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RapidPro Hardware

Signal conditioning, power stages, and intelligent I/O subsystems

Highlights

- Scalable, modular, and configurable system architecture
- Compact and robust enclosure
- For in-vehicle, laboratory, and test bench use
- Comprehensive software support
- Application-specific configurations for common application areas (p. 7)
- Advances for engine control: Any-crank/cam technologies and start/stop development support



Signal Conditioning and Power Stages

The wide variety of sensors and actuators used in the automotive field, especially during the prototyping phase, means that each sensor or actuator often requires its own signal conditioning and power stage circuits. The flexibility and intelligent assistance provided by RapidPro will help you achieve challenging tasks for signal conditioning and power stages with high efficiency.

For details, see **Use Scenario A** (p. 3)

Intelligent I/O Subsystems

The functions being developed and integrated into cars are growing in complexity and volume. The acquisition and generation of I/O signals is also growing in complexity, for example, in engine management applications. Moreover, sophisticated algorithms usually need to be processed in a minimum of time. All these demanding tasks need to be performed within a standard prototyping environment with intelligent tools for assistance. With RapidPro you can build an intelligent I/O subsystem based on an MPC565 microcontroller.

For details, see **Use Scenario B** (p. 4)

Key Benefits

The RapidPro hardware works as an extension to dSPACE prototyping systems. Its enclosure is designed so that you can use the RapidPro units separately or connect several of them to build a stack to use as one physical unit. Off-the-shelf hardware- and software-configurable signal conditioning (SC) and power stage (PS) modules (p. 18) can be installed in the units to set up individual systems that optimally fit the needs of a particular application. The modular concept, using modules that are hardware- and software-configurable, means that all components can be reused, reconfigured, or extended with a minimum of effort, for example in later projects or if requirements change.

Application Areas

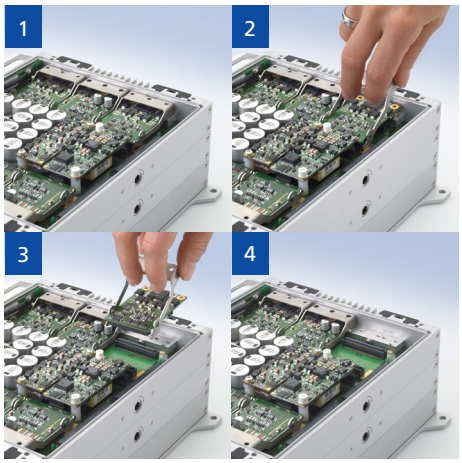
The RapidPro hardware can be used for various applications. To get you started working easily, dSPACE offers off-the-shelf, predefined configurations for common application areas such as:

- Engine control
- Body control
- Chassis control
- Transmission control
- Electric motor control

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Several RapidPro units can be connected for use as one physical unit.



RapidPro modules (p. 18) can be easily installed in and removed from the units.

Engineering Services for RapidPro

To assist you with your function prototyping activities, dSPACE offers specific engineering services (please see also dSPACE Engineering Services) for RapidPro hardware:

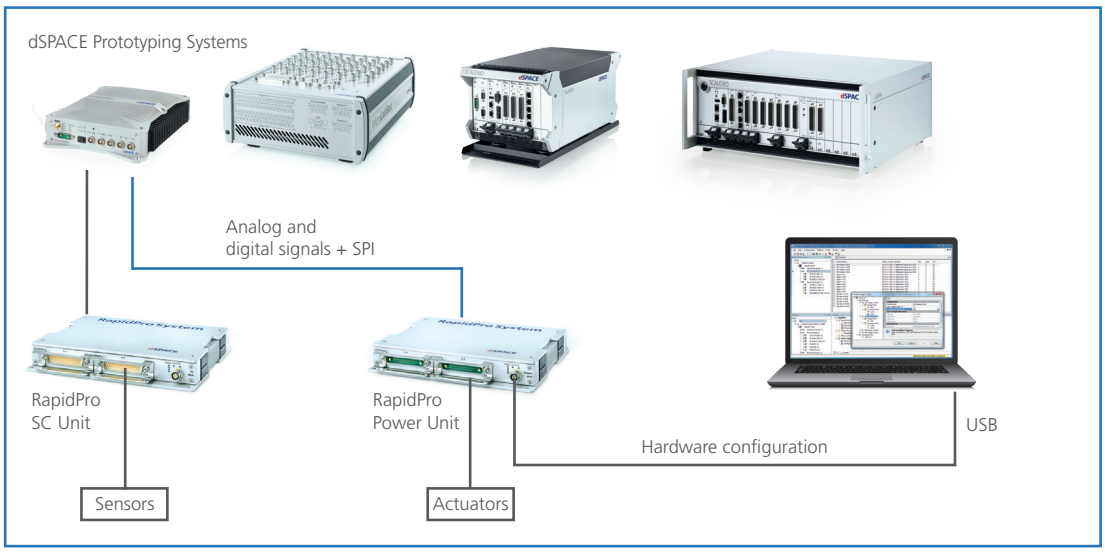
- System design and configuration
- Mapping of actuators and sensors to signal conditioning (SC) and power stage (PS) modules
- Specification and assembly of wiring harnesses
- Development of customer-specific SC and PS modules
- Template Simulink®/Real-Time Interface (RTI) models
- Commissioning and system introduction onsite

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Use Scenario A

Signal Conditioning and Power Stages for dSPACE Prototyping Systems

The RapidPro SC Unit and the RapidPro Power Unit (equipped with the relevant SC and PS modules, p. 18) can be used as separate units in conjunction with prototyping systems (MicroAutoBox, MicroLabBox, DS1104, SCALEXIO Hardware including DS6001 plus I/O boards). The RapidPro SC Unit supports your prototyping system wherever demanding signal conditioning tasks such as signal protection, amplification, attenuation, filtering, and electrical isolation have to be performed. In turn, actuators like drives, valves, injectors, lamps, and relays require high current and/or high voltage output drivers. The RapidPro Power Unit provides your prototyping system with the necessary power stages.
Automotive protection and extensive diagnostic capabilities are especially important for power stages. Using dSPACE's ConfigurationDesk software you can easily configure the unit and carry out diagnostics. In this use scenario, the RapidPro hardware can be used for developing control applications in fields such as engine, transmission, chassis, body, and drives control.



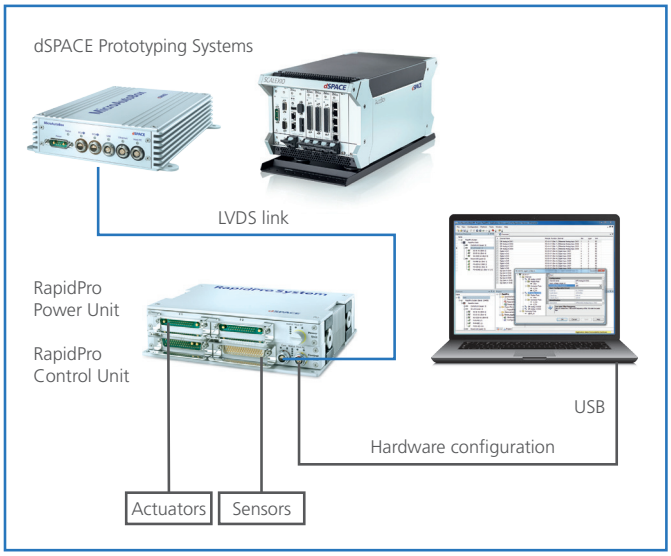
In this scenario, automotive sensors and actuators are adapted to a dSPACE prototyping system with the help of the RapidPro SC Unit and the RapidPro Power Unit.

