MicroAutoBox II

# Hardware Installation and Configuration

Release 2016-B – November 2016

Embedded Success dSPACE

## How to Contact dSPACE


| | |
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## How to Contact dSPACE Support

To contact dSPACE if you have problems and questions, fill out the support request form provided on the website at http://www.dspace.com/go/supportrequest.

The request form helps the support team handle your difficulties quickly and efficiently.

In urgent cases contact dSPACE via phone: +49 5251 1638-941 (General Technical Support)

## Software Updates and Patches

dSPACE strongly recommends that you download and install the most recent patches for your current dSPACE installation. Visit http://www.dspace.com/go/support for software updates and patches.

## Important Notice

# Contents

# About This Document

**Contents**

This document will show you the installation and hardware configuration of the different variants of MicroAutoBox II. The variants are:

- MicroAutoBox II 1401/1501
- MicroAutoBox II 1401/1504
- MicroAutoBox II 1401/1505/1507
- MicroAutoBox II 1401/1507
- MicroAutoBox II 1401/1511
- MicroAutoBox II 1401/1511/1512
- MicroAutoBox II 1401/1511/1514
- MicroAutoBox II 1401/1512/1513
- MicroAutoBox II 1401/1513
- MicroAutoBox II 1401/1513/1514
- All MicroAutoBox II variants named above with MicroAutoBox Embedded PC

It describes the hardware installation procedure and shows how to configure the hardware. It also gives you information about connecting external devices to the dSPACE system.

**Where to go from here**

Information in this section

# Conventions Used in the Documentation

**Admonitions**

The following admonitions may be used in this document.

| Admonition | Description |
|---|---|
| DANGER | Indicates a hazardous situation that, if not avoided, will result in death or serious injury. |
| WARNING | Indicates a hazardous situation that, if not avoided, could result in death or serious injury. |
| CAUTION | Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury. |
| NOTICE | Indicates a hazard that may cause property damage if you do not avoid it by following the instructions given. |
| Note | Indicates important information that should be kept in mind, for example, to avoid malfunctions. |
| Tip | Indicates tips containing useful information to make your work easier. |

**Naming conventions**

The following abbreviations and formats are used in this document:

**%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.

Precedes the document title in a link that refers to another document.

Indicates that a link refers to another document, which is available in dSPACE HelpDesk.

Indicates that a link refers to a glossary entry.

**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%\My 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 Online Help and PDF Files

**Objective**

After you install your dSPACE software, the documentation for the installed products is available as online help and Adobe® PDF files.

**Online help**

You can access the online help, dSPACE HelpDesk, as follows:

**Windows Start menu** Select Start – (All) Programs – <ProductName> – dSPACE HelpDesk (<ProductName>) to open dSPACE HelpDesk with the start page of the selected product displayed. You can also navigate and search in the user documentation of any other installed software product and its supported hardware.

**Context-sensitive** Press the **F1** key or click the Help button in the dSPACE software to get help on the currently active context.

**Note**

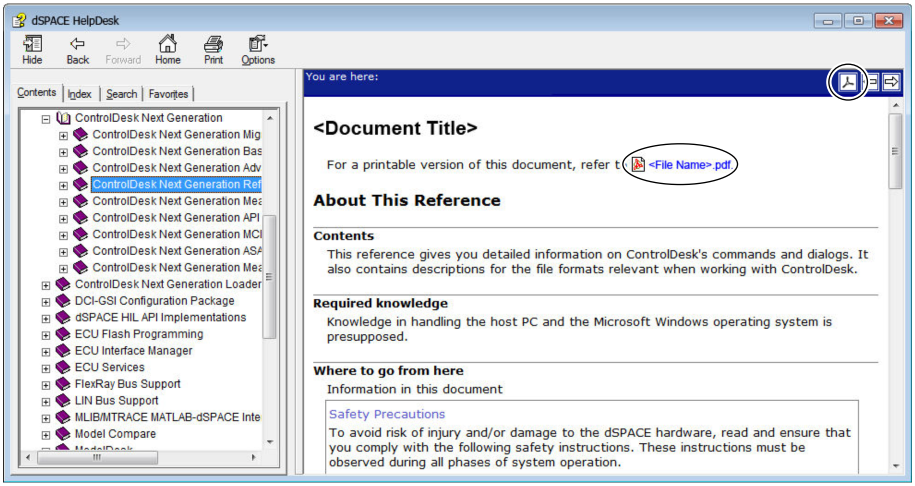
In some software products, context-sensitive help is not available.

**Help menu in the dSPACE software** On the menu bar, select Help – Contents or Help – Search (not available in all software products) to open dSPACE HelpDesk. It opens at the start page of the currently active product. You can also navigate and search in the user documentation of any other installed software product and its supported hardware.

**PDF files**

You can access the PDF files as follows:

**dSPACE HelpDesk** Click the PDF link at the beginning of a document or on a topic pane's header:




# Related Documents

Below is a list of documents that you are recommended to read when working with MicroAutoBox:

Information in other documents

Installation documents

*Software Installation and Management Guide*
Provides detailed instructions on installing and handling the dSPACE software. It also shows you how to manage dSPACE licenses.

Getting started with MicroAutoBox

*First Work Steps with a dSPACE System*
Provides information on configuring dSPACE systems after you installed the dSPACE hardware. It shows you how to get started with your dSPACE system after installation. This document is aimed at users who have no experience with dSPACE systems.

*MicroAutoBox Features*
Provides feature-oriented access to the information you need to implement your control models on your real-time hardware.

# Safety Precautions

**Objective**

To avoid risk of injury and/or damage to the dSPACE hardware, read and ensure that you comply with the following safety precautions. These precautions must be observed during all phases of system operation.

**dSPACE General Safety Precautions**

In addition to the safety precautions given in this document, it is recommended to read the 🕮 dSPACE General Safety Precautions. This document describes the risks of injury and damage to the dSPACE hardware in general.

A printed document of the 🕮 dSPACE General Safety Precautions is delivered together with your hardware. You can also find the document in PDF format on the dSPACE DVD.

**Where to go from here**

Information in this section

## Intended Use

| | |
|---|---|
| **Intended use of MicroAutoBox** | MicroAutoBox is intended to be used for the development, research and test of functions for electronic control units (ECU). Using MicroAutoBox for purposes other than these (e.g., in vehicles intended for sale to consumers, or in machines as part of production machinery) is considered to be improper and non-contractual use. |

## Safety Precautions for Installing and Connecting the Hardware

**User qualification**

Only qualified persons with experience in installing computer hardware and electric devices should install or uninstall hardware.

In the specific case that electric devices must be soldered, special qualifications for soldering are recommended. For details, refer to *Soldering devices* on page 23.

**Installation sequence**

- Read the instructions carefully before starting installation.
- Note all given warnings.
- Install the components of your system in exactly the order stated.

  Any other sequence may lead to unpredictable results or even damage the system. For the installation and configuration procedure, refer to *Installation and Configuration Overview* on page 37.

**Using MicroAutoBox on wet locations**

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

- Do not use MicroAutoBox on wet locations.

**Electromagnetic compatibility**

MicroAutoBox 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 details on CE compliance, refer to the data sheet:

- MicroAutoBox II 1401/1501 (refer to *Certifications* on page 222)
- MicroAutoBox II 1401/1504 (refer to *Certifications* on page 256)

- MicroAutoBox II 1401/1507 (refer to *Certifications* on page 329)
- MicroAutoBox II 1401/1505/1507 (refer to *Certifications* on page 289)
- MicroAutoBox II 1401/1511 (refer to *Certifications* on page 352)
- MicroAutoBox II 1401/1511/1512 (refer to *Certifications* on page 385)
- MicroAutoBox II 1401/1511/1514 (refer to *Certifications* on page 429)
- MicroAutoBox II 1401/1512/1513 (refer to *Certifications* on page 473)
- MicroAutoBox II 1401/1513 (refer to *Certifications* on page 512)
- MicroAutoBox II 1401/1513/1514 (refer to *Certifications* on page 549)

**Notes for handling hardware with electrostatic sensitive devices (ESD)**

dSPACE hardware contains sensitive electronic devices.

Before unpacking, installing and removing dSPACE hardware, take the following precautions to avoid damage caused by high electrostatic voltage:

- Make sure that you and all material the board comes in contact with are properly grounded.
- Do not touch the contacts of the connectors.

**Installing or uninstalling hardware**

You install and uninstall dSPACE hardware at your own risk. Any damage to or malfunction of dSPACE hardware caused by improper installation or uninstallation is not covered by the warranty, unless the handling and installation instructions are shown to be defective.

Before doing any installation or uninstallation work, make sure that:

- The power supply (vehicle engine) is switched off.
- No external devices are connected to the dSPACE system.

  In case of a failure, connected external devices might conduct dangerous high voltage into the dSPACE system or parts of the circuitry.

**Soldering devices**

In some specific cases, electric devices must be soldered to the dSPACE hardware. Unprofessional soldering will damage the hardware and/or lead to lost of hardware functionality.

You solder devices at your own risk. Any damage to or malfunction of dSPACE hardware caused by improper soldering is not covered by the warranty.

To avoid hardware damage:

- 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: e.g., a suitable SMD soldering station.

**Connecting and disconnecting devices**

- Do not apply voltages or currents outside the specified ranges to the connector pins.
- Do not connect or disconnect any devices while the dSPACE system is powered up and/or external devices are switched on. Make sure that external devices are turned off beforehand.
- If MicroAutoBox II is powered via ZIF I/O connector, the applied voltages are also available at the pins of the power input connector. Do not remove the protective cap of the connector when it is unconnected.

**Notes on using MicroAutoBox II 1401/1507**

Installing, uninstalling and configuring IP modules might result in personal injury and will damage MicroAutoBox II 1401/1507.

- Do not install/uninstall IP modules to MicroAutoBox II 1401/1507 yourself.

  If you want to use IP modules with your MicroAutoBox II 1401/1507, the IP modules must be installed by dSPACE. The assembling positions of the DS1401 Base Board and the DS1507 I/O Board in the MicroAutoBox housing do not allow direct access to the IP slots of the DS1507.
- Do not configure a IP module yourself (soldering resistors for the wake-up function).

  If you want to use the wake-up function, the configuration must be done by dSPACE.

## Safety Precautions for Using MicroAutoBox in a Vehicle

**Guidelines for safe and trouble-free use**

- Turn off the vehicle engine while connecting or disconnecting the car battery. Even a brief disconnection of the battery while the engine is running results in a load dump of the car generator, producing hazardous voltages of more than 100 V.

- Double-check the supply voltage polarity of MicroAutoBox. Reverse polarity might destroy parts of MicroAutoBox immediately under some circumstances, even if the remote control input is turned off.

## Safe In-Vehicle Use of dSPACE Products

**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 further 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 such 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 especially 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 which would be a hazard if they malfunctioned.

The guidelines accordingly apply to the use of dSPACE products in aircraft or vessels in line with the contractual purposes.

## Safety Precautions for Using MicroAutoBox Break-Out Boxes

**Working with Break-Out Boxes**

Depending on the connected devices there can be hazardous voltages on the contacts of the boxes caused by failures.

- Do not touch bare contacts, connector pins or any connected terminals and devices while the system is powered.

Changing the existing cable harness via a break-out box can cause uncontrolled movements of connected devices or damage them.

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

Only MicroAutoBox Break-Out Box DS5374:

Changing the termination of bus lines via termination switches can cause failures in bus communication. These failures might lead to uncontrolled movements of connected devices or damage them.

- Make sure that the termination change complies with the bus specification.

**Connecting devices**

- Do not connect any high-voltage devices to the I/O connectors of the Break-Out Box.
- Do not apply voltages or currents outside the specified ranges of the used MicroAutoBox to the terminal points of the Break-Out Boxes.
- Do not connect or disconnect sensors or actuators while the power supply of MicroAutoBox and all the devices is switched on.
- Observe all safety precautions described in the documentation of the connected devices.

**Installation location**

- Do not use the Break-Out Boxes in the vehicle's engine compartment.
- Do not use the Break-Out Boxes on wet locations.

  The Break-Out Boxes are not moisture-proof. They must not be moistened by any liquids.

# Introduction to MicroAutoBox

| | |
|---|---|
| **Objective** | The dSPACE system based on MicroAutoBox comprises hardware and software. |
| **Where to go from here** | Information in this section |



## Hardware

**Objective**

MicroAutoBox combines the advantages of a rapid prototyping (RCP) system with those of an automotive electronic control unit (ECU). Therefore, it is ideally suited as hardware for prototyping in a vehicle.

MicroAutoBox can operate without user intervention, just like an ECU, and can be installed virtually anywhere in the vehicle. At the same time MicroAutoBox provides all the benefits of a dSPACE real-time system. A PC or notebook can be attached temporarily for program download, data analysis and calibration.

**Variants**

Different variants of MicroAutoBox are available. This document describes the installation and configuration of all variants:

- MicroAutoBox II 1401/1501
- MicroAutoBox II 1401/1504

- MicroAutoBox II 1401/1505/1507
- MicroAutoBox II 1401/1507
- MicroAutoBox II 1401/1511
- MicroAutoBox II 1401/1511/1512
- MicroAutoBox II 1401/1511/1514
- MicroAutoBox II 1401/1512/1513
- MicroAutoBox II 1401/1513
- MicroAutoBox II 1401/1513/1514
- All MicroAutoBox variants named above with MicroAutoBox Embedded PC

For detailed information on the hardware differences of the various variants, refer to the corresponding data sheets in this document. For detailed information on the software differences of the various variants, refer to *Hardware Concept* (📖 *MicroAutoBox Features*).

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**Compatibility of MicroAutoBox II to MicroAutoBox (earlier revisions)**

MicroAutoBox II is the successor of MicroAutoBox. There are some points to note, when you want to replace an existing MicroAutoBox in your application by a MicroAutoBox II:

- The host interface of MicroAutoBox II is based on Ethernet TCP/IP protocol. Earlier versions of MicroAutoBox use a bus interface for host communication.
- The housing dimensions are equal. Thus the mounting place (inclusive the bore holes) provided for earlier MicroAutoBox revisions can be used as well as for MicroAutoBox II.
- The ZIF I/O connector and/or Sub-D I/O connector pinout of the following MicroAutoBox II variants is fully compatible to earlier MicroAutoBox revisions:
  - MicroAutoBox II 1401/1501
  - MicroAutoBox II 1401/1504
  - MicroAutoBox II 1401/1505/1507
  - MicroAutoBox II 1401/1507

  This means you can use a cable harness which has been built for earlier MicroAutoBox revisions as well as for the MicroAutoBox II variants named above. For example, you can still power these MicroAutoBox II variants via the power supply pins on the ZIF I/O connector.

  The pinout of the following MicroAutoBoxes is not compatible to earlier MicroAutoBox revisions:

- MicroAutoBox II 1401/1511
- MicroAutoBox II 1401/1511/1512
- MicroAutoBox II 1401/1511/1514
- MicroAutoBox II 1401/1512/1513
- MicroAutoBox II 1401/1513
- MicroAutoBox II 1401/1513/1514

- The software is compatible:
  - Programs or models that were prepared and compiled for earlier MicroAutoBox revisions do not need to be recompiled for MicroAutoBox II.
  - Programs or models that were prepared and compiled for MicroAutoBox II run on earlier MicroAutoBox revisions without changes. However the new software features of MicroAutoBox II are not supported on earlier revisions.

**Content of the package**

MicroAutoBox consists of two resp. three boards in a milled aluminum box. The package contains:

- MicroAutoBox containing a DS1401 Base Board and one or two I/O boards (DS1501, DS1504, DS1505, DS1507, DS1511, DS1512, DS1513, DS1514) depending on the variant.
- A power input cable and a separate power input connector to grant access to power supply of the MicroAutoBox.
- All variants with the exception of MicroAutoBox II 1401/1507:

  156-pin zero insertion force (ZIF) I/O connector for matching the corresponding connector at the MicroAutoBox. It grants access to the input and output signals provided by MicroAutoBox.

  Each ZIF I/O connector is delivered with:

  - Five stickers with the names of the different I/O boards printed on. You can use these stickers to mark the connector unambiguously.
  - One coding kit. To code the ZIF I/O connector to prevent faulty connections.
  - A jumper cable with crimp contacts to connect two pins inside the ZIF I/O connector.

  The package of MicroAutoBox II 1401/1511/1512, MicroAutoBox II 1401/1511/1514, MicroAutoBox II 1401/1512/1513 , and MicroAutoBox II 1401/1513/1514 contains two ZIF I/O connectors and coding kits.

- Only MicroAutoBox II 1401/1507 and 1401/1505/1507:

  78-pin, male Sub-D connector. It grants access to the I/O signals of CAN, FlexRay, LIN and the serial interfaces.
- A host interface cable is included for the connection between MicroAutoBox and your host PC.
- A crimper tool, crimp contacts (AWG 20-22) and a tool to remove the contacts are included to build the I/O connector according to your needs.
- An external 1000 µF capacitor to be connected in parallel to a lab power supply output, to prevent the MicroAutoBox inrush current from triggering the power supply's overcurrent protection.
- A printed document "dSPACE General Safety Precautions".

The image below shows a MicroAutoBox II 1401/1501 with some parts coming with the package.


**Optional accessories**

- Additional I/O connectors and cables are available from dSPACE upon request.
- MicroAutoBox Break-Out Boxes are supplied on demand. The boxes provide easy access to signals on the MicroAutoBox I/O connectors. It allows you to measure signals and to reconnect signals without changing an existing cable harness.

  For details, refer to *Using MicroAutoBox Break-Out Boxes* on page 175.

# Software

**Host PC software**

The dSPACE software, such as the implementation and the experiment software, comes on DVD and has to be installed first. For further information, refer to *Basics on dSPACE Software Installation* (📖 *Software Installation and Management Guide*). You can find the document in PDF format on the dSPACE DVD.

