC. The PC is connected via Ethernet with the SCALEXIO system.

Fault Simulation

For fault simulation, the SCALEXIO customized system can be equipped with I/O boards providing integrated fault simulation, namely the HighFlex boards (DS2601, DS2621, DS2642, and DS2671) and MultiCompact I/O Units (DS2680 and DS2690). Additionally, customized solutions are available from dSPACE Engineering Services.

Technical Details

Parameters	Description
Processing hardware	■ SCALEXIO Processing Unit (p. 19) ■ DS6001 Processor Board (p. 24) ■ Support of multiprocessor systems
I/O hardware	■ HIL simulator for any number and type of SCALEXIO boards
Signal conditioning	❍ ■ Included on SCALEXIO MultiCompact I/O units and SCALEXIO HighFlex Boards
Substitute loads	●
Real-load connector	● ■ Modular load concept (customer-specific configuration)
Real system components	■ Can be integrated in the system, e.g., injection, valves, hydraulic components, and sensors
Failure Insertion Unit	❍
Integration of third-party hardware, e.g., load panels	❍
ECU connectors	■ One or more 90-pin connectors for each ECU (standardized) ■ Additional connectors optional
OBDI diagnostic connector/connection to diagnostic tools	■ Standard 16-pin CARB connector ■ Diagnostic connector (CAN, K-Line) ■ Others on request
48 V-capable	●
Host interface	■ Ethernet
Ambient temperature	■ 0 °C ... +40 °C (32 … 104 °F)
Operating humidity	■ 80% max. if < 31 °C (87.8 °F) (non-condensing environment)
Size	■ 19'' cabinet, 17 ... 41 U
Mass	■ More than 100 kg, depending on installed components
Power supply (remotely controlled)	■ One or two power supplies for simulating 1- or 2-voltage systems ■ Simulation of car batteries ■ Programmable switched-mode power supply

● included
❍ optional

Order Information

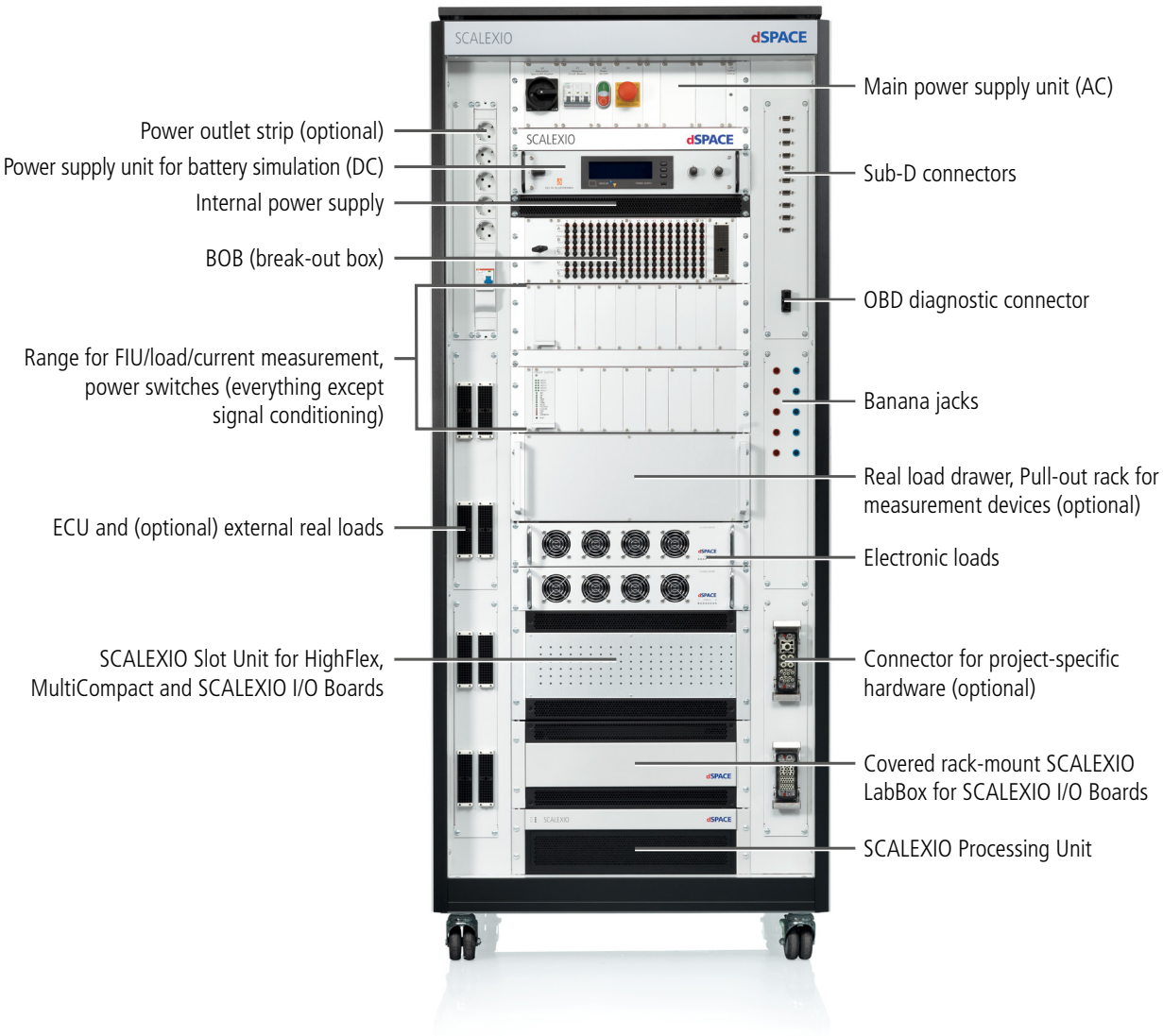
Product	Order Number
SCALEXIO Customized System	■ Please inquire

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk

Hardware	Product
Required	■ SCALEXIO Processing Unit
Optional	■ SCALEXIO boards

Commonly Used Components



Comprehensive Customization Options

- Maximum flexibility thanks to a modular concept
- Minimal hardware modifications needed if requirements change
- All signals accessible on terminal stripes for additional measurement tasks and for a flexible response to changing specifications
- Clear and transparent system architecture
- Multirack systems possible

Flexible, Modular Hardware

- Single-processor or multiprocessor system for high computation requirements
- Freely expandable with any SCALEXIO board according to project needs
- Expandable, e.g., with hardware for fault insertion and load simulation (customer-specific configuration)
- Expandable, e.g., with flexible FPGA boards

Signal Conditioning

- Signal conditioning included with SCALEXIO MultiCompact I/O and SCALEXIO HighFlex hardware
- Support of almost any signal type, e.g., digital in/out, analog in/out, relay simulation, current sink/source, LVT simulation, resistance simulation, and linear lambda probe simulation
- Additional modules on request

- **Simulation of Linear Lambda Probes**

  LSU (Lambda Sonde Universal, universal lambda probe) is a signal conditioning module that simulates the behavior of linear lambda probes. These probes measure the air-fuel ratio in a car's exhaust system. The engine ECU reacts by varying the injection time, so the catalytic converter can operate at an optimal performance rate.

  The LSU module allows for generating Nernst cell voltage on four independent channels based on pump current and Nernst cell inner resistance. The module functions as a linear probe or as a jump probe. Parameters such as maximum/minimum Nernst cell voltage can be adjusted.

Load Capabilities

- Modular load concept with customer-specific configuration
- Support of single-ended and double-ended loads
- Resistive loads or other kinds of equivalent loads
- Connection of electrically equivalent loads or low-power resistive loads
- Connection of real loads, optional rack integration
- Integration of customer's load panels
- High-speed electronic loads, e.g., simulation of electric machines
- Connection to high-voltage emulation systems and test benches

Programmable Power Supplies

The programmable power supply unit feeds the components to be tested and allows for simulating real voltages such as a vehicle's battery voltage during start-up. The power supply unit is remotely controlled from within the real-time model. Various power supplies are available for different applications, for example:

- 0 ... 20 V
- 0 ... 60 V

SCALEXIO Processing Unit

Product lines for high core performance and high parallel performance

Highlights

- Product line for high core performance
- Product line for high parallel performance
- High-performance host interface
- Multiprocessor support

The SCALEXIO Processing Units are based on an industrial PC with an Intel® XEON® processor, a real-time operating system, and an IOCNET plug-on card for communication with the I/O and with other real-time processors. A Processing Unit can be equipped with four or eight IOCNET ports. You can use IOCNET ports to connect multiple SCALEXIO Processing Units to set up multiprocessor systems or to couple a DS100x-based system to a SCALEXIO Processing Unit via Gigalink. One of the available processor cores is reserved for system services, the others can be used for computing real-time models.

High Core Performance

Application Areas

The SCALEXIO Processing Unit with a XEON® E3-1275v6 processor is ideally suited for all applications that require a strong computation performance on each individual core. Therefore, it is the main Processing Unit for hardware-in-the-loop testing systems that covers all applications, such as vehicle dynamics or electric drive simulations.

Key Benefits

The Processing Unit with a XEON® E3 processor is tailored for processing sophisticated and complex models with a large amount of I/O. The highest core performance enables the handling of the large data volumes in modern bus communication, such as Ethernet or FlexRay. Using a dedicated core for system services minimizes negative effects on the real-time performance. The high-performance host interface allows for the observation of a large number of signals.

High Parallel Performance

Application Areas

The SCALEXIO Processing Unit with an Intel® XEON® Gold 6208U processor provides 16 cores and is geared specifically toward customers who often have to compute very large simulation models in parallel, for example, AD HIL scenarios or vehicle dynamics simulation with detailed plant models. This enables engineers to use high-fidelity, physically realistic models, increases model accuracy, and makes HIL simulations more realistic.

Key Benefits

The Processing Unit with an Intel® XEON® Gold 6208U processor is ideal for the parallel execution of complex and computationally intensive simulation models. Using a dedicated core for system services minimizes negative effects on the real-time performance. A high-performance host interface allows for a large number of signals to be observed.

Technical Details

Parameter		Specification	
		High Core Performance	**High Parallel Performance**
Processor		■ Intel XEON® E3-1275v6 ■ Frequency: 3.8 GHz ■ Number of cores: 4 ■ 3 cores for model computation ■ 1 core for services, e.g., host communication	■ Intel® XEON® Gold 6208U ■ Frequency: 2.9 GHz ■ Number of cores: 16 ■ 15 cores for model computation ■ 1 core for services, e.g., host communication
Memory		■ L1 cache: 32 + 32 kB (data + instructions) ■ L2 cache: 256 kB ■ L3 cache: 8 MB ■ 16 GB RAM	■ L1 cache: 32 + 32 kB (data + instructions) ■ L2 cache: 1 MB ■ L3 cache: 22 MB ■ 64 GB RAM
Solid State Disk (SSD)		■ Data recording and replay ■ Optional: 480 GB	■ Data recording and replay ■ Included: 480 GB
Angular processing unit (APU)		■ 6 APUs on the DS2502 IOCNET Link Board	
	Angular resolution	■ 0.011°	
	Speed range	■ ± 28,610 rpm	
	Speed resolution	■ 0.109 rpm	
Interfaces	IOCNET	■ 4 or 8 IOCNET connectors on the DS2502 IOCNET Link Board (can be optionally used as Gigalink connectors)	
	PCI Express/PCI[1)]	■ 2 x PCI ■ 1 x PCIe Gen3 x16 ■ 2 x PCIeGen 3 x4 ■ 2 x PCIe Gen3 x1	■ 2 x PCIe Gen3 x16 or 4 x PCIe Gen3 x8 ■ 1 x PCIe Gen3 x8 ■ 1 x PCIe Gen3 x4 ■ 1 x PCIe Gen3 x1
	Ethernet interface	■ 1 x Gigabit Ethernet I/O interface ■ Additional ports via SCALEXIO Ethernet Boards	■ 2 x Gigabit Ethernet I/O interface ■ 1 x 10 Gigabit Ethernet I/O interface ■ Additional ports via SCALEXIO Ethernet Boards
	Serial interface	■ RS232 interface with standard UART allowing transfer rates up to 115.2 kbit/s kBaud	
Host interface		■ Gigabit Ethernet	■ 10 Gigabit Ethernet
Multiprocessor system		■ Building multiprocessor systems with more SCALEXIO Processing Units and/or processor boards	
Cooling		■ Active cooling	
Ambient temperature		■ Operating temperature 0 °C ... 40 °C (32 °F ... 104 °F)	
Operating humidity		■ 5% ... 95% (non-condensing environment)	
Size (width x height x depth)		■ Rack-mount version: 483 x 132 x 400 mm (19.0 x 5.2 x 15.7 in) ■ Desktop version: 428 x 132 x 400 mm (16.9 x 5.2 x 15.7 in) ■ 19-inch subrack ■ 3 height unit (H)	
Mass		■ Approx. 12 kg	
Power supply		■ 100 ... 240 V AC, 50/60 Hz, 500 W	■ 200 ... 240 V AC, 50/60 Hz, 1200 W ■ 100 ... 120 V AC, 50/60 Hz, 800 W

[1)] *Only dSPACE products and dSPACE qualified products can be used with the PCI and PCIe slots. Please contact dSPACE for more information.*

SCALEXIO Hypervisor Extension for Linux-Based Tools

The SCALEXIO Hypervisor Extension is based on a kernel-based virtual machine (KVM). It runs the SCALEXIO real-time operating system and virtual machines with standard Linux distributions simultaneously. This lets you integrate Linux real-time and non-real-time applications into the SCALEXIO Processing Unit environment supporting low-latency, high-bandwidth data exchange between the two. The SCALEXIO Hypervisor Extension is the ideal choice to integrate Linux-based modeling and simulation tools and allows for a reuse of existing models, such as Functional Mock-up Units that were developed in an earlier development phase. Virtualization saves hardware installation space and reduces hardware maintenance costs, because no additional external PC hardware is required.

Order Information

Hardware		Order Number
SCALEXIO Processing Unit with an Intel XEON® E3-1275v6 processor	Desktop version	■ SCLX_PU_HCP_DESK_P03_4P (with 4 IOCNET interfaces) ■ SCLX_PU_HCP_DESK_P03_8P (with 8 IOCNET interfaces) ■ SCLX_PU_HCP_L_DESK_P03_4P (with 4 IOCNET interfaces, cost-efficient, reduced feature scale, i.e., one core for model calculation)
	Rack-mount version	■ SCLX_PU_HCP_RACK_P03_4P (with 4 IOCNET interfaces) ■ SCLX_PU_HCP_RACK_P03_8P (with 8 IOCNET interfaces) ■ SCLX_PU_HCP_L_RACK_P03_4P (with 4 IOCNET interfaces, cost-efficient, reduced feature scale, i.e., one core for model calculation)
SCALEXIO Processing Unit with an Intel XEON® E5-2640v3 processor	Desktop version	■ SCLX_PU_HPP_DESK_P02_4P (with 4 IOCNET interfaces) ■ SCLX_PU_HPP_DESK_P02_8P (with 8 IOCNET interfaces)
	Rack-mount version	■ SCLX_PU_HPP_RACK_P02_4P (with 4 IOCNET interfaces) ■ SCLX_PU_HPP_RACK_P02_8P (with 8 IOCNET interfaces)
Solid State Disk – add-on product for the SCALEXIO Processing Unit for data replay and data recording purposes		■ SCLX_PU_SSD_480GB (part of the SCALEXIO Processing Unit) ■ SCLX_PU_SSD_RETROFIT_480GB (retrofitted by the customer)

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk
Optional	■ SCALEXIO Hypervisor Extension

Hardware	Product
Optional	■ SCALEXIO LabBox or ■ SCALEXIO rack system or ■ SCALEXIO customized rack system ■ SCALEXIO Ethernet Boards ■ SCALEXIO Interface Solution for ARINC 429 ■ SCALEXIO Interface Solution for ARINC 664 and AFDX® ■ SCALEXIO Interface Solution for MIL-STD-1553 ■ SCALEXIO Fieldbus Solution for PROFIBUS and EtherCAT ■ SCALEXIO MP Switch

DS6001 Processor Board

High-performance processor board

Highlights

- Intel® Core™ i7-6820EQ, quad-core, 2.8 GHz
- High bandwidth and fast access to SCALEXIO I/O boards
- Onboard Ethernet I/O and host interface
- Compact two slot processing unit for SCALEXIO LabBox and SCALEXIO AutoBox
- Multiprocessor support

Application Areas

The DS6001 Processor Board equipped with an Intel® Core™ i7-6820EQ quad-core processor is the most compact processing unit in the dSPACE SCALEXIO portfolio. It is an excellent fit for application areas where system size matters, such as desktop-based real-time systems for function development and testing. The DS6001 features high computation power and excellent real-time performance, with minimum jitter and latency. It is the perfect choice for use cases with high requirements regarding computation power and data bandwidth (e.g., assisted, highly automated, and autonomous driving) as well as real-time applications that require fast closed-loop rates (e.g., electric drives and vibration cancellation).

Key Benefits

All of the four cores of the DS6001 are available for parallel computing of real-time applications, which makes the board ideal for demanding tasks. The SCALEXIO real-time system can easily be scaled by connecting additional I/O boards or coupling several DS6001 Processor Boards or SCALEXIO Processing Units to form a multiprocessor system. The DS6001 provides an onboard Ethernet I/O interface for direct real-time model access from external devices via TCP/IP or UDP/IP protocol or to provide an ECU Interface (e.g., for bypassing).

IOCNET – Real-Time Network

IOCNET is the primary communication network for SCALEXIO systems. It is used for connecting a SCALEXIO system using the DS6001 with an additional I/O or processing hardware.

Multiprocessor Setup

The integrated multiprocessor support for SCALEXIO allows for connecting additional processing hardware via IOCNET to increase computational power and I/O bandwidth to provide a solution that can handle even the most demanding applications.

SCALEXIO Hypervisor Extension

The SCALEXIO Hypervisor Extension is based on a kernel-based virtual machine (KVM). It runs the SCALEXIO real-time operating system and virtual machines with standard Linux distributions simultaneously. This lets you integrate Linux real-time and non-real-time applications into the DS6001 Processor Board environment supporting low-latency, high-bandwidth data exchange between the two. The SCALEXIO Hypervisor Extension as an optional extension is the ideal choice to integrate Linux-based modeling and simulation tools and allows for a reuse of existing models, such as Functional Mock-up Units that were developed in an earlier development phase. Virtualization saves hardware installation space and reduces hardware maintenance costs, because no additional external PC hardware is required.

Technical Details

Parameter		Specification
Processor	Real-time processor	■ Intel i7-6820EQ, quad-core, 2.8 GHz ■ Number of Cores: 4 ■ L1 cache: 32 kB + 32 kB (data + instruction) per core ■ L2 cache: 256 kB per core ■ L3 cache: 8 MB total
	Host communication coprocessor	■ ARM® Cortex®-A9, 1.2 GHz
Memory		■ 4 GB RAM memory (DDR4) ■ 8 GB flash memory
Angular processing unit (APU)		■ 6 APUs
	Angular resolution	■ 0.011°
	Speed range	■ ± 28.610 rpm
	Speed resolution	■ 0.109 rpm
Interfaces	IOCNET	■ 2 IOCNET interfaces usable as multiprocessor and I/O extension[1)] ■ IOCNET link speed: up to 2.5 Gb/s
	PCI Express	■ 2 PCIe x4 interfaces[2)] ■ 3 PCIe x1 interfaces[2)]
	Ethernet interface	■ Integrated low-latency Gigabit Ethernet I/O interface
	Serial interface	■ RS232 interface with standard UART allowing transfer rates up to 480.6 kBaud
Host interface		■ Gigabit Ethernet
Multiprocessor system		■ Building systems with more SCALEXIO Processing Units and/or processor boards
Cooling		■ Temperature-controlled active cooling
Size		■ 238 x 100 x 39 mm (9.4 x 4 x 1.6 in) ■ Requires 2 slots
Typical power consumption		■ 70 W

1) *SFP transceiver modules have to be ordered separately.*
2) *Provides PCI Express interfaces to dedicated I/O slots of the SCALEXIO LabBox and the SCALEXIO AutoBox.*

Order Information

Product	Order Number
DS6001 Processor Board	■ DS6001
Solid State Disk – add-on product for the DS6001 for data replay and data recording purposes	■ DS6001_SSD_120GB

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk

Hardware	Product
Required	■ SCALEXIO LabBox or
	■ SCALEXIO AutoBox
Optional	■ SFP transceiver
	■ SCALEXIO MP Switch
	■ DS6333-CS Automotive Ethernet Board
	■ DS6335-CS Ethernet Board

SCALEXIO FPGA Subsystems

FPGA technology as computation accelerator

Highlights

- Modular concept with different user programmable FPGA base boards
- Extensible with up to five flexible I/O modules
- Seamless integration in dSPACE tool chain
- Multi-gigabit transceiver (MGT) for high-speed
- communication
- Scalable real-time performance by using Inter-FPGA via onboard MGTs

User programmable FPGAs allow for acceleration of challenging real-time applications. Sample times can be shifted down in the Microsecond range due to (bare metal operation) the absence of an operating system. This technology is a perfect choice for implementing fast control loops or simulation models with high time resolution.
The SCALEXIO FPGA portfolio comprises several FPGA base boards with Xilinx® FPGA, and I/O modules as add-ons for highly dynamic applications or customer-specific features.