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Use Scenario B

Intelligent I/O Subsystems for dSPACE Prototyping Systems

Applications such as engine management need to acquire complex I/O signals, for example, for crankshaft and camshaft positions, and to generate complex signals for ignition and injection independently of the RCP system's main processor and the model's simulation step size. Offloading specific, time-critical tasks like these to a dedicated microcontroller decisively reduces the main processor's load. The RapidPro Control Unit variant with MPC565 is used in this scenario as a slave microcontroller to extend existing prototyping systems with additional I/O functionality. The RapidPro Control Unit variant can be used together with the MicroAutoBox II or can additionally be combined with other RapidPro units. An integrated Unit Connection Bus (UCB) allows you to connect several RapidPro SC or Power Units directly to the Control Unit without external wiring. Communication between the RapidPro Control Unit and the prototyping system is performed via a high-speed link. A RapidPro Control Unit Blockset (p. 8) for MicroAutoBox II is available as an I/O Real-Time Interface (RTI) for Simulink. dSPACE's ConfigurationDesk provides intuitive configuration of the unit and diagnostics handling. In this use scenario, the RapidPro hardware can be used for developing control applications in fields such as engine, transmissions, chassis, body, and drives control.



In this scenario, two RapidPro units form a stack including signal conditioning and power stages, so that complex I/O signals can be acquired and generated independently of the main CPU of the prototyping system.

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Application-Specific Configurations

RapidPro's predefined configurations cover a wide range of typical signal conditioning and power stage tasks in various application areas. For example, the configurations for engine control prototyping let you run engines with up to 6 cylinders and all modern sensors and actuators, and the configuration for electric motor control serves as a flexible inverter stage during the prototyping phase of diverse AC electric motors. Each configuration consists of selected RapidPro power and signal conditioning modules (p. 18) installed in the corresponding number of RapidPro units. A RapidPro Control Unit is used whenever complex I/O signals need to be captured or generated, or a large number of I/O signals are involved.

dSPACE also provides dedicated Simulink® startup models for the configurations. These include all the available I/O signals which are already configured in corresponding tasks (e.g. angle-synchronous tasks for engine control). This enables a fast startup and lets you concentrate fully on your primary task of developing control algorithms for your application. If your specific I/O requirements differ from the setups, this is no problem at all. You can adapt one of the ready-made configurations or build a new RapidPro system from scratch. Either way, RapidPro will help you solve your specific signal conditioning and power stage task.

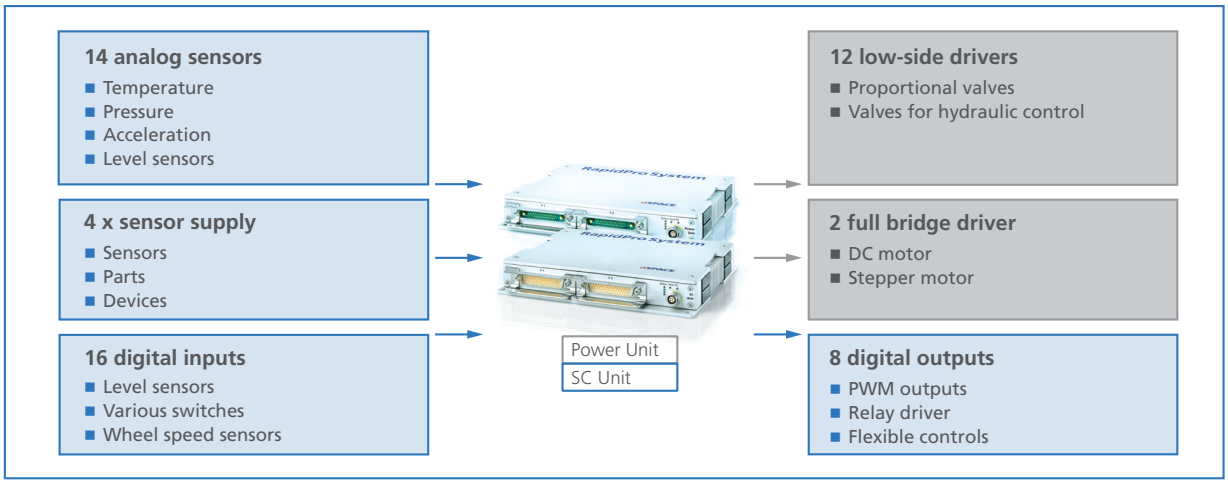
For further information, please contact dSPACE.

Overview of RapidPro Configurations

Application	RapidPro Control Unit	RapidPro SC Unit	RapidPro Power Unit
Engine control Basic configuration (based on Use Scenario B)	■ 10 analog inputs ■ 2 lambda inputs ■ 6 crank/camshaft inputs ■ 8 digital inputs ■ 7 digital outputs	–	■ 6 high-side outputs ■ 12 low-side outputs ■ 2 DC motor outputs (opt. 2 direct injection outputs)
Engine control Advanced configuration for 6 cylinders (based on Use Scenario B)	■ 2 lambda inputs ■ 4 knock sensor inputs ■ 6 crank/camshaft inputs ■ 8 digital inputs	■ 30 analog inputs ■ 16 digital outputs ■ 4 sensor supply outputs	■ 6 direct injection outputs ■ 6 high-side outputs ■ 24 low-side outputs ■ 2 DC motor outputs (2 RapidPro Power Units needed)
Body control Basic configuration (based on Use Scenario A)	–	■ 24 digital inputs ■ 10 analog inputs ■ 8 digital outputs	■ 6 low-side outputs ■ 18 high-side outputs ■ 2 full-bridge outputs
Body control Advanced configuration (based on Use Scenario B)	■ 32 digital inputs (opt. 4 sensor supply outputs)	■ 28 digital inputs ■ 10 analog inputs	■ 6 low-side outputs ■ 24 high-side outputs ■ 2 full-bridge outputs
Chassis control Basic configuration (based on Use Scenario A)	–	■ 14 analog inputs ■ 16 digital inputs ■ 8 digital outputs ■ 4 sensor supply outputs	■ 12 low-side outputs ■ 2 full-bridge outputs
Chassis control Advanced configuration (based on Use Scenario B)	■ 16 digital outputs	■ 16 digital outputs ■ 4 sensor supply outputs ■ 24 digital inputs	■ 18 low-side outputs ■ 2 full-brige outputs
Transmission control (based on Use Scenario B)	■ 20 analog sensors ■ 16 digital inputs	–	■ 12 low-side outputs ■ 6 high-side outputs ■ 2 full-bridge outputs
Electric motor control	–	–	■ 6 digital motor control inputs ■ 2 digital brake chopper inputs ■ 3 motor phase half-brigde outputs ■ 1 brake chopper half-bridge output ■ 3 analog outputs for motor current measurement

