

RapidPro System

Hardware Installation Guide

For Components of a RapidPro System

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How to Contact dSPACE Support

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- Local dSPACE companies and distributors: <http://www.dspace.com/go/locations>
- For countries not listed, contact dSPACE GmbH in Paderborn, Germany.
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You can also use the support request form: <http://www.dspace.com/go/supportrequest>. If you are logged on to mydSPACE, you are automatically identified and do not need to add your contact details manually.

If possible, always provide the relevant dSPACE License ID or the serial number of the CmContainer in your support request.

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About This Guide





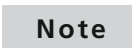



Contents

This guide provides all instructions to installing and connecting the hardware components of the RapidPro system, such as:

- Installing the hardware in a vehicle
- Building the cable harness
- Connecting the RapidPro system
- Changing RapidPro hardware:
 - Changing the assembly
 - Changing installation of modules
 - Changing hardware configuration

Symbols

dSPACE user documentation uses the following symbols:

Symbol	Description
	Indicates a hazardous situation that, if not avoided, will result in death or serious injury.
	Indicates a hazardous situation that, if not avoided, could result in death or serious injury.
	Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.
	Indicates a hazard that, if not avoided, could result in property damage.
	Indicates important information that you should take into account to avoid malfunctions.
	Indicates tips that can make your work easier.
	Indicates a link that refers to a definition in the glossary, which you can find at the end of the document unless stated otherwise.
	Precedes the document title in a link that refers to another document.

Naming conventions

dSPACE user documentation uses the following naming conventions:

%name% Names enclosed in percent signs refer to environment variables for file and path names.

< > Angle brackets contain wildcard characters or placeholders for variable file and path names, etc.

Special folders

Some software products use the following special folders:

Common Program Data folder A standard folder for application-specific configuration data that is used by all users.

`%PROGRAMDATA%\dSPACE\<InstallationGUID>\<ProductName>`

or

`%PROGRAMDATA%\dSPACE\<ProductName>\<VersionNumber>`

Documents folder A standard folder for user-specific documents.

`%USERPROFILE%\Documents\dSPACE\<ProductName>\<VersionNumber>`

Local Program Data folder A standard folder for application-specific configuration data that is used by the current, non-roaming user.

`%USERPROFILE%\AppData\Local\dSPACE\<InstallationGUID>\<ProductName>`

Accessing dSPACE Help and PDF Files


After you install and decrypt dSPACE software, the documentation for the installed products is available in dSPACE Help and as PDF files.

dSPACE Help (local) You can open your local installation of dSPACE Help:

- On its home page via Windows Start Menu
- On specific content using context-sensitive help via **F1**

dSPACE Help (Web) You can access the Web version of dSPACE Help at www.dspace.com/go/help.

To access the Web version, you must have a *mydSPACE* account.

PDF files You can access PDF files via the  icon in dSPACE Help. The PDF opens on the first page.

Safety Precautions

Objective	To avoid risk of injury and/or property damage, read and ensure compliance with the safety precautions stated.
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Where to go from here	Information in this section
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Safe In-Vehicle Use of dSPACE Products

Connecting to the battery/power supply

A car battery can supply high currents. If a short circuit occurs, e.g., in the cable harness, the current of the car battery (power supply) generates heat in the connected cables. The heat might cause a fire.

- Insert fuses into the power supply cable and other cables that are connected to the battery/power supply to avoid an electrical fire.
- Locate the fuses close to the battery/power supply.

- Choose fuse ratings that ensure that the fuses break the circuit if the connected cables are loaded with the maximum currents supported by the cross sections of the cables used.
- Make sure that you use flame-retardant cables specified for temperatures up to 105 °C (220 °F) that were tested in conformity with IEC 60332-1-2, IEC 60332-2-2, or UL VW-1.
- Make sure that you use flame-retardant connectors specified for temperatures up to 105 °C (220 °F) and V-2 classified in conformity with IEC 60695-11-10 or UL 94.

Batteries cannot be switched off. Therefore, locate a disconnect switch in the power supply cabling:

- Use an all-pole disconnect switch that matches the rating of the RapidPro system.
- Make sure that the disconnect switch can be reached by the user in case of an emergency.

Guidelines for safe in-vehicle use of dSPACE products

Any in-vehicle use of dSPACE products in line with the contractual purposes requires the use of enclosed test tracks that are specially safety-secured for the specific purpose, i.e., with appropriately restricted access and additional appropriate safety measures.

If you intend to use dSPACE products outside enclosed tracks, you have to check with the relevant authorities in your country under which circumstances this is possible. You and the local authorities involved bear full responsibility for this type of use.

You must take appropriate measures to ensure that the overall system enters a safe state if a dangerous situation occurs, e.g., by implementing emergency shutdown or a limp-home mode. This particularly applies in the following cases:

- Where safety-critical interventions that affect vehicle behavior are performed, e.g., the stimulation of a bus system, such as CAN, or the calibration or bypassing of in-vehicle electronic control units (ECUs) that control powertrain, chassis, or body systems.
- Where dSPACE products are deployed in conjunction with ECUs that can pose a hazard if they malfunction.

Accordingly, the guidelines apply to the use of dSPACE products in aircraft or vessels in compliance with the contractual purposes.

General Warnings on Using dSPACE Products

Using ConfigurationDesk for RapidPro

Using dSPACE software can be dangerous. You must observe the following safety instructions and the relevant instructions in the user documentation.

WARNING

Improper or negligent use can result in serious personal injury and/or property damage.

Using the ConfigurationDesk for RapidPro software can have a direct effect on dSPACE systems and technical (electrical, hydraulic, mechanical) systems connected to them.

- **Only persons who are qualified to use dSPACE software, and who have been informed of the above dangers and possible consequences, are permitted to use it.**
- All applications where malfunctions or misoperation involve the danger of injury or death must be examined for potential hazards by the user, who must if necessary take additional measures for protection (for example, an emergency off switch).

Liability

It is your responsibility to adhere to instructions and warnings. Any unskilled operation or other improper use of this product in violation of the respective safety instructions, warnings, or other instructions contained in the user documentation constitutes contributory negligence, which may lead to a limitation of liability by dSPACE GmbH, its representatives, agents and regional dSPACE companies, to the point of total exclusion, as the case may be. Any exclusion or limitation of liability according to other applicable regulations, individual agreements, and applicable general terms and conditions remain unaffected.

Data loss during operating system shutdown

The shutdown procedure of Microsoft Windows operating systems causes some required processes to be aborted although they are still being used by dSPACE software. To avoid data loss, the dSPACE software must be terminated manually before a PC shutdown is performed.

Safety Precautions for Handling the System

Objective

To avoid risk of injury and/or damage to the hardware and to achieve safe and trouble-free operation, you have to observe the following guidelines.

Configuring via ConfigurationDesk for RapidPro

Changes to software-configurable hardware parameter values can cause uncontrolled movements of and/or material damage to connected devices. To avoid risk of injury and material damage:

- Before changing software-configurable parameter values, think through the effects of the changes you are planning.
- Ensure that no one is in the potential danger zone of the device (test bench, etc.) when the changes first take effect.

Updating RapidPro firmware

Updating the PLD firmware of any SC or PS module can cause uncontrolled movements of connected devices. To avoid the risk of injury and material damage: Disconnect actuators and/or sensors from the affected modules before updating the firmware.

Electromagnetic compatibility

The RapidPro hardware is a CE class A device. This equipment may cause interference in a residential installation. In this case the user is encouraged to perform appropriate measures to correct the interference. For more information on EMC standards, refer to [RapidPro SC Unit Data Sheet \(RapidPro System Hardware Reference !\[\]\(ec9132f1d27c8919987d92907322654d_img.jpg\)](#)), [RapidPro Power Unit Data Sheet \(RapidPro System Hardware Reference !\[\]\(9db1a20e6fdae9c15975d240125424df_img.jpg\)](#)), or [RapidPro Control Unit Data Sheet \(RapidPro System Hardware Reference !\[\]\(69e745cb555ee0441d11497d43826bd7_img.jpg\)](#)).

Using RapidPro hardware on wet locations

The RapidPro hardware is not moisture-proof and is not intended to be used on wet locations according to IEC 61010-1 (product safety).

- Do not use RapidPro hardware on wet locations.

Handling the RapidPro hardware

The housing and the connectors of the RapidPro hardware can reach temperatures above 95 °C (203 °F). To avoid burning your hands:

- Do not touch the housing and the connectors plugged to it during operation.
- Before connecting/disconnecting any device or doing other installation work, wait for the housing to cool down after switching off the unit or use protective gloves.

Connecting devices

To avoid risk of injury and damage to the RapidPro hardware:

- Do not connect any high-voltage devices to the I/O connectors of the units.
- Do not apply voltages/currents outside the specified ranges to the connector pins.
- Do not connect or disconnect any devices (for example, sensors/actuators) while the power supply of the RapidPro system and these devices is switched on.
- Observe all safety precautions described in the documentation of the connected devices.

The RapidPro hardware provides electrical energy at the I/O pins, which can cause a fire if external components such as sensors/actuators are not appropriately connected. This particularly concerns output pins of modular boards that provide internal voltages to supply external components.

- To prevent a fire, apply the general fire safety regulations, e.g., supervise the operation, remove fire loads, and use fire-proof materials and enclosures.

Handling hardware with electrostatic sensitive devices

dSPACE hardware contains sensitive electronic devices. There is a risk of damaging the hardware or reducing its lifetime due to electrical fields or electrostatic discharge (ESD) that occur on touch. To avoid this risk, take the following precautions:

- Only qualified persons with knowledge of protective measures for electrostatic sensitive devices are allowed to unpack, install, or remove sensitive electronic devices.
- During the transport and storage of a sensitive electronic device, place it in closed ESD packaging.
- While handling a sensitive electronic device, place it on a properly grounded workstation, such as a special ESD desk or desk mat.
- You must ensure potential equalization between the environment and you, e.g., by wearing a grounded ESD wristband.
- Do not touch the board or the contacts of the connectors, even after installing the sensitive electronic device.

Assembling RapidPro hardware

Before doing any installation or assembly work on the RapidPro hardware:

1. Power off the RapidPro hardware.
2. Disconnect all connectors.

Assembling a stack with unit connection bus (UCB)

To avoid malfunctions of your system, do not change the assembly of a stack with unit connection bus (UCB) yourself. Specifically:

- Do not add or remove a unit.
- Do not change the order of the units.

If it is necessary to change a stack with UCB, contact dSPACE (local representative) to have this done.

Handling and mounting modules

You install dSPACE hardware at your own risk. Only qualified persons with experience in installing computer hardware and electric devices should perform the installation. Any damage to or malfunction of dSPACE hardware caused by improper installation is not covered by the warranty, unless the handling and installation instructions are shown to be defective.

Using thermal conduction foil Mounting SC, PS, or COM modules without using thermal conduction foil as isolation between the module and the unit's carrier board damages the hardware. Ensure that there is thermal conduction foil

to avoid electrical contact between the module and the attachment mount of the unit's carrier board.

Soldering devices to modules

Unprofessional soldering damages the hardware and/or leads to loss of hardware functionality.

- Only qualified persons with knowledge and experience in the following areas should solder electric devices:
 - Soldering in general (in particular, soldering SMD devices)
 - PCB (printed circuit boards) assembly
- Use only the correct tools, for example, a suitable SMD soldering station.
- You solder at your own risk. Any damage to or malfunction of dSPACE hardware caused by improper soldering is not covered by the warranty.

Soldering on powered and mounted modules damages the hardware! Before you begin to solder:

1. Power off the RapidPro hardware.
2. Disconnect all connectors.
3. Uninstall the module you want to modify.

Safety Precautions for Using Specific RapidPro Modules

Knowledge about modules

You need detailed knowledge of the RapidPro modules to be used in your application. You should especially familiarize yourself with the safety precautions for each module. An overview of all the precautions is given below. They must be observed to avoid damage to the hardware and achieve safe and trouble-free operation.

For module details, refer to the module chapters in the *RapidPro System – Installation and Configuration Reference*.

SC-DO 8/1 (DS1646)

Changing the signal polarity parameter in ConfigurationDesk for RapidPro can damage the connected devices.

- Before changing the parameter, think through the effects of the changes you are planning.
- You can also invert the signal via the RTI RapidPro Control Unit Blockset (if used). If you are not sure what the actual polarity is, measure/monitor the output signals before connecting a device.

SC-EGOS 2/1 (DS1634)

Setting the pump reference current unequal 0 A can damage the connected lambda probe.

To avoid damage:

- Change the pump reference current parameter only according to the technical specifications of the lambda probe. The setting must not exceed the maximum current specified in the probe's documentation.

PS-FBD 2/1 (DS1661) and PS-HCFBD 1/1 (DS1667)

Choosing the fast-decay mode can cause uncontrolled movements and/or material damage of connected devices.

In fast-decay mode, both input signals (xxxx_DIR_IN and xxxx_CTRL_IN) are set to low level if you build a Simulink model without connecting PWM signals to the full-bridge. This means that a connected motor starts if you download your application and no PWM signals are connected to the module inputs. If you invert the polarity of the signals via ConfigurationDesk for RapidPro, high-level signals trigger the described behavior.

To avoid risk of injury and material damage:

- When building the Simulink model, think through the effects of the connections you are planning and the settings of the modules.
- Ensure that no one is in the potential danger zone of the device (test bench, etc.) when the changes first take effect.

PS-HCHBD 2/1 (DS1668)

Load dump and/or static overvoltage damages the Power Unit, if you use the PS-HCHBD 2/1 module in low-side driver mode.

To avoid damage to the Power Unit:

- Take suitable measures against load dump and/or static overvoltage on the part of the load.
- Use the PS-HCHBD 2/1 module's low-side driver mode only if load dump and/or static overvoltage cannot occur in your application.

PS-DINJ 2/1 (DS1664)

The PS-DINJ 2/1 module (DS1664) can generate hazardous voltages up to 100 V. To avoid risk of electric shock, observe the precautions stated in [Safety Precautions for Using the PS-DINJ 2/1 Module](#) on page 15.

Safety Precautions for Using the PS-DINJ 2/1 Module

Objective

The PS-DINJ 2/1 module (DS1664) can generate hazardous voltages up to 100 V. According to international standards, a voltage higher than 60 V DC or 42.4 V AC_{peak} is specified as hazardous.

Observe the following safety precautions to avoid risk of electric shock.

Designated use

The PS-DINJ 2/1 module (DS1664) is designed exclusively for use in a RapidPro system to drive electromagnetic injection valves.

The RapidPro system (and therefore the module) must be used only for prototyping purposes, for example, in development and research projects.

Using the PS-DINJ 2/1 module for purposes other than those mentioned above (such as for serial operation in vehicles or machines) is considered contrary to its designated use.

User qualification

Work on the module, and on the connected electrical equipment, must be carried out only by a skilled electrician or by instructed persons under the supervision and guidance of a skilled electrician and in accordance with electrical engineering rules and regulations.

A skilled electrician is a person with sufficient technical training, knowledge, and experience, and knowledge of the relevant regulations, to assess the tasks assigned to him/her and to recognize possible dangers.

Safety guidelines

WARNING

Hazardous voltages! The PS-DINJ 2/1 module (DS1664) generates output voltages up to 100 V.

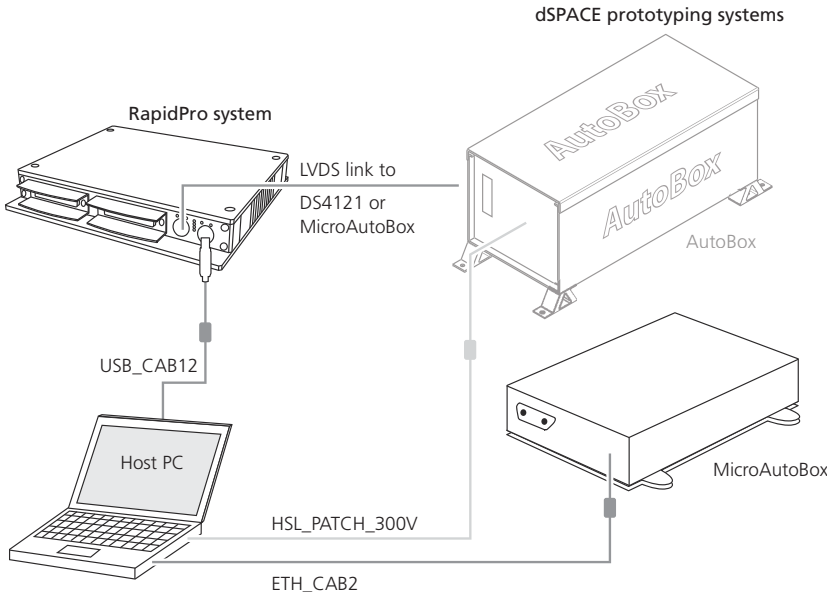
Risk of serious injury or death due to electric shock

- Do not touch the connector pins of the RapidPro Power Unit or any connected terminals and devices while the system is powered.
- Do not power the RapidPro system if the cover of the housing has been removed.
- After the RapidPro system is powered down, wait at least 3 minutes for the internal voltage to dissipate, before connecting/disconnecting devices or doing any installation work.
- **In the event of hardware damage to the PS-DINJ 2/1 module, hazardous voltages also can occur at unexpected positions on any device which is connected directly or indirectly to the RapidPro system. Therefore:**
 - Use only electrically safe host PC connection cables provided by dSPACE.
 - Connect the RapidPro housing to the negative terminal of your power supply (to the negative pole of the battery in the vehicle).
 - Ensure that the RapidPro system and all devices connected to it are within a separate test area according to the locally valid safety standards for the installation and operation of electrical test equipment. See below for detailed descriptions of the necessary safety measures.

Safety measures provided by dSPACE

To avoid the risk of electric shock, dSPACE provides safety measures which take effect even in the event of hardware damage to the PS-DINJ 2/1 module.

Do not use and operate the PS-DINJ 2/1 module (DS1664) without observing the safety measures described below.

Measures	Description
Electrically safe connection between dSPACE hardware and host PC	<p>If you use a RapidPro system with a DS1664 installed inside, you must protect your host PC and yourself against unexpected hazardous voltages. To do so, you must connect the host PC to the dSPACE hardware (RapidPro system and a connected dSPACE prototyping system) via electrically safe PC connection cables as shown below:</p> <ul style="list-style-type: none"> ▪ USB_CAB12: to connect the RapidPro system to the host PC ▪ ETH_CAB2: to connect MicroAutoBox II to the host PC ▪ HSL_PATCH_300V: to connect an expansion box (for example, PX10, AutoBox) to the host PC. Instead of this safe crossed-over patch cable, you can use a connection via fiber-optic cable. <p style="text-align: right;">dSPACE prototyping systems</p>  <p>The cables provide galvanical isolation. They are electrically safe up to voltages of 300 VDC/AC_{RMS} and 600 V_{peak}. The cable names are printed on the cable.</p>
Connection of RapidPro housing to negative terminal	<p>You must connect the housing to the negative terminal of the power supply (to the negative pole of the battery in a vehicle) via a ground lead. If you do not perform the connection, the housing can carry hazardous voltages if hardware damage occurs to the DS1664.</p> <ul style="list-style-type: none"> ▪ RapidPro systems delivered as of November 2006: Each system provides a male cable lug on the rear side as shown below. A ground lead (2.5 mm²) with female cable lug is delivered with every RapidPro system. In a stack, it is

Measures	Description
	<p>sufficient to establish only one connection between housing and negative terminal.</p> <ul style="list-style-type: none"> ▪ RapidPro systems delivered before November 2006: Contact dSPACE to upgrade your system. <p>Star point grounding is recommended. For details, refer to Grounding Examples on page 45.</p>
Warning labels on the RapidPro hardware	<p>A RapidPro system with DS1664 installed inside has a HAZARDOUS VOLTAGES warning label with safety precautions on the cover of the unit (or stack). The module also has a warning label.</p> <p>Use and operate a RapidPro system with a DS1664 (installed inside) only if the warning labels are properly attached as shown above. If you need further labels, contact dSPACE.</p>
Warning labels on connected Break-Out Boxes	<p>All RapidPro Break-Out Boxes which you want to connect to a RapidPro system with DS1664 installed inside must have the HAZARDOUS VOLTAGES warning label on their housing as shown below.</p> <p>If a Break-Out Box does not have a warning label, attach it firmly to a Sub-D connector of the box. If you need further labels, contact dSPACE.</p>

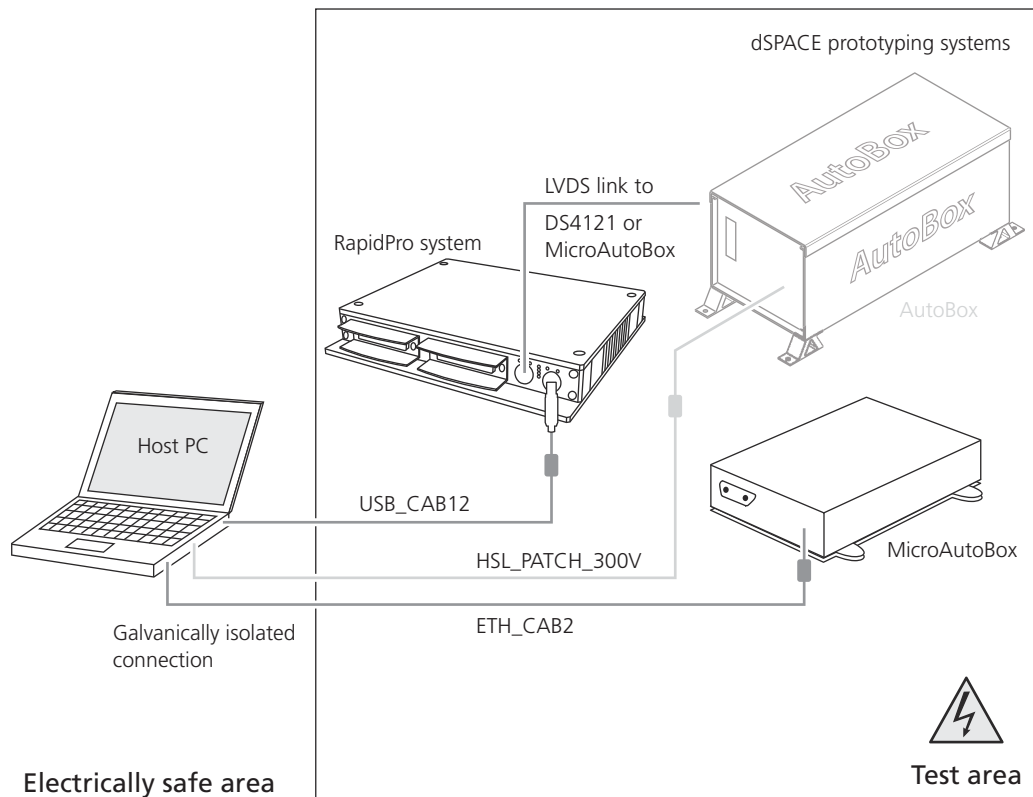
Safety measures to be carried out by the user

In addition to the measures provided by dSPACE, you are responsible for setting up the electrical equipment in your test area. In detail:

- When setting up your electrical system and the equipment of your test bench/vehicle, you have to comply with the locally valid safety standards for the installation and operation of electrical test equipment.
- Ensure that the RapidPro system and all devices connected to it are within a separate test area according to these locally valid safety standards.

Example of setup

As an example, the illustration below shows a setup with dSPACE hardware (RapidPro system and dSPACE prototyping system) connected to the host PC using galvanically isolated cables. This connection is electrically safe if the voltage applied to the hardware within the test area does not exceed 300 V DC/ AC_{RMS} , or 600 V_{peak}.



Safety Precautions for Using Break-Out Boxes

Objective

To avoid risk of injury and/or damage to the hardware and to achieve safe and trouble-free operation, you have to observe the following guidelines.

Working with Break-Out Boxes

Depending on the connected devices and the modules used in the connected RapidPro units, there can be hazardous voltages on the contacts of the boxes. To avoid risk of serious injury or death due to electric shock:

- Do not touch bare contacts, connector pins or any connected terminals and devices while the system is powered.
- The PS-DINJ 2/1 module (DS1664) can generate hazardous voltages up to 100 V. To avoid risk of electric shock, also observe the module-specific precautions stated in [Safety Precautions for Using the PS-DINJ 2/1 Module](#) on page 15.

Changing the existing cable harness via Break-Out Box can cause uncontrolled movements of and/or damage to connected devices. To avoid risk of injury and material damage:

- Before changing the cabling, think through the effects of the changes you are planning.
- Ensure that no one is in the potential danger zone of the device (test bench, etc.) when the changes first take effect.

Connecting devices

To avoid risk of injury and damage to the RapidPro hardware:

- Do not connect any high-voltage devices to the I/O connectors of the units.
- Do not apply voltages/currents outside the specified ranges to the connector pins.
- Do not connect or disconnect any devices (for example, sensors/actuators) while the power supply of the RapidPro system and these devices is switched on.
- Observe all safety precautions described in the documentation of the connected devices.

The RapidPro hardware provides electrical energy at the I/O pins, which can cause a fire if external components such as sensors/actuators are not appropriately connected. This particularly concerns output pins of modular boards that provide internal voltages to supply external components.

- To prevent a fire, apply the general fire safety regulations, e.g., supervise the operation, remove fire loads, and use fire-proof materials and enclosures.

Connecting UBAT and GND

To avoid damage to the Break-Out Boxes:

- Do not connect your power supply directly to the UBAT and GND terminals of the boxes.
- Observe the instructions given in [Powering a RapidPro System with Connected Break-Out Boxes](#) on page 69.

Installation location

To avoid damage to the Break-Out Boxes:

- Do not use the Break-Out Boxes in the vehicle's engine compartment.
- Do not use the Break-Out Boxes in humid ambient conditions.

Safety Precautions for Shipping a RapidPro Control Unit

Shipping a RapidPro Control Unit

Observe the following when shipping RapidPro hardware with Control Unit:

- The packaging must be stable and withstand a 1.2 m (47 in.) drop test.
- The packaging must bear the *Lithium Battery Mark* label with UN number 3091 and a phone number of your company for further information.



A person must be available at the phone number provided who can provide information about the device being sent. The phone number must begin with the country code.

- The *Lithium Battery Mark* label must be at least 110 mm (4.4 in.) high and at least 120 mm (4.8 in.) wide.
- If the RapidPro hardware is shipped by plane, enter the following note to the *Nature and Quantity of Goods* field of the airbill:

Lithium metal batteries in compliance with Section II of PI 970

For battery characteristics, refer to [RapidPro Control Unit Data Sheet \(RapidPro System Hardware Reference !\[\]\(8bba887393ca45b761e5cb49e755e762_img.jpg\)](#)).

Safety Precautions for Disposing dSPACE Hardware

Disposing dSPACE hardware

You must ensure that dSPACE hardware is disposed of in accordance with the applicable regional rules and regulations. You are strongly recommended to contact the regional waste management authorities to find a disposal or recycling center for the proper and environmentally sound disposal of dSPACE hardware (e-waste). Recycle or reuse dSPACE hardware wherever possible.

Battery information A Lithium battery is permanently installed in the RapidPro Control Unit. If your RapidPro hardware contains a Control Unit and you are shipping the RapidPro hardware to a disposal or recycling center, observe the notes on shipment.

For battery characteristics, refer to [RapidPro Control Unit Data Sheet \(RapidPro System Hardware Reference !\[\]\(799877f5c2f906134441300079881630_img.jpg\)](#)).

Introduction to RapidPro Hardware

Objective	The RapidPro hardware is modular and therefore very flexible. With different unit types and interchangeable modules, you can use the RapidPro hardware in different use cases.
------------------	--

Where to go from here

Information in this section

System Overview.....	24
Information on the RapidPro system's hardware and software for configuration will help you assess its possible uses.	
RapidPro System Used in a Signal Conditioning Scenario.....	25
You can expand an existing dSPACE prototyping system with solutions for signal conditioning and power stages with the help of RapidPro hardware.	
RapidPro System Used as an I/O Subsystem.....	26
You can use RapidPro hardware as an intelligent I/O subsystem of an existing prototyping system including signal conditioning and power stages.	
RapidPro Units.....	28
The RapidPro system provides three different unit types. An overview will show you the main characteristics of the units.	
RapidPro SC/PS/COM Modules.....	30
You can distinguish several module types which can be installed in the different units. An overview will show you the main characteristics of the modules.	
Hardware Accessories.....	32
You get information on the accessories that form part of the hardware package as standard and the optional accessories.	

System Overview

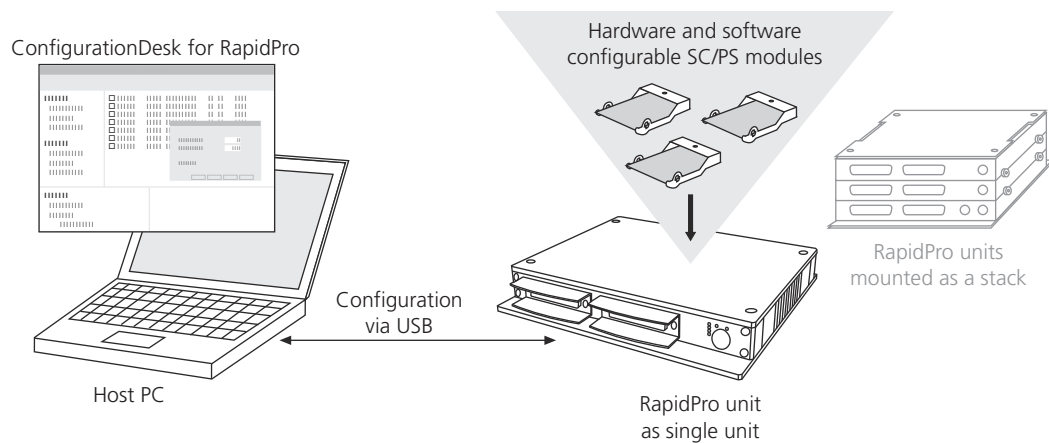
System architecture

The RapidPro system has a modular, scalable and configurable system architecture.

System components

With three unit types and different interchangeable modules, the RapidPro system can be adapted to various requirements. You can easily configure hardware parameters of the modules using the ConfigurationDesk for RapidPro software from dSPACE.

The illustration below shows a RapidPro system with its main components.



RapidPro units

The RapidPro hardware consists of three different unit types:

- RapidPro SC Unit (signal conditioning unit)
- RapidPro Power Unit (power stage unit)
- RapidPro Control Unit (microcontroller unit, used as an intelligent I/O subsystem for dSPACE prototyping system)

With their compact and robust housing, the units are especially designed for in-vehicle use, but can also be used in laboratories and on test benches. The units are installed as single units (= separate units) or mounted as a stack of several units.

For more details, refer to [RapidPro Units](#) on page 28.

SC/PS modules

Hardware- and software-configurable signal conditioning (SC) and power stage (PS) modules can be mounted into the RapidPro units to set up application-specific systems. You can change hardware parameters with minimum effort, to fit the needs of your specific use case.

For more details, refer to [RapidPro SC/PS/COM Modules](#) on page 30.

ConfigurationDesk for RapidPro

ConfigurationDesk for RapidPro is a stand-alone Windows application that allows intuitive and efficient configuration of the RapidPro hardware.

It also provides detailed information on the hardware components installed in a RapidPro system (like modules used, hardware versions, serial numbers, and pinout information of the I/O connectors).

RapidPro System Used in a Signal Conditioning Scenario

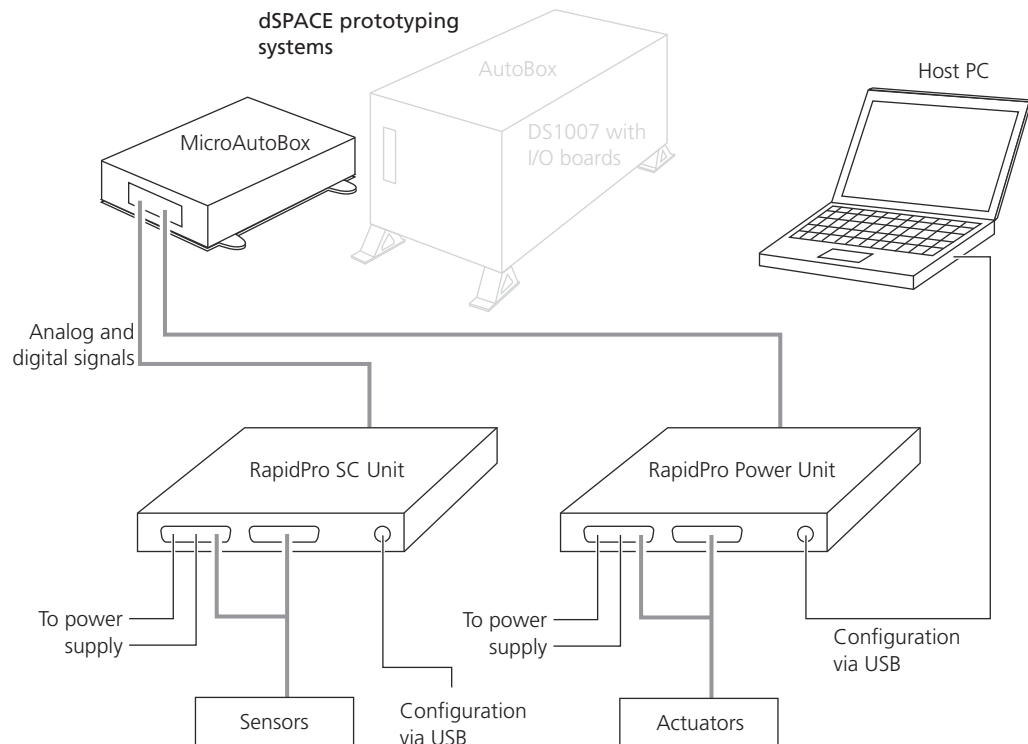
Use case

The RapidPro system can expand an existing dSPACE prototyping system with solutions for signal conditioning and power stages.

Involved hardware

The *RapidPro SC Unit* and/or the *RapidPro Power Unit* (equipped with the relevant SC and PS modules) are used as separate units (= single units) in conjunction with a prototyping system such as MicroAutoBox or AutoBox including DS1007 plus I/O boards.

The illustration below shows the involved hardware.



Main task of involved units

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

- The SC Unit supports your prototyping system by performing signal conditioning tasks, such as amplification, attenuation, filtering, and electrical isolation.
- The Power Unit adds the necessary power stages to your prototyping system to provide current and/or voltages required by actuators like drives, valves, injectors, lamps, and relays.

RapidPro System Used as an I/O Subsystem

Use case

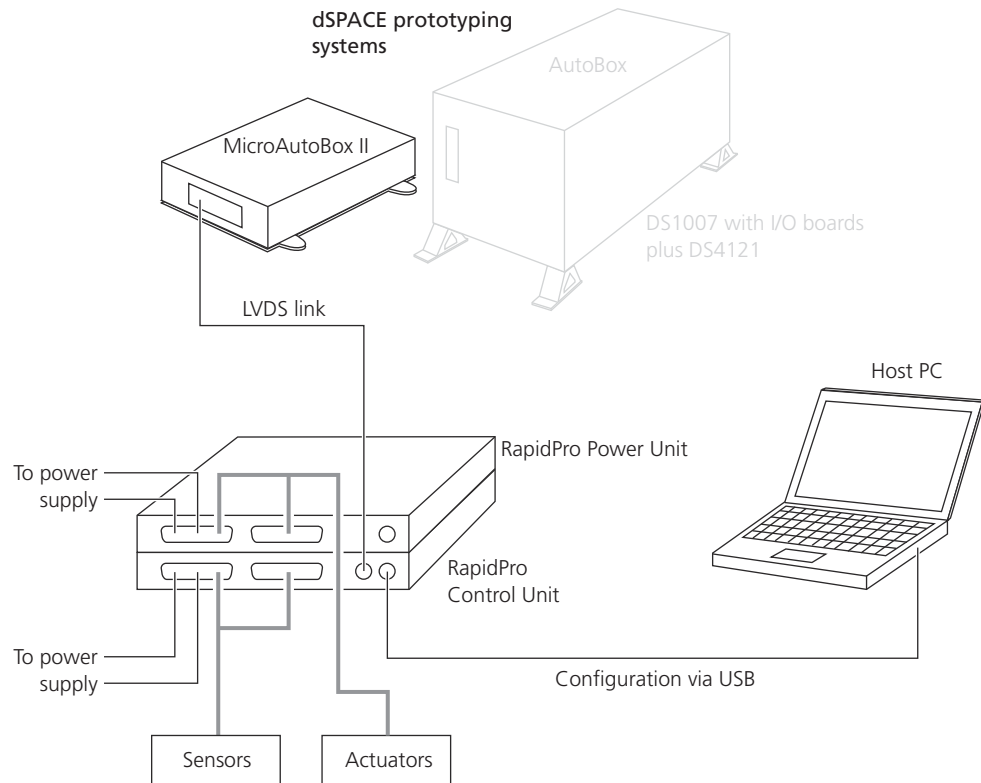
The RapidPro system can be used as an I/O subsystem of an existing RCP system in combination with signal conditioning and power stages.

Involved hardware

The *RapidPro Control Unit based on a microcontroller MPC565* comes into play in this scenario. The MPC565 is used here as a slave microcontroller to extend existing prototyping systems (MicroAutoBox II or AutoBox including DS1007 plus DS4121) with additional I/O functionality.

To build a system, the RapidPro Control Unit can be used separately or in combination with the other units (*SC Unit* and/or *Power Unit*). An integrated unit connection bus (UCB) then connects several RapidPro SC or Power Units electrically to the Control Unit without external wiring.

In the illustration below, two RapidPro units form a stack with UCB including signal conditioning (on the Control Unit) and power stages.



Note

MicroAutoBox III does not support this use scenario.

Communication to dSPACE prototyping system

Communication between the RapidPro Control Unit and the prototyping system is realized via a high-speed serial link (LVDS).

Main task of involved units

In use cases such as engine or vehicle dynamics control, complex I/O tasks can be shifted from the prototyping system to the RapidPro Control Unit (with MPC565). Thus, complex I/O signals can be acquired and generated independently from the main CPU of the prototyping system.

In addition, the RapidPro Control Unit provides slots for signal conditioning modules, so that different sensors can be adapted to the system.

The RapidPro SC Unit (not shown in the illustration above) expands the Control Unit with further space for signal conditioning tasks. The RapidPro Power Unit expands the Control Unit with power stages to adapt many different types of actuators to the system.

RapidPro Units

Objective

The RapidPro hardware consists of three different unit types (SC Unit, Power Unit, Control Unit). They all are based on the same system architecture.