FPGA subsystems offer parallel computation with fast high-resolution I/O signal processing in the range of Nanoseconds for control applications demanding highest closed loop performance or for hardware-in-the-loop simulation of high accuracy and nonlinear models and topology-based power electronics. Furthermore, the FPGA subsystem is a powerful platform for easy implementation of custom-specific interfaces and functions, e.g., communication protocols or I/O data preprocessing.

Key Benefits and Application Areas

FPGA Base Board	Key Benefits	Application Areas
Allrounder DS6601 FPGA Base Board	■ Standard platform for Rapid control prototyping and Hardware-in-the-loop simulation ■ Xilinx® Kintex® UltraScale™ KU035 with 444k Logic cells and 1700 DSP slices	■ Motor and power electronics control ■ Basic electric drive simulation ■ Suitable for smaller FPGA applications, e.g., protocol implementations
High-end DS6602 FPGA Base Board	■ Advanced Platform for more realistic Hardware-in-the-loop simulation ■ Xilinx® Kintex® UltraScale+™ KU15P with 1,143k Logic cells and 1968 DSP slices ■ 4 GByte external onboard RAM	■ Topology-based power electronics simulations ■ Power electronics simulation ■ Advanced electric drive simulation ■ High accuracy and nonlinear model simulations

I/O Modules

Three I/O modules are available for expanding the I/O channels of the dSPACE FPGA base boards: the DS2655M1 Multi-I/O Module, the DS2655M2 Digital I/O Module, and the DS6651 Multi-I/O Module. Up to five I/O modules can be connected to each FPGA base board, thus providing a flexible, customized channel set.

Programming the FPGA

FPGA applications are easy to implement in Simulink with the Xilinx® System Generator, RTI FPGA Programming Blockset and the related dSPACE XSG-based solutions. If required, you can react flexibly to new requirements, such as new interfaces or having to accelerate the execution of submodels. You can also test the program in offline simulation before implementing it on the real-time hardware. Using dSPACE ConfigurationDesk, you can download the programs to the FPGA.

DS6601 FPGA Base Board

SCALEXIO I/O boards with the Xilinx® FPGA technology

Highlights

- User-programmable FPGA boards
- Flexible boards for special I/O solutions
- Up to 5 piggyback I/O modules
- Multi-gigabit transceivers for high-speed communication

Application Areas

The DS6601 FPGA Base Board has been designed for applications that require very fast, high-resolution signal processing, for example:

- Electric vehicle applications
- Industrial drive applications
- Electric power industry applications
- Electric drive simulation
- Power electronics simulation
- Power hardware-in-the-loop simulation
- Electric motor control development
- Power electronics control development

The DS6601offers a powerful FPGA, making it well-suited for applications that involve protocols, third-party interfaces, processor-based electric drive simulation, or developing electric drive and power electronic controllers in the context of rapid control prototyping (RCP). The DS6601 is the cost-effective alternative to the DS6602.

Key Benefits

The DS6601 is the successor of the DS2655 FPGA Base Board (7K160 version) and includes a newer and approximately two times larger FPGA. The DS6601 features four multi-gigabit transceivers (MGT) that enable high-speed communication. To include more I/O channels, you can connect up to five I/O modules to each board. Additionally, you can connect multiple boards via inter-FPGA communication for direct data exchange between FPGA stacks.

I/O Modules

Three I/O modules are available to expand the I/O channels of the dSPACE FPGA base boards: the DS2655M1 Multi-I/O Module, the DS2655M2 Digital I/O Module, and the DS6651 Multi-I/O Module. Up to five I/O modules can be connected to each FPGA base board, thus providing a flexible, customized channel set.

Programming the FPGA

Applications for the DS6601 FPGA are modeled with the Xilinx® System Generator, RTI FPGA Programming Blockset and the related dSPACE XSG-based solutions. If required, you can react flexibly to new requirements, such as new interfaces or having to accelerate the execution of submodels. You can also test the program in offline simulation before implementing it on the real-time hardware. Using dSPACE ConfigurationDesk, you can download the programs to the FPGA.

Technical Details

Parameter	Specification
General	■ User-programmable FPGA board
FPGA	■ Xilinx® Kintex® UltraScale™ KU035 ■ System logic cells: 444,000 (DSP slices: 1700) ■ Distributed RAM: 5,908 kbit ■ Block RAM: 19,000 kbit
Additional onboard RAM	–
Angular Processing Units (APUs)	■ Up to 6 as master or slave
Number of connectors for I/O modules	■ 5 connectors for standard I/O modules ■ 1 connector with 4 multi-gigabit transceivers (MGTs)[1)]
Device timing	■ 125 MHz
Internal communication interface	■ IOCNET
Physical size	■ 238 x 100 x 19 mm (9.4 x 3.9 x 0.7 in) ■ Requires 1 slot plus one additional slot for each I/O module
Typical power consumption	■ 50 W

[1)] *Using the multi-gigabit transceivers requires an adapter.*

Order Information

Product	Order Number
DS6601 FPGA Base Board	■ DS6601
Inter-FPGA communication cable	■ SCLX_INT_FPGA_CAB1
Adapter for Multi-Gigabit Transceiver	■ DS6601_MGT1

Relevant Software and Hardware

Software	Product
Required	■ RTI FPGA Programming Blockset
	■ ConfigurationDesk
Optional	■ XSG Utils Library
	■ XSG AC Motor Control Library
	■ XSG Electric Components Library
	■ SCALEXIO EMH Solution
	■ Electrical Power Systems Simulation Package

Hardware	Product
Required	■ SCALEXIO Processing Unit or ■ DS6001 Processor Board
	■ SCALEXIO LabBox or ■ SCALEXIO AutoBox or ■ SCALEXIO rack system or ■ SCALEXIO customized rack system
Optional	■ DS2655M1 Multi-I/O Module
	■ DS2655M2 Digital I/O Module
	■ DS5450 SC Board for DS2655M1
	■ DS6651 Multi-I/O Board

DS6602 FPGA Base Board

SCALEXIO I/O boards with the latest Xilinx® FPGA technology

Highlights

- User-programmable FPGA boards
- Flexible boards for special I/O solutions
- Up to 5 piggyback I/O modules
- Multi-gigabit transceivers for high-speed communication

Application Areas

The DS6602 FPGA Base Board has been designed for applications that require very fast, high-resolution signal processing, for example:

- Electric vehicle applications
- Industrial drive applications
- Electric power industry applications
- Electric drive simulation
- Power electronics simulation
- Power hardware-in-the-loop simulation
- Electric motor control development
- Power electronics control development

With its very large and powerful FPGA, the DS6602 is the perfect candidate for hardware-in-the-loop (HIL) testing, which usually involves large simulation models.

Key Benefits

The DS6602 is the new high-end FPGA board from dSPACE. It is equipped with the largest FPGA of the latest Xilinx® Kintex® UltraScale+™ FPGA generation. Its additional on-board RAM allows for storage of very large datasets, e.g., model parameter sets required for advanced electric drives simulation. The DS6602 features four multi-gigabit transceivers (MGT) that enable high-speed communication. To include more I/O channels, you can connect up to five I/O modules to each board. Additionally, you can connect multiple boards via inter-FPGA communication for direct data exchange between FPGA stacks.

I/O Modules

Three I/O modules are available for expanding the I/O channels of the dSPACE FPGA base boards: the DS2655M1 Multi-I/O Module, the DS2655M2 Digital I/O Module, and the DS6651 Multi-I/O Module. Up to five I/O modules can be connected to each FPGA base board, thus providing a flexible, customized channel set.

Programming the FPGA

Applications for the DS6602 FPGA are modeled with the Xilinx® System Generator, RTI FPGA Programming Blockset and the related dSPACE XSG-based solutions. If required, you can react flexibly to new requirements, such as new interfaces or having to accelerate the execution of submodels. You can also test the program in offline simulation before implementing it on the real-time hardware. Using dSPACE ConfigurationDesk, you can download the programs to the FPGA.

Technical Details DS6602

Parameter	Specification
General	■ User-programmable FPGA board
FPGA	■ Xilinx® Kintex® UltraScale+™ KU15P ■ System logic cells: 1,143,000 (DSP slices: 1968) ■ Distributed RAM: 9,800 kbit ■ Block RAM: 34,600 kbit ■ Ultra RAM: 36,000 kbit
Additional onboard RAM	■ 4 GB
Angular Processing Units (APUs)	■ Up to 6 as master or slave
Number of connectors for I/O modules	■ 5 connectors for standard I/O modules ■ 1 connector with 4 multi-gigabit transceivers (MGTs)[1)]
Device timing	■ 125 MHz
Internal communication interface	■ IOCNET
Physical size	■ 238 x 100 x 39 mm (9.4 x 3.9 x 1.5 in) ■ Requires 2 slots plus one additional slot for each I/O module
Typical power consumption	■ 75 W

1) *Using the multi-gigabit transceivers requires an adapter.*

Order Information

Product	Order Number
DS6602 FPGA Base Board	■ DS6602
Inter-FPGA communication cable	■ SCLX_INT_FPGA_CAB1
Adapter for Multi-Gigabit Transceiver	■ DS6602_MGT1

Relevant Software and Hardware

Software	Product
Required	■ RTI FPGA Programming Blockset
	■ ConfigurationDesk
Optional	■ XSG Utils Library
	■ XSG AC Motor Control Library
	■ XSG Electric Components Library
	■ SCALEXIO EMH Solution
	■ Electrical Power Systems Simulation Package

Hardware	Product
Required	■ SCALEXIO Processing Unit or ■ DS6001 Processor Board
	■ SCALEXIO LabBox or ■ SCALEXIO AutoBox or ■ SCALEXIO rack system or ■ SCALEXIO customized rack system
Optional	■ DS2655M1 Multi-I/O Module
	■ DS2655M2 Digital I/O Module
	■ DS5450 SC Board for DS2655M1
	■ DS6651 Multi-I/O Board

DS2655 FPGA Base Board

SCALEXIO I/O board with user-programmable FPGA

Highlights

- User-programmable FPGA
- Flexible board for special I/O solutions
- Up to 5 piggyback I/O modules

Application Areas

The DS2655 FPGA Base Board has been designed for applications that require very fast, high-resolution signal processing, for example:

- Hybrid vehicle applications
- Electric drive applications
- Processor-based electric drive simulation
- Power hardware-in-the-loop applications
- FPGA-based electric drive simulation
- Electric power industry applications
- Power electronics simulation
- Electric motor control development
- Protocols
- Power electronics control development

Key Benefits

The DS2655 is available in two versions of freely field-programmable gate arrays (FPGA):

- The DS2655 7K160 includes a Xilinx® Kintex®-7 160T and is a cost-effective solution for smaller applications.
- The DS2655 7K410 includes a Xilinx® Kintex®-7 410T with a large RAM, which makes it ideal for electric drive applications.

To include more I/O channels, you can connect up to five I/O modules to the board. Additionally, you can connect two DS2655 boards with the inter FPGA communication cable for direct data exchange between FPGA stacks.

As successors of the DS2655, the **DS660x** FPGA Base Boards are equipped with FPGAs of the latest Xilinx® Kintex® UltraScale™ and UltraScale+™ generations.

I/O Modules

Three I/O modules are available to expand the I/O channels of the DS2655 FPGA Base Board: the DS2655M1 Multi-I/O Module, the DS2655M2 Digital I/O Module, and the DS6651 Multi-I/O Module. Up to five I/O modules can be connected to the board, thus providing a flexible, customized channel set.

Programming the FPGA

Applications for the DS2655's FPGA are modeled with the Xilinx® System Generator, RTI FPGA Programming Blockset and the related dSPACE XSG-based solutions. If required, you can react flexibly to new requirements, such as new interfaces or having to accelerate the execution of submodels. You can also test the program in offline simulation before implementing it on the real-time hardware. Using dSPACE ConfigurationDesk, you can download the programs to the FPGA.

Technical Details DS2655

Parameter	Specification	
	DS2655 7K160	DS2655 7K410
General	■ User-programmable FPGA	
FPGA	■ Xilinx® Kintex®-7 160T ■ Logic cells: 162,240 (DSP slices: 600) ■ Distributed RAM: 2,188 kbit ■ Block RAM: 11,700 kbit	■ Xilinx® Kintex®-7 410T ■ Logic cells: 406,720 (DSP slices: 1540) ■ Distributed RAM: 5,663 kbit ■ Block RAM: 28,620 kbit
Number of connectors for I/O modules	■ 5	
Device timing	■ 125 MHz	
Internal communication interface	■ IOCNET	
Physical size	■ 238 x 100 x 19 mm (9.4 x 3.9 x 0.7 in) ■ Requires 1 slot plus one additional slot for each I/O module	
Typical power consumption	■ DS2655 7K160: 15 W	■ DS2655 7K410: 30 W

Order Information

Product	Order Number
DS2655 FPGA Base Board (7K160)	■ DS2655 7K160
DS2655 FPGA Base Board (7K410)	■ DS2655 7K410
Inter-FPGA communication cable	■ SCLX_INT_FPGA_CAB1

Relevant Software and Hardware

Software		Product
Required		■ RTI FPGA Programming Blockset
		■ ConfigurationDesk
Optional		■ XSG Electric Components Library
		■ XSG Utils Library
		■ XSG AC Motor Control Library
		■ SCALEXIO EMH Solution
	For DS2655 FPGA Base Board (7K410)	■ Electrical Power Systems Simulation Package

Hardware	Product
Required	■ SCALEXIO Processing Unit or ■ DS6001 Processor Board
	■ SCALEXIO LabBox or ■ SCALEXIO AutoBox or ■ SCALEXIO rack system or ■ SCALEXIO customized rack system or ■ External I/O Unit
Optional	■ DS2655M1 Multi-I/O Module
	■ DS2655M2 Digital I/O Module
	■ DS5450 SC Board for DS2655M1
	■ DS6651 Multi-I/O Board

FPGA I/O Modules

For expanding the I/O channels of the dSPACE FPGA base boards

Highlights

- Three I/O modules for dSPACE FPGA base boards
- High number of digital and analog I/O channels
- Tailored channel set for the control and simulation of electric drives and power electronics components

Application Areas

Three I/O modules are available for expanding the I/O channels of the dSPACE FPGA base boards. They provide a high number of the digital and analog I/O channels required for applications such as electric drives:

- The DS6651 Multi-I/O Module, which provides a tailored channel set for controlling and simulating electric drives and power electronic components.
- The DS2655M1 Multi-I/O Module with five analog in and out channels as well as ten digital channels. The DS2655M1 can be extended by the DS5450 SC add-on module. The add-on module contains five switchable transformers for decoupling the five DAC channels of the DS2655M1 module from system ground.
- The DS2655M2 Digital I/O Module with 32 digital channels.

The I/O modules can be combined as desired to meet any use case requirements.

Technical Details DS6651

Parameter		Specification
General		■ 6 A/D channels, 6 D/A channels, 16 digital I/O channels ■ 1x 50-pin Sub-D connector ■ ±60 V overvoltage protection
Analog I/O	Input	■ 6 channels ■ Input voltage ranges selectable for each channel: ■ +/- 1 V, +/- 5 V, +/- 10 V or 60 V ■ ADC resolution: 16 bits ■ Sampling rate: 5 MS/s ■ Selectable load resistor: 220 Ω (for channels 5 and 6 only)
	Output	■ 6 channels ■ Output voltage range: +/- 10 V ■ DAC resolution: 16 bits ■ Update rate: 10 MS/s ■ Selectable transformer (for channels 5 and 6 only)
Digital I/O		■ 16 ground-based digital I/O channels ■ Channels can be configured in pairs to full differential pairs ■ Time resolution: 8 ns
	Input (ground-based mode)	■ Maximum input voltage range: 0 ... 30 V ■ Threshold voltage: 0 ... 12 V ■ Input frequency: max. 25 MHz
	Output (ground-based mode)	■ Voltage range: ■ 3.3 V TTL/CMOS ■ 5 V TTL ■ Output modes: ■ High-side switch (+3.3 V or +5 V) ■ Low-side switch (GND) ■ Push/pull ■ Output frequency: 25 MHz (max. at 50% duty cycle)

Technical Details DS6651

Parameter	Specification
Digital I/O RS485	■ Voltage range: RS485 levels ■ Bit rate: max. 16 Mbit/s
Sensor supply	■ 2x 5 V (max. 500 mA each)
Physical size	■ Requires 1 slot ■ 232 x 100 x 19 mm (9.2 x 3.9 x 0.7 in) without fastening bracket
Typical power consumption	■ 6 W

Technical Details DS2655M1 Multi-I/O Module

Parameter		Specification
General		■ 5 A/D channels, 5 D/A channels, 10 digital I/O channels ■ 1 x 50-pin Sub-D connector
Analog I/O	Input	■ 5 channels ■ Resolution 14 bit ■ Sampling rate 4 MSPS SAR ■ Input voltage range selectable for each channel: ±5 V or ±30 V
	Output	■ 5 channels ■ Resolution: 14 bit ■ Update rate: 7.8 MSPS ■ Output voltage range: ±10 V
Digital I/O		■ 10 channels, usable as input or output
	Input	■ Maximum input voltage: 15 V ■ Threshold for each channel adjustable from 0 V to +10.5 V
	Output	■ Push-pull drivers ■ One output voltage can be selected for all channels: 3.3 V or 5 V
Physical size		■ 209 x 100 x 19 mm (8.2 x 3.9 x 0.7 in) ■ Mounted on the FPGA base board, requires one additional slot for each I/O module
Typical power consumption		■ 9.6 W

Technical Details DS2655M2 Digital I/O Module

Parameter		Specification
General		■ 32 channels, usable as input or output ■ 1 x 50-pin Sub-D connector
Digital I/O	Input	■ Maximum input voltage: 15 V ■ Threshold for each channel adjustable form 1 V to 7.5 V
	Output	■ Push-pull drivers ■ One output voltage can be selected for all channels: 3.3 V or 5 V
	UART	■ 16 channels extended with RS232/RS485 transceivers ■ RS232: max. 250 kBaud ■ RS485: max. 16 MBaud
Maximal configuration of the functions		■ 32 x digital input ■ 32 x digital output, (push/pull or push or pull) ■ 16 x digital output, (push/pull/tristate) ■ 8 x RS232 RX, (24 digital I/O or 8 x RS232 TX channels are free) ■ 8 x RS232 TX, (24 digital I/O or 8 x RS232 RX channels are free) ■ 8 x RS485 RX, (16 digital I/O channels are free) ■ 8 x RS485 TX, (16 digital I/O channels are free) ■ 8 x RS485 RX/TX, (8 digital I/O channels are free)
Physical size		■ 209 x 100 x 19 mm (8.2 x 3.9 x 0.7 in) ■ Mounted on the FPGA base board, requires one additional slot for each I/O module
Typical power consumption		■ 9.6 W

Technical Details DS5450 SC Module (Add-on for DS2655M1)

Parameter		Specification
General		■ Direct connection to the front Sub-D connector of a DS2655M1 ■ Application-specific configuration of the analog I/O via onboard jumpers ■ Status LEDs for operation voltage and channel configuration
Analog I/O	Input	■ Optional 220 Ω resistors for each of the five ADC channels
	Output	■ Optional decoupling transformers for each of the five DAC channels
Digital I/O		■ Digital I/O from the DS2655M1 are routed through the DS5450 board

Order Information

Product	Order Number
DS6651 Multi-I/O Module	■ DS6651
DS2655M1 Multi-I/O Module	■ DS2655_M1
DS2655M2 Digital I/O Module	■ DS2655_M2
DS5450 SC Board for DS2655M1	■ Please inquire
Adapter for two Sub-D 50 connectors to one Hypertac connector	■ HYPERTRONICS_CON90_FP1_QT

Relevant Hardware and Software

Hardware	Product
Required	■ DS6601 FPGA Base Board or ■ DS6602 FPGA Base Board or ■ DS2655 FPGA Base Board

Software	Product
Required	■ RTI FPGA Programming Blockset
Optional	■ XSG Utils Library ■ XSG AC Motor Control Library ■ XSG Electric Component Models ■ Electrical Power Systems Simulation Package

DS6101 Multi-I/O Board

SCALEXIO I/O board with signal conditioning for automotive systems

Highlights

- 69 channels with comprehensive I/O functions
- Signal conditioning for signal levels of 12-V, 24-V, and 48-V automotive systems
- Ideally suited for engine, powertrain, and vehicle dynamics applications

Application Areas

The DS6101 comprises a large variety of I/O functions needed for hardware-in-the-loop simulation and can be used for generating and measuring typical automotive signals. This makes the DS6101 ideally suited for applications with extensive I/O requirements.