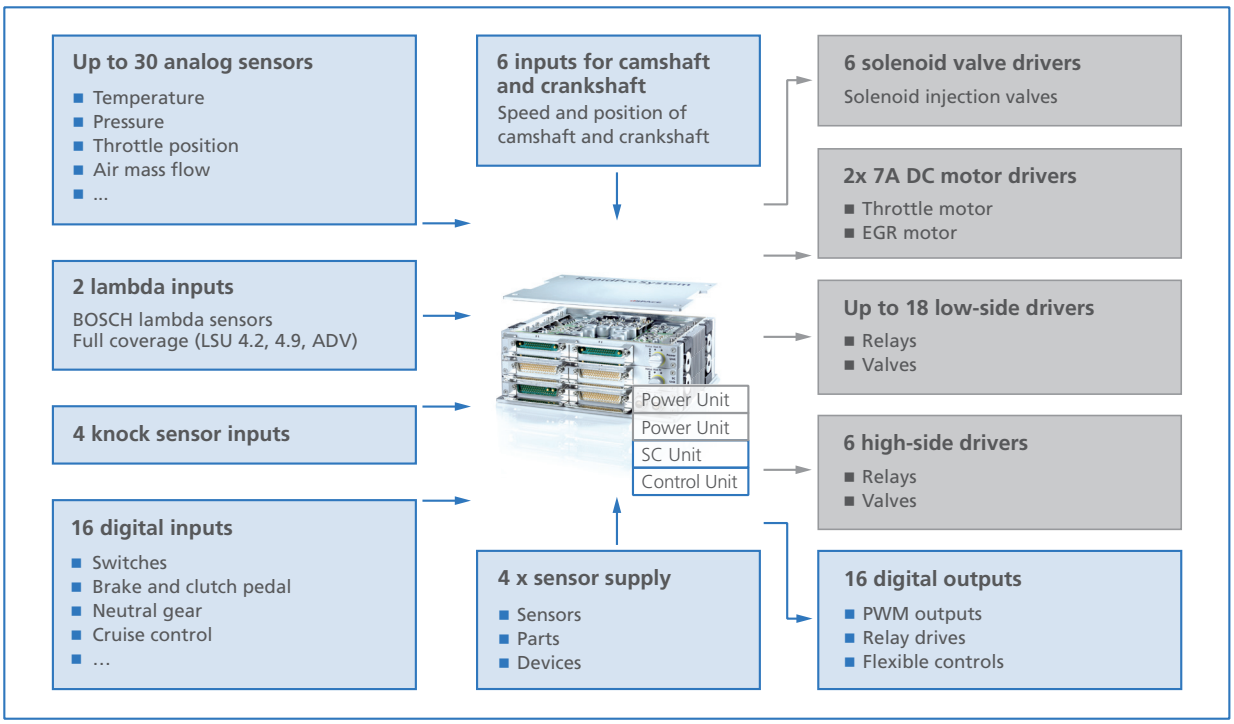
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Basic Configuration for Chassis Control



The basic configuration for chassis control is based on Use Scenario A (p. 3) and offers all the sensors and actuators needed for chassis control development.

Advanced Configuration for Engine Control



The advanced configuration for engine control is based on Use Scenario B (p. 4) and is suitable for engine control development for up to 6 cylinders.

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Application Areas for RapidPro Modules

To cover today´s variety of sensors and actuators, the RapidPro hardware consists of ready-made and easy-to-insert hardware- and software-configurable interface modules for the highest degree of flexibility. Changes in the sensor and actuator setup are no longer a risk for your development project, and home-made solutions are no longer necessary. The RapidPro signal conditioning and power stage modules (p. 18) can be easily combined to cover a wide range of application fields.

Available Signal Conditioning and Power Stage Modules	Application Fields				
	Engine Control	Transmission	Chassis	Body Control	Drives
SC-SENS 4/1 Sensor supply	✓	✓	✓	✓	✓
SC-AI 4/1 Analog inputs	✓	✓	✓	✓	
SC-AI 10/1 Analog inputs	✓	✓	✓	✓	
SC-DI 8/1 Digital inputs	✓	✓	✓	✓	✓
SC-CCDI 6/1 Crankshaft/camshaft sensors	✓				
SC-DO 8/1 Digital outputs	✓		✓	✓	
SC-DO 8/2 Digital outputs push-pull	✓		✓	✓	✓
SC-EGOS 2/1 Bosch exhaust gas oxygen sensors	✓				
SC-UHEGO 2/1 DENSO exhaust gas oxygen sensors	✓				
SC-KNOCK 4/1 Knock sensors	✓				
SC-TC 8/1 Thermocouple sensors	✓				
PS-FBD 2/1 Full-bridge driver	✓	✓	✓	✓	✓
PS-LSD 6/1 Low-side driver	✓	✓	✓	✓	
PS-HSD 6/1 High-side driver	✓	✓			
PS-HCFBD 1/1 High-current full-bridge driver		✓		✓	✓
PS-HCHBD 2/1 High-current half-bridge driver	✓	✓	✓		✓
PS-HCFBD 1/2 High-current full-bridge driver (24 V)		✓		✓	✓
PS-HCHBD 2/2 High-current half-bridge driver (24 V)	✓	✓	✓		✓
PS-DINJ 2/1 Direct injection driver	✓				

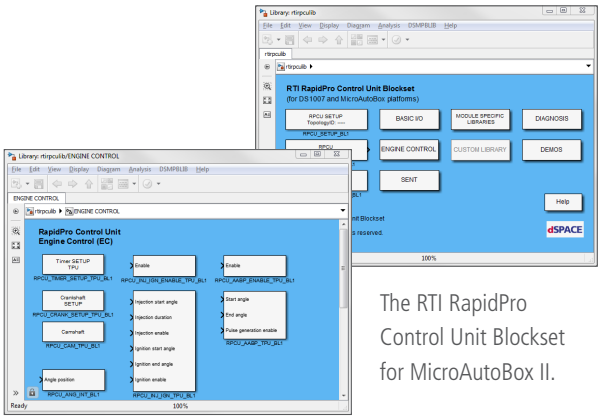
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RTI RapidPro Control Unit Blockset

In conjunction with the MPC565-based RapiPro Control Unit (Use Scenario B, p. 4), a generic Real-Time Interface (RTI) Blockset for Simulink is available for MicroAutoBox II.
The blockset provides extensive standard I/O functionalities (PWM, bit I/O, A/D) including incremental encoder interface and stepper motor control, as well as diagnostic functionalities and special functionalities for engine, chassis and drives control. Examples:

- Crankshaft signal measurement
- Engine speed and status
- Camshaft signal measurement
- Injection and ignition pulse generation
- Angle-synchronized task triggers
- Reading diagnostic data of modules
- Checking the status of a carrier board
- Any-crank/cam technologies with fully configurable, map-based setup of crank/cam wheel geometry
- Support of crank sensors with rotation detection for HEV and start/stop system development
- Fast, ECU-like engine synchronization

Functionalities can be combined with each other in realtime applications, e.g., drives and engine functionalities. When combining the MPC565-based RapidPro Control Unit and MicroAutoBox II, you gain additional functionalities for engine control compared to using the MicroAutoBox II on its own:

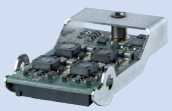


The RTI RapidPro Control Unit Blockset for MicroAutoBox II.

MicroAutoBox plus RapidPro Control Unit	
Topic	**Examples of extended functionality**
Crankshaft control	■ Crankshaft signals with up to 3600 pulses per wheel with or without gaps
Camshaft control	■ Support of virtually every type of camshaft wheel ■ Phase measurement of camshaft position ■ Up to 4 camshaft wheels at a time
Injection control	■ Generation of peak-and-hold pulse patterns (up to three phases) ■ Up to 15 injection pulses for one injection cycle
Common	■ Up to 12 channels for injection plus 12 channels for ignition simultaneously ■ High engine angle resolution of 0.1° ■ 4 periodical and 16 absolute angle-based interrupts per engine cycle