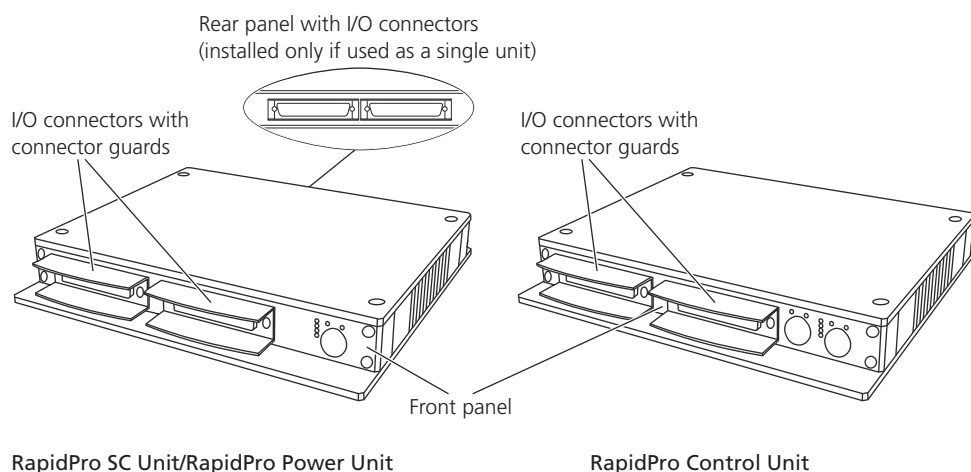
Main characteristics

Every unit contains a carrier board, which provides the slots for the RapidPro modules (for example, SC and PS modules). The table below shows you the main characteristics of the different unit types:

Unit	Characteristics
RapidPro SC Unit	<ul style="list-style-type: none"> ▪ Signal conditioning unit ▪ Slots for up to 8 signal conditioning modules (SC modules) ▪ Easily adaptable to different sensor types via configurable modules
RapidPro Power Unit	<ul style="list-style-type: none"> ▪ Power stage unit ▪ Slots for up to 6 power stage modules (PS modules) ▪ Easily adaptable to different actuators via configurable modules. The Power Unit is designed to support high current signals for driving actuators.
RapidPro Control Unit	<ul style="list-style-type: none"> ▪ Intelligent microcontroller unit, can be used as I/O subsystem to expand an existing RCP system ▪ Includes a microcontroller module (based on MPC565) ▪ Slots for up to 6 signal conditioning modules (SC modules) ▪ Slots for up to 2 communication modules (COM modules): The COM modules are used for communication with the host PC and for communication with the dSPACE prototyping system.

Housing components

The illustration below shows the housing of the different unit types.



The front and rear panels are also designed as modules. They provide the I/O connectors, connectors for communication, and status LEDs.

Unit combinations

The modular design of the RapidPro housing allows you to use the units in different combinations.

Single unit Every unit can be used separately.

Stack without UCB You can mount several single units together to build a stack. The units have no internal electrical connection. Each unit functions as a separate RapidPro system, as if used as a single unit.

Stack with UCB The RapidPro Control Unit can be combined with RapidPro SC and/or Power Unit in a stack to build a common system. An integrated unit connection bus (UCB) connects the SC and Power Units directly to the Control Unit without external wiring.

Operating conditions

With their compact and robust mechanical design, the units are ideally suited for in-vehicle use, and can also be used on test benches and in laboratories. All the modules used with the RapidPro units can be locked safely on the carrier board to avoid accidental disconnection.

The table below shows parameters which specify details on the operating conditions:

Parameter	Specification	
Power Supply	<ul style="list-style-type: none"> ▪ +6 V ... +54 V ¹⁾ ▪ Load dump protection up to +100 V ▪ Reverse voltage protection up to –100V 	
I/O protection	All inputs and outputs are protected for use in automotive environments. Detailed values depend on the modules used.	
Operating temperature	IEC60068-2-14-Nb	–40 ... +85 °C (–40 ... +185 °F)
Humidity	0 ... 95%, noncondensing	
Shock	ISO 16750-3:2007 / 4.2.2.	Test conditions: <ul style="list-style-type: none"> ▪ Linear shock (1/2 sine pulse), 6-axis ▪ Operating: 500 m/s², 6 ms, 10 pulses per axis
Vibration	EN 60068-2-6	Mechanical test of resistance to vibration: <ul style="list-style-type: none"> ▪ Test conditions: Sinusoidal vibration, 3-axis test, 5 ... 2000 Hz, up to 5 g, 30 minutes per axis

¹⁾ With an additional absolute maximum tolerance of +6 V.

Installation conditions

For the requirements on the installation location (for example, the space required), refer to [Choosing the Installation Location](#) on page 37.

More details

For complete reference information on the units (for example, the data sheet), refer to the corresponding unit chapters in the *RapidPro System – Installation and Configuration Reference*.

RapidPro SC/PS/COM Modules

Objective

Signal conditioning (SC), power stage (PS) and communication (COM) modules can be easily mounted on the RapidPro units to set up your system according to the needs of your use case.

Design and usage

The three module types (SC, PS and COM) have the same mechanical design concept. Modules are not limited in size: If complex electronic circuits require more space or pins than a single slot module offers, module types with double or triple slot form factors are used. The differences in use are:

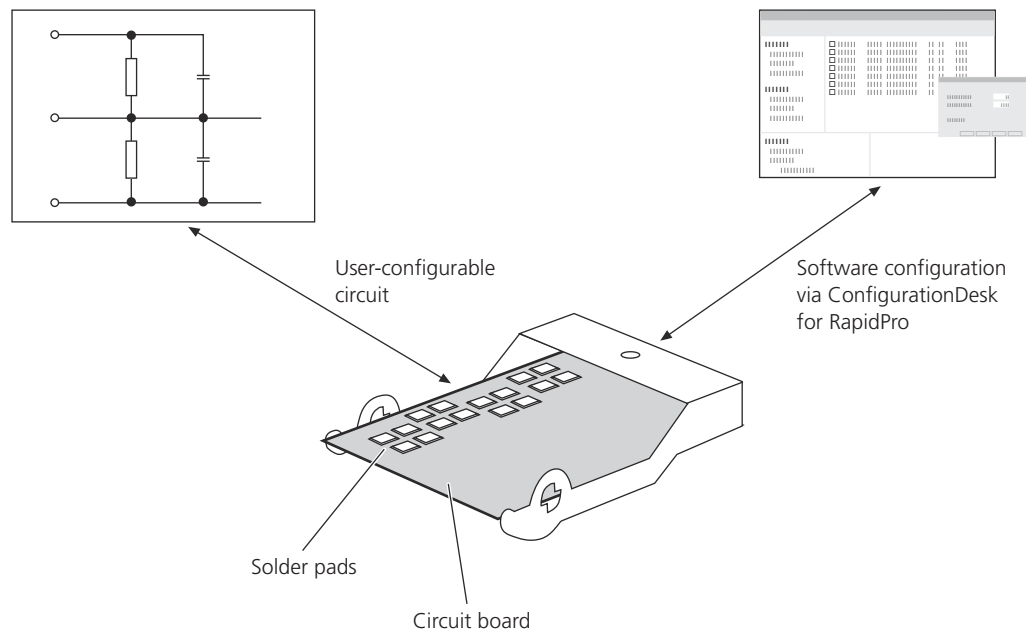
- The hardware- and software-configurable SC modules add signal conditioning to the RapidPro units. They can be mounted into the RapidPro SC Unit and the RapidPro Control Unit.
- The hardware- and software-configurable PS modules add power stage functions to the RapidPro units. The PS modules require the RapidPro Power Unit.
- The COM modules enable the RapidPro Control Unit to access USB and LVDS. These unconfigurable modules are not required in the SC and Power Units.

Configuring SC and PS modules

The SC and PS modules can be configured via software and/or by adding hardware components as follows:

- Parameters like input voltage range, output voltage range, filter frequency, etc. are configurable from a host PC (for example, notebook) with ConfigurationDesk for RapidPro via USB interface.
- Input circuits/output circuits of various modules can be configured by soldering additional electronic components (for example, pull-up and pull-down resistors) to user-configurable circuits.

The illustration below shows the SC-AI 4/1 module as an example. This module provides both configuration options. This is not the case with every module type.



Module types

The following table shows a selection of the available standard modules, and is not complete.

Module Type		Description
SC modules	SC-AI 4/1	4-channel differential analog input module
	SC-AI10/1	10-channel analog input module
	SC-DI 8/1	8-channel digital input module
	SC-DO 8/1	8-channel digital output module
	SC-SENS 4/1	4-channel sensor supply module
PS modules	PS-FBD 2/1	2-channel full-bridge driver module
	PS-HSD 6/1	6-channel high side driver module
	PS-LSD 6/1	6-channel low side driver module
COM modules	COM-USB-CI 1/1	1-channel USB configuration interface module (only used in the I/O subsystem scenario)
	COM-LVDS 1/1	1-channel LVDS interface module

More details

For complete reference information on the modules (for example, the data sheet), refer to the corresponding module chapters in the *RapidPro System – Installation and Configuration Reference*.

Hardware Accessories

Objective

To make working and handling with the RapidPro system easier, dSPACE provides some accessories for the hardware components.

Standard accessories

The following accessories are delivered with the hardware package as standard.

Accessory	Utilization	Specification
Hexagon socket wrench	For assembling RapidPro units and installing/uninstalling RapidPro modules.	1 x 2.5 mm (0.1 in.)
		1 x 6 mm (0.24 in.)
Sub-D rear connector set ¹⁾	For connecting the R1 or R2 rear I/O connector of the SC Unit or Power Unit.	1 x Sub-D connector, 50-pin male
		1 x metal hood for the 50-pin Sub-D connector
		50 x crimp contact, male (AWG18)
		2 x locking screw
		2 x locking hook
Sub-D front connector set	For connecting the F1 or F2 front I/O connector of the SC Unit, or the F2 front I/O connector of the Control Unit.	1 x Sub-D connector, female connector with 50 signal pins
		1 x metal hood for the 50-pin Sub-D connector
		50 x crimp contact, female (AWG18)
		2 x locking screw
		2 x locking hook
	For connecting the F1 or F2 front I/O connector of the Power Unit.	1 x Sub-D connector, female connector with 25 signal and 2 power pins
		1 x metal hood for the 25 (+2)-pin Sub-D connector
		25 x crimp contact, female (AWG18)
		2 x high-current contact, female, for soldering
		2 x locking screw
		2 x locking hook
	For connecting the F1 front I/O connector of the Control Unit.	1 x Sub-D connector, female connector with 41 signal and 2 power pins
		1 x metal hood for the 41 (+2)-pin Sub-D connector
		41 x crimp contact, female (AWG18)
		2 x high-current contact, female, for soldering
		2 x locking screw
		2 x locking hook

¹⁾ Is only delivered if you ordered the SC or Power Unit to use it as single unit.

Optional accessories

The following accessories are supplied on demand:

Accessory	Utilization	Specification
Crimper tool	Especially designed dSPACE crimper tool to connect wires to the contacts of the I/O connectors.	–
Contact removal tool (AWG20)	To remove contacts of the I/O connectors from the wires.	–
PC connection cable	To connect a single SC and/or Power Unit via USB to the host PC	–
	To connect a RapidPro system used as an I/O subsystem via USB to the PC	
LVDS connection cable	To connect a RapidPro Control Unit via LVDS with a dSPACE RCP system.	MicroAutoBox
		AutoBox with DS4121
Housing kit	Kit 1: For rebuilding a single unit from a stack without UCB.	1 x cover
		1 x base plate
		8 x hexagon socket head screw (M3 x 12, DIN912 A2)
		4 x protective caps to protect the threads of the half screws
	Kit 2: To mount a single unit to a stack without UCB.	1 x metal sheet for EMC
		6 x Phillips screw (M3 x 4, DIN912 A2)
		4 x nut (M12, hexagon socket)
		2 x guide pin (M4)

Note

It is strictly recommended to use cables, tools, screws, etc. provided by dSPACE to guarantee that the RapidPro system functions properly.

Third-party accessories

Accessory	Utilization	Specification
Contact removal tool for the male I/O connector power pins (Power Unit: F1 and F2 – Control Unit: F1)	To remove contacts of the I/O connectors from the wires.	DRK38 from FCT electronic GmbH

Installation and Configuration Overview

Objective

Your RapidPro system is delivered preconfigured according to your order. However, you need to prepare the system to adapt it to your application. It is recommended to proceed step by step.

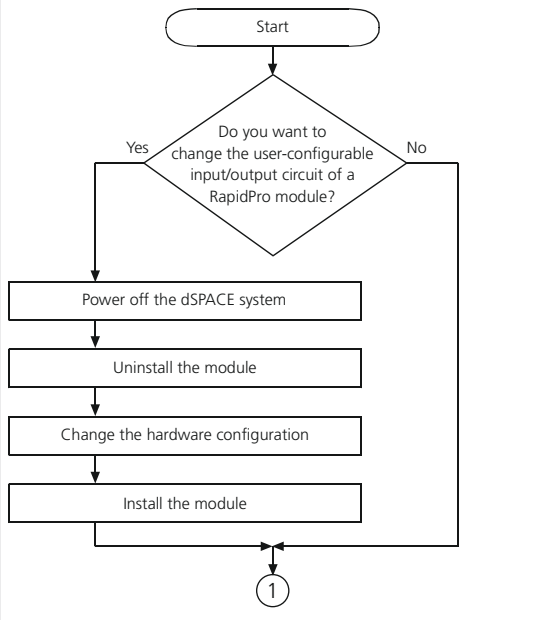
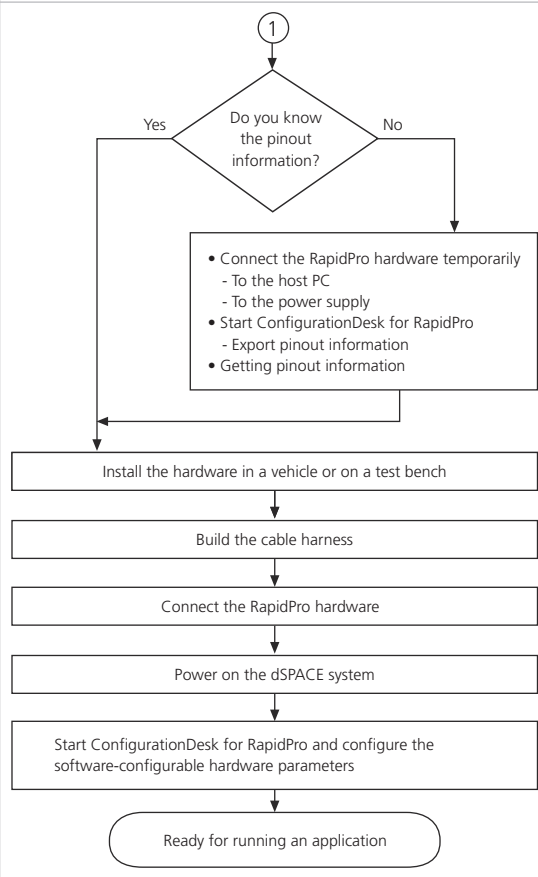
Steps for Installing and Configuring a RapidPro System

Recommended steps

If you want to install a RapidPro system, it is recommended to follow the steps in the table below.

Note

You must install dSPACE software on your host PC before you connect RapidPro hardware to it. You need administrator rights on the host PC to do so.

Procedure	Refer to ...
 <pre> graph TD Start([Start]) --> Decision1{Do you want to change the user-configurable input/output circuit of a RapidPro module?} Decision1 -- Yes --> PowerOff[Power off the dSPACE system] PowerOff --> Uninstall[Uninstall the module] Uninstall --> ChangeConfig[Change the hardware configuration] ChangeConfig --> Install[Install the module] Install --> Join1(()) Decision1 -- No --> Join1 Join1 --> 1((1)) </pre>	<p>Changing the Installation of SC/PS/COM Modules on page 100</p>
 <pre> graph TD 1((1)) --> Decision2{Do you know the pinout information?} Decision2 -- Yes --> Install[Install the hardware in a vehicle or on a test bench] Decision2 -- No --> TempConnect[Connect the RapidPro hardware temporarily - To the host PC - To the power supply Start ConfigurationDesk for RapidPro - Export pinout information Getting pinout information] TempConnect --> Install Install --> BuildHarness[Build the cable harness] BuildHarness --> ConnectHardware[Connect the RapidPro hardware] ConnectHardware --> PowerOn[Power on the dSPACE system] PowerOn --> Configure[Start ConfigurationDesk for RapidPro and configure the software-configurable hardware parameters] Configure --> Ready([Ready for running an application]) </pre>	<p>Basics on Connecting to Power Supply on page 58</p> <p>Getting Pinout Information on page 78</p> <p>Installing RapidPro Hardware in a Vehicle/Test Bench on page 37</p> <p>Building the Cable Harness on page 41</p> <p>Putting RapidPro Hardware into Operation on page 89</p> <p><i>ConfigurationDesk for RapidPro – Guide</i></p>

Installing RapidPro Hardware in a Vehicle/Test Bench

Objective	You can install the RapidPro hardware either in a vehicle or on the test bench. Proper installation protects the hardware and its environment against damage.
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Where to go from here	Information in this section
------------------------------	------------------------------------

Choosing the Installation Location.....	37
Provides some general points to consider, and information on the space required for the units or a stack.	
How to Install RapidPro Hardware.....	39
Describes how to install a unit or a stack to protect it and its environment against damage as a result of slipping while, for example, the vehicle is moving.	

Choosing the Installation Location

Objective	Before you install the RapidPro hardware in a vehicle or on a test bench, you have to decide on a location.
------------------	---

Space required

The space required depends on the hardware you have assembled (single unit or stack).

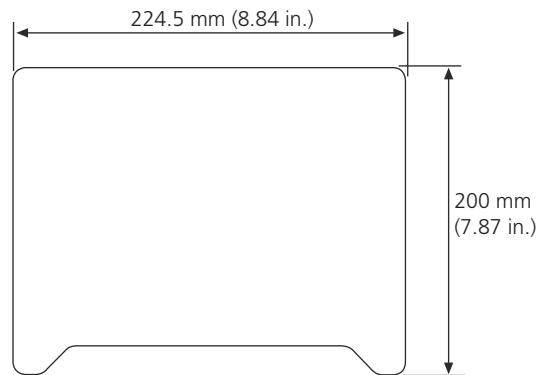
Note

In addition to the dimensions of the hardware, remember that additional space is needed for:

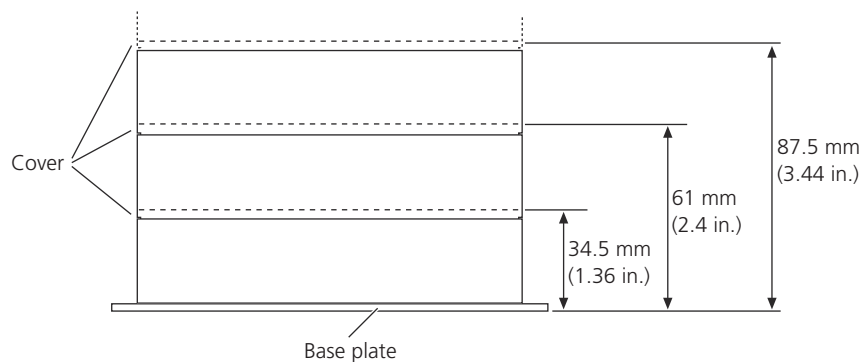
- Connectors matching the I/O connectors of the RapidPro hardware (on front and rear panels)
- Connecting and disconnecting the units or the stack.

The following illustration shows the dimensions of the hardware. You can also determine the height of your stack from these.

Top view



Front view

**Mounting location**

When you choose a location to mount the RapidPro hardware you have to consider the following points:

- Choose an even surface. If you fix the hardware to an uneven surface, distortion of the housing and therefore damage to the electronics inside may occur.

- You can install the hardware in any position: horizontal or vertical, even upside down. As long as the maximum housing temperature $T_{\text{Housing}} = +95\text{ °C}$ ($+203\text{ °F}$) is not exceeded, the function of the RapidPro system is guaranteed.
- The housing of the units is used as heat sink. The housing and the connectors of especially the RapidPro Power Unit, and a stack with Power Unit can reach temperatures above $+95\text{ °C}$ (203 °F). To avoid damage to flammable devices, components, cables etc., install them at a safe distance from the Power Unit, respectively the stack with Power Unit.
- Leave enough space between the RapidPro hardware and other devices to ensure sufficient heat dissipation.

Max. length of the connection cables

If you decide on a location, consider the specifics of your cable harness, such as the maximum lengths of the connection cables. For further information, refer to [Building the Cable Harness](#) on page 41.

How to Install RapidPro Hardware

Objective

You have to fix the RapidPro hardware firmly in place, especially in a vehicle. This protects it and its environment against damage as a result of slipping while the vehicle is moving. Every single unit and every stack is equipped with a base plate that has mounting holes to fix it.

Preconditions

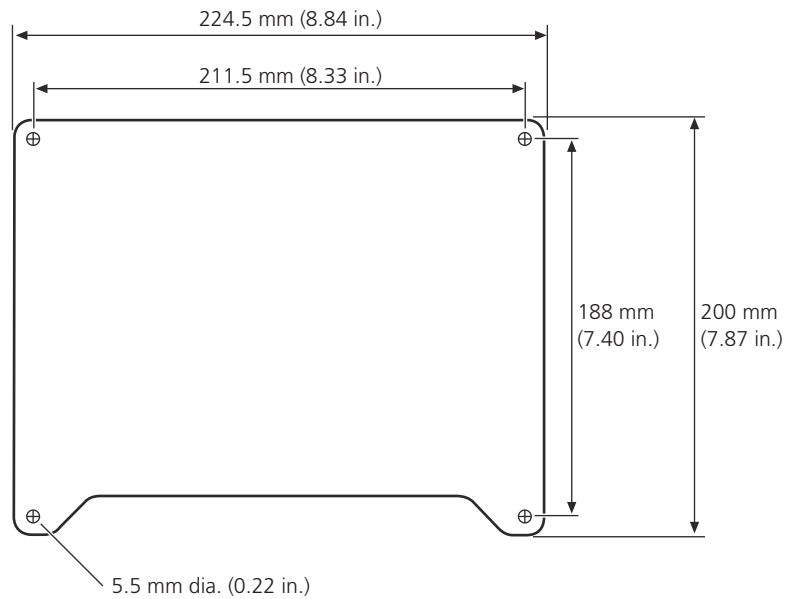
- The installation location has been chosen. For the space required and general points, refer to [Choosing the Installation Location](#) on page 37.
- One or more RapidPro units are mounted on a base plate. For assembling options and the corresponding instructions, refer to [Changing the Assembly of RapidPro Units](#) on page 149.
- For installation you need:
 - Four bolts and nuts (M5 is recommended), alternatively four self-tapping screws
 - A drilling machine

Method**To install the RapidPro hardware**

- 1 Clean the surface of the mounting position.
- 2 Use the following illustration to determine the positions of the bore holes.

Note

The illustration is not to scale.



- 3** Drill the four holes.
- 4** Fix the hardware using four bolts and the nuts (M5 is recommended), respectively four self-tapping screws.

Result

The RapidPro hardware now is firmly mounted and protected against slipping.

Building the Cable Harness

Objective	To ensure that the RapidPro hardware functions properly, there are specific requirements you must meet when planning and building the cable harness. There is also a specially designed dSPACE crimper tool that will help you to build the cable harness.
------------------	--

Where to go from here	Information in this section
	Proper Cabling..... 42 Provides information on proper cabling, such as aspects of grounding, shielding, and wiring up external devices.
	Basics on Connecting to Power Supply..... 58 Provides basic information (notes and tips) on connecting the RapidPro units to a power supply.
	Basics on Connecting the Enable and Watchdog Inputs..... 72 If you use an SC Unit or Power Unit as a single unit, you must connect an enable/disable signal to it to switch its outputs on or off.
	Basics on Connecting the RapidPro System to a dSPACE RCP System..... 75 Provides information on connecting an RCP system via high-speed serial link (LVDS).
	Building the I/O Connector..... 78 Gives information on getting pinout information and building the I/O connectors.
	Crimping Contacts..... 83 Gives instructions on crimping contacts with the dSPACE crimper tool, which is especially designed for the dSPACE RapidPro hardware.

Proper Cabling

Objective

Proper cabling, including grounding and shielding, reduces noise, capacitive and inductive effects, and influences caused by electro-static discharge (ESD) pulses.

Tip

The advice specified here also applies to the cabling of the devices inside your vehicle or test bench. It is better to eliminate the cause than to reduce the effects.

Where to go from here

Information in this section

Terms and Definitions Concerning Grounding.....	42
Grounding Concept of RapidPro Units.....	44
Grounding Examples.....	45
Evaluating Star Point Grounding Schemes.....	49
Building the Cable Harness.....	53
Shielding.....	54
Avoiding Crosstalk by Proper Cabling.....	56
Note for Building a Cable Harness to Connect Devices to a PS-DINJ 2/1 Module.....	56

Terms and Definitions Concerning Grounding

Ground signal classes

The following definitions help you distinguish between the various signal classes:

- A *signal return line* is the reference potential of a signal. It should carry the same amount of current as the corresponding signal line, and this current must be kept small.
- The *power supply ground* is the return path for the supply voltage. It carries large and varying currents resulting in significant (AC) voltage drops along the cable. Never use the same wire for signal return and power supply ground.
- The *chassis ground* is the power supply ground of vehicles. In most cases, the chassis ground is connected to the negative pole of the battery.

- A *shield* is a barrier to keep everything inside in and keep everything outside out. It is usually connected to the device enclosures at both ends to form a closed cage around all signals. It is not necessarily connected to power supply ground.

Ideal grounding

Ideal grounding is a grounding scheme where each signal return line is separated from other signal return lines and no ground loops exists. All devices must provide potential-free interfaces to connect the signals with their own signal return line. With ideal grounding, the measurement result of sensor input signals cannot be corrupted by voltage drops caused by load current flow on the ground lines.

For most applications, ideal grounding is not suitable because most devices do not provide potential-free interfaces and a separate signal return line for each signal. However, the separation of signal return lines always help you to avoid ground loops.

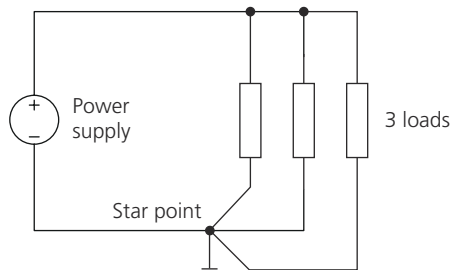
For an example, refer to [Grounding Examples](#) on page 45.

Star point grounding

Star point grounding is a grounding scheme where all ground lines are connected at a common point, the star point. The star point provides the same reference potential for all signal and supply voltages. This prevents ground loops and their possible effects on measurement results in the application. Star point grounding comes near to an ideal configuration and is applicable for most applications.

In a star point configuration, the signal return lines of the different devices are separated. You can connect devices that provide common signal return lines for several signal lines, and devices that provide potential-free interfaces. To come near to an ideal configuration, different signal return lines of one device are separately connected to the star point.

For the basic principle, refer to the following illustration.



You can use the following devices in an application with star point grounding:

- Devices that provide a common signal return line for several signal lines.
- Devices that provide potential-free interfaces for their signals.
- With limitations on signal quality, devices that use chassis ground as a signal return line or the signal return line is hard-wired to chassis ground.

For an grounding example with a sensor that is connected to the star point and an additional ground connection, refer to [Bad configuration example 1](#) on page 48.

For an star point grounding example, refer to [Grounding Examples](#) on page 45.

Grounding Concept of RapidPro Units

Grounding concept

The rear connectors of RapidPro units are connected to the dSPACE prototyping system (e.g., MicroAutoBox), the front connectors to the sensors, actuators, loads, and the power supply.

To avoid ground loops between the dSPACE prototyping system and the RapidPro system, the signal return lines of the rear connectors are isolated from the signal return lines and power supply grounds of the front connectors.

Each connector provides separate signal return lines for digital signals and analog signals to avoid crosstalk from digital signals to analog signals.

Note

At the front connector, the signal return lines of the modules are neither connected to each other nor to power supply ground. This lets you implement different grounding schemes.

- To prevent unexpected offsets between the power supply ground of the RapidPro units and the signal return lines, make sure that all pins for signal return lines at the front connector are connected to a reference potential such as the star point (star point grounding) or power supply ground (ideal grounding).

For examples, refer to [Grounding Examples](#) on page 45.

Signal description of the grounds

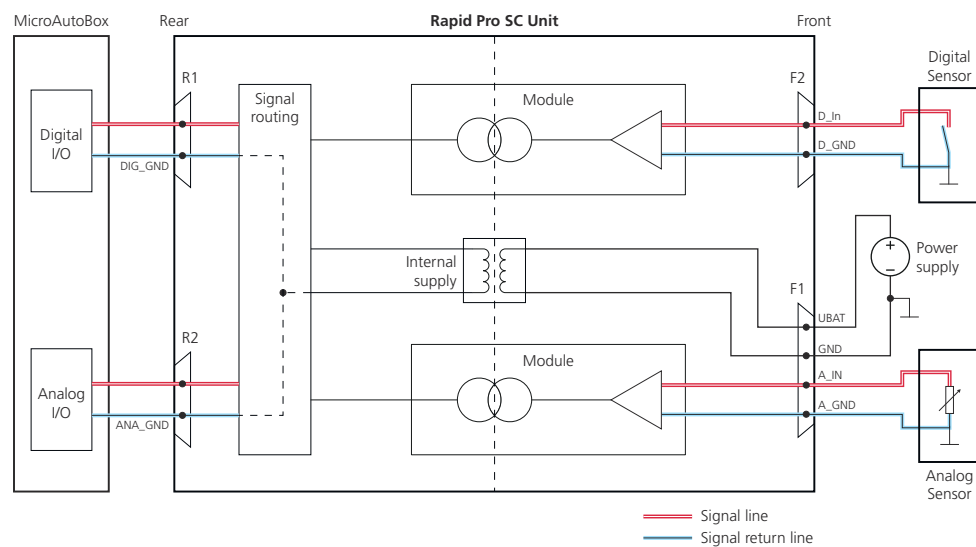
Connector	Signal Name	Description
Front connector	D_GND ¹⁾	Signal return line for digital signals
	A_GND ¹⁾	Signal return line for analog signals
	GND	Power supply ground
	GND1	Power supply ground for a RapidPro Power Unit and the modules inserted in slots 1 ... 3 ²⁾
	GND2	Power supply ground for modules inserted in slots 4 ... 6 of a RapidPro Power Unit ²⁾

Connector	Signal Name	Description
Rear connector	DIG_GND	Signal return line for digital signals of the dSPACE prototyping system
	ANA_GND	Signal return line for analog signals of the dSPACE prototyping system

- 1) For the pinout of the front connector, refer to [Getting Pinout Information](#) on page 78.
- 2) For details, refer to [Connecting a Power Unit to Power Supply](#) on page 61.

Circuit diagram

The following example shows a simplified diagram of a RapidPro SC Unit that is connected to sensors and a dSPACE prototyping system.

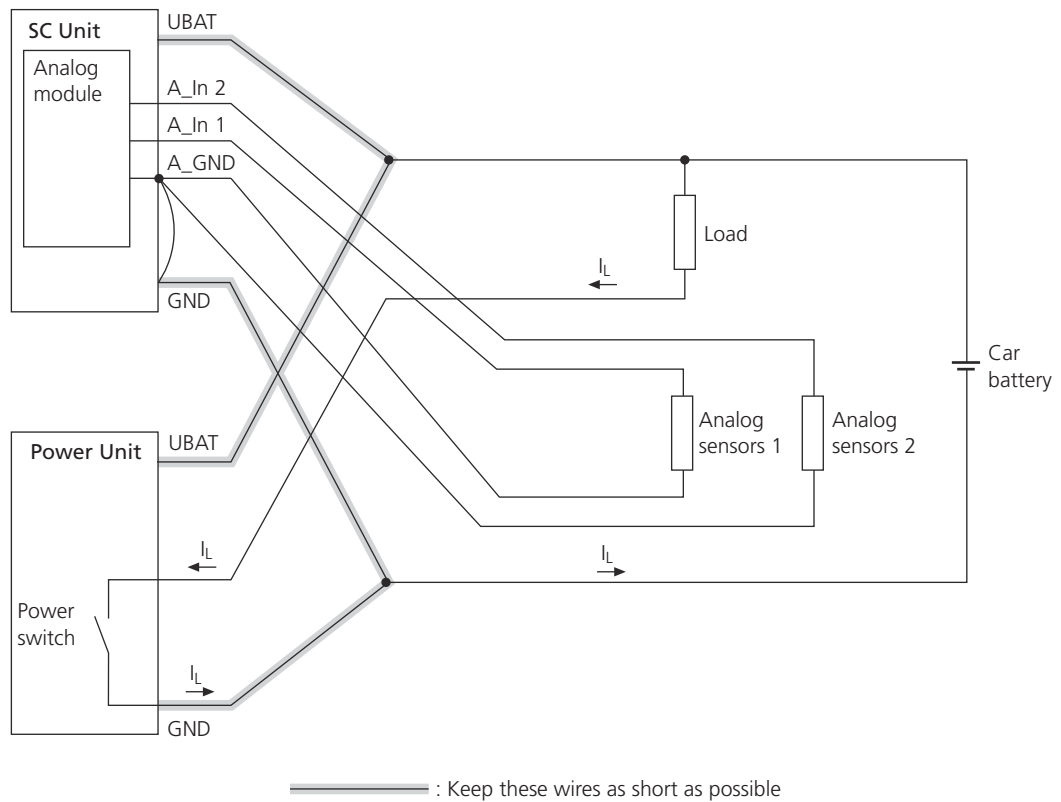


Grounding Examples

Objective

Ideal grounding and star point grounding have different requirements on the device's signal return lines. Star point grounding is suitable for most applications.

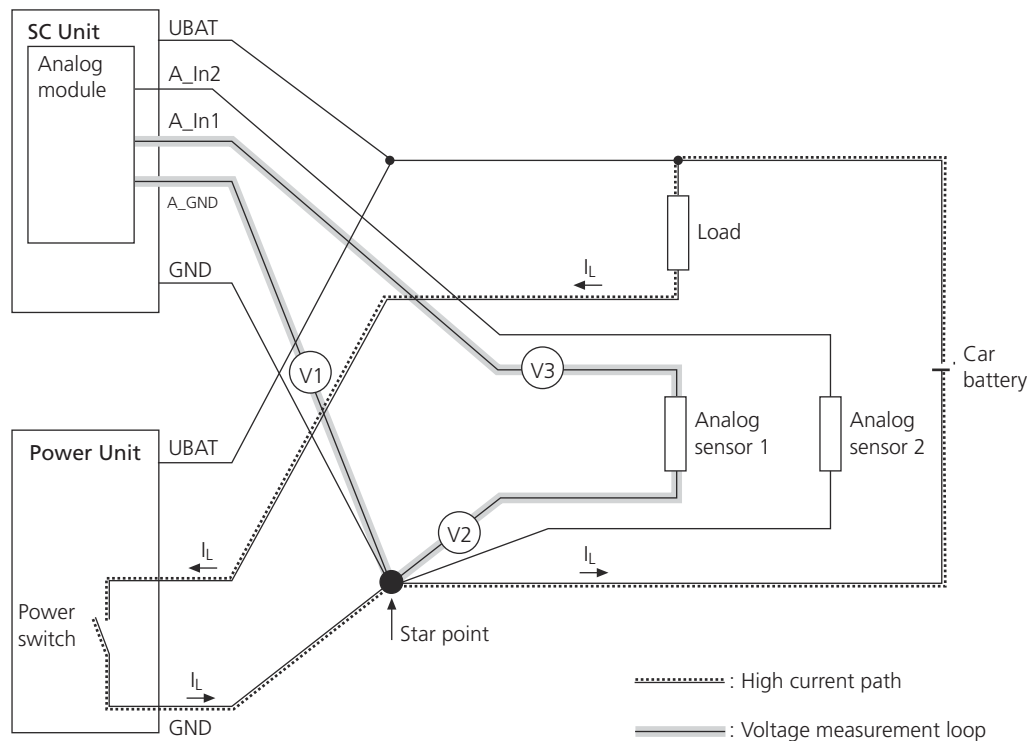
Ideal grounding



Note the following points:

- The power supply connections (UBAT, GND) to the units must be as short as possible.
- Connect the signal return lines directly to the RapidPro units. Make sure that each signal return line and the corresponding signal are connected to the same module.
- To prevent unexpected voltage offsets, connect the signal return lines to power supply ground at the RapidPro system. An offset between a signal return line and power supply ground might cause malfunction.

Star point grounding



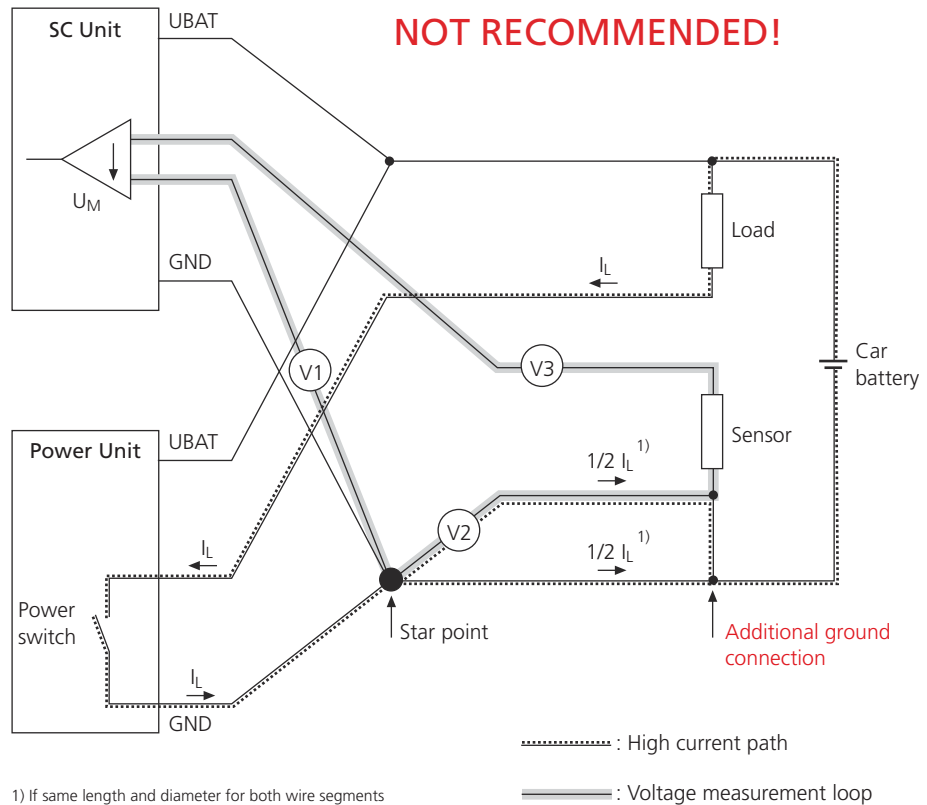
The configuration differs from ideal grounding in the following points:

- Signal return lines are connected to the star point. Sensors and actors should be connected to the star point with their own signal return lines.
- All ground pins of the signal return lines of the RapidPro units are connected to the star point:
 - Keep signal return lines of different modules separated.
 - Keep the A_GND and D_GND pins separated.

AC or DC noise injections to V1, V2, and V3 must be zero or negligible in a proper cable harness. You can achieve low AC or DC noise injections if you keep the cable length between the star point and the RapidPro system as short as possible and route the cables in a good way. For details on cable routing, refer to [Building the Cable Harness](#) on page 53.