# Overview of MicroAutoBox Variants

**Hardware feature comparison**

The following table gives a hardware feature overview of MicroAutoBox:

| Feature | | MicroAutoBox II | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1401/1501 | 1401/1504 | 1401/1505/1507 | 1401/1507 | 1401/1511 | 1401/1511/1512 | 1401/1511/1514 | 1401/1512/1513 | 1401/1513 | 1401/1513/1514 |
| Analog inputs | ADC unit type 1[1)] | ✓ | ✓ | ✓ | – | – | – | – | – | – | – |
| | ADC unit type 3[1)] | – | ✓ | – | – | – | – | – | – | – | – |
| | ADC unit type 4[1)] | – | – | – | – | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | AIO type 1 ADC unit[1)] | – | – | – | – | – | – | – | ✓ | ✓ | ✓ |
| Analog outputs | DAC unit type 1[2)] | ✓ | – | ✓ | – | – | – | – | – | – | – |
| | DAC unit type 3[2)] | – | – | – | – | ✓ | ✓ | ✓ | – | – | – |
| | AIO type 1 DAC unit[2)] | – | – | – | – | – | – | – | ✓ | ✓ | ✓ |
| Digital inputs | | ✓ | ✓ | ✓ | – | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Digital outputs | | ✓ | ✓ | ✓ | – | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| ECU interface | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| ECU interface connector | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Slots for IP modules (e.g., FlexRay) | | – | – | ✓ | ✓ | – | ✓ | ✓ | ✓ | – | ✓ |

| Feature | | MicroAutoBox II | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1401/1501 | 1401/1504 | 1401/1505/1507 | 1401/1507 | 1401/1511 | 1401/1511/1512 | 1401/1511/1514 | 1401/1512/1513 | 1401/1513 | 1401/1513/1514 |
| Slot for I/O module | DS1552 Multi-I/O Module | – | – | – | – | – | ✓ | ✓ | ✓ | – | ✓ |
| | DS1554 Engine Control I/O Module[3)] | – | – | – | – | – | – | ✓ | – | – | ✓ |
| CAN | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| LIN | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Serial interface | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Ethernet host interface | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Ethernet I/O interface | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Power input connector | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| ZIF I/O connector | | ✓ | ✓ | ✓ | – | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Sub-D I/O connector | | – | – | ✓ | ✓ | – | – | – | – | – | – |
| USB connector (for flight recording) | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

1) For details on the ADC unit types, refer to *Overview of the A/D Conversion Units* (📖 *MicroAutoBox Features*).

2) For details on the DAC unit types, refer to *Overview of the D/A Conversion Units* (📖 *MicroAutoBox Features*).

3) You can extend your MicroAutoBox only by using the *FPGA1401Tp1 with DS1554 Engine Control Module* framework from the RTI FPGA Programming Blockset.

**DS1401 Base Board revisions**

MicroAutoBox was first released in October 1999. The major updates of the DS1401 Base Board and the I/O boards are listed below.

These are the most important DS1401 Base Board revisions:

| Date | Revision | Modifications | Boot Firmware Version | dSPACE Release[1)] |
|---|---|---|---|---|
| Q2/2010 | 22 | ■ Processor: PPC750GL<br>■ CPU clock: 900 MHz<br>■ Memory: 16 MB<br>■ Ethernet host interface<br>■ Ethernet I/O interface | ■ 2.7<br>For MicroAutoBox II variants 1401/1501, 1401/1504, 1401/1507, 1401/1505/1507<br>■ 3.0<br>For MicroAutoBox II variants 1401/1511, 1401/1511/1512 | Using the new components requires at least Release 6.6. |
| | | ■ Watchdog handling | ■ 3.3<br>(System PLD version 1.4) | 7.4 |
| | | ■ Challenge-response monitoring | ■ 3.3<br>(System PLD version 1.5) | 2016-B |
| Q4/2011 | 23 | ■ Ethernet host interface and Ethernet I/O interface with GBit support | ■ 3.2 | 7.2 |
| | | ■ Onboard pressure sensor | ■ 3.2<br>(System PLD version 1.3) | 7.3 |
| | | ■ Onboard acceleration sensor | ■ 3.3<br>(System PLD version 1.4) | 7.4 |
| Q2/2012 | 25 | Internal Ethernet switch | 3.3<br>(System PLD version 1.4) | 7.4 |

1) The hardware is delivered independently of a dSPACE Release. This column shows the first dSPACE Release that provides the required boot firmware version.

**Note**

The table lists the minimum boot firmware version required by the respective board revision to support the new feature. Higher boot firmware versions can be used without problems. With lower boot firmware versions, MicroAutoBox does not work.

A real-time application for MicroAutoBox can be executed on newer revisions, if the specified I/O is available and the boot firmware version is at least the firmware version listed above. You can possibly not use the entire memory, see the table above.

**I/O board revisions**

The following I/O board revisions are of interest:

| Date | Revision | Features | Boot Firmware Version | dSPACE Release |
|---|---|---|---|---|
| **DS1501** | | | | |
| Q2/2002 | 07 | Multichannel PWM added | not relevant | 3.4 |
| Q3/2003 | 09 | LIN support added | not relevant | Using the LIN support requires at least Release 4.0. |
| **DS1504** | | | | |
| Q2/2003 | 03 | LIN support added | not relevant | Using the LIN support requires at least Release 4.0. |
| **DS1505** | | | | |
| Q3/2003 | 01 | Internal redesign to support MicroAutoBox with two I/O boards. | not relevant | not relevant |
| **DS1507** | | | | |
| Q4/2005 | 01 | ■ LIN support<br>■ FlexRay support<br>■ 2 ECU interfaces | not relevant | Using DS1507 requires at least Release 4.0. |
| **DS1511** | | | | |
| Q4/2010 | 03 | New I/O board providing:<br>■ ADC Type 4<br>■ DAC Type 3<br>■ DIO Type 3<br>■ Updated CAN Type 1 | 3.0.1 | 7.0 |
| Q4/2011 | 03 | New I/O features for DIO Type 3:<br>■ Multichannel PWM signal generation<br>■ SENT receiver | not relevant (DIO Type 3 PLD version 1.3) | 7.2 |
| Q2/2012 | 03 | New I/O feature for DIO Type 3:<br>■ SPI master | not relevant (DIO Type 3 PLD version 1.4) | 7.3 |

| Date | Revision | Features | Boot Firmware Version | dSPACE Release |
|---|---|---|---|---|
| Q4/2015 | 03 | New I/O feature for DIO Type 3:<br>■ Pulse width measurement (PW2D) | not relevant<br>(DIO Type 3 PLD version 1.5) | 2015-B |
| **DS1512** | | | | |
| Q4/2010 | 03 | New I/O board providing:<br>■ Xilinx® Spartan 6 FPGA XC6SLX150<br>■ Updated FlexRay support | 3.0.1 | 7.0 |
| Q2/2011 | 03 | ■ FPGA support<br>■ Support of DS1552 Multi-I/O Module | 3.1.2 | 7.1 |
| Q2/2012 | 03 | Support of serial interface via FPGA module | 3.1.2 | 7.3 |
| **DS1513** | | | | |
| Q3/2013 | 01 | New I/O board providing:<br>■ ADC Type 4<br>■ AIO Type 1<br>■ DIO Type 4<br>■ Updated CAN Type 1 | 3.3 | 2013-B |
| Q4/2015 | 01 | New I/O feature for DIO Type 4:<br>■ Pulse width measurement (PW2D) | not relevant<br>(DIO Type 4 PLD version 1.5) | 2015-B |
| **DS1514** | | | | |
| Q2/2015 | 01 | New I/O board providing:<br>■ Xilinx® Kintex®-7 FPGA XC7K325T<br>■ Support of DS1552 Multi-I/O Module | 3.9 | 2015-A |
| Q2/2016 | 01 | Support of DS1554 Engine Control I/O Module | 3.9 | 2016-A |

# Before You Start

| | |
|---|---|
| **Objective** | Make yourself familiar with the installation and configuration procedures of MicroAutoBox and check if your system fulfills the system requirements. |
| **Where to go from here** | Information in this section |



## Installation and Configuration Overview

**Installation sequence**

**NOTICE**

**Changing the installation sequence may lead to unpredictable results or even damage the system.**

- Install the components of your system in exactly the order stated.
- Read the instructions carefully before starting installation.
- Consider all given warnings.

Installing the MicroAutoBox requires the following steps in the specified order.

1. Check whether the software has been installed on the host PC.

   You must first install the software before connecting MicroAutoBox to the host PC. For detailed instructions on installing the software, refer to *Installing dSPACE Software* (📖 *Software Installation and Management Guide*).

   > **Note**
   >
   > You need administrator rights to install dSPACE software.

2. Check whether your hardware meets the requirements for MicroAutoBox. Refer to *Checking the System Requirements* on page 40.
3. If you use FlexRay IP modules (DS4340 or third-party) or CAN FD modules (DS4342) in MicroAutoBox, check whether the IP modules are already installed. For details on installing IP modules, refer to *How to Install IP Modules* on page 204.
4. If you want to use MicroAutoBox as the LIN master, you must add a pull-up resistor and a diode to the LIN network. You can add these electrical components to the I/O board of MicroAutoBox. For details, refer to *How to Configure MicroAutoBox as the LIN Master* on page 108.
5. If you terminate a CAN bus on MicroAutoBox II 1401/1511, 1401/1511/1512, and 1401/1511/1514, you can solder termination resistors on the DS1511 I/O Board. For details on soldering the resistors, refer to *How to Terminate the CAN Bus* on page 124.
6. To set MicroAutoBox into operation for the first time in your laboratory you have to connect the box to the power supply. Refer to *Basics on Connecting to Power Supply* on page 44.
7. You must connect MicroAutoBox to your host PC via Ethernet. For this MicroAutoBox is treated as a network client. After connecting MicroAutoBox to the host PC via network cable, you have to set up the Ethernet connection. Refer to *Connecting MicroAutoBox to the Host PC via Ethernet* on page 61.

8. Before working with MicroAutoBox in a vehicle you should put the system into operation in your laboratory to configure the dSPACE system and to get started with MicroAutoBox loading applications to the system. Refer to *Building the Power and I/O Connections* on page 43, *Connecting MicroAutoBox to the Host PC via Ethernet* on page 61, and *Connecting MicroAutoBox to a FlexRay, LIN, or CAN Bus* on page 79.
9. If you want to install MicroAutoBox in a vehicle, refer to *How to Mount MicroAutoBox in a Vehicle* on page 157.

**Configuration sequence**

After you install your MicroAutoBox, you can configure it in the following steps:

1. Using MicroAutoBox's flight recorder requires some preparatory steps.
2. Check if your platform is ready to run real-time applications.
3. The firmware of the MicroAutoBox can be updated if you install a new dSPACE Release.

**Installation problems**

**Tip**

If you encounter any problems during installation and configuration:

- Check the Support section of our website.

  See http://www.dspace.com/go/support.
- The FAQ section and application notes provide a lot of useful information.

  See http://www.dspace.com/go/FAQ.
- To stay up-to-date with information on possible problems, you should periodically check the known problem reports.

  See http://www.dspace.com/go/ProblemReports.

If self-help does not solve the problem, contact dSPACE Support and give them information about your dSPACE environment and the problems you have. The best way to do this is with the support request form provided on the website at http://www.dspace.com/go/supportrequest, but you can also send an e-mail or phone us. For details, refer to *Contacting dSPACE Support* (📖 *Software Installation and Management Guide*).

**Next steps**

- After you install and configure your system, you are ready to implement a model – either via a Simulink model including blocks from dSPACE's Real-Time Interface (RTI) or via a handcoded algorithm – and download the corresponding application to your real-time hardware. You can use ControlDesk to experiment with your real-time application. Refer to 🕮 *First Work Steps with a dSPACE System*.

**Related topics**

Basics


- *Hardware* on page 27
- *Installing dSPACE Software* (🕮 *Software Installation and Management Guide*)
- *Introduction to MicroAutoBox* on page 27
- *Software* on page 31


# Checking the System Requirements

**Objective**

Before installing dSPACE's hardware, you have to check whether your hardware meets the system requirements.

**Host PC**

Your host PC must fulfill the system requirements concerning:

- The dSPACE software and other required third-party software,
- The requirements for the hardware which is needed for connecting the host PC and MicroAutoBox.

  This connection has to be established via Ethernet interface.

For details, refer to *Appendix: System Requirements* (🕮 *Software Installation and Management Guide*).

**Power supply**

MicroAutoBox requires a power supply in the range 6 … 40 V. The required power depends on the MicroAutoBox variant (refer to the type plate on the bottom of MicroAutoBox).

MicroAutoBox draws an inrush current of several amperes depending on the operating voltage. At 12 V operating voltage, a power supply that delivers 5 A peak is sufficient. If you use a lab power supply with a lower output power capability, it is recommended to connect a 1000 µF capacitor in parallel to the power supply output.

**Note**

If you use a power supply with a lower output power capability without a 1000 µF capacitor MicroAutoBox might start in secured mode (host PC LED is flashing red, see *Checking MicroAutoBox* on page 672)

# Building the Power and I/O Connections

**Where to go from here**

Information in this section

# Notes on Connecting to Power Supply, Sensors and Actuators

**EMC precautions**

To maintain compliance with CE directives, common EMC filter and shielding practices must be applied when wiring up MicroAutoBox. With long unshielded cables a common ferrite clamp surrounding all wires should be mounted as close as possible to the main connector of MicroAutoBox.

**Where to go from here**

Information in this section



## Basics on Connecting to Power Supply

**Objective**

To set MicroAutoBox into operation for the first time in your laboratory, you have to connect the box to the power supply.

**Safety precautions**

⚠ WARNING

**Even a brief disconnection of the battery while the engine is running results in a load dump of the car generator, producing hazardous voltages of more than 100 V.**

- Turn off the engine while connecting or disconnecting the car battery.

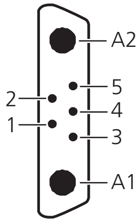
*NOTICE*

**Reverse polarity might destroy parts of MicroAutoBox immediately under some circumstances, even if the remote control input is turned off.**

- Double-check the supply voltage polarity of MicroAutoBox.

**Required connections**

To connect MicroAutoBox with power input connector (front view) to the car battery, the following connections are required:

| Connector | Pin | Signal | Pin | Signal |
|---|---|---|---|---|
|  | A2[1] | VBAT (6 V … 40 V DC) | | |
| | | | 5 | REMOTE_Pullup |
| | 2 | Do not connect | 4 | REMOTE[2] |
| | 1 | Do not connect | 3 | Do not connect |
| | A1 | GND | | |

[1] NOTE: It is highly recommended to insert a fuse into the main power supply input wire (close to battery). Choose the value of the fuse according to the maximum current. A 10 A fuse is recommended.

[2] The REMOTE input must be connected via switch or bridge to UBAT to run MicroAutoBox. For example, you can use it for switching MicroAutoBox with KL15 (output of the ignition/driving switch). So, you can use the nonvolatile data feature to store data you may want to use again when restarting the application. For further information, refer to *Nonvolatile Data Handling* (📖 *MicroAutoBox RTLib Reference*).

The following table gives a description of the pins used for power input and output for MicroAutoBox:

| Pin | Signal | Description/Function |
|---|---|---|
| A2 | VBAT | Main power supply input. Connect this pin to the positive pole of your car battery. |
| A1 | GND | Main power supply return and reference for all input and output signals. Connect this pin to the minus pole of your car battery. This signal is also connected to the case of MicroAutoBox. |
| 4 | REMOTE | ■ The REMOTE input may be used for starting MicroAutoBox with a remote switch, for example KL15 (output of the ignition/driving switch).<br>■ If you connect the remote pin to the plus pole of the car battery directly, MicroAutoBox will always be turned on, and the car battery will soon be exhausted if the engine is not running. Thus, a switch is highly recommended.<br>■ The voltage connected to the REMOTE pin should not exceed the supply voltage.<br>■ Only valid for MicroAutoBox II 1401/1513, 1401/1512/1513 and 1401/1513/1514: To wake up MicroAutoBox via CAN messages, the REMOTE pin must be left open when MicroAutoBox is powered down. This is due to the fact that there is an additional internal connection to the REMOTE pin. Nevertheless, you can always use a remote switch to supply voltage (e.g., VBAT) to start MicroAutoBox. |

| Pin | Signal | Description/Function |
|---|---|---|
| 5 | REMOTE_Pullup | You can use this output to connect a remote switch between REMOTE and this pin. REMOTE_Pullup is internally connected to VBAT via 39 kΩ pull-up resistor. |

**Note**

**Valid only for the following MicroAutoBox variants:**

- MicroAutoBox II 1401/1501
- MicroAutoBox II 1401/1504
- MicroAutoBox II 1401/1505/1507

It is strictly recommended to use the pins on the power input connector, even though the VBAT, GND and REMOTE pins are also located on the ZIF I/O connector.

Using a cable harness which was built for earlier MicroAutoBox revisions:

- The pinout of the ZIF I/O connector on the MicroAutoBox variants named above is fully compatible with earlier MicroAutoBox revisions. This means that for MicroAutoBox you can use a cable harness which was built for earlier MicroAutoBox revisions. Thus you can power MicroAutoBox via the power supply pins on the ZIF I/O connector.
- To avoid damage, do not use the VBAT, GND and REMOTE pins on the ZIF I/O connector and the power input connector at the same time.

***NOTICE***

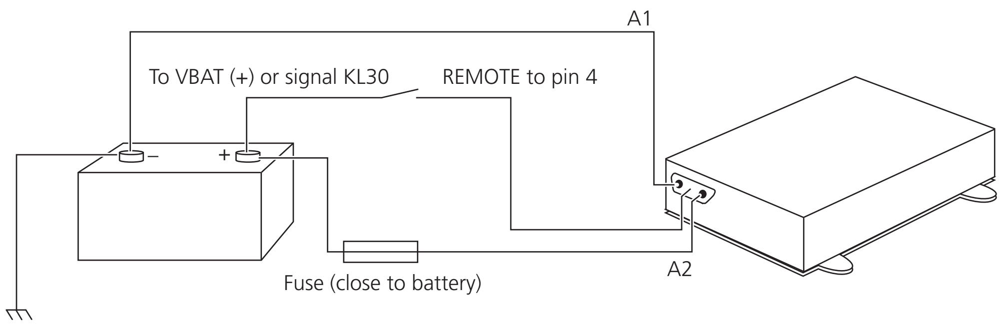
**Risk of material damage**

**If MicroAutoBox is powered via ZIF I/O connector, the applied voltages are also available at the pins of the power input connector.**

Do not remove the protective cap of the connector when it is unconnected.