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Hardware Overview

Component	Description	Further Information	Use Scenario A (p. 3)	Use Scenario B (p. 4)
RapidPro SC Unit 	■ Signal conditioning unit ■ Slots for up to 8 signal conditioning modules ■ USB interface for hardware configuration via ConfigurationDesk	p. 10	✓	✓
RapidPro Power Unit 	■ Power stage unit ■ Slots for up to 6 power stage modules ■ USB interface for hardware configuration via ConfigurationDesk	p. 12	✓	✓
RapidPro Control Unit 	■ Intelligent I/O subunit for adding additional I/O functionality to the dSPACE prototyping system ■ MPC565 microcontroller module ■ Up to 6 signal conditioning modules ■ Up to 2 communication modules ■ USB interface for hardware configuration via ConfigurationDesk ■ LVDS interface for high-speed slave communication with MicroAutoBox II	p. 15	–	✓
SC Modules 	■ 4-channel sensor supply module	p. 19	✓	✓
	■ 4-channel differential analog input module	p. 19	✓	✓
	■ 10-channel analog input module	p. 19	✓	✓
	■ 8-channel digital input module	p. 19	✓	✓
	■ 8-channel digital output module	p. 19	✓	✓
	■ Crankshaft/camshaft sensor input module	p. 19	✓	✓
	■ 2-channel exhaust gas oxygen sensor module for Bosch LSU 4.2, 4.9, and LSU ADV broadband lambda probes	p. 19	✓	✓
	■ 4-channel knock sensor module	p. 19	–	✓
	■ 8-channel thermocouple sensor input module	p. 19	–	✓
	■ 2-channel exhaust gas oxygen sensor module for DENSO broadband lambda probes	p. 20	✓	✓
	■ 8-channel digital out module with push-pull functionality	p. 20	✓	✓
	■ Further modules are under development			
PS modules 	■ 2-channel full-bridge driver module	p. 20	✓	✓
	■ 6-channel low side driver module	p. 20	✓	✓
	■ 6-channel high side driver module	p. 21	✓	✓
	■ 1-channel, high-current, full-bridge driver module	p. 21	✓	✓
	■ 2-channel, high-current, half-bridge driver module	p. 21	✓	✓
	■ 2-channel direct-injection driver module[1)]	p. 21	✓	✓
	■ 1-channel, high-current, full-bridge driver module for 12 V and 24 V applications	p. 22	✓	✓
	■ 2-channel, high-current, half-bridge driver module for 12 V and 24 V applications	p. 22	✓	✓
	■ Further modules are under development			

[1)] *If the DS1664 2-channel direct injection driver module is used with RapidPro, electrically safe host PC interface cables (up to 300 V DC/ACRMS and 600 V peak) are mandatory for all connected systems such as MicroAutoBox II. You must perform all the safety precautions described in the documentation.*

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RapidPro SC Unit

Flexible signal conditioning unit

Highlights

- Signal conditioning for dSPACE prototyping systems
- Easily adaptable to different sensor types via configurable modules
- Slots for up to 8 signal conditioning modules
- Wide supply range (6 V to 60 V), reverse and overvoltage-protected



Application Areas

The RapidPro SC Unit in conjunction with the standard SC modules (p. 19) or customer-specific modules lets you adapt almost any type of sensor (for example, temperature, pressure, and crankshaft and camshaft sensors) to specific prototyping systems.

Key Benefits

The RapidPro SC Unit is highly modular, flexible, intelligent, and especially designed for rapid control prototyping in automotive applications. It comes with a robust, compact enclosure and an advanced mechanical concept. It is not only suited to in-vehicle use, but also to the laboratory and the test bench. All inputs and outputs are automotive-protected. A RapidPro SC Unit can be equipped with single- and/or multi-channel SC modules mounted on the carrier board. The whole RapidPro SC Unit can be switched on or off from a dSPACE prototyping system via a remote control input, or all outputs deactivated via an enable/disable input. A USB interface is available for communicating with the host PC. dSPACE's ConfigurationDesk provides easy configuration of the unit and diagnostics handling.

Technical Details

Parameter		Specification
General		■ 8 slots for configurable, analog or digital signal conditioning modules (SC modules, p. 19) ■ Support of modules with different form factors ■ Up to 64 channels per unit (for example, 40 analog plus 24 digital I/O or 40 digital plus 24 analog I/O) ■ Unit Connection Bus for use with RapidPro Control Unit (p. 15) ■ Onboard A/D converter to display I/O signals of the installed SC modules ■ Internal temperature and voltage monitoring ■ Remote control input to switch the unit on or off ■ Enable/disable input to switch all outputs of a unit on or off
Software support	Configuration	■ Configuration of the SC modules from a host PC via ConfigurationDesk (see relevant product information)
	Diagnostics	■ Diagnostics handling via ConfigurationDesk
Electrical characteristics	Power supply	■ +6 … +60 V DC ■ Load dump protection up to +100 V ■ Reverse voltage protection up to -100 V

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Technical Details

Parameter		Specification
Mechanical characteristics	Enclosure	■ Aluminum enclosure with cooling fins (no fan) ■ Advanced mechanical concept with special coulter clips for easy installation and module locking ■ Enclosure designed for flexible assembly (stack or single unit)
	Physical size (with cover and base plate)	■ 200 x 225 x 35 mm (7.87 x 8.86 x 1. 38 in)
	Physical size (without cover and base plate)	■ 172 x 225 x 25 mm (6.77 x 8.86 x 0.98 in)
Environmental characteristics	Ambient temperature	■ -40 … +85 °C (-40 … +185 °F)
Vibration resistance[1)]	EN 60068-2-6	■ Test conditions: ■ Swept sine, 1 octave per minute, 3-axis test ■ 5 ... 2000 Hz, 5 g (crossover 13 Hz), 2 sweeps ■ Operating
	ISO 16750-3:2007 / 4.1.2.4 Test IV	■ Test conditions: ■ Broadband noise, 2 h per axis / 3 spatial axes ■ RMS acceleration: 27.8 m/s² ■ Operating
Shock resistance[1)]	EN 60068-2-27	■ Test conditions: ■ Shock direction: six spatial directions ■ Acceleration: 15 g/11 ms; 100 g/5 ms ■ Operating
	ISO 16750-3:2007 / 4.2.2	■ Test conditions: ■ Shock direction: six spatial directions ■ Acceleration: 50 g/6 ms; half-sinusoidal ■ Number of shocks: 10 per direction ■ Operating

[1)] *For more detailed information about test conditions and tested variants, please inquire.*

Order Information

Product	Order Number
RapidPro SC Unit	■ RAPIDPRO_1621 (please inquire)

Relevant Software and Hardware

Software		Order Number
Required	ConfigurationDesk (see relevant product information)	■ CFD-C

Hardware		Order Number
Required	SC Modules	See p. 19
	If the DS1664 2-channel direct injection driver module is used with RapidPro (Power Unit), electrically safe host PC interface cables (up to 300 V DC/ACRMS and 600 V peak) are mandatory for all connected systems such as MicroAutoBox II. You must perform all the safety precautions described in the documentation.	■ USB_CAB12 (USB PC to LEMO cable with galvanic isolation, 4.5 m) ■ Further cables: please inquire.
Optional	RapidPro Power Unit (p. 12)	■ RAPIDPRO_1651 (please inquire)
	RapidPro Control Unit (p. 15)	■ RAPIDPRO_1601 (please inquire)
	Front connectors for RapidPro SC Unit	■ RPS_F1F2
	Rear connectors for RapidPro SC Unit	■ RPS_R1R2
	Crimping tool for RapidPro systems	■ RAPIDPRO_CRIMP
	RapidPro Break-Out Box for SC Unit (p. 23); 2 x connection cable RapidPro SC Unit (F1/F2) and BOB (F1/F2), 0.5 m	■ DS1687
	USB PC to LEMO cable, 3 m	■ USB_CAB6

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RapidPro Power Unit

Flexible power stage unit

Highlights

- Power stages for dSPACE prototyping systems
- Easily adaptable to different actuators via configurable modules
- Slots for up to 6 power stage modules
- Wide supply range (6 V to 60 V), reverse and over-voltage-protected



Application Areas

The RapidPro Power Unit, in conjunction with the standard PS modules (p. 20) or customer-specific modules, lets you adapt many different types of actuators (for example, drives, injectors, valves, relays, ohmic loads) to specific prototyping systems.