Key Benefits

The DS6101 Multi-I/O Board offers 69 I/O channels for voltage-related functions, including analog, digital, resistance, and special input/output groups, for example for lambda probe simulation. The integrated signal conditioning is tailored to automotive project requirements, such as voltages of 12 V, 24 V, and 48 V.

I/O Functionality

The DS6101 provides 33 I/O functions that are supported by different I/O channels. Please see page 11 for the mapping between I/O functions and I/O channels.

The channels are defined and configured graphically with dSPACE ConfigurationDesk.

Analog In
- Voltage In
- Voltage Signal Capture

Digital In
- Multi Bit In
- Trigger In
- PWM/PFM In
- Digital Pulse Capture
- SENT In

Analog Out
- Voltage Out
- Current Sink
- Wavetable Voltage Out
- Wavetable Current Sink
- Waveform Voltage Out
- Waveform Current Sink
- Angular Wavetable Voltage Out

Digital Out
- Multi Bit Out
- PWM/PFM Out
- Digital Pulse Out
- Wavetable Digital Out
- Waveform Digital out
- Angular Wavetable Digital Out
- SENT Out

Engine Simulation
- Injection/Ignition Voltage In
- Crank/Cam Voltage Out
- Crank/Cam Current Sink
- Crank/Cam Digital Out
- Knock Signal Out
- Lambda DCR
- Lambda NCCR

Resistor Simulation
- Resistance Out
- Potentiometer Out

Further Sensor Simulation
- Digital Incremental Encoder Out
- Wheel Speed Out

Technical Details

Parameter		Specification
General		■ 69 software-configurable I/O channels ■ 3 x 50-pin Sub-D connectors
Signal measurement	■ 10 x analog inputs (Analog In 4)	■ Voltage measurement range 0 ... 60 V ■ Resolution 16 bit
	■ 12 x digital inputs (Digital In 3)	■ Voltage measurement range 0 ... 60 V
	■ 10 x variable inputs (Flexible In 3)	■ Voltage measurement digital ■■ Voltage range -10 ... 10 V ■■ Fast threshold adaptation (useful for ignition/injection signal measurement) ■ Voltage measurement analog ■■ Voltage range -10 ... 10 V ■■ Resolution 16 bit
Signal generation	■ 8 x analog outputs (DC) (Analog Out 6)	■ Only voltage generation ■ Output voltage 0 ... 10 V ■ Output current -5 ... +5 mA ■ Resolution 14 bit
	■ 4 x analog outputs (DC) (Analog Out 9)	■ Output voltage 0 ... 10 V ■ Output current -5 ... +5 mA ■ Resolution 14 bit ■ Current sink: Current range -30 ... +30 mA
	■ 3 x analog outputs (AC) (Analog Out 8)	■ Only voltage generation ■ Output voltage -20 ... +20 V ■ Resolution 14 bit
	■ 6 x resistance simulation channels (Resistance Out 2)	■ Effective inner resistance range 16 Ω ... 1 MΩ ■ Voltage range -3 ... +18 V to GND ■ Current range -80 ... +80 mA ■ Power max. 250 mW
	■ 14 x digital outputs (Digital Out 3)	■ Configurable as low-side/high-side switch or push/pull ■ Low-side = GND ■ High-side Dig-Out-Ref 1 or 2 ■ Voltage range high-side: 5 ... 60 V ■ Current range 0 ... ±150 mA ■ 150 mA per channel and 1 A in sum per group
Special I/O channels	■ 1 analog input and output group, e.g., for lambda probe simulation (Analog In 5, Analog Out 7)	■ 1 ADC, 12 bit ■ 1 DAC, 14 bit ■ Voltage range -10 ... +10 V ■ Current range -5 ... +5 mA
Internal communication interface		■ IOCNET
Physical size		■ 238 x 100 x 59 mm (9.4 x 3.9 x 2.3 in) ■ Requires 3 slots
Typical power consumption		■ 14.4 W

Order Information

Product	Order Number
DS6101 Multi-I/O Board	■ DS6101
Adapter for two Sub-D 50 connectors to one Hypertac connector	■ HYPERTRONICS_CON90_FP1_QT

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk

Hardware	Product
Required	■ SCALEXIO Processing Unit or ■ DS6001 Processor Board
	■ SCALEXIO LabBox or ■ SCALEXIO AutoBox or ■ SCALEXIO rack system or ■ SCALEXIO customized rack system

DS6121 Multi-I/O Board

SCALEXIO I/O board for electric drive and power electronics control applications

Highlights

- Tailored channel set for electric drive control
- Powerful I/O function library
- Support of the latest motor designs

Application Areas

With its application-specific I/O library and tailored channel set, the DS6121 Multi-I/O Board is ideally suited for dynamic electric drive and power electronics control applications. The DS6121 supports a wide range of electric drives from small auxiliary motors to high-performance traction motors in various application areas, such as in-vehicle electrification and electric powertrains as well as industrial automation, e.g., highly dynamic test benches.

Key Benefits

The DS6121 Multi-I/O Board combines flexible interfaces for multiple position sensors, multichannel PWM generation for block and sine commutation, and analog channels for accurate analog measurement on a single board. Onboard I/O synchronization and I/O preprocessing enable highly dynamic control scenarios and provide outstanding real-time performance. A powerful I/O function library with easy access allows for quick prototyping of control applications. Furthermore, several e-drive control demo models are included to get you started.

I/O Functionality

The channel set of the DS6121 Multi-I/O Board supports the following I/O functions. Please see page 11 for the mapping between I/O functions and I/O channels.

The channels are defined and configured graphically with dSPACE ConfigurationDesk.

Position Sensors	Analog In	Digital In	Digital Out
■ 3x Sine Encoder In ■ 3x Digital Incremental Encoder In ■ 3x EnDat Master ■ 3x SSI Master ■ 2x Hall Encoder In ■ 1x Resolver In	■ 6x Voltage In ■ 6x Voltage Signal Capture	■ 4x PWM/PFM In ■ 4x Multi Bit In ■ 4x Trigger In	■ 16x Multi Bit Out ■ 16x PWM/PFM Out ■ 16x Multi-Channel PWM Out ■ 2x Block Commutated PWM Out ■ 4x Digital Pulse Out

Technical Details

Parameter		Specification
General		■ 1 x 50-pin Sub-D connector ■ ±60 V overvoltage protection[1)]

Signal measurement	Analog input
	(6x Analog In 16)
		■ Input voltage range
		  ■ -10 ... +10 V
		  ■ -60 ... +60 V
		■ ADC resolution: 16 bits
		■ Sampling rate: 2 MS/s
		■ -3 dB cutoff frequency: 3.5 MHz

	Digital input (4x Digital In/Out 9)	■ Voltage range: 0 ... 60 V ■ Threshold voltage: 0 ... 12 V ■ Pulse width: 25 ns (typ.) ■ Input resistance: 120 kΩ

Signal generation	Digital output
	(4x Digital In/Out 9,
	12x Digital Out 8)
		■ Voltage range
		  ■ 3.3 V TTL
		  ■ 5 V TTL/CMOS
		■ Output modes
		  ■ High-side switch
		  ■ Low-side switch
		  ■ Push/Pull
		■ Output current: ±40 mA
		■ Output pulse width: 25 ns (typ.)

Position sensor interfaces	Position encoder
	(6x Flexible In/Out 1)
		■ Encoder signal types
		  ■ Sinusoidal signals: 1 V_{PP} or 2 V_{PP} differential
		  ■ Digital signals: RS485
		  ■ Individually configurable for each channel
		■ Analog input voltage range
		  ■ ±0.5 V (1 V_{PP})
		  ■ ±1 V (2 V_{PP})
		■ ADC resolution: 14 bits
		■ Sampling rate: 10 MS/s
		■ -3 dB cutoff frequency: 3 MHz (typ.)

	Resolver interface (1x Resolver In 2)	■ Excitation output voltage: 3 V_{RMS}, 7 V_{RMS}, or 10 V_{RMS} ■ Excitation output current: max. 160 mA_{RMS} ■ Excitation output frequency range: 2 ... 20 kHz ■ Input voltage range: 1.5 V_{RMS}, 3.5 V_{RMS}, or 5 V_{RMS} ■ Resolution: 10, 12, 14, 16 bits ■ Overvoltage protection: ±12 V continuous
Sensor supply		■ 2x 5 V (max. 500 mA each)
Internal communication interface		■ IOCNET
Physical size		■ 238 x 100 x 19 mm (9.4 x 3.9 x 0.7 in) without fastening bracket ■ Requires 1 slot
Typical power consumption		■ 12 W

[1)] Resolver provides a reduced overvoltage protection.

Order Information

Product	Order Number
DS6121 Multi-I/O Board	■ DS6121
Adapter for two Sub-D 50 connectors to one Hypertac connector	■ HYPERTRONICS_CON90_FP1_QT

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk

Hardware	Product
Required	■ SCALEXIO Processing Unit or ■ DS6001 Processor Board
	■ SCALEXIO LabBox or ■ SCALEXIO AutoBox or ■ SCALEXIO rack system or ■ SCALEXIO customized rack system

DS6201 Digital I/O Board

SCALEXIO I/O board with 96 bidirectional digital I/O channels

Highlights

- 96 channels for high channel count requirements
- Signal conditioning up to 60 V
- Measures and generates automotive signals and TLL signals
- All channels software-configurable as input or output

Application Areas

The DS6201 Digital I/O Board comprises a large number of digital I/O channels that can all be configured as input or output channels. The available I/O functions cover digital, PWM, and PFM functions for hardware-in-the-loop simulation in automotive projects, such as the test of body electronics ECUs.

Additionally, the DS6201 includes an onboard signal conditioning unit. This makes the DS6201 a cost-efficient way to start a HIL simulation project.

Key Benefits

The DS6201 Digital I/O Board offers 96 I/O channels for signal measurement and signal generation. The onboard signal conditioning is tailored to automotive project requirements, such as voltages of 12 V, 24 V, 36 V, and 48 V, as well as to customary TTL levels.

I/O Functionality

The 96 digital channels of the DS6201 can be configured for signal measurement or signal generation. Each channel supports the following I/O functions:

- Multi Bit In
- Multi Bit Out
- PWM/PFM In
- PWM/PFM Out

The channels are defined and configured graphically with dSPACE ConfigurationDesk.

Technical Details

Parameter		Specification
I/O connector		■ 96 software-configurable I/O channels ■ 3 x 50-pin Sub-D connectors
Digital signal measurement or generation (Digital In/Out 3)	Digital inputs	■ Measurement range 0 ... 60 V
	Digital outputs	■ Configurable as low-side/high-side switch or push/pull ■ Low-side = GND ■ High-side = 2 independent external high-side references per group (Sub-D connector / 32 channels) ■ Voltage range high-side: 3.3 ... 60 V ■ Current max. 150 mA ■ 150 mA per channel and 2 A in sum per group
Internal communication interface		■ IOCNET
Physical size		■ 238 x 100 x 59 mm (9.4 x 3.9 x 2.3 in) ■ Requires 3 slots
Typical power consumption		■ 8.9 W

Order Information

Product	Order Number
DS6201 Digital I/O Board	■ DS6201
Adapter for two Sub-D 50 connectors to one Hypertac connector	■ HYPERTRONICS_CON90_FP1_QT

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk

Hardware	Product
Required	■ SCALEXIO Processing Unit or ■ DS6001 Processor Board
	■ SCALEXIO LabBox or ■ SCALEXIO AutoBox or ■ SCALEXIO rack system or ■ SCALEXIO customized rack system

DS6202 Digital I/O Board

SCALEXIO I/O board for generating and capturing digital signals

Highlights

- 32 software-configurable bidirectional channels
- Adjacent channels usable as differential inputs
- Minimum pulse width 24 ns (time resolution 8 ns)
- Support of 3.3 V, 5 V TTL, and RS-485 signal levels
- Comprehensive I/O functions

Application Areas

With its precise digital I/O channels and its comprehensive I/O functions the DS6202 Digital I/O Board is ideally suited for various application areas, such as renewable energy, electric drives control, robotics, vehicle engineering, and mechanical test benches. It captures digital signals for measuring parameters, such as position, frequency, and phase and generates digital signal patterns to control actuators or to simulate sensors.

Based on its comprehensive I/O library, the DS6202 combines a wide variety of high-performace I/O tasks on a single board.

Key Benefits

The DS6202 Digital I/O Board provides 32 digital high-speed channels that support of 3.3 V and 5 V TTL voltage levels. Each channel is software-configurable as an input or output. Adjacent channels can be configured as full-differential inputs with RS-485 signal levels. Based on its comprehensive I/O library, the DS6202 combines a wide variety of high-performace I/O tasks on a single board. The board features general digital I/O functions plus advanced functionality, such as high-resolution signal capturing and pattern generation. Furthermore, the DS6202 provides interfaces for up to six incremental encoders.

I/O Functionality

The 32 digital channels of the DS6202 can be configured for signal measurement or signal generation. The board supports the following I/O functions:

- 32x Multi Bit In/Out
- 32x PWM/PFM In/Out
- 32x Multi-Channel PWM Out
- 16x Digital Pulse Capture
- 16x Waveform Digital Out
- 16x Wavetable Digital Out
- 16x Angular Wavetable Digital Out
- 10x Trigger In
- 8x Sent In/Out
- 6x Digital Incremental Encoder In/Out
- 4x Digital Pulse Out

The channels are defined and configured graphically with dSPACE ConfigurationDesk.

Technical Details

Parameter		Specification
General		■ 32 ground-based digital I/O channels ■ Channels can be configured in pairs to full-differential inputs ■ 8 ns time resolution ■ ± 60 V overvoltage protection ■ 50-pin Sub-D connector
Input (differential mode) (Digital In/Out 5)	Voltage range	■ RS-485 levels
	Baud rate	■ Max. 20 MBd
	Input resistance	■ 266 kΩ
Input (ground-based mode) (Digital In/Out 5)	Voltage range	■ 0 ... 30 V
	Threshold voltage	■ 0 ... 12 V
	Pulse width	■ Min. 25 ns
	Input resistance	■ 120 kΩ
Output (Digital In/Out 5)	Voltage range	■ 3.3 V TTL ■ 5 V TTL/CMOS
	Output modes	■ High-side switch ■ Low-side switch ■ Push/Pull
	Output current	■ ± 40 mA
	Output pulse width	■ Min. 25 ns
Sensor supply		■ 2 x 5 V (max 500 mA each) ■ 1x 12 V (max 125 mA)
Internal communication interface		■ IOCNET
Physical size		■ 238 x 100 x 19 mm (9.4 x 3.9 x 0.7 in) without fastening bracket ■ Requires 1 slot
Typical power consumption		■ 15 W

Order Information

Product	Order Number
DS6202 Digital I/O Board	■ DS6202
Adapter for two Sub-D 50 connectors to one Hypertac connector	■ HYPERTRONICS_CON90_FP1_QT

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk

Hardware	Product
Required	■ SCALEXIO Processing Unit or ■ DS6001 Processor Board
	■ SCALEXIO LabBox or ■ SCALEXIO AutoBox or ■ SCALEXIO rack system or ■ SCALEXIO customized rack system

DS6221 A/D Board

Fast A/D board

Highlights

- 16 differential A/D channels
- 16-bit resolution
- 250 ns conversion time (4 MSPS)
- Versatile trigger capabilities
- High throughput streaming interface

Application Areas

With its accurate high-speed analog channels and versatile trigger capabilities, the DS6221 is an excellent fit for precise measurements, even of fast analog signals sequences, in various applications areas. It can be used for scenarios such as the development and testing of electric drives applications or vibration and noise cancellation applications as well as for high volume data acquisition in test bench scenarios.

Key Benefits

Each of the 16 differential input channels included in the DS6221 has an independent A/D converter with a resolution of 16 bits and a minimum conversion time of 250 ns. Advanced configurable channel-specific triggers, such as onboard timers, external trigger input lines, or predefined angles of SCALEXIO's angular processing unit, allow for the precise event-based capturing of analog values and signal sequences. For comprehensive and fast data capturing the IOCNET-based streaming interface provides a continuous sample data throughput of up to 40 MSPS to the real-time application[1].

I/O Functionality

The 16 analog input channels of the DS6221 each supports the following I/O functions:

- Voltage In
- Voltage Signal Capture

The channels are defined and configured graphically with dSPACE ConfigurationDesk.

[1] *Depends on the SCALEXIO processing hardware and the system topology.*

Technical Details

Parameter		Specification
General		■ 16 A/D input channels (differential) with independent A/D converters ■ 250 ns ... 100 ms trigger interval (adjustable) ■ 8 external trigger input lines ■ ± 60 V input overvoltage protection ■ Up to 40 MSPS max. total throughput[1)] ■ 1 x 50-pin Sub-D connector
A/D channels (Analog In 6)	Resolution	■ 16 bit
	Conversion time	■ 250 ns
	Input voltage range	■ ± 10 V
	Input voltage working range	■ ± 12 V
	Offset error	■ ± 1 mV
	Gain error	■ ± 0.1 % of FSR
	Input offset drift	■ ± 20 µV/K
	Gain drift	■ ± 10 ppm/K
	SNR (signal-to-noise ratio)	■ > 85 dB at 10 kHz
	THD (total harmonic distortion)	■ -100 dB (typ., at 10 kHz, 25 °C) ■ -93 dB (typ., at 100 kHz, 25 °C) (for balanced signals)
	-3 dB cutoff frequency	■ 1.9 MHz
	Input impedance	■ 1 MΩ
Digital trigger input (Trigger In 1)	Input threshold voltage	■ 0 V ... 24 V
	Hysteresis	■ 600 mV (typ.)
Interrupt controller		■ Start of conversion ■ End of conversion
External trigger input	Input voltage	■ 0 V ... 24 V
Internal communication interface		■ IOCNET (up to 2.5 Gbit/s link speed)
Physical size		■ 238 x 100 x 19 mm (9.4 x 4 x 0.8 in) ■ Requires 1 slot
Typical power consumption		■ 12.6 W

[1)] *Depends on the SCALEXIO processing hardware and the system topology.*

Order Information

Product	Order Number
DS6221 A/D Board	■ DS6221
Adapter for two Sub-D 50 connectors to one Hypertac connector	■ HYPERTRONICS_CON90_FP1_QT

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk

Hardware	Product
Required	■ SCALEXIO Processing Unit or ■ DS6001 Processor Board
	■ SCALEXIO LabBox or ■ SCALEXIO AutoBox or ■ SCALEXIO rack system or ■ SCALEXIO customized rack system

DS6241 D/A Board

Multi-Channel D/A board

Highlights

- 20 D/A channels with dedicated ground sense potential
- 16-bit resolution
- 5 µs settling time
- Versatile synchronization mechanisms

Application Areas

With its accurate analog out channels, the DS6241 can be used for rapid control prototyping (RCP) as well as hardware-in-the-loop (HIL) testing applications. During the development of ECU functions, it works as an analog signal generator for actuator control, e.g., for noise cancellation. In test scenarios, it generates signals for sensor simulation.

Key Benefits

Each of the 20 output channels included in the DS6241 comes with a dedicated ground sense line and provides a resolution of 16 bits. The board offers a flexible simulation of sensor signals and a versatile synchronization mechanism, e.g., a configurable trigger function for four channels and synchronization with SCALEXIO's angular processing unit.

I/O Functionality

The 20 analog channels of the DS6241 each supports the following I/O functions:

- Voltage Out
- Wavetable Voltage Out
- Waveform Voltage Out
- Angular Wavetable Voltage Out

The channels are defined and configured graphically with dSPACE ConfigurationDesk.