**Wiring scheme**

To connect MicroAutoBox with power input connector to the car battery, you have to connect the following solder contacts:




For the wires the following values are recommended:

| Pin | AWG | Diameter (mm) | Cross section (mm$^2$) |
|---|---|---|---|
| A1 and A2 | 15 | 1.45 | 1.65 |
| | 16 | 1.29 | 1.3 |
| REMOTE | 20 | 0.81 | 0.51 |
| | 21 | 0.72 | 0.41 |
| | 22 | 0.64 | 0.32 |
| | 24 | 0.51 | 0.2 |

The ends of the wires should be stripped for 3 … 4 mm.

**Note**

It is highly recommended to insert a fuse into the main power supply input wire (close to battery). Choose the value of the fuse according to the maximum current. A 10 A fuse is recommended.

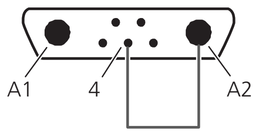
**Preconfigured matching power input connector**

A preconfigured cable for the supply voltage is provided by dSPACE. This cable is intended to operate MicroAutoBox with a laboratory power supply during development. Therefore, the REMOTE input (pin 4) is shorted to VBAT (pin A2) inside the connector in order to save a separate switch. Do not use this cable in the vehicle. Otherwise, MicroAutoBox will always be turned on. The VBAT wire (red) contains a melting fuse. Each wire has a cross-section of 1.5 mm$^2$.

Fuse specification:

- Cable delivered through dSPACE Release 2013-B: 7.5 A, time lag
- Cable delivered as of dSPACE Release 2014-A: 10 A, time lag

The following illustration shows the power input connector:




**Power supply for digital inputs and outputs**

This does not apply to MicroAutoBox II 1401/1507:

To use the digital inputs and outputs you have to power the corresponding I/O circuits. Thus you have to connect the VDRIVE pin inside the ZIF I/O connector according to the logic level needed.

**Note**

*The VDRIVE pin is not preconfigured in the ZIF I/O connector delivered with each MicroAutoBox.* You have to connect VDRIVE to VSENS or VBATprot yourself. Use the preconfigured jumper cable which is included in the MicroAutoBox package.

For the power supply of the input/output circuits the following connections are relevant. The pins are located on the ZIF I/O connector.

| Signal | Description/ Function |
|---|---|
| VDRIVE | This input supplies all digital input and output circuits.<br>■ Connect this input to VSENS to set CMOS/TTL-compatible logic levels for the inputs/outputs.<br>■ Connect this input to VBATprot to set automotive-compatible logic levels for the inputs/outputs.<br>■ Do not connect this pin directly to VBAT, because the input and output circuits are not load-dump-protected or reverse-voltage-protected for this signal.<br>■ While MicroAutoBox is being powered down, the output stages may have pull-up behavior to VDRIVE. So the outputs may reach the level of VDRIVE. If this behavior is critical in your application, you have to power down your external devices or VDRIVE before powering down MicroAutoBox. You can also use the REMOTE signal (Kl.15) with the power control software functionality to first switch off VDRIVE via a relay. |
| VSENS | Sensor supply output.<br>Use this output to supply your sensors and/or VDRIVE. If you need CMOS/TTL-compatible logic levels at the inputs/outputs connect VSENS to VDRIVE. |

| Signal | Description/ Function |
|---|---|
| VBATprot | Protected VBAT output.<br>Use this output to drive VDRIVE when automotive logic levels are needed. |

The pinout depends on the MicroAutoBox variant. Refer to:

- MicroAutoBox II 1401/1501: *ZIF I/O Connector* on page 224
- MicroAutoBox II 1401/1504: *ZIF I/O Connector* on page 258
- MicroAutoBox II 1401/1505/1507: *ZIF I/O Connector* on page 291
- MicroAutoBox II 1401/1511: *ZIF I/O Connector* on page 354
- MicroAutoBox II 1401/1511/1512:

  - *DS1511 ZIF I/O Connector* on page 387

  - *DS1512 ZIF I/O Connector* on page 389
- MicroAutoBox II 1401/1511/1514:

  - *DS1511 ZIF I/O Connector* on page 431

  - *DS1514 ZIF I/O Connector* on page 433
- MicroAutoBox II 1401/1512/1513:

  - *DS1512 ZIF I/O Connector* on page 475

  - *DS1513 ZIF I/O Connector* on page 476
- MicroAutoBox II 1401/1513: *ZIF I/O Connector* on page 514
- MicroAutoBox II 1401/1513/1514:

  - *DS1513 ZIF I/O Connector* on page 551

  - *DS1514 ZIF I/O Connector* on page 553

The signal levels depend on the MicroAutoBox variant. Refer to:

- MicroAutoBox II 1401/1501: *Absolute Maximum Levels* on page 221
- MicroAutoBox II 1401/1504: *Absolute Maximum Levels* on page 255
- MicroAutoBox II 1401/1505/1507: *Absolute Maximum Levels* on page 288
- MicroAutoBox II 1401/1511: *Absolute Maximum Levels* on page 351
- MicroAutoBox II 1401/1511/1512: *Absolute Maximum Levels* on page 384
- MicroAutoBox II 1401/1511/1514: *Absolute Maximum Levels* on page 427

- MicroAutoBox II 1401/1512/1513: *Absolute Maximum Levels* on page 472
- MicroAutoBox II 1401/1513: *Absolute Maximum Levels* on page 511
- MicroAutoBox II 1401/1513/1514: *Absolute Maximum Levels* on page 548

**Related topics**

Basics

- *Safety Precautions for Installing and Connecting the Hardware* on page 22

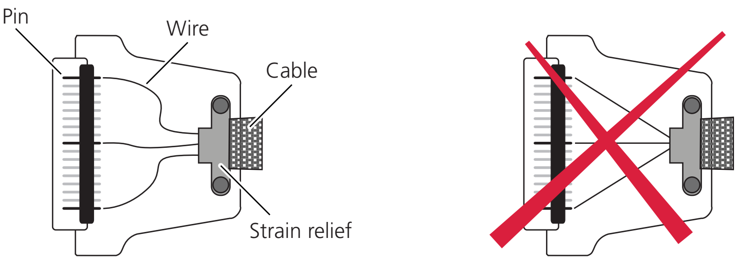
## Plugging Sub-D Connectors

**Checking connectors before the first use**

Before you plug 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 plug the connector easily the pins are loosely mounted. When the connector pins are stretched, the connector might not fit to the corresponding connector.
- 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.

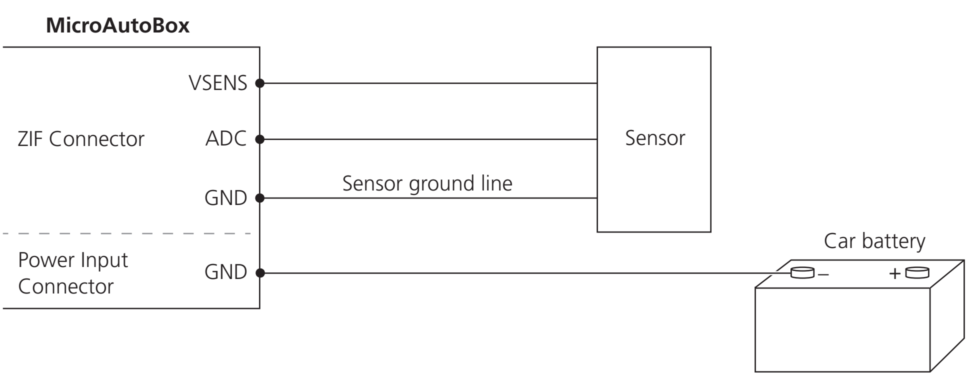
## Connecting Sensor Ground Lines to MicroAutoBox

**Objective**

The measurement result of sensor input signals can be impaired by improper grounding. Use ideal grounding for best measurement results.

**Ideal grounding**

Ideal grounding as shown in the illustration below is strongly recommended. Do not share the same wire for sensor ground and supply ground. Use separate wires for each sensor ground line and connect them as close as possible to a GND pin of the MicroAutoBox I/O connector.




**Tip**

It is highly recommended to use the power input connector to connect MicroAutoBox to the car battery. This automatically separates the sensor ground and the supply ground.

# Fulfilling the Requirements for CE Certification

**Affected MicroAutoBox variants**

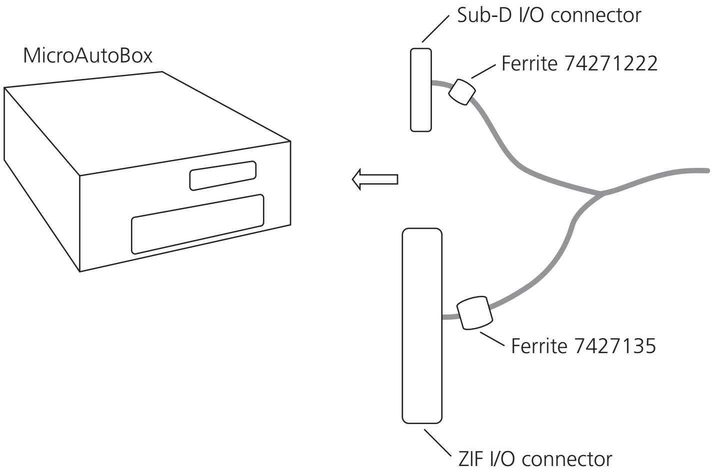
The requirements given below are valid only for:

- MicroAutoBox II 1401/1505/1507
- MicroAutoBox II 1401/1507

Other variants are not affected. Therefore these variants are not shipped with the required ferrites.

**Attaching ferrites**

To fulfill the requirements for *CE* certification, you have to attach the enclosed ferrites to the cable harness, see the illustration below:




- Attach the ferrite with part number *74271222* close to the Sub-D I/O connector.
- Attach the ferrite with part number *7427135* close to the ZIF I/O connector.

> **Tip**
>
> Place the ferrites as close as possible to the related connector of the MicroAutoBox cable harness for optimum results.

**Shielded CAN connection cables**

To fulfill the requirements for *CE* certification, you must use shielded CAN connection cables and connect shields to ground pins of the MicroAutoBox.

# Using dSPACE MicroAutoBox Crimper Tool

**Where to go from here**

Information in this section



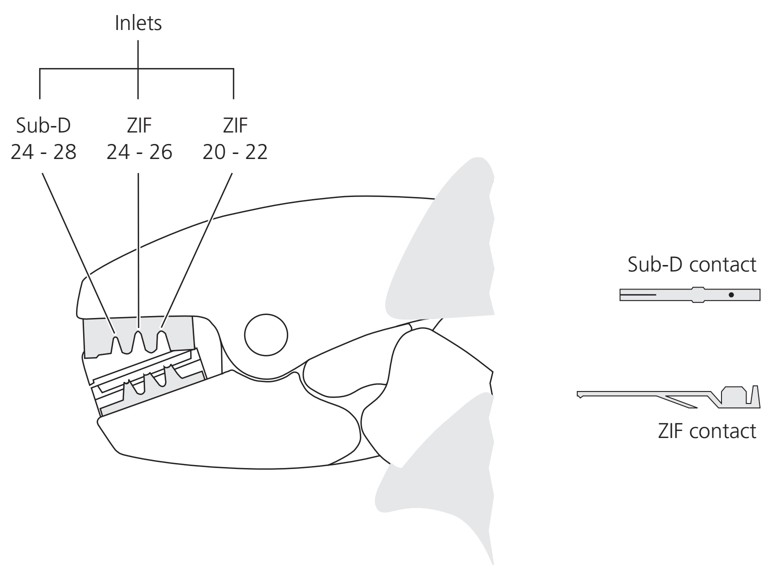
## Details on MicroAutoBox Crimper Tool

**Objective**

dSPACE provides a crimper tool which is especially designed to crimp the contacts needed for the Sub-D connector (MicroAutoBox II 1401/1507 and MicroAutoBox II 1401/1505/1507) and the zero insertion force (ZIF) connector.

**Overview**

The following illustration shows the crimper tool and the Sub-D and ZIF contacts which can be crimped with it. You can crimp contacts 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, crimper contact, and crimp tool all fit.

**Possible wire dimensions**

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

| Inlet | AWG[1)] | Diameter (mm) | Cross Section ($mm^2$) |
|---|---|---|---|
| ZIF 20 – 22 | 20<br>21<br>22 | 0.812<br>0.723<br>0.644 | 0.518<br>0.411<br>0.326 |
| ZIF 24 – 26 | 24<br>25<br>26 | 0.511<br>0.455<br>0.405 | 0.205<br>0.163<br>0.129 |
| Sub-D 24 – 28 | 24<br>25<br>26<br>27<br>28 | 0.511<br>0.455<br>0.405<br>0.360<br>0.330 | 0.205<br>0.163<br>0.129<br>0.096<br>0.080 |

1) AWG = American Wire Gauge

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

The crimp contacts supplied with the MicroAutoBox are ZIF 20 - 22.

## How to Crimp Contacts with the Crimper Tool

**Objective**

The following instructions apply if you want to crimp with the crimper tool for MicroAutoBox connectors.

**Preconditions**

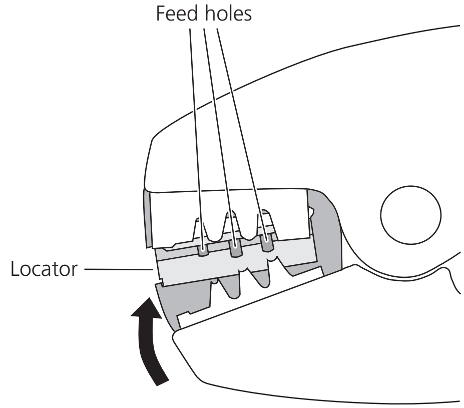
The end of the wire is stripped for 3 … 4 mm.

**Method**

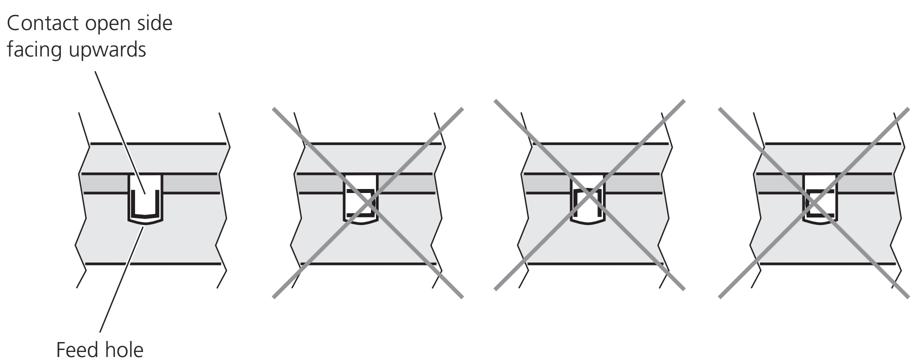
**To crimp contacts with the crimper tool**

1 To open the crimper tool, press the handles of the tool together.

2 Push up the locator a little to see the feed holes in the locator as shown in the illustration below.




3 Hold the crimper contact with the open side facing upwards and insert it into its specific feed hole, so that the open side points towards the top as shown in the illustration below.




4 Insert the wire.

5 To crimp the contact, close the crimper tool up to its end position, where it automatically reopens.

If it does not reopen, it is not properly closed up to its end position.

**Result**

The contact and the wire are properly connected.

# Preparing the ZIF I/O Connector

**Objective**

Before connecting, you have to fasten the wires and fix the connector cover. To prevent wrong connections, it is recommended to mount coding pins on your I/O connector.

**Where to go from here**

Information in this section



## How to Fasten the Wires at the ZIF I/O Connector

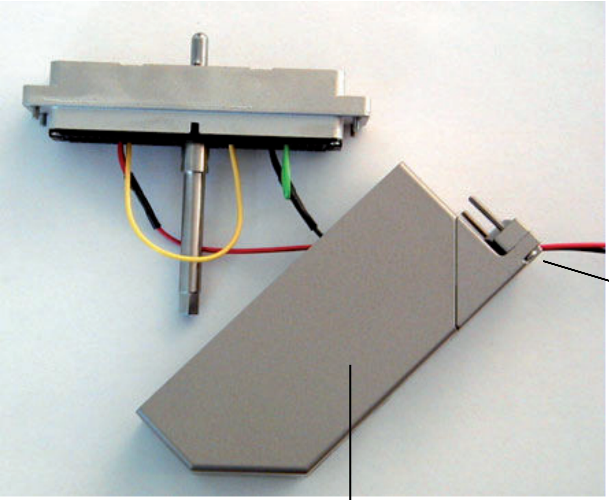
**Objective**

Before connecting the ZIF connector to MicroAutoBox you have to fasten the wires.

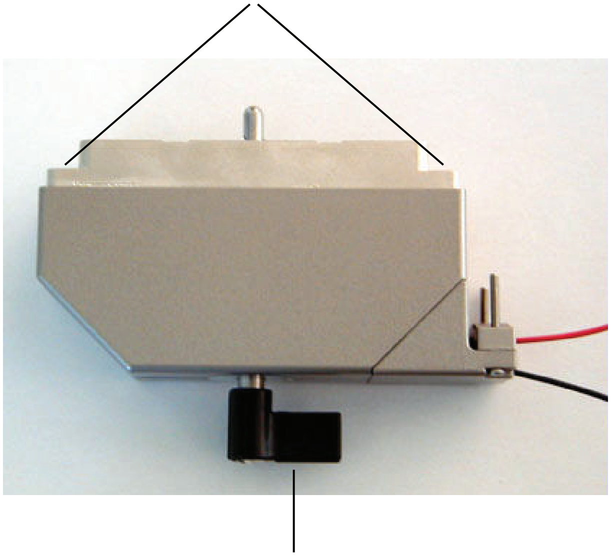
**Method**

**To fasten the wires at the ZIF I/O connector**

**1** Insert the wires in the eye of the connector cover.



**2** Use the four screws to fasten the cover.




**3** Tighten the strain relief clamp.

**Next step**

Now you can insert the connector into the socket of MicroAutoBox and turn the handle to the LOCK position to secure the connector against accidental disconnection.