Key Benefits

The RapidPro Power Unit is based on the same advanced architecture as the RapidPro SC Unit (p. 10). The main difference is that the power unit is designed to support high current signals for driving actuators. The carrier board offers space for up to six power stage modules (p. 20), with or without current feedback. Each RapidPro Power Unit can have up to 48 power driver channels. The whole RapidPro Power Unit can be switched on or off from dSPACE prototyping systems via a remote control input, or all outputs can be deactivated via an enable/disable input. dSPACE's ConfigurationDesk provides easy configuration of the unit and extensive diagnostics handling.

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Technical Details

Parameter		Specification
General		■ 6 slots for configurable power stage modules (PS modules) (p. 20) ■ Support of modules with different form factors ■ Up to 48 power stage channels per power unit ■ Unit Connection Bus for use with RapidPro Control Unit (p. 15) ■ USB interface for communication with host PC ■ SPI interface for diagnostics with MicroAutoBox ■ Internal temperature and voltage monitoring ■ Remote control input to switch the unit on or off ■ Enable/disable input to switch all outputs of a unit on or off ■ Defined "powered-off" state during initialization and booting
Software support	Configuration	■ Configuration of the PS modules from a host PC via ConfigurationDesk (see relevant product information)
	Diagnostics	■ Diagnostics handling via ConfigurationDesk ■ Interactive diagnostics feedback to the model via RTI blockset (p. 8)
Electrical characteristics	Power supply	■ +6 ... +60 V DC ■ Load dump protection up to +100 V ■ Reverse voltage protection up to -100 V
Mechanical characteristics	Enclosure	■ Aluminum enclosure with cooling fins (no fan) ■ Advanced mechanical concept with special coulter clips for easy installation and module locking ■ Enclosure designed for flexible assembly (stack or single unit)
	Physical size (with cover and base plate)	■ 200 x 225 x 35 mm (7.87 x 8.86 x 1.38 in)
	Physical size (without cover and base plate)	■ 172 x 225 x 25 mm (6.77 x 8.86 x 0.98 in)
Environmental characteristics	Ambient temperature	■ -40 ... +85 °C (-40 … +185 °F)
Vibration resistance[1)]	EN 60068-2-6	■ Test conditions: ■ Swept sine, 1 octave per minute, 3-axis test ■ 5 ... 2000 Hz, 5 g (crossover 13 Hz), 2 sweeps ■ Operating
	ISO 16750-3:2007 / 4.1.2.4 Test IV	■ Test conditions: ■ Broadband noise, 2 h per axis / 3 spatial axes ■ RMS acceleration: 27.8 m/s^2 ■ Operating
Shock resistance[1)]	EN 60068-2-27	■ Test conditions: ■ Shock direction: six spatial directions ■ Acceleration: 15 g/11 ms; 100 g/5 ms ■ Operating
	ISO 16750-3:2007 / 4.2.2	■ Test conditions: ■ Shock direction: six spatial directions ■ Acceleration: 50 g/6 ms; half-sinusoidal ■ Number of shocks: 10 per direction ■ Operating

[1)] *For more detailed information about test conditions and tested variants, please inquire.*

Order Information

Product	Order Number
RapidPro Power Unit	■ RAPIDPRO_1651 (please inquire)

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Relevant Software and Hardware

Software		Order Number
Required	ConfigurationDesk (see relevant product information)	■ CFD-C
Optional	Real-Time Interface (RTI) (see relevant product information)	■ RTI

Hardware		Order Number
Required	PS Modules	See p. 20
	If the DS1664 2-channel direct injection driver module is used with RapidPro, electrically safe host PC interface cables (up to 300 V DC/ACRMS and 600 V peak) are mandatory for all connected systems such as MicroAutoBox II. You must perform all the safety precautions described in the documentation.	■ USB_CAB12 (USB PC to LEMO cable with galvanic isolation, 4.5 m) ■ Further cables: please inquire.
Optional	RapidPro SC Unit (p. 10)	■ RAPIDPRO_1621 (please inquire)
	RapidPro Control Unit (p. 15)	■ RAPIDPRO_1601 (please inquire)
	Front connectors for RapidPro Power Unit	■ RPP_F1F2
	Rear connectors for RapidPro Power Unit	■ RPP_R1R2
	Crimping tool for RapidPro systems	■ RAPIDPRO_CRIMP
	RapidPro Break-Out Box for Power Unit (p. 23); 2 x connection cable RapidPro Power Unit (F1/F2) and BOB (F1/F2), 0.5 m	■ DS1688
	USB PC to LEMO cable, 3 m	■ USB_CAB6

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RapidPro Control Unit

Intelligent I/O subsystem for dSPACE prototyping systems

Highlights

- MPC565 microcontroller module
- Complex I/O signal generation and acquisition
- Up to 6 signal conditioning modules
- USB configuration interface
- LVDS slave communication interface
- Powerful FPGA



Application Areas

The MPC565-based RapidPro Control Unit can be used as an intelligent I/O subunit to provide existing prototyping systems – such as MicroAutoBox II – with additional I/O functionality. For example, in applications such as engine or vehicle dynamics control, complex I/O tasks can be shifted from the prototyping system to the RapidPro Control Unit.

The RapidPro Control Unit also provides space for signal conditioning modules, so that different sensors can be adapted to a specific prototyping system.

Key Benefits

The MPC565-based RapidPro Control Unit is based on the same architecture as the RapidPro SC Unit (p. 10). Additionally, the RapidPro Control Unit is equipped with a powerful microcontroller module, including an MPC565 microcontroller, which is dedicated to handling complex I/O tasks. The carrier board provides space for up to six signal conditioning modules (SC modules, p. 19) and two communication (COM) modules. The signal conditioning modules are the same modules as for the SC Unit. The USB configuration interface module is used for communication with the host PC. The LVDS slave interface module enables high-speed communication with dSPACE prototyping systems (MicroAutoBox II).

The RapidPro Control Unit can be used separately or in combination with the other units to build an intelligent I/O subsystem tailored to a particular application. An integrated Unit Connection Bus allows you to connect several RapidPro SC or Power Units directly to the Control Unit without external wiring. Efficient configuration of a single control unit or a stack and diagnostics handling are provided by ConfigurationDesk via the USB configuration interface connected to the host PC. Interactive diagnostics with feedback to the model can be performed with the RTI RapidPro Control Unit Blockset (p. 8). This blockset also provides extensive standard I/O functionalities such as PWM, bit I/O, A/D and special functionalities for engine, chassis and drives control.