Bad configuration example 1

For an example of current flow behavior in an application with star point grounding, where the *sensor is grounded at an additional position*, refer to the following illustration:



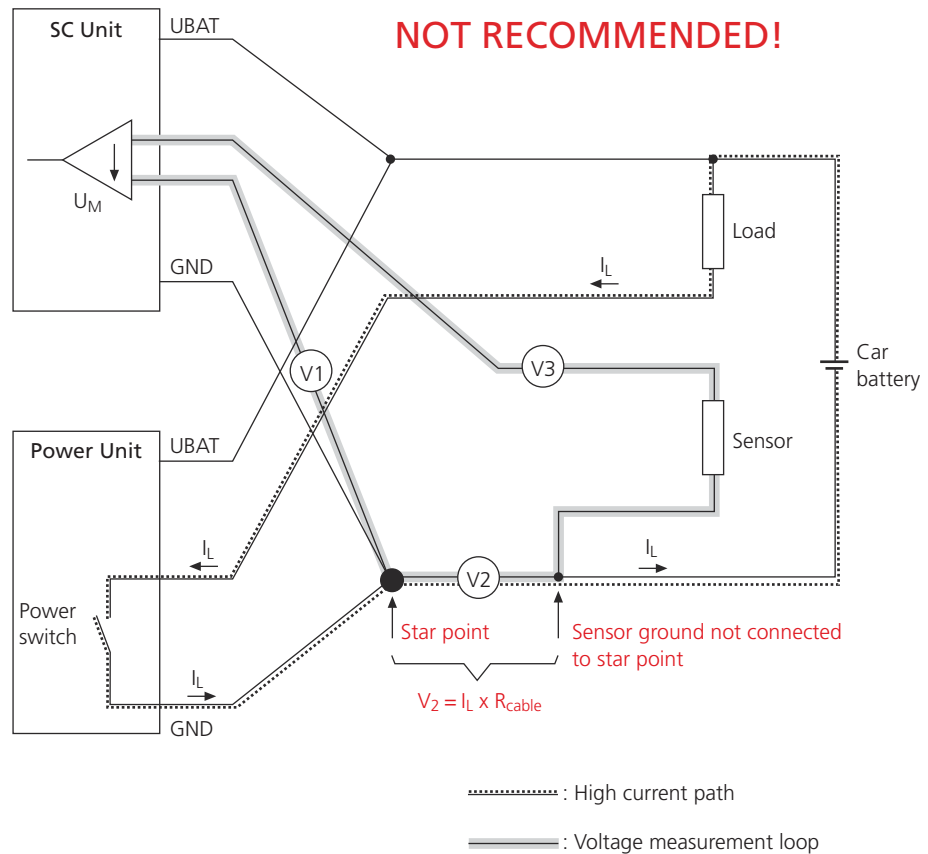
In this configuration, the current flow on V2 results in a negative voltage offset at U_M of an amount proportional to I_L .

Tip

You can reduce the voltage offset if you reduce the resistance between the star point and the additional connection. This can be done by an additional wire between the star point and the additional connection. The wire should have a substantial cross section.

Bad configuration example 2

For an example of current flow behavior in an application where the *sensor is grounded at a wrong position (no star point)*.



In this configuration, the current flow on V2 results in a negative voltage offset at U_M of an amount proportional to I_L .

Evaluating Star Point Grounding Schemes

Objective

To improve the signal quality and to avoid faulty measurements, observe the following general aspects on star point grounding in a RapidPro system.

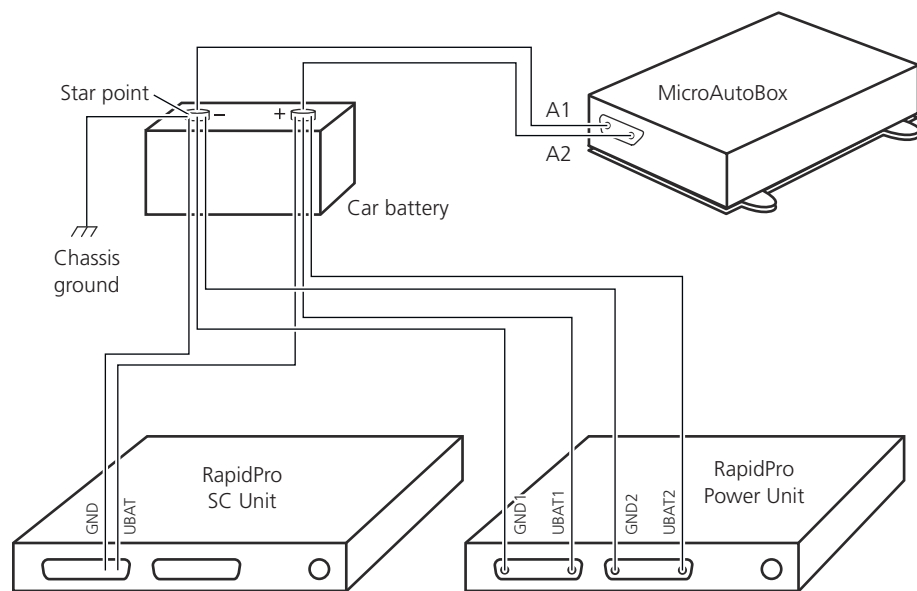
General rule

A grounding scheme has to be evaluated according to its AC current flow and not only to its DC behavior. Start the evaluation with the high current paths (power supply and actors that are supplied with high currents).

Connecting the power supply

- Each device is supplied via its own cable for supply voltage and power supply ground.
- Keep chassis ground and RapidPro's power supply ground separated to avoid ground loops.
- The male cable lug on the rear side of the RapidPro system's housing exists only for safety reasons. For details on the cable lug, refer to [Safety Precautions for Using the PS-DINJ 2/1 Module](#) on page 15.
- The power supply connections from the star point to the RapidPro units and the dSPACE prototyping system must be as short as possible.

For an example of a star point configuration for power supply, refer to the following illustration:

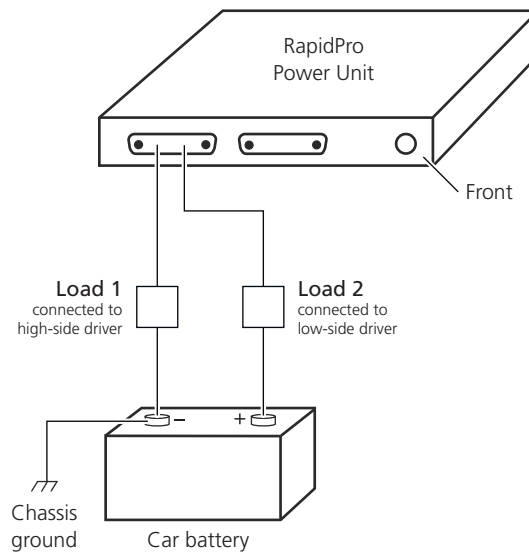
**Tip**

In most application there is no possibility to connect all wires directly to the battery. Choose a star point where you can connect all wires and wire this star point with a sufficient cross section to the battery.

For details on connecting a RapidPro system to power supply, refer to [Basics on Connecting to Power Supply](#) on page 58.

Connecting loads

- Loads that are driven by a high-side switch of a RapidPro Power Unit must be connected to the star point. Do not use the power supply grounds GND1 or GND2 of the RapidPro system.
- Loads that are driven by a low-side switch of a RapidPro Power Unit must be connected to the power supply. Do not use the power supply voltages UBAT1 or UBAT2 of the RapidPro system.



Connecting signals

- Connect each signal return line of the sensors and actuators to the star point. Each signal should have its own signal return line.

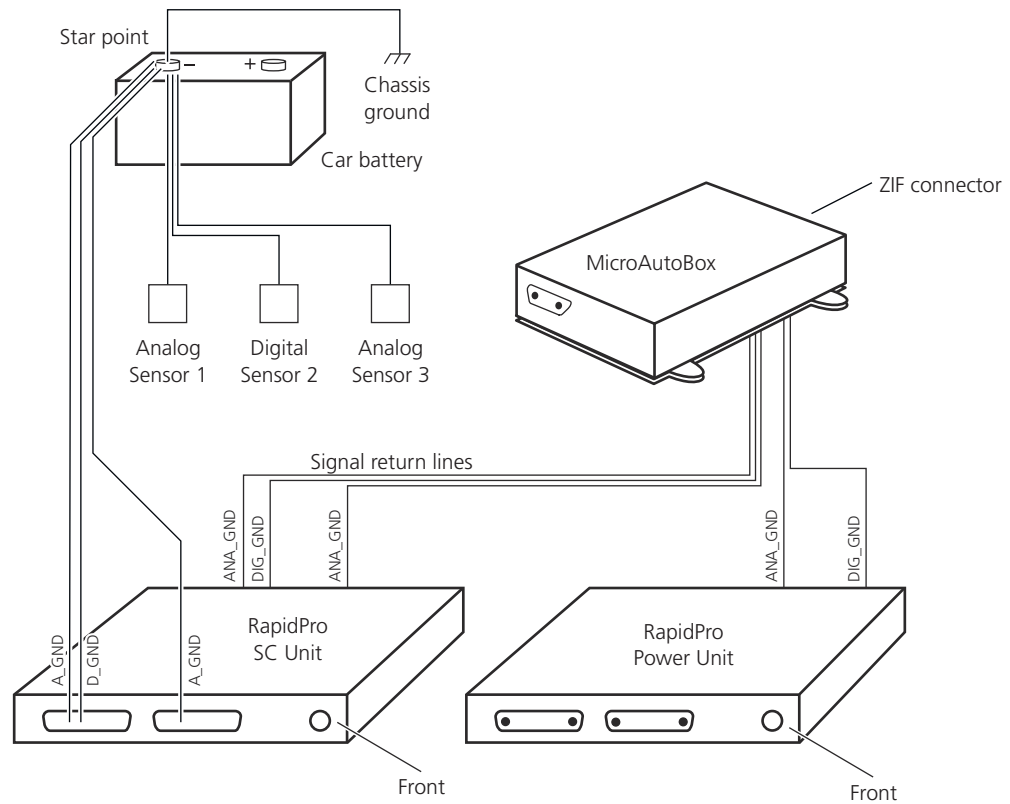
Note

Use the same star point for power supply ground and the signal return lines. In a star point configuration, there is only one star point for the whole system.

For devices that use chassis ground as a signal return line, add an additional wire from the chassis ground connection of the device to the star point. The wire should have a substantial cross section. For details on the effects if the signal return line has an additional connection, refer to [Bad configuration example 1](#) on page 48.

- Connect the signal return lines of RapidPro's front connector to the star point:
 - Keep analog (A_GND) and digital (D_GND) signal return lines separated.
 - Keep signal return lines of different modules separated.
- Connect signal return lines of RapidPro's rear connector directly to the dSPACE prototyping system. Keep the signal return lines separated.

The following illustration shows you an example.



Handling ground pins of unused modules

Note

Unconnected A_GND and D_GND pins of unused modules at the front connector of RapidPro units can cause modules to malfunction.

- Make sure that you connect unused pins for signal return lines at the front connector to the star point.

Grounding the RapidPro unit's housing

Note

You have to connect the housing of the RapidPro system to chassis ground only if you use a PS DINJ 2/1 module (DS1664). For details, refer to [Safety Precautions for Using the PS-DINJ 2/1 Module](#) on page 15.

Building the Cable Harness

Cabling supply lines

- The power supply must be connected by two twisted or parallel, large-diameter wires from the star point (e.g., the car battery) to the power supply inputs.
- Keep the cables as short as possible.

Cabling signals

- Use twisted pair cables for signals to reduce inductive coupling and so electromagnetic fields cancel out one another. Always twist the signal line and its signal return line. Never twist two signal lines.
- If a signal cable contains unused leads, connect them to signal return lines at both ends to lower the inductance between the dSPACE system and the sensor or actuator.
- Valid only for a star point configuration: Signal lines and signal return lines are twisted only between the sensor or actuator and the star point. Never twist a signal return line with signal lines between the star point and the RapidPro system.
- Valid only for an ideal configuration:
 - Always connect the signal line and the corresponding signal return line to the same module at RapidPro's front connector.
 - Connect the signal return lines with power supply ground (GND) of the RapidPro system.

Routing the cables

When wiring the different devices in your vehicle or test bench, consider that the routing of the cables can have effects on signal quality. For example, noise and/or crosstalk can be reduced and possibly avoided if you follow the notes and tips specified here.

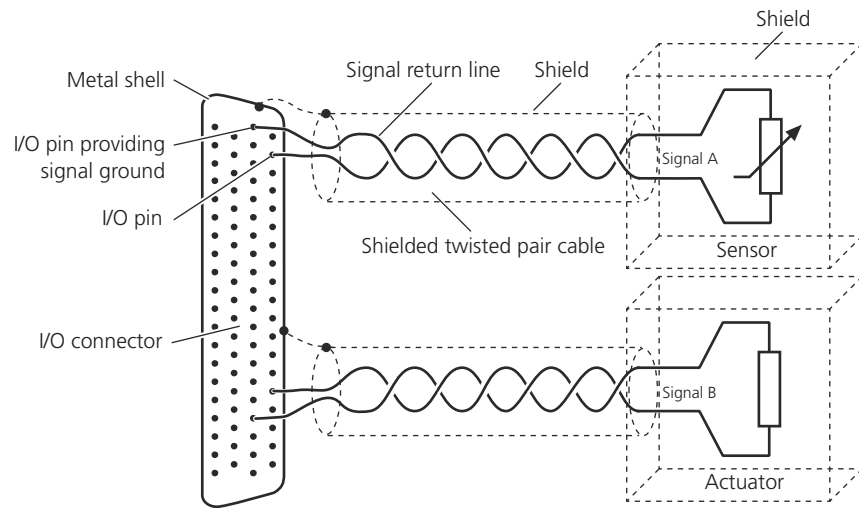
- Use connections that are as short as possible between the different devices in your vehicle or test bench: Sensors and actuators to RapidPro system and RapidPro system to the dSPACE prototyping system (e.g., MicroAutoBox).
The cable harness between the RapidPro system and the dSPACE prototyping system must not exceed 5 m (16.4 ft.).
- Keep cabling away from noise sources. Protect signal lines from magnetic fields caused by devices such as monitors, electric motors, welding equipment, transformers, and so on, by running these through special metal conduits.
- The supply voltage must be routed by two twisted or parallel large-diameter wires from power supply to the star point and from the star point to the devices.
- Do not route signal lines through conduits that also contain power lines.
- Separate signal lines from high-current or high-voltage lines. These lines are capable of inducing currents on the signal lines if they run parallel and close to them. To reduce the magnetic coupling between lines, separate them by a reasonable distance if they run in parallel, or run the lines at right angles to each other.

- Separate digital and analog signal lines. Keep fast-changing signals far away from analog inputs.

Shielding

Objective	Proper shielding reduces noise, inductive effects, and influences caused by electrostatic discharge (ESD) pulses. This is a precondition for achieving high-accuracy measurement results.
Background information	<p>The best shield is a low-inductance conductive barrier surrounding the complete setup of the device, cable and system, keeping everything inside in and keeping everything outside out (Faraday cage). Low resistance, and most especially low inductance, are the key to a good shield against electric fields.</p> <p>EMC radiation and immunity are mostly affected by the outer cable shield. Individual lead shielding has only a minor effect if a common outer shield is present. Individual shielding is only necessary to reduce crosstalk.</p>
Cabling	<p>For cabling, you should use shielded, twisted pair cables. The inner twisted pair leads are used for the signal line and the signal return line. The signal return line must be connected to ground pins of the respective connector of the dSPACE hardware.</p> <p>Ideally, each signal must be twisted with its signal return line so that any electromagnetic fields cancel out one another.</p>
Connecting shield	<ul style="list-style-type: none"> ▪ Use metal shell connectors. ▪ Use shielded twisted pair cables to shield the signal lines that are attached to each Sub-D connector. ▪ The shield must be connected directly to the sensor or actuator housing. Sometimes sensors and actuators have dedicated shield pins available at their connector. The idea is to form one closed shielding cage consisting of the cable shield and sensor or actuator enclosure, which is ideally not connected to a signal return line. Use a large-area connection and avoid pigtails.

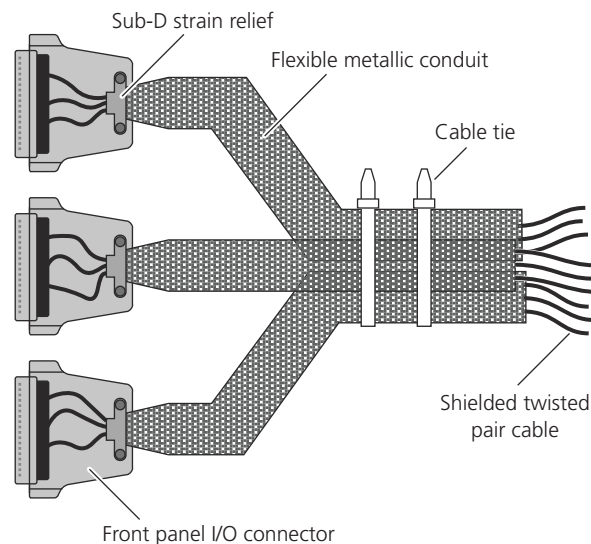
For a visualization of the above guidelines, refer to the following illustration:



Note

Do not connect the shield to a signal return line.
Never use a shield for power supply ground.

- Use a flexible metallic conduit to insert all cables that are connected to the I/O connectors. Each metallic conduit must be completely inserted in the strain relief of the respective I/O connector with surface contact (to obtain ESD protection).
- You are recommended to tie together the conduits of all I/O connectors, refer to the following illustration:



- The conduits do not need to be long. They can end after the cable tie, which should be close to the Sub-D connectors.

Avoiding Crosstalk by Proper Cabling

Background information

Crosstalk is any phenomenon in which a signal transmitted on one circuit or channel of a transmission system creates an undesired effect in another circuit or channel.

Crosstalk occurs if a signal with steep edges or a high frequency runs close to a high-impedance signal. The main reasons for crosstalk are capacitive and inductive coupling.

Measures to avoid crosstalk

If crosstalk becomes a problem in your application, take the following measures to reduce and possibly avoid it:

- Twist each signal line with its return line.
- Never twist two signal lines.
- Separate digital and analog signal lines. Keep fast-changing signals far away from analog inputs.
- Transform high-impedance sources, with a RapidPro SC-AI 10/1 module for example, to a lower impedance value before connecting it to the inputs of MicroAutoBox or dSPACE boards in an AutoBox.
- If you use multiconductor cables, the individual twisted pairs must be shielded.
- You should also read the advice in [Building the Cable Harness](#) on page 53.

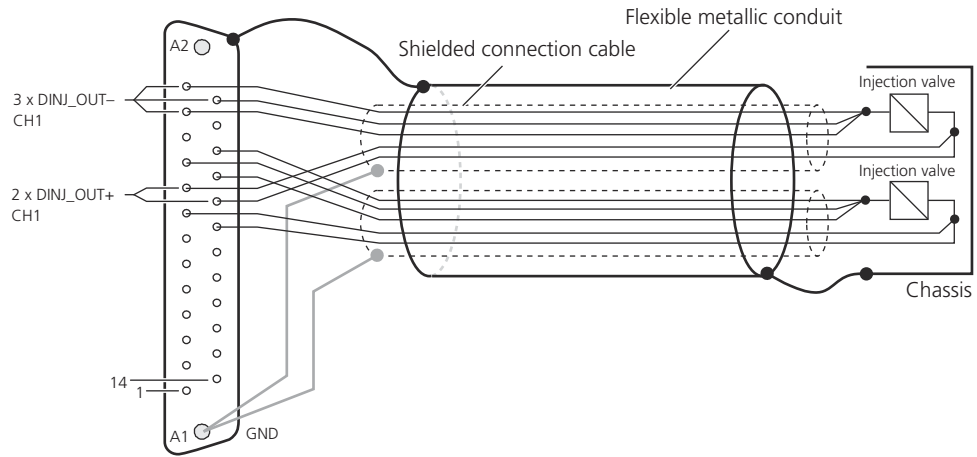
Note for Building a Cable Harness to Connect Devices to a PS-DINJ 2/1 Module

Objective

The PS-DINJ 2/1 module can generate very high and very short voltage spikes by driving injection valves. To avoid electromagnetic interferences to other devices in your test bench, you have to pay attention to specific guidelines when you build the cable harness.

Connection example

For an example of the cable harness for a Power Unit with an installed PS-DINJ 2/1 module, refer to the following illustration:

**Guidelines for building the cable harness**

- Keep the connection to the injection valves as short as possible.
- Connect all 5 output pins of the PS-DINJ 2/1 module (2 x DINJ_OUT+ and 3 x DINJ_OUT-) to each injection valve. Twist the signal lines of each channel.
- Use a separate shielded cable for each channel of the PS-DINJ 2/1 module. For example, HELUKABEL F-CY-OZ 5 x 0.75, 5 x 1.
- Connect the shields of the cables to the GND pin (A1) of the Sub-D connector. Do not connect the shields on the valve side to avoid ground loops.
- The shielded cables to the injection valves must be coated with a flexible metallic conduit, even if it is only one shielded cable. Connect one side of the conduit to the RapidPro housing via the connector shell of the I/O connector and the other side to the enclosure of the injection valves or other metallic parts of the engine (test bench).

Basics on Connecting to Power Supply

Objective The power supply for your RapidPro system can be a car battery or a laboratory power supply.

Connection variants There are two different ways to connect the power supply to the units, depending on the assembly:

- **Single unit and stack without internal electrical connection**
If you use an SC Unit, Power Unit, or Control Unit as single unit, each has to be connected to the power supply separately. If several units are assembled in a stack without internal electrical connection, they must each be connected separately to the power supply, too.
- **Stack with internal electrical connection (UCB)**
You have to connect only the Control Unit of the stack. All the other units in the stack get their power supply from the Control Unit via UCB (unit connection bus). However, Power Units in the stack must be connected to the power supply separately to drive loads at their outputs.

Where to go from here

Information in this section

Connecting an SC Unit to Power Supply.....	58
Connecting a Power Unit to Power Supply.....	61
Connecting a Control Unit or a Stack with UCB to Power Supply.....	65
Provides basic information on connecting a Control Unit, or a stack with UCB, to power supply.	
Powering a RapidPro System with Connected Break-Out Boxes.....	69
Requirements for a Lab Power Supply.....	70
Provides information for choosing a suitable laboratory power supply.	

Information in other sections

Connecting an SC Unit to Power Supply

SC Unit as part of a stack with UCB If the SC Unit is part of a RapidPro stack with UCB, you do not have to connect it to the power supply separately. The power supply inputs of the SC Unit are deactivated. The supply voltage connected on the front I/O connector of the stack's Control Unit is passed on via the UCB connectors. So the SC Unit is powered by its UCB connectors.

For basics on connecting power to a stack with UCB via Control Unit, refer to [Connecting a Control Unit or a Stack with UCB to Power Supply](#) on page 65.

Power supply inputs

For connection to power supply, the SC Unit provides the following pins:

- Power supply input (*UBAT*)
- Power supply ground line (*GND*)
- Remote control input (*KL15*)
- Power output to pull up the KL15 pin (*KL15_PU*).

Connection variants

There are two connection variants, depending on the operation mode:

- Remote control mode

The SC Unit provides a remote control input (KL15). This allows you to switch the unit on/off by a remote switch: signal KL15 (output of the ignition/driving switch), for example. The remote control mode is strongly recommended if you use the car battery as the power supply. If you connect the remote control input (KL15) to the car battery directly, the unit will always be on, and the car battery will soon be exhausted if the engine is not running.

- Continuous mode

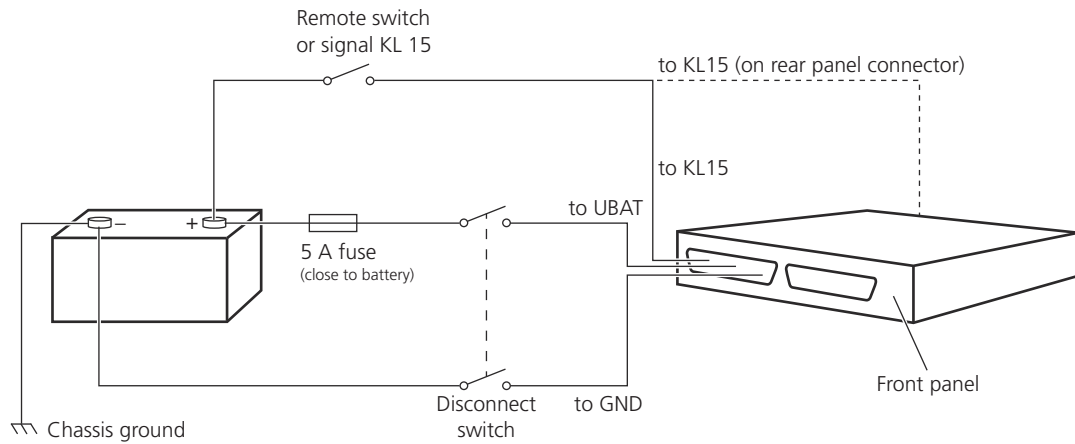
In continuous mode, you can switch the SC Unit on/off by switching or connecting/disconnecting the recommended laboratory power supply. You must connect the remote control input (KL15) to the KL15_PU pin for this. Thus, the remote control input is connected to the power supply internally via the unit.

Tip

To enable the outputs of a unit used as single unit, you have to connect an enable signal and, if activated, a watchdog signal to the rear connector panel. For further information, refer to [Basics on Connecting the Enable and Watchdog Inputs](#) on page 72.

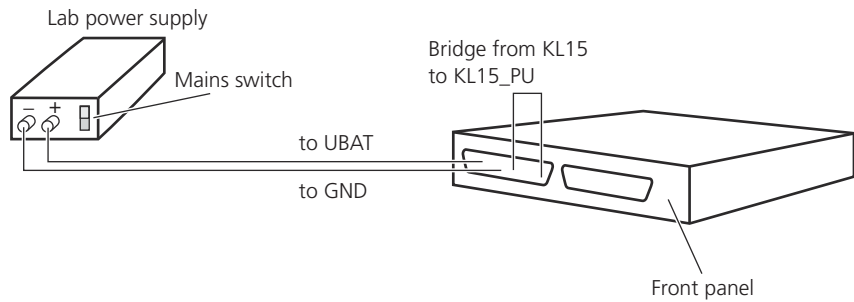
Wiring for remote control mode

For remote control mode, perform the wiring according to the following illustration:



Wiring for continuous mode

For continuous mode, perform the wiring according to the following illustration:



Tip

For continuous operation in a vehicle, you can also connect the remote control input (KL15) to the positive terminal of the car battery or to signal KL30. Thus, the unit will always be on, and the car battery will soon be exhausted if the engine is not running.

Mapping the signals

For the mapping of the power supply signals (UBAT, GND, etc.) to the pins of the I/O connectors, refer to [Pin Numbering of I/O Connectors](#) on page 80.

Notes on connecting UBAT and GND

⚠ CAUTION

Short circuit between cables connected to the car battery/power supply can lead to electric arcs or fire

If a short circuit occurs, e.g., in the cable harness, the current of the car battery (power supply) generates heat in the connected cables. The heat might cause a fire. Batteries always supply high currents if a short circuit occurs.

- Insert fuses into the power supply cable and other cables that are connected to the battery/power supply to avoid an electrical fire.
- Locate the fuses close to the battery/power supply.
- Choose fuse ratings that ensure that the fuses break the circuit if the connected cables are loaded with the maximum currents supported by the cross sections of the cables used.
- Make sure that you use flame-retardant cables specified for temperatures up to 105 °C (220 °F) that were tested in conformity with IEC 60332-1-2, IEC 60332-2-2, or UL VW-1.
- Make sure that you use flame-retardant connectors specified for temperatures up to 105 °C (220 °F) and V-2 classified in conformity with IEC 60695-11-10 or UL 94.

When connecting the power supply input (UBAT) and the power supply ground line (GND), note the following points:

- Use wires with large cross-sections to avoid poor performance of the power supply, too much voltage drop, and excessive heating of the wires. Choose the cross-section and the length of the wires according to the maximum current. Recommended: minimum cross-section 0.8 mm² (AWG 18), maximum length 5 m (16.4 ft.)
- Notes on connecting RapidPro hardware to a car battery:
 - It is strongly recommended to insert a fuse into the power supply input wire (close to the battery). Choose the value of the fuse according to the maximum current. Recommended: 5 A
 - It is recommended to connect GND to the negative pole of the car battery. If you connect it directly to the car chassis, ensure low-impedance and safe connection to the chassis.
 - Use an all-pole disconnect switch that matches the rating of the RapidPro system.
 - Make sure that the disconnect switch can be reached by the user in case of an emergency.

Connecting a Power Unit to Power Supply

Power Unit as part of a stack with UCB

If the Power Unit is part of a RapidPro stack with UCB, you must connect it to the power supply separately.

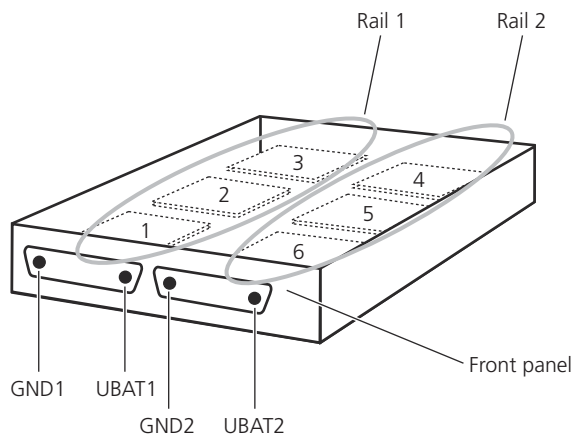
For basics on connecting power to a stack with UCB, refer to [Connecting a Control Unit or a Stack with UCB to Power Supply](#) on page 65.

Power supply inputs

For connection to power supply, the Power Unit provides the following pins:

- Power supply inputs (*UBAT1* and *UBAT2*)
- Power supply ground lines (*GND1* and *GND2*)
- Remote control input (*KL15*)

Connecting *UBAT1* and *GND1* powers all internal functions of the unit and supplies the modules which are inserted on rail 1 (slots 1 ... 3). Additionally, you must connect *UBAT2* and *GND2* if modules are inserted on rail 2 (slots 4 ... 6). See the illustration below.



Connection variants

There are two connection variants, depending on the operation mode:

- Remote control mode

The Power Unit provides a remote control input (*KL15*). This allows you to switch the unit on/off by a remote switch: signal *KL15* (output of the ignition/driving switch), for example. The remote control mode is strongly recommended if you use the car battery as the power supply. If you connect the remote control input (*KL15*) to the car battery directly, the unit will always be on, and the car battery will soon be exhausted if the engine is not running.

- Continuous mode

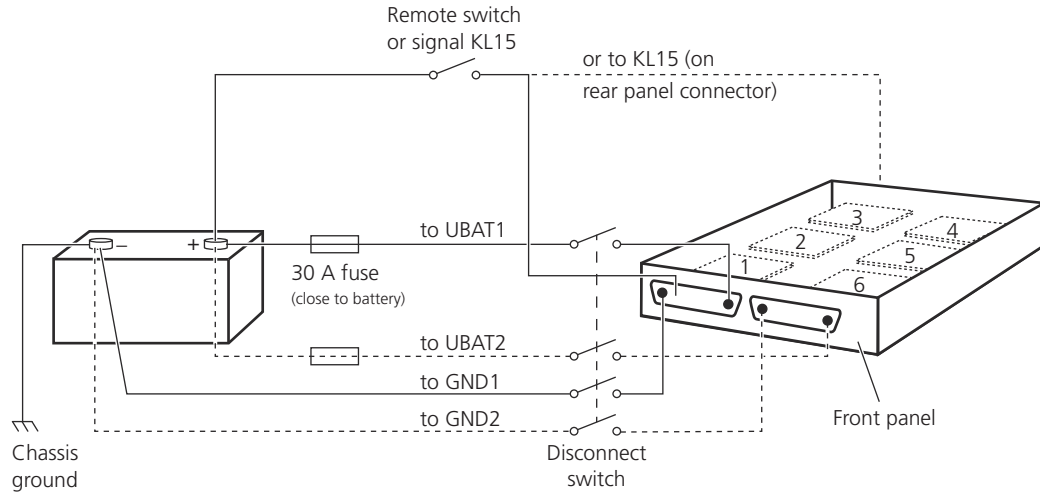
In continuous mode, you can switch the Power Unit on/off by switching or connecting/disconnecting the recommended laboratory power supply. You must connect the remote control input (*KL15*) to *UBAT1* for this. Thus, the remote control input is connected to the power supply internally via the unit.

Tip

To enable the outputs of a unit used as single unit, you have to connect an enable signal and, if activated, a watchdog signal to the rear connector panel. For further information, refer to [Basics on Connecting the Enable and Watchdog Inputs](#) on page 72.

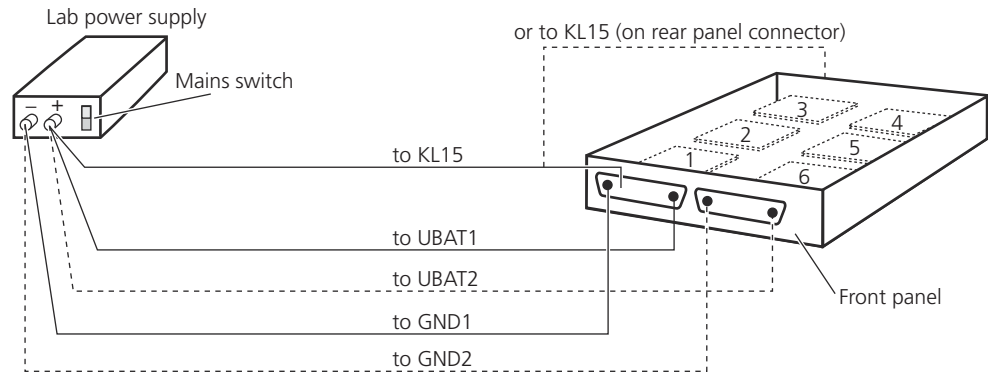
Wiring for remote control mode

For remote control mode, perform the wiring according to the following illustration. The dashed lines to UBAT2 and GND2 are optional and must be connected if modules are inserted on slots 4 ... 6 (rail 2).



Wiring for continuous mode

For continuous mode, perform the wiring according to the following illustration. The dashed lines to UBAT2 and GND2 are optional and must be connected if modules are inserted on slots 4 ... 6 (rail 2).



Mapping the signals

For the mapping of the power supply signals (UBAT1/UBAT2, etc.) to the pins of the I/O connectors, refer to [Pin Numbering of I/O Connectors](#) on page 80.

Notes on connecting UBATx and GNDx**⚠ CAUTION****Short circuit between cables connected to the car battery/power supply can lead to electric arcs or fire**

If a short circuit occurs, e.g., in the cable harness, the current of the car battery (power supply) generates heat in the connected cables. The heat might cause a fire. Batteries always supply high currents if a short circuit occurs.

- Insert fuses into the power supply cable and other cables that are connected to the battery/power supply to avoid an electrical fire.
- Locate the fuses close to the battery/power supply.
- Choose fuse ratings that ensure that the fuses break the circuit if the connected cables are loaded with the maximum currents supported by the cross sections of the cables used.
- Make sure that you use flame-retardant cables specified for temperatures up to 105 °C (220 °F) that were tested in conformity with IEC 60332-1-2, IEC 60332-2-2, or UL VW-1.
- Make sure that you use flame-retardant connectors specified for temperatures up to 105 °C (220 °F) and V-2 classified in conformity with IEC 60695-11-10 or UL 94.

When connecting the UBAT1/UBAT2 and GND1/GND2, note the following points:

- Use wires with large cross-sections to avoid poor performance of the power supply, too much voltage drop, and excessive heating of the wires. Choose the cross-section and the length of the wires according to the maximum current. Recommended: minimum cross-section 2 mm² (AWG 14), maximum cross-section 8.35 mm² (AWG 8), maximum length 5 m (16.4 ft.)
- Notes on connecting RapidPro hardware to a car battery:
 - It is strongly recommended to insert one fuse per power supply input wire (close to the battery). Choose the value of the fuses according to the maximum current. Recommended: 30 A (per UBAT wire)
 - It is recommended to connect each ground line (GND1, GND2) with a separate wire to the negative pole of the car battery. If you connect them directly to the car chassis take care of a low-impedance and safe connection to the chassis.
 - Use an all-pole disconnect switch that matches the rating of the RapidPro system.
 - Make sure that the disconnect switch can be reached by the user in case of an emergency.

Connecting a Control Unit or a Stack with UCB to Power Supply

Connecting a stack with UCB to power supply

If the stack with UCB consists of a Control Unit and one or more SC Unit, you have to connect only the stack's Control Unit to the power supply. The supply voltage connected on the Control Unit's front I/O connector is passed on via the UCB connectors. So the other units are powered by their UCB connectors.

However, if there is a Power Unit in the stack you must connect its power supply inputs and the power supply ground lines to drive loads on the power stage outputs.

Power supply inputs

For connection to power supply, the Control Unit provides the following pins:

- Power supply input (*UBAT*)
- Power supply ground line (*GND*)
- Remote control input (*KL15*)
- Power output to pull up the KL15 pin (*KL15_PU*).

Connection variants

There are two connection variants, depending on the operation mode:

- Remote control mode

The Control Unit provides a remote control input (KL15). This allows you to switch the unit on/off by a remote switch: signal KL15 (output of the ignition/driving switch), for example. The remote control mode is strongly recommended if you use the car battery as the power supply. If you connect the remote control input (KL15) to the car battery directly, the unit will always be on, and the car battery will soon be exhausted if the engine is not running.

- Continuous mode

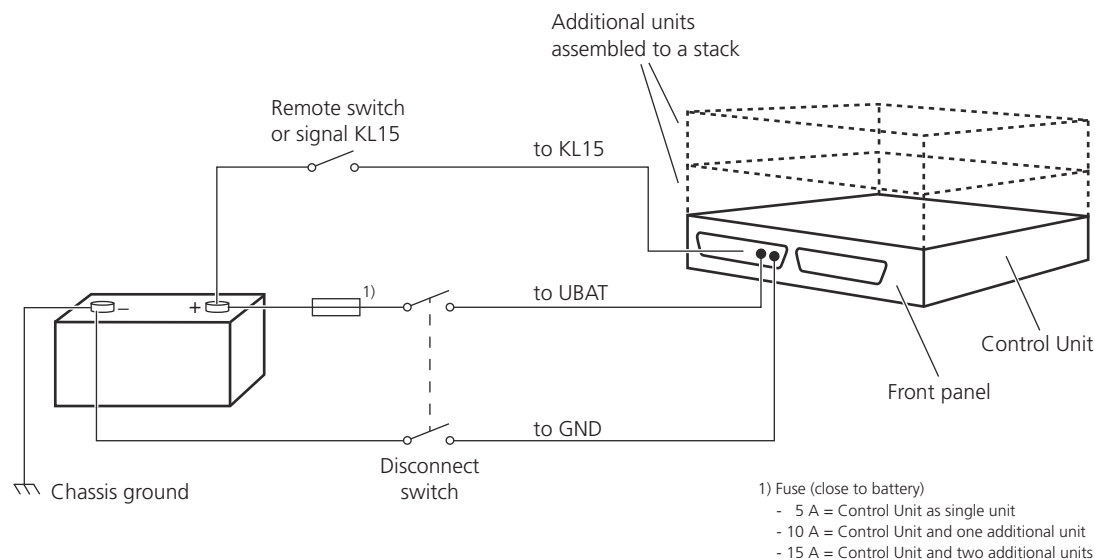
In continuous mode, you can switch the Control Unit on/off by switching or connecting/disconnecting the recommended laboratory power supply. You must connect the remote control input (KL15) to the KL15_PU pin for this. Thus, the remote control input is connected to the power supply internally via the unit.

Note

For a stack with UCB, you must connect only the pins KL15 and KL15_PU of the Control Unit depending on the connection variant. The pins of the other units in the stack (KL15/KL15_PU) are disabled. It has no effect, if you still connect these pins on the other units.