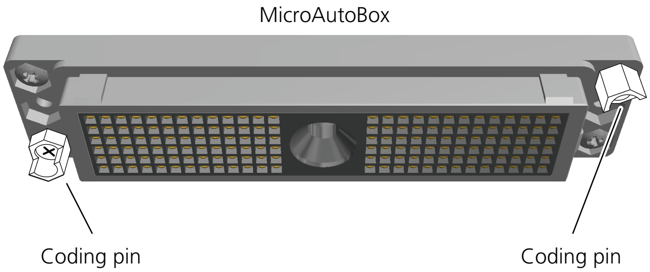
# Coding the ZIF I/O Connector

**Objective**

Each ZIF I/O connector is delivered with a coding kit to prevent wrong connections. It contains coding pins which you can mount on the ZIF I/O connector.

**Coding at connector socket**

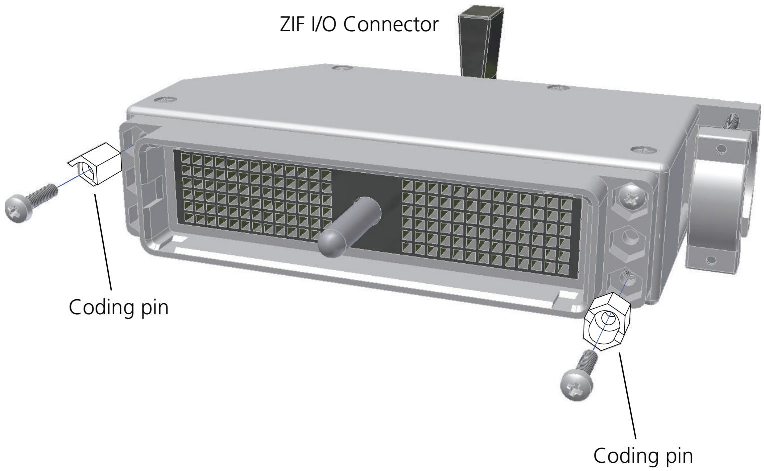
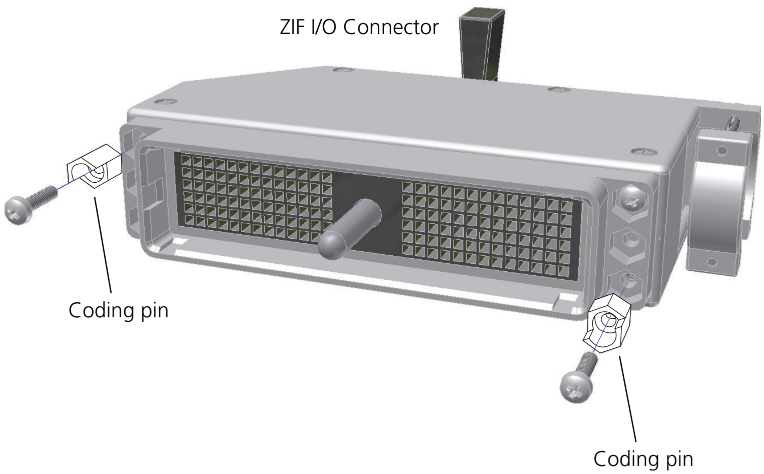
Two coding pins are ready-mounted on each of the MicroAutoBox's connector sockets by dSPACE. The table below shows the possible codes and the mounted coding pins.

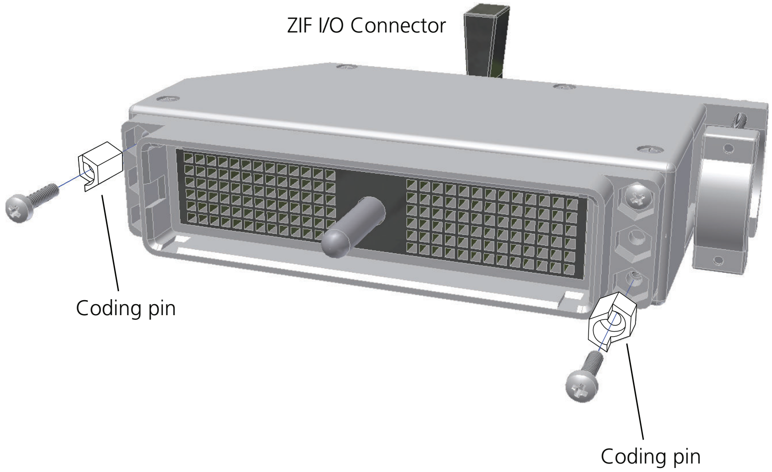
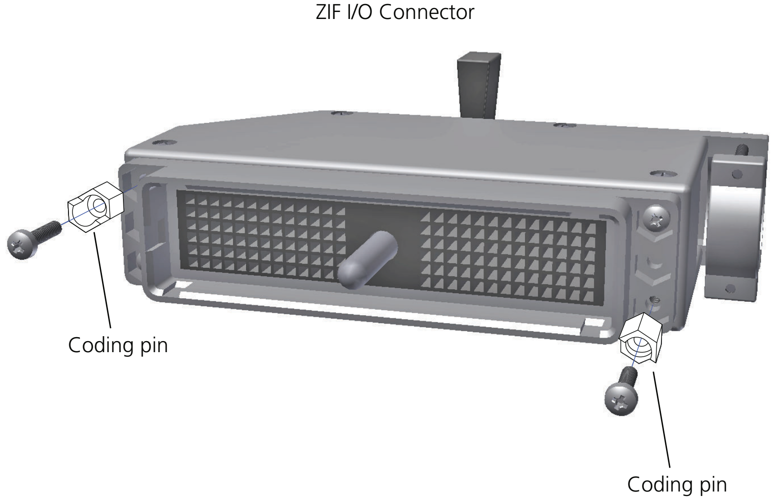
| Code | Characteristics | Connector |
|---|---|---|
| Code 1 |  | DS1511 I/O Connector |
| Code 2 |  | ■ DS1512 I/O Connector<br>■ DS1514 I/O Connector |
| Code 3 |  | ■ DS1501 I/O Connector<br>■ DS1504 I/O Connector<br>■ DS1505 I/O Connector |
| Code 4 |  | DS1513 I/O Connector |

**Coding at ZIF I/O connector**

You have to code the ZIF I/O connector yourself according to the code used at the connector socket. The coding kit (delivered with each I/O connector) contains the necessary pins and screws. Mount the pins in a position that matches the pins at the socket.

The table below shows the codes and the required mounting positions of the pins.

| Code | Characteristics |
|---|---|
| Code 1 |  |
| Code 2 |  |

| Code | Characteristics |
|---|---|
| Code 3 |  |
| Code 4 |  |

**Note**

It is recommended to code the ZIF I/O connector to avoid malfunction or damage to your external devices.

# Connecting MicroAutoBox to the Host PC via Ethernet

**Objective**

You must connect MicroAutoBox to your host PC via Ethernet. For this MicroAutoBox is treated as a network client.

After connecting MicroAutoBox to the host PC via network cable, you have to set up the Ethernet connection.

**Note**

Setting up an Ethernet connection between host PC and MicroAutoBox is recommended for advanced users only.

**Tip**

For hints on best practices concerning the host interface of MicroAutoBox, refer to *Using the host interface* on page 151.

# Setting Up The Ethernet Connection

**Objective**

The connection between the PC (host) and MicroAutoBox (client) is based on the TCP/IP protocol provided by Windows 7. There are two ways to connect a client to the host:

- *Peer-to-peer connection (P2P)*

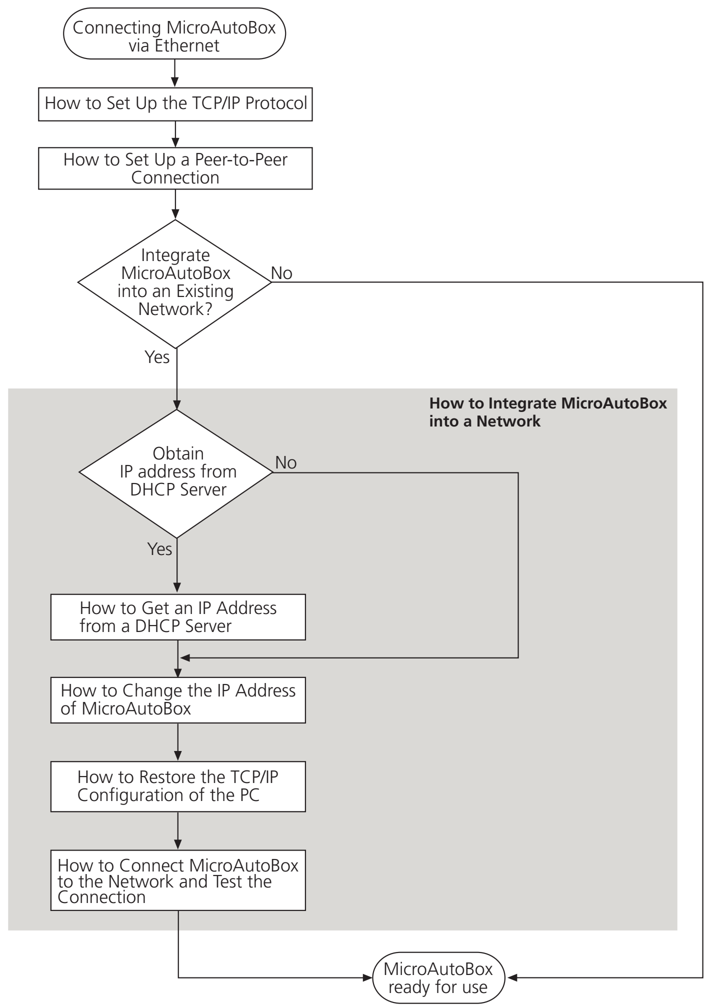
  MicroAutoBox and the host PC are directly connected in a peer-to-peer configuration, and neither the host nor the client is connected to any other network.

- *Integration in an existing network*

  MicroAutoBox becomes part of an existing network using TCP/IP, for example, a local area network.

**Setup procedure**

To connect MicroAutoBox via Ethernet, follow the instructions given in the flow chart below. The boxes in the flow chart refer to the corresponding sections in the text.




**Where to go from here**

Information in this section

# Preparing the TCP/IP Configuration

## How to Set up the TCP/IP Protocol

**Objective**

Before you can connect the MicroAutoBox to the host PC via Ethernet, you have to set up the TCP/IP protocol of the network adapter in your host PC.

**Precondition**

**Note**

Setting up the TCP/IP configuration requires administrator rights.

**Previous configuration**

During this procedure, write down the previous TCP/IP configuration for later restoration.

**Method**

**To set up the TCP/IP protocol**

1 From the Start menu, choose (depending on your PC configuration):

- Settings – Network Connections
- Settings – Control Panel – Double-click Network Connections and Sharing Center.
- Control Panel – Double-click Network Connections and Sharing Center.

2 Double-click Local Area Connection

- or -

Click View Status of Local Area Connection.

The Local Area Connection Status dialog opens.

3 Click Properties.

The Local Area Connection Properties dialog opens.

4 Select Internet Protocol Version 4 (TCP/IPv4), and click Properties.

The Internet Protocol (TCP/IP) Properties dialog opens.

5 From the Internet Protocol (TCP/IP) Properties dialog, write down all the configured values and options so that you can restore them later.

6 From the Internet Protocol (TCP/IP) Properties dialog, select Use the Following IP address. Enter a value in the range `192.168.140.2` ... `192.168.140.254` in the IP Address edit field.

> **Note**
>
> - MicroAutoBox uses 192.168.140.1 as the default IP address.
> - If you also want to connect the DCI-GSI2, note its default IP address (192.168.140.2).

7 In the Subnet Mask edit field, enter the value `255.255.255.0`.

8 Click OK to close the Internet Protocol (TCP/IP) Properties dialog.

9 Click OK to close the Local Area Connection Properties dialog.

10 Click Close to close the Local Area Connection Status dialog.

11 If prompted, confirm to restart the host PC.

**Next steps**

Proceed with:

- *How to Set Up a Peer-to-Peer Connection* on page 65 *or*
- *Integrating MicroAutoBox into a Network* on page 67.

**Solving problems**

> **Tip**
>
> If a problem occurs when you set up the TCP/IP protocol, see *Problems When Setting Up the TCP/IP Protocol* on page 677.

# Setting Up a Peer-to-Peer Connection

## How to Set Up a Peer-to-Peer Connection

**Objective**

A peer-to-peer connection means that the host PC and the MicroAutoBox are directly connected with a network cable.

You should carry out this step, even if you want to integrate MicroAutoBox into an existing network. In that case the IP address of

MicroAutoBox must comply with the conventions of the network. So its default IP address (192.168.140.1) must be changed after setting up a peer-to-peer connection between the host PC and MicroAutoBox.

**Limitation**

If you want to use a permanent peer-to-peer connection, you must always deactivate the DHCP server connection (default setting MicroAutoBox: DHCP server connection = off). For instructions on deactivating a DHCP server connection, refer to *How to Get an IP Address from a DHCP Server* on page 71.

**Method**

**To set up and test a peer-to-peer connection**

1. If the host PC is already part of an existing network, switch it off, and disconnect it from the network.
2. Connect MicroAutoBox to the host PC, using the supplied patch cable.
3. Turn on the host PC and power MicroAutoBox.

   The connection between the host PC and MicroAutoBox can now be tested.
4. Open a Command Prompt window (DOS window): For example, from the Start menu, choose Run ..., enter cmd and click OK.
5. Enter the command: **`ping 192.168.140.1`**, which is the default IP address of MicroAutoBox.

   It is assumed that the default IP address is active.

   If the following message appears, the peer-to-peer connection is ready for use (the values vary on different computers and networks):

```
Pinging 192.168.140.1 with 32 bytes of data:
Reply from 192.168.140.1: bytes=32 time<10ms TTL=32
Reply from 192.168.140.1: bytes=32 time<10ms TTL=32
Reply from 192.168.140.1: bytes=32 time<10ms TTL=32
Reply from 192.168.140.1: bytes=32 time<10ms TTL=32
```

**Next steps**

- If MicroAutoBox is used *only in a peer-to-peer connection*, the network setup is now complete.

  Continue with the 🕮 *First Work Steps with a dSPACE System* document.
- If MicroAutoBox is to be *used in an existing network*, proceed with *How to Change the IP Address of MicroAutoBox* on page 68.

# Integrating MicroAutoBox into a Network

**Where to go from here**

Information in this section



## Workflow for Integrating MicroAutoBox into a Network

**Setup steps**

The following step-by-step instructions show you how to integrate MicroAutoBox into an existing network:

1. Establish a temporary peer-to-peer connection to check the basic characteristics of the connection between host PC and MicroAutoBox. Refer to *How to Set Up a Peer-to-Peer Connection* on page 65.
2. Change the IP address of MicroAutoBox so it complies with the IP addresses used in the network. Refer to *How to Change the IP Address of MicroAutoBox* on page 68.
3. After you changed the IP address of MicroAutoBox, you can restore the previous IP address of the host PC. Refer to *How to Restore the TCP/IP Configuration of the PC* on page 75.
4. Finish by performing the steps in *How to Connect MicroAutoBox to the Network and Test the Connection* on page 76.

**Related topics**

HowTos

- *How to Connect MicroAutoBox to the Network and Test the Connection* on page 76
- *How to Restore the TCP/IP Configuration of the PC* on page 75

# How to Change the IP Address of MicroAutoBox

**Objective**

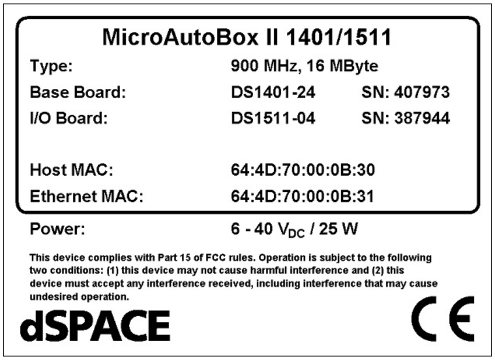
Use the MicroAutoBox II Configuration Tool to change the IP address of your MicroAutoBox II.

**Required information**

For changing the IP address, you need

- Either the current IP address
- Or the Host MAC address and base board serial number of your MicroAutoBox. These are printed on a type plate on the bottom of your MicroAutoBox.

  Type plate example:




**Method**

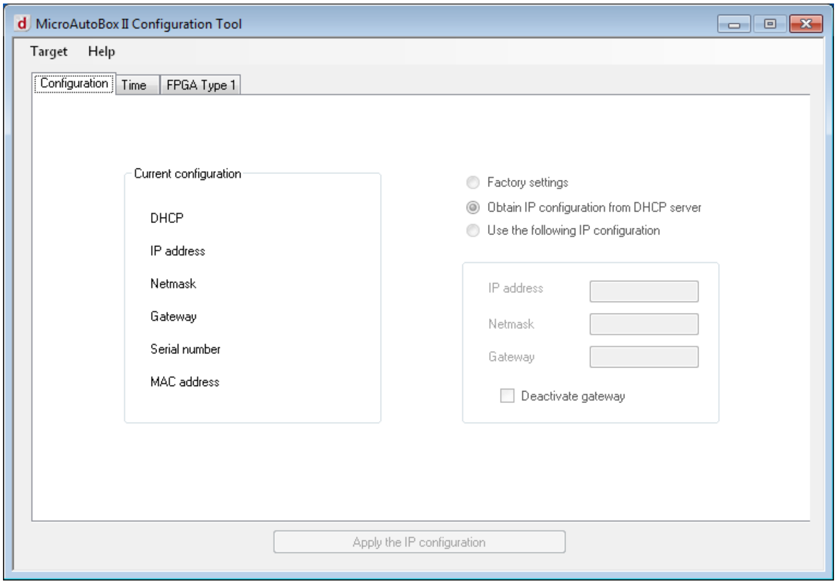
**To change the IP address**

1 Contact your network administrator to obtain an unused IP address that you can use for your MicroAutoBox.

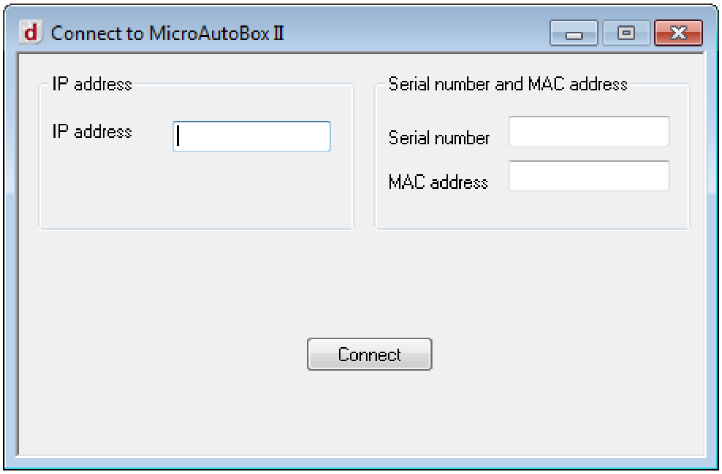
2 On the Start menu of Windows, select dSPACE RCP and HIL <Version> — Command Prompt for dSPACE RCP and HIL <Version>.