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Technical Details

Parameter		Specification
General		■ 6 slots for configurable, analog or digital signal conditioning modules (SC modules) (p. 19) ■ Support of modules with different form factors ■ 2 slots for communication interface modules (USB configuration interface module, LVDS slave interface module) ■ Unit Connection Bus to expand RapidPro Control Unit with several RapidPro Power and/or SC Units ■ Internal temperature and voltage monitoring ■ Remote control input to switch the unit on or off ■ Power management, sleep, and wake-up via prototyping system ■ Support of table-based algorithm for wider coverage of crank/cam wheel architectures, e.g., asynchronous crank wheels for 3-cylinder engines ■ Support of crank speed sensors with rotation detection for start/stop development
Microcontroller module		■ MPC565, 56 MHz ■ 4 MB external SRAM, 16 MB external flash ■ Onboard FPGA for additional functionality ■ 48-channel time processing unit (TPU) ■ 40-channel bit I/O ■ 22-channel multi I/O timer (MIOS) ■ 2 queued A/D converters with internal sample/hold ■ 40 A/D converter channels (10-bit resolution, 4 µs conversion time per channel)
Software support	Configuration	■ Configuration of connected units and modules from a host PC via ConfigurationDesk see relevant product information)
	Diagnostics	■ Diagnostics handling via ConfigurationDesk ■ Interactive diagnostics feedback to the model via RTI RapidPro Control Unit Blockset (p. 8)
	I/O Real-Time Interface	■ RTI RapidPro Control Unit Blockset (p. 8)
Electrical characteristics	Power supply	■ +6 ... +60 V DC ■ Load dump protection up to +100 V ■ Voltage reverse protection up to -100 V
Mechanical characteristics	Enclosure	■ Aluminum enclosure with cooling fins (no fan) ■ Advanced mechanical concept with special coulter clips for easy installation and module locking ■ Enclosure designed for flexible assembly (stack or single unit)
	Physical size (with cover and base plate)	■ 200 x 225 x 35 mm (7.87 x 8.86 x 1.38 in.)
	Physical size (without cover and base plate)	■ 172 x 225 x 25 mm (6.77 x 8.86 x 0.98 in.)
Environmental characteristics	Ambient temperature	■ -40 ... +85 °C (-40 ... +185 °F)
Vibration resistance[1)]	EN 60068-2-6	■ Test conditions: ■ Swept sine, 1 octave per minute, 3-axis test ■ 5 ... 2000 Hz, 5 g (crossover 13 Hz), 2 sweeps ■ Operating
	ISO 16750-3:2007 / 4.1.2.4 Test IV	■ Test conditions: ■ Broadband noise, 2 h per axis / 3 spatial axes ■ RMS acceleration: 27.8 m/s^2 ■ Operating
Shock resistance[1)]	EN 60068-2-27	■ Test conditions: ■ Shock direction: six spatial directions ■ Acceleration: 15 g/11 ms; 100 g/5 ms ■ Operating
	ISO 16750-3:2007 / 4.2.2	■ Test conditions: ■ Shock direction: six spatial directions ■ Acceleration: 50 g/6 ms; half-sinusoidal ■ Number of shocks: 10 per direction ■ Operating

[1)] *For more detailed information about test conditions and tested variants, please inquire.*

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Order Information

Products	Order Number
RapidPro Control Unit	■ RAPIDPRO_1601 (please inquire)
Stack: RapidPro Control Unit plus RapidPro Power Unit	■ RAPIDPRO_1601/1651
Stack: RapidPro Control Unit plus RapidPro SC Unit plus RapidPro Power Unit	■ RAPIDPRO_1601/1621/1651

Relevant Software and Hardware

Software		Order Number
Required	ConfigurationDesk (see relevant product information)	■ CFD-C
	Real-Time Interface (RTI) (see relevant product information)	■ RTI
	RTI RapidPro Control Unit Blockset (p. 8)	■ RTIRAPIDPRO_BS

Hardware		Order Number
Required	SC Modules	See p. 19
	If the DS1664 2-channel direct injection driver module is used with RapidPro, electrically safe host PC interface cables (up to 300 V DC/ACRMS and 600 V peak) are mandatory for all connected systems such as MicroAutoBox II. You must perform all the safety precautions described in the documentation.	■ USB_CAB12 (USB PC to LEMO cable with galvanic isolation, 4.5 m) ■ Further cables: please inquire.
Optional	RapidPro SC Unit (p. 10)	■ RAPIDPRO_1621 (please inquire)
	RapidPro Power Unit (p. 12)	■ RAPIDPRO_1651 (please inquire)
	Front connector1 for RapidPro Control Unit	■ RPC_F1
	Front connector2 for RapidPro Control Unit	■ RPC_F2
	Crimping tool for RapidPro systems	■ RAPIDPRO_CRIMP
	RapidPro Break-Out Box for Control Unit (p. 23); 1 x connection cable between RapidPro Control Unit (F1) and BOB (F1), 0.5 m; 1 x connection cable between RapidPro Control Unit (F2) and BOB (F2); 0.5 m	■ DS1689
	USB PC to LEMO cable, 3 m	■ USB_CAB6
	LVDS-Link cable LEMO-1S to ZIF crimp contacts, 5 m, 60 °C	■ LVDS_CAB1
	LVDS-Link cable LEMO-1S to LEMO-1S, 5 m, 60 °C	■ LVDS_CAB2
	LVDS-Link cable LEMO-1S to LEMO-1S, 5 m, 85 °C	■ LVDS_CAB15
	LVDS-Link cable LEMO-1S to LEMO-1S, 5 m, 150 °C	■ LVDS_CAB3
	LVDS-Link cable LEMO-1S to ZIF crimp contacts, 1 m, 60 °C	■ LVDS_CAB9

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RapidPro SC/PS Modules

Mountable signal conditioning and power stage modules for RapidPro units

Highlights

- Hardware- and software-configurable standard modules
- Easy to mount on RapidPro units
- Safe locking of modules on RapidPro units
- Signal conditioning and power stage functionality



Application Areas

The RapidPro signal conditioning (SC) and power stage (PS) modules bring vital signal conditioning and power stage functionality to the RapidPro units. The SC modules can be installed in the RapidPro SC Unit and the RapidPro Control Unit. The PS modules are installed in the RapidPro Power Unit.

Standard Modules and Custom Modules

Besides the standard modules described in the following tables (p. 19-20), dSPACE also offers you engineering services to develop individual signal conditioning and power stage modules for your specific application scenario.

Key Benefits

A wide choice of hardware- and software-configurable modules is available that provide standard solutions in many different applications. Installing and removing the modules is easy, so the RapidPro units can be reused efficiently in different projects. Customer-specific modules will also be available on request. All the modules used with the RapidPro units are automotive-protected and can be locked safely on the carrier boards with coulter clips. This makes them suitable for in-vehicle applications. Modules are not limited in size. If complex electronic circuits require more space or pins than a single slot module offers, modules with other form factors can be used.

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Signal Conditioning (SC) Modules

Signal Conditioning Module (SC Module)	Description	Order Number
SC-SENS 4/1	■ 4-channel sensor supply module ■ Requires 1 slot in a RapidPro unit ■ Software-adjustable voltage range: 2 V ... 20 V, adjustable in steps of 5.5 mV ■ Output power: 1.2 W per channel ■ Fully isolated outputs ■ Thermal overcurrent protection ■ Accuracy 1%	■ DS1626
SC-AI 4/1	■ 4-channel differential analog input module ■ Requires 1 slot in a RapidPro unit ■ Software-adjustable input range: ±100 mV ... ±50 V ■ Output range: 0 ... 5 V, ±5 V, 0 ...10 V, ±10 V, software-adjustable globally for all four channels ■ Four software-selectable 1st order low-pass filters (per channel). Cutoff frequencies: 10 Hz, 50 Hz, 100 Hz, 1 kHz ■ Input circuit: up to 4 hardware-configurable devices per channel, for example, pull-up, pull-down	■ DS1631
SC-AI 10/1	■ 10-channel analog input module ■ Requires 2 slots in a RapidPro unit ■ Double size module (requires two slots) ■ Onboard sensor supply: 5 V, 1 W ■ External supply input ■ Input circuit: up to 9 hardware configurable devices per channel, for example, pull-up, pull-down, 1st order low pass filter	■ DS1633
SC-DI 8/1	■ 8-channel digital input module ■ Requires 1 slot in a RapidPro unit ■ Software-adjustable comparator threshold and hysteresis voltage, software-adjustable in a range of ±39.5 V ■ Input voltage range: up to ±55 V continuous ■ Input circuit: up to 3 hardware-configurable devices per channel, for example, pull-up, pull-down	■ DS1642
SC-DO 8/1	■ 8-channel digital output module ■ Requires 1 slot in a RapidPro unit ■ Open collector output ■ Output current: each channel 1 A, total permissible current for all channels: 1 A ■ Output voltage: 40 V ■ Fully isolated outputs of one module (one common ground) ■ Overcurrent protection	■ DS1646
SC-CCDI 6/1	■ Crankshaft/camshaft sensor input module ■ Requires 1 slot in a RapidPro unit ■ Connection of rotational speed sensors with open load voltage up to ±200 V (±60 V DC) ■ 4 inputs for cam sensors with common ground	■ DS1637
SC-EGOS 2/1	■ 2-channel, exhaust gas oxygen sensor module for connecting Bosch LSU4.2, LSU4.9 or LSU ADV broadband lambda probes ■ Requires 1 slot in a RapidPro unit ■ Based on Bosch ASIC CJ125 ■ Lambda measurement range: 0.65 ... ∞ and 0.75 ... ∞ (software-configurable) ■ Pump reference current: 0 ... 150 µA (software-configurable in 10 µA steps)	■ DS1634
SC-KNOCK 4/1	■ 4-channel knock sensor module ■ Requires 1 slot in a RapidPro unit ■ Based on Bosch ASIC CC196 (with on-board DSP)	■ DS1635
SC-TC 8/1	■ 8-channel thermocouple sensor input module ■ Requires 3 slots in a RapidPro unit ■ Suitable for type J and K thermocouples ■ One 24-bit A/D converter per channel, sampling rate for each converter (software-configurable) 0.1 Hz ... 50 Hz ■ Splitter cable (available as J or K variant) plus memory identifying the connected thermocable and thermocouples ■ High-precision cold junction compensation	■ DS1638