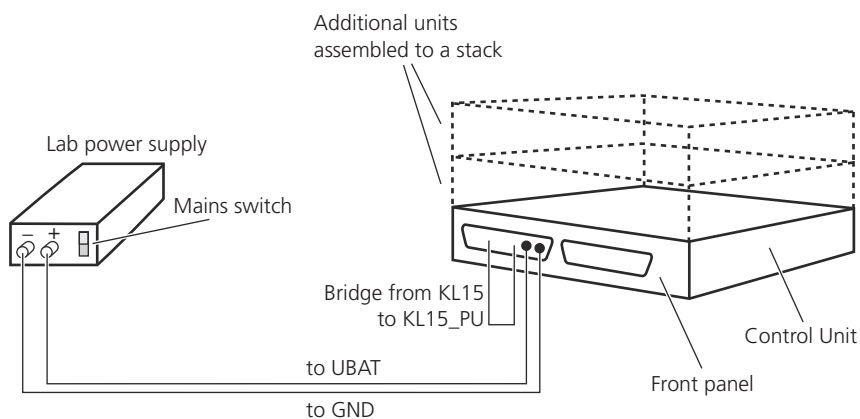
Wiring for remote control mode

For remote control mode, perform the wiring according to the following illustration:



Wiring for continuous mode

Perform the wiring according to the following illustration, if you want to use the continuous mode:



Tip

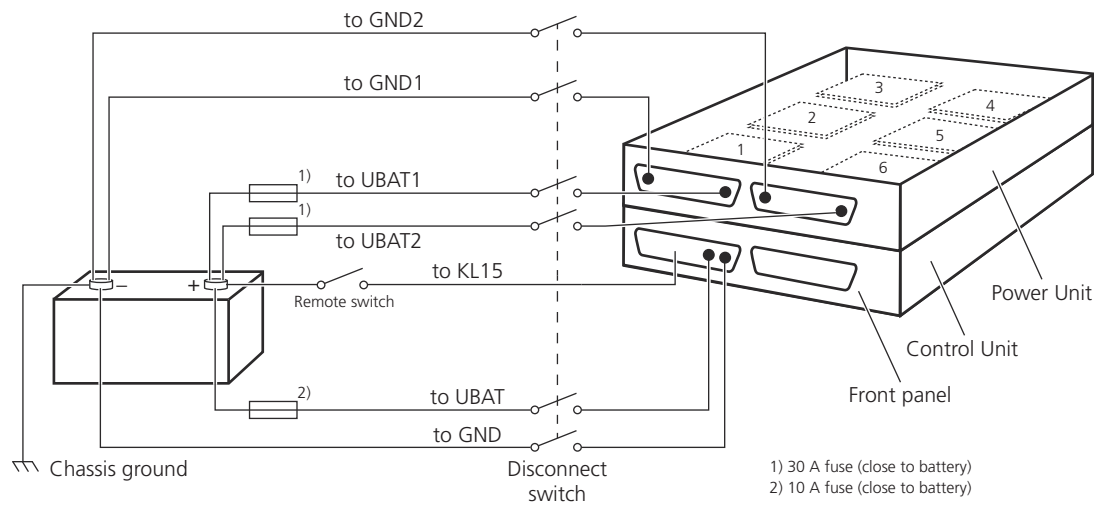
For continuous mode in a vehicle, you can also connect the remote control input (KL15) to the positive terminal of the car battery or to signal KL30. Thus, the unit will always be on, and the car battery will soon be exhausted if the engine is not running.

Wiring a stack with UCB containing a Power Unit

In addition to connecting the Control Unit to the power supply, you must connect it to the Power Unit as follows:

- If modules are inserted only in slots 1 ... 3 (rail 1) it is sufficient to connect UBAT1 and GND1.
- If modules are inserted only in slots 4 ... 6 (rail 2) it is sufficient to connect UBAT2 and GND2.

Perform the wiring according to the following illustration, if a Power Unit is assembled in a stack with UCB:



Mapping the signals

For the mapping of the power supply signals (UBAT, GND, etc.) to the pins of the I/O connectors, refer to [Pin Numbering of I/O Connectors](#) on page 80.

Notes on connecting UBAT and GND

⚠ CAUTION

Short circuit between cables connected to the car battery/power supply can lead to electric arcs or fire

If a short circuit occurs, e.g., in the cable harness, the current of the car battery (power supply) generates heat in the connected cables. The heat might cause a fire. Batteries always supply high currents if a short circuit occurs.

- Insert fuses into the power supply cable and other cables that are connected to the battery/power supply to avoid an electrical fire.
- Locate the fuses close to the battery/power supply.
- Choose fuse ratings that ensure that the fuses break the circuit if the connected cables are loaded with the maximum currents supported by the cross sections of the cables used.
- Make sure that you use flame-retardant cables specified for temperatures up to 105 °C (220 °F) that were tested in conformity with IEC 60332-1-2, IEC 60332-2-2, or UL VW-1.
- Make sure that you use flame-retardant connectors specified for temperatures up to 105 °C (220 °F) and V-2 classified in conformity with IEC 60695-11-10 or UL 94.

When connecting the power supply input (UBAT) and the power supply ground line (GND), note the following points:

- Use wires with large cross-sections to avoid poor performance of the power supply, too much voltage drop, and excessive heating of the wires. Choose the cross-section and the length of the wires according to the maximum current. Recommended: minimum cross-section 2 mm² (AWG 14), maximum length 5 m (16.4 ft.)
- Notes on connecting RapidPro hardware to a car battery:
 - It is strongly recommended to insert a fuse into the power supply input wire (close to the battery). Choose the value of the fuse according to the maximum current and assembling option. The recommended values are listed in the table below:

Assembling Option		Fuse
Control Unit as single unit		5 A
Stack with UCB containing:	Control Unit, SC Unit ¹⁾	10 A (Control Unit)
	Control Unit, Power Unit	<ul style="list-style-type: none"> ▪ 10 A (Control Unit) ▪ 30 A (per UBAT wire of the Power Unit)
	Control Unit, SC Unit ¹⁾ , Power Unit	<ul style="list-style-type: none"> ▪ 15 A (Control Unit)

Assembling Option	Fuse
	<ul style="list-style-type: none"> ▪ 30 A (per UBAT wire of the Power Unit)

¹⁾ The SC Unit need not be powered separately in a stack with UCB.

- It is recommended to connect GND to the negative pole of the car battery. If you connect it directly to the car chassis, ensure low-impedance and safe connection to the chassis.
- Use an all-pole disconnect switch that matches the rating of the RapidPro system.
- Make sure that the disconnect switch can be reached by the user in case of an emergency.

Powering a RapidPro System with Connected Break-Out Boxes

Objective Powering a RapidPro system with connected Break-Out Boxes depends on the type of the RapidPro system (single unit or stack with UCB).

Connecting UBAT and GND terminals directly to the power supply

NOTICE

Connecting UBAT and GND terminals directly to the power supply can damage the Break-Out Box and the connected RapidPro system.

- Break-Out Boxes for SC Unit and Break-Out Boxes for Control Unit:
Use a fuse if you connect the power supply directly to the UBAT and GND terminals of the Break-Out Box.
- Break-Out Box for Power Unit:
The ampacity of the box's terminals is limited. Do not connect the power supply directly to the UBAT1 and/or UBAT2 terminals of the Break-Out Box for Power Unit. You must connect the power supply to the UBAT1 and/or UBAT2 pins of the box's male I/O connectors (F1/F2).

If you connect a Break-Out Box to a car battery, observe the following:

- Use an all-pole disconnect switch that matches the rating of the RapidPro system.
- Make sure that the disconnect switch can be reached by the user in case of an emergency.

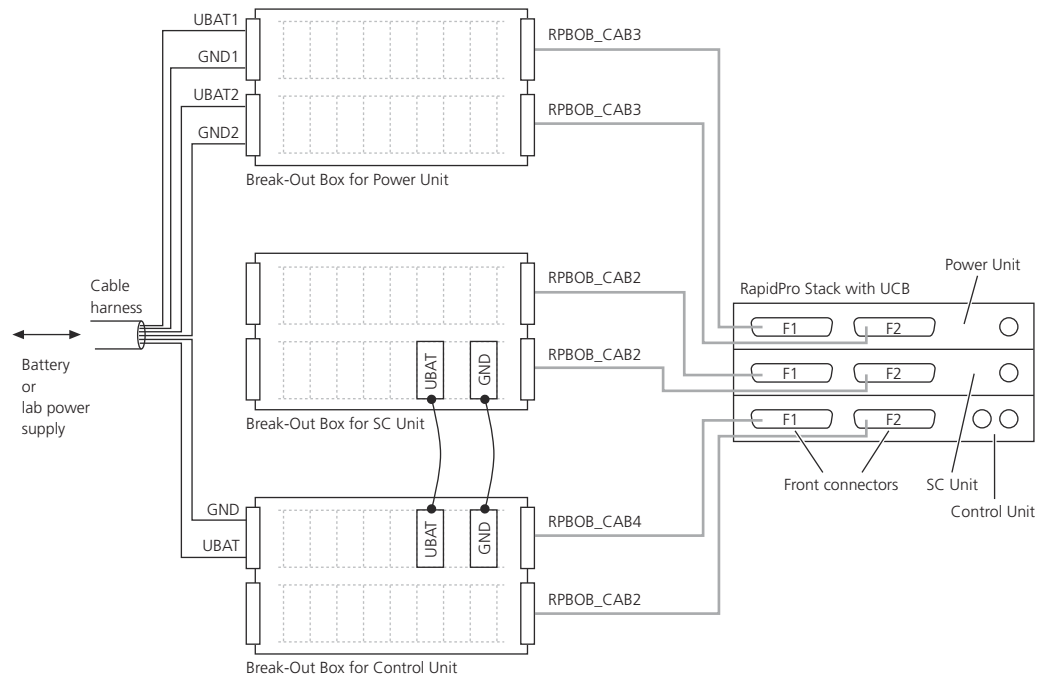
Break-Out Boxes connected to a single unit

If you connect a Break-Out Box to a single RapidPro unit, the supply voltage is passed on via the Break-Out Box. Thus, the power supply connected to the cable harness powers both the Break-Out Box and the unit. Each Break-Out Box is equipped with a fuse for UBAT to protect the box and the connected unit.

The Break-Out Box for Power Unit provides two fuses.

Break-Out Boxes connected to a stack with UCB

The power supply connected to the cable harness powers both the Break-Out Boxes for Control Unit and Power Unit, and the connected stack. You have to connect at least one UBAT terminal and one GND terminal of the Control Unit's Break-Out Box to the Break-Out Box for SC Unit. This is to enable the LED functionality of the Break-Out Box for SC Unit. The following illustration shows the necessary wiring.



During operation

Note

During operation the RapidPro Break-Out Boxes generate a faint noise. This is due to their internal power supply and is not a defect. The noise is minimized if you switch off the LEDs.

Notes on proper cabling

For basic information on proper cabling, such as aspects of grounding, shielding, and wiring up external devices, refer to [Proper Cabling](#) on page 42.

Requirements for a Lab Power Supply

Objective

For working with the RapidPro system in a laboratory, you can use a laboratory power supply instead of the car battery.

Required voltage range

The laboratory power supply must generate the operating voltage for the RapidPro units. Voltages in the range +12 V ... +14 V are recommended for best efficiency of the internal power supplies. For specific values, refer to [Operating conditions](#) on page 29.

Required output power

Two use cases define the requirements for the laboratory power supply to be used:

- Working with the RapidPro hardware (single unit – stack with UCB) for configuration purposes via ConfigurationDesk for RapidPro without running an application and without connected sensors and actuators.

In this case your laboratory power supply must be able to supply each unit with up to 10 W. For example, a stack with three RapidPro units requires up to 30 W.

- Running an application on the RapidPro hardware (with connected sensors and actuators).

Your laboratory power supply must be able to supply the required continuous output power.

Each unit requires up to 30 W, depending on the RapidPro modules used. The power consumed by the loads and the sensors must be added.

Note

- The RapidPro hardware needs a high start-up current on power-up for a few ms. Thus, your laboratory power supply must be able to supply approximately 5 A for each RapidPro unit (e.g., stack with two units = 10 A, etc.).
- If your laboratory power supply provides adjustable current limiting: Always use the maximum value.

Basics on Connecting the Enable and Watchdog Inputs

Objective

The SC and Power Unit used as single unit each provides two inputs for safety purposes:

- You *must* use the enable input to enable the channel outputs of the RapidPro hardware.
- You *can* use the watchdog input for example to check the status of the real-time application on your RCP system.

Where to go from here

Information in this section

Connecting the Enable Input.....	72
Connecting the Watchdog Input.....	73

Information in other sections

Connecting the Enable Input

Objective

The SC Unit and the Power Unit used as single units each provide an enable input on their rear connector panels that must be connected.

Function

To switch the outputs of the modules installed in the unit on, you have to connect the enable input to an external +5 V DC signal.

Additionally the enable signal switches the RapidPro unit from idle mode to execution mode. Only in idle mode you can download and configure the hardware. For details, refer to [Characteristics of Application States and Operating Modes \(ConfigurationDesk for RapidPro - Guide !\[\]\(e3f255517d37bb309a3a931ec4849e6a_img.jpg\)](#)).

Use scenario

You can use the enable input to control the RapidPro hardware via your prototyping system, for example, MicroAutoBox.

Connect the RapidPro hardware and the RCP system so, that as long as the prototyping system is not executing an application the enable signal is set to low and you can configure the RapidPro unit. When the prototyping system starts the application it turns on the module outputs of the RapidPro unit by setting the enable signal to high level.

Note

You can additionally activate the watchdog function via ConfigurationDesk for RapidPro. If the watchdog function is activated there must be signals connected to the enable input *and* the watchdog input to switch on the module outputs of the unit.

Pin location For the location of the ENABLE pin on a unit's rear I/O connector, refer to [Pin Numbering of I/O Connectors](#) on page 80.

Connecting the Watchdog Input

Objective The SC Unit and the Power Unit used as single units each provide a watchdog input (WDT pin) on their rear connector panels.

Software configurable You can activate/deactivate the watchdog function via ConfigurationDesk for RapidPro. By default, the watchdog function is deactivated.

For detailed instructions, refer to [How to Enable the Watchdog Function of Single SC and Power Units \(ConfigurationDesk for RapidPro - Guide !\[\]\(e3f8612927870f2e0f9f5989e6dd3064_img.jpg\)](#)).

Function If the watchdog function is activated via ConfigurationDesk for RapidPro you can switch the outputs of the modules installed in the unit on or off.

The module outputs are switched on if there is a square-wave signal, 0 ... +5 V, 10 Hz ... 100 kHz connected to the watchdog input. If the signal stops, the watchdog function disables all module outputs of the unit (switching time: min. 100 ms).

Additionally the watchdog signal switches the RapidPro unit from idle mode to execution mode. Only in idle mode you can download and configure the hardware. For details, refer to [Characteristics of Application States and Operating Modes \(ConfigurationDesk for RapidPro - Guide !\[\]\(003082e50e3009141f59bd5df831749f_img.jpg\)](#)).

Use scenario You can use the watchdog function for safety purposes. For example: a square-wave signal (0 ... +5 V, 10 Hz ... 100 kHz) coming from the connected RCP system enables the module outputs of the RapidPro unit. If the RCP system crashes for any reason, the signal is no longer present and the module outputs of the RapidPro unit are disabled.

Note

If the watchdog function is activated via ConfigurationDesk for RapidPro there must be signals connected to the watchdog input *and* the enable input to switch on the module outputs of the unit.

Pin location

For the location of the WDT pin on a unit's rear I/O connector, refer to [Pin Numbering of I/O Connectors](#) on page 80.

Basics on Connecting the RapidPro System to a dSPACE RCP System

Where to go from here

Information in this section

[Connecting a Control Unit and a RCP System via LVDS..... 75](#)

Provides information that is relevant if you use the RapidPro system as I/O subsystem.

[Connecting Digital I/O to dSPACE Modular System..... 76](#)

Provides information required if you connect digital signals from/to a single SC, or Power Unit via its rear connectors to dSPACE modular hardware.

Information in other sections

Connecting a Control Unit and a RCP System via LVDS

Objective

A RapidPro Control Unit requires a connection via LVDS to establish communication with the RCP system (MicroAutoBox II/modular system based on DS1007 installed in an AutoBox). The connection via LVDS is essential if you use the RapidPro system as I/O subsystem.

Control Unit connector

The COM connector is used to obtain access to the signals from/to the LVDS interface of the Control Unit.


MicroAutoBox II connector

The following table shows the connector(s) of the MicroAutoBox II variants for the connection via LVDS:

MicroAutoBox II Variant	Number of ECU Channels	Connector (LEMO)
MicroAutoBox II 1401/1507	3	ECU interface connector (ECU CH1 ... CH3)
MicroAutoBox II 1401/1511	2	ECU interface connector
MicroAutoBox II 1401/1511/1514	2	ECU interface connector
MicroAutoBox II 1401/1513	2	ECU interface connector
MicroAutoBox II 1401/1513/1514	2	ECU interface connector

Synchronous power down delay

To ensure a synchronous power down delay of the overall system (MicroAutoBox II and RapidPro) it is recommended to connect all KL15 pins together. For details


on the power down functionality, refer to [DS1401_POWER_DOWN](#) (MicroAutoBox II RTI Reference )

LVDS connector of dSPACE AutoBox

The LVDS connection between RapidPro hardware and a modular system installed in an AutoBox has to be established via its DS4121 ECU Interface Board. This board provides two ECU interface channels and therefore two LVDS connectors.

Which connector you have to use, depends on the channel you have specified in the Simulink® model.

Matching connection cables

You can order matching LVDS connection cables to connect to MicroAutoBox II or to AutoBox from dSPACE. For details, refer to [LVDS Link Cables](#) (RapidPro System Hardware Reference )

Connecting Digital I/O to dSPACE Modular System

Objective

When you connect a single SC, or Power Unit via its rear connectors to dSPACE modular hardware (containing boards with digital I/O, such as, DS4001, DS4002, DS4003, or DS5101) there are points to note on cabling and building the cable harness. This is to ensure signal integrity on the digital signal connections.

Use of twisted pair cable

Each signal must have its own return line. It is essential to use twisted pair cable for each signal and its signal return line. Ideally, you should use shielded twisted pair cable for each signal.

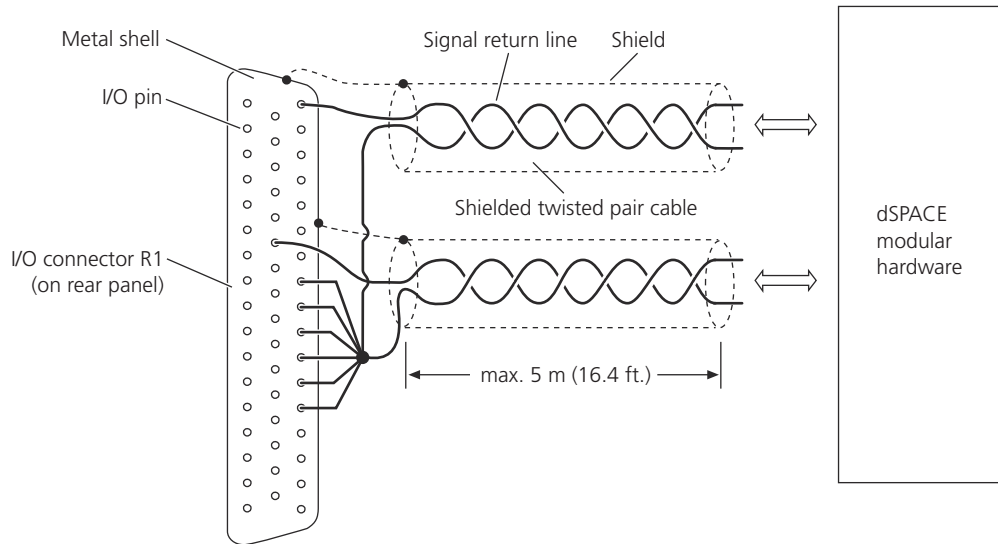
Maximum cable length

The cable harness must be as short as possible and must not exceed 5 m (16.4 ft.).

High number of digital signals

The I/O connector R1 provides 6 pins to connect signal return lines for digital signals. If you have to connect more signal return lines, the lines must be connected in star configuration to all 6 connector pins. The star point must be kept as short as possible to the connector to reduce ground line inductance.

The illustration below visualizes the requirements on the cable harness:



Overview on all measures for proper cabling

The measures named above are a summary especially for connecting digital I/O. For these and further information on proper cabling, refer to [Proper Cabling](#) on page 42.

Building the I/O Connector

Objective

You have to solder or crimp wires to the I/O connectors to connect the units or a stack to the power supply and external devices, such as sensors and actuators, and/or an RCP system. This section gives basic information on getting the necessary pinout information and shows the pin numbering of the I/O connectors.

Where to go from here

Information in this section

Getting Pinout Information.....	78
Gives basic information on getting the pinout of your RapidPro system.	
Contents of the Pinout Information File.....	79
Gives basic information on reading the exported pinout information file.	
Pin Numbering of I/O Connectors.....	80
Provides the pin numbering. You can use this information to build the I/O connectors.	

Getting Pinout Information

Objective

You need the pinout information for building the I/O connectors. The mapping between a single I/O signal of a module and a pin on the I/O connectors depends on the types of the installed modules and the carrier board slots that they are inserted in.

Exporting the pinout information

ConfigurationDesk for RapidPro features a function to provide you with the necessary pinout information of the connected RapidPro hardware. For access to the information, you can export it via ConfigurationDesk for RapidPro and edit it with Microsoft™ Excel.

For detailed instructions, refer to [How to Export Pinout Information \(ConfigurationDesk for RapidPro - Guide !\[\]\(ab4e2b3fc7e7887b7a72f548aa6f5e60_img.jpg\)](#)).

Printout of the pinout information

A printout of the pinout information is delivered with the RapidPro system you ordered. However, this pinout information applies only to this system.

Note

Changing the hardware (for example, removing/adding a module) can change the mapping of the I/O connectors. Thus, you have to read/export the pinout information via ConfigurationDesk for RapidPro.

Contents of the Pinout Information File

Objective

ConfigurationDesk for RapidPro lets you save the pinout information of the connected hardware as an XLS or a CSV file. This file contains all relevant information to enable you to build the cable harness.

Entries in the pinout information file

The entries in the file are explained below, taking a Power Unit used as single unit as an example.

F-Connector, Pin	R-Connector, Pin	Signal	Signal Description	Channel	Channel Name	Channel Description	Module	Layer	Unit Type	Slot
F1, 017		FB_OUTB	Driver output B	1	Door left - Ch01	Full Bridge Output, Ch01	PS-FBD 2/1	1	Power	1
F1, 005		FB_OUTA	Driver output A	1	Door left - Ch01	Full Bridge Output, Ch01	PS-FBD 2/1	1	Power	1
	R2, 001	FB_PWM_IN	PWM control input	1		Full Bridge Output, Ch01	PS-FBD 2/1	1	Power	1
	R2, 002	FB_DIR_IN	Direction control input	1		Full Bridge Output, Ch01	PS-FBD 2/1	1	Power	1
	R1, 001	FB_VU_OUT	Current measurement output	1		Full Bridge Output, Ch01	PS-FBD 2/1	1	Power	1
F1, 016		FB_OUTB	Driver output B	2	Door right - Ch02	Full Bridge Output, Ch02	PS-FBD 2/1	1	Power	1
F1, 004		FB_OUTA	Driver output A	2	Door right - Ch02	Full Bridge Output, Ch02	PS-FBD 2/1	1	Power	1
	R2, 003	FB_PWM_IN	PWM control input	2		Full Bridge Output, Ch02	PS-FBD 2/1	1	Power	1
	R2, 004	FB_DIR_IN	Direction control input	2		Full Bridge Output, Ch02	PS-FBD 2/1	1	Power	1
	R1, 002	FB_VU_OUT	Current measurement output	2		Full Bridge Output, Ch02	PS-FBD 2/1	1	Power	1
F1, 025		FB_OUTB	Driver output B	1	Full Bridge Out Ch01	Full Bridge Output, Ch01	PS-FBD 2/1	1	Power	2
F1, 013		FB_OUTA	Driver output A	1	Full Bridge Out Ch01	Full Bridge Output, Ch01	PS-FBD 2/1	1	Power	2
	R2, 007	FB_PWM_IN	PWM control input	1		Full Bridge Output, Ch01	PS-FBD 2/1	1	Power	2
		FB_DIR_IN	Direction control input	1		Full Bridge Output, Ch01	PS-FBD 2/1	1	Power	2
		FB_VU_OUT	Current measurement output	1		Full Bridge Output, Ch01	PS-FBD 2/1	1	Power	2

One channel – several I/O pins

Note that several I/O pins on the front I/O connector (F-Connector) and rear I/O connector (R-Connector) may be related to a single logical channel number, for example, for complex I/O channels like full bridge drivers.

The table below provides descriptions of the file entries:

Column	Description
F-connector, Pin	Information for locating the pin on a specific <i>front</i> connector. Example: <ul style="list-style-type: none"> F1 = Front I/O connector F1 017 = Pin number 17 To locate the front I/O connector of a specific unit in a stack unambiguously, you also need the layer number.
R-connector, Pin	Information for locating the pin on a specific <i>rear</i> connector: Example:

Column	Description
	<ul style="list-style-type: none"> ▪ R2 = Rear I/O connector R2 ▪ 001 = Pin number 1
Channel	Number of the channel on the specific module.
Channel name	Shows the name that you edited via ConfigurationDesk for RapidPro.
Layer	<p>Indicates the position of the unit, as follows:</p> <ul style="list-style-type: none"> ▪ In a stack with unit connection bus (UCB), the layer number is counted up from the bottom unit (layer number 1) to the top unit. ▪ In a single unit (or a stack without UCB), the layer number is always "1".
Unit Type	<p>The type of the RapidPro unit in which the module is inserted.</p> <ul style="list-style-type: none"> ▪ "SC" stands for SC Unit. ▪ "Power" stands for Power Unit. ▪ "Control" stands for Control Unit.
Slot	The number of the unit slot in which the module is inserted.

Note

If you export the pinout information of a RapidPro stack with UCB, the "R-Connector, Pin" column is replaced by the "MC Channel" column. The "MC Channel" column indicates which channel of the Control Unit's microcontroller module is involved.

Pin Numbering of I/O Connectors

Objective

This section provides the pin numbering of the I/O connectors of the units. You can use this information to solder or crimp the wires to the I/O connectors. You can also assign the signals which are needed to connect a power supply to the unit.

Pin numbering

The pin numbering used for Sub-D connectors is not standardized. The following illustrations show the numbering used.

Note

Do not rely on the numbers written on Sub-D connectors.

SC Unit

The following illustrations show the available panels with their I/O connectors and their pin numbering.

Panel	Connectors and Pins
Front panel	
Rear panel (mounted only for single unit use)	

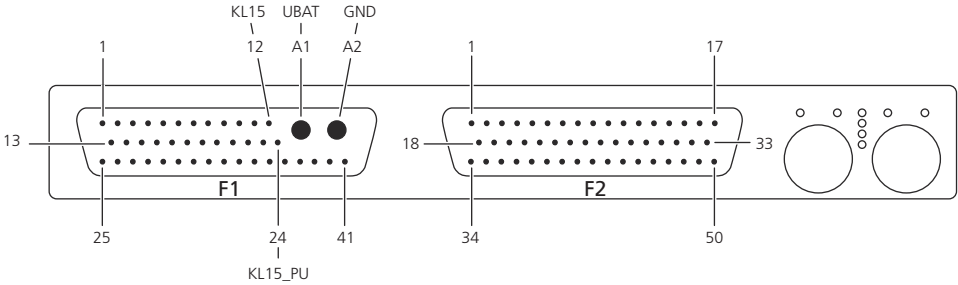
Power Unit

The following illustrations show the available panels with their I/O connectors and their pin numbering.

Panel	Connectors and Pins
Front panel	
Rear panel (mounted only for single unit use)	

Control Unit

The following illustration shows the available panel with its I/O connectors and their pin numbering.

Panel	Connectors and Pins
Front panel	

Crimping Contacts

Objective dSPACE provides connectors, a crimper tool, crimp contacts, and a contact removal tool for your RapidPro system. These allow you to build the connectors for your application yourself.

Where to go from here

Information in this section

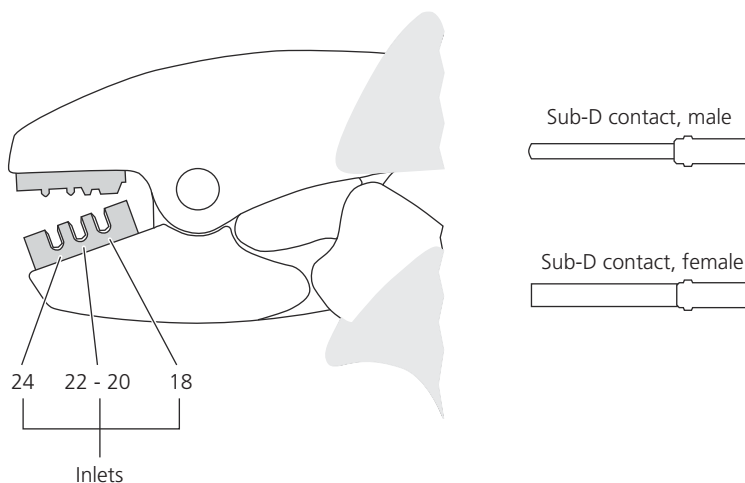
Introduction to the RapidPro Crimper Tool.....	83
How to Crimp Contacts with the RapidPro Crimper Tool.....	84

Introduction to the RapidPro Crimper Tool

Objective dSPACE provides a crimper tool which is especially designed to crimp the contacts needed for the RapidPro I/O connectors of the RapidPro units.

Overview

The following illustration shows the RapidPro crimper tool and the Sub-D contacts which can be crimped with it. You can crimp I/O contacts of different dimensions and for different wire dimensions.



Precondition for a proper crimp

The precondition for a crimp contact being properly crimped to the wire is that the wire dimension, strip length, crimp contact, and crimper tool all fit.

Possible wire dimensions

The crimper tool supplied by dSPACE supports the following wire dimensions:

Inlet		AWG ¹⁾	Diameter (mm)	Cross-Section (mm ²)
I/O contacts	Sub-D 18	18	1.024	0.823
	Sub-D 20 – 22	20	0.812	0.519
		21	0.723	0.412
		22	0.644	0.325
	Sub-D 24	24	0.511	0.205

¹⁾ AWG = American Wire Gauge

The AWG range for each feed hole is indicated on the crimper tool.

How to Crimp Contacts with the RapidPro Crimper Tool

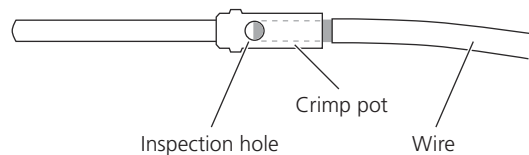
Preconditions

- The end of the wire is stripped for 4 ... 5 mm (0.15 in. ... 0.2 in.).
- The wire dimension, crimp contact, and crimper tool all fit.

Method**To crimp contacts with the RapidPro crimper tool**

- 1 To open the crimper tool, press its handles together.
- 2 Insert the stripped wire in the crimp pot of the contact. The wire must be visible thru the inspection hole (see illustration below).

Sub-D contact, male



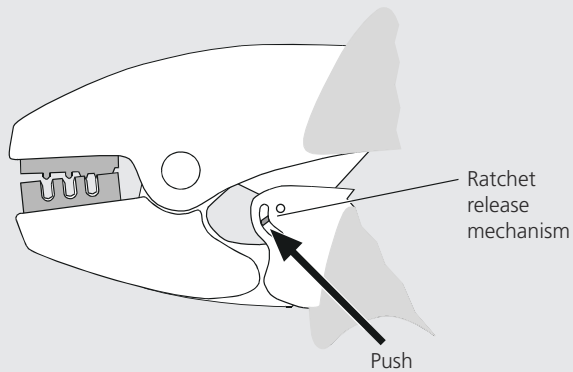
- 3 Insert the wire and the contact in the matching inlet of the crimper tool.
- 4 To crimp the contact, close the crimper tool up to its end position, where it automatically reopens.

Result

The contact and the wire are properly connected.

Tip

If the RapidPro crimper tool does not reopen, it is not properly closed up to its end position. You can also reopen the crimper tool if complications occur during the crimping process. To do so, push up the ratchet release mechanism (see illustration below) with a screwdriver.



Adapting Ranges of Signals at Rear Connectors

Objective

The RapidPro SC and Power Unit used as single unit provide digital and analog signals on their rear connectors. For some applications it may be necessary to adapt the voltage range of especially the digital inputs to the RapidPro units.

Adapting Digital Inputs

Objective

If you use SC Units and Power Units as single units, the signals connected to the digital I/O must meet specific requirements. Maybe, it is necessary to adapt the signals coming from other external devices to the signal levels of the units.

Note

If the inputs of an SC Unit or Power Unit are connected to digital output from the MicroAutoBox, the MicroAutoBox digital outputs limit the current, so that the RapidPro Unit will not be damaged.

When connecting other external devices with logic levels 0 V ... +15 V and without current limitation, the SC/Power Unit could be damaged. For a remedy, refer to [Increasing voltage range](#) on page 88.

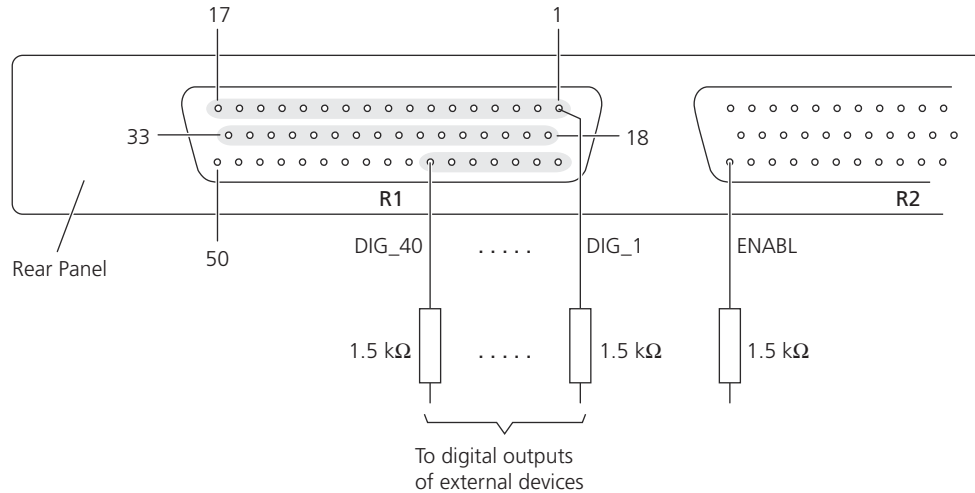
Voltage range of RapidPro units

The digital I/O channels (DIG_1 ... DIG_40) are available at the R1 rear I/O connector of the RapidPro units (ENABLE pin at R2). They have a specified input voltage range of 0 V ... +5 V.

If you want to connect digital outputs from other external devices to these channels, this range may not be sufficient. This is the case, for example, if such an external device is setup to provide automotive-compatible logic levels at the outputs.

Increasing voltage range

You can extend the allowed input voltage range of a channel (DIG_1 ... DIG_40 - ENABLE) to 0 V ... +15 V by connecting the outputs of an external device via 1.5 k Ω series resistors.



Tip

You can export a pinout information file via ConfigurationDesk for RapidPro to get the pinout of the rear I/O connector R1. For details, refer to [How to Export Pinout Information \(ConfigurationDesk for RapidPro - Guide\)](#).

Putting RapidPro Hardware into Operation

Objective	<p>You get the RapidPro hardware ready for operation by connecting various external devices to it and to power them afterwards, such as:</p> <ul style="list-style-type: none">▪ Sensors and/or actuators▪ A dSPACE RCP system (MicroAutoBox or a modular system) if you use the Control Unit as an I/O subsystem▪ A host PC
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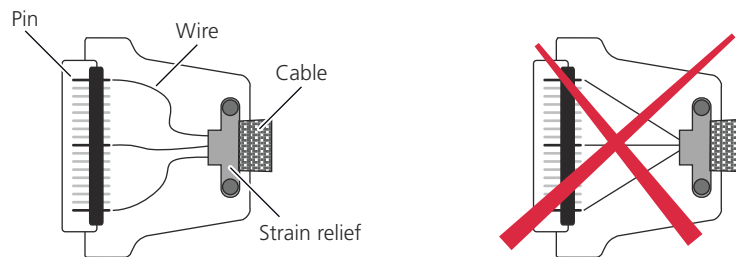
Where to go from here	Information in this section
	<p>Using Sub-D Connectors..... 90</p> <p>How to Connect and Power RapidPro Hardware..... 90</p> <p>How to Connect the Host PC to the RapidPro Hardware..... 93</p> <p>How to Update RapidPro Firmware..... 94</p> <p>Your RapidPro system always contains the newest firmware available at the time of delivery. However, a firmware update is mandatory if ConfigurationDesk for RapidPro displays RapidPro hardware with out-of-date firmware.</p> <p>How to Disconnect Devices from RapidPro Hardware..... 96</p>

Using Sub-D Connectors

Checking connectors before first use

Before you use a crimped or soldered connector for the first time, check the following points:

- The pins are straight and not deformed.
- The contact surfaces of the male and female connectors are clean.
Especially the contact surfaces of soldered connectors must be free from solder and flux.
- Inside the connector, the wires of the connector cable are long enough and do not stretch the connector pins.



To easily plug the connector the pins are loosely mounted. When the connector pins are stretched, it might not be possible to connect the connector to its counterpart.

- The connector shell is mounted.
This helps you hold the connector straight for plugging.

Plugging the connector

NOTICE

Improper plugging might deform connector pins

Using connectors with deformed connector pins might result in defective contacts and disturbed signals.

- Hold the connector shell straight and do not force the connector.
Holding the connector at an angle might deform pins.

How to Connect and Power RapidPro Hardware

Objective

To prepare the RapidPro system for operation, you have to plug the I/O connectors of the cable harness to the front, respectively, the rear panel(s) of the unit(s).

Precondition

- The cable harness is ready for connection.
- The RapidPro hardware is powered off.

- If you want to connect a Control Unit that is used as an I/O subsystem, you must have a LVDS_CAB2 connection cable to connect MicroAutoBox or AutoBox with DS4121.

Method

To connect and power RapidPro hardware

⚠ WARNING

To avoid damage to RapidPro hardware:

- Do not connect or disconnect any devices (for example sensors/actuators) while the power supply of the RapidPro system and these devices is switched on.
- Do not connect any high-voltage devices to the I/O connectors of the units.
- To avoid problems caused by ESD (electro-static discharge) pulses it is recommended to mount the I/O connectors with the supplied locking screws (order number: 101671).

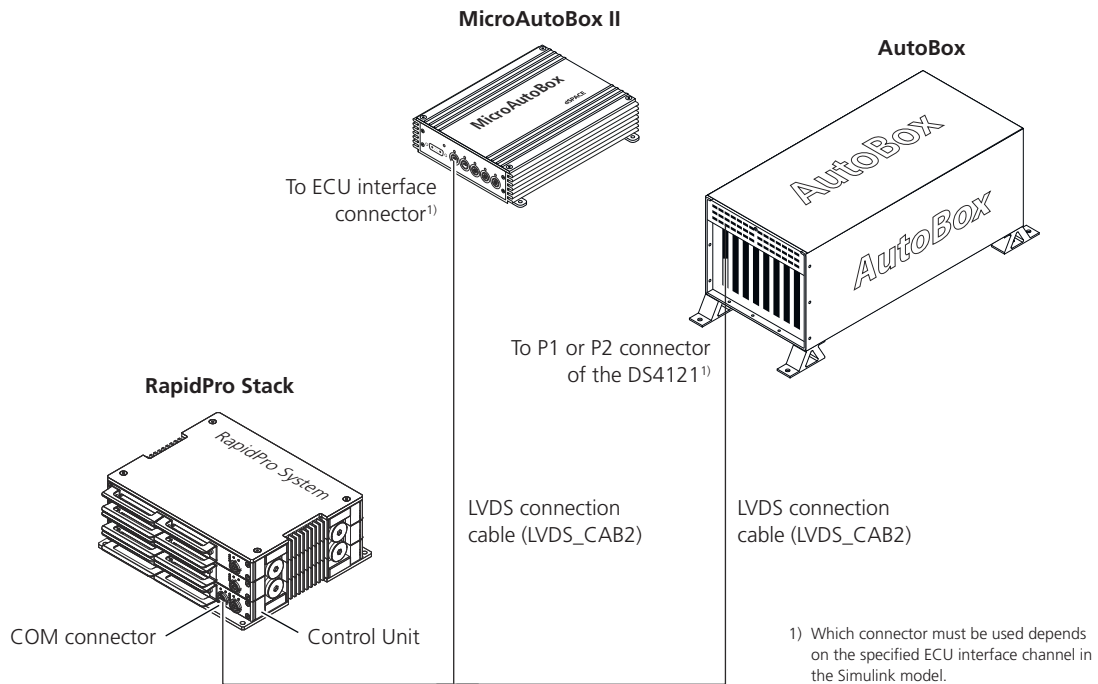
⚠ CAUTION

Connected components can cause fire

The RapidPro hardware provides electrical energy at the I/O pins, which can cause a fire if external components such as sensors/actuators are not appropriately connected. This particularly concerns output pins of modular boards that provide internal voltages to supply external components.