A Command Prompt window opens.

**3** Enter **`ds1401configgui.exe`** to open the MicroAutoBox II Configuration Tool.



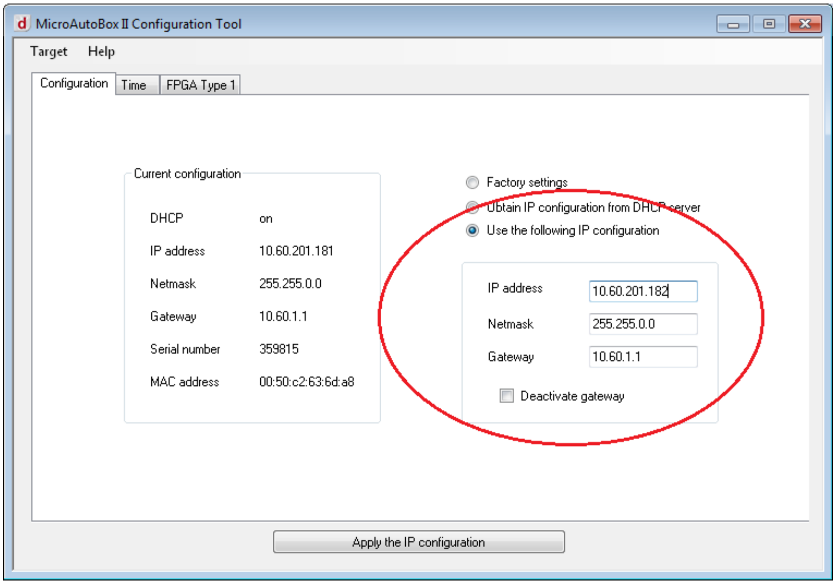

**4** Choose Target — Connect to MicroAutoBox II and enter either the current IP address or the serial number <u>and</u> the MAC address in the Connect to MicroAutoBox II window shown below and click Connect.



**Note**

*Using the serial number and MAC address instead of the IP address for connecting MicroAutoBox to the DHCP server causes broadcasts which can increase network traffic.* To avoid problems in this case, you should establish a peer-to-peer connection between host PC and the MicroAutoBox when using the MicroAutoBox II Configuration Tool.

5 Choose Use the following IP configuration, change the settings in IP address and Netmask.




6 If no gateway is needed, select Deactivate gateway.

7 Click Apply the IP configuration and restart MicroAutoBox so that the changes become effective.

**Result**

You have changed the MicroAutoBox IP address.

For specifying the DHCP server setting, refer to *How to Get an IP Address from a DHCP Server* on page 71.

**Next step**

Proceed with *How to Restore the TCP/IP Configuration of the PC* on page 75.

**Factory default settings**

Choose Factory settings to reset the MicroAutoBox II:

- IP address: 192.168.140.1
- Netmask: 255.255.255.0
- DHCP: off

**Target menu**

The entries of the Target menu are listed in the table below:

| Entry | Description |
|---|---|
| Connect to MicroAutoBox II | Opens the Connect to MicroAutoBox II window to find a MicroAutoBox on the basis of either the current IP address or the serial number and the MAC address. |
| Show all MicroAutoBox II units | Opens a window that lists all available MicroAutoBox in your network. |

**Command line utility**

The command line utility **`ds1401configcmd`** provides all functionalities of the MicroAutoBox II Configuration Tool. Type **`ds1401configcmd /?`** in a dSPACE Command Shell window to get all options.

**FPGA Type 1 page**

The FPGA Type 1 page can only be used with the following MicroAutoBox variants:

- MicroAutoBox II 1401/1511/1512
- MicroAutoBox II 1401/1511/1514
- MicroAutoBox II 1401/1512/1513
- MicroAutoBox II 1401/1513/1514

For further information, refer to *FPGA Support* (📖 *MicroAutoBox Features*).

**User functions in ControlDesk**

ControlDesk allows you to embed MicroAutoBox II Configuration Tool as user function. For further information, refer to *Adding User Functions to ControlDesk* (📖 *ControlDesk Customization*).

# How to Get an IP Address from a DHCP Server

**Objective**

You can get an IP address for MicroAutoBox automatically from a DHCP server. A DHCP server manages the network configuration centrally. As a precondition, your network administrator has to map the MAC address of your MicroAutoBox to an IP address in the DHCP server configuration beforehand.

To activate the connection to the DHCP server, use the MicroAutoBox II Configuration Tool.

**Required information**

For the settings in the MicroAutoBox II Configuration Tool, you need

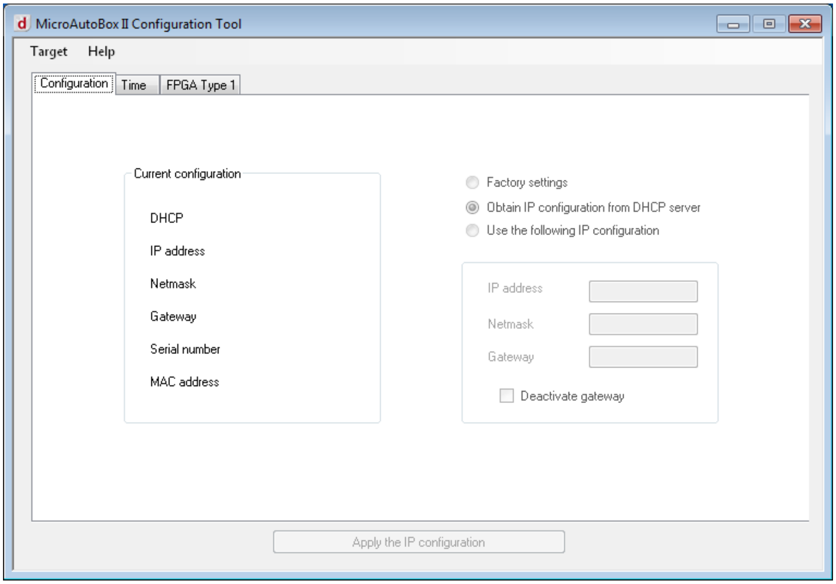
- Either the mapped IP address on the DHCP server
- Or the MAC address and serial number of your MicroAutoBox. These are printed on a type plate on the bottom of your MicroAutoBox.

**Method**

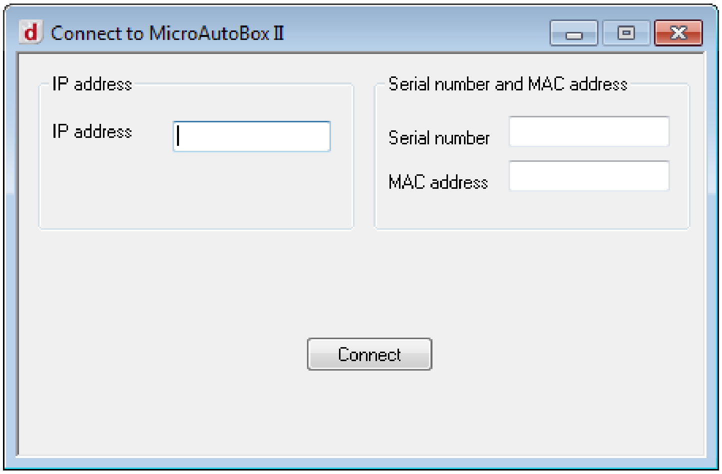
**To get an IP address from a DHCP server**

1. Contact your network administrator to provide the MAC address of your MicroAutoBox and to obtain the mapped IP address that you can use for configuration, for example, in your experimentation software.
2. On the Start menu of Windows, select dSPACE RCP and HIL <Version> — Command Prompt for dSPACE RCP and HIL <Version>.

   A Command Prompt window opens.
3. Enter **`ds1401configgui.exe`** to open the MicroAutoBox II Configuration Tool.



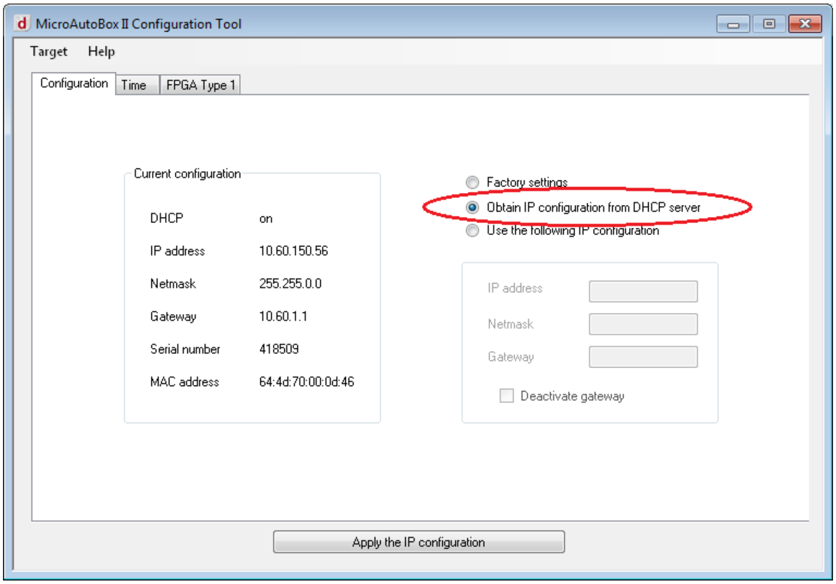
4 Choose Target — Connect to MicroAutoBox II and enter either the current IP address or the serial number and the MAC address in the Connect to MicroAutoBox II window shown below and click Connect.




**Note**

Using the serial number and MAC address instead of the IP address for connecting MicroAutoBox to the DHCP server causes broadcasts which can increase network traffic. To avoid problems in this case, you should establish a peer-to-peer connection between host PC and the MicroAutoBox when using the MicroAutoBox II Configuration Tool.

5 Choose Obtain IP configuration from DHCP server and click Apply the IP configuration.




You have to restart MicroAutoBox so that the changes become effective.

**Next step**

Proceed with *How to Restore the TCP/IP Configuration of the PC* on page 75.

**Command line utility**

The command line utility `ds1401configcmd` provides all functionalities of the MicroAutoBox II Configuration Tool. Type `ds1401configcmd /?` in a dSPACE Command Shell window to get all options.

**FPGA Type 1 page**

The FPGA Type 1 page can only be used with the following MicroAutoBox variants:

- MicroAutoBox II 1401/1511/1512
- MicroAutoBox II 1401/1511/1514
- MicroAutoBox II 1401/1512/1513
- MicroAutoBox II 1401/1513/1514

For further information, refer to *FPGA Support* (📖 *MicroAutoBox Features*).

**User functions in ControlDesk**

> **Tip**
>
> ControlDesk allows you to embed MicroAutoBox II Configuration Tool as user function. For further information, refer to *Adding User Functions to ControlDesk* (📖 *ControlDesk Customization*).

## How to Restore the TCP/IP Configuration of the PC

**Objective**

After you have changed the IP address of the MicroAutoBox to integrate it in a network, you can restore the previous IP address of the host PC.

**Precondition**

To restore the TCP/IP configuration of the host PC, you need the values and options which you wrote down when setting up the TCP/IP protocol (see *How to Set up the TCP/IP Protocol* on page 64).

**Method**

**To restore the TCP/IP configuration of the host PC**

1. On the example of Windows 7:

   From the Start menu, choose (depending on your PC configuration):

   - Settings – Network Connections
   - Settings – Control Panel – Double-click Network Connections and Sharing Center.
   - Control Panel – Double-click Network Connections and Sharing Center.

2. Double-click Local Area Connection

   - or -

   Click View Status of Local Area Connection.

   The Local Area Connection Status dialog opens.

3. Click Properties.

   The Local Area Connection Properties dialog opens.

4. Select Internet Protocol Version 4 (TCP/IPv4), and click Properties.

   The Internet Protocol (TCP/IP) Properties dialog opens

5 Enter all the configured values and options you wrote down before.

6 Click OK to close the Internet Protocol (TCP/IP) Properties dialog.

7 Click OK to close the Local Area Connection Properties dialog.

8 Click Close to close the Local Area Connection Status dialog.

9 If prompted, confirm to restart the host PC.

**Next steps**

Proceed with *How to Connect MicroAutoBox to the Network and Test the Connection* on page 76.

## How to Connect MicroAutoBox to the Network and Test the Connection

**Method**

**To connect MicroAutoBox to the network and test the connection**

1 Turn off MicroAutoBox.

2 Connect MicroAutoBox and the host PC to the network.

3 Turn on MicroAutoBox.

The connection between the host PC and MicroAutoBox can now be tested.

4 Open a Command Prompt window (DOS window): For example, from the Start menu, choose Run ..., enter cmd and click OK.

5 Enter the command:

**`ping<IP address of MicroAutoBox>.`**

**Result**

If the following message appears, the network connection is ready for use (the values vary on different computers and networks). The IP address 10.1.202.178 serves as an example.

```
Pinging 10.1.202.178 with 32 bytes of data:
Reply from 10.1.202.178: bytes=32 time<10ms TTL=32
Reply from 10.1.202.178: bytes=32 time<10ms TTL=32
Reply from 10.1.202.178: bytes=32 time<10ms TTL=32
Reply from 10.1.202.178: bytes=32 time<10ms TTL=32
```

**Solving problems**

**Tip**

If any problem comes up when you integrate MicroAutoBox in a network, see *General Errors Using Ethernet Connection* on page 676.

# Connecting MicroAutoBox to a FlexRay, LIN, or CAN Bus

**Where to go from here**

Information in this section

# Connecting to a FlexRay Bus

**Objective**

MicroAutoBox II 1401/1505/1507, 1401/1507, 1401/1511/1512, 1401/1511/1514, 1401/1512/1513, and 1401/1513/1514 can be connected to a FlexRay bus if they are equipped with FlexRay IP modules.

**Where to go from here**

Information in this section



# General Information on FlexRay IP Modules

## Supported FlexRay IP Modules

**Objective**

This topic provides information on which MicroAutoBox variants are supported and which FlexRay IP modules can be used.

**MicroAutoBox variants**

FlexRay IP modules can only be installed in

- MicroAutoBox II 1401/1505/1507
- MicroAutoBox II 1401/1507
- MicroAutoBox II 1401/1511/1512
- MicroAutoBox II 1401/1511/1514
- MicroAutoBox II 1401/1512/1513
- MicroAutoBox II 1401/1513/1514

**FlexRay IP modules**

The following FlexRay IP modules can be installed in MicroAutoBox and are supported by dSPACE implementation software:

- FlexRay IP modules provided by dSPACE
  - DS4340 FlexRay Interface Module
- FlexRay IP modules provided by a third-party
  - DECOMSYS::FlexIM(MFR4200) (DECOMSYS::FlexIM2+ or DECOMSYS::FlexIM4+, V9.x)
  - DECOMSYS::FlexIM(V11 IP-Core) (DECOMSYS::FlexIM4+, V11.x)
  - DECOMSYS::FlexIM(E-Ray)

**Software support**

The *RTI FlexRay Configuration Blockset* supports all the FlexRay IP modules listed above.

**Related topics**

Basics


- *Connecting Real-Time Systems to the FlexRay Bus* (📖 *FlexRay Configuration Features*)
- *Installing and Uninstalling IP Modules* on page 204


# Using DS4340 Modules

**Objective**

MicroAutoBox II 1401/1505/1507, 1401/1507, 1401/1511/1512, 1401/1511/1514, 1401/1512/1513, and 1401/1513/1514 can be equipped with up to two DS4340 FlexRay Interface Modules.

**Where to go from here**

Information in this section

## Basics on DS4340 FlexRay Interface Modules

**Objective**

Basic information on the DS4340's features, bus termination, feed-through lines, and connecting the bus lines is given below.

**Features of DS4340 modules**

DS4340 FlexRay Interface Modules are FlexRay communication modules provided by dSPACE. They have the following features:

- Freescale MFR43x0 FlexRay Communication Controller
- Dual physical layer interface with TJA1080
- Feed-through for FlexRay bus signals in passive-linear bus topology
- Switchable termination circuit

DS4340 FlexRay Interface Modules are supported by the RTI FlexRay Configuration Blockset.

**Bus termination**

You can terminate the bus lines if the channels of the DS4340 module are connected at the end of the FlexRay bus. The termination resistance is switched via software in the RTIFLEXRAYCONFIG CONTROLLER SETUP block, refer to *Options Page (RTIFLEXRAYCONFIG CONTROLLER SETUP)* (📖 *RTI FlexRay Configuration Blockset Reference*). For a detailed description of bus termination, refer to *DS4340 Connections in Different Topologies* on page 87.

**Feed-through lines**

If the DS4340 is not connected at an end of the FlexRay bus, but connected to a linear passive bus, you can use the feed-through bus lines to keep the stub length as short as possible. This improves the EMC robustness and FlexRay signal integrity, especially in a topology consisting of many nodes and long distances between the splices or ECUs. For details, refer to *DS4340 Connections in Different Topologies* on page 87.

**Pinout, pin description**

If DS4340 modules are installed in MicroAutoBox, all their pins for the bus lines are connected to the I/O connector on the rear side (Sub-D or ZIF).

For details on the signals and pinouts, refer to *Data Sheet DS4340 FlexRay Interface Module* on page 631.

**Related topics**

HowTos

- *How to Install IP Modules* on page 204
- *How to Uninstall IP Modules* on page 208

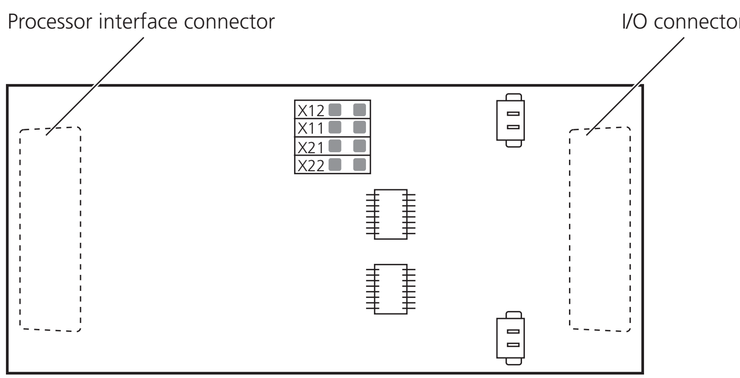
# DS4340 Module Overview and Connector Pinouts

**Objective**

A DS4340 FlexRay Interface Module provides two 50-pin connectors for connecting a real-time processor to a FlexRay bus.