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Signal Conditioning Module (SC Module)	Description	Order Number
SC-UHEGO 2/1	■ 2-channel exhaust gas oxygen sensor module ■ For integrating DENSO broadband lambda probes (PLUS2.1, PLUS3.x, PLUS5.0, PLUS5.1) into a function prototyping setup ■ Requires 1 slot in a RapidPro unit ■ Based on DENSO ASIC technology ■ Air-fuel ratio measurement range: software-configurable, wide range: AFR 10 … ∞, stoichiometric range: AFR 12 … 25	■ DS1639
SC-DO 8/2	■ 8-channel digital out module with push-pull functionality ■ Requires 1 slot in a RapidPro unit ■ Configurable output stage: push-pull, low-side driver, high-side driver ■ Enables fast control of digital circuitry (e.g. dashboard applications, external power stages for electrical drives) ■ Tri-state capability during shutdown and idle state of the real-time application ■ Low-side driver mode for driving loads (e.g. relays) ■ Parallel channel operation for increased current capability ■ Routing compatible with SC-DO 8/1 (DS1646)	■ DS1647

Power Stage (PS) Modules

Power Stage Module (PS Module)	Description	Order Number
PS-FBD 2/1	■ 2-channel full-bridge driver module ■ Requires 1 slot in a RapidPro unit ■ Each driver 5 A continuous, 7 A peak (depends on the Power Unit the module is mounted in) ■ Maximum supply voltage: 40 V continuous, 45 V peak (0.5 sec) ■ Usable as: full-bridge, half-bridge, low or high side driver ■ Software adjustable current limitation and switch-off time ■ High-side rise time: 1.8 µs typ., 3.5 µs max., high-side fall time: 0.2 µs typ., 0.8 µs max., low-side rise time: 6.5 µs typ., 11 µs max., low-side fall-time: 4.3 µs typ., 6.5 µs max. ■ Detailed load failure diagnosis ■ Current measurement with software adjustable filters (2nd order) on both channels ■ Overload protection, overtemperature protection, short-circuit protection to ground, U_{BAT} and across the load ■ Integrated on carrier board: load dump protection up to +100 V, reverse voltage protection up to -100 V	■ DS1661
PS-LSD 6/1	■ 6-channel low-side driver module ■ Requires 1 slot in a RapidPro unit ■ 4 output channels with up to 5 A (hardware-configurable) ■ 2 output channels with up to 1 A ■ Max. supply voltage: 37 V continuous ■ Clamping voltage: 45 V or 70 V (depending on hardware configuration) ■ Switching time: <10 µs ■ Detailed load failure diagnosis ■ Current measurement with hardware-adjustable low-pass filter (1st order) on channel 1 and 2 ■ Overload protection, overtemperature protection, short-circuit protection to ground, active output clamping ■ Integrated on carrier board: load dump protection up to +100 V (only valid for internal voltage supply of the module), reverse voltage protection up to -100 V	■ DS1662

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Power Stage Module (PS Module)	Description	Order Number
PS-HSD 6/1	■ 6-channel high-side driver module ■ Requires 1 slot in a RapidPro unit ■ 4 output channels with up to 5 A, clamping voltage 48 V ■ 2 output channels with up to 1 A, clamping voltage 63 V ■ Max. supply voltage: 36 V continuous, 40 V peak ■ Switching time: <30 µs ■ Load failure diagnosis ■ Current measurement with hardware-adjustable low-pass filter (1st order) on channel 1 and 2 ■ Overload protection, overtemperature protection, short-circuit protection to ground, V_{BAT} and across the load, active output clamping ■ Integrated on carrier board: load dump protection up to +100 V (only valid for internal voltage supply of the module), reverse voltage protection up to -100 V	■ DS1663
PS-HCFBD 1/1	■ 1-channel high-current full bridge driver module ■ Requires 3 slots in a RapidPro unit ■ Up to 60 A DC peak current (1 s), 42 A rms continuous ($T_{ambient}$= 25 °C, filter frequency 1 kHz, corresponding duty cycle) ■ Up to 60 A DC peak current (1 s), 29 A rms continuous (depends on ambient temperature) ■ Max. supply voltage: <20 V continuous ■ Current measurement with hardware-adjustable low-pass filter (1st order) ■ Internal free-wheeling diodes ■ Protection against: short circuit, overtemperature, and overvoltage ■ Load failure diagnostics	■ DS1667
PS-HCHBD 2/1	■ 2-channel, high-current, half-bridge driver module ■ Requires 3 slots in a RapidPro unit ■ Each channel up to 30 A peak current (1 s), 25 A rms continuous (depends on ambient temperature) ■ Parallel mode possible (30 A DC peak per channel, 19 A rms continuous per channel) ■ Usable as half-bridge or low-side or high-side driver output ■ Max. supply voltage: <20 V continuous ■ Current measurement with hardware-adjustable low-pass filter (1st order) for each channel ■ Internal free-wheeling diodes ■ Protection against short circuit, overtemperature, and overvoltage ■ Load failure diagnostics	■ DS1668
PS-DINJ 2/1[1)]	■ 2-channel direct-injection driver module ■ Requires 2 slots in a RapidPro unit ■ Single or double injector operation mode (two injectors of the same bank cannot be driven at the same time) ■ Booster voltage U_{max}: 100 V[1)] ■ I_{max}: 30 A peak, 15 A continuous ■ Control of start injection ■ Software-adjustable booster voltage ■ Software-adjustable injection duration (peak and hold times) ■ Software-adjustable peak current (upper and lower values), subpulse A and B available for Use Scenario B ■ Software-adjustable hold current (upper and lower values) ■ Detailed load failure diagnosis	■ DS1664

[1)] *If the DS1664 2-channel direct injection driver module is used with RapidPro, electrically safe host PC interface cables (up to 300 V DC/ACRMS and 600 V peak) are mandatory for all connected systems such as MicroAutoBox II. You must perform all the safety precautions described in the documentation.*