- To prevent a fire, apply the general fire safety regulations, e.g., supervise the operation, remove fire loads, and use fire-proof materials and enclosures.

- 1 Plug all the I/O connectors of the cable harness to the I/O connectors of the RapidPro unit(s).
- 2 Only if you use the RapidPro hardware as an I/O subsystem: Connect the LVDS connection cable to the RapidPro Control Unit and to the dSPACE RCP system as shown in the illustration below.



Tip

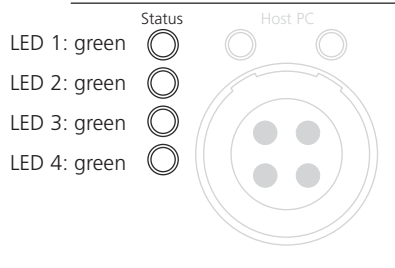
If you connect the LVDS connection cable to the Control Unit, ensure that the red dot on the connector faces upward.

3 Power on the RapidPro hardware.

Result

The RapidPro hardware is ready for operation.

Status LEDs 1 ... 4 on the front panel of the units in the connected system must be lit as follows:



For the meanings of the LEDs, refer to the respective chapters of the RapidPro units in the *RapidPro System – Installation and Configuration Reference*.

Next step

To configure the RapidPro system you need a connection to the host PC. Refer to [How to Connect the Host PC to the RapidPro Hardware](#) on page 93.

How to Connect the Host PC to the RapidPro Hardware

Objective You need a connection between your host PC and the RapidPro hardware to get access via software on the host PC.

USB for connection to the host PC The RapidPro hardware supports the universal serial bus (USB 1.1 and 2.0 compatible) for connection to the host PC. It therefore supports hot plug-and-play capability. This means you can connect the devices at any time, regardless of whether they are powered on or not.

Connecting multiple systems Only one RapidPro system can be accessed via ConfigurationDesk for RapidPro. If multiple RapidPro systems are connected to the host PC and powered, the first RapidPro system detected by the host PC is accessible via ConfigurationDesk for RapidPro.

Using a PS-DINJ 2/1 module (DS1664) in your system The PS-DINJ 2/1 module (DS1664) can generate hazardous voltages up to 100 V. You must observe all safety precautions to avoid risk of electric shock, and you must follow the connection instructions stated in the [Safety Precautions for Using the PS-DINJ 2/1 Module](#) on page 15.

Preconditions Depending on your use case ensure that you have the cables listed in the table below:

Use case	Cable
Single SC and/or Power Unit	PC connection cable (USB_CAB6)
RapidPro system used as an I/O subsystem	
Using a PS-DINJ 2/1 module (DS1664) in a RapidPro system used as I/O subsystem	PC Connection Cable for Calibration Hub/RapidPro (USB_CAB12)

Method

To connect the host PC to the RapidPro hardware

WARNING

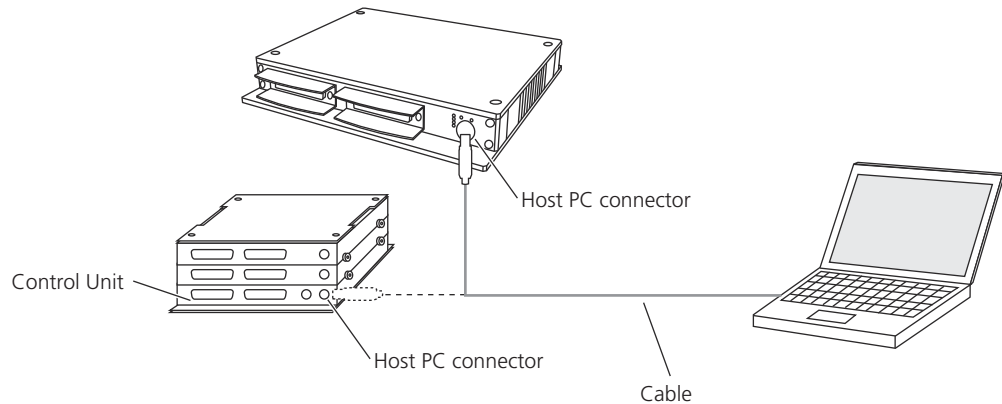
Hot surface

Risk of burning your hands!

The housing and the connectors of the RapidPro hardware can reach temperatures above 95 °C (203 °F).

- Do not touch the housing and the connectors plugged to it during operation.
- Before connecting/disconnecting any device, wait for the housing to cool down after switching off the RapidPro hardware or use protective gloves.

- 1 Plug the cable to the host PC connector at the RapidPro unit.



Note

For a stack with UCB you must only connect the Control Unit to your host PC.

- 2 Plug the USB connector on a USB port of your host PC.

Result

The connection is established and at the RapidPro side it is now protected against accidental disconnection by a locking mechanism.

How to Update RapidPro Firmware

Objective

Your RapidPro system always contains the newest firmware available at the time of delivery. As part of continuous development, dSPACE updates the firmware to support new features or to fix bugs.

A firmware update is mandatory if ConfigurationDesk for RapidPro displays RapidPro hardware with out-of-date firmware. In this case working with the RapidPro system is restricted.

Distribution

Firmware updates are distributed either in the regular dSPACE Releases or as patches on <http://www.dspace.com/goto?support>.

Recommendation

dSPACE recommends to check the status of your firmware periodically and to update the firmware to the latest version.

Update tool

To simplify the update procedure, dSPACE provides a specific RapidPro Firmware Update tool. The tool compares the current firmware versions with those

available in the active dSPACE installation. You are prompted to state whether your system needs an update.

You can also use this tool if you are not sure about the state of your firmware.

Note

You can only access the RapidPro firmware update tool if the **Real-Time Interface** product set is installed on your PC. This product set includes the latest RapidPro firmware and the tool itself.

Duration of update

Updating a stack with UCB, consisting of Control Unit, Power Unit, and SC Unit, can take up to 45 minutes, if every single component of the stack needs to be updated.

At the beginning, the RapidPro Firmware Update tool checks the connected hardware and displays the actual duration of the update.

Preconditions

- The Real-Time Interface product set is installed on your PC, which contains the latest RapidPro firmware and the RapidPro Firmware Update tool.
- The dSPACE installation that contains the latest available firmware files is active.

You can use the dSPACE Installation Manager to check which dSPACE installation is active. For details, refer to [Activating and Deactivating dSPACE Installations \(Managing dSPACE Software Installations\)](#).

- The RapidPro system is connected to your host PC via USB.
- If you use the RapidPro system as an I/O subsystem (for example, single Control Unit, or a stack with UCB):
 - The Control Unit is connected to the rapid control prototyping (RCP) hardware (MicroAutoBox II or DS1007) via LVDS.
 - The RCP hardware (MicroAutoBox II or DS1007) is connected to your host PC.
- All systems (host PC, RapidPro, RCP) are switched on.

Method

To update RapidPro firmware

NOTICE

Interrupting the update process disables the function of the hardware.

If the firmware update is interrupted, you have to restart the update process.

- 1 Check that all required connections exist and the involved systems are switched on. See preconditions above.
- 2 Close ConfigurationDesk for RapidPro.

- 3 Open a Command Prompt window (= DOS window) via the Command Prompt for dSPACE RCP and HIL <x.y> shortcut from the Windows Start menu.

Tip

If you use the Command Prompt for dSPACE RCP and HIL shortcut the required paths and environment settings are automatically set.

- 4 Type the following at the command line: **RapidProUpdate**
- 5 Follow the instructions on the screen and check if the *PLD firmware* of SC and/or PS modules has to be updated.

⚠ WARNING

Risk of injury and/or material damage. Updating the PLD firmware of any SC or PS module can cause uncontrolled movements of connected devices.

Disconnect actuators and/or sensors from the affected modules before you continue the update process.

Result

The firmware update for the RapidPro system is complete.

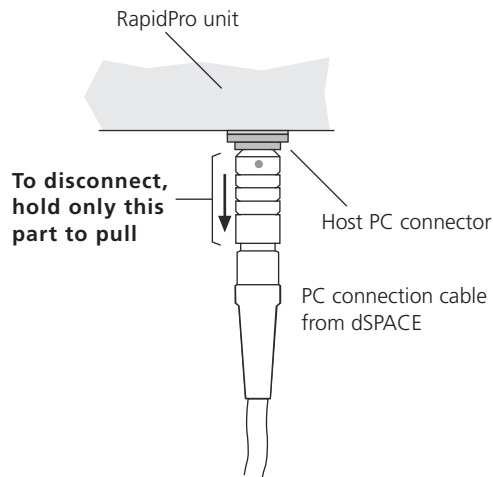
How to Disconnect Devices from RapidPro Hardware

USB for connection to the host PC

The RapidPro hardware supports the universal serial bus (USB 1.1 and 2.0 compatible) for connection to the host PC. It therefore supports hot plug-and-play capability. This means you can connect the devices at any time, regardless of whether they are powered on or not.

Release the locking mechanism

The USB and the LVDS connection cables provide a locking mechanism against accidental disconnection. To disconnect such a connection cable from a RapidPro unit, you have to release the locking mechanism. The illustration below shows how to disconnect the USB connection cable.



The way to unlock the LVDS connector from a Control Unit's COM connector is identical.

Method

To disconnect devices from RapidPro hardware

⚠ WARNING

To avoid damage to RapidPro hardware:
Do not disconnect any devices (for example sensors/actuators) while the power supply of the RapidPro system and these devices is switched on.

- 1 Power off the RapidPro hardware.

⚠ WARNING

Hot surface

Risk of burning your hands!

The housing and the connectors of the RapidPro hardware can reach temperatures above 95 °C (203 °F).

- Do not touch the housing and the connectors plugged to it during operation.
- Before connecting/disconnecting any device, wait for the housing to cool down after switching off the RapidPro hardware or use protective gloves.

- 2 Unlock the locking hooks, respectively, unscrew the locking screws.
- 3 Disconnect the I/O connectors from the RapidPro hardware.
- 4 Disconnect the PC connection cable from the host PC and from the RapidPro hardware.

- 5 If a Control Unit is part of your system, disconnect the LVDS connection cable from the RapidPro hardware.

Result

Disconnection has been completed.

Advanced: Changing the Hardware of the RapidPro System

Objective	<p>The modularity of the hardware allows you to set up unique systems that optimally fit the needs of a particular application.</p> <p>If your system is not preconfigured or you want to use your existing system in another configuration, you may have to change the hardware.</p>
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Where to go from here

Information in this section

Changing the Installation of SC/PS/COM Modules.....	100
Gives information on changing signal conditioning modules (SC modules), power stage modules (PS modules) and communication modules (COM modules) in RapidPro units. This may be necessary, for example, if you want to get access to the hardware configuration (solder components etc.) or to replace a module.	
Restrictions on Changing SC/PS/COM Modules.....	109
Provides information you have to keep in mind if you want to change or rearrange the modules in a unit or a stack.	
Changing the Hardware Configuration of SC/PS Modules.....	148
Some SC and PS modules provide user-configurable input or output circuits. These circuits can be configured by soldering electronic components to them. This section gives you notes and tips on changing user-configurable circuits.	
Changing the Assembly of RapidPro Units.....	149
Provides information on how to change the assembly of your units. You can build single units or assemble several units to build a stack. However, there are some restrictions to note.	

Changing the Installation of SC/PS/COM Modules

Objective

Your RapidPro hardware is equipped with signal conditioning modules (SC modules), power stage modules (PS modules), and/or communication modules (COM modules). However, it might be necessary to install or uninstall a module, for example, to get access to the user-configurable circuit on it or to replace a module.

Where to go from here

Information in this section

SC/PS Module Identification.....	100
Provides information on identifying each RapidPro module unambiguously by the dSPACE number and a serial number.	
How to Install SC/PS/COM Modules.....	101
How to Uninstall SC/PS/COM Modules.....	105

SC/PS Module Identification

Objective

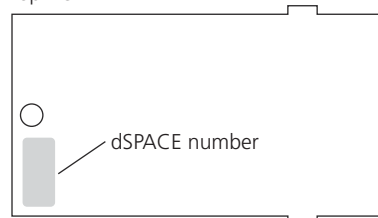
You can identify each RapidPro module unambiguously by a dSPACE number (e.g., DS1631) and a serial number.

Location of the dSPACE number

Every SC/PS module has an imprint on the top with its dSPACE number. The COM modules have an imprint on the underside.

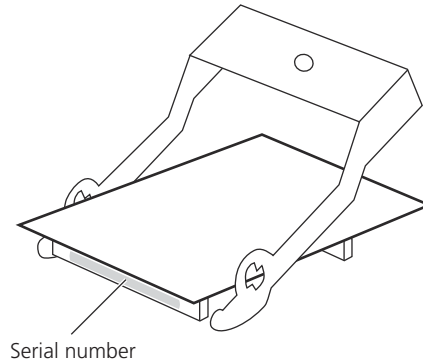
The illustration below shows the location of the dSPACE number on an SC-CCDI 6/1 module:

Top view



Location of the serial number

The serial number is printed on an adhesive label that is located on the front male connector of each module as shown in the illustration below.



Tip

Additionally, the dSPACE number and the serial number are stored in a memory chip on the module. You can display them via ConfigurationDesk for RapidPro, when the module is mounted in a connected RapidPro system.

How to Install SC/PS/COM Modules

Objective

Installing a module may be necessary if you have changed the user-configurable circuit on it or have to replace a module.

Location of the slots on the different units

The following table shows the different units with the locations and the slot numbering:

Control Unit	SC Unit	Power Unit
<ul style="list-style-type: none"> SCx = Slots for SC modules COMx = Slots for COM modules 		PSx = Slots for PS modules

Restrictions

- To familiarize yourself with the restrictions on changing RapidPro modules on the carrier boards, refer to [Restrictions on Changing SC/PS/COM Modules](#) on page 109.

Preconditions

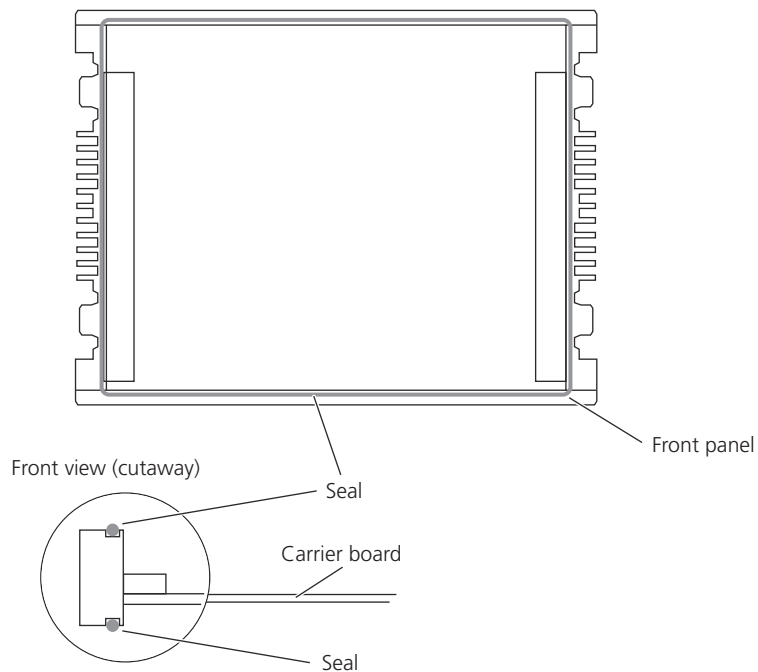
- The module is uninstalled from the unit. For instructions, refer to [How to Uninstall SC/PS/COM Modules](#) on page 105.
- Ensure you have all the items in the table below before starting:

Items	Count	Description
Hexagon socket wrench	1	2.5 mm (0.1 in.)
	1	6 mm (0.24 in.)
Hexagon socket head screw	1 ... 2 ¹⁾	M3 x 12, DIN912 A2
All screws, nuts, and protective caps you collected while uninstalling the module	—	—

¹⁾ Depends on the specific module and is used to secure the module against accidental disconnection.

- Ensure that all units have a seal in the grooves around the top and the underside, see illustration below. The seals are necessary to guard the RapidPro hardware against dirt, to make it splash-proof, and to make it EMC-compatible.

Top view



Method

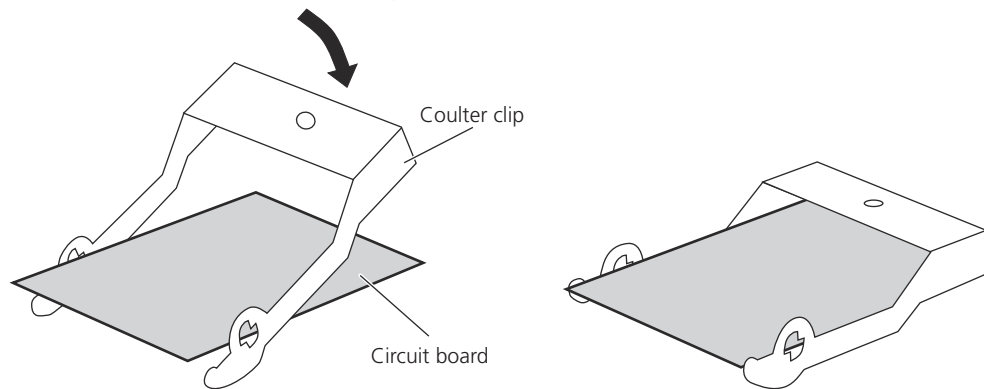
To install SC/PS/COM modules

⚠ WARNING**Electrostatic discharges can damage the hardware.**

Before working on the hardware, make sure that you comply with the following instructions:

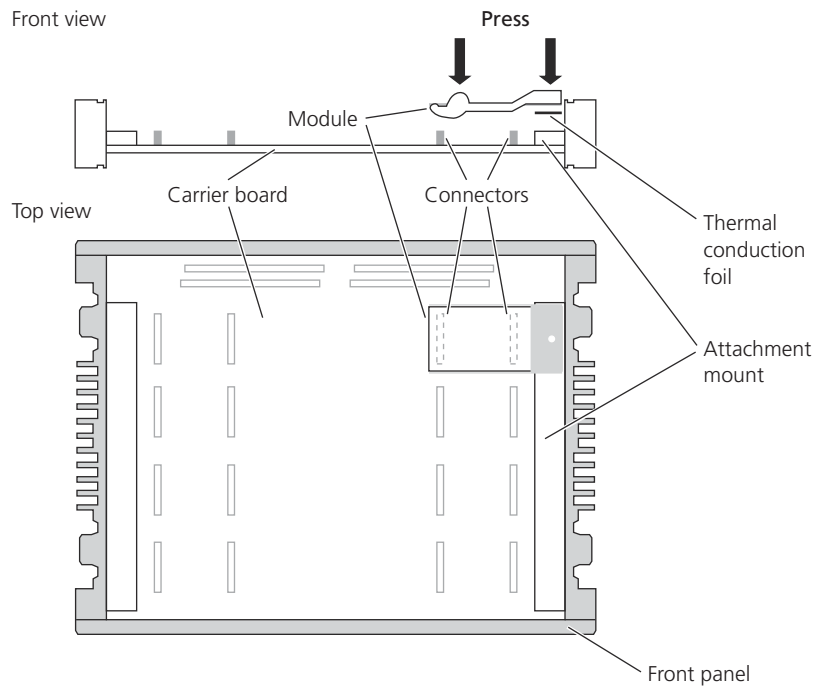
- You yourself and all material the unit and the module come in contact with must be properly grounded.
- During storage or handling, place the unit and the module on conductive foam or in a protective bag.
- Do not touch the carrier board, its connectors and the module connectors.

- 1 Close the coulter clip as shown in the illustration below.



- 2 Insert the module in the unit's slot by pressing evenly on the coultier clip as shown for an SC Unit in the illustration below.

Front view

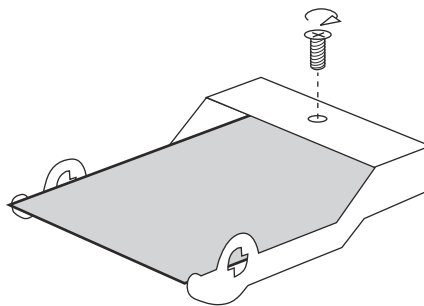


⚠ WARNING

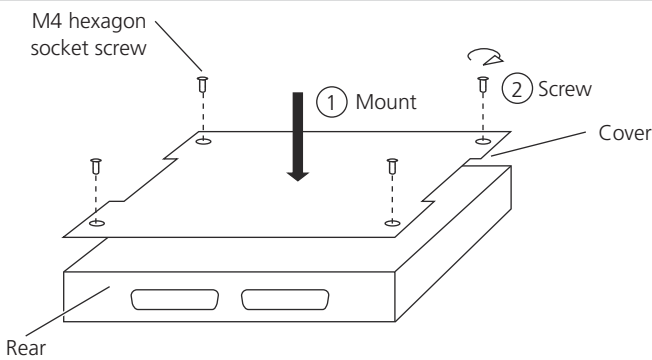
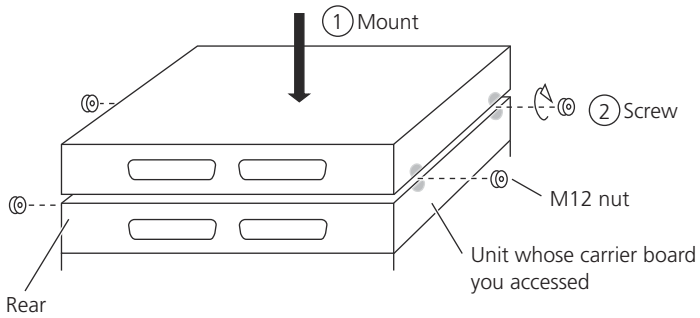
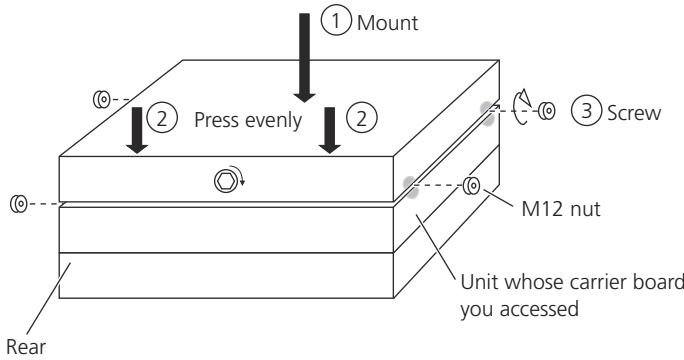
Mounting SC, PS, or COM modules without using thermal conduction as isolation between the module and the unit's attachment mount damages the hardware!

Ensure that there is thermal conduction foil to avoid electrical contact between the module and the attachment mount of the RapidPro unit.

- 3 Screw the screw(s) of the coultier clip with a hexagon socket wrench (2.5 mm (0.1 in.)) to secure the module against accidental disconnection (see the example illustration below).



- 4 If you want to install another module, proceed with step 2.
- 5 Reassemble the RapidPro unit(s) depending on the assembly before (single unit or stack) and the position of the unit in a stack according to the table below.

Unit to Reassemble	Illustration
Single unit – Top unit in a stack	
Other unit in a stack without UCB	
Other unit in a stack with UCB	

Result

The module(s) is(are) changed.

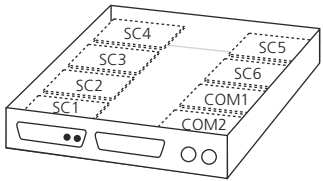
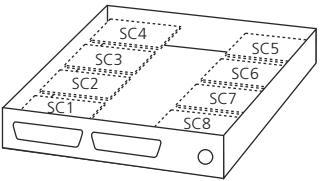
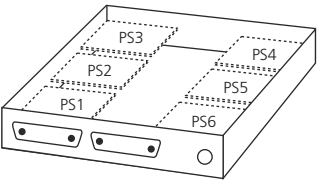
How to Uninstall SC/PS/COM Modules

Objective

Uninstalling a module may be necessary if you need to change the user-configurable circuit on it or have to replace a module.

Location of the slots on the different units

The following table shows the different units with the locations and the slot numbering:

Control Unit	SC Unit	Power Unit
		
<ul style="list-style-type: none"> SCx = Slots for SC modules COMx = Slots for COM modules 		PSx = Slots for PS modules

Restrictions

- To familiarize yourself with the restrictions on changing RapidPro modules on the carrier boards, refer to [Restrictions on Changing SC/PS/COM Modules](#) on page 109.

Preconditions

- The unit or the stack is powered off.
- All connectors of the RapidPro hardware are disconnected.
- The RapidPro hardware is uninstalled from the vehicle/test bench, if this is necessary for access to all screws and nuts.
- Ensure you have all the items in the table below before starting:

Items	Count	Description
Hexagon socket wrench	1	2.5 mm (0.1 in.)
	1	6 mm (0.24 in.)

Method**To uninstall SC/PS/COM modules****⚠ WARNING****Electrostatic discharges can damage the hardware.**

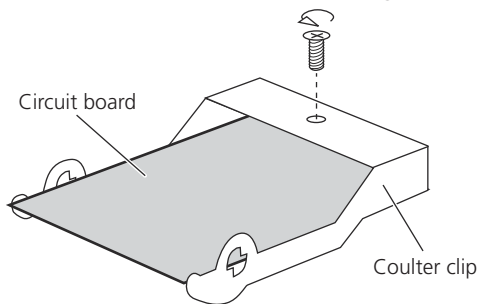
Before working on the hardware, make sure that you comply with the following instructions:

- You yourself and all material the unit and the module come in contact with must be properly grounded.
- During storage or handling, place the unit and the module on conductive foam or in a protective bag.
- Do not touch the carrier board, its connectors and the module connectors.

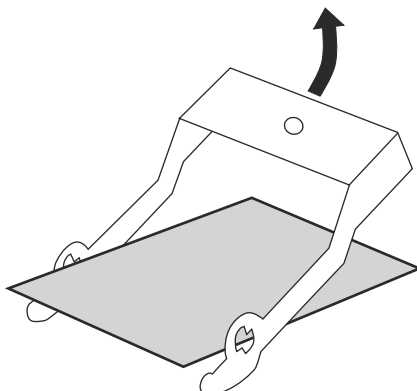
- 1 Disassemble the RapidPro unit(s) depending on the assembly (single unit or stack) and the position of the unit in a stack according to the table below.

Unit to Access	Illustration
Single unit – Top unit in a stack	
Other unit in a stack without UCB	
Other unit in a stack with UCB	

- 2 Unscrew the screw(s) of the couler clip that secures the module against accidental disconnection with a hexagon socket wrench (2.5 mm (0.1 in.)).



- 3** Pull the coulter clip as shown in the illustration below to eject the module.



- 4** If you want to uninstall another module, proceed with step 2.

Result

Uninstalling is complete.

Next steps

Now you can work on the module, for example, change the user-configurable circuit.

Restrictions on Changing SC/PS/COM Modules

Objective	If you want to change or rearrange the modules in a unit or a stack, you have to consider some restrictions.
Definition via routing code	<p>Which RapidPro module can be installed on which slot is defined via the routing code that is stored in the specific single unit or stack with UCB. This code varies according to the assembly (single unit or stack) and the unit you use (SC Unit, Power Unit, Control Unit with MPC565).</p> <p>You can identify it via its unique RoutingID, which can be displayed via ConfigurationDesk for RapidPro.</p>
Installing or rearranging an SC-UHEGO 2/1 module (DS1639)	If you want to install or rearrange an SC-UHEGO 2/1 module (DS1639) in a single unit or a stack with UCB, you need a custom-built routing code. Contact dSPACE for an appropriate routing code.
Where to go from here	Information in this section <div> Restrictions on Changing SC/PS Modules in Single Units..... 109 Restrictions on Changing SC/PS Modules in a Stack with UCB..... 114 Restrictions on Changing COM Modules..... 147 </div>

Restrictions on Changing SC/PS Modules in Single Units

Where to go from here	Information in this section <div> Single SC Unit – RoutingID 37854..... 110 Single Power Unit – RoutingID 44205..... 111 Single Power Unit – RoutingID 60766..... 112 Single Control Unit with MPC565 – RoutingID 16384..... 113 </div>
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Single SC Unit – RoutingID 37854

Objective

Which SC module can be installed on which slot of a single SC Unit is defined via routing code. Currently, only one routing code (RoutingID 37854) is provided.

Note

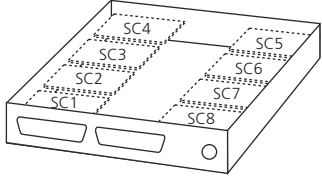
If you rearrange the modules on the carrier board contrary to the tables below, the routing code stored in the unit has to be modified by dSPACE.

Installing or rearranging an SC-UHEGO 2/1 module (DS1639)

If you want to install or rearrange an SC-UHEGO 2/1 module (DS1639) in a single unit or a stack with UCB, you need a custom-built routing code. Contact dSPACE for an appropriate routing code.

RoutingID 37854

The following table shows you which SC modules can be installed on which slot on a single SC Unit using the routing code with RoutingID 37854:

Single SC Unit	Module	SC1	SC2	SC3	SC4	SC5	SC6	SC7	SC8
	SC-AI 4/1 ¹⁾ (DS1631)	✓	✓	✓	✓	✓	✓	✓	–
	SC-AI 10/1 ²⁾ (DS1633)	✓	✓	✓	✓	✓	✓	–	–
	SC-DI 8/1 (DS1642)	–	–	–	✓	✓	✓	✓	✓
	SC-DO 8/1 (DS1646)	–	–	–	✓	✓	✓	✓	✓
	SC-DO 8/2 (DS1647)	–	–	–	✓	✓	✓	✓	✓
	SC-SENS 4/1 ³⁾ (DS1626)	✓	✓	✓	✓	✓	✓	✓	✓
	SC-CCDI 6/1 (DS1637)	–	–	–	✓	✓	✓	✓	✓
	SC-EGOS 2/1 (DS1634) ⁴⁾	–	–	–	✓	✓	✓	✓	–

¹⁾ You can insert a maximum of 4 SC-AI 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.

²⁾ The SC-AI 10/1 has 10 channels and requires two adjacent slots. The first slot has to process 8 channels and the second slot 2 channels. You can mount it on slots SC1 ... SC2, SC3 ... SC4, and SC5 ... SC6.

³⁾ The SC-SENS 4/1 module is a sensor supply module and does not have internal signal connections to the unit's carrier board. Thus, you can insert an SC-SENS 4/1 module in any available slot. You can insert a maximum of 2 SC-SENS 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.

⁴⁾ If you use the SC-EGOS 2/1 module, the required current for heating the lambda probe must be provided by an additional RapidPro Power Unit where a specific PS module must be installed, for example, a low side driver module (PS-LSD 6/1) or a high side driver module (PS-HSD 6/1). For details, refer to Connection to Lambda Probes in the RapidPro System – Installation and Configuration Reference.

If you have an SC module which is not listed in the table above, choose a slot that suits the module's signals needed in your application. The table below gives you the information on the slots' signals:

Slot	Signals
SC1	8 x analog
SC2	4 x analog
SC3	8 x analog
SC4	4 x analog/8 x digital
SC5	8 x analog/8 x digital
SC6	4 x analog/8 x digital
SC7	4 x analog/8 x digital
SC8	8 x digital

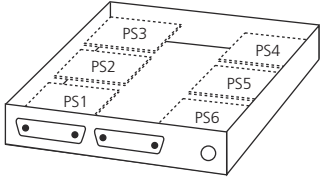
Single Power Unit – RoutingID 44205

Objective

Which PS module can be installed on which slot of a single Power Unit is defined via routing code. You can use all available PS modules with this routing code (RoutingID 44205).

RoutingID 44205

The following table shows you which PS modules can be installed on which slot on a single Power Unit using the routing code with RoutingID 44205:

Single Power Unit	Module	PS1	PS2	PS3	PS4	PS5	PS6
	PS-FBD 2/1 (DS1661)	✓	✓	✓	✓	✓	✓
	PS-HSD 6/1 (DS1663)	✓	✓	✓	✓	✓	✓
	PS-LSD 6/1 (DS1662)	✓	✓	✓	✓	✓	✓
	PS-DINJ 2/1 (DS1664)	✓		–	–	✓	
	PS-HCFBD 1/1 ^{1), 2)} (DS1667)	✓			✓		
	PS-HCHBD 2/1 ^{1), 2)} (DS1668)	✓			✓		
	PS-HCFBD 1/2 ¹⁾ (DS1767)	✓			✓		
	PS-HCHBD 2/2 ^{1), 3)} (DS1768)	✓			✓		

¹⁾ The PS-HCxBD x/x module requires three adjacent slots. You can mount a module in rail 1 (slots PS1 ... PS3) or in rail 2 (slots PS4 ... PS6).

²⁾ The PS-HCxBD x/1 module uses only the available I/O signals of slot PS2 (if mounted in rail 1) or of slot PS5 (if mounted in rail 2). The I/O signals of slots PS1 and PS3 (or PS4 and PS5) are not connected to the module.

Single Power Unit	Module	PS1	PS2	PS3	PS4	PS5	PS6
-------------------	--------	-----	-----	-----	-----	-----	-----

³⁾ This routing code is only valid for PS-HCHBD 2/2 modules in *General purpose, single channel* or *General purpose, double channel* mode.

If you have a PS module which is not listed in the table above, choose a slot that suits the module's signals needed in your application. The table below gives you the information on the slots' signals:

Slot	Signals
PS1	6 with max. 4 current measurement channels
PS2	
PS3	
PS4	
PS5	8 with max. 4 current measurement channels
PS6	

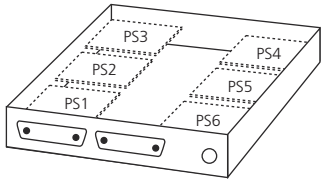
Single Power Unit – RoutingID 60766

Objective

Which PS module can be installed on which slot of a single Power Unit is defined via routing code. This routing code (RoutingID 60766) is optimized to the high-current PS modules.

RoutingID 60766

The following table shows you which PS modules can be installed on which slot on a single Power Unit using the routing code with RoutingID 60766:

Single Power Unit	Module	PS1	PS2	PS3	PS4	PS5	PS6
	PS-FBD 2/1 (DS1661)	–	–	–	–	–	–
	PS-HSD 6/1 (DS1663)	–	–	–	–	–	–
	PS-LSH 6/1 (DS1662)	–	–	–	–	–	–
	PS-DINJ 2/1 (DS1664)	–	–	–	–	–	–
	PS-HCFBD 1/1 ^{1), 2)} (DS1667)	✓			✓		
	PS-HCHBD 2/1 ^{1), 2)} (DS1668)	✓			✓		
	PS-HCFBD 1/2 ¹⁾ (DS1767)	✓			✓		
	PS-HCHBD 2/2 ¹⁾ (DS1768)	✓			✓		

¹⁾ The PS-HCxBD x/x module requires three adjacent slots. You can mount a module in rail 1 (slots PS1 ... PS3) or in rail 2 (slots PS4 ... PS6).

²⁾ The PS-HCxBD x/1 module uses only the available I/O signals of slot PS2 (if mounted in rail 1) or of slot PS5 (if mounted in rail 2). The I/O signals of slots PS1 and PS3 (or PS4 and PS6) are not connected to the module.

Single Control Unit with MPC565 – RoutingID 16384

Objective

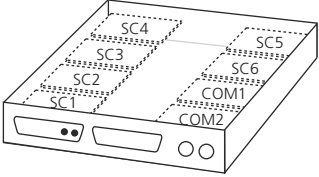
Which SC module can be installed on which slot of a Control Unit with MC-MPC565 1/1 module is defined via routing code.

Installing or rearranging an SC-UHEGO 2/1 module (DS1639)

If you want to install or rearrange an SC-UHEGO 2/1 module (DS1639) in a single unit or a stack with UCB, you need a custom-built routing code. Contact dSPACE for an appropriate routing code.

RoutingID 16384 – Control Unit (MPC565)

The following table shows which SC modules can be installed on which slot of the Control Unit with MC-MPC565 1/1 module and suit the specifics of the unit's microcontroller channels you need in your application.

Single Control Unit (RoutingID 16384)	Slot	Signal	MPC565 Channel	Possible Module
	SC 1	6 x TPU	TPU_A: 1 ... 6	<ul style="list-style-type: none"> SC-AI 4/1 ¹⁾ (DS1631) SC-AI 10/1 ²⁾ (DS1633) SC-DI 8/1 (DS1642) SC-DO 8/1 ³⁾ (DS1646) SC-DO 8/2 ³⁾ (DS1647) SC-SENS 4/1 ⁴⁾ (DS1626) SC-CCDI 6/1 (DS1637)
		2 x ADC (TRIG)	1 ... 2	
		8 x analog	1 ... 8	
	SC 2	8 x TPU	TPU_A: 9 ... 16	
		8 x analog	9 ... 16	
	SC 3	8 x TPU	TPU_B: 1 ... 8	
		8 x analog	17 ... 24	
	SC 4	4 x analog	25 ... 28	
		8 x bit I/O	1 ... 8	
	SC 5	8 x analog	29 ... 36	
		8 x bit I/O	9 ... 16	
	SC 6	4 x analog	37 ... 40	
		8 x bit I/O	17 ... 24	

- ¹⁾ You can insert a maximum of 4 SC-AI 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.
- ²⁾ The SC-AI 10/1 has 10 channels and requires two adjacent slots.
- ³⁾ If an SC-DO 8/1 or SC-DO 8/2 module is inserted in the first slot (SC1) you can use only a maximum of 6 module output channels.
- ⁴⁾ The SC-SENS 4/1 module is a sensor supply module and does not have signal connections to the Control Unit's microcontroller channels. Thus, you can insert an SC-SENS 4/1 module in any available slot. You can insert a maximum of 2 SC-SENS 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.

Restrictions on Changing SC/PS Modules in a Stack with UCB

Where to go from here

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Stack with Control Unit (MPC565) and SC Unit – RoutingID 16553 for SC-TC 8/1 Module

Objective

The routing code with RoutingID 16553 applies to the following configuration:

Stack with UCB consisting of:

- Control Unit with MC-MPC565 1/1 module (layer 1)
- SC Unit (layer 2) with one or more SC-TC 8/1 modules

Note

The routing of the Control Unit in this stack is identical to the routing of a single Control Unit with RoutingID 16384. Thus, an existing single Control Unit can be easily extended with an SC Unit with SC-TC 8/1 module(s) without changing the assembly of the other modules in the unit.