**Overview illustration**

The illustration shows where the connectors are located on the module. The illustration is not to scale.



**Components**

The DS4340 contains the following connectors:

- *Interface connector* for connecting the DS4340 module to the DS1507 (resp., DS1512, DS1514) I/O Board of MicroAutoBox. The interface connector has the signals for the real-time processor.
- *I/O connector* for connecting the DS4340 module to the DS1507 (resp., DS1512, DS1514) I/O Board of MicroAutoBox. The I/O connector has the signals which are routed to the I/O connector on the rear side of the MicroAutoBox.

## FR_CAB1 and FR_CAB3 FlexRay Interface Cable for MicroAutoBox

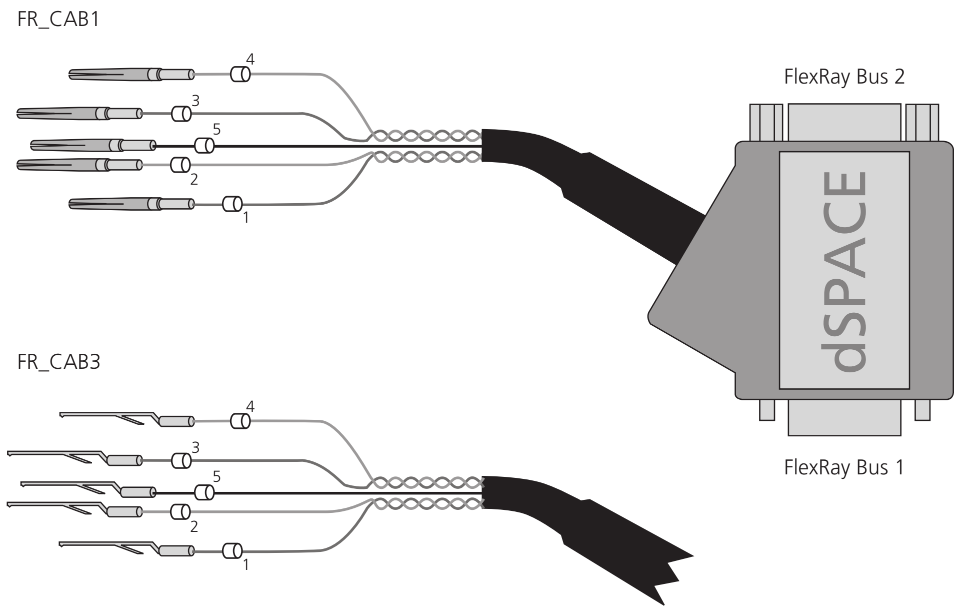
**Objective**

The FR_CAB1 (for MicroAutoBox II 1401/1507 and 1401/1505/1507) and FR_CAB3 (for MicroAutoBox II 1401/1511/1512, 1401/1511/1514, 1401/1512/1513, and 1401/1513/1514) FlexRay Interface Cable for MicroAutoBox can be used to connect FlexRay bus lines to MicroAutoBox if it has DS4340 modules. The cable has two 9-pin D-Sub connectors to connect it to the FlexRay bus lines.

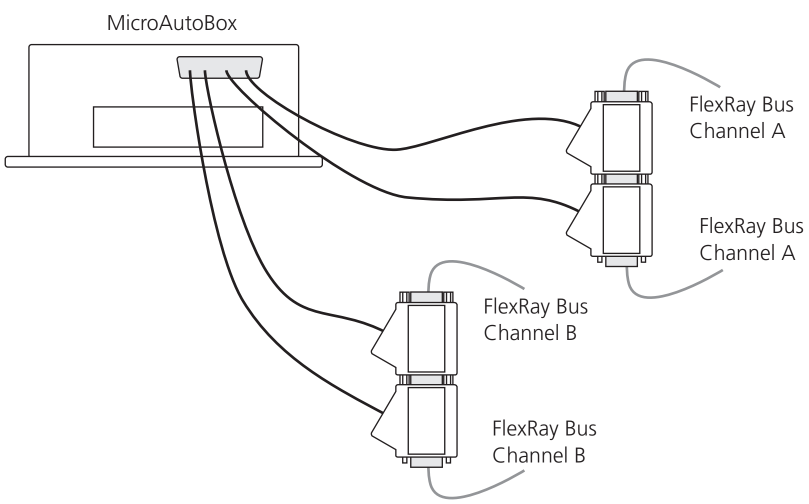
**Features**

The FlexRay Interface Cable provides the following features:

- Connecting one FlexRay channel (A or B) to MicroAutoBox.
- Specially designed for using the feed-through functionality of the DS4340 (see *DS4340 Connections in Different Topologies* on page 87).
- Female 9-pin Sub-D connector for FlexRay Bus 1 (connector for incoming bus lines)
- Male 9-pin Sub-D connector for FlexRay Bus 2 (connector for outgoing (feed-through) bus lines)




The following illustration shows how the FlexRay Interface Cable is used. In this example, MicroAutoBox II 1401/1505/1507 with two DS4340 modules is connected to a FlexRay bus. This requires four FlexRay Interface Cables because a cable can only connect one channel (A or B).



**Connecting the cable to MicroAutoBox**

The FlexRay Interface Cable has crimped contact plugs matching the I/O Connector of MicroAutoBox (Sub-D or ZIF). The following table shows the assignments of the signals to the connectors of the FlexRay Interface Cable.

| Label | Color | Signal | Female 9-pin Sub-D Connector | Male 9-pin Sub-D Connector |
|---|---|---|---|---|
| 1 | Pink | BP[1)] | 7 | - |
| 2 | Green | BM[1)] | 2 | - |
| 3 | Pink | BP_FT[2)] | - | 7 |
| 4 | Green | BM_FT[2)] | - | 2 |
| 5 | Black | GND | 3 | 3 |

1) The wires of BP and BM signals are twisted.
2) The wires of BP_FT and BM_FT signals are twisted.

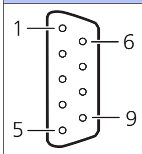
All pins for the FlexRay bus lines are connected to the I/O connector on the rear side (Sub-D or ZIF).

For details on the signals and pinouts, refer to *Data Sheet DS4340 FlexRay Interface Module* on page 631.

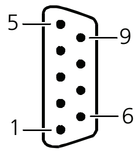
**Connecting the cable to the FlexRay bus**

Both Sub-D connectors are for the FlexRay bus lines. The female Sub-D connector connects the incoming bus lines. The male Sub-D connector connects the outgoing (feed-through) bus lines. Pin 5 of both connectors is connected to the shielding of the connectors. Pins 1, 4, 6, 8, 9 of both connectors are connected to the pins with the same number.

The FlexRay bus 1 connector (female Sub-D connector) has the following pinout:

| Connector | Pin | Signal | Pin | Signal |
|---|---|---|---|---|
|  | 1 | Connected to pin 1 of male Sub-D connector | | |
| | 2 | BM | 6 | Connected to pin 6 of male Sub-D connector |
| | 3 | GND | 7 | BP |
| | 4 | Connected to pin 4 of male Sub-D connector | 8 | Connected to pin 8 of male Sub-D connector |
| | 5 | Connected to shielding of connector | 9 | Connected to pin 9 of male Sub-D connector |

The FlexRay bus 2 connector (male Sub-D connector) has the following pinout:

| Connector | Pin | Signal | Pin | Signal |
|---|---|---|---|---|
|   | 5 | Connected to shielding of connector | | |
| | 4 | Connected to pin 4 of female Sub-D connector | 9 | Connected to pin 9 of female Sub-D connector |
| | 3 | GND | 8 | Connected to pin 8 of female Sub-D connector |
| | 2 | BM_FT | 7 | BP_FT |
| | 1 | Connected to pin 1 of female Sub-D connector | 6 | Connected to pin 6 of female Sub-D connector |

**Tip**

If you want to build a linear FlexRay bus consisting of two or more FlexRay IP modules on one or more MicroAutoBoxes, connect the appropriate FlexRay channels of each module to their FlexRay Interface Cables. Then plug the Interface Cables into each other. Several FlexRay Interface Cables can be mounted directly next to each other.

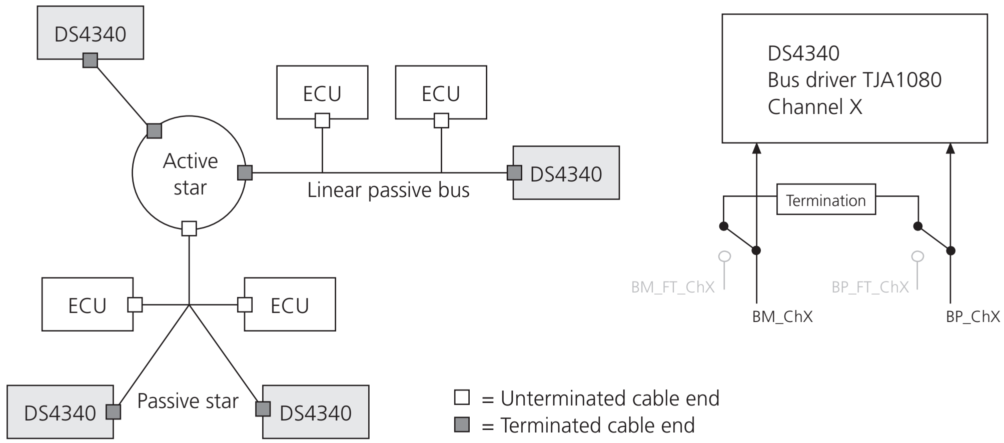
## DS4340 Connections in Different Topologies

**Objective**

You can terminate bus lines of the DS4340 FlexRay Interface module or use them unterminated. You can use feed-through pins to shorten the stub length if the DS4340 is used in a linear passive bus. This topic gives you information on the bus topology and termination. You can configure the termination in the *RTIFLEXRAYCONFIG CONTROLLER SETUP* (📖 *RTI FlexRay Configuration Blockset Reference*) block.

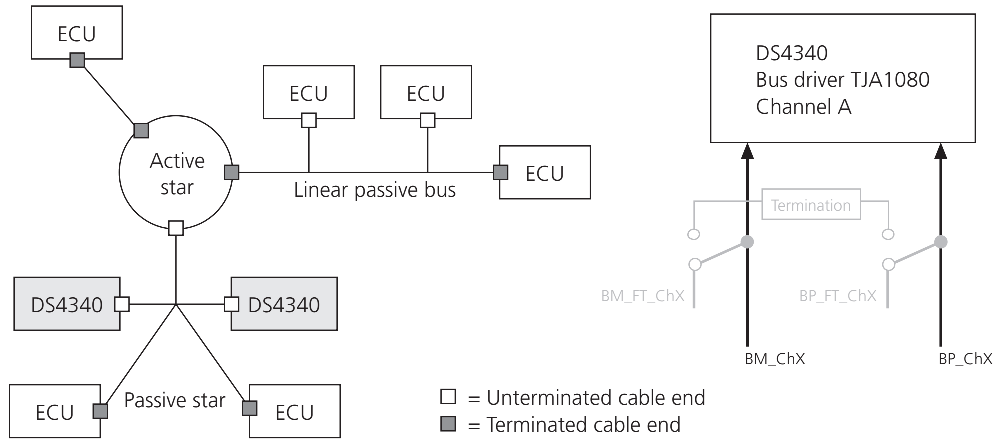
**Terminated cable end without feed-through**

If the DS4340 is connected at an end of the FlexRay bus, its bus lines must be terminated. The termination resistor is activated via software (see above).



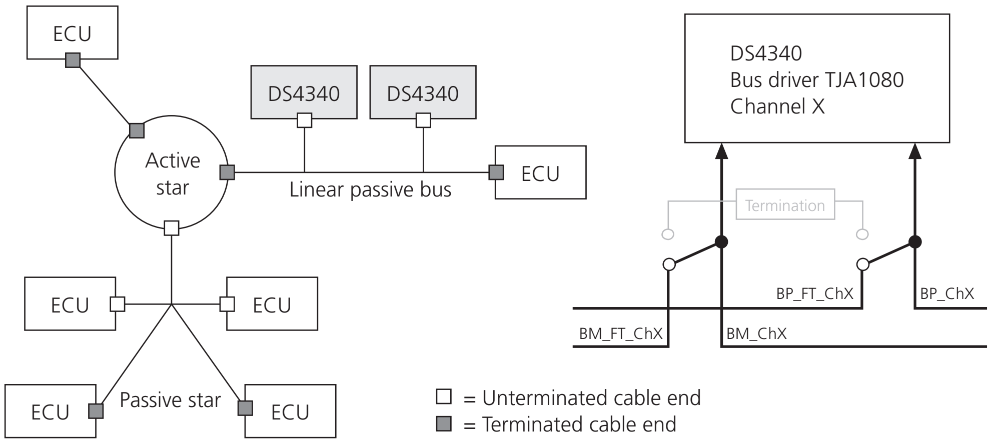

**Unterminated cable end without feed-through**

If the DS4340 is not connected at an end of the FlexRay bus, its bus lines must be unterminated. The termination resistor is deactivated via software (see *RTIFLEXRAYCONFIG CONTROLLER SETUP* (📖 *RTI FlexRay Configuration Blockset Reference*)).




**Unterminated cable end with feed-through**

If a DS4340 is connected at a linear passive bus, you can connect the feed-through bus lines to keep the stub length as short as possible. This improves the EMC robustness and FlexRay signal integrity, especially in a topology consisting of many nodes and long distances between the splices or ECUs.




dSPACE provides a special interface cable to support the feed-through functionality, refer to *FR_CAB1 and FR_CAB3 FlexRay Interface Cable for MicroAutoBox* on page 84.

## Example of Connecting One DS4340 Module to a FlexRay Bus

**Objective**

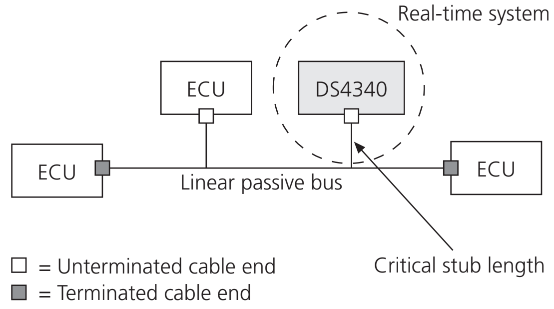
This example shows how one DS4340 module of MicroAutoBox can be connected to a linear passive FlexRay bus. The DS4340 module is not connected at the end of the FlexRay bus. The termination resistor is therefore not activated.

**Note**

To keep the stub length as short as possible, the feed-through bus lines are used.

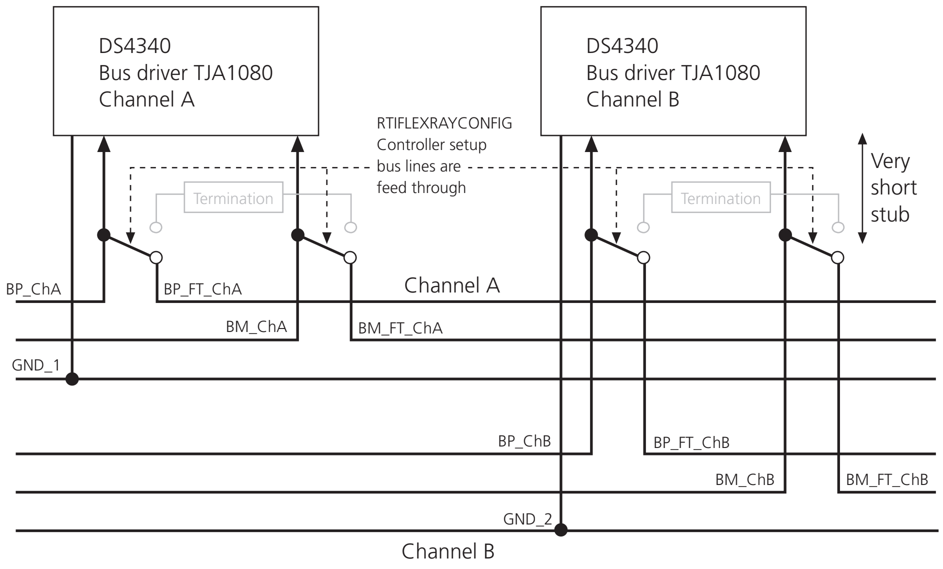
**Topology**

The following illustration shows the network that the DS4340 module of MicroAutoBox is connected to.




**Circuit**

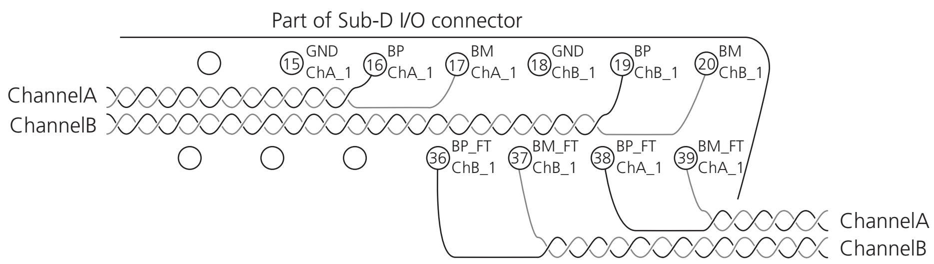
The following illustration shows the connection of the FlexRay bus lines plus and minus. The incoming bus lines are connected to the BP_ChA and BM_ChA pins (BP_ChB and BM_ChB, respectively). The outgoing bus lines are connected to the feed-through pins BP_FT_ChA and BM_FT_ChA (BP_FT_ChB and BM_FT_ChB, respectively). The incoming and outgoing bus lines are connected directly on the DS4340 module, which results in a very short stub length from the connection to the transceiver. The switch for the connection is set via software (see *RTIFLEXRAYCONFIG CONTROLLER SETUP* (📖 *RTI FlexRay Configuration Blockset Reference*)).