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Power Stage Module (PS Module)	Description	Order Number
PS-HCFBD 1/2	■ 1-channel high-current full-bridge driver module for 12 V and 24 V applications ■ Requires 3 slots in a RapidPro unit ■ Suitable for Use Scenarios A and B (p. 3, p. 4) ■ Support of DC motors and stepper motors ■ Up to 60 A DC peak current (1 s), 42 A rms continuous (depends on ambient temperature) ■ Max. supply voltage: 30 V ■ Current measurement with software-configurable low-pass filter (1st order/2nd order) ■ Protection against: short circuit, overtemperature, and overvoltage	■ DS1767
PS-HCHBD 2/2	■ 2-channel, high-current, half-bridge driver module for 12 V and 24 V applications ■ Requires 3 slots in a RapidPro unit ■ Suitable for Use Scenarios A and B (p. 3, p. 4) ■ Each channel up to 60A peak current (1 s), 42 A rms continuous per channel (depends on ambient temperature, electric drive mode) ■ Electrical drive mode: Control of three-phase electrical motors (BLDC motors and synchronous motors). Requires two PS-HCHBD 2/2 modules in the same Power Unit and includes a brake chopper for conversion of breaking energy into heat ■ General purpose mode for controlling high current actuators (e.g. valves, resistive loads) (up to 30 A peak current. 19 A rms current) ■ Each channel up to 30 A peak current per channel (1 s), 19 A rms continuous per channel (depends on ambient temperature) ■ Output stages in the general purpose mode configurable as half-bridge, low-side or high-side driver ■ Max. supply voltage: 30 V ■ Current measurement with software-configurable low-pass filter (1st order/2nd order) ■ Protection against: short circuit, overtemperature, and overvoltage ■ Optional: RP-HC-CAB1 cable for connecting external loads such as three-phase electric motors	■ DS1768

For more detailed information, please contact dSPACE. Further signal conditioning modules are under development. Please let us know about your requirements for future modules.

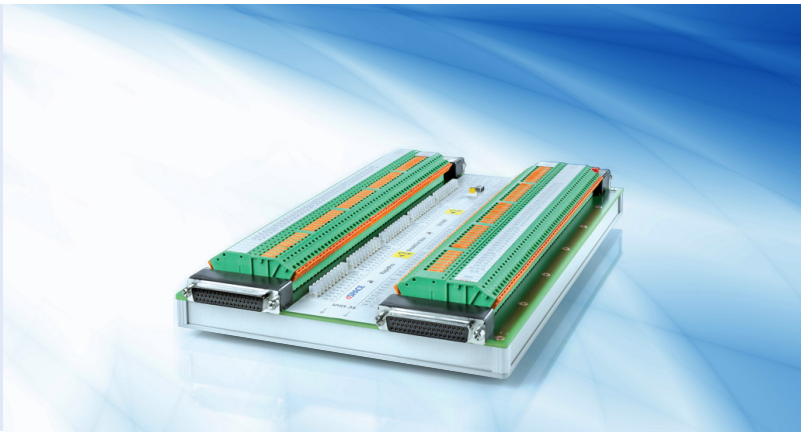
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RapidPro Break-Out Boxes[1)]

Desktop connection panels for RapidPro systems

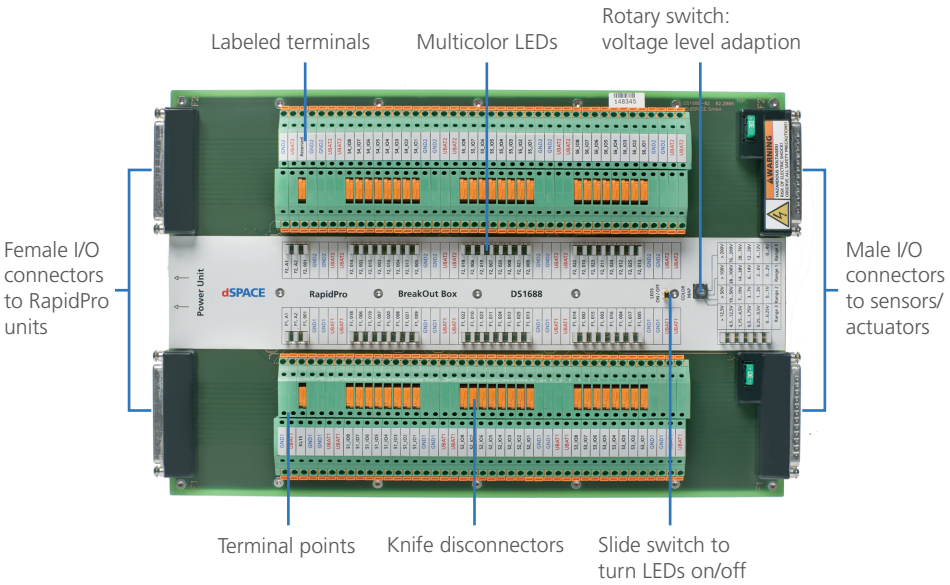
Highlights

- Fast and flexible sensor and actuator connection
- Checking and reconnecting signals without changing an existing cable harness



Key Benefits

With the RapidPro Break-Out Boxes, you can connect sensors and actuators to RapidPro units flexibly and see at a glance which signals are connected, including their statuses. You can also reconnect signals without changing an existing cable harness. This makes the RapidPro Break-Out Boxes an important accessory in setting up signal conditioning, power stages and intelligent I/O subsystems with RapidPro units in combination with dSPACE prototyping systems. Each RapidPro Break-Out Box provides a number of multicolor LEDs, one LED per signal. The LEDs indicate different voltage ranges and the signals by different colors.



[1)] *Devices connected to RapidPro Break-Out Boxes can feed in high currents and high voltages which can be dangerous for the user. Under all circumstances, you must observe all the safety precautions described in the documentation of the RapidPro Break-Out Boxes and of the devices connected!*

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Technical Details

Parameter		Specification
General		■ Three variants for different RapidPro units: DS1687 for SC Unit, DS1688 for Power Unit, DS1689 for Control Unit ■ I/O connectors a) for connection to RapidPro units and b) for connection to an existing cable harness ■ Each Break-Out Box provides the same number of terminals as the connected unit: up to 6 terminal points for each signal. There are knife disconnectors to interrupt the signal path. ■ LEDs to indicate signal status (one multicolor LED for each signal path). Indication adjustable to different voltages. Slide switch to turn all LEDs on/off.
Electrical characteristics	Power supply	■ +6 ... +60 V DC ■ MINI® Fuse (blade type automotive fuse): 1x 10 A (Break-Out Box for SC Unit), 2x 30 A (Break-Out Box for Power Unit), 1x 5 A or 1x 10 A (Break-Out Box for Control Unit) ■ Load dump protection up to +100 V ■ Reverse voltage protection up to -100 V
Mechanical characteristics	Physical size	■ 356 x 224 x 50 mm (14 x 8.8 x 1.95 in)
Environmental characteristics	Ambient temperature	■ 0 ... +70 °C (+32 ... +158 °F)

Order Information

Products	Order Number
RapidPro Break-Out Box for SC Unit; 2 x connection cable RapidPro SC Unit (F1/F2) and BOB (F1/F2), 0.5 m	■ DS1687
RapidPro Break-Out Box for Power Unit, 2 x connection cable RapidPro Power Unit (F1/F2) and BOB (F1/F2), 0.5 m	■ DS1688
RapidPro Break-Out Box for Control Unit, 1 x connection cable between RapidPro Control Unit (F1) and BOB (F1), 0.5 m; 1 x connection cable between RapidPro Control Unit (F2) and BOB (F2), 0.5 m	■ DS1689

Relevant Software and Hardware

Software		Order Number
Required	ConfigurationDesk (see relevant product information)	■ CFD-C

Hardware		Order Number
Required	RapidPro unit with corresponding SC/PS modules	See relevant product information

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