Note

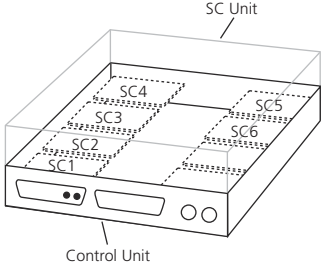
If you rearrange the modules on the carrier boards contrary to the table below, the routing code stored in the units has to be modified by dSPACE.

Installing or rearranging an SC-UHEGO 2/1 module (DS1639)

If you want to install or rearrange an SC-UHEGO 2/1 module (DS1639) in a single unit or a stack with UCB, you need a custom-built routing code. Contact dSPACE for an appropriate routing code.

RoutingID 16553 – Control Unit (MPC565)

The following table shows which SC modules can be installed on which slot of the unit, and which suit the specifics of the Control Unit's microcontroller channels you need in your application.

Stack with UCB (RoutingID 16553)	Slot	Signal	MPC565 Channel	Possible Module
Control Unit (layer 1) 	SC1	6 x TPU 2 x ADC (TRIG) 8 x analog	TPU_A: 1 ... 6 1 ... 2 1 ... 8	<ul style="list-style-type: none"> ▪ SC-AI 4/1 ¹⁾ (DS1631) ▪ SC-AI 10/1 ²⁾ (DS1633) ▪ SC-DI 8/1 (DS1642) ▪ SC-DO 8/1 ³⁾ (DS1646) ▪ SC-DO 8/2 ³⁾ (DS1647) ▪ SC-SENS 4/1 ⁴⁾ (DS1626) ▪ SC-CCDI 6/1 (DS1637)
	SC2	8 x TPU 8 x analog	TPU_A: 9 ... 16 9 ... 16	
	SC3	8 x TPU 8 x analog	TPU_B: 1 ... 8 17 ... 24	
	SC4	8 x bit I/O 4 x analog	1 ... 8 25 ... 28	
	SC5	8 x bit I/O 8 x analog	9 ... 16 29 ... 36	
	SC6	8 x bit I/O 4 x analog	17 ... 24 37 ... 40	

¹⁾ You can insert a maximum of 4 SC-AI 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.

²⁾ The SC-AI 10/1 has 10 channels and requires two adjacent slots. The first slot has to process 8 channels and the second slot 2 channels. You can mount it on slots SC5 ... SC6.

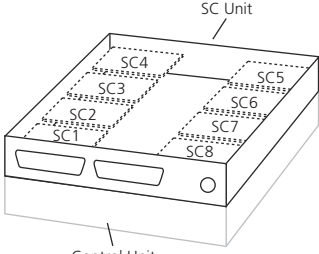
³⁾ If an SC-DO 8/1 or SC-DO 8/2 module is inserted in the first slot (SC1) you can use only a maximum of 6 module output channels.

Stack with UCB (RoutingID 16553)	Slot	Signal	MPC565 Channel	Possible Module
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- ⁴⁾ The SC-SENS 4/1 module is a sensor supply module and does not have signal connections to the Control Unit's microcontroller channels. Thus, you can insert an SC-SENS 4/1 module in any available slot. You can insert a maximum of 2 SC-SENS 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.

RoutingID 16553 – SC Unit

The following table shows which SC modules can be installed on which slot of the SC Unit, and which suit the specifics of the Control Unit's microcontroller channels you need in your application.

Stack with UCB (RoutingID 16553)	Slot	Signal	MPC565 Channel	Possible Module
SC Unit (layer 2) 	SC1	8 x MIOS (PWM)	1 ... 8	<ul style="list-style-type: none"> SC-TC 8/1 ¹⁾ (DS1638) SC-DO 8/1 (DS1646) SC-DO 8/2 (DS1647) SC-SENS 4/1 ²⁾ (DS1626)
	SC2	8 x MIOS (DASM)	1 ... 8	<ul style="list-style-type: none"> SC-TC 8/1 ¹⁾ (DS1638) SC-DI 8/1 (DS1642) SC-CCDI 6/1 (DS1637) SC-SENS 4/1 ²⁾ (DS1626)
	SC3	7 x TPU	TPU_A: 7 TPU_B: 11 ... 16	<ul style="list-style-type: none"> SC-TC 8/1 ¹⁾ (DS1638) SC-DI 8/1 (DS1642) SC-DO 8/1 ³⁾ (DS1646) SC-DO 8/2 ³⁾ (DS1647) SC-CCDI 6/1 (DS1637) SC-SENS 4/1 ²⁾ (DS1626)
		1 x SDI ⁴⁾	1	
	SC4	8 x TPU	TPU_C: 1 ... 8	<ul style="list-style-type: none"> SC-DI 8/1 (DS1642) SC-DO 8/1 (DS1646) SC-DO 8/2 (DS1647) SC-CCDI 6/1 (DS1637) SC-SENS 4/1 ²⁾ (DS1626)
	SC5	–	–	<ul style="list-style-type: none"> SC-TC 8/1 ¹⁾ (DS1638) SC-SENS 4/1 ²⁾ (DS1626)
	SC6	–	–	
	SC7	1 x TPU	TPU_A: 8	
		1 x SDI ⁴⁾	2	
	SC8	8 x TPU	TPU_C: 9 ... 16	<ul style="list-style-type: none"> SC-DI 8/1 (DS1642) SC-DO 8/1 (DS1646) SC-DO 8/2 (DS1647) SC-CCDI 6/1 (DS1637) SC-SENS 4/1 ²⁾ (DS1626)

- ¹⁾ The SC-TC 8/1 requires three adjacent slots. You can mount it on the SC Unit's slots SC1 ... SC3, and on slots SC5 ... SC7. The module uses only the available I/O signals of slot SC3 or of slot SC7. The I/O signals of slots SC1 and SC2 (or SC5 and SC6) are not connected to the module.
- ²⁾ The SC-SENS 4/1 module is a sensor supply module and does not have signal connections to the Control Unit's microcontroller channels. Thus, you can insert an SC-SENS 4/1 module in any available slot. You can insert a maximum of 2 SC-SENS 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.
- ³⁾ If an SC-DO 8/1 or SC-DO8/2 module is inserted in the SC Unit's third slot (SC3) you can use only a maximum of 6 module output channels.
- ⁴⁾ Serial Digital Interface for a connection to/from the microcontroller of the Control Unit.

Stack with Control Unit (MPC565) and Power Unit – RoutingID 35429

Objective

Which SC/PS module can be installed on which slot of a unit in a stack with UCB containing a Control Unit and a Power Unit is defined via routing code.

Note

If you rearrange the modules on the carrier boards contrary to the table below, the routing code stored in the units has to be modified by dSPACE.

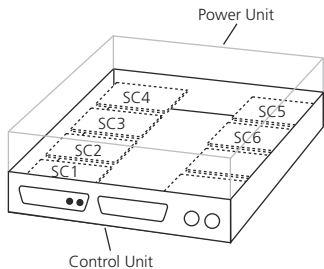
Installing or rearranging an SC-UHEGO 2/1 module (DS1639)

If you want to install or rearrange an SC-UHEGO 2/1 module (DS1639) in a single unit or a stack with UCB, you need a custom-built routing code. Contact dSPACE for an appropriate routing code.

RoutingID 35429 – Control Unit (MPC565)

The routing code with the RoutingID 35429 is valid only if the stack consists of a Control Unit with MC-MPC565 1/1 module (layer 1) and a Power Unit (layer 2).

The following table shows which SC modules can be installed on which slot of the unit and suit the specifics of the Control Unit's microcontroller channels you need in your application.

Stack with UCB (RoutingID 35429)	Slot	Signal	MPC565 Channel	Possible Module
<div><div>Control Unit (layer 1)</div><div></div><div>Control Unit</div></div>	SC1	6 x TPU	TPU_A: 1 ... 6	<ul style="list-style-type: none">▪ SC-DI 8/1 (DS1642)▪ SC-DO 8/1 ¹⁾ (DS1646)▪ SC-DO 8/2 ¹⁾ (DS1647)▪ SC-SENS 4/1 ²⁾ (DS1626)▪ SC-CCDI 6/1 (DS1637)
		2 x ADC (TRIG)	1 ... 2	
	SC2	8 x TPU	TPU_A: 9 ... 16	<ul style="list-style-type: none">▪ SC-AI 4/1 ³⁾ (DS1631)▪ SC-DI 8/1 (DS1642)▪ SC-DO 8/1 (DS1646)▪ SC-DO 8/2 (DS1647)▪ SC-SENS 4/1 ²⁾ (DS1626)▪ SC-CCDI 6/1 (DS1637)
		4 x analog	13 ... 16	
	SC3	8 x TPU	TPU_B: 1 ... 8	<ul style="list-style-type: none">▪ SC-AI 4/1 ³⁾ (DS1631)▪ SC-AI 10/1 ⁴⁾ (DS1633)▪ SC-DI 8/1 (DS1642)▪ SC-DO 8/1 (DS1646)▪ SC-DO 8/2 (DS1647)▪ SC-SENS 4/1 ²⁾ (DS1626)
		8 x analog	17 ... 24	
	SC4	4 x analog	25 ... 28	
		8 x bit I/O	1 ... 8	
	SC5	8 x analog	29 ... 36	

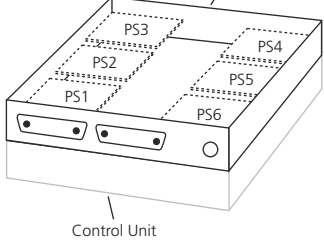
Stack with UCB (RoutingID 35429)	Slot	Signal	MPC565 Channel	Possible Module
		8 x bit I/O	9 ... 16	▪ SC-CCDI 6/1 (DS1637)
	SC6	4 x analog	37 ... 40	
		8 x bit I/O	17 ... 24	

- ¹⁾ If an SC-DO 8/1 or SC-DO 8/2 module is inserted in the first slot (SC1) you can use only a maximum of 6 module output channels.
- ²⁾ The SC-SENS 4/1 module is a sensor supply module and does not have signal connections to the Control Unit's microcontroller channels. Thus, you can insert an SC-SENS 4/1 module in any available slot. You can insert a maximum of 2 SC-SENS 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.
- ³⁾ You can insert a maximum of 4 SC-AI 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.
- ⁴⁾ The SC-AI 10/1 has 10 channels and requires two adjacent slots in the Control Unit. The first slot has to process 8 channels and the second slot 2 channels. You can mount it on slots SC3 ... SC4, and SC5 ... SC6.

RoutingID 35429 – Power Unit

The routing code with the RoutingID 35429 is valid only if the stack consists of a Control Unit with MC-MPC565 1/1 module (layer 1) and a Power Unit (layer 2).

The following table shows which PS modules can be installed on which slot of the Power Unit and suit the specifics of the Control Unit's microcontroller channels you need in your application.

Stack with UCB (RoutingID 35429)	Slot	Signal	MPC565 Channel	Possible Module
	PS1	2 x analog	1 ... 2	<ul style="list-style-type: none"> PS-FBD 2/1 (DS1661) PS-HSD 6/1 (DS1663) PS-LSD 6/1 (DS1662) PS-HCFBD 1/1 ^{1), 2)} (DS1667) PS-HCHBD 2/1 ^{1), 2)} (DS1668) PS-HCFBD 1/2 ¹⁾ (DS1767) PS-HCHBD 2/2 ^{1), 3)} (DS1768)
		4 x TPU	TPU_B: 9 ... 12	
		2 x bit out	25 ... 26	
	PS2	2 x analog	3 ... 4	
		4 x TPU	TPU_B: 13 ... 16	
		2 x bit out	27 ... 28	
	PS3	2 x analog	5 ... 6	
		4 x TPU	TPU_C: 1 ... 4	
		2 x bit out	29 ... 30	
	PS4	2 x analog	7 ... 8	
		4 x TPU	TPU_C: 5 ... 8	
		2 x bit out	31 ... 32	
	PS5	2 x analog	9 ... 10	
		4 x TPU	TPU_C: 9 ... 12	
		2 x bit out	33 ... 34	
	PS6	2 x analog	11 ... 12	
		4 x TPU	TPU_C: 13 ... 16	
		2 x bit out	35 ... 36	

¹⁾ The PS-HCxBD x/x module requires three adjacent slots. You can mount a module in rail 1 (slots PS1 ... PS3) or in rail 2 (slots PS4 ... PS6).

²⁾ The PS-HCxBD x/1 module uses only the available I/O signals of slot PS2 (if mounted in rail 1) or of slot PS5 (if mounted in rail 2). The I/O signals of slots PS1 and PS3 (or PS4 and PS5) are not connected to the module.

³⁾ This routing code is only valid for PS-HCHBD 2/2 modules in *General purpose, single channel* or *General purpose, double channel* mode.

Stack with UCB Consisting of Control Unit (MPC565), SC Unit, and Power Unit – RoutingID 28555 for SC-TC 8/1 Module

Objective

The routing code with RoutingID 28555 applies to the following configuration:

Stack with UCB consisting of:

- Control Unit with MC-MPC565 1/1 module (layer 1)
- SC Unit (layer 2) with one or more SC-TC 8/1 modules
- Power Unit (layer 3)

Note

The routing of the Control Unit and the Power Unit in this stack is identical to the routing of the double stack consisting of Control and Power Unit with RoutingID 35429. Thus, an existing double stack can be easily extended with an SC Unit with SC-TC 8/1 module(s) without changing the assembly of the other modules in the stack.

Note

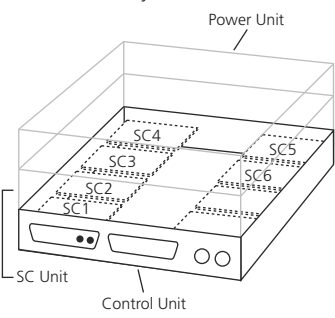
If you rearrange the modules on the carrier boards contrary to the table below, the routing code stored in the units has to be modified by dSPACE.

Installing or rearranging an SC-UHEGO 2/1 module (DS1639)

If you want to install or rearrange an SC-UHEGO 2/1 module (DS1639) in a single unit or a stack with UCB, you need a custom-built routing code. Contact dSPACE for an appropriate routing code.

RoutingID 28555 – Control Unit (MPC565)

The following table shows which SC modules can be installed on which slot of the unit, and which suit the specifics of the Control Unit's microcontroller channels you need in your application.

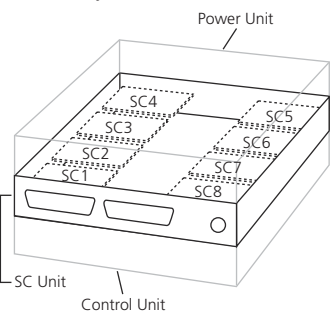
Stack with UCB (RoutingID 28555)	Slot	Signal	MPC565 Channel	Possible Module	
	SC1	6 x TPU	TPU_A: 1 ... 6	<ul style="list-style-type: none">▪ SC-DI 8/1 (DS1642)▪ SC-DO 8/1 ¹⁾ (DS1646)▪ SC-DO 8/2 ¹⁾ (DS1647)▪ SC-SENS 4/1 ²⁾ (DS1626)▪ SC-CCDI 6/1 (DS1637)	
		2 x ADC (TRIG)	1 ... 2		
	SC2	8 x TPU	TPU_A: 9 ... 16		<ul style="list-style-type: none">▪ SC-AI 4/1 ³⁾ (DS1631)▪ SC-DI 8/1 (DS1642)▪ SC-DO 8/1 (DS1646)▪ SC-DO 8/2 (DS1647)▪ SC-SENS 4/1 ²⁾ (DS1626)▪ SC-CCDI 6/1 (DS1637)
		4 x analog	13 ... 16		
	SC3	8 x TPU	TPU_B: 1 ... 8	<ul style="list-style-type: none">▪ SC-AI 4/1 ³⁾ (DS1631)▪ SC-AI 10/1 ⁴⁾ (DS1633)▪ SC-DI 8/1 (DS1642)▪ SC-DO 8/1 (DS1646)▪ SC-DO 8/2 (DS1647)▪ SC-SENS 4/1 ²⁾ (DS1626)	
		8 x analog	17 ... 24		
	SC4	4 x analog	25 ... 28		
		8 x bit I/O	1 ... 8		
	SC5	8 x analog	29 ... 36		

Stack with UCB (RoutingID 28555)	Slot	Signal	MPC565 Channel	Possible Module
	SC6	8 x bit I/O	9 ... 16	▪ SC-CCDI 6/1 (DS1637)
		4 x analog	37 ... 40	
		8 x bit I/O	17 ... 24	

- ¹⁾ If an SC-DO 8/1 or SC-DO 8/2 module is inserted in the first slot (SC1) you can use only a maximum of 6 module output channels.
- ²⁾ The SC-SENS 4/1 module is a sensor supply module and does not have signal connections to the Control Unit's microcontroller channels. Thus, you can insert an SC-SENS 4/1 module in any available slot. You can insert a maximum of 2 SC-SENS 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.
- ³⁾ You can insert a maximum of 4 SC-AI 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.
- ⁴⁾ The SC-AI 10/1 has 10 channels and requires two adjacent slots in the Control Unit. The first slot has to process 8 channels and the second slot 2 channels. You can mount it on slots SC3 ... SC4, and SC5 ... SC6.

RoutingID 28555 – SC Unit

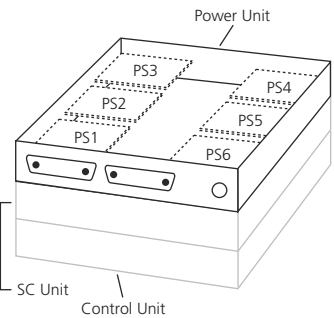
The following table shows which SC modules can be installed on which slot of the unit, and which suit the specifics of the Control Unit's microcontroller channels you need in your application.

Stack with UCB (RoutingID 28555)	Slot	Signal	MPC565 Channel	Possible Module
	SC1	–	–	▪ SC-TC 8/1 ¹⁾ (DS1638) ▪ SC-SENS 4/1 ²⁾ (DS1626)
	SC2	–	–	
	SC3	1 x TPU 1 x SDI ³⁾	TPU_A: 7 1	
	SC4	8 x MIOs (PWM)	1 ... 8	▪ SC-DO 8/1 (DS1646) ▪ SC-DO 8/2 (DS1647) ▪ SC-SENS 4/1 ²⁾ (DS1626)
	SC5	–	–	▪ SC-TC 8/1 ¹⁾ (DS1638) ▪ SC-SENS 4/1 ²⁾ (DS1626)
	SC6	–	–	
	SC7	1 x TPU 1 x SDI ³⁾	TPU_A: 8 2	▪ SC-DI 8/1 (DS1642) ▪ SC-DO 8/1 (DS1646) ▪ SC-DO 8/2 (DS1647) ▪ SC-SENS 4/1 ²⁾ (DS1626) ▪ SC-CCDI 6/1 (DS1637)
	SC8	4 x bit I/O 4 x MIOs (DASM)	37 ... 40 1 ... 4	

- ¹⁾ The SC-TC 8/1 requires three adjacent slots. You can mount it on the SC Unit's slots SC1 ... SC3, and on slots SC5 ... SC7. The module uses only the available I/O signals of slot SC3 or of slot SC7. The I/O signals of slots SC1 and SC2 (or SC5 and SC6) are not connected to the module.
- ²⁾ The SC-SENS 4/1 module is a sensor supply module and does not have signal connections to the Control Unit's microcontroller channels. Thus, you can insert an SC-SENS 4/1 module in any available slot. You can insert a maximum of 2 SC-SENS 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.
- ³⁾ Serial Digital Interface for a connection to/from the microcontroller of the Control Unit.

RoutingID 28555 – Power Unit

The following table shows which PS modules can be installed on which slot of the Power Unit, and which suit the specifics of the Control Unit's microcontroller channels you need in your application.

Stack with UCB (RoutingID 28555)	Slot	Signal	MPC565 Channel	Possible Module
Power Unit (layer 3) 	PS1	2 x analog	1 ... 2	<ul style="list-style-type: none"> PS-FBD 2/1 (DS1661) PS-HSD 6/1 (DS1663) PS-LSD 6/1 (DS1662) PS-HCFBD 1/1 ^{1), 2)} (DS1667) PS-HCHBD 2/1 ^{1), 2)} (DS1668) PS-HCFBD 1/2 ¹⁾ (DS1767) PS-HCHBD 2/2 ^{1), 3)} (DS1768)
		4 x TPU	TPU_B: 9 ... 12	
		2 x bit out	25 ... 26	
	PS2	2 x analog	3 ... 4	
		4 x TPU	TPU_B: 13 ... 16	
		2 x bit out	27 ... 28	
	PS3	2 x analog	5 ... 6	
		4 x TPU	TPU_C: 1 ... 4	
		2 x bit out	29 ... 30	
	PS4	2 x analog	7 ... 8	
		4 x TPU	TPU_C: 5 ... 8	
		2 x bit out	31 ... 32	
	PS5	2 x analog	9 ... 10	
		4 x TPU	TPU_C: 9 ... 12	
		2 x bit out	33 ... 34	
	PS6	2 x analog	11 ... 12	
		4 x TPU	TPU_C: 13 ... 16	
		2 x bit out	35 ... 36	

¹⁾ The PS-HCxBD x/x module requires three adjacent slots. You can mount a module in rail 1 (slots PS1 ... PS3) or in rail 2 (slots PS4 ... PS6).

²⁾ The PS-HCxBD 1/x module uses only the available I/O signals of slot PS2 (if mounted in rail 1) or of slot PS5 (if mounted in rail 2). The I/O signals of slots PS1 and PS3 (or PS4 and PS5) are not connected to the module.

³⁾ This routing code is only valid for PS-HCHBD 2/2 modules in *General purpose, single channel* or *General purpose, double channel* mode.

Stack with Control Unit (MPC565), Power Unit, and SC Unit – RoutingID 11550

Objective

Which SC/PS module can be installed on which slot of a unit in a stack with UCB containing a Control Unit (MPC565), Power Unit, and SC Unit is defined via routing code.

Note

If you rearrange the modules on the carrier boards contrary to the table below, the routing code stored in the units has to be modified by dSPACE.

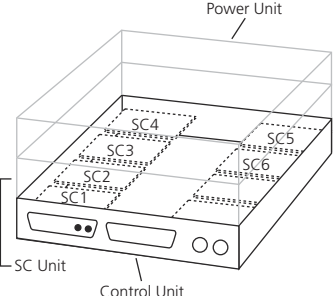
Installing or rearranging an SC-UHEGO 2/1 module (DS1639)

If you want to install or rearrange an SC-UHEGO 2/1 module (DS1639) in a single unit or a stack with UCB, you need a custom-built routing code. Contact dSPACE for an appropriate routing code.

RoutingID 11550 – Control Unit (MPC565)

The routing code with the RoutingID 11550 is valid only if the stack consists of a Control Unit with MC-MPC565 1/1 module (layer 1), SC Unit (layer 2), and a Power Unit (layer 3).

The following table shows which SC modules can be installed on which slot of the unit and suit the specifics of the Control Unit's microcontroller channels you need in your application.

Stack with UCB (RoutingID 11550)	Slot	Signal	MPC565 Channel	Possible Module
	SC 1	6 x TPU 2 x ADC (TRIG)	TPU_A: 1 ... 6 1 ... 2	<ul style="list-style-type: none"> SC-DI 8/1 (DS1642) SC-DO 8/1 ¹⁾ (DS1646) SC-DO 8/2 ¹⁾ (DS1647) SC-SENS 4/1 ²⁾ (DS1626) SC-CCDI 6/1 (DS1637)
	SC 2	8 x TPU	TPU_A: 9 ... 16	
	SC 3	8 x TPU	TPU_B: 1 ... 8	
	SC 4	8 x bit I/O	1 ... 8	
	SC 5	8 x bit I/O	9 ... 16	
	SC 6	8 x bit I/O	17 ... 24	

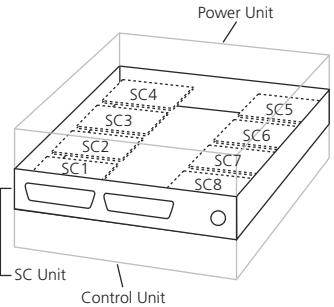
¹⁾ If an SC-DO 8/1 or SC-DO 8/2 module is inserted in the Control Unit's first slot (SC1) or in the SC Unit's third slot (SC3) you can use only a maximum of 6 module output channels.

²⁾ The SC-SENS 4/1 module is a sensor supply module and does not have signal connections to the Control Unit's microcontroller channels. Thus, you can insert an SC-SENS 4/1 module in any available slot. You can insert a maximum of 2 SC-SENS 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.

RoutingID 11550 – SC Unit

The routing code with the RoutingID 11550 is valid only if the stack consists of a Control Unit with MC-MPC565 1/1 module (layer 1), SC Unit (layer 2), and a Power Unit (layer 3).

The following table shows which SC modules can be installed on which slot of the SC Unit and suit the specifics of the Control Unit's microcontroller channels you need in your application.

Stack with UCB (RoutingID 11550)	Slot	Signal	MPC565 Channel	Possible Module
 <p>Power Unit</p> <p>SC Unit</p> <p>Control Unit</p>	SC1	8 x MIOS (PWM)	1 ... 8	<ul style="list-style-type: none"> SC-DO 8/1 ¹⁾ (DS1646) SC-DO 8/2 ¹⁾ (DS1647) SC-SENS 4/1 ²⁾ (DS1626)
	SC2	8 x MIOS (DASM)	1 ... 8	<ul style="list-style-type: none"> SC-DI 8/1 (DS1642) SC-CCDI 6/1 (DS1637) SC-SENS 4/1 ²⁾ (DS1626)
	SC3	4 x bit I/O	37 ... 40	<ul style="list-style-type: none"> SC-DI 8/1 (DS1642)
		2 x MIOS (DASM)	9 ... 10	<ul style="list-style-type: none"> SC-DO 8/1 ¹⁾ (DS1646) SC-DO 8/2 ¹⁾ (DS1647) SC-SENS 4/1 ²⁾ (DS1626)
		2 x TPU	TPU_A: 7 ... 8	<ul style="list-style-type: none"> SC-CCDI 6/1 (DS1637)
	SC4	4 x analog	13 ... 16	<ul style="list-style-type: none"> SC-AI 4/1 ³⁾ (DS1631) SC-SENS 4/1 ²⁾ (DS1626)
	SC5	8 x analog	17 ... 24	<ul style="list-style-type: none"> SC-AI 4/1 ³⁾ (DS1631)
	SC6	4 x analog	25 ... 28	<ul style="list-style-type: none"> SC-AI 10/1 ⁴⁾ (DS1633) SC-SENS 4/1 ²⁾ (DS1626)
	SC7	8 x analog	29 ... 36	
	SC8	4 x analog	37 ... 40	

¹⁾ If an SC-DO 8/1 or SC-DO 8/2 module is inserted in the Control Unit's first slot (SC1) or in the SC Unit's third slot (SC3) you can use only a maximum of 6 module output channels.

²⁾ The SC-SENS 4/1 module is a sensor supply module and does not have signal connections to the Control Unit's microcontroller channels. Thus, you can insert an SC-SENS 4/1 module in any available slot. You can insert a maximum of 2 SC-SENS 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.

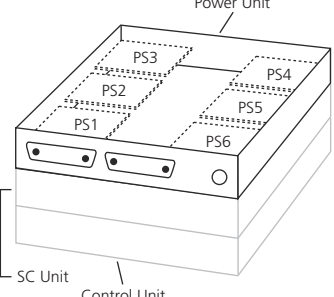
³⁾ You can insert a maximum of 4 SC-AI 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.

⁴⁾ The SC-AI 10/1 has 10 channels and requires two adjacent slots. The first slot has to process 8 channels and the second slot 2 channels. You can mount it on slots SC5 ... SC6, and SC7 ... SC8.

RoutingID 11550 – Power Unit

The routing code with the RoutingID 11550 is valid only if the stack consists of a Control Unit with MC-MPC565 1/1 module (layer 1), SC Unit (layer 2), and a Power Unit (layer 3).

The following table shows which PS modules can be installed on which slot of the Power Unit and suit the specifics of the Control Unit's microcontroller channels you need in your application.

Stack with UCB (RoutingID 11550)	Slot	Signal	MPC565 Channel	Possible Module
	PS1	2 x analog	1 ... 2	<ul style="list-style-type: none"> PS-FBD 2/1 (DS1661) PS-HSD 6/1 (DS1663) PS-LSD 6/1 (DS1662) PS-HCFBD 1/1 ^{1), 2)} (DS1667) PS-HCHBD 2/1 ^{1), 2)} (DS1668) PS-HCFBD 1/2 ¹⁾ (DS1767) PS-HCHBD 2/2 ^{1), 3)} (DS1768)
		4 x TPU	TPU_B: 9 ... 12	
		2 x bit out	25 ... 26	
	PS2	2 x analog	3 ... 4	
		4 x TPU	TPU_B: 13 ... 16	
		2 x bit out	27 ... 28	
	PS3	2 x analog	5 ... 6	
		4 x TPU	TPU_C: 1 ... 4	
		2 x bit out	29 ... 30	
	PS4	2 x analog	7 ... 8	
		4 x TPU	TPU_C: 5 ... 8	
		2 x bit out	31 ... 32	
	PS5	2 x analog	9 ... 10	
		4 x TPU	TPU_C: 9 ... 12	
		2 x bit out	33 ... 34	
	PS6	2 x analog	11 ... 12	
		4 x TPU	TPU_C: 13 ... 16	
		2 x bit out	35 ... 36	

¹⁾ The PS-HCxBD x/x module requires three adjacent slots. You can mount a module in rail 1 (slots PS1 ... PS3) or in rail 2 (slots PS4 ... PS6).

²⁾ The PS-HCxBD 1/x module uses only the available I/O signals of slot PS2 (if mounted in rail 1) or of slot PS5 (if mounted in rail 2). The I/O signals of slots PS1 and PS3 (or PS4 and PS5) are not connected to the module.

³⁾ This routing code is only valid for PS-HCHBD 2/2 modules in *General purpose, single channel* or *General purpose, double channel* mode.

Stack with Control Unit (MPC565), SC Unit, and Power Unit – RoutingID 50551 for SC-TC 8/1 Module

Objective

The routing code with RoutingID 50551 applies to the following configuration:

Stack with UCB consisting of:

- Control Unit with MC-MPC565 1/1 module (layer 1)
- SC Unit (layer 2) with one or more SC-TC 8/1 modules
- Power Unit (layer 3)

Note

The routing of the Control Unit and the Power Unit in this stack is identical to the routing of the triple stack consisting of Control Unit, SC Unit, and Power Unit with RoutingID 11550. Thus, the SC Unit of an existing triple stack can be easily replaced by an SC Unit with SC-TC 8/1 module(s) without changing the assembly of the other modules in the stack.

Note

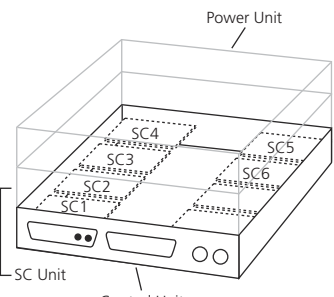
If you rearrange the modules on the carrier boards contrary to the table below, the routing code stored in the units has to be modified by dSPACE.

Installing or rearranging an SC-UHEGO 2/1 module (DS1639)

If you want to install or rearrange an SC-UHEGO 2/1 module (DS1639) in a single unit or a stack with UCB, you need a custom-built routing code. Contact dSPACE for an appropriate routing code.

RoutingID 50551 – Control Unit (MPC565)

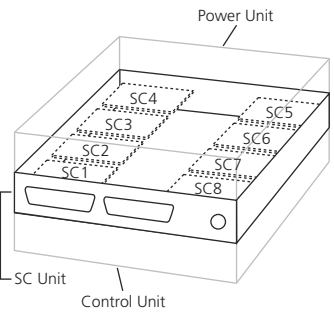
The following table shows which SC modules can be installed on which slot of the unit, and which suit the specifics of the Control Unit's microcontroller channels you need in your application.

Stack with UCB (RoutingID 50551)	Slot	Signal	MPC565 Channel	Possible Module
 <p>Control Unit (layer 1)</p> <p>Power Unit</p> <p>SC Unit</p> <p>Control Unit</p>	SC1	6 x TPU 2 x ADC (TRIG)	TPU_A: 1 ... 6 1 ... 2	<ul style="list-style-type: none"> ▪ SC-DI 8/1 (DS1642) ▪ SC-DO 8/1 ¹⁾ (DS1646) ▪ SC-DO 8/2 ¹⁾ (DS1646) ▪ SC-SENS 4/1 ²⁾ (DS1626) ▪ SC-CCDI 6/1 (DS1637)
	SC2	8 x TPU	TPU_A: 9 ... 16	
	SC3	8 x TPU	TPU_B: 1 ... 8	
	SC4	8 x bit I/O	1 ... 8	
	SC5	8 x bit I/O	9 ... 16	
	SC6	8 x bit I/O	17 ... 24	

- ¹⁾ If an SC-DO 8/1 or SC-DO 8/2 module is inserted in the Control Unit's first slot (SC1) you can use only a maximum of 6 module output channels.
- ²⁾ The SC-SENS 4/1 module is a sensor supply module and does not have signal connections to the Control Unit's microcontroller channels. Thus, you can insert an SC-SENS 4/1 module in any available slot. You can insert a maximum of 2 SC-SENS 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.

RoutingID 50551 – SC Unit

The following table shows which SC modules can be installed on which slot of the unit, and which suit the specifics of the Control Unit's microcontroller channels you need in your application.

Stack with UCB (RoutingID 50551)	Slot	Signal	MPC565 Channel	Possible Module
	SC1	8 x MIOS (PWM)	1 ... 8	<ul style="list-style-type: none"> SC-DO 8/1 (DS1646) SC-DO 8/2 (DS1647) SC-SENS 4/1 ¹⁾ (DS1626)
	SC2	8 x MIOS (DASM)	1 ... 8	<ul style="list-style-type: none"> SC-DI 8/1 (DS1642) SC-CCDI 6/1 (DS1637) SC-SENS 4/1 ¹⁾ (DS1626)
	SC3	4 x bit I/O	37 ... 40	<ul style="list-style-type: none"> SC-DI 8/1 (DS1642) SC-DO 8/1 ²⁾ (DS1646) SC-DO 8/2 ²⁾ (DS1646) SC-SENS 4/1 ¹⁾ (DS1626) SC-CCDI 6/1 (DS1637)
		2 x MIOS (DASM)	9 ... 10	
	SC4	4 x analog	13 ... 16	<ul style="list-style-type: none"> SC-AI 4/1 ³⁾ (DS1631) SC-SENS 4/1 ¹⁾ (DS1626)
	SC5	8 x analog	17 ... 24	<ul style="list-style-type: none"> SC-TC 8/1 ⁴⁾ (DS1638) SC-AI 4/1 ³⁾ (DS1631) SC-AI 10/1 ⁵⁾ (DS1633) SC-SENS 4/1 ¹⁾ (DS1626)
	SC6	4 x analog	25 ... 28	
	SC7	8 x analog	29 ... 36	
		1 x TPU	TPU_A: 8	
	SC8	4 x analog	37 ... 40	<ul style="list-style-type: none"> SC-AI 4/1 ³⁾ (DS1631) SC-AI 10/1 ⁵⁾ (DS1633) SC-SENS 4/1 ¹⁾ (DS1626)
			1 x SDI ⁶⁾	

¹⁾ The SC-SENS 4/1 module is a sensor supply module and does not have signal connections to the Control Unit's microcontroller channels. Thus, you can insert an SC-SENS 4/1 module in any available slot. You can insert a maximum of 2 SC-SENS 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.

²⁾ If an SC-DO 8/1 or SC-DO 8/2 module is inserted in the SC Unit's third slot (SC3) you can use only a maximum of 6 module output channels.

³⁾ You can insert a maximum of 4 SC-AI 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.

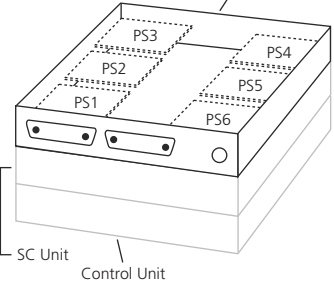
⁴⁾ The SC-TC 8/1 requires three adjacent slots. You can mount it on the SC Unit's slots SC5 ... SC7. The module uses only the available I/O signals of slot SC7. The I/O signals of slots SC5 and SC6 are not connected to the module.

⁵⁾ The SC-AI 10/1 has 10 channels and requires two adjacent slots. The first slot has to process 8 channels and the second slot 2 channels. You can mount it on slots SC5 ... SC6, and SC7 ... SC8.

⁶⁾ Serial Digital Interface for a connection to/from the microcontroller of the Control Unit.

RoutingID 50551 – Power Unit

The following table shows which PS modules can be installed on which slot of the Power Unit, and which suit the specifics of the Control Unit's microcontroller channels you need in your application.

Stack with UCB (RoutingID 50551)	Slot	Signal	MPC565 Channel	Possible Module
	PS1	2 x analog	1 ... 2	<ul style="list-style-type: none"> PS-FBD 2/1 (DS1661) PS-HSD 6/1 (DS1663) PS-LSD 6/1 (DS1662) PS-HCFBD 1/1 ^{1), 2)} (DS1667) PS-HCHBD 2/1 ^{1), 2)} (DS1668) PS-HCFBD 1/2 ¹⁾ (DS1767) PS-HCHBD 2/2 ^{1), 3)} (DS1768)
		4 x TPU	TPU_B: 9 ... 12	
		2 x bit out	25 ... 26	
	PS2	2 x analog	3 ... 4	
		4 x TPU	TPU_B: 13 ... 16	
		2 x bit out	27 ... 28	
	PS3	2 x analog	5 ... 6	
		4 x TPU	TPU_C: 1 ... 4	
		2 x bit out	29 ... 30	
	PS4	2 x analog	7 ... 8	
		4 x TPU	TPU_C: 5 ... 8	
		2 x bit out	31 ... 32	
	PS5	2 x analog	9 ... 10	
		4 x TPU	TPU_C: 9 ... 12	
		2 x bit out	33 ... 34	
	PS6	2 x analog	11 ... 12	
		4 x TPU	TPU_C: 13 ... 16	
		2 x bit out	35 ... 36	

¹⁾ The PS-HCxBD x/x module requires three adjacent slots. You can mount a module in rail 1 (slots PS1 ... PS3) or in rail 2 (slots PS4 ... PS6).

²⁾ The PS-HCxBD 1/x module uses only the available I/O signals of slot PS2 (if mounted in rail 1) or of slot PS5 (if mounted in rail 2). The I/O signals of slots PS1 and PS3 (or PS4 and PS5) are not connected to the module.

³⁾ This routing code is only valid for PS-HCHBD 2/2 modules in *General purpose, single channel* or *General purpose, double channel* mode.

Stack with Control Unit (MPC565), Two SC Units, and Power Unit – RoutingID 53202 for SC-TC 8/1 Module

Objective

The routing code with RoutingID 53202 applies to the following configuration:

Stack with UCB consisting of:

- Control Unit with MC-MPC565 1/1 module (layer 1)
- SC Unit 1 (layer 2)

- SC Unit 2 (layer 3) with one or more SC-TC 8/1 modules
- Power Unit (layer 4)

Note

The routing of the Control Unit and the Power Unit in this stack is identical to the routing of the triple stack consisting of Control Unit, SC Unit, and Power Unit with RoutingID 11550. Thus, an existing triple stack can be easily extended with an SC Unit with SC-TC 8/1 module(s) without changing the assembly of the other modules in the stack.