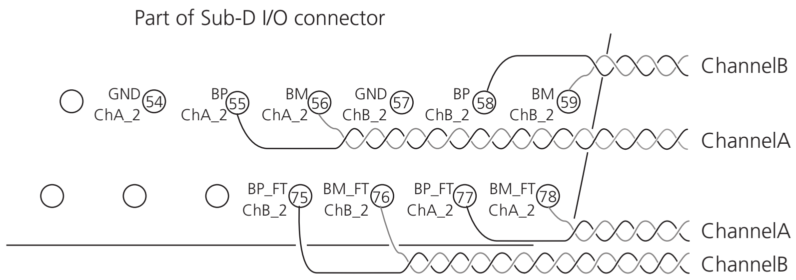

**Sub-D I/O connector**

MicroAutoBox II 1401/1505/1507 and 1401/1507 provide the FlexRay signals on a Sub-D connector.

**DS4340 installed in slot 1** The following illustration shows a part of the Sub-D I/O connector with the connected bus lines if the DS4340 is installed in slot 1.



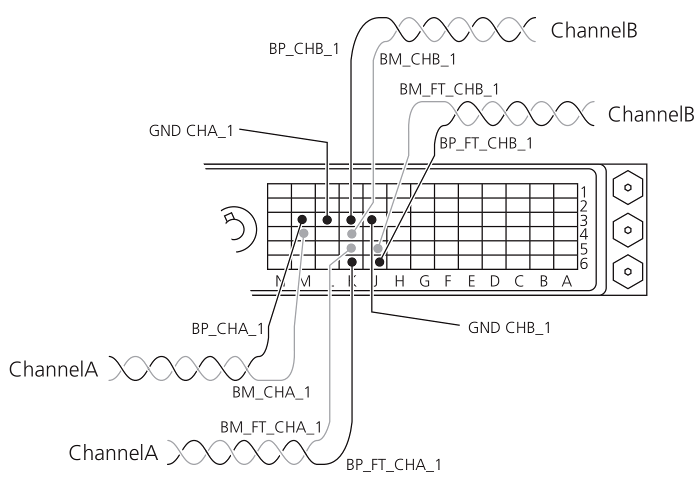
**DS4340 installed in slot 2** The following illustration shows a part of the Sub-D I/O connector with the connected bus lines if the DS4340 is installed in slot 2.



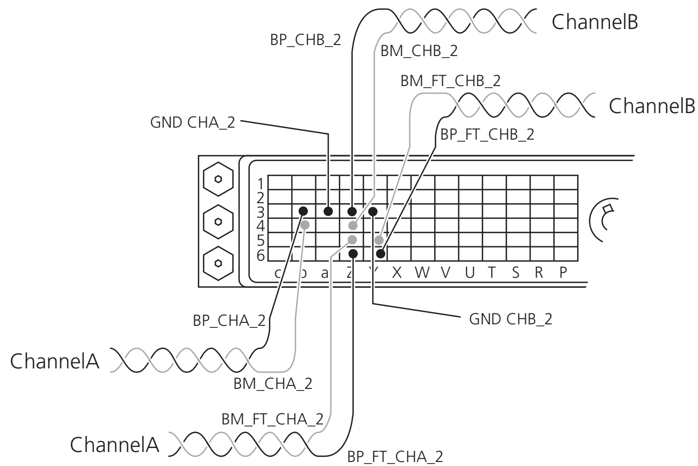

**ZIF I/O connector**

MicroAutoBox II 1401/1511/1512 and MicroAutoBox II 1401/1512/1513 provide the FlexRay signals on the DS1512 ZIF I/O connector. MicroAutoBox II 1401/1511/1514 and MicroAutoBox II 1401/1513/1514 provide the FlexRay signals on the DS1514 ZIF I/O connector.

**DS4340 installed in slot 1** The following illustration shows a part of the ZIF I/O connector with the connected bus lines if the DS4340 is installed in slot 1.



**DS4340 installed in slot 2** The following illustration shows a part of the ZIF I/O connector with the connected bus lines if the DS4340 is installed in slot 2.




## FlexRay Interface Cable

If the dSPACE FlexRay Interface Cable (FR_CAB1: DS1507, FR_CAB3: DS1512 and DS1514) is used to connect the FlexRay bus lines to MicroAutoBox, two cables are required. One cable is used for channel A, another cable is used for channel B. The pins of the I/O connector to be connected depend on the slot on which the DS4340 module is mounted.

**DS4340 installed in slot 1** The following table shows the pins of channel A if the DS4340 module is installed in slot 1.

| Cable | Signal | Pin Label | Pin at Sub-D I/O Connector (1507) | Pin at ZIF I/O Connector (1512 or 1514) |
|---|---|---|---|---|
| 1st Cable | BP_ChA_1 | 1 | 16 | M3 |
| | BM_ChA_1 | 2 | 17 | M4 |
| | BP_FT_ChA_1 | 3 | 38 | K6 |
| | BM_FT_ChA_1 | 4 | 39 | K5 |
| | GND | 5 | 15 | L3 |

The following table shows the pins of channel B.

| Cable | Signal | Pin Label | Pin at Sub-D I/O Connector (1507) | Pin at ZIF I/O Connector (1512 or 1514) |
|---|---|---|---|---|
| 2nd Cable | BP_ChB_1 | 1 | 19 | K3 |
| | BM_ChB_1 | 2 | 20 | K4 |
| | BP_FT_ChB_1 | 3 | 36 | J6 |
| | BM_FT_ChB_1 | 4 | 37 | J5 |
| | GND | 5 | 18 | J3 |

**DS4340 installed in slot 2** The following table shows the pins of channel A if the DS4340 module is installed in slot 2.

| Cable | Signal | Pin Label | Pin at Sub-D I/O Connector (1507) | Pin at ZIF I/O Connector (1512 or 1514) |
|---|---|---|---|---|
| 1st Cable | BP_ChA_2 | 1 | 55 | b3 |
| | BM_ChA_2 | 2 | 56 | b4 |
| | BP_FT_ChA_2 | 3 | 77 | Z6 |
| | BM_FT_ChA_2 | 4 | 78 | Z5 |
| | GND | 5 | 54 | a3 |

The following table shows the pins of channel B.

| Cable | Signal | Pin Label | Pin at Sub-D I/O Connector (1507) | Pin at ZIF I/O Connector (1512 or 1514) |
|---|---|---|---|---|
| 2nd Cable | BP_ChB_2 | 1 | 58 | Z3 |
| | BM_ChB_2 | 2 | 59 | Z4 |
| | BP_FT_ChB_2 | 3 | 75 | Y6 |
| | BM_FT_ChB_2 | 4 | 76 | Y5 |
| | GND | 5 | 57 | Y3 |

The incoming and outgoing FlexRay bus lines must be connected to the Sub-D connector of the FlexRay Interface Cable, see *FR_CAB1 and FR_CAB3 FlexRay Interface Cable for MicroAutoBox* on page 84.

**Related topics**

Basics

• *FR_CAB1 and FR_CAB3 FlexRay Interface Cable for MicroAutoBox* on page 84

# Example of Connecting Two DS4340 Modules to a FlexRay Bus

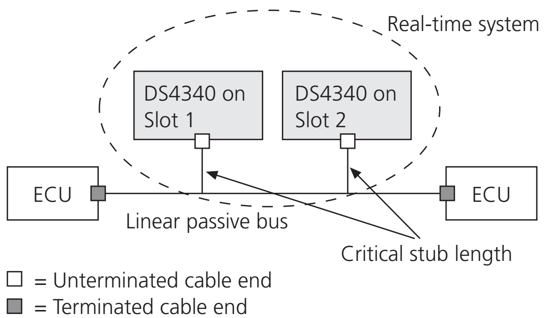
**Objective**

This example shows how two DS4340 modules of MicroAutoBox can be connected to a linear passive FlexRay bus. The DS4340 modules are not connected at the end of the FlexRay bus. The termination resistor is therefore not activated.

> **Note**
>
> To keep the stub length as short as possible, the feed-through bus lines are used.

**Topology**

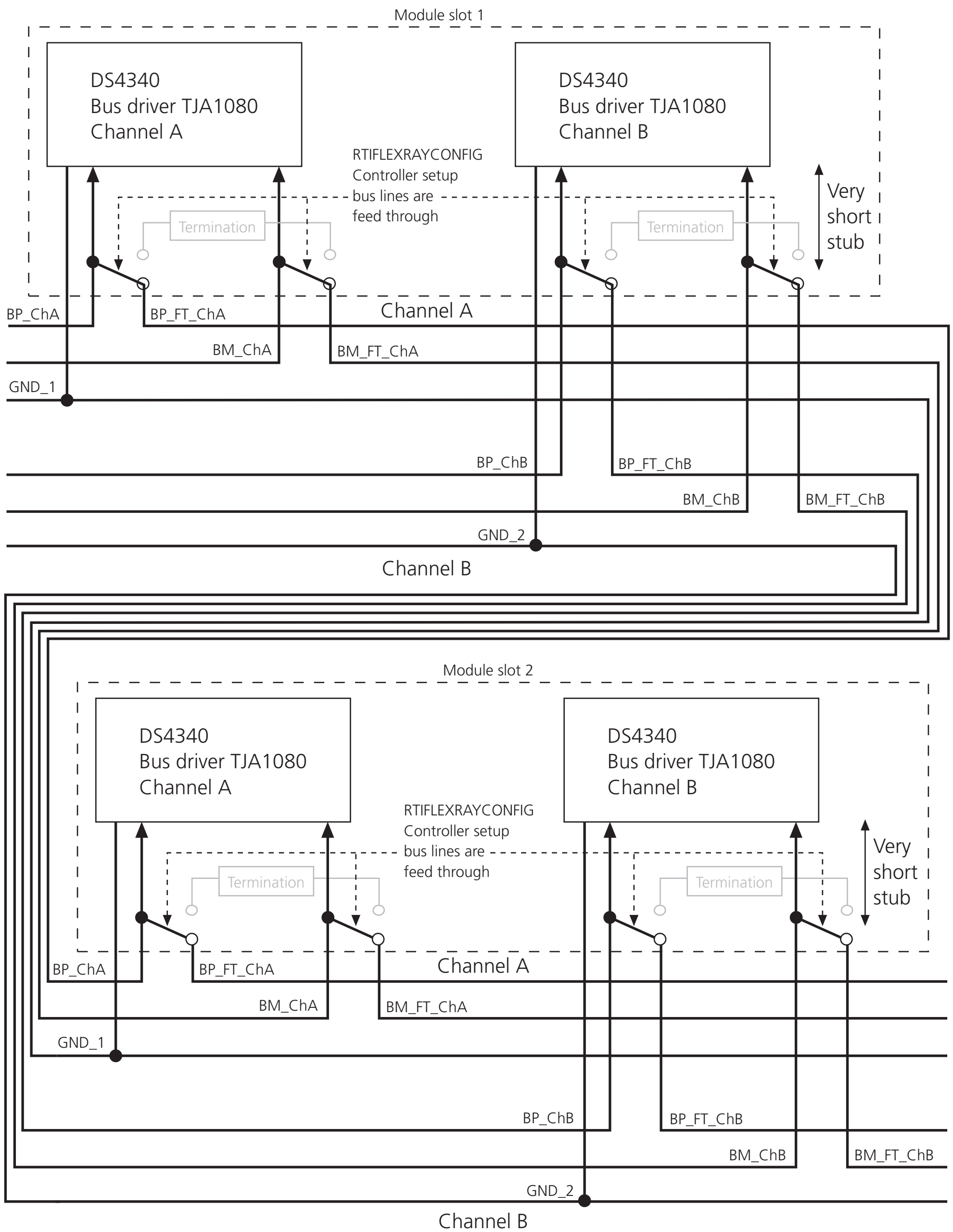
The following illustration shows the topology that the DS4340 modules of MicroAutoBox are connected to.




**Circuit**

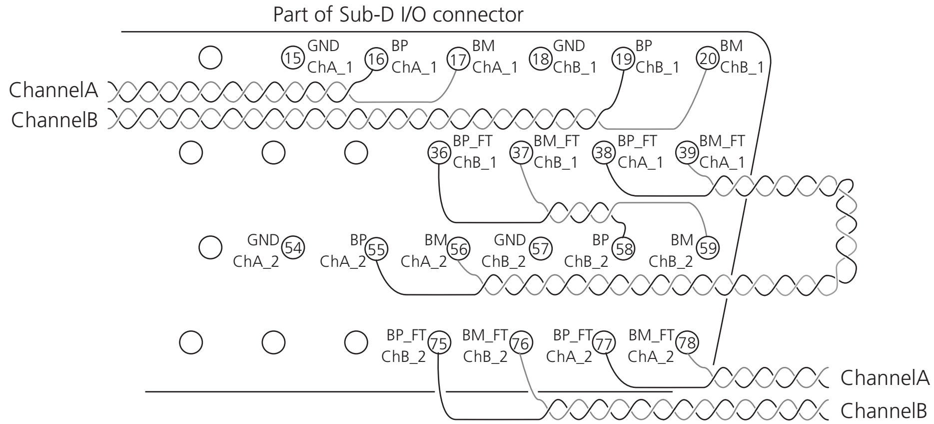
The following illustration shows the connection to the FlexRay bus lines plus and minus on both modules. The incoming bus lines are connected to the BP_ChA and BM_ChA pins (BP_ChB and BM_ChB, respectively). The outgoing bus lines are connected to the feed-through pins BP_FT_ChA and BM_FT_ChA (BP_FT_ChB and BM_FT_ChB, respectively). The incoming and outgoing bus lines are connected directly on the DS4340 module, which results in a very short stub length from the connection to the transceiver. The switch for the connection is set via software (see *RTIFLEXRAYCONFIG*

*CONTROLLER SETUP* (📖 *RTI FlexRay Configuration Blockset Reference*)).



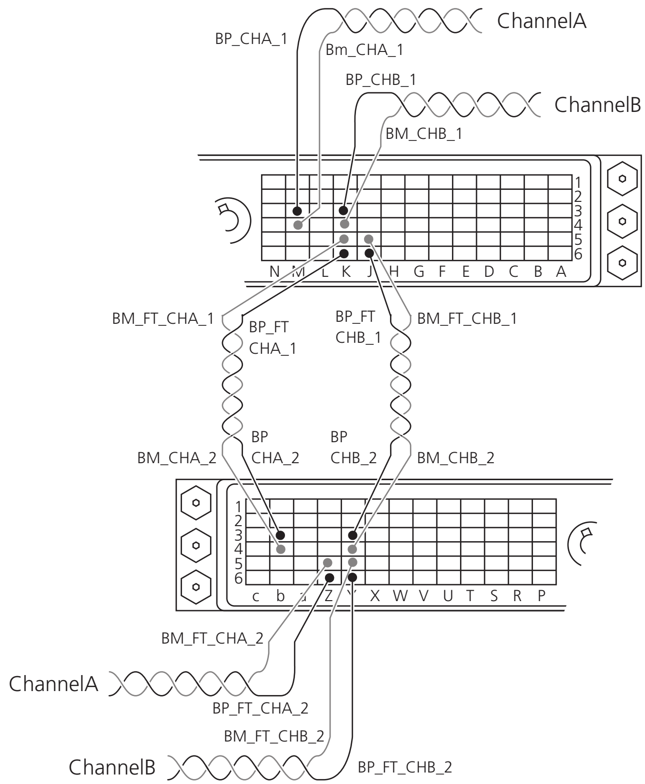
**Sub-D I/O connector**

The following illustration shows a part of the Sub-D I/O connector with the connected bus lines.




**ZIF I/O connector**

The bus lines are connected to the DS1512 or to the DS1514 ZIF I/O connector. The following illustration shows a part of the ZIF I/O connector with the connected bus lines.




**FlexRay Interface Cable**

If FR_CAB1 (DS1507) or FR_CAB3 (DS1512 and DS1514) FlexRay Interface Cable for MicroAutoBox is used to connect the FlexRay bus lines to MicroAutoBox, two cables are required. One cable is used for channel A, another cable is used for channel B. The pins of the Sub-D I/O connector (DS1507) or ZIF I/O connector (DS1512 and DS1514) to be connected depend on the slot on which the DS4340 module is mounted. The following table shows the pins of channel A if the DS4340 modules are mounted in slots 1 and 2.

| Cable | Signal | Pin Label | Pin at Sub-D I/O Connector (1507) | Pin at ZIF I/O Connector (1512 or 1514) |
|---|---|---|---|---|
| 1st Cable | BP_ChA | 1 | 16 | M3 |
| | BM_ChA | 2 | 17 | M4 |
| | BP_FT_ChA | 3 | 38 | K6 |
| | BM_FT_ChA | 4 | 39 | K5 |
| | GND | 5 | 15 | L3 |

| Cable | Signal | Pin Label | Pin at Sub-D I/O Connector (1507) | Pin at ZIF I/O Connector (1512 or 1514) |
|---|---|---|---|---|
| 2nd Cable | BP_ChA | 1 | 55 | b3 |
| | BM_ChA | 2 | 56 | b4 |
| | BP_FT_ChA | 3 | 77 | Z6 |
| | BM_FT_ChA | 4 | 78 | Z5 |
| | GND | 5 | 54 | a3 |

The following table shows the pins of channel B.

| Cable | Signal | Pin Label | Pin at Sub-D I/O Connector (1507) | Pin at ZIF I/O Connector (1512 or 1514) |
|---|---|---|---|---|
| 3rd Cable | BP_ChB | 1 | 19 | K3 |
| | BM_ChB | 2 | 20 | K4 |
| | BP_FT_ChB | 3 | 36 | J6 |
| | BM_FT_ChB | 4 | 37 | J5 |
| | GND | 5 | 18 | J3 |
| 4th Cable | BP_ChB | 1 | 58 | Z3 |
| | BM_ChB | 2 | 59 | Z4 |
| | BP_FT_ChB | 3 | 75 | Y6 |
| | BM_FT_ChB | 4 | 76 | Y5 |
| | GND | 5 | 57 | Y3 |

To connect the FlexRay bus lines of the DS4340 modules, the 1st cable must be connected to the 2nd cable and the 3rd cable must be connected to the 4th cable.