Technical Details

Parameter		Specification
General		■ 20 D/A output channels with independent D/A converters ■ 4 external trigger input lines ■ ± 60 V overvoltage protection ■ 1 x 50-pin Sub-D connector
D/A channels (Analog Out 10)	Output voltage	■ ± 10 V
	Reference voltage	■ ± 2 V
	Output current	■ ±5 mA (min.) ■ ±10 mA (typ.)
	Resolution	■ 16 bit
	Settling time	■ 5 µs (typ.)
	Update rate	■ 0 … 500 kSPS
	Gain error	■ ±0.03% (typ.)
	Offset error	■ ±1 mV (typ.)
Trigger channel (Trigger In 2)	Input threshold voltage	■ 1 … 23 V
	Hysteresis	■ 200 mV (typ.)
Internal communication interface		■ IOCNET (up to 2.5 Gbit/s link speed)
Physical size		■ 238 x 100 x 19 mm (9.4 x 4 x 0.8 in) ■ Requires 1 slot
Typical power consumption		■ 7.5 W

Order Information

Product	Order Number
DS6241 D/A Board	■ DS6241
Adapter for two Sub-D 50 connectors to one Hypertac connector	■ HYPERTRONICS_CON90_FP1_QT

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk

Hardware	Product
Required	■ SCALEXIO Processing Unit or ■ DS6001 Processor Board
	■ SCALEXIO LabBox or ■ SCALEXIO AutoBox or ■ SCALEXIO rack system or ■ SCALEXIO customized rack system

DS6301 CAN/LIN Board

SCALEXIO I/O board for connecting simulators to CAN/CAN FD and LIN bus systems

Highlights

- For CAN, CAN FD, and LIN bus systems
- Low power modes and partial networking
- Software-configurable termination and CAN feedthrough mode

Application Areas

The DS6301 CAN/LIN Board is the interface between a dSPACE SCALEXIO system and CAN, CAN FD and LIN bus systems. It has eight channels, four of which are dedicated for CAN/CAN FD communication and the other four for LIN communication. All features and settings of this board can be configured with the dSPACE software ConfigurationDesk.

Key Benefits

With its support of CAN and LIN networks, the DS6301 is tailored to typical applications for automotive projects. With 8 channels per board, it offers a high channel density. Its integrated FPGA provides high flexibility and low I/O response times.

I/O Functionality

The DS6301 provides 4 CAN/CAN FD channels and 4 LIN channels.

The channels are defined and configured graphically with dSPACE ConfigurationDesk. This comprises functions such as termination and CAN feedthrough mode.

The DS6301 supports the standards typically used in automotive applications, such as high-speed CAN and CAN low power modes (Wake-up and Sleep).

Technical Details

Parameter		Specification
General		■ 8 bus channels in total ■ 4 CAN/CAN FD channels ■ 4 LIN channels ■ 1 x 50-pin Sub-D connector
CAN communication (CAN 2)		■ CAN/CAN FD (ISO 11898-1, ISO 11898-5, ISO 11898-6 , and non-ISO) ■ High-speed CAN (ISO 11898-2) ■ Fault-tolerant CAN (ISO 11898-3) ■ Overcurrent protection 100 mA
	High-speed CAN / CAN FD	■ NXP TJA1145T/FD high-speed CAN transceiver ■ Data phase baud rate for CAN: 40 kBd ... 1 MBd ■ Data phase baud rate for CAN FD: 40 kBd ... 8 MBd ■ Usable in SAE J2284-4 and SAE J2284-5 CAN networks ■ Use of customer-specific transceiver possible ■ Software-configurable termination: 560 Ω or 5.6 kΩ
	Fault-tolerant CAN	■ NXP TJA1055 fault-tolerant CAN ■ Data rate: 40 kBaud ... 125 kBaud ■ Software-configurable termination: 120 Ω
LIN communication (LIN 2)		■ Support of LIN standards (1.3, 2.0, 2.1, 2.2) ■ Overcurrent protection 20 mA ■ Infineon TLE 7257SJ ■ Data rate: 0 Bd ... 20 kBd ■ Software-configurable master termination: 1 kΩ
Internal communication interface		■ IOCNET
Physical size		■ 238 x 100 x 59 mm (9.4 x 3.9 x 2.3 in) ■ Requires 1 slot
Typical power consumption		■ 5 W

Order Information

Product	Order Number
DS6301 CAN/LIN Board	■ DS6301

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk
Optional	■ Bus Manager
	■ RTI CAN MultiMessage Blockset
	■ RTI LIN MultiMessage Blockset

Hardware	Product
Required	■ SCALEXIO Processing Unit or ■ DS6001 Processor Board
	■ SCALEXIO LabBox or ■ SCALEXIO AutoBox or ■ SCALEXIO rack system or ■ SCALEXIO customized rack system

DS6311 FlexRay Board

SCALEXIO I/O board for connecting simulators to FlexRay bus systems

Highlights

- Four fully featured FlexRay controllers
- Each controller provides an A and a B channel
- Wake-up on FlexRay support

Application Areas

The DS6311 is the interface between a SCALEXIO system and FlexRay bus systems. It provides four independent FlexRay controllers for RCP and HIL applications. The board supports FlexRay protocol specification 2.1 and offers downward compatibility to previous standards. It provides a software-configurable, switchable termination circuit.

Key Benefits

- 4 fully featured and independent FlexRay controllers
- Channel A and B of each controller can be used in parallel with other controllers
- All I/O functions are software-configurable via ConfigurationDesk, so there is no need for hardware changes.

Technical Details

Parameter	Specification
General	■ 4 fully featured and independent FlexRay controllers ■ Supports FlexRay protocol specification 2.1 ■ Channel A and B of each controller are independent of other controllers ■ Software-controlled termination resistor ■ Software-controlled feed-through mode ■ Overvoltage protection up to ± 60 V ■ Wake-up on FlexRay support ■ Supported data rates: 2.5 Mbit/s, 5 Mbit/s and 10 Mbit/s ■ 1 x 50-pin Sub-D connector
Internal communication interface	■ IOCNET
Physical size	■ 238 x 100 x 59 mm (9.4 x 3.9 x 2.3 in) ■ Requires 1 slot
Typical power consumption	■ 6 W

Order Information

Product	Order Number
DS6311 FlexRay Board	■ DS6311

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk ■ FlexRay Configuration Package

Hardware	Product
Required	■ SCALEXIO Processing Unit or ■ DS6001 Processor Board
	■ SCALEXIO LabBox or ■ SCALEXIO AutoBox or ■ SCALEXIO rack system or ■ SCALEXIO customized rack system

DS6321 UART Board

SCALEXIO I/O board for connecting simulators to external devices with serial interfaces

Highlights

- Support of RS232, RS422, RS485, and K-Line interfaces
- Software-configurable via ConfigurationDesk
- Four independent channels for individual configuration

Application Areas

With the DS6321 UART Board, you can connect a SCALEXIO system to ECUs or other external devices with serial interfaces. It provides four independent channels, each of which can be individually configured. The board is well suited for both RCP and HIL applications and can be configured directly from ConfigurationDesk.

Technical Details

Parameter		Specification
General		■ 4 independent serial communication channels, each with a 16550-compatible UART (universal asynchronous receiver/transmitter) ■ Supported protocols: RS232-C, RS422, RS485, K-Line ■ Each channel supports RTS/CTS ■ 50-pin Sub-D connector
Interrupts		■ RX-, TX-FIFO-empty-, LSR-, and MSR-interrupts
Baud rate range	RS232	■ Up to 1 Mbit/s
	RS422	■ Up to 10 Mbit/s
	RS485	■ Up to 10 Mbit/s
	K-Line	■ Up to 19.2 kbit/s
Parity bits		■ Even, odd, or no parity
Stop bits		■ 1, 1.5, or 2 bits
Word length		■ 5, 6, 7, or 8 bits
Internal communication interface		■ IOCNET
Physical size		■ 238 x 100 x 59 mm (9.4 x 3.9 x 2.3 in) ■ Requires 1 slot
Typical power consumption		■ 5 W

Order Information

Product	Order Number
DS6321 UART Board	■ DS6321

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk

Hardware	Product
Required	■ SCALEXIO Processing Unit or ■ DS6001 Processor Board
	■ SCALEXIO LabBox or ■ SCALEXIO AutoBox or ■ SCALEXIO rack system or ■ SCALEXIO customized rack system

SCALEXIO Ethernet Boards

Additional Ethernet ports for SCALEXIO systems

Highlights

- For general and automotive Ethernet use cases
- Ethernet interfaces from 10 Mbit/s up to 10 GBit/s
- Automotive Ethernet interfaces of 100/1,000 Mbit/s
- Integrated Ethernet switch

The SCALEXIO Ethernet boards provide additional Ethernet interfaces to the SCALEXIO Processing Unit, the SCALEXIO LabBox, or the SCALEXIO AutoBox. Boards that offer native BroadR-Reach support and an integrated Ethernet switch are available for both platforms, and they can be configured via modules. For less complex use cases, dSPACE offers boards that only support standard Ethernet and do not include an internal Ethernet switch. In addition to the Ethernet standard, SCALEXIO offers a wide range of boards for different bus systems and networks that work together seamlessly in one system.

Native 100/1000Base-T1 Support

Application Areas

The DS6333-PE/-CS Automotive Ethernet Board and the DS6335-CS Ethernet Board provide five additional Ethernet ports for a SCALEXIO system. Four of these ports can be configured for automotive or standard Ethernet communication, depending on the modules used. The fifth port always provides a standard Ethernet connection and is ideal for monitoring or for cascading two switches. The boards support applications such as ECU interfacing and simulator coupling, and enable you to configure a system as a simulation node in an Ethernet SOME/IP (scalable service-oriented middleware over IP) network. The cost-effective DS6335-CS is dedicated for use cases such as simulator coupling and ECU interfacing and does not include SOME/IP support.

Key Benefits

- 4 ports can be configured for standard Ethernet (10/100/1000 Mbit/s) and automotive Ethernet (100/1000 Mbit/s)
- 1 additional port (e.g., for data mirroring or cascading)
- Integrated managed Ethernet switch
- 4 Gigabit Ethernet controllers

BroadR-Reach, 100Base-T1, and 1000Base-T1

100Base-T1 is a 100 Mbit/s Ethernet interface developed for automotive use cases. It operates with one unshielded or shielded twisted pair of wires. 100Base-T1 is based on BroadR-Reach and has been standardized by the IEEE 802.3bw working group. The 1000Base-T1 standard is similar to 100Base-T1 but supports a data transfer of 1 Gbit/s over one twisted pair of wires.

Standard Ethernet Support up to 10 GBit/s

Application Areas

The DS6331-PE Ethernet Board and the DS6334-PE Ethernet Board provide four additional Ethernet ports for the SCALEXIO Processing Unit. They support applications which do not require automotive Ethernet connections or an Ethernet switch. The DS6335-CS is a cost-effective board for projects without a requirement for SOME/IP communication, such as bypassing and simulator coupling. If service-oriented communication (SOME/IP) has to be configured with the dSPACE Ethernet Configuration Package, the DS6331-PE is the right choice.

For use cases that require a higher bandwith, dSPACE provides the DS6336-PE and DS6336-CS Ethernet boards. These boards offer two ports with separate controllers. Each port can be used with the following data rates: 100 MBit/s, 1 GBit/s, 2.5 GBit/s, 5 GBit/s, and 10 GBit/s. These data rates enable you to use ECUs with multi-gigabit interfaces by means of a media converter.

Key Benefits

- Optimized boards tailored for different applications
- 2 to 4 ports providing data rates from 10 MBit/s to 10 GBit/s standard Ethernet
- No switch, enabling fast and direct Ethernet traffic

Technical Details

	DS6331-PE Ethernet Board	DS6333-PE Automotive Ethernet Board	DS6333-CS Automotive Ethernet Board	DS6334-PE Ethernet Board
Automotive Ethernet Ports (100/1000 Mbit/s)	–	5 in total (4 configurable ports, 1 standard Ethernet)	5 in total (4 configurable ports, 1 standard Ethernet)	–
Standard Ethernet Ports (10/100/1000 Mbit/s)	4			4
Standard Ethernet Ports (100 Mbit/s - 10 GBit/s)	–	–	–	–
Ethernet switch	–	✓	✓	–
Controllers	4	4	4	4
Use cases				
ECU interfacing	✓	✓	✓	✓
Simulator coupling	✓	✓	✓	✓
Custom protocols	✓	✓	✓	✓
ECU communication with SOME/IP	✓	✓	✓	–
Ethernet analysis and monitoring	✓	✓	✓	✓
Platform				
SCALEXIO Processing Unit	✓	✓	–	✓
SCALEXIO LabBox	–	–	✓	–
SCALEXIO AutoBox	–	–	✓	–

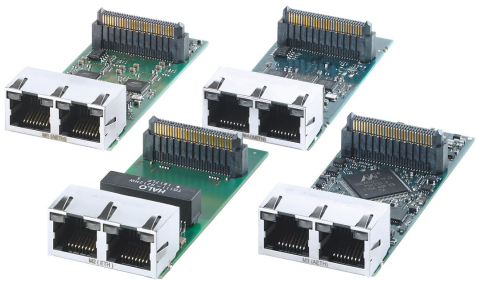
Technical Details

	DS6335-CS Ethernet Board	DS6336-PE Ethernet Board	DS6336-CS Ethernet Board
Automotive Ethernet Ports (100/1000 Mbit/s)	5 in total (4 configurable ports, 1 standard Ethernet)	–	–
Standard Ethernet Ports (10/100/1000 Mbit/s)		–	–
Standard Ethernet Ports (100 Mbit/s - 10 GBit/s)	–	2	2
Ethernet switch	✓	–	–
Controllers	4	2	2
Use cases			
ECU interfacing	✓	✓	✓
Simulator coupling	✓	✓	✓
Custom protocols	✓	✓	✓
ECU communication with SOME/IP	–	✓	✓
Ethernet analysis and monitoring	✓	✓	✓
Platform			
SCALEXIO Processing Unit	–	✓	–
SCALEXIO LabBox / SCALEXIO AutoBox	✓	–	✓

Extensions for Ethernet Boards

The dSPACE SCALEXIO Ethernet boards can be divided into two groups: fixed Ethernet boards with a defined set of features and modular Ethernet boards that can be extended by adding one or more modules.

- Fixed Ethernet boards: DS6331-PE Ethernet Board, DS6334-PE Ethernet Board, DS6336-CS Ethernet Board, and DS6336-PE Ethernet Board
- Modular Ethernet boards: DS6333-CS Automotive Ethernet Board, DS6333-PE Automotive Ethernet Board, and DS6335-CS Ethernet Board



A range of modules is available for the modular Ethernet boards. Each module provides two channels:

- DS6330M1 Automotive Ethernet Module for automotive Ethernet (100BASE-T1 and 1000BASE-T1)
- DS6330M2 Ethernet Module for different standard Ethernet speed rates from 10 to 1000 Mbit/s
- DS6330M3 Automotive Ethernet Module for 10 MBit/s automotive Ethernet (10BASE-T1S)
- DS6330M4 Automotive Ethernet Module for automotive Ethernet (100BASE-T1 and 1000BASE-T1) with hardware MACsec support

Order Information

Product	Order Number
DS6331-PE Ethernet Board	■ DS6331_PE
DS6333-PE Automotive Ethernet Board	■ DS6333_PE
DS6333-CS Automotive Ethernet Board	■ DS6333_CS
DS6334-PE Ethernet Board	■ DS6334_PE
DS6335-CS Ethernet Board	■ DS6335_CS
DS6336-PE Ethernet Board[1)]	■ DS6336_PE
DS6336-CS Ethernet Board[1)]	■ DS6336_CS

[1)] *The board can only be used in combination with the new basic operating system based on Linux(R) introduced with Release 2020-B or with the Hypervisor Extension.*

Relevant Software and Hardware

Software	Product	
Required	For ■ DS6331-PE Ethernet Board ■ DS6333-PE/CS Automotive Ethernet Board ■ DS6334-PE Ethernet Board ■ DS6335-CS Ethernet Board ■ DS6336-PE/CS Ethernet Board	■ ConfigurationDesk
Optional	For ■ DS6331-PE Ethernet Board ■ DS6333-PE/CS Automotive Ethernet Board ■ DS6336-PE/CS Ethernet Board[2)]	■ ConfigurationDesk UDP/TCP Function ■ dSPACE Ethernet Configuration Package ■ ECU Interface Manager
	For ■ DS6334-PE Ethernet Board ■ DS6335-CS Ethernet Board	■ ConfigurationDesk UDP/TCP Function ■ ECU Interface Manager

Hardware	Product	
Required	For ■ DS6331-PE Ethernet Board ■ DS6333-PE Automotive Ethernet Board ■ DS6334-PE Ethernet Board ■ DS6336-PE Ethernet Board	■ SCALEXIO Processing Unit
		■ SCALEXIO rack system or ■ SCALEXIO customized rack system
	For ■ DS6333-CS Automotive Ethernet Board ■ DS6335-CS Ethernet Board ■ DS6336-CS Ethernet Board	■ DS6001 Processor Board
		■ SCALEXIO LabBox or ■ SCALEXIO AutoBox
	For ■ DS6333-CS Automotive Ethernet Board ■ DS6333-PE Automotive Ethernet Board ■ DS6335-CS Ethernet Board	■ DS6330M1 Automotive Ethernet Module[3)] and/or ■ DS6330M2 Ethernet Module[3)]

[2)] *The support by dSPACE Ethernet Configuration Package is planned for the future.*
[3)] *Two modules have to be installed.*

DS6341 CAN Board

SCALEXIO I/O board for connecting simulators to CAN bus systems

Highlights

- Four independent CAN/CAN FD channels
- Wake-up and sleep support
- Software-configurable termination

Application Areas

The DS6341 CAN Board is the interface between a SCALEXIO system and CAN/CAN FD bus systems. It provides four channels for RCP and HIL applications. Network management functions such as wake-up and sleep are also included as a software-configurable, switchable termination circuit.

Key Benefits

- Independent and fully featured CAN/CAN FD channels that can be used for all kinds of application and topologies
- All I/O functions are software-configurable via ConfigurationDesk, so no hardware changes are necessary.

Technical Details

Parameter	Specification
General	■ 4 independent CAN/CAN FD channels ■ CAN low power modes ISO 11898-5 (wake-up and sleep) ■ CAN partial networking ISO 11898-6 ■ Support of J1939 ■ Software-switchable CAN feed-through mode ■ CAN/CAN FD (ISO 11898-1, ISO 11898-5, ISO 11898-6, and non-ISO) ■ High-speed CAN (ISO 11898-2) ■ Fault-tolerant CAN (ISO 11898-3) ■ 1 x 50-pin Sub-D connector
CAN communication (CAN 2)	■ NXP TJA1145T/FD high-speed CAN transceiver ■ Data phase baud rate for CAN: 40 kBd ... 1 MBd ■ Data phase baud rate for CAN FD: 40 kBd ... 8 MBd ■ Usable in SAE J2284-4 and SAE J2284-5 CAN networks ■ Use of customer-specific transceiver possible ■ Software-configurable termination: 560 Ω or 5.6 kΩ
	■ NXP TJA1055 fault-tolerant CAN: Data rate: 40 kBaud ... 125 kBaud ■ Software-configurable termination: 120 Ω
Internal communication interface	■ IOCNET
Physical size	■ 238 x 100 x 59 mm (9.4 x 3.9 x 2.3 in) ■ Requires 1 slot
Typical power consumption	■ 5 W

Order Information

Product	Order Number
DS6341 CAN Board	■ DS6341

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk
Optional	■ Bus Manager
	■ RTI CAN MultiMessage Blockset

Hardware	Product
Required	■ SCALEXIO Processing Unit or ■ DS6001 Processor Board
	■ SCALEXIO LabBox or ■ SCALEXIO AutoBox or ■ SCALEXIO rack system or ■ SCALEXIO customized rack system

DS6342 CAN Board

SCALEXIO I/O board with high channel density for CAN bus systems

Highlights

- Eight independent CAN/CAN FD channels
- Ideal for compact systems with a limited number of slots
- Software-configurable termination

Application Areas

The DS6342 CAN Board is the interface between a SCALEXIO system and CAN/CAN FD bus systems. It provides eight channels for development and test applications, which makes it ideal for compact test systems with a limited number of available slots, such as the SCALEXIO AutoBox or the eight-slot SCALEXIO LabBox. Network management functions such as wake-up and sleep are also included as a software-configurable, CAN feed-through, and termination circuit.

Key Benefits

- Independent and fully featured CAN/CAN FD channels that can be used for all kinds of application and topologies
- Supports CAN FD with up to eight mega baud data phase

Technical Details

Parameter	Specification
General	■ 8 independent CAN/CAN FD channels ■ Support of CAN low power modes compliant with ISO 11898-5 (wake-up and sleep) ■ Support of CAN partial networking compliant with ISO 11898-6 ■ Support of J1939 ■ Support of software-switchable CAN feed-through mode ■ CAN/CAN FD (ISO 11898-1, ISO 11898-5, and ISO 11898-6) ■ High-speed CAN (ISO 11898-2) ■ Fault-tolerant CAN (ISO 11898-3)
CAN / CAN FD	■ NXP TJA1145T/FD high-speed CAN transceiver ■ Data phase baud rate for CAN: 40 kBd ... 1 MBd ■ Data phase baud rate for CAN FD: 40 kBd ... 8 MBd ■ Use of customer-specific transceiver possible ■ NXP TJA1055 fault-tolerant CAN ■ Data rate 40 kBaud ... 125 kBaud
Internal communication interface	■ IOCNET
Physical size	■ 238 x 100 x 59 mm (9.4 x 3.9 x 2.3 in) ■ Requires 1 slot
Typical power consumption	■ 5 W

Order Information

Product	Order Number
DS6342 CAN Board	■ DS6342

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk
Optional	■ Bus Manager
	■ RTI CAN MultiMessage Blockset

Hardware	Product
Required	■ SCALEXIO Processing Unit or ■ DS6001 Processor Board
	■ SCALEXIO LabBox or ■ SCALEXIO AutoBox or ■ SCALEXIO rack system or ■ SCALEXIO customized rack system

DS6351 LIN Board

SCALEXIO I/O board for connecting simulators to LIN bus systems

Highlights

- Eight LIN channels with LIN master and slave support
- All channels are independent
- Software-configurable termination

Application Areas

The DS6351 LIN Board is the interface between a SCALEXIO system and LIN bus systems. It provides eight channels for RCP and HIL applications. Depending on the use case, the LIN master or slave functionality can be simulated.