Note

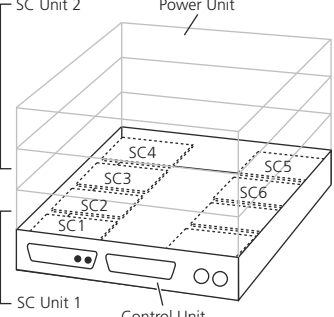
If you rearrange the modules on the carrier boards contrary to the table below, the routing code stored in the units has to be modified by dSPACE.

Installing or rearranging an SC-UHEGO 2/1 module (DS1639)

If you want to install or rearrange an SC-UHEGO 2/1 module (DS1639) in a single unit or a stack with UCB, you need a custom-built routing code. Contact dSPACE for an appropriate routing code.

RoutingID 53202 – Control Unit (MPC565)

The following table shows which SC modules can be installed on which slot of the unit, and which suit the specifics of the Control Unit's microcontroller channels you need in your application.

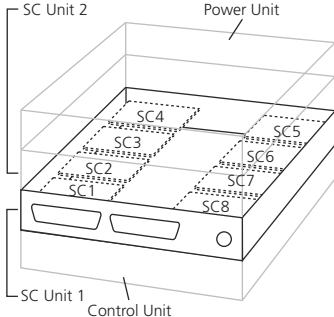
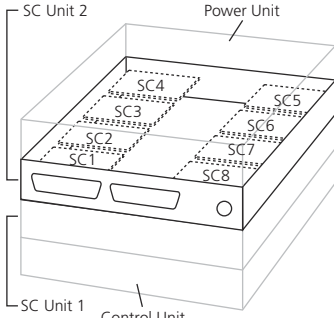
Stack with UCB (RoutingID 53202)	Slot	Signal	MPC565 Channel	Possible Module
	SC1	6 x TPU 2 x ADC (TRIG)	TPU_A: 1 ... 6 1 ... 2	<ul style="list-style-type: none"> ▪ SC-DI 8/1 (DS1642) ▪ SC-DO 8/1 ¹⁾ (DS1646) ▪ SC-DO 8/2 ¹⁾ (DS1647) ▪ SC-SENS 4/1 ²⁾ (DS1626) ▪ SC-CCDI 6/1 (DS1637)
	SC2	8 x TPU	TPU_A: 9 ... 16	
	SC3	8 x TPU	TPU_B: 1 ... 8	
	SC4	8 x bit I/O	1 ... 8	
	SC5	8 x bit I/O	9 ... 16	
	SC6	8 x bit I/O	17 ... 24	

¹⁾ If an SC-DO 8/1 or SC-DO 8/2 module is inserted in the Control Unit's first slot (SC1) you can use only a maximum of 6 module output channels.

²⁾ The SC-SENS 4/1 module is a sensor supply module and does not have signal connections to the Control Unit's microcontroller channels. Thus, you can insert an SC-SENS 4/1 module in any available slot. You can insert a maximum of 2 SC-SENS 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.

RoutingID 53202 – SC Units

The following table shows which SC modules can be installed on which slot of the SC Units, and which suit the specifics of the Control Unit's microcontroller channels you need in your application.

Stack with UCB (RoutingID 53202)	Slot	Signal	MPC565 Channel	Possible Module
SC Unit 1 (layer 2) 	SC1	8 x MIOS (PWM)	1 ... 8	<ul style="list-style-type: none"> SC-DO 8/1 (DS1646) SC-DO 8/2 (DS1647) SC-SENS 4/1 ¹⁾ (DS1626)
	SC2	8 x MIOS (DASM)	1 ... 8	<ul style="list-style-type: none"> SC-DI 8/1 (DS1642) SC-CCDI 6/1 (DS1637) SC-SENS 4/1 ¹⁾ (DS1626)
	SC3	4 x bit I/O	37 ... 40	<ul style="list-style-type: none"> SC-DI 8/1 (DS1642) SC-DO 8/1 ²⁾ (DS1646) SC-DO 8/2 ²⁾ (DS1647) SC-SENS 4/1 ¹⁾ (DS1626) SC-CCDI 6/1 (DS1637)
		2 x MIOS (DASM)	9 ... 10	
	SC4	4 x analog	13 ... 16	<ul style="list-style-type: none"> SC-AI 4/1 ³⁾ (DS1631) SC-SENS 4/1 ¹⁾ (DS1626)
	SC5	8 x analog	17 ... 24	<ul style="list-style-type: none"> SC-AI 4/1 ³⁾ (DS1631) SC-AI 10/1 ⁴⁾ (DS1633) SC-SENS 4/1 ¹⁾ (DS1626)
	SC6	4 x analog	25 ... 28	
	SC7	8 x analog	29 ... 36	
SC Unit 2 (layer 3) 	SC8	4 x analog	37 ... 40	<ul style="list-style-type: none"> SC-TC 8/1 ⁵⁾ (DS1638) SC-SENS 4/1 ¹⁾ (DS1626)
	SC1	–	–	
	SC2	–	–	
	SC3	1 x TPU	TPU_A: 7	<ul style="list-style-type: none"> SC-SENS 4/1 ¹⁾ (DS1626)
		1 x SDI ⁶⁾	1	
	SC4	–	–	<ul style="list-style-type: none"> SC-TC 8/1 ⁵⁾ (DS1638) SC-SENS 4/1 ¹⁾ (DS1626)
	SC5	–	–	
	SC6	–	–	
	SC7	1 x TPU	TPU_A: 8	<ul style="list-style-type: none"> SC-SENS 4/1 ¹⁾ (DS1626)
		1 x SDI ⁶⁾	2	
	SC8	–	–	<ul style="list-style-type: none"> SC-SENS 4/1 ¹⁾ (DS1626)

¹⁾ The SC-SENS 4/1 module is a sensor supply module and does not have signal connections to the Control Unit's microcontroller channels. Thus, you can insert an SC-SENS 4/1 module in any available slot. You can insert a maximum of 2 SC-SENS 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.

²⁾ If an SC-DO 8/1 or SC-DO 8/2 module is inserted in the SC Unit's third slot (SC3) you can use only a maximum of 6 module output channels.

³⁾ You can insert a maximum of 4 SC-AI 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.

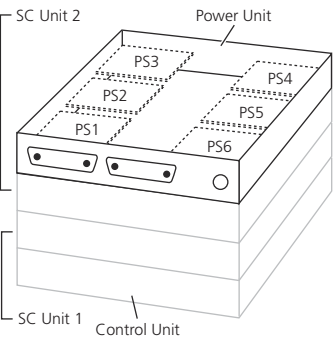
⁴⁾ The SC-AI 10/1 has 10 channels and requires two adjacent slots. The first slot has to process 8 channels and the second slot 2 channels. You can mount it on slots SC5 ... SC6, and SC7 ... SC8.

⁵⁾ The SC-TC 8/1 requires three adjacent slots. You can mount it on the SC Unit's slots SC1 ... SC3, and on slots SC5 ... SC7. The module uses only the available I/O signals of slot SC3 or of slot SC7. The I/O signals of slots SC1 and SC2 (or SC5 and SC6) are not connected to the module.

⁶⁾ Serial Digital Interface for a connection to/from the microcontroller of the Control Unit.

RoutingID 53202 – Power Unit

The following table shows which PS modules can be installed on which slot of the Power Unit, and which suit the specifics of the Control Unit's microcontroller channels you need in your application.

Stack with UCB (RoutingID 53202)	Slot	Signal	MPC565 Channel	Possible Module
 <p>Power Unit (layer 4)</p> <p>SC Unit 2</p> <p>Power Unit</p> <p>PS3</p> <p>PS2</p> <p>PS4</p> <p>PS1</p> <p>PS5</p> <p>PS6</p> <p>SC Unit 1</p> <p>Control Unit</p>	PS1	2 x analog	1 ... 2	<ul style="list-style-type: none"> PS-FBD 2/1 (DS1661) PS-HSD 6/1 (DS1663) PS-LSD 6/1 (DS1662) PS-HCFBD 1/1 ^{1), 2)} (DS1667) PS-HCHBD 2/1 ^{1), 2)} (DS1668) PS-HCFBD 1/2 ¹⁾ (DS1767) PS-HCHBD 2/2 ^{1), 3)} (DS1768)
		4 x TPU	TPU_B: 9 ... 12	
		2 x bit out	25 ... 26	
	PS2	2 x analog	3 ... 4	
		4 x TPU	TPU_B: 13 ... 16	
		2 x bit out	27 ... 28	
	PS3	2 x analog	5 ... 6	
		4 x TPU	TPU_C: 1 ... 4	
		2 x bit out	29 ... 30	
	PS4	2 x analog	7 ... 8	
		4 x TPU	TPU_C: 5 ... 8	
		2 x bit out	31 ... 32	
	PS5	2 x analog	9 ... 10	
		4 x TPU	TPU_C: 9 ... 12	
		2 x bit out	33 ... 34	
	PS6	2 x analog	11 ... 12	
		4 x TPU	TPU_C: 13 ... 16	
		2 x bit out	35 ... 36	

¹⁾ The PS-HCxBD x/x module requires three adjacent slots. You can mount a module in rail 1 (slots PS1 ... PS3) or in rail 2 (slots PS4 ... PS6).

²⁾ The PS-HCxBD 1/x module uses only the available I/O signals of slot PS2 (if mounted in rail 1) or of slot PS5 (if mounted in rail 2). The I/O signals of slots PS1 and PS3 (or PS4 and PS5) are not connected to the module.

³⁾ This routing code is only valid for PS-HCHBD 2/2 modules in *General purpose, single channel* or *General purpose, double channel* mode.

Stack with Control Unit (MPC565), Power Unit, and SC Unit – RoutingID 29752 for Engine Control

Objective

Which SC/PS module can be installed on which slot of a unit in a stack with UCB containing a Control Unit (MPC565), Power Unit, and SC Unit is defined via routing code that is optimized for engine control applications for up to six-cylinder engines.

Note

If you rearrange the modules on the carrier boards contrary to the table below, the routing code stored in the units has to be modified by dSPACE.

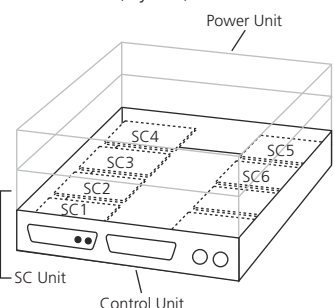
Installing or rearranging an SC-UHEGO 2/1 module (DS1639)

If you want to install or rearrange an SC-UHEGO 2/1 module (DS1639) in a single unit or a stack with UCB, you need a custom-built routing code. Contact dSPACE for an appropriate routing code.

RoutingID 29752 – Control Unit (MPC565) – engine control

The routing code with the RoutingID 29752 is valid only if the stack consists of a Control Unit with MC-MPC565 1/1 module (layer 1), SC Unit (layer 2), and a Power Unit (layer 3).

The following table shows which SC modules can be installed on which slot of the unit and suit the specifics of the Control Unit's microcontroller channels you need in your application.

Stack with UCB (RoutingID 29752) – Engine Control	Slot	Signal	MPC565 Channel	Possible Module
 <p>Control Unit (layer 1)</p> <p>Power Unit</p> <p>SC Unit</p> <p>Control Unit</p>	SC1	1 x TPU, used as crankshaft signal	TPU_A: 3	<ul style="list-style-type: none"> SC-DI 8/1 (DS1642) SC-CCDI 6/1 (DS1637) SC-SENS 4/1 ¹⁾ (DS1626)
		2 x TPU, used as camshaft signals	TPU_A: 4, 5	
		1 x ADC (TRIG)	1	
		4 x bit I/O	26 ... 29	
	SC2	2 x MIOS (PWM), used to monitor the lambda probe heater control ²⁾	2, 3	<ul style="list-style-type: none"> SC-EGOS 2/1 (DS1634)

Stack with UCB (RoutingID 29752) – Engine Control	Slot	Signal	MPC565 Channel	Possible Module
		2 x bit I/O, used as Ri measurement controls	3, 4	<ul style="list-style-type: none"> SC-SENS 4/1 ¹⁾ (DS1626)
		4 x analog, used as module outputs	25 ... 28	
	SC3	1 x TPU, used for generating the measurement window	TPU_A: 16	<ul style="list-style-type: none"> SC-KNOCK 4/1 (DS1635) SC-SENS 4/1 ¹⁾ (DS1626)
		1 x SDI ³⁾	1	
		2 x bit I/O, used for channel selection	33, 34	
	SC4	4 x TPU	TPU_C: 2 ... 5	<ul style="list-style-type: none"> SC-DI 8/1 (DS1642) SC-DO 8/1 (DS1646) SC-DO 8/2 (DS1647) SC-CCDI 6/1 (DS1637) SC-SENS 4/1 ¹⁾ (DS1626)
		4 x bit I/O	1, 2, 35, 36	
	SC5	8 x analog	1 ... 8	<ul style="list-style-type: none"> SC-AI 4/1 (DS1631) SC-AI 10/1 ⁴⁾ (DS1633) SC-SENS 4/1 ¹⁾ (DS1626)
	SC6	2 x analog	9, 10	<ul style="list-style-type: none"> SC-AI 10/1 ⁴⁾ (DS1633) SC-SENS 4/1 ¹⁾ (DS1626)

¹⁾ The SC-SENS 4/1 module is a sensor supply module and does not have signal connections to the Control Unit's microcontroller channels. Thus, you can insert an SC-SENS 4/1 module in any available slot. You can insert a maximum of 2 SC-SENS 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.

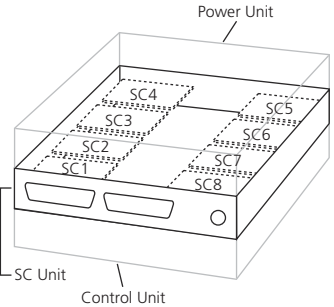
²⁾ The signals are also routed to the Power Unit (see PS5 on the Power Unit).

³⁾ Serial Digital Interface for a connection to/from the microcontroller of the Control Unit.

⁴⁾ The SC-AI 10/1 has 10 channels and requires two adjacent slots. The first slot has to process 8 channels and the second slot 2 channels. You can mount it on the Control Unit's slots SC5 ... SC6, and on the SC Unit's slots SC3 ... SC4.

RoutingID 29752 – SC Unit – engine control

The routing code with the RoutingID 29752 is valid only if the stack consists of a Control Unit with MC-MPC565 1/1 module (layer 1), SC Unit (layer 2), and a Power Unit (layer 3). The following table shows which SC modules can be installed on which slot of the SC Unit and suit the specifics of the Control Unit's microcontroller channels you need in your application.

Stack with UCB (RoutingID 29752) – Engine Control	Slot	Signal	MPC565 Channel	Possible Module
 <p>SC Unit (layer 2)</p> <p>Power Unit</p> <p>SC Unit</p> <p>Control Unit</p>	SC1	4 x analog	11 ... 14	<ul style="list-style-type: none"> SC-AI 4/1 (DS1631) SC-SENS 4/1 ¹⁾ (DS1626)
	SC2	–	–	<ul style="list-style-type: none"> SC-SENS 4/1 ¹⁾ (DS1626)
	SC3	8 x MIOS (DASM)	1 ... 8	<ul style="list-style-type: none"> SC-AI 4/1 (DS1631) SC-AI 10/1 ²⁾ (DS1633)
		8 x analog	15 ... 22	<ul style="list-style-type: none"> SC-DI 8/1 (DS1642) SC-CCDI 6/1 (DS1637) SC-SENS 4/1 ¹⁾ (DS1626)
	SC4	2 x MIOS (DASM)	9, 10	<ul style="list-style-type: none"> SC-AI 10/1 ²⁾ (DS1633) SC-DI 8/1 ³⁾ (DS1642)
		4 x bit I/O	23, 24, 31, 32	<ul style="list-style-type: none"> SC-DO 8/1 ⁴⁾ (DS1646)
		2 x analog	23 ... 24	<ul style="list-style-type: none"> SC-DO 8/2 ⁴⁾ (DS1647) SC-CCDI 6/1 (DS1637) SC-SENS 4/1 ¹⁾ (DS1626)
	SC5	6 x TPU, used as ignition signals	TPU_B: 4 ... 9	<ul style="list-style-type: none"> SC-DI 8/1 ³⁾ (DS1642) SC-DO 8/1 (DS1646) SC-DO 8/2 (DS1647)
		2 x TPU	TPU_B: 10, 11	<ul style="list-style-type: none"> SC-CCDI 6/1 ⁵⁾ (DS1637) SC-SENS 4/1 ¹⁾ (DS1626)
	SC6	4 x MIOS (PWM)	9 ... 12	
		4 x bit I/O	19 ... 22	
	SC7	2 x MIOS (PWM)	6 ... 7	
		6 x bit I/O	15, 16, 37 ... 40	
	SC8	5 x TPU	TPU_C: 8 ... 12	
		3 x bit I/O	17, 18, 25	

¹⁾ The SC-SENS 4/1 module is a sensor supply module and does not have signal connections to the Control Unit's microcontroller channels. Thus, you can insert an SC-SENS 4/1 module in any available slot. You can insert a maximum of 2 SC-SENS 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.

²⁾ The SC-AI 10/1 has 10 channels and requires two adjacent slots. The first slot has to process 8 channels and the second slot 2 channels. You can mount it on the Control Unit's slots SC5 ... SC6, and on the SC Unit's slots SC3 ... SC4.

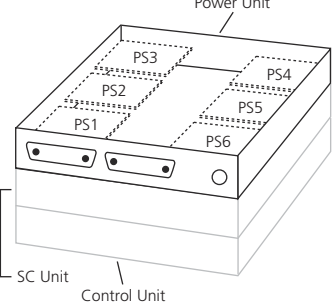
³⁾ If an SC-DI 8/1 module is inserted in the SC Unit's fourth (SC4) or in the seventh slot (SC7) you can use only a maximum of 6 module input channels, inserted in the SC Unit's sixth slot (SC6) you can use only a maximum of 4 module input channels.

⁴⁾ If an SC-DO 8/1 or SC-DO 8/2 module is inserted in the SC Unit's fourth slot (SC4) you can use only a maximum of 4 module output

⁵⁾ If an SC-CCDI 6/1 module is inserted in the SC Unit's sixth slot (SC6) you can use only a maximum of 2 module input channels.

RoutingID 29752 – Power Unit – engine control

The routing code with the RoutingID 29752 is valid only if the stack consists of a Control Unit with MC-MPC565 1/1 module (layer 1), SC Unit (layer 2), and a Power Unit (layer 3). The following table shows which PS modules can be installed on which slot of the Power Unit and suit the specifics of the Control Unit's microcontroller channels you need in your application.

Stack with UCB (RoutingID 29752) – Engine Control	Slot	Signal	MPC565 Channel	Possible Module
 <p>Power Unit (layer 3)</p> <p>Power Unit</p> <p>SC Unit</p> <p>Control Unit</p>	PS1	2 x TPU, used as injection signals	TPU_A: 6, 8	<ul style="list-style-type: none"> PS-FBD 2/1 (DS1661) PS-HSD 6/1 (DS1663) PS-LSD 6/1 (DS1662)
		2 x TPU	TPU_B: 12, 13	
		2 x MIOS (PWM)	4, 5	
		2 x analog	29, 30	
	PS2	2 x TPU, used as injection signals	TPU_A: 10, 12	<ul style="list-style-type: none"> PS-FBD 2/1 (DS1661) PS-LSD 6/1 (DS1662)
		2 x TPU	TPU_B: 14, 15	
		2 x bit I/O	5, 6	
		2 x analog	31, 32	
	PS3	2 x TPU, used as injection signals	<ul style="list-style-type: none"> TPU_A: 14 TPU_B: 2 	
		2 x TPU	TPU_C: 6, 7	
		1 x MIOS (PWM)	8	
		1 x bit I/O	30	
		2 x analog	33, 34	
	PS4	1 x TPU, used as throttle signal	TPU_B: 16	
		1 x MIOS (PWM)	1	
		2 x bit I/O	7, 8	
		2 x analog	35, 36	
	PS5	2 x MIOS (PWM), used as lambda probe heater control signals	2, 3	
		4 x bit I/O	9 ... 12	
		2 x analog	37, 38	
	PS6	4 x TPU	TPU_C: 13 ... 16	<ul style="list-style-type: none"> PS-FBD 2/1 (DS1661) PS-HSD 6/1 (DS1663) PS-LSD 6/1 (DS1662)
		2 x bit I/O	13, 14	
		2 x analog	39, 40	

Stack with Control Unit (MPC565), Power Unit, and SC Unit – RoutingID 61376 for PS-DINJ 2/1 Module

Objective

The routing code with the RoutingID 61376 applies the following configuration:

- Engine control use scenario for engines with up to 4 cylinders
- Stack with UCB consisting of:
 - Control Unit with MC-MPC565 1/1 module (layer 1)
 - SC Unit (layer 2)
 - Power Unit (layer 3)
- One or more PS-DINJ 2/1 module

Note

If you rearrange the modules on the carrier boards contrary to the table below, the routing code stored in the units has to be modified by dSPACE.

Safety precautions**⚠ WARNING**

Hazardous voltages! The PS-DINJ 2/1 module generates output voltages up to 100 V.

Risk of electric shock

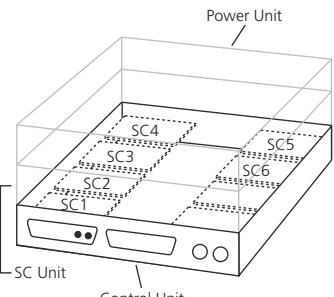
- Observe all safety precautions stated before using the PS-DINJ 2/1 module. Refer to [Safety Precautions for Using the PS-DINJ 2/1 Module](#) on page 15.

Installing or rearranging an SC-UHEGO 2/1 module (DS1639)

If you want to install or rearrange an SC-UHEGO 2/1 module (DS1639) in a single unit or a stack with UCB, you need a custom-built routing code. Contact dSPACE for an appropriate routing code.

RoutingID 61376 – Control Unit (MPC565) – engine control

The following table shows which SC modules can be installed on which slot of the unit and suit the specifics of the Control Unit's microcontroller channels you need in your application.

Stack with UCB (RoutingID 61376) – Engine Control	Slot	Signal	MPC565 Channel	Possible Module
Control Unit (layer 1) 	SC1	1 x TPU, used as crankshaft signal	TPU_A: 3	<ul style="list-style-type: none"> ▪ SC-DI 8/1 (DS1642) ▪ SC-CCDI 6/1 (DS1637) ▪ SC-SENS 4/1 ¹⁾ (DS1626)
		2 x TPU, used as camshaft signals	TPU_A: 4, 5	
		1 x ADC (TRIG)	1	
		4 x bit I/O	26 ... 29	
	SC2	2 x MIOS (PWM), used to monitor the	2, 3	<ul style="list-style-type: none"> ▪ SC-EGOS 2/1 (DS1634)

Stack with UCB (RoutingID 61376) – Engine Control	Slot	Signal	MPC565 Channel	Possible Module
		lambda probe heater controls ²⁾		<ul style="list-style-type: none"> SC-SENS 4/1 ¹⁾ (DS1626)
		2 x bit I/O, used as Ri measurement controls	3, 4	
		4 x analog, used as module outputs	25 ... 28	
	SC3	1 x TPU, used for generating the measurement window	TPU_A: 16	<ul style="list-style-type: none"> SC-KNOCK 4/1 (DS1635) SC-SENS 4/1 ¹⁾ (DS1626)
		1 x SDI ³⁾	1	
		2 x bit I/O, used for channel selection	33, 34	
	SC4	4 x TPU	TPU_C: 2 ... 5	<ul style="list-style-type: none"> SC-DI 8/1 (DS1642) SC-DO 8/1 (DS1646) SC-DO 8/2 (DS1647) SC-CCDI 6/1 (DS1637) SC-SENS 4/1 ¹⁾ (DS1626)
		4 x bit I/O	1, 2, 35, 36	
	SC5	8 x analog	1 ... 8	<ul style="list-style-type: none"> SC-AI 4/1 (DS1631) SC-AI 10/1 ⁴⁾ (DS1633) SC-SENS 4/1 ¹⁾ (DS1626)
	SC6	2 x analog	9, 10	<ul style="list-style-type: none"> SC-AI 10/1 ⁴⁾ (DS1633) SC-SENS 4/1 ¹⁾ (DS1626)

¹⁾ The SC-SENS 4/1 module is a sensor supply module and does not have signal connections to the Control Unit's microcontroller channels. Thus, you can insert an SC-SENS 4/1 module in any available slot. You can insert a maximum of 2 SC-SENS 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.

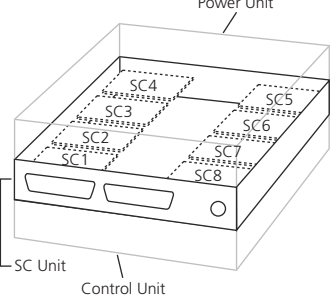
²⁾ The signals are also routed to the Power Unit (see PS5 on the Power Unit).

³⁾ Serial Digital Interface for a connection to/from the microcontroller of the Control Unit.

⁴⁾ The SC-AI 10/1 has 10 channels and requires two adjacent slots. The first slot has to process 8 channels and the second slot 2 channels. You can mount it on the Control Unit's slots SC5 ... SC6, and on the SC Unit's slots SC3 ... SC4.

RoutingID 61376 – SC Unit – engine control

The following table shows which SC modules can be installed on which slot of the SC Unit and suit the specifics of the Control Unit's microcontroller channels you need in your application.

Stack with UCB (RoutingID 61376) – Engine Control	Slot	Signal	MPC565 Channel	Possible Module
 <p>Power Unit</p> <p>SC Unit</p> <p>Control Unit</p>	SC1	4 x analog	11 ... 14	<ul style="list-style-type: none"> SC-AI 4/1 (DS1631) SC-SENS 4/1 ¹⁾ (DS1626)
	SC2	–	–	<ul style="list-style-type: none"> SC-SENS 4/1 ¹⁾ (DS1626)
	SC3	8 x MIOS (DASM)	1 ... 8	<ul style="list-style-type: none"> SC-AI 4/1 (DS1631) SC-AI 10/1 ²⁾ (DS1633)
		8 x analog	15 ... 22	<ul style="list-style-type: none"> SC-DI 8/1 (DS1642) SC-CCDI 6/1 (DS1637) SC-SENS 4/1 ¹⁾ (DS1626)
	SC4	2 x MIOS (DASM)	9, 10	<ul style="list-style-type: none"> SC-AI 10/1 ²⁾ (DS1633) SC-DI 8/1 ³⁾ (DS1642)
		4 x bit I/O	23, 24, 31, 32	<ul style="list-style-type: none"> SC-DO 8/1 ⁴⁾ (DS1646)
		2 x analog	23 ... 24	<ul style="list-style-type: none"> SC-DO 8/2 ⁴⁾ (DS1647) SC-CCDI 6/1 (DS1637) SC-SENS 4/1 ¹⁾ (DS1626)
	SC5	8 x TPU, used as ignition signals	TPU_B: 4 ... 11	<ul style="list-style-type: none"> SC-DI 8/1 ³⁾ (DS1642) SC-DO 8/1 (DS1646)
	SC6	4 x MIOS (PWM)	9 ... 12	<ul style="list-style-type: none"> SC-DO 8/2 (DS1647)
		4 x bit I/O	19 ... 22	<ul style="list-style-type: none"> SC-CCDI 6/1 ⁵⁾ (DS1637) SC-SENS 4/1 ¹⁾ (DS1626)
	SC7	2 x MIOS (PWM)	6 ... 7	
		6 x bit I/O	15, 16, 37 ... 40	
	SC8	5 x TPU	TPU_C: 8 ... 11, 16	
		3 x bit I/O	17, 18, 25	

¹⁾ The SC-SENS 4/1 module is a sensor supply module and does not have signal connections to the Control Unit's microcontroller channels. Thus, you can insert an SC-SENS 4/1 module in any available slot. You can insert a maximum of 2 SC-SENS 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.

²⁾ The SC-AI 10/1 has 10 channels and requires two adjacent slots. The first slot has to process 8 channels and the second slot 2 channels. You can mount it on the Control Unit's slots SC5 ... SC6, and on the SC Unit's slots SC3 ... SC4.

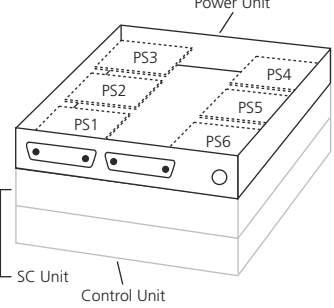
³⁾ If an SC-DI 8/1 module is inserted in the SC Unit's fourth (SC4) or in the seventh slot (SC7) you can use only a maximum of 6 module input channels, inserted in the SC Unit's sixth slot (SC6) you can use only a maximum of 4 module input channels.

⁴⁾ If an SC-DO 8/1 or SC-DO 8/2 module is inserted in the SC Unit's fourth slot (SC4) you can use only a maximum of 4 module output

⁵⁾ If an SC-CCDI 6/1 module is inserted in the SC Unit's sixth slot (SC6) you can use only a maximum of 2 module input channels.

RoutingID 61376 – Power Unit with PS-DINJ 2/1 – engine control

The following table shows which PS modules can be installed on which slot of the Power Unit and suit the specifics of the Control Unit's microcontroller channels you need in your application.

Stack with UCB (RoutingID 61376) – Engine Control	Slot	Signal	MPC565 Channel	Possible Module
 <p>Power Unit (layer 3)</p> <p>Power Unit</p> <p>PS1 PS2 PS3 PS4 PS5 PS6</p> <p>SC Unit Control Unit</p>	PS1	4 x TPU, used as injection signals	TPU_A: 6 ... 9	■ PS-DINJ 2/1 (DS1664) ¹⁾
		2 x analog	29, 30	
	PS2	–	–	
	PS3	2 x MIOS (PWM), used as lambda probe heater control signals	2, 3	■ PS-LSD 6/1 (DS1662)
		4 x bit I/O	9 ... 12	
		2 x analog	33, 34	
	PS4	4 x TPU	TPU_A: 10 ... 13	■ PS-DINJ 2/1 (DS1664) ¹⁾
		2 x analog	35, 36	
	PS5	–	–	
	PS6	1 x TPU, used as throttle signal	TPU_B: 16	■ PS-FBD 2/1 (DS1661)
		1 x MIOS (PWM)	1	
		2 x bit I/O	7, 8	
		2 x analog	39, 40	

¹⁾ The PS-DINJ 2/1 has 2 channels and requires two adjacent slots. The first slot has to process both channels. You can mount it on the Power Unit's slots PS1 ... PS2, and PS4 ... PS5.

Stack with Control Unit (MPC565), two Power Units, and SC Unit – RoutingID 65422 for PS-DINJ 2/1 Module

Objective

The routing code with the RoutingID 65422 applies the following configuration:

- Engine control use scenario for engines with up to 8 cylinders
- Stack with UCB consisting of:
 - Control Unit with MC-MPC565 1/1 module (layer 1)
 - SC Unit (layer 2)
 - Power Unit 1 (layer 3)
 - Power Unit 2 (layer 4)
- One or more PS-DINJ 2/1 module

Note

If you rearrange the modules on the carrier boards contrary to the table below, the routing code stored in the units has to be modified by dSPACE.

Safety precautions

⚠ WARNING

Hazardous voltages! The PS-DINJ 2/1 module generates output voltages up to 100 V.

Risk of electric shock

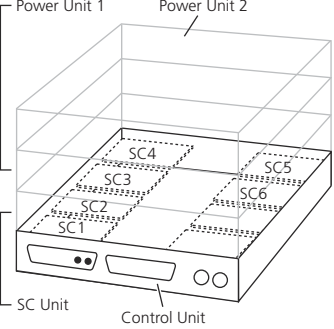
- Observe all safety precautions stated before using the PS-DINJ 2/1 module. Refer to [Safety Precautions for Using the PS-DINJ 2/1 Module](#) on page 15.

Installing or rearranging an SC-UHEGO 2/1 module (DS1639)

If you want to install or rearrange an SC-UHEGO 2/1 module (DS1639) in a single unit or a stack with UCB, you need a custom-built routing code. Contact dSPACE for an appropriate routing code.

RoutingID 65422 – Control Unit (MPC565) – engine control

The following table shows which SC modules can be installed on which slot of the unit and suit the specifics of the Control Unit's microcontroller channels you need in your application.

Stack with UCB (RoutingID 65422) – Engine Control	Slot	Signal	MPC565 Channel	Possible Module
	SC1	1 x TPU, used as crankshaft signal	TPU_A: 3	<ul style="list-style-type: none"> SC-DI 8/1 (DS1642) SC-CCDI 6/1 (DS1637) SC-SENS 4/1 ¹⁾ (DS1626)
		2 x TPU, used as camshaft signals	TPU_A: 4, 5	
		1 x ADC (TRIG)	1	
		4 x bit I/O	26 ... 29	
	SC2	2 x MIOS (PWM), used to monitor the lambda probe heater controls ²⁾	2, 3	<ul style="list-style-type: none"> SC-EGOS 2/1 (DS1634) SC-SENS 4/1 ¹⁾ (DS1626)
		2 x bit I/O, used as Ri measurement controls	3, 4	
		4 x analog, used as module outputs	25 ... 28	
	SC3	1 x TPU, used for generating the measurement window	TPU_A: 16	<ul style="list-style-type: none"> SC-KNOCK 4/1 (DS1635) SC-SENS 4/1 ¹⁾ (DS1626)
		1 x SDI ³⁾	1	
		2 x bit I/O, used for channel selection	33, 34	
	SC4	4 x TPU	TPU_C: 2 ... 5	<ul style="list-style-type: none"> SC-DI 8/1 (DS1642) SC-DO 8/1 (DS1646) SC-DO 8/2 (DS1647) SC-CCDI 6/1 (DS1637)
		4 x bit I/O	1, 2, 35, 36	

Stack with UCB (RoutingID 65422) – Engine Control	Slot	Signal	MPC565 Channel	Possible Module
				<ul style="list-style-type: none"> SC-SENS 4/1 ¹⁾ (DS1626)
	SC5	8 x analog	1 ... 8	<ul style="list-style-type: none"> SC-AI 4/1 (DS1631) SC-AI 10/1 ⁴⁾ (DS1633) SC-SENS 4/1 ¹⁾ (DS1626)
	SC6	2 x analog	9, 10	<ul style="list-style-type: none"> SC-AI 10/1 ⁴⁾ (DS1633) SC-SENS 4/1 ¹⁾ (DS1626)

¹⁾ The SC-SENS 4/1 module is a sensor supply module and does not have signal connections to the Control Unit's microcontroller channels. Thus, you can insert an SC-SENS 4/1 module in any available slot. You can insert a maximum of 2 SC-SENS 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.

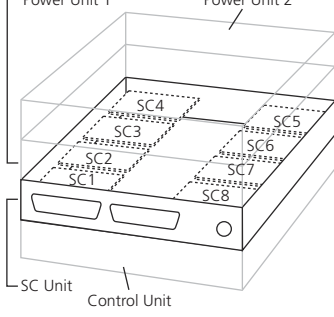
²⁾ The signals are also routed to the Power Unit (see PS5 on the Power Unit).

³⁾ Serial Digital Interface for a connection to/from the microcontroller of the Control Unit.

⁴⁾ The SC-AI 10/1 has 10 channels and requires two adjacent slots. The first slot has to process 8 channels and the second slot 2 channels. You can mount it on the Control Unit's slots SC5 ... SC6, and on the SC Unit's slots SC3 ... SC4.

RoutingID 65422 – SC Unit – engine control

The following table shows which SC modules can be installed on which slot of the SC Unit and suit the specifics of the Control Unit's microcontroller channels you need in your application.

Stack with UCB (RoutingID 65422) – Engine Control	Slot	Signal	MPC565 Channel	Possible Module
SC Unit (layer 2) 	SC1	4 x analog	11 ... 14	<ul style="list-style-type: none"> SC-AI 4/1 (DS1631) SC-SENS 4/1 ¹⁾ (DS1626)
	SC2	–	–	<ul style="list-style-type: none"> SC-SENS 4/1 ¹⁾ (DS1626)
	SC3	8 x MIOS (DASM)	1 ... 8	<ul style="list-style-type: none"> SC-AI 4/1 (DS1631) SC-AI 10/1 ²⁾ (DS1633)
		8 x analog	15 ... 22	<ul style="list-style-type: none"> SC-DI 8/1 (DS1642) SC-CCDI 6/1 (DS1637) SC-SENS 4/1 ¹⁾ (DS1626)
	SC4	2 x MIOS (DASM)	9, 10	<ul style="list-style-type: none"> SC-AI 10/1 ²⁾ (DS1633) SC-DI 8/1 ³⁾ (DS1642)
		4 x bit I/O	23, 24, 31, 32	<ul style="list-style-type: none"> SC-DO 8/1 ⁴⁾ (DS1646) SC-DO 8/2 ⁴⁾ (DS1647)
		2 x analog	23 ... 24	<ul style="list-style-type: none"> SC-CCDI 6/1 (DS1637) SC-SENS 4/1 ¹⁾ (DS1626)
	SC5	8 x TPU	TPU_B: 4 ... 11	<ul style="list-style-type: none"> SC-DI 8/1 ³⁾ (DS1642) SC-DO 8/1 (DS1646)
	SC6	4 x MIOS (PWM)	9 ... 12	<ul style="list-style-type: none"> SC-DO 8/2 (DS1647)
		4 x bit I/O	19 ... 22	<ul style="list-style-type: none"> SC-CCDI 6/1 ⁵⁾ (DS1637)

Stack with UCB (RoutingID 65422) – Engine Control	Slot	Signal	MPC565 Channel	Possible Module
	SC7	2 x MIOS (PWM)	6 ... 7	▪ SC-SENS 4/1 ¹⁾ (DS1626)
		6 x bit I/O	15, 16, 37 ... 40	
	SC8	5 x TPU	TPU_C: 8 ... 11, 16	
		3 x bit I/O	17, 18, 25	

¹⁾ The SC-SENS 4/1 module is a sensor supply module and does not have signal connections to the Control Unit's microcontroller channels. Thus, you can insert an SC-SENS 4/1 module in any available slot. You can insert a maximum of 2 SC-SENS 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.

²⁾ The SC-AI 10/1 has 10 channels and requires two adjacent slots. The first slot has to process 8 channels and the second slot 2 channels. You can mount it on the Control Unit's slots SC5 ... SC6, and on the SC Unit's slots SC3 ... SC4.

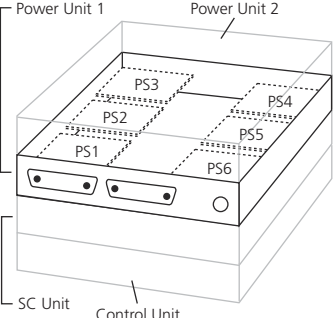
³⁾ If an SC-DI 8/1 module is inserted in the SC Unit's fourth (SC4) or in the seventh slot (SC7) you can use only a maximum of 6 module input channels, inserted in the SC Unit's sixth slot (SC6) you can use only a maximum of 4 module input channels.

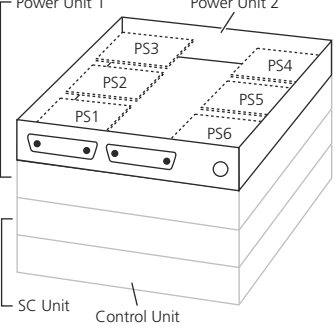
⁴⁾ If an SC-DO 8/1 or SC-DO 8/2 module is inserted in the SC Unit's fourth slot (SC4) you can use only a maximum of 4 module output.

⁵⁾ If an SC-CCDI 6/1 module is inserted in the SC Unit's sixth slot (SC6) you can use only a maximum of 2 module input channels.