The incoming and outgoing FlexRay bus lines must be connected to the Sub-D connector of the FlexRay Interface Cable, see *FR_CAB1 and FR_CAB3 FlexRay Interface Cable for MicroAutoBox* on page 84.

**Related topics**

Basics

- *FR_CAB1 and FR_CAB3 FlexRay Interface Cable for MicroAutoBox* on page 84

# How to Wake Up MicroAutoBox by Activity on the FlexRay Bus

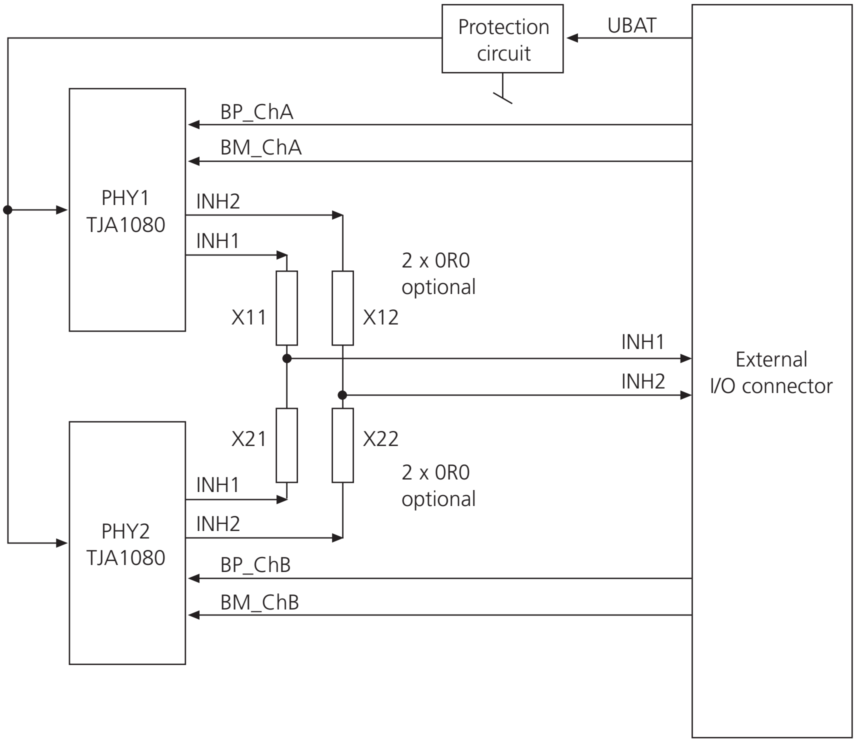
**Objective**

You can configure MicroAutoBox with DS4340 modules to be woken up when the FlexRay bus comes alive.

**Basics**

A DS4340 FlexRay Interface Module is supplied with two transceivers TJA1080. Each transceiver provides two inhibit signals (INH1 and INH2) which can be used for waking up MicroAutoBox. When the transceiver detects activity on the FlexRay bus, the inhibit signals are set to UBAT voltage level; a special wake-up frame is not required. This starts MicroAutoBox if the inhibit signals are connected to the REMOTE pin of MicroAutoBox (for example, on zero insertion force (ZIF) connector, M 3 pin). For detailed information on the inhibit signals (INH1 and INH2), refer to the TJA1080 data sheet (http://www.nxp.com).

The inhibit signals are not connected to the Sub-D I/O (DS1507) or the ZIF I/O (DS1512 or DS1514) connector by default. To connect them, you must solder SMD resistors (resistance: 0 Ω, size: 1206) on the DS4340, see the following circuit.



**Valid only for MicroAutoBox II 1401/1507**

**NOTICE**

**Do not configure IP modules that are installed in MicroAutoBox II 1401/1507 yourself. You might destroy parts of MicroAutoBox.**

All modules that are installed in MicroAutoBox II 1401/1507 must be configured by dSPACE. The assembling positions of the DS1401 Base Board and the DS1507 I/O Board in the MicroAutoBox housing do not allow direct access to the IP slots of the DS1507.

**Method**

**To wake up MicroAutoBox by activity on the FlexRay bus**

1 If the DS4340 module is installed in MicroAutoBox, you must uninstall it first. Refer to *How to Uninstall IP Modules* on page 208.

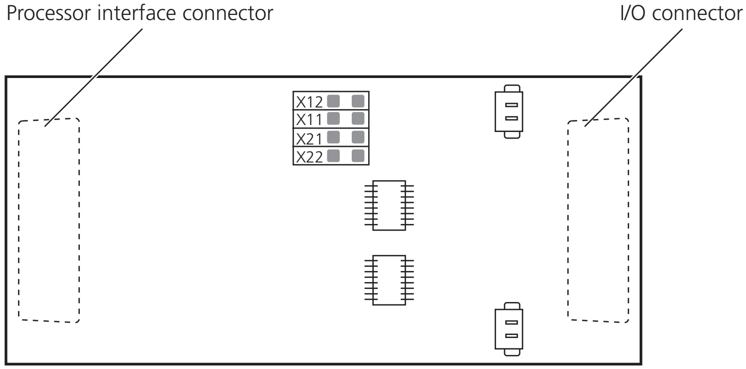
2 Solder the resistors on the soldering pads of the inhibit signals. The positions depend on the monitored channel and inhibit signal used, see the following table.

| Channel | Inhibit Signal | Solder Pad |
|---|---|---|
| A | INH1 | X11 |
| A | INH2 | X12 |
| B | INH1 | X21 |
| B | INH2 | X22 |

**Note**

It is recommended to use either channel A or channel B.

The following illustration shows the locations of the solder pads on the DS4340.




3 Install the DS4340 module in MicroAutoBox, see *How to Install IP Modules* on page 204.

4 Connect the pins. The pins which must be connected depend on the selected inhibit signal (channel A or channel B) and module (slot 1 or slot 2).

   - Connect the inhibit pin of the Sub-D I/O connector (DS1507) or the ZIF I/O connector (DS1512 or DS1514) to the REMOTE pin of the power input connector.
   - Connect the battery voltage to the VBAT pins of the power input connector.
   - Connect battery ground to the GND pin of the power input connector.
   - Connect the FlexRay bus to the Sub-D I/O connector (DS1507) or the ZIF I/O connector (DS1512 or DS1514).
   - Connect the FlexRay power input pin and the GND pin to the battery. (In the example 2: H5 and L3)

   For general information on connecting MicroAutoBox, refer to *Building the Power and I/O Connections* on page 43.

   For information on the pinouts, refer to

   - MicroAutoBox II 1401/1505/1507: *Connector Pinouts* on page 291
   - MicroAutoBox II 1401/1507: *Connector Pinouts* on page 331

- MicroAutoBox II 1401/1511/1512: *Connector Pinouts* on page 387
- MicroAutoBox II 1401/1511/1514: *Connector Pinouts* on page 431
- MicroAutoBox II 1401/1512/1513: *Connector Pinouts* on page 475
- MicroAutoBox II 1401/1513/1514: *Connector Pinouts* on page 551

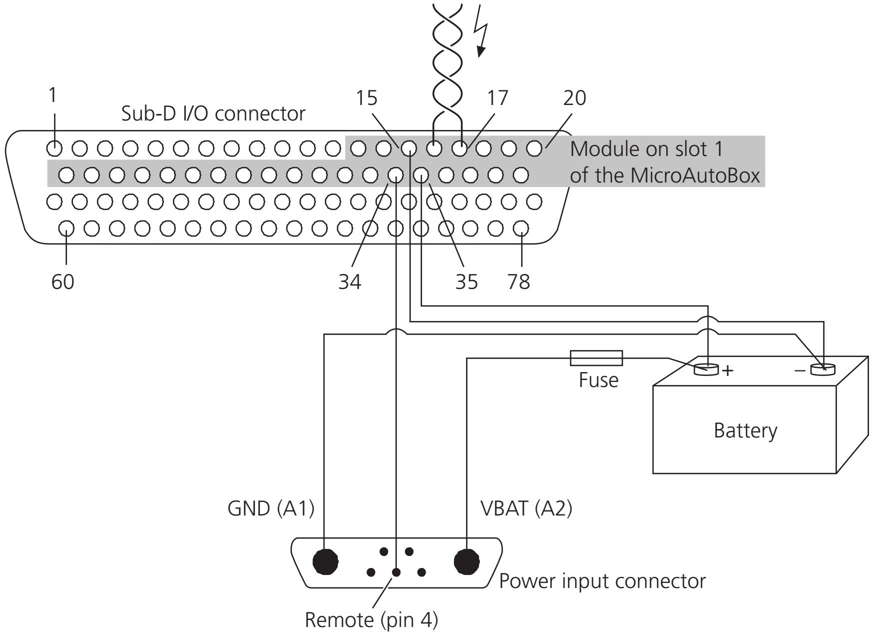
**Result**

When activity is detected on the selected FlexRay channel, MicroAutoBox starts.

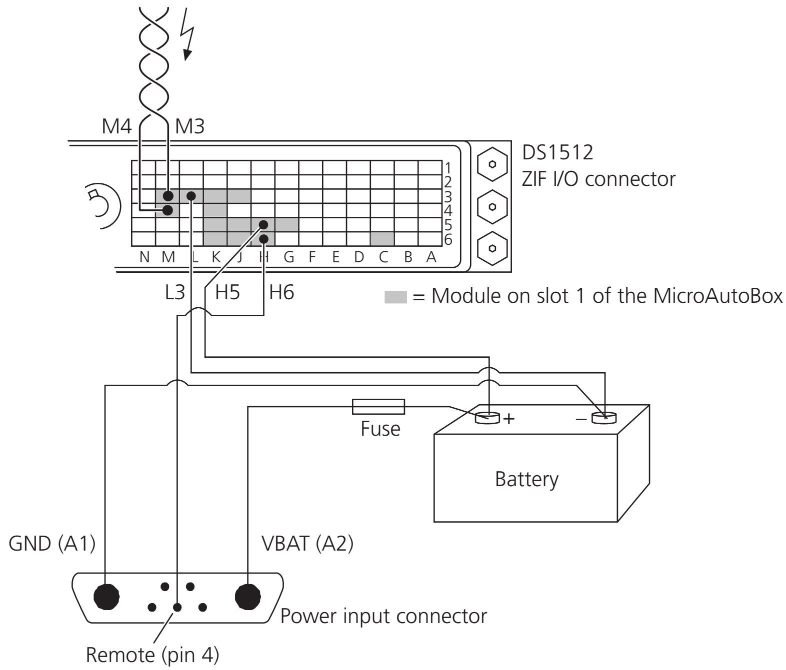
**Examples**

The following illustrations show examples of how MicroAutoBox can be connected to a FlexRay bus. In these examples, channel A of module on slot 1 is used for waking up. The inhibit signal INH2_1 (Sub-D pin 34)(1401/1511/1512, 1401/1511/1514, 1401/1512/1513, and 1401/1513/1514: ZIF pin H6) is connected to the REMOTE pin.

**Example 1 - for MicroAutoBox II 1401/1507 and MicroAutoBox II 1401/1505/1507**



**Example 2 - for MicroAutoBox II 1401/1511/1512, 1401/1511/1514, 1401/1512/1513, and 1401/1513/1514**




**Tip**

The VBAT, GND and REMOTE pins are also located on the ZIF I/O connector. However it is recommended to use the pins only on the power input connector. Do not use the pins on the power input connector and on the ZIF I/O connector at the same time.

# Using Third-Party FlexRay IP Modules

**Objective**

MicroAutoBox can be equipped with FlexRay IP modules provided by a third party.

The following MicroAutoBox variants can be equipped with up to two FlexRay IP modules provided by a third party:

- MicroAutoBox II 1401/1505/1507
- MicroAutoBox II 1401/1507
- MicroAutoBox II 1401/1511/1512
- MicroAutoBox II 1401/1511/1514
- MicroAutoBox II 1401/1512/1513
- MicroAutoBox II 1401/1513/1514

For information on supported third-party modules, refer to *Supported FlexRay IP Modules* on page 80.

## Details on Third-Party FlexRay IP Modules

**Objective**

Below is some basic information on the pinout and pin descriptions if third-party FlexRay IP modules are installed in MicroAutoBox.

**Detailed information**

For detailed information, refer to the documentation provided with the third-party FlexRay IP module.

**Pinout, pin description**

If FlexRay IP modules are installed in MicroAutoBox, the pins for the bus lines are located at the following connector:

- DS1507 I/O Board: 78-pin Sub-D I/O connector
- DS1512 I/O Board: DS1512 ZIF I/O connector
- DS1514 I/O Board: DS1514 ZIF I/O connector

| Module/Slot | Signal | Description | Pin on Sub-D I/O Connector (DS1507) | Pin on ZIF I/O Connector (DS1512 or DS1514) |
|---|---|---|---|---|
| 1 | IP bus high/A1 | Channel A, bus line plus, module 1 | 16 | M3 |
| | IP bus low/B1 | Channel A, bus line minus, module 1 | 17 | M4 |
| | IP GND 1 | Ground for FlexRay channel A, module 1 | 15 | L3 |
| | IP bus high/A2 | Channel B, bus line plus, module 1 | 19 | K3 |
| | IP bus low/B2 | Channel B, bus line minus, module 1 | 20 | K4 |
| | IP GND 2 | Ground for FlexRay channel B, module 1 | 18 | J3 |

| Module/Slot | Signal | Description | Pin on Sub-D I/O Connector (DS1507) | Pin on ZIF I/O Connector (DS1512 or DS1514) |
|---|---|---|---|---|
| 2 | IP bus high/A3 | Channel A, bus line plus, module 2 | 55 | b3 |
| | IP bus low/B3 | Channel A, bus line minus, module 2 | 56 | b4 |
| | IP GND 3 | Ground for FlexRay channel A, module 2 | 54 | a3 |
| | IP bus high/A4 | Channel B, bus line plus, module 2 | 58 | Z3 |
| | IP bus low/B4 | Channel B, bus line minus, module 2 | 59 | Z4 |
| | IP GND 4 | Ground for FlexRay channel B, module 2 | 57 | Y3 |

Third-party FlexRay IP modules have no feed-through lines and inhibit signals to wake up MicroAutoBox.

For details on the signals and pinouts of MicroAutoBox II 1401/1505/1507, refer to


- *Sub-D I/O Connector* on page 293
- *Interfaces* on page 316


For details on the signals and pinouts of MicroAutoBox II 1401/1507, refer to


- *Sub-D I/O Connector* on page 331
- *Interfaces* on page 338


For details on the signals and pinouts of MicroAutoBox II 1401/1511/1512, refer to


- *DS1512 ZIF I/O Connector* on page 389
- *IP Module Connectors* on page 390
- *Interfaces* on page 410


For details on the signals and pinouts of MicroAutoBox II 1401/1511/1514, refer to


- *DS1514 ZIF I/O Connector* on page 433
- *IP Module Connectors* on page 435
- *Interfaces* on page 456


For details on the signals and pinouts of MicroAutoBox II 1401/1512/1513, refer to


- *DS1512 ZIF I/O Connector* on page 475
- *IP Module Connectors* on page 479
- *Interfaces* on page 499

For details on the signals and pinouts of MicroAutoBox II 1401/1513/1514, refer to

- *DS1514 ZIF I/O Connector* on page 553
- *IP Module Connectors* on page 555
- *Interfaces* on page 576

**Related topics**

Basics

- *Supported FlexRay IP Modules* on page 80

HowTos

- *How to Install IP Modules* on page 204
- *How to Uninstall IP Modules* on page 208

# Connecting to a LIN Bus

## How to Configure MicroAutoBox as the LIN Master

**Default configuration**

If you run MicroAutoBox within a LIN network, it is configured as a LIN slave by default. You must reconfigure MicroAutoBox if you want to use it as the LIN master.

**Changing the default configuration**

You can configure MicroAutoBox as the LIN master by adding a series connection consisting of a 1 kΩ pull-up resistor and a diode. This circuit must be wired in parallel to the LIN transceiver. For detailed information, refer to the specification of the LIN transceiver used.

**Note**

Because LIN and K-line use the same circuits, wiring a 1 kΩ pull-up resistor also affects the operation of the K-line.

**Possible methods**

- Add the series connection of the pull-up resistor and diode externally.

  This is possible for all MicroAutoBox variants, refer to *Method 1* on page 109.
- Add the pull-up resistor internally by soldering it to the I/O board. The diode is already soldered on the I/O board.

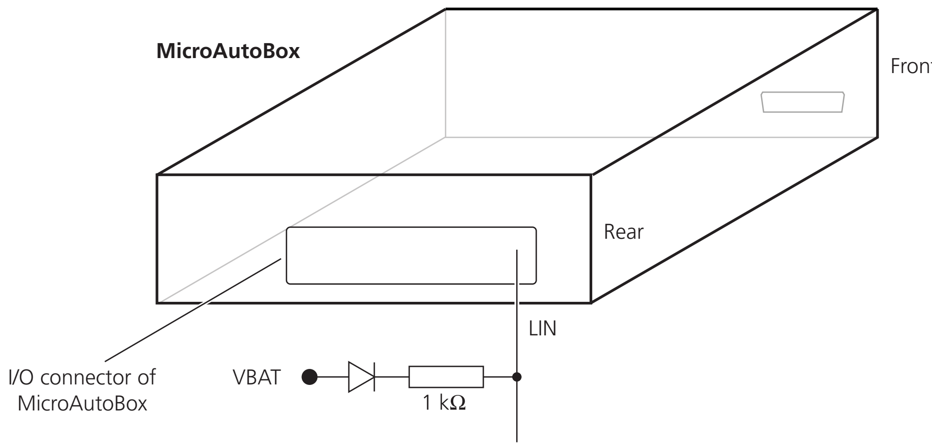
  The configuration varies according to the MicroAutoBox variant.
  - For MicroAutoBox II 1401/1505/1507, refer to *Method 2* on page 110.
  - For MicroAutoBox II 1401/1507, refer to *Method 3* on page 113.
  - For MicroAutoBox II 1401/1511, refer to *Method 4* on page 115.
  - For MicroAutoBox II 1401/1511/1512, refer to *Method 5* on page 117.
  - For MicroAutoBox II 1401/1511/1514, refer to *Method 5* on page 117.

- For MicroAutoBox II 1401/1512/1513, refer to *Method 6* on page 119.
- For MicroAutoBox II 1401/1513, refer to *Method 7* on page 120.
- For MicroAutoBox II 