Key Benefits

- High channel density with eight channels on each board resulting in a low price per LIN channel
- Independent and fully featured LIN channels that can be used for all kinds of application and topologies
- All of the I/O functions are software-configurable via ConfigurationDesk, so no hardware changes are necessary.

Technical Details

Parameter	Specification
General	■ 8 LIN channels ■ All channels are independent ■ Software-configurable master termination: 1 kΩ ■ 1 x 50-pin Sub-D connector
LIN communication (LIN 2)	■ Infineon TLE 7257SJ ■ Data rate: 1000 Bd ... 20 kBd
Internal communication interface	■ IOCNET
Physical size	■ 238 x 100 x 59 mm (9.4 x 3.9 x 2.3 in) ■ Requires 1 slot
Typical power consumption	■ 5 W

Order Information

Product	Order Number
DS6351 LIN Board	■ DS6351

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk
Optional	■ Bus Manager
	■ RTI LIN MultiMessage Blockset

Hardware	Product
Required	■ SCALEXIO Processing Unit or ■ DS6001 Processor Board
	■ SCALEXIO LabBox or ■ SCALEXIO AutoBox or ■ SCALEXIO rack system or ■ SCALEXIO customized rack system

DS2601 Signal Measurement Board[1)]

HighFlex board for measuring ECU output signals

Highlights

- Current and voltage measurement
- Channel bundling to increase current carrying capacity
- Configurable fuses
- Onboard failure routing unit
- Onboard loads or external loads via second connector
- Galvanically isolated channels

Application Areas

The DS2601 Signal Measurement Board measures ECU output signals and passes the measurement values to the real-time processor. Signal measurement can be time-triggered or event-triggered, and the execution of signal measurement can be voltage- or current-triggered.

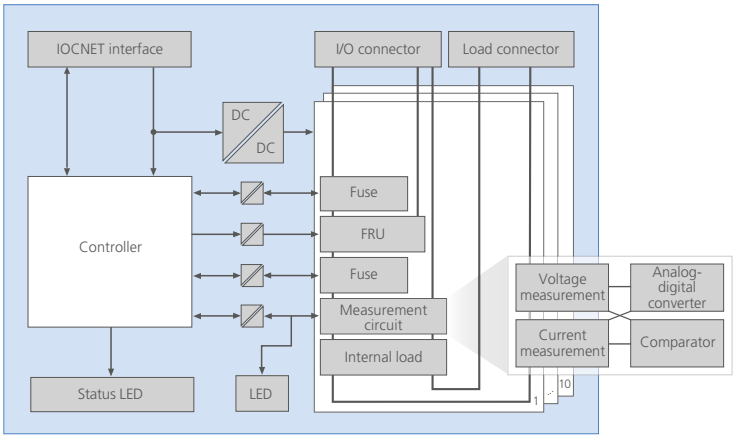
Key Benefits

The DS2601 offers 10 versatile, software-configurable channels that can be used as analog or digital input for measuring voltage and current. The channels can be connected in parallel to increase the current-carrying capacity up to 80 A (RMS).

The board also includes an onboard failure routing unit.

I/O Functionality

The DS2601's input channels can connect analog as well as digital measurement units (analog-digital converters or comparators, respectively) to measure the current and voltage. For example, the measurement units can be combined to trigger analog current measurement if a specified voltage is exceeded. The channels are defined and configured in the ConfigurationDesk software. The 10 channels on the DS2601 can be connected in parallel. This channel bundling increases the current-carrying capacity up to 80 A (RMS). ConfigurationDesk displays the bundled channels as one single I/O function. The DS2601 supports the use of loads for the ECU. You can either plug substitute loads onto the board itself or connect real loads via a cable harness to the externally accessible load connector.



[1)] *Devices connected to the dSPACE HIL system, for example, electronic control units, can feed in high currents and high voltages (voltages over 60 V DC or 30 V ACRMS), which can be dangerous for the user. This can happen, for example, in systems for piezoelectric or hybrid applications. Such currents and voltages can result in property damage, personal injury, or death. Under all circumstances, you must observe all the safety precautions described in the documentation. Please contact dSPACE for additional safety-related equipment, such as electrically safe interface cables.*

Technical Details

Parameter		Specification
General		■ 10 galvanically isolated channels for signal measurement ■ Load connections for plugging loads of up to 2 W on the board ■ External load connection (for real loads or substitute loads > 2 W) ■ Up to 10 channels connected in parallel to increase the continuous current to max. 80 A ■ Status LED for overall board status ■ 10 channel-specific LEDs to indicate channel voltage
Electrical capacity		■ Voltage ±60 V per channel ■ Continuous current ±10 A per channel ■ Maximum continuous current of 80 A when all 10 channels bundled
Signal measurement (Flexible In 1)		■ Adjustable digital filtering for analog measurements ■ Current/voltage measurement: Sampling rate up to 250 kHz
	Voltage measurement	■ Voltage measurement ±60 V per channel ■ Voltage, analog and digital (settable trigger value) ■ ADC resolution 16 bit
	Current measurement	■ Current measurement ±30 A per channel ■ Current measurement, analog and digital (settable trigger value) ■ ADC resolution 16 bit
	Trigger	■ Time-, angle- and event-driven signal measurement ■ Voltage-driven current measurement ■ Control from within the model
Fault simulation		■ Onboard failure routing unit (FRU) ■ Signal forwarding to central FIU ■ Relay-based ■ Available for each channel
Electronic fuses		■ Software-configurable and software-resettable ■ Fuse trip settable 0.5 ... 10 A_{eff}
Internal communication interface		■ IOCNET
Physical size		■ 410 x 100 x 41 mm (16.1 x 4.2 x 1.6 in) ■ Requires 2 slots
Typical power consumption		■ 24 W

Order Information

Product	Order Number
DS2601 Signal Measurement Board	■ DS2601

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk
Optional	■ SCALEXIO fault simulation

Hardware	Product
Required	■ SCALEXIO Processing Unit
	■ SCALEXIO rack system or ■ SCALEXIO customized rack system

DS2621 Signal Generation Board[1)]

HighFlex I/O board for simulating ECU input signals

Highlights

- Signal generation for simulating voltage, current, resistance and switches
- Channel bundling to increase output voltage
- Onboard failure routing unit
- Galvanically isolated channels

Application Areas

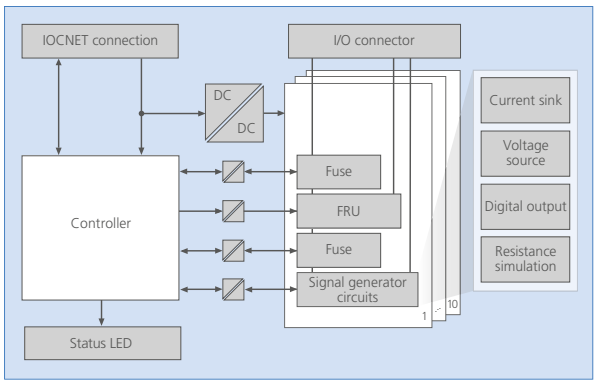
The DS2621 Signal Generation Board stimulates ECU inputs. It mimics sensors or switches such as door contact switches, Hall sensors, and sensors for wheel speed and oil temperature. Each of the DS2621's 10 channels can be software-configured as a voltage source, a current sink, a digital output simulation or a resistance simulation.

Key Benefits

The DS2621 offers 10 versatile, software-configurable output channels that can be connected in parallel or in series to increase the current or voltage range. The board also includes an onboard failure routing unit.

I/O Functionality

The DS2621 has 10 flexibly configurable output channels to make analog and digital signal generators available. To increase the current or voltage range, up to 10 channels can be bundled in parallel or in series. For example, two voltage sources can be switched in sequence, or two current sinks in parallel, to increase the output voltage or current. The digital output can be used as a switch and can generate time- and frequency-dependent signals (such as PWM). For example, the resistance simulation can be used to pass the specified temperature changes to an ECU via the environment model. Channel bundling is supported by the software. ConfigurationDesk displays the bundled channels as one single I/O function.



[1)] *Devices connected to the dSPACE HIL system, for example, electronic control units, can feed in high currents and high voltages (voltages over 60 V DC or 30 V ACRMS), which can be dangerous for the user. This can happen, for example, in systems for piezoelectric or hybrid applications. Such currents and voltages can result in property damage, personal injury, or death. Under all circumstances, you must observe all the safety precautions described in the documentation. Please contact dSPACE for additional safety-related equipment, such as electrically safe interface cables.*

Technical Details

Parameter		Specification
General		■ 10 galvanically isolated channels ■ Up to 10 channels can be connected in sequence or in parallel to increase the current range to max. ±320 mA and the voltage range to max. ±60 V ■ Status LED for overall board status
Signal generation (Flexible Out 1)	Voltage source	■ Output voltage ±20 V ■ Output current ±40 mA ■ DAC resolution 16 bit ■ Signal frequency 0 … 140 kHz (sine)
	Current sink	■ Voltage range ±60 V ■ Current range ±40 mA ■ DAC resolution 15 bit ■ Signal frequency 0 ... 140 kHz (sine)
	Resistance simulation	■ Resistance range 17.5 Ω ... 1 MΩ ■ Voltage range ±20 V ■ Current range ±40 mA
	Digital output	■ Voltage range ±60 V ■ Current range ±40 mA ■ Signal frequency 0 ... 1 MHz
Fault simulation		■ Onboard failure routing unit (FRU) ■ Signal forwarding to central FIU ■ Relay-based ■ Available for each channel
Electronic fuses		■ 100 mA RMS ECU (effective value) ■ On ECU side tripping at I = 100 mA ■ On sensor side with configurable trip range I = 5 ... 40 mA
Internal communication interface		■ IOCNET
Physical size		■ 410 x 100 x 15 mm (16.1 x 3.9 x 0.6 in) ■ Requires 1 slot
Typical power consumption		■ 31.2 W

Order Information

Product	Order Number
DS2621 Signal Generation Board	■ DS2621

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk
Optional	■ SCALEXIO fault simulation

Hardware	Product
Required	■ SCALEXIO Processing Unit ■ SCALEXIO rack system or ■ SCALEXIO customized rack system

DS2642 FIU & Power Switch Board[1)]

HighFlex board for power-switching with Failure Insertion Unit

Highlights

- Central FIU
- Switched battery voltage
- Fault feedforward
- High-precision current measurement on each channel

Application Areas

The DS2642 FIU & Power Switch Board combines two components:

- Central Failure Insertion Unit (FIU) for simulating faults for the I/O channels of the SCALEXIO HighFlex boards and MultiCompact units
- Power switches for simulating up to 10 switched potentials, for example, on terminal K15

Key Benefits

The DS2642 offers 10 switchable software-configurable channels, that can be bundled for increasing the current possible.

Central FIU

The central FIU on the DS2642 is connected to the failure routing units of the I/O boards via the failrails. It switches the faults for the channels on the boards.

The following options are available:

- Broken wires on each individual channel, with or without bouncing as selected
- Crossed wire between two channels, with or without bouncing
- Short circuit to a fixed potential such as the supply voltage, with or without bouncing

The faults are prepared on the I/O boards by relays, and failure insertion is performed by semiconductor switches on the central FIU. The result is a fast switching frequency that enables loose contacts to be simulated.

Power Switch

The power switch provides 10 switchable channels, which supply current to the external devices such as ECUs and loads. The current can be measured simultaneously. The central FIU can also use the power switch channels to simulate short circuits to the supply to the ECU. The channels can be bundled to increase the current, and are selected in ConfigurationDesk. Several DS2642s can be used in one SCALEXIO system.

Current Measurement

The power consumption of the connected components can be measured precisely on each power switch channel.

[1)] *Devices connected to the dSPACE HIL system, for example, electronic control units, can feed in high currents and high voltages (voltages over 60 V DC or 30 V ACRMS), which can be dangerous for the user. This can happen, for example, in systems for piezoelectric or hybrid applications. Such currents and voltages can result in property damage, personal injury, or death. Under all circumstances, you must observe all the safety precautions described in the documentation. Please contact dSPACE for additional safety-related equipment, such as electrically safe interface cables.*

Technical Details

Parameter		Specification
Power switches (Power Switch 1)	General	■ 10 channels for the ECU's current supply ■ Voltage 60 V ■ Continuous current 10 A per channel ■ Channel parallelization to increase the measurement range to max. 80 A (RMS) ■ Status LED for overall board status ■ 10 channel-specific LEDs for channel status (power switch open/closed)

	Current measurement	■ Current measurement on each channel
		■ Precision mode
		  ■ Resolution 6.25 µA
		  ■ Sampling time 135 ms
		  ■ Measurement range 0 ... 1.6 A
		■ Dynamic mode
		  ■ Resolution 150 µA
		  ■ Sampling time 262 µs
		  ■ Measurement range 0 A ... 39 A

	Electronic fuses	■ 10 A RMS ECU (effective value) ■ Software-configurable and software-resettable
Failure Insertion Unit	General	■ Voltage ±60 V ■ Fault switch for up to 80 A ■ Continuous current for high-current failrail 80 A ■ Continuous current failrail with low capacitance 1 A ■ Status LED for the FIU component
	Fault types	■ Broken wire ■ Short circuit to GND or U_{Bat} ■ Crossed wire between two channels ■ All faults with optional bouncing
Internal communication interface		■ IOCNET
Physical size		■ 410 x 100 x 41 mm (16.1 x 3.9 x 1.6 in) ■ Requires 2 slots
Typical power consumption		■ 19.2 W

Order Information

Product	Order Number
DS2642 FIU & Power Switch Board	■ DS2642

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk
Optional	■ SCALEXIO fault simulation

Hardware	Product
Required	■ SCALEXIO Processing Unit
	■ SCALEXIO rack system or ■ SCALEXIO customized rack system

DS2671 Bus Board[1)]

HighFlex board for connecting to different bus systems

Highlights

- Supports CAN, CAN FD, LIN, and FlexRay bus systems
- 4 flexibly configurable channels
- Onboard failure routing unit

Application Areas

The DS2671 Bus Board is the interface between a SCALEXIO system and various bus systems. It has 4 multifunctional channels, each of which can support a bus system that is assigned to it by software.

Key Benefits

The DS2671 offers 4 software-configurable channels that can be used flexibly for different bus systems. If additional bus systems and protocols are needed, they can be added on request.

I/O Functionality

Each channel on the DS2671 has the circuit parts for supporting various bus systems, comprising an FPGA for the core and assorted transceivers. The bus system controllers, which include certified IP cores such as the Bosch E-Ray controller for FlexRay, are implemented on the bus FPGA. To use a bus system or protocol that is not yet standardly supported, you can install the necessary transceiver in the channel's piggyback slot.

The following buses and protocols are supported:

- FlexRay
- CAN (high-speed & fault-tolerant)
- CAN FD (ISO and non-ISO)
- LIN/K-Line
- RS232, RS422, RS485
- TTL-based protocols

A different bus system can be used on each of the 4 channels on the DS2671.

[1)] *Devices connected to the dSPACE HIL system, for example, electronic control units, can feed in high currents and high voltages (voltages over 60 V DC or 30 V ACRMS), which can be dangerous for the user. This can happen, for example, in systems for piezoelectric or hybrid applications. Such currents and voltages can result in property damage, personal injury, or death. Under all circumstances, you must observe all the safety precautions described in the documentation. Please contact dSPACE for additional safety-related equipment, such as electrically safe interface cables.*

Technical Details

Parameter	Specification
General	■ 4 independent bus channels ■ Overvoltage and undervoltage protection for transceivers ■ Parallel termination resistors with overcurrent protection ■ Status LED for overall board status ■ Channel-specific LEDs for individual bus channels (inactive, ready for data transfer, data transfer running, error message) ■ One piggyback module slot per channel for a customer-specific transceiver
Fault simulation	■ Onboard failure routing unit (FRU) ■ Relay based ■ Available for each channel
Supported protocols/bus systems	■ FlexRay 2.1 (based on Bosch E-Ray) ■ High-speed CAN (ISO 11898-2), incl. CAN FD (ISO and non-ISO) ■ Fault-tolerant CAN (ISO 11898-3) ■ Usable in SAE J2284-4 and SAE J2284-5 CAN networks ■ LIN 2.0/K-Line (ISO 9141) ■ RS232, RS422 and RS485 ■ TTL driver
Internal communication interface	■ IOCNET
Physical size	■ 410 x 100 x 15 mm (16.1 x 3.9 x 0.6 in) ■ Requires 1 slot
Typical power consumption	■ 24 W

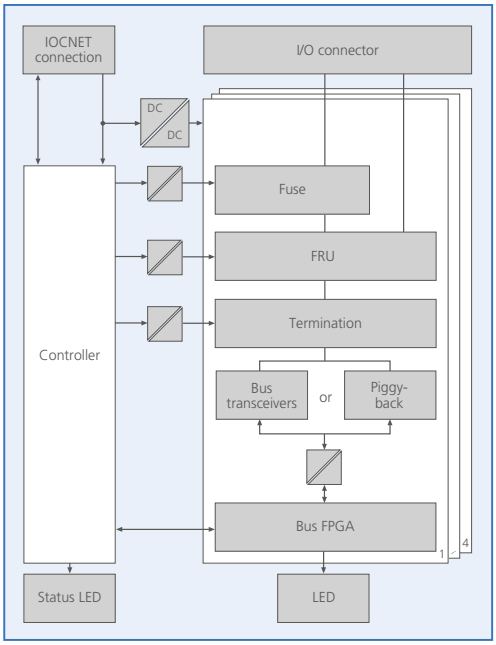
Order Information

Product	Order Number
DS2671 Bus Board	■ DS2671

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk
Optional	■ RTI CAN MultiMessage Blockset
	■ RTI LIN MultiMessage Blockset
	■ dSPACE FlexRay Configuration Package
	■ Bus Manager
	■ SCALEXIO fault simulation

Hardware	Product
Required	■ SCALEXIO Processing Unit
	■ SCALEXIO rack system or ■ SCALEXIO customized rack system



DS2680 I/O Unit[1)]

MultiCompact I/O unit for powertrain and vehicle dynamics scenarios

Highlights

- 140 channels for extensive I/O functions
- Compact half 19" unit
- Provides all basic functionalities for HIL tests
- Attractive price

Application Areas

The DS2680 I/O Unit is a MultiCompact I/O unit for the SCALEXIO system that provides all the I/O channels required for the hardware-in-the-loop simulation, e.g., of transmission or vehicle dynamics ECUs. Most of the I/O channels have a fixed function, i.e., they are dedicated analog or digital channels.

Key Benefits

Despite the compact design, the DS2680 offers a high number of predefined channels that include FIU functionalities. The described features in combination with the unit's attractive price, makes the DS2680 the ideal tool for specific application scenarios.

Testing Electrical Faults

The DS2680 includes a Failure Insertion Unit (FIU) for testing ECU behavior in the event of a fault. It can be used as a central FIU for the SCALEXIO system. Each channel has a failure routing unit (FRU) for switching the connection to the FIU via the failrails.

Real Loads

Substitute loads can be plugged onto the DS2680 internally if required. An exchangeable load board is available for you to mount different plug-on loads. Real loads or large substitute loads can be connected externally via the load connector provided for them.

Component Variants

The DS2680 is available with and without an integrated bus board. The integrated bus board provides two channels for each of the bus protocols LIN, CAN and FlexRay. If you need more or different bus channels, for example, four CAN channels, you can use a HighFlex bus board in addition or as an alternative.

[1)] *Devices connected to the dSPACE HIL system, for example, electronic control units, can feed in high currents and high voltages (voltages over 60 V DC or 30 V ACRMS), which can be dangerous for the user. This can happen, for example, in systems for piezoelectric or hybrid applications. Such currents and voltages can result in property damage, personal injury, or death. Under all circumstances, you must observe all the safety precautions described in the documentation. Please contact dSPACE for additional safety-related equipment, such as electrically safe interface cables.*

I/O Functionality

The DS2680 provides 38 I/O functions that are supported by different I/O channels. Please see page 11 for the mapping between I/O functions and I/O channels.

The channels are defined and configured graphically with dSPACE ConfigurationDesk.

Analog In

- Voltage In
- Voltage Signal Capture
- Current In
- Triggered Current In
- Current Signal Capture

Analog Out

- Voltage Out
- Current Sink
- Wavetable Voltage Out
- Wavetable Current Sink
- Waveform Voltage Out
- Waveform Current Sink
- Angular Wavetable Voltage Out

Digital In

- Multi Bit In
- Trigger In
- PWM/PFM In
- Digital Pulse Capture
- SENT In

Digital Out

- Multi Bit Out
- PWM/PFM Out
- Digital Pulse Out
- Wavetable Digital Out
- Waveform Digital out
- Angular Wavetable Digital Out
- SENT Out

Engine Simulation

- Injection/Ignition Voltage In
- Injection/Ignition Current In
- Crank/Cam Voltage Out
- Crank/Cam Current Sink
- Crank/Cam Digital Out
- Knock Signal Out
- Lambda DCR
- Lambda NCCR

Resistor Simulation

- Resistance Out
- Potentiometer Out

Further Sensor Simulation

- Digital Incremental Encoder Out
- Wheelspeed Out

Technical Details

Parameters		Specification
Signal measurement		■ Max. 6 A per channel ■ Substitute loads pluggable, up to 2 W per measurement channel ■ Connector for real loads ■ Channel bundling to increase current carrying capacity ■ Multifuse for electrical safety
	■ 20 analog inputs (Analog In 1)	■ Only voltage measurement ■ Measurement range 0 ... 60 V ■ Resolution 16 bit
	■ 30 digital inputs (Digital In 1)	■ Voltage measurement ■ Trigger value 0 ... 24 V ■ Voltage range 0 ... 60 V

	■ 18 variable inputs (Flexible In 2)	■ Voltage measurement digital
		  ■ Voltage range 0 ... 60 V
		  ■ Trigger value 0 ... 24 V
		■ Current measurement analog and digital
		  ■ Measurement range ±18 A
		  ■ Resolution 16 bit (analog)

Signal generation	■ 15 analog outputs (DC) (Analog Out 1)	■ Only voltage generation ■ Output voltage 0 ... 10 V ■ Output current -5 ... +5 mA ■ Resolution 14 bit
	■ 8 analog outputs (DC) (Analog Out 4)	■ Output voltage 0 ... 10 V ■ Output current -5 ... +5 mA ■ Resolution 14 bit ■ Current sink: Current range -30 ... +30 mA
	■ 7 analog outputs (AC) (Analog Out 3)	■ Only voltage generation ■ Output voltage -20 ... +20 V ■ Resolution 14 bit ■ Effective inner resistance 250 Ω
	■ 12 resistance simulation channels (Resistance Out 1)	■ Resistance range 16 Ω ... 1 MΩ ■ Voltage range -3 ... +18 V to GND ■ Current range -80 ... +80 mA ■ Power max. 250 mW
	■ 28 digital outputs (Digital Out 1)	■ Configurable as low-side/high-side switch or push/pull ■ Low-side = GND ■ High-Side = V_{BAT} or Dig-Out-Ref ■ High-side voltage range: 5 ... 60 V ■ Current range -80 ... +80 mA
Special I/O channels	■ 2 analog input and output groups, e.g., for lambda probe simulation (Analog In 2, Analog Out 2, Load 1)	■ 1 ADC ■ 1 DAC ■ 1 load (component channel) ■ Voltage range -10 ... +10 V ■ Current range -5 ... +5 mA
Voltage supply	■ 1 channel to control the power unit (Power Control 1)	■ Control of TDK-Lambda Genesys™ power supply
	■ 6 power switches without current measurement (Power Switch 2)	■ Up to 60 V ■ Continuous current 4 x 6 A per channel (but a maximum total of 50 A for all channels)

Parameters		Specification
Buses[1]	■ 2 CAN (CAN 1)	■ CAN/CAN FD (ISO 11898-1, ISO 11898-5, ISO 11898-6, and non-ISO) ■ High-speed CAN (ISO 11898-2) ■ Fault-tolerant CAN (ISO 11898-3) ■ J1939 ■ Software-switchable bus termination ■ Conventional CAN VBAT
	■ 2 LIN (LIN 1)	■ Configurable as K-Line ■ Conventional LIN V_{BAT} ■ Software-switchable bus termination
	■ 2 FlexRay (FlexRay 1)	■ Only 4 bus lines, i.e., 1 fault-tolerant FlexRay bus (channels A + B) or 2 FlexRay buses (channel A) ■ Conventional FlexRay V_{BAT}
Failure Insertion Unit	General	■ Voltage ±60 V ■ Fault switch for up to 48 A ■ Continuous current for high-current failrail 48 A ■ Continuous current failrail with low capacitance 1 A
	Fault types	■ Broken wire ■ Short circuit to GND or U_{BAT} ■ Crossed wire between two channels ■ All faults with optional bouncing
Internal communication interface		■ IOCNET
Physical size		■ 475 x 215 x 132 mm (18.7 x 8.5 x 5.2 in)
Typical power consumption		■ 84 W including buses ■ 60 W without buses

[1] *Only for DS2680 with bus support.*

Order Information

Product		Order Number
DS2680 I/O Unit (without bus support)		■ DS2680_ONLY
DS2680 I/O Unit (with bus support)		■ DS2680_2672
Additional hardware	DS2680-IL Load Board (exchangeable load board)	■ DS2680_IL
	OBD to Sub-D Adapter Cable	■ SCLX_OBD_CAB1

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk
Optional	■ SCALEXIO fault simulation
Optional for DS2680 I/O Unit with bus support	■ RTI CAN MultiMessage Blockset
	■ RTI LIN MultiMessage Blockset
	■ dSPACE FlexRay Configuration Package
	■ Bus Manager

Hardware	Product
Required	■ SCALEXIO Processing Unit
	■ SCALEXIO rack system or ■ SCALEXIO customized rack system

DS2690 Digital I/O Board[1)]

MultiCompact I/O board for vehicle body scenarios

Highlights

- Large number of digital I/O channels
- Signal measurement or generation
- Connection of real loads
- Seamless integration into SCALEXIO FIU concept
- Attractive price

Application Areas

The DS2690 Digital I/O Board is the tailored SCALEXIO solution for hardware-in-the-loop (HIL) simulation of body electronics ECUs. Vehicle body applications such as electric window lift and windscreen wipers require many high-current digital I/O channels, as well as the ability to simulate faults. An onboard failure routing unit (FRU) enables fault simulation on all channels.

Key Benefits

The DS2690 offers a large number of dedicated digital I/O channels for signal generation and measurement. Their supported I/O functionalities cover exactly the ones needed for body electronic ECUs. Real loads can be connected to each channel individually. An onboard failure routing unit (FRU) enables fault simulation on all channels.

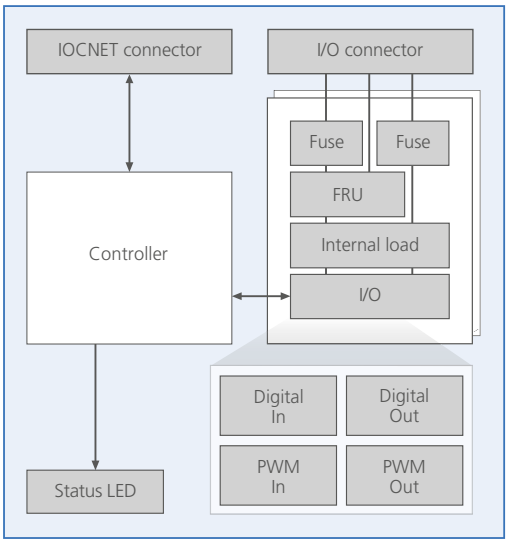
I/O Functionality

The DS2690 offers digital channels that are either predefined for signal measurement or signal generation, or can be individually configured. Channels for signal measurement and generation are usable as Digital In, PWM In or Digital Out, PWM Out.

The signal types and channel bundling are configured with ConfigurationDesk.

Real Loads for Real Currents

Testing ECUs under realistic circumstances sometimes requires real currents, so real loads can be connected externally. Substitute loads are available internally as well.



[1)] *Devices connected to the dSPACE HIL system, for example, electronic control units, can feed in high currents and high voltages (voltages over 60 V DC or 30 V ACRMS), which can be dangerous for the user. This can happen, for example, in systems for piezoelectric or hybrid applications. Such currents and voltages can result in property damage, personal injury, or death. Under all circumstances, you must observe all the safety precautions described in the documentation. Please contact dSPACE for additional safety-related equipment, such as electrically safe interface cables.*

Technical Details

Parameters		Specification
General		■ Multifuse for electrical safety ■ Channels bundling to increase the continuous current
Signal measurement (Digital In 2)		■ 10 channels ■ Measurement range 0 ... 60 V ■ Max. 6 A per channel ■ Substitute loads pluggable, up to 2 W per measurement channel ■ Real loads can be wired externally ■ FIU via high-current failrail
Signal generation (Digital Out 2)		■ 10 channels ■ Configurable as low-side/high-side switch or push/pull ■ Low-side = GND ■ High-side = external reference for each channel ■ Voltage range high-side: 5 ... 60 V ■ Current range -80 ... +80 mA ■ FIU via low-capacitance failrail
Signal measurement or generation (Digital In/Out 1)		■ 10 channels ■ FIU via low-capacitance failrail
	Digital In	■ Measurement range 0 ... 60 V ■ Max. 100 mA per channel ■ Substitute loads pluggable, up to 2 W per measurement channel ■ Real loads can be wired externally
	Digital Out	■ Configurable as low-side/high-side switch or push/pull ■ Low-side = GND ■ High-side = external reference for each channel ■ Voltage range high-side: 5 ... 60 V ■ Current range -80 ... +80 mA
Fault simulation		■ Onboard failure routing unit (FRU) ■ Signal forwarding to central FIU ■ Based on relays ■ Available for each channel
Physical size		■ 402 x 100 x 58 mm (15.8 x 3.9 x 2.3 in) ■ Requires 3 slots
Typical power consumption		■ 18 W

Order Information

Product	Order Number
DS2690 Digital I/O Board	■ DS2690

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk
Optional	■ SCALEXIO fault simulation

Hardware	Product
Required	■ SCALEXIO Processing Unit
	■ SCALEXIO rack system or ■ SCALEXIO customized rack system

Fault Simulation

Fault simulation lets you insert faults, such as broken wires and short circuits, on the electrical level. For fault simulation, dSPACE provides an integrated solution on the SCALEXIO HighFlex I/O boards and the MultiCompact I/O unit. Additionally, customized rack systems can be equipped with special fault simulation solutions to provide higher currents or more fail rails.

Overview

Feature	SCALEXIO FIU	SCALEXIO Customized Rack Systems		
		Variant 1	Variant 2	High-Current
General	■ Available in SCALEXIO rack systems and SCALEXIO customized rack systems ■ Integrated with SCALEXIO MultiCompact I/O units and HighFlex boards	■ Available with SCALEXIO customized rack systems ■ Engineering needed		
FIU cards	■ DS2601 ■ DS2621 ■ DS2671 ■ DS2672 ■ DS2680 ■ DS2690	■ DS291	■ DS282	■ DS5355/DS5390
Number of cards per simulator	■ Via the I/O boards	■ Configurable	■ Configurable	■ Configurable
Number of channels per card	■ Depends on I/O board	■ 10	■ 10	■ Up to 9
Switch type	■ Relay ■ Central module with semiconductor switch	■ Relay	■ Relay	■ Relay
Central modules	■ DS2642 ■ DS2680	–	■ 1 x DS293	–
Simulation of transition impedance	–	–	■ 1 x DS289 Rsim Module (simulates a resistance in the range 1 Ω ...131 kΩ in steps of 1 Ω)	–
Max. continuous current	■ Up to 80 A (depends on I/O board)	■ 8 A	■ 8 A	■ 50 A
Possible fault types				
Broken wire	●	●	●	●
Short circuit to ground	●	●	●	●
Short circuit to battery voltage	●	●	●	●
Short circuit to another ECU pin via common failrail	●	●	●	●
Broken wire with additional hardware (Rsim, Meas or Source) in series	–	–	●	–
Short circuit to another ECU pin via additional hardware (Rsim, Meas or Source)	–	–	●	–
Short circuit to 5 reference points (potential 0 ... 4) directly or via additional hardware (Rsim, Meas or Source)	–	–	●	–

● *included* – *not available*

SCALEXIO Fault Simulation

Hardware Components

The SCALEXIO Failure Insertion Unit (FIU) consists of several components:

- An onboard failure routing unit (FRU) on the I/O channels prepares fault simulation by switching the I/O channels to failrails. The FRU is available for each channel on the MultiCompact and HighFlex boards and uses relays to provide the features of the central failure simulation unit to each channel.
- Depending on their properties, the channels are connected to the failure simulation system by the high-current (up to 80 A) or the low-capacitance (up to 1 A) failrail. The low-capacitance failrail for an optimized signal quality connects signal generation channels and bus channels to the central FIU. The high-current failrail connects signal measurement channels to the central FIU.
- The central FIU is located on either the DS2642 FIU & Power Switch Board or the DS2680 I/O Unit. The central FIU uses semiconductor switches for switching the faults. It switches very fast, which makes it possible to simulate loose contacts or insert faults for a very precise duration.
- The failrail segment switch is used to switch selected segments into the failrails for fault simulation. This way, the conducting capacity can be minimized to avoid signal corruption, even for large simulation systems that have a high number of inputs/outputs or that are distributed across several cabinets.

Available Fault Types

Fault Type	Fault on Single Signals	Fault on Several Signals
Open circuit	1 channel	All channels[1)]
Short circuit to ground or U_{BAT}	1 channel	Up to 10 channels[1)2)]
Short between channels	2 channels	Up to 10 channels[1)2)]
Fault with pulsed switching	✓	–

1) Requires the option "Activation by FRU relay" and is only possible on I/O channels without current enhancement.
2) Depending on the ampacity of the failrail.

License Concept

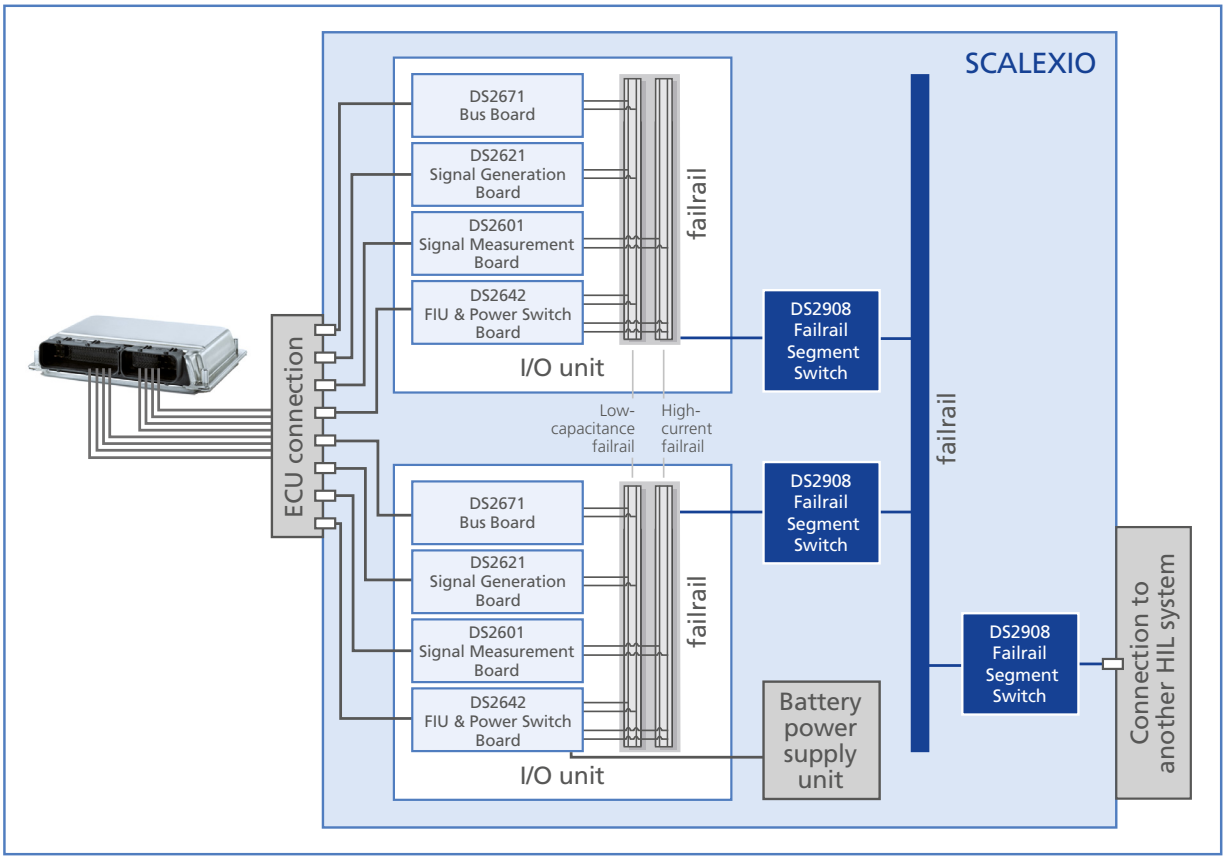
- The SCALEXIO HighFlex and MultiCompact boards include a fault simulation (FS) function. You need an additional FS license to activate the fault simulation. The FS license will be checked at the host PC. Each license can be used for one SCALEXIO system.
- The licenses are scaled for fault simulation with different numbers of I/O channels capable of fault simulations. The fault simulation is configured in ConfigurationDesk, so you need the appropriate SCALEXIO Failure Simulation license for the number of I/O functions that are mapped to channels with an FRU that you use in your real-time application. The FS license is needed only for running the simulation, not for configuring the I/O channels with ConfigurationDesk.

Tracing FIU States

The diagnostic functions of ECUs have to detect each fault within a specified time. To help test an ECU's diagnostic functions, SCALEXIO provides FIU state tracing. This enables you to measure or plot FIU states and therefore to monitor the time from a change in FIU state to any other event, such as the detection of the fault.

Faults on Multiple Signals

SCALEXIO supports the simultaneous insertion of multiple faults during simulation to allow fault classes such as broken wire, short circuit to ground or U_{BAT}, or short between channels. This function can be enabled in ConfigurationDesk for channels without current enhancement.



The SCALEXIO FIU concept with an example selection of HighFlex I/O boards.

Order Information

Product	Order Number
SCALEXIO Fault Simulation	■ SCLX_FS_100 (for 100 functions)
	■ SCLX_FS_200 (for 200 functions)
	■ SCLX_FS_300 (for 300 functions)
	■ SCLX_FS_500 (for 500 functions)
	■ SCLX_FS_1000 (for 1000 functions)
	■ SCLX_FS_UNLTD (for an unlimited number of functions)

Relevant Hardware

Hardware	Product
Optional	■ DS2680 I/O Unit
	■ DS2690 Digital I/O Board
	■ DS2601 Signal Measurement Board
	■ DS2621 Signal Generation Board
	■ DS2642 FIU & Power Switch Board
	■ DS2671 Bus Board

Fault Insertion Units for Customized Systems

For the customized system, additional types of fault simulation are available besides the SCALEXIO Fault Simulation. This enables you to tailor the system to your project-specific requirements.

The fault simulation for customized sytems can be remotely controlled with the ControlDesk Failure Simulation Module or, optionally, with AutomationDesk.

Fault Simulation Variant 1

Variant 1 for fault simulation on SCALEXIO supports fault simulation on all ECU input and output pins. All digital and analog I/O boards from dSPACE can be used for fault simulation. The relay boards (DS291) for fault simulation can be used on their own for fault simulation on sensor signals (ECU inputs) or in conjunction with load boards (DS281) on actuator signals (ECU outputs). Fault relays are controlled via a serial RS232.

Fault Simulation Variant 2

The second fault simulation variant uses a central relay switching matrix (DS293) for fault simulation on ECU inputs and outputs. Five different system potentials (for example, Terminal 30, Terminal 31, Terminal 15) can be switched on three different rails via load modules (DS282). Further devices that can be connected, including various measurement devices (Meas0-4), an electronic source (Source), and Rsim modules for transition impedance. Fault simulation is controlled via a CAN interface.

High-Current Fault Simulation

The high-current fault simulation unit on SCALEXIO supports fault simulation on ECU inputs and outputs. One FIU controller card (DS5355) supports up to 19 signal channels on two high-current FIU relay trays (DS5390). Due to its modularity, the FIU controller card can be expanded to increase the number of channels. These relay trays allow for faults with currents up to 50 A and voltages of up to 300 V. The FIU is controlled from ControlDesk via a serial RS232 or CAN.

Customized Interfaces to Diagnostic and Calibration Hardware

Many companies already have their own diagnostic and calibration hardware to perform tasks such as reading out internal ECU variables from the fault memory. If you want to use your own diagnostic and calibration hardware, a special interface for SCALEXIO is needed, which, in some cases, might require engineering. You can connect any kind of measuring device, digital scope, and diagnostic device you like with special protocols such as GPIB or RS232.

Real System Components

In some cases, the real system components (such as injection valves, hydraulic components, and sensors) have to be integrated into SCALEXIO. This is necessary, for example, if components for the same ECU are provided by different suppliers and have to be checked together with the ECU within the simulated environment. Moreover, not every vehicle component can be simulated accurately enough with a justifiable amount of time and money. Some ECUs require real loads at their outputs to function.

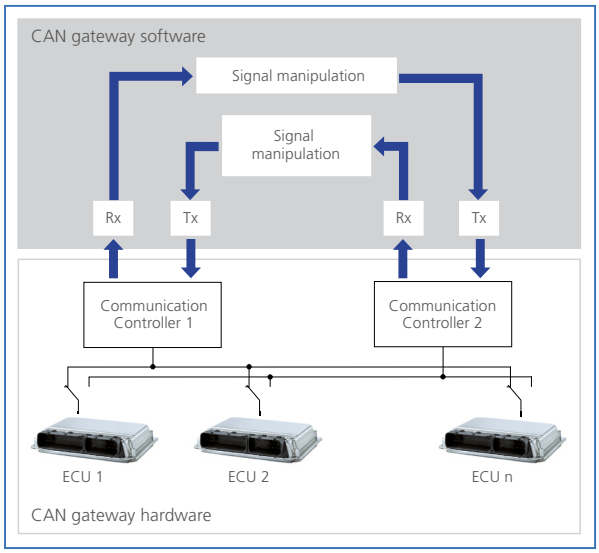
Other Hardware Components

- Optional inclusion of third-party hardware, e.g., load panels, signal routing units, GPIB instruments
- Power switch modules

CAN Gateway

In large-scale CAN networks, testing bus communication plays a key role. Engineers need to test the behavior of ECUs and distributed functions if an expected CAN message fails to arrive or contains unexpected signals.

To simulate faults, a CAN gateway module is inserted into the CAN network (see illustration). Each ECU can be connected individually to one of the two CAN controllers in the dSPACE Simulator. Signal manipulation via software allows you to change any CAN messages from any ECU to achieve a predefined effect on the other ECUs in the CAN network. The CAN software (RTI CAN MultiMessage Blockset) offers a wide range of typical error situations right up to the message or individual signal level.



CAN gateway for simulating errors in large ECU networks.

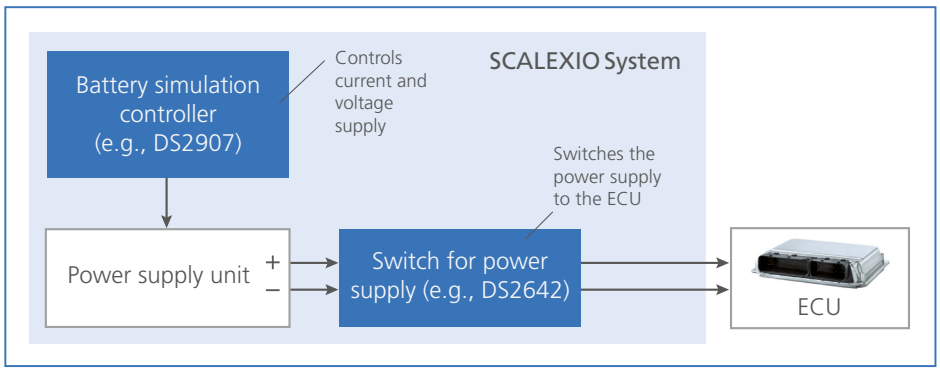
Power Supply Control for Battery Simulation

With the SCALEXIO rack or customized rack system, the battery simulation can be addressed from directly within the simulation model. No additional I/O is needed. The battery simulation consists of three components:

- Battery simulation controller (e.g., DS2907 Battery Simulation Controller) to control the power supply unit by current and voltage values
- Power supply unit to generate current and voltage
- A switch for the power supply to the ECU (e.g., DS2642 FIU & Power Switch Board)

In the DS2680 I/O Unit, the control for the power supply and the power switch are already integrated.

You can read out and check the latest current and voltage values at any time during simulation. The voltage behavior is specified in the model.

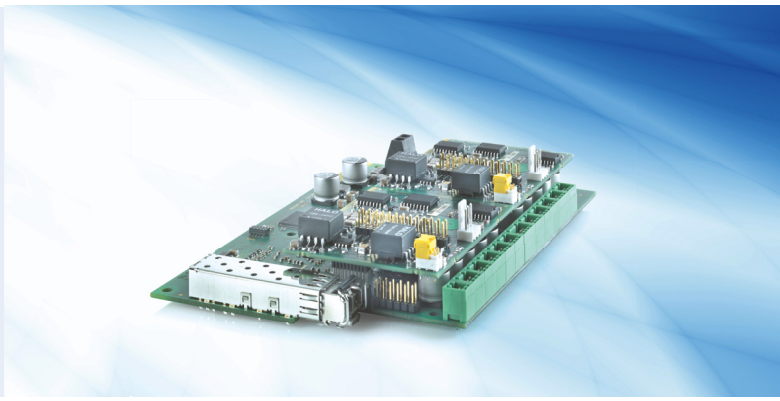


DS2907 Battery Simulation Controller

Power supply control for battery simulation

Highlights

- Supports different power supply units for battery simulation
- Wiring simplified by adapter



Application Areas

The DS2907 Battery Simulation Controller is used to control the current and voltage values of battery simulation in a SCALEXIO system. Control is performed by software.

Two battery simulation modules can be plugged onto the DS2907 to support up to two power supply units from different manufacturers like TDK-Lambda and Delta. Other power supply units can also be used.

Supported Power Supply Units

Two adapter modules are available for easier connection and wiring of different power supply units.

No slot is needed for mounting it in SCALEXIO. An optical IOCNET connection acts as an internal interface.

Battery Simulation Adapter Module	Supported Power Supply Units
DS2907M1 Adapter Module	■ TDK-Lambda Genesys™ 20V76A
	■ TDK-Lambda Genesys™ 40V38A
	■ TDK-Lambda Genesys™ 60V25A
DS2907M2 Adapter Module	■ Delta SM35/45 (with RS232 option – P183)[1)]
	■ Delta SM15/100 (with RS232 option – P183)[1)]

[1)] *Example of customer-specific solution. Further power supplies can be supported on request.*

Order Information

Product	Order Number
DS2907 Battery Simulation Controller (Base Board)	■ DS2907
DS2907M1 Adapter Module for TDK-Lambda power supply units	■ DS2907_M1
DS2907M2 Adapter Module for Delta power supply units	■ DS2907_M2

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk

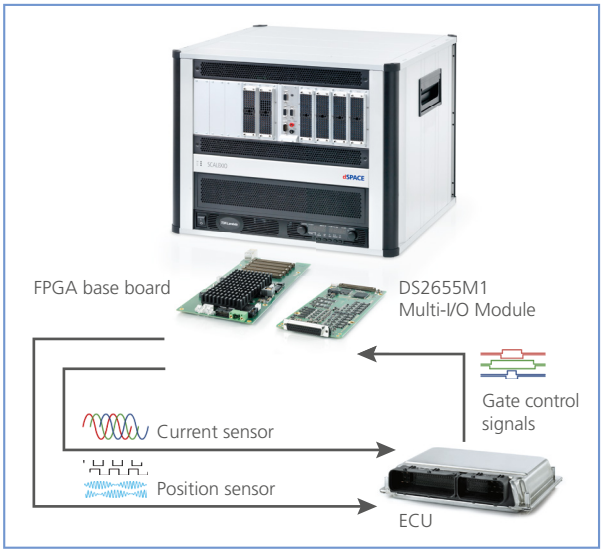
Hardware	Product
Required	■ SCALEXIO Processing Unit or ■ DS6001 Processor Board
	■ SCALEXIO rack system or ■ SCALEXIO customized rack system

Additional Solutions

SCALEXIO EMH Solution for Electric Drives Simulation

Processor-Based Simulation of Electric Drives

The SCALEXIO EMH Solution can be used for defining the I/O functions for the simulation of up to two electric drives. The required FPGA base board (DS6601, DS6602 or DS2655) is configured from within ConfigurationDesk. Thanks to the predefined function blocks, users do not have to program or generate FPGA code. The DS2655M1 and DS6651 Multi-I/O Modules as well as the integrated angular processing units (APUs) enable the use of high-resolution I/O to support applications in the areas of position sensor simulation (PSS) and pulse width modulation (PWM). The variable I/O channel mapping and the flexible support of up to five DS2655M1 or up to five DS6651 Multi-I/O Modules open up the hardware's full potential. If the drive controller requires an enhanced simulation resolution, a seamless switch to FPGA-based simulation is possible without changing the hardware. The EMH Solution FPGA design includes four internal APUs running on the FPGA base board to calculate the local position. Furthermore, up to six master APUs can be referenced globally as position sources via IOCNET. Each of the position sensors can be configured for allocating one of the ten APUs as the position source.



Technical Details

Main Functions for	Description
Position Sensor Simulation (PSS)	■ Resolver Out ■ Sine Encoder Out ■ Incremental Encoder Out ■ Hall Encoder Out ■ Analog Wavetable Encoder Out ■ Digital Wavetable Encoder Out
Pulse Width Modulation (PWM)	■ Six-Channel PWM In ■ Single-Channel PWM In ■ Single-Channel PWM Out
Basic I/O Functions	■ Multi-Bit In ■ Multi-Bit Out ■ Multi-Voltage In ■ Multi-Voltage Out

Basic I/O Functions

Function	Description	Number of Functions per FPGA Base Board	I/O Requirements per Function
Multi-Bit In	Standard digital input functionality for variable number of channels	4	■ 1-50 Digital (In)
Multi-Bit Out	Standard digital output functionality for variable number of channels	4	■ 1-50 Digital (Out)
Multi-Voltage In	Standard analog input functionality for variable number of channels	4	■ 1-25 Analog In
Multi-Voltage Out	Standard analog output functionality for variable number of channels	4	■ 1-25 Analog Out

Main Functions for Position Sensor Simulation (PSS)

Function	Description	Number of Functions per FPGA Base Board	I/O Requirements per Function
Resolver Out	Simulation with configurable pole pair number, offset angle, transformer ratio. Excitation input signal delay. Output amplitude and phase error manipulation.	2	■ Excitation: 1x Analog In ■ Sin/Cos: 2x Analog Out
Sine Encoder Out	Simulation with configurable number of lines, output amplitude and DC offset	2	A,B, Index: ■ 3x Analog Out or[1)] ■ 6x Analog Out
Incremental Encoder Out	Simulation with configurable number of lines and offset angle	2	A,B, Index: ■ 3x Digital (Out) or[1)] ■ 6x Digital (Out)
Hall Encoder Out	Simulation with configurable pole pair number, offset angle, angle-dependent pulse activation/deactivation	2	A,B,C: ■ 3x Digital (Out) or[1)] ■ 6x Digital (Out)
Analog Wavetable Encoder Out	Output with freely designable analog shape format for 360 degrees with up to 16383 values and optional linear interpolation for intermediate values. Configurable number of waveforms per revolution.	3	■ 1x Analog Out
Digital Wavetable Encoder Out	Output with freely designable digital shape format for 360 degrees with up to 16383 values. Configurable number of waveforms per revolution.	3	■ 1x Digital (Out)

[1)] *If inverted signal generation is activated.*

Main Functions for Pulse Width Modulation (PWM)

Function	Description	Number of Functions per FPGA Base Board	I/O Requirements per Function
Six-Channel PWM In	■ Supporting duty cycle, period time, latch time and dead time[2)] measurement and configurable interrupt generation (latch-based measurement), oversampling, downsampling ■ Optional external triggering ■ Optional[2)] dead time violation interrupt generation	2	Gates: ■ 3x Digital (In) or[2)] ■ 6x Digital (In) Optional ext. trigger: ■ 1x Digital (In) Optional latch pulse: ■ 1x Digital (Out)
Single-Channel PWM In	Combined edge-based and latch-based measurement of duty cycle and frequency	4	■ 1x Digital (In)
Single-Channel PWM Out	PWM generation with variable frequency and duty cycle	4	■ 1x Digital (Out)

[2)] *If high-side and corresponding low-side signals are used.*

Order Information

Product		Order Number
Required	SCALEXIO EMH Solution	■ SCLX_EMH_SOL
	DS2655 FPGA Base Board (7K160) or DS2655 FPGA Base Board (7K410) or DS6601 FPGA Base Board or DS6602 FPGA Base Board	■ DS2655 7K160 ■ DS2655 7K410 ■ DS6601 ■ DS6602
	DS2655M1 Multi-I/O Module DS6651 Multi-I/O Module	■ DS2655_M1 ■ DS6651
Optional	DS5450 SC Board for DS2655M1	■ Please inquire

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk
Optional	■ ASM Electric Components Library

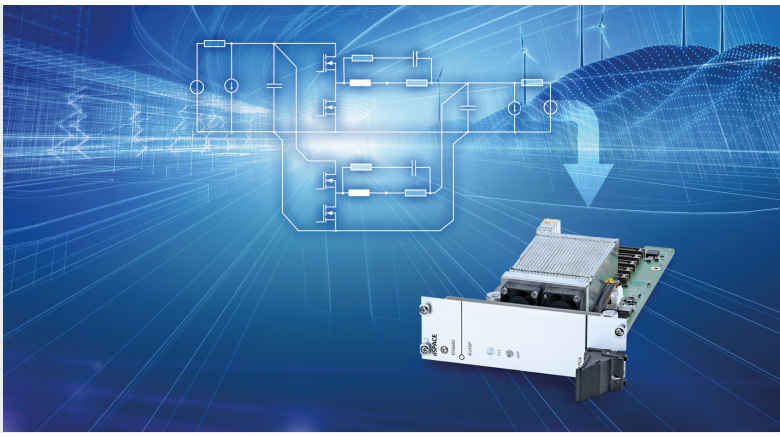
Hardware	Product
Required	■ SCALEXIO Processing Unit or ■ DS6001 Processor Board
	■ SCALEXIO LabBox or ■ SCALEXIO AutoBox or ■ SCALEXIO rack system or ■ SCALEXIO customized rack system

Electrical Power Systems Simulation Package

Easy real-time simulation of power electronic circuits developed with Simscape Electrical™

Highlights

- Real-time simulation of Simscape Electrical™ (formerly SimPowerSystems™) circuits for HIL applications
- FPGA-based approach for low-latency simulation down to a simulation step size of 400 ns
- Processor-based approach for mid-latency simulation down to a simulation step size of 25 µs
- Multiprocessor and multi-FPGA features for large and distributed simulation models



Application Areas

The Electrical Power Systems Simulation (EPSS) Package allows for the real-time simulation of electrical models developed in Simscape Electrical™ (Specialized Power Systems). The package provides various ways to integrate Simscape Electrical™ (Specialized Power Systems) models in a dSPACE hardware-in-the-loop (HIL) environment, e.g., for testing:

- Charging stations and onboard chargers
- DC/DC converters
- Active rectifiers and industrial inverters
- Wind and solar converters
- Smart grids

The FPGA-based approach involves configuring a ready-to-use FPGA application according to the given Simscape Electrical™ (Specialized Power Systems) model. This achieves low latency HIL simulation. Using the processor-based approach, an extension library is available for modifying a Simscape Electrical™ (Specialized Power Systems) model to allow real-time-capable code generation on dSPACE real-time processors by means of Simulink Coder™.

Key Benefits

For FPGA-based simulation, there are preconfigured FPGA applications to allow easy integration without time-consuming FPGA synthesis. In particular, no FPGA-specific knowledge or software is required. For processor-based simulation, there are mean value models for different bridge circuits used in power electronics to assure precise simulation of power semiconductor switching devices. Library functions for easy integration of multirate systems help avoid interference effects.

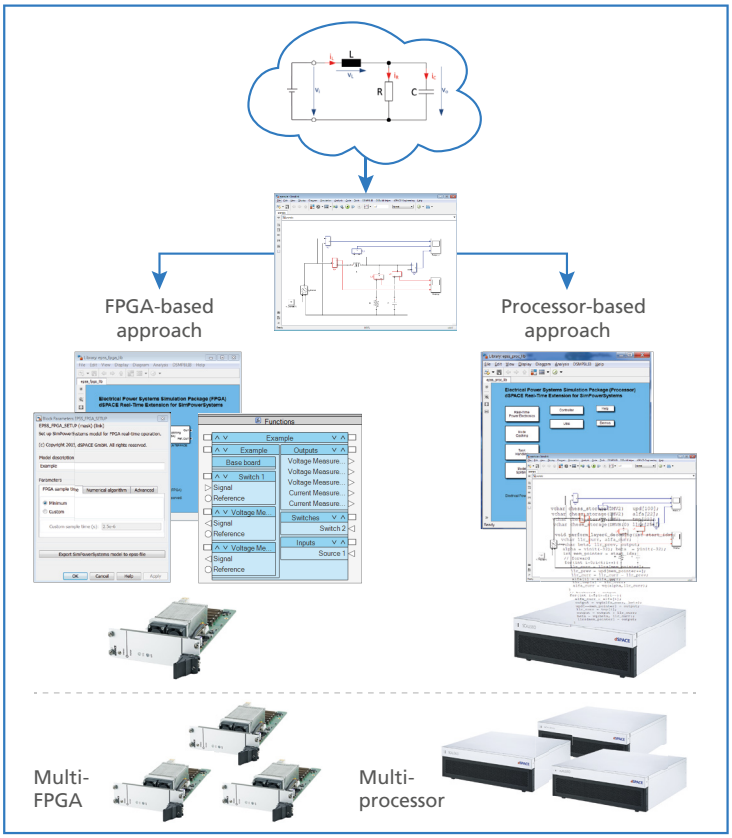
The speed of both simulation types is increased by precalculating the model states. By providing model separation (model splitting), the package lets you use multiple dSPACE real-time platforms simultaneously for computation. An integrated scope function lets you capture high-frequency signals within the FPGA clock rate. Furthermore, diverse comfortable analysis tools let you examine your model with regard to stability, switch combinations, and FPGA capability.

Unique Features

To facilitate the simulation of large and complex topologies, the EPSS Package contains most advanced multi-processor and multi-FPGA features. The tooling for semiautomatic model separation enables you to find a stable and most performant splitting position without expert knowledge. Therefore, you can easily set up multi-processor and multi-FPGA systems by using the individual cores, processors, or several FPGA boards. This feature can significantly speed up simulations by providing an option for parallel computing and a high-performance data exchange between individual simulation platforms. Moreover, you can assign the I/O boards and inter-FPGA connections by graphical programming. Thanks to the package's seamless integration into the dSPACE tool chain, you can easily extend the functionality to established XSG-based models and high-voltage load modules.

Functionality Overview

Functionality	Description
General	■ Model analysis tools for enhanced usability ■ Supports a combination of FPGA- and processor-based simulation for simulating large distributed systems
FPGA-based approach – low-latency simulation down to a step size of 400 ns	■ Ready-to-use FPGA applications provided ■ Standard Simscape Electrical™ (Specialized Power Systems) components ■ Preconfigured FPGA applications for calculating Simscape Electrical™ (Specialized Power Systems) models ■ Supports model separation (model splitting) ■ Precomputation of switch-configuration-dependent matrices (mode caching) ■ User interface for comfortable exclusion of non-relevant switch combinations ■ User interface for offline analysis to determine the switch combinations occurring in custom models ■ Integrated scope function that captures high-frequency signals within the FPGA clock rate and synchronously sends the captured data to the processor, where it can be displayed and stored in instruments, such as the ControlDesk XY plotters. ■ Inter-FPGA communication between several FPGAs (EPSS-based or XSG-based applications) via I/O module slots or multi-gigabit transceivers (MGT)
Processor-based approach – for mid-latency simulation down to a step size of 25 µs	■ Standard Simscape Electrical™ (Specialized Power Systems) components for linear parts and slow-switching semiconductors, such as rectifiers ■ Mean value models for fast-switching semiconductors and connecting to dSPACE I/O channels for PWM measurement ■ Supports Simscape Electrical™ (Specialized Power Systems) in separately triggered tasks (task handling) ■ Supports model separation (model splitting) ■ Precomputation of switch-configuration-dependent matrices (mode caching) ■ Automatic code generation for dSPACE real-time platforms



Workflow overview

Order Information

Product	Order Number
Electrical Power Systems Simulation Package for processor-based approach	■ EPSS_PROC_SPS_SOL
Electrical Power Systems Simulation Package for FPGA-based approach	■ EPSS_FPGA_SPS_SOL

Relevant Software and Hardware for Processor-Based Approach

Software		Order Number
Required	ConfigurationDesk	■ See relevant product information
Optional	ControlDesk	■ See relevant product information
	SCALEXIO EMH Solution	■ See relevant product information

Hardware		Order Number
Required	SCALEXIO processing hardware	■ See relevant product information
Optional	DS2655 FPGA Base Board (7K160)[1] or DS2655 FPGA Base Board (7K410)[1] or DS6601 FPGA Base Board[1] or DS6602 FPGA Base Board[1]	■ See relevant product information
	DS2655M1 Multi-I/O Module[1] or DS6651 Multi-I/O Module[1]	■ See relevant product information

[1] *Only in combination with SCALEXIO EMH Solution.*

Relevant Software and Hardware for FPGA-Based Approach

Software		Order Number
Required	ConfigurationDesk	■ See relevant product information
Optional	ControlDesk	■ See relevant product information

Hardware		Order Number
Required	SCALEXIO processing hardware	■ See relevant product information
	DS2655 FPGA Base Board (7K410) or DS6601 FPGA Base Board or DS6602 FPGA Base Board	■ See relevant product information
Optional	DS2655M1 Multi-I/O Module or DS6651 Multi-I/O Module	■ See relevant product information
	Adapter for Multi-Gigabit Transceiver	■ DS6601MGT1 or ■ DS6602MGT1
	Inter-FPGA communication cable[1]	■ SCLX_INT_FPGA_CAB1

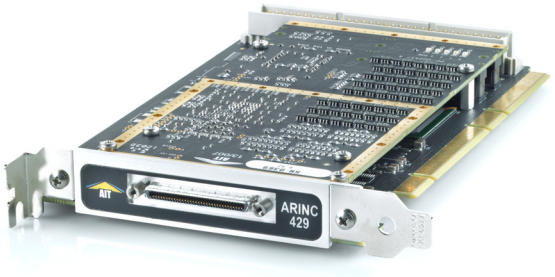
[1] *Via the I/O module slot.*

SCALEXIO Interface Solution for ARINC 429

The SCALEXIO Interface Solution for ARINC 429 enables the connection of a dSPACE real-time system to an ARINC 429 network. ARINC 429 is typically used in commercial aircraft projects.

The solution is based on plug-on modules from AIT, full-featured and industry-proven hardware. The modules are installed on a carrier board that is plugged into the SCALEXIO system[1)], providing the optimal bandwidth to the real-time model. dSPACE specifically developed device drivers to ensure real-time simulation capability.

Configuration with the well-known and established AIT Flight Simulyzer is seamlessly integrated into the configuration process via dSPACE ConfigurationDesk.



Technical Details

Parameter	Specification
General	■ AIT ARINC 429 module on a PCI, PCIe, or Compact PCI Serial carrier board ■ 4, 8, 16, or 32 software-programmable TX/RX channels per module ■ AIT Flight Simulyzer for bus configuration ■ Code generation by ConfigurationDesk
Features	■ Programmable high-speed and low-speed operation ■ Transmission and reception of multiple labels per channel ■ Multiple transmission rates for individual labels ■ Configuration of the labels based on the data formats and scaling factors ■ Transmission of identical labels with different SDI values ■ Scheduled transfers and block transfers ■ Data buffers for individual labels for scheduled and block transfers ■ Continuous and counter-based transfers

Order Information

Product	Order Number
SCALEXIO Interface Solution for ARINC 429	■ Please inquire

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk

Hardware	Product
Required	■ SCALEXIO Processing Unit
Optional	■ SCALEXIO LabBox ■ SCALEXIO AutoBox

1) *The SCALEXIO Processing Unit, SCALEXIO LabBox, and SCALEXIO AutoBox provide various options for using SCALEXIO solutions.*

SCALEXIO Interface Solution for ARINC 664 and AFDX®

The SCALEXIO Interface Solution for ARINC 664 and AFDX® (a registered trademark of Airbus) enables the connection of a dSPACE real-time system to an ARINC 664 or AFDX network. ARINC 664 and AFDX are typically used for commercial aircraft.

The solution is based on plug-on modules from AIT, full-featured and industry-proven hardware. The modules are installed on a carrier board that is plugged into the SCALEXIO system[1)], providing the optimal bandwidth to the real-time model. dSPACE specifically developed device drivers to ensure real-time simulation capability.

Configuration with the well-known and established AIT Flight Simulyzer is seamlessly integrated into the configuration process via dSPACE ConfigurationDesk.

Technical Details

Parameter	Specification
General	■ AIT ARINC 664 module on a PCIe or Compact PCI Serial carrier board ■ Dual-channel ARINC 664 interface ■ AIT Flight Simulyzer used for network configuration ■ Code generation by ConfigurationDesk

Features	■ Simulates up to 32 end systems, including virtual link (VL) traffic shaping and input VL redundancy management
	■ Support for up to 128 output virtual links
	■ Support for up to 512 input virtual links
	■ Time-stamping of all received messages with 8 ns resolution
	■ Support for transfers of the following types:
	  ■ UDP Sampling
	  ■ UDP Queuing
	  ■ SAP (Service Access Ports) UDP
	  ■ SAP IP
	  ■ SAP MAC

Order Information

Product	Order Number
SCALEXIO Interface Solution for ARINC 664 and AFDX®	■ Please inquire

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk

Hardware	Product
Required	■ SCALEXIO Processing Unit
Optional	■ SCALEXIO LabBox ■ SCALEXIO AutoBox

1) *The SCALEXIO Processing Unit, SCALEXIO LabBox, and SCALEXIO AutoBox provide various options for using SCALEXIO solutions.*

SCALEXIO Interface Solution for MIL-STD-1553

The SCALEXIO Interface Solution for MIL-STD-1553 enables the connection of a dSPACE real-time system to a MIL-STD-1553 network, which is typically used in non-commercial aerospace projects.

The solution is based on plug-on modules from AIT, full-featured and industry-proven hardware. The modules are installed on a carrier board that is plugged into the SCALEXIO Processing Unit[1], providing the optimal bandwidth to the real-time model. dSPACE specifically developed device drivers to ensure real-time simulation capability.

Configuration with the well-known and established AIT Flight Simulyzer is seamlessly integrated into the configuration process via dSPACE ConfigurationDesk.

Technical Details

Parameter	Specification
General	■ AIT MIL-STD-1553 module on a PCI or PCIe carrier board ■ One, two, or four dual redundant MIL-STD-1553A/B databus streams ■ Operation as bus controller, 31 remote terminals, and bus monitor ■ AIT Flight Simulyzer used for bus configuration ■ Code generation by ConfigurationDesk
Features	■ Multi-level trigger for capture and filtering ■ IRIG-B time code encoder/decoder ■ FPGA-based hardware architecture ■ Transformer or direct coupling for connection to the MIL-STD-1553A/B bus stub

Order Information

Product	Order Number
SCALEXIO Interface Solution for MIL-STD-1553	■ Please inquire

Relevant Software and Hardware

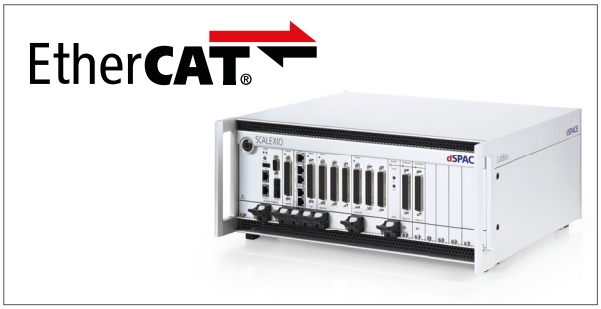
Software	Product
Required	■ ConfigurationDesk

Hardware	Product
Required	■ SCALEXIO Processing Unit

[1] *The different versions of the SCALEXIO Processing Unit provide various options for using SCALEXIO solutions.*

SCALEXIO Fieldbus Solution

The dSPACE SCALEXIO Fieldbus Solution lets you connect a SCALEXIO real-time system to various fieldbus types, such as EtherCAT and PROFIBUS. It is optimized and tested for frequency converter controlling. The EtherCAT master is based on a software stack which can use any free Ethernet port on your SCALEXIO system. The EtherCAT slave and the PROFIBUS master/slave are based on PCIe and CompactPCI Serial cards that can be plugged into your SCALEXIO system. Specially developed device drivers ensure sufficient real-time capability. Different licenses are required according to the type of fieldbus. You can use ConfigurationDesk for the configuration process.



Technical Details

Parameter		Specification
EtherCAT features	EtherCAT master	■ High bus cycle time (125µs and lower) ■ Synchronized to the real-time application ■ Support of distributed clocks (DC) ■ Support of CANopen over EtherCAT (CoE) ■ Diagnosis ■ Up to 30 slaves supported[1)]
	EtherCAT slave	■ Bus-synchronous receive interrupts ■ Bus cycle time depending on the EtherCAT bus master
PROFIBUS features		■ Bus master and slave support ■ Maximum baud rate: 12 Mbit/s

Order Information

Product		Order Number
SCALEXIO Fieldbus Solution	Software license for both versions	■ SCLX_FB_SOL_BASIC (basic license for the SCALEXIO Fieldbus Solution) ■ SCLX_FB_SOL_ECAT (required additionally for using EtherCAT) ■ SCLX_FB_SOL_ECAT_STACK (only required with EtherCAT master) ■ SCLX_FB_SOL_PRO (required additionally for using PROFIBUS)
	Hardware version for use in SCALEXIO LabBox or SCALEXIO AutoBox	■ SCLX_FB_SOL_RE_CS_SL (EtherCAT slave functionality)
	Hardware version for use with SCALEXIO Processing Unit	■ SCLX_CIFX50_RE_SL (EtherCAT slave functionality)

Relevant Hardware and Software

Hardware	Product
Required	■ SCALEXIO Processing Unit or ■ DS6001 Processor Board
	■ SCALEXIO LabBox[2)] or ■ SCALEXIO AutoBox or ■ SCALEXIO rack system or ■ SCALEXIO customized rack system
Optional for EtherCAT master	■ SCALEXIO Ethernet Boards

Software	Product
Required	■ ConfigurationDesk

1) *More slaves can be supported on request.*
2) *The DS6411 CS Adapter is required for using a CPCI card.*

SCALEXIO Serial Interface Solution

The SCALEXIO Serial Interface Solution lets you use the Serial Peripheral Interface (SPI) and Inter-Integrated Circuit (I^2C) bus with a SCALEXIO system. The solution consists of an I/O solution base board equipped with specific I/O-hardware and software for parameterizing these interfaces with ConfigurationDesk. The solution can be used with a SCALEXIO rack system, a SCALEXIO LabBox, a SCALEXIO AutoBox or an external I/O unit. The use of an external I/O unit makes it possible to reduce the distance to the device under test, which allows higher frequencies.

Technical Details

Feature	SPI	I^2C
General	■ Software-adjustable signal voltage level (3.3 / 5 V) ■ Communication with up to 20 MHz	■ Software-adjustable signal voltage level (3.3 / 5 V) ■ Communication with up to 1 MHz (Fast-mode plus)
Master features	■ Up to 4 masters ■ Adjustable timing for each chip select cycle ■ Adjustable data format for each chip select cycle	■ Up to 5 master nodes ■ Supports the following speed modes: Standard-mode, Fast-mode and Fast-mode plus ■ 10 bit addressing possible
Slave features	■ Up to 12 slaves ■ Adjustable cycle format and data bit width for each slave ■ Star or daisy chain topology available	■ Up to 5 slave nodes ■ Each physical slave node can have up to 16 logical slaves with different addresses ■ For each slave up to 16 bytes can be received or sent ■ Clock stretching is possible
Internal communication interface	■ IOCNET	■ IOCNET
Typical power consumption	■ 25 W	■ 25 W

Order Information

Product	Order Number
SCALEXIO Serial Interface Solution software (custom I/O function for ConfigurationDesk)	■ DS2656_SERIAL_IF_SW
SCALEXIO Serial Interface Solution hardware	■ DS2656_SERIAL_IF_HW

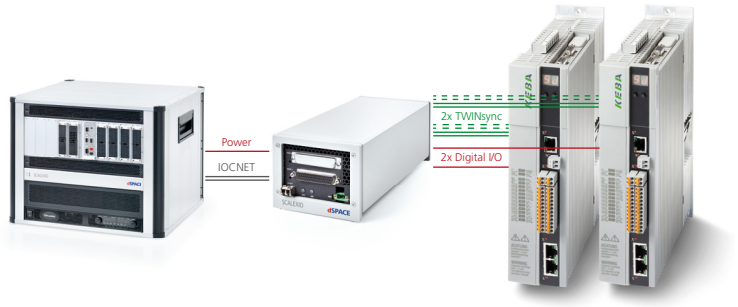
Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk

Hardware	Product
Required	■ DS6001 Processor Board or ■ SCALEXIO Processing Unit
	■ SCALEXIO LabBox or ■ SCALEXIO AutoBox or ■ SCALEXIO rack system or ■ SCALEXIO customized rack system or
	■ External I/O Unit

SCALEXIO TWINsync Solution

The SCALEXIO TWINsync Solution provides an interface for the proprietary TWINsync protocol from KEBA (formerly LTi Motion GmbH), thus enabling highly dynamic control of one ore more LTi ServoOne motor controllers. Thanks to the installed IOCNET connection, full synchronicity of the connected load motor control can be achieved even in large test facilities at a distance of up to 100 m from the HIL simulator. The associated blockset makes it easy to configure the SCALEXIO TWINsync solution in ConfigurationDesk.



Technical Details

Feature[1)2)]	Specification
TWINsync interface	2
General purposes I/O for controlling (24 V reference needs to be connected)	8 digital relay outputs
General purposes I/O for reading 24 V	6 digital inputs
TTL encoder processing interface	2
SSI interface	6
EnDat 2.1 interface	6
dSPACE remote sensor interface (RSI)	6
Internal communication interface	IOCNET
Typical power consumption	16.8 W

1) *The I/O is divided into 2 identical galvanically isolated groups.*
2) *The TWINsync interface cannot be used in parallel with the SSI, EnDat, and RSI interface.*

Order Information

Product		Order Number
Required	SCALEXIO TWINsync solution Software	■ DS2656_TWINSYNC_SW
	SCALEXIO TWINsync solution Hardware	■ DS2656_TWINSYNC_HW
Optional	EV1132 TWINsync Transfer Module	■ Please inquire
	EV1117 Remote Sensor Interface (RSI)	■ Please inquire

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk

Hardware	Product
Required	■ SCALEXIO Processing Unit or ■ DS6001 Processor Board
	■ SCALEXIO LabBox or ■ SCALEXIO AutoBox or ■ SCALEXIO rack system or ■ SCALEXIO customized rack system

PSI5 Master/Slave Solution

The PSI5 Master/Slave Solution is an interface box for a decentralized connection of sensors and actuators to a dSPACE systems via diverse serial interfaces and protocols. It enables the emulation of sensor signals (e.g., of yaw rate or crash sensors) during a hardware-in-the-loop (HIL) simulation. For rapid control prototyping (RCP) applications, it enables the ModelSim-based development of control algorithms for new PSI5 master devices.
The solution supports up to 4 master and 10 slaves and is connected to a SCALEXIO system via Ethernet.

Technical Details

Feature	Specification
General	■ Voltage output supply: 5 V, 6.5 V and 8 V ■ Software-configurable with ConfigurationDesk ■ 4 master and 10 slave interfaces
Master features	■ Simulation of up to 4 PSI5 masters ■ Internal communication interface: Ethernet ■ Bus mode: synchronous and asynchronous functionality ■ Speed mode: 125 kbps ... 189 kbps ■ Sink current: 13 mA ... 26 mA ■ Sync Voltage: 3.7 V ... 4.8 V
Slave features	■ Simulation of up to 10 PSI5 slaves ■ Synchronization pulse threshold: 0 V ... 31 V, resolution: 1.892 mV ■ Sink current low: 2 mA ... 100 mA, resolution: 6.1µA ■ Sink current high: 2 mA ...100 mA, resolution: 6.1µA

Order Information

Product	Order Number
PGI PSI5 Master/Slave Function Blocks	■ PGI1_PSI5_BS
PGI PSI5 Master/Slave Hardware	■ PGI1_PSI5

Relevant Software and Hardware

Software	Product
Required	■ ConfigurationDesk

Hardware	Product
Required	■ SCALEXIO Processing Unit or ■ DS6001 Processor Board
	■ SCALEXIO LabBox or ■ SCALEXIO AutoBox or ■ SCALEXIO rack system or ■ SCALEXIO customized rack system

Smart Charging Solution

Developing and testing intelligent charging technologies

Highlights

- Support of all common charging standards, such as ISO 15118, DIN SPEC 70121, IEC 61851-1, CHAdeMO, and GB/T
- High degree of customization as well as fault injection and logging capabilities
- Seamless workflow with Simulink®

Application Areas

The Smart Charging Solution is a key solution for developing and testing technologies involved in the electric vehicle charging process. The combination of hardware and software components offers comprehensive test possibilities. Thanks to its high flexibility, the Smart Charging Solution offers versatile application options, including the simulation of electric vehicle supply equipment (EVSE) as well as the simulation, test, and development of onboard chargers. In this way, it supports both manufacturers of electric vehicles and manufacturers of charging stations in developing and testing smart charging technologies.

Key Benefits

- ISO 15118 and DIN 70121 powerline communication
- CHAdeMO and GB/T support
- Isolated interface between the HIL simulator and the ECU
- Interfaces for all common charging plugs (e.g., Type 1, Type 2, CCS1, CCS2, GB/T, CHAdeMO)
- Support of AC and DC charging
- CAN FD interface for easy integration
- Rapid control prototyping (RCP) as well as hardware-in-the-loop (HIL) simulation
- Monitoring and manipulation of power-line communication used, e.g., for pairing mechanism (Signal Level Attenuation Characterization, SLAC)
- Simulation of errors during communication

Simulating Electric Vehicle Supply Equipment

- Test real electric vehicles and onboard chargers by connecting them to simulated charging stations supporting different standards
- Test various ECUs and power electronics components involved in the charging process

Simulating and Developing Onboard Chargers[1)]

- Test charging stations with simulated vehicles
- Replace the vehicle ECU or the communication controller for testing vehicle prototypes

[1)] *Available for CHAdeMO and GB/T communication. ISO 15118 and DIN SPEC 70121 communication will be available with a later Release.*

DS5366 Smart Charging Interface

The hardware component of the Smart Charging Solution, the DS5366 Smart Charging Interface, comes as an isolated interface between the hardware-in-the-loop (HIL) simulator and the electronic control unit (ECU). It provides a CAN FD interface for connecting to the HIL simulator as well as USB and Ethernet interfaces for protocol tracing and data logging.

Hardware - Technical Details

- Internal 4 GB SD card for customer settings
- Host interface
  - 1 Mbit/s CAN FD
  - USB logging on connected PC
  - Ethernet raw data
  - Input for custom PWM voltage
  - Input for custom PWM impedance resistor
- Target interface
  - Control pilot (CP), proximity pilot (PP), protective earth (PE)
  - 2 x relay output for power switching and user applications
- CAN FD interface
  - Monitoring of SLAC and vehicle-to-grid (V2G) messages via CAN
  - Dynamic access to control messages of the DS5366 Smart Charging Interface
- Power supply
  - 8 ... 30 V DC input voltage
  - ~ 6 W power consumption

Smart Charging Interface Software

The Smart Charging Interface Software includes a Simulink® model, ControlDesk layouts, and a DBC file that describes the CAN FD communication. The Simulink model supports all common charging communication standards. It includes a user interface for parametrization and allows for the connection and simulation of power electronics components. By using the ControlDesk layouts, you get an overview of all the relevant electrical information, the messages involved in the charging communication, and the communication status. You can also use the layout for configuration purposes, e.g., for parametrization as well as electrical and timing manipulation.

Software - Functionality Overview

- Simulink model
- Behavior model of a charging station
- User interface for connecting and simulating power electronics components
- Open model for all communication standards that can be coded for different real-time systems
- Suitable interface for ASM Electric Components
- ControlDesk layouts
- Overview layout including electrical information as wells information on the communication status
- Specific overview and configuration layout including timing manipulation for all standards
- Status and device information
- Plotting of charging curves with all relevant data
- CAN monitoring for the message exchange with the real-time system
- Warnings and error counter
- Automatic Mode and Manipulation Mode
- Logging of all request and response messages on CAN FD
- Override mechanism for parameter manipulations
- Possibility to connect power electronics components
- V2G data manipulation
- Timing manipulation by restraining V2G response messages on CAN FD

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