RoutingID 65422 – Power Units with PS-DINJ 2/1 – engine control

The following table shows which PS modules can be installed on which slot of a Power Unit and suit the specifics of the Control Unit's microcontroller channels you need in your application.

Stack with UCB (RoutingID 65422) – Engine Control	Slot	Signal	MPC565 Channel	Possible Module
	PS1	4 x TPU, used as injection signals	TPU_A: 6 ... 8	▪ PS-DINJ 2/1 (DS1664) ¹⁾
		2 x analog	29, 30	
	PS2	–	–	
	PS3	2 x MIOS (PWM), used as lambda probe heater control signals	2, 3	▪ PS-LSD 6/1 (DS1662)
		4 x bit I/O	9 ... 12	
		2 x analog	33, 34	
	PS4	4 x TPU, used as injection signals	TPU_A: 10 ... 13	▪ PS-DINJ 2/1 (DS1664) ¹⁾
		2 x analog	35, 36	
	PS5	–	–	
	PS6	1 x TPU, used as throttle signal	TPU_B: 16	▪ PS-FBD 2/1 (DS1661)
		1 x MIOS (PWM)	1	
		2 x bit I/O	7, 8	
		2 x analog	39, 40	

Stack with UCB (RoutingID 65422) – Engine Control	Slot	Signal	MPC565 Channel	Possible Module
	PS1	2 x TPU	TPU_A: 14, 15	<ul style="list-style-type: none"> PS-FBD 2/1 (DS1661)²⁾ PS-HSD 6/1 (DS1663)²⁾ PS-LSD 6/1 (DS1662)²⁾
		2 x MIOS (PWM)	4, 5	
		2 x bit I/O	5, 6	
	PS2	4 x TPU, used as injection signals	TPU_C: 12 ... 15	<ul style="list-style-type: none"> PS-DINJ 2/1 (DS1664)³⁾
		2 x analog	31, 32	
	PS3	–	–	
	PS4	4 x TPU	TPU_B: 12 ... 15	<ul style="list-style-type: none"> PS-FBD 2/1 (DS1661)²⁾ PS-HSD 6/1 (DS1663)²⁾ PS-LSD 6/1 (DS1662)²⁾
		1 x MIOS (PWM)	8	
		1 x bit I/O	13	
	PS5	4 x TPU	TPU_B: 2, 3 TPU_C: 6, 7	<ul style="list-style-type: none"> PS-DINJ 2/1 (DS1664)³⁾
		2 x analog	37, 38	
	PS6	–	–	

¹⁾ Power Unit (layer 3): The PS-DINJ 2/1 has 2 channels and requires two adjacent slots. The first slot has to process both channels.

You can mount it on the Power Unit's slots PS1 ... PS2, and PS4 ... PS5.

²⁾ If the module is installed in this slot, the current measurement feature is not supported.

³⁾ Power Unit (layer 4): The PS-DINJ 2/1 has 2 channels and requires two adjacent slots. The first slot has to process both channels.

You can mount it on the Power Unit's slots PS2 ... PS3, and PS5 ... PS6.

Stack with Control Unit (MPC565), Power Unit, two SC Units – RoutingID 10243 for PS-DINJ 2/1 and SC-TC 8/1 Modules

Objective

The routing code with the RoutingID 10243 applies the following configuration:

- Engine control use scenario for engines with up to 4 cylinders
- Stack with UCB consisting of:
 - Control Unit with MC-MPC565 1/1 module (layer 1)
 - SC Unit 1 (layer 2)
 - SC Unit 2 (layer 3) with one or more SC-TC 8/1 module
 - Power Unit (layer 4) with one or more PS-DINJ 2/1 module

Note

If you rearrange the modules on the carrier boards contrary to the table below, the routing code stored in the units has to be modified by dSPACE.

Safety precautions

⚠ WARNING

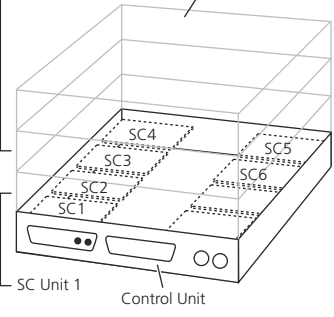
Hazardous voltages! The PS-DINJ 2/1 module generates output voltages up to 100 V.

Risk of electric shock

- Observe all safety precautions stated before using the PS-DINJ 2/1 module. Refer to [Safety Precautions for Using the PS-DINJ 2/1 Module](#) on page 15.

RoutingID 10243 – Control Unit (MPC565) – engine control

The following table shows which SC modules can be installed on which slot of the unit and suit the specifics of the Control Unit's microcontroller channels you need in your application.

Stack with UCB (RoutingID 10243) – Engine Control	Slot	Signal	MPC565 Channel	Possible Module
	SC1	1 x TPU, used as crankshaft signal	TPU_A: 3	<ul style="list-style-type: none"> SC-DI 8/1 (DS1642) SC-CCDI 6/1 (DS1637) SC-SENS 4/1 ¹⁾ (DS1626)
		2 x TPU, used as camshaft signals	TPU_A: 4, 5	
		1 x ADC (TRIG)	1	
		4 x bit I/O	26 ... 29	
	SC2	2 x MIOS (PWM), used to monitor the lambda probe heater controls ²⁾	2, 3	<ul style="list-style-type: none"> SC-EGOS 2/1 (DS1634) SC-SENS 4/1 ¹⁾ (DS1626)
		2 x bit I/O, used as Ri measurement controls	3, 4	
		4 x analog, used as module outputs	25 ... 28	
	SC3	1 x TPU, used for generating the measurement window	TPU_A: 16	<ul style="list-style-type: none"> SC-KNOCK 4/1 (DS1635) SC-SENS 4/1 ¹⁾ (DS1626)
		1 x SDI ³⁾	1	
		2 x bit I/O, used for channel selection	33, 34	
	SC4	4 x TPU	TPU_C: 2 ... 5	<ul style="list-style-type: none"> SC-DI 8/1 (DS1642) SC-DO 8/1 (DS1646) SC-DO 8/2 (DS1647) SC-CCDI 6/1 (DS1637) SC-SENS 4/1 ¹⁾ (DS1626)
		4 x bit I/O	1, 2, 35, 36	
	SC5	8 x analog	1 ... 8	<ul style="list-style-type: none"> SC-AI 4/1 (DS1631) SC-AI 10/1 ⁴⁾ (DS1633)

Stack with UCB (RoutingID 10243) – Engine Control	Slot	Signal	MPC565 Channel	Possible Module
				<ul style="list-style-type: none"> SC-SENS 4/1 ¹⁾ (DS1626)
	SC6	2 x analog	9, 10	<ul style="list-style-type: none"> SC-AI 10/1 ⁴⁾ (DS1633) SC-SENS 4/1 ¹⁾ (DS1626)

¹⁾ The SC-SENS 4/1 module is a sensor supply module and does not have signal connections to the Control Unit's microcontroller channels. Thus, you can insert an SC-SENS 4/1 module in any available slot. You can insert a maximum of 2 SC-SENS 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.

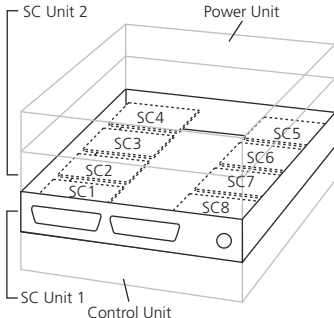
²⁾ The signals are also routed to the Power Unit (see PS5 on the Power Unit).

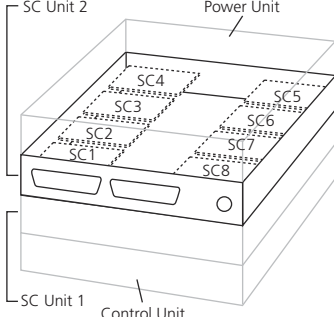
³⁾ Serial Digital Interface for a connection to/from the microcontroller of the Control Unit.

⁴⁾ The SC-AI 10/1 has 10 channels and requires two adjacent slots. The first slot has to process 8 channels and the second slot 2 channels. You can mount it on the Control Unit's slots SC5 ... SC6.

RoutingID 10243 – SC Units

The following table shows which SC modules can be installed on which slot of the SC Units, and which suit the specifics of the Control Unit's microcontroller channels you need in your application.

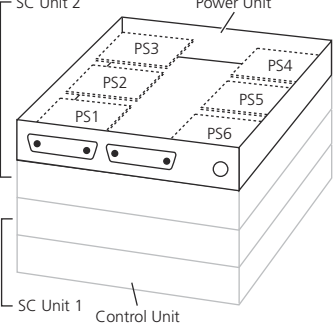
Stack with UCB (RoutingID 10243) – Engine Control	Slot	Signal	MPC565 Channel	Possible Module
<p>SC Unit 1 (layer 2)</p>  <p>SC Unit 2</p> <p>Power Unit</p> <p>SC Unit 1</p> <p>Control Unit</p>	SC1	4 x analog	11 ... 14	<ul style="list-style-type: none"> SC-AI 4/1 (DS1631) SC-SENS 4/1 ¹⁾ (DS1626)
	SC2	–	–	<ul style="list-style-type: none"> SC-SENS 4/1 ¹⁾ (DS1626)
	SC3	8 x MIOS (DASM)	1 ... 8	<ul style="list-style-type: none"> SC-AI 4/1 (DS1631) SC-AI 10/1 ²⁾ (DS1633) SC-DI 8/1 (DS1642) SC-CCDI 6/1 (DS1637) SC-SENS 4/1 ¹⁾ (DS1626)
		8 x analog	15 ... 22	
	SC4	2 x MIOS (DASM)	9, 10	
		4 x bit I/O	23, 24, 31, 32	
		2 x analog	23 ... 24	
	SC5	8 x TPU	TPU_B: 4 ... 11	<ul style="list-style-type: none"> SC-DI 8/1 ³⁾ (DS1642) SC-DO 8/1 (DS1646) SC-DO 8/2 (DS1647) SC-CCDI 6/1 (DS1637) SC-SENS 4/1 ¹⁾ (DS1626)
	SC6	4 x MIOS (PWM)	9 ... 12	
		4 x bit I/O	19 ... 22	
	SC7	2 x MIOS (PWM)	6 ... 7	
		6 x bit I/O	15, 16, 37 ... 40	
	SC8	5 x TPU	TPU_C: 8 ... 11, 16	
		3 x bit I/O	17, 18, 25	

Stack with UCB (RoutingID 10243) – Engine Control	Slot	Signal	MPC565 Channel	Possible Module
 <p>SC Unit 2 (layer 3)</p> <p>SC Unit 1</p> <p>Power Unit</p> <p>Control Unit</p>	SC1	–	–	<ul style="list-style-type: none"> SC-TC 8/1 ⁶⁾ (DS1638) SC-SENS 4/1 ¹⁾ (DS1626)
	SC2	–	–	
	SC3	1 x TPU 1 x SDI ⁷⁾	TPU_A: 14 2	
	SC4	8 x TPU	TPU_B: 12 ... 15 TPU_C: 12 ... 15	<ul style="list-style-type: none"> SC-DI 8/1 (DS1642) SC-DO 8/1 (DS1646) SC-DO 8/2 (DS1647) SC-CCDI 6/1 (DS1637) SC-SENS 4/1 ¹⁾ (DS1626)
	SC5	–	–	<ul style="list-style-type: none"> SC-TC 8/1 ⁶⁾ (DS1638) SC-SENS 4/1 ¹⁾ (DS1626)
	SC6	–	–	
	SC7	1 x TPU 1 x SDI ⁷⁾	TPU_A: 15 3	
	SC8	2 x MIOS (PWM)	4, 5	<ul style="list-style-type: none"> SC-DI 8/1 ⁸⁾ (DS1642) SC-DO 8/1 (DS1646) SC-DO 8/2 (DS1647) SC-CCDI 6/1 (DS1637) SC-SENS 4/1 ¹⁾ (DS1626)
		4 x TPU	TPU_B: 2, 3 TPU_C: 6, 7	
		2 x bit I/O	5, 6	

- ¹⁾ The SC-SENS 4/1 module is a sensor supply module and does not have signal connections to the Control Unit's microcontroller channels. Thus, you can insert an SC-SENS 4/1 module in any available slot. You can insert a maximum of 2 SC-SENS 4/1 modules in a unit to avoid exceeding the unit's maximum possible power consumption.
- ²⁾ SC Unit 1 (layer 2) - The SC-AI 10/1 has 10 channels and requires two adjacent slots. The first slot has to process 8 channels and the second slot 2 channels. You can mount it on the slots SC3 ... SC4.
- ³⁾ SC Unit 1 (layer2): Slot SC4 and SC7: You can use only the module input channels 1 ... 6. Slot SC6: You can use only the module input channels 5 ... 8.
- ⁴⁾ SC Unit 1 (layer 2) - If an SC-DO 8/1 or SC-DO 8/2 module is inserted in the fourth slot (SC4) you can use only the module output channels 1 ... 4.
- ⁵⁾ SC Unit 1 (layer 2) - If an SC-CCDI 6/1 module is inserted in the sixth slot (SC6) you can use only the input channels 5 and 6.
- ⁶⁾ SC Unit 2 (layer 3) - The SC-TC 8/1 requires three adjacent slots. You can mount it on the SC Unit's slots SC1 ... SC3, and on slots SC5 ... SC7. The module uses only the available I/O signals of slot SC3 or of slot SC7. The I/O signals of slots SC1 and SC2 (or SC5 and SC6) are not connected to the module.
- ⁷⁾ Serial Digital Interface for a connection to/from the microcontroller of the Control Unit.
- ⁸⁾ SC Unit 2 (layer 3) - slot SC8: You can use only the module input channels 1 ... 6.

RoutingID 10243 – Power Unit with PS-DINJ 2/1 – engine control

The following table shows which PS modules can be installed on which slot of a Power Unit and suit the specifics of the Control Unit's microcontroller channels you need in your application.

Stack with UCB (RoutingID 10243) – Engine Control	Slot	Signal	MPC565 Channel	Possible Module
 <p>Power Unit (layer 4)</p> <p>SC Unit 2</p> <p>Power Unit</p> <p>SC Unit 1</p> <p>Control Unit</p>	PS1	4 x TPU, used as injection signals	TPU_A: 6 ... 9	▪ PS-DINJ 2/1 ¹⁾ (DS1664)
		2 x analog	29, 30	
	PS2	–	–	
	PS3	2 x MIOS (PWM), used as lambda probe heater control signals	2, 3	▪ PS-LSD 6/1 (DS1662)
		4 x bit I/O	9 ... 12	
		2 x analog	33, 34	
	PS4	4 x TPU, used as injection signals	TPU_A: 10 ... 13	▪ PS-DINJ 2/1 ¹⁾ (DS1664)
		2 x analog	35, 36	
	PS5	–	–	
	PS6	1 x TPU, used as throttle signal	TPU_B: 16	▪ PS-FBD 2/1 (DS1661)
		1 x MIOS (PWM)	1	
		2 x bit I/O	7, 8	
		2 x analog	39, 40	

¹⁾ The PS-DINJ 2/1 has 2 channels and requires two adjacent slots. The first slot has to process both channels. You can mount it on the Power Unit's slots PS1 ... PS2, and PS4 ... PS5.

Restrictions on Changing COM Modules

Changing COM Modules in Control Units

Changing COM modules

Do not change the position of the communication modules on a Control Unit. Every COM slot is assigned to a specific front connector as shown in the table below:

Slot	Front panel connector	Module
COM 1	COM	COM-LVDS 1/1 (DS1606)
COM 2	Host PC	COM-USB CI 1/1 (DS1609)

Changing the Hardware Configuration of SC/PS Modules

Objective

You can adapt the input and/or output circuit, called the user-configurable circuit below, for some signal conditioning and power stage modules, for example, SC-AI 4/1, and PS-HSD 6/1.

Notes on Changing an SC/PS Module's Hardware Configuration

Objective

Soldering resistors, capacitors or diodes to input and/or output channels allows you to adapt the channels to the specifications of the connected sensors and/or actuators.

Soldering SMD components

For soldering the user-configurable circuits on RapidPro modules, they provide solder pads for adding SMD components.

WARNING

Soldering on powered and mounted modules damages the hardware.

Before changing the hardware:

- Power off the RapidPro hardware.
- Disconnect all connectors.
- Uninstall the module you want to modify.

Information needed

For easy access to the information you need for soldering, dSPACE provides module-specific configuration templates. The hardware configuration can be entered in these for planning and documentation.

Each template contains items such as:

- The user-configurable circuit
- The location of the solder pads
- The recommended package type of a component

For detailed information, refer to the respective chapters of the RapidPro modules in the *RapidPro System – Installation and Configuration Reference*.

Changing the Assembly of RapidPro Units

Objective

You can change the assembly of the RapidPro units according to your use case and the installation requirements. You can build single units or assemble several units to build a stack.

However, you have to notice assembling restrictions.

Where to go from here

Information in this section

Assembling Options and Restrictions.....	149
Gives an overview of the different assembling options and restrictions you have when assembling the RapidPro hardware.	
How to Assemble a Single Unit.....	151
How to Assemble a Stack without UCB.....	153
How to Disassemble a Stack without UCB.....	157

Assembling Options and Restrictions

Objective

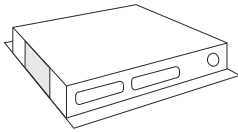
The different units of the RapidPro system can be used as single units or they can form a stack for use as one physical unit, depending on your configuration requirements. However, there are restrictions you have to note.

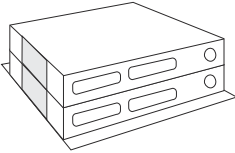
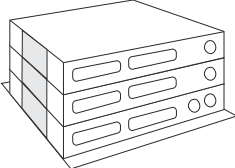
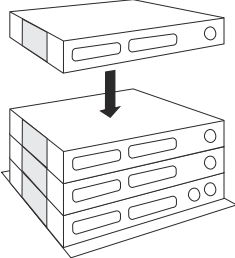
Thermal capacity limitations

The mechanical assembly of the RapidPro system is limited by the thermal capacity of the housing. As long as the maximum housing temperature $T_{\text{Housing}} = +95\text{ °C}$ ($+203\text{ °F}$) is not exceeded, the function of the RapidPro system is guaranteed.

Overview

The following table shows the assembling options and their restrictions:

Assembling Option		Comments and Restrictions	Refer to ...
Single unit		You can use a RapidPro unit as a single unit if you mount a base plate and a cover on it.	How to Assemble a Single Unit on page 151

Assembling Option	Comments and Restrictions	Refer to ...
Stack without UCB (unit connection bus) 	<p>You can combine several units (single units) to one physical unit.</p> <ul style="list-style-type: none"> You must always place a Power Unit on the top of the stack to ensure proper heat dissipation. The number of units assembled in a stack without UCB is only limited by the thermal capacity of the housing. The units have no internal electrical connection with each other. One base plate is necessary for mounting the stack on a level surface. 	How to Assemble a Stack without UCB on page 153
Stack with UCB 	<p>One Control Unit and several SC and Power Units can be delivered as stack with internal electrical connection (via unit connection bus = UCB) by dSPACE.</p> <ul style="list-style-type: none"> <i>Do not change the order of the units, add or remove a unit from a stack with UCB.</i> <i>Changing the assembly has to be done only by dSPACE.</i> 	—
Stack with UCB + single units 	<p>On a stack with UCB, you can mount additional single units to assemble the hardware to one physical unit.</p> <ul style="list-style-type: none"> The additional single units have no internal electrical connection to the stack with UCB. If you mount a single unit on the top of a stack with UCB, ensure that the maximum housing temperature of +95 °C (+203 °F) is not exceeded. This guarantees the function of the system. You must place an EMC plate between the single unit and the stack and between every further single unit to avoid malfunctions. 	—

How to Assemble a Single Unit

Objective

You can use the RapidPro SC Unit, Power Unit and/or Control Unit as single unit. This section gives you instructions on assembling a single unit, for example, if you want to use a unit that was removed from a stack without UCB.

Restrictions

Only units of a stack without UCB can be reused as a single unit. Units from a stack with UCB can only be removed by dSPACE.

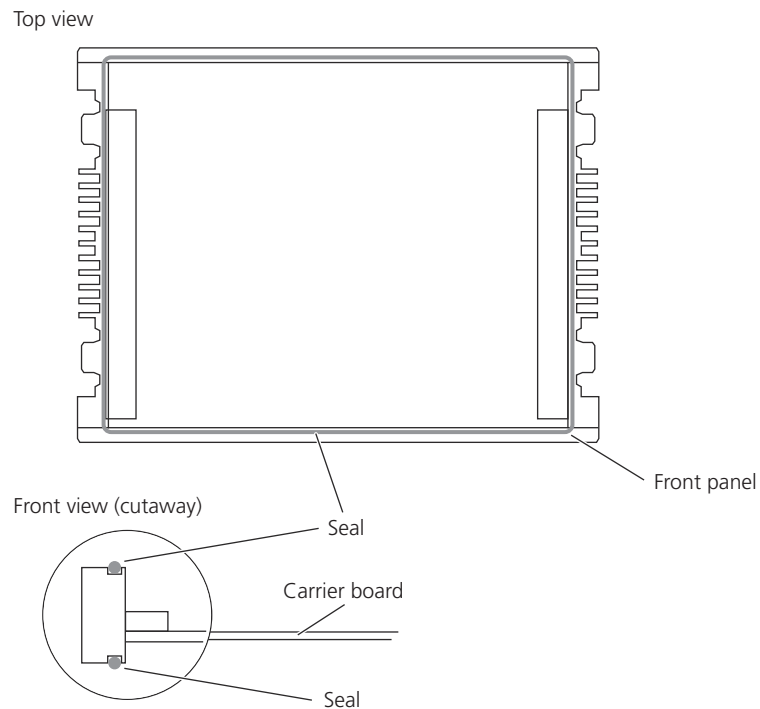
Preconditions

- The unit is disassembled. For instructions, refer to [How to Disassemble a Stack without UCB](#) on page 157.
- Ensure you have all the items in the table below before starting:

Items	Count	Description
Hexagon socket wrench	1	2.5 mm (0.1 in.)
	1	6 mm (0.24 in.)
Base plate ¹⁾	1	—
Cover ¹⁾	1	—
Hexagon socket head screw ¹⁾	8	M3 x 12, DIN912 A2
Protective cap ¹⁾	4	Plastic caps to protect the threads of the half screws.

¹⁾ If you want to reuse a unit that was assembled in a stack before, dSPACE provides a housing kit with all necessary items.

- Ensure that the unit has a seal in the grooves around the top and the underside, see illustration below. The seals are necessary to guard the RapidPro hardware against dirt, to make it splash-proof, and to make it EMC-compatible.



Method

To assemble a single unit

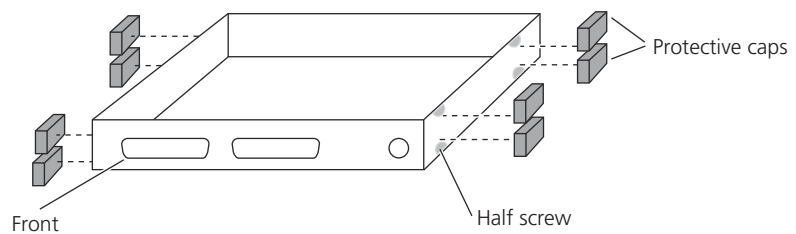
⚠ WARNING

Electrostatic discharges can damage the hardware.

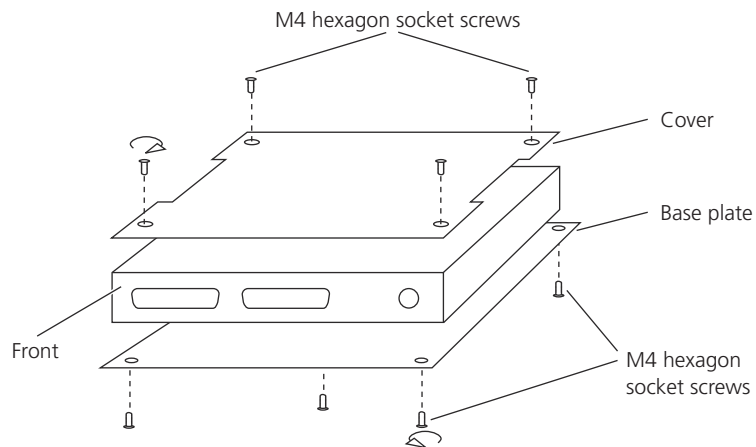
Before working on the hardware, make sure that you comply with the following instructions:

- You yourself and all material the unit and the module come in contact with must be properly grounded.
- During storage or handling, place the unit and the module on conductive foam or in a protective bag.
- Do not touch the carrier board, its connectors and the module connectors.

- 1 Attach the protective caps on both sides of the unit to protect the threads of the half screws as shown in the illustration below.



- 2 Assemble the base plate and the cover on the enclosure of the unit as shown in the illustration below.



- 3 Mount the screws of the base plate and the cover using the hexagon socket wrench, size 2.5 mm (0.1 in.).

Result You have assembled a single unit.

Next step Now you can install the single unit in a vehicle or on a test bench. For details, refer to [Installing RapidPro Hardware in a Vehicle/Test Bench](#) on page 37.

How to Assemble a Stack without UCB

Objective You can combine several single units in a physical unit, called a stack below. If the units are not connected to each other internally, the functionality of each unit is unchanged.

Planning the assembly Ensure that the space required for the stack is available at the installation location. Pay attention to the height of the stack. For information on determining the required space, refer to [Choosing the Installation Location](#) on page 37.

Preconditions

- The units are disassembled. For instructions, refer to [How to Disassemble a Stack without UCB](#) on page 157.

- Ensure you have all the items in the table below before starting:

Items	Count	Description
Hexagon socket wrench	1	2.5 mm (0.1 in.)
	1	6 mm (0.24 in.)
Base plate	1	–
Cover	1	–
Hexagon socket countersunk screw	8	To mount the cover and the base plate (M4 x 7 mm)
Hexagon socket nut ¹⁾	4, or 8, or 16 ... ²⁾	To mount the units (M12)
Guide pin ¹⁾	2, or 4, or 6 ... ³⁾	M4, guide pin
Phillips screwdriver	1	To mount with the Phillips screws the EMC metal plate to the underside of a unit.
EMC metal plate ¹⁾	1, or 2, or 3 ...	Metal plate to shield the units among each other against electromagnetic interferences.
Phillips screw ¹⁾	6, or 12, or 18 ... ⁴⁾	M3 x 4 mm, DIN912 A2
Protective cap	4	Plastic caps to protect the threads of the half screws.

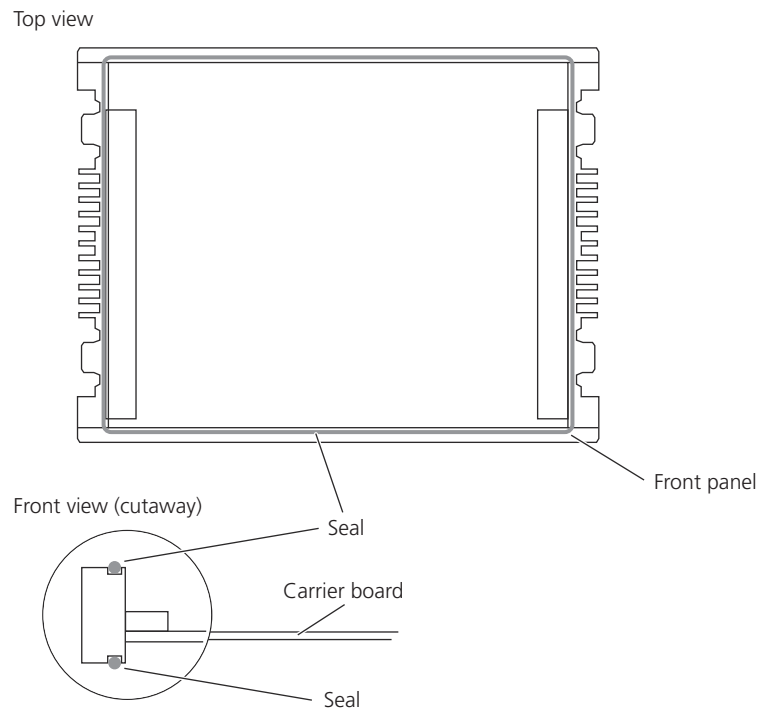
¹⁾ If you want to assemble a unit that was used as single unit before, dSPACE provides a housing kit with all necessary items.

²⁾ Depends on the number of units in a stack. Two units build a stack = 4 nuts, three units build a stack = 8 nuts, etc.

³⁾ Depends on the number of units in a stack. Two units build a stack = 2 guide pins, three units build a stack = 4 guide pins, etc.

⁴⁾ Depends on the number of units in a stack. Two units build a stack = 6 Phillips screws, three units build a stack = 12 Phillips screws, etc.

- Ensure that all units have a seal in the grooves around the top and the underside, see illustration below. The seals are necessary to guard the RapidPro hardware against dirt, to make it splash-proof, and to make it EMC-compatible.



Method

To assemble a stack without UCB

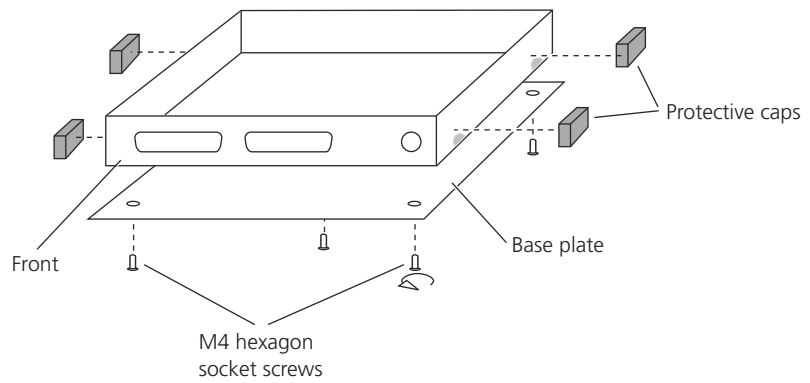
⚠ WARNING

Electrostatic discharges can damage the hardware.

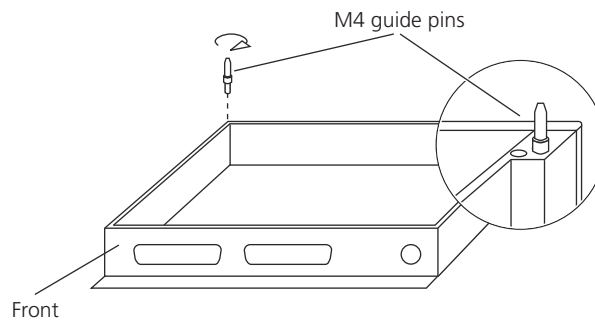
Before working on the hardware, make sure that you comply with the following instructions:

- You yourself and all material the unit and the module come in contact with must be properly grounded.
- During storage or handling, place the unit and the module on conductive foam or in a protective bag.
- Do not touch the carrier board, its connectors and the module connectors.

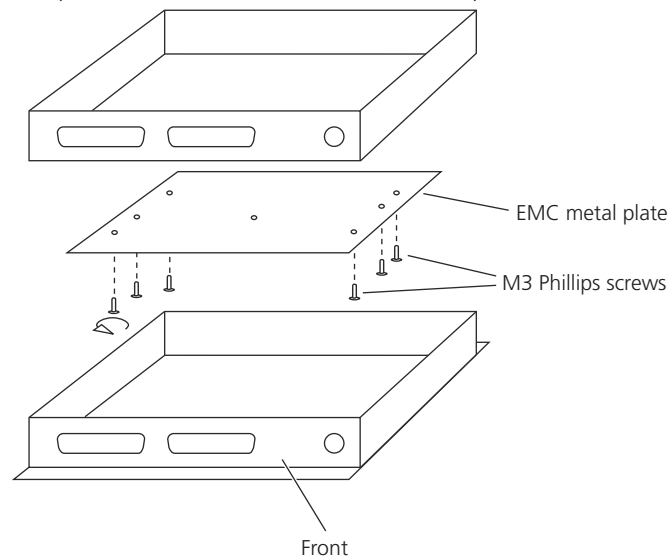
- 1** Attach 4 protective caps to the half screws of the unit that is the bottom of the stack to protect the threads as shown in the illustration below.
- 2** Mount the base plate on the unit that is the bottom of the stack. Use the 4 M4 hexagon socket screws delivered with the base plate.



- 3** Screw the guide pins in the assigned tapholes on the rear side of the unit as shown in the illustration below.

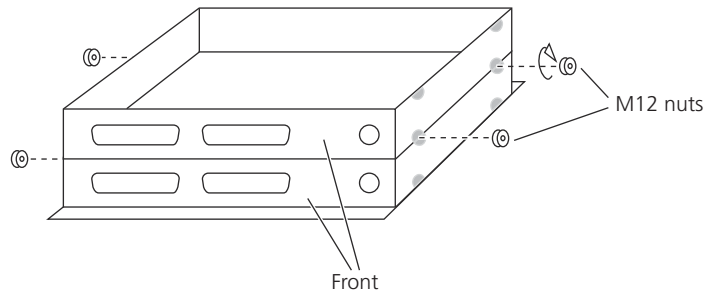


- 4** Mount the EMC metal plate on the underside of the next unit. Use the 6 M3 Phillips screws delivered with the EMC metal plate.

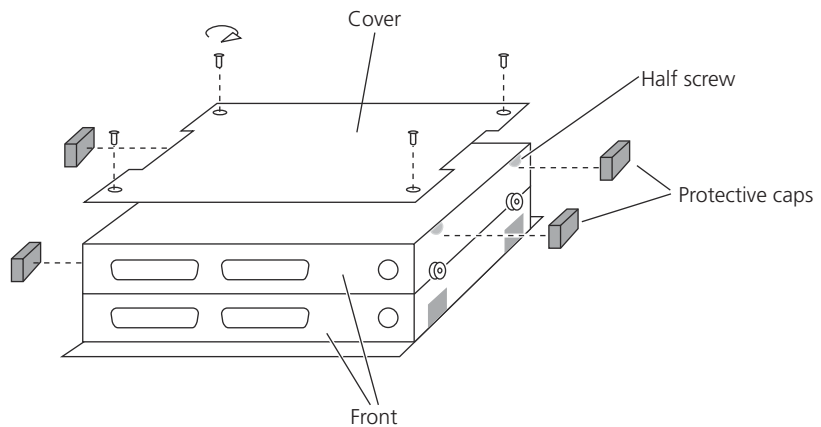


- 5** Place the next unit on top of the previous one using the guide pins and press evenly until the two units are in complete contact.

- 6** Mount the 4 M12 nuts as shown in the illustration below.



- 7** If you want to assemble another unit, proceed with step 3.
- 8** Attach 4 protective caps on both sides of the stack to protect the threads of the upper half screws as shown in the illustration below.
- 9** Mount the cover on the upper unit. Use the 4 M4 hexagon socket screws delivered with the cover as shown in the illustration below.



Result

The RapidPro system is assembled as a stack without unit connection bus (UCB).

Next step

Now you can install the stack in a vehicle. For details, refer to [Installing RapidPro Hardware in a Vehicle/Test Bench](#) on page 37.

How to Disassemble a Stack without UCB

Objective

This section gives instructions on disassembling a stack that has no internal electrical connections between the units via unit connection bus (UCB), for example, if you want to remove a unit from the stack to use it as single unit.

Preconditions

- The stack is powered off.
- All connectors of the stack are disconnected.
- The stack is uninstalled from the vehicle/test bench.
- Ensure you have all the items in the table below before starting:

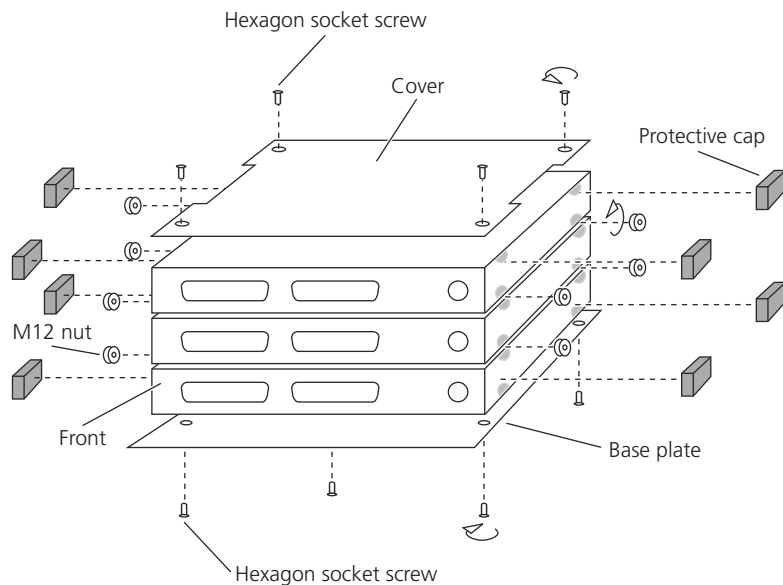
Items	Count	Description
Hexagon socket wrench	1	2.5 mm (0.1 in.)
	1	6 mm (0.24 in.)
Phillips screwdriver	1	To remove the EMC metal plate from a unit.

Method**To disassemble a stack without UCB****⚠ WARNING****Electrostatic discharges can damage the hardware.**

Before working on the hardware, make sure that you comply with the following instructions:

- You yourself and all material the unit and the module come in contact with must be properly grounded.
- During storage or handling, place the unit and the module on conductive foam or in a protective bag.
- Do not touch the carrier board, its connectors and the module connectors.

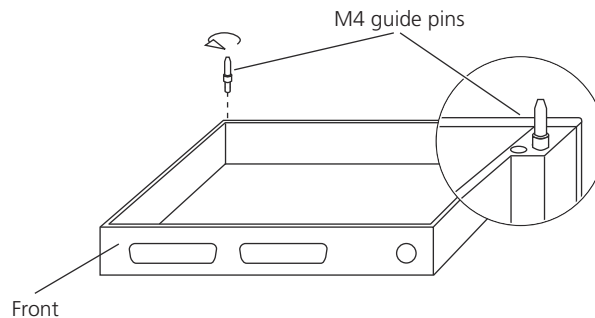
- 1 Disassemble the stack by removing the screws and the nuts as shown in the illustration below.



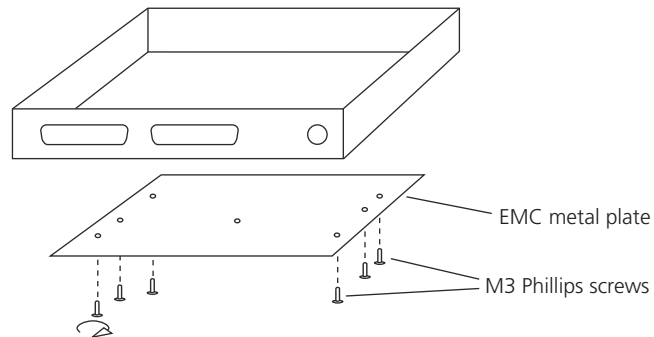
Tip

If you want to isolate a unit in the middle of the stack, it is not necessary to remove the cover, the base plate, and/or any other unit that is not in contact with the specific unit.

- 2 Remove the guide pins (see illustration below), if they are mounted and if you want to reuse the unit as a single unit.



- 3 Remove the EMC metal plate (see illustration below), if it is mounted and if you want to reuse the unit as a single unit.

**Result**

The stack without UCB is disassembled.

Next steps

Now you can reassemble the unit as a single unit or with other units in a new stack without UCB.

For detailed instructions, refer to:

- [How to Assemble a Single Unit](#) on page 151.
- [How to Assemble a Stack without UCB](#) on page 153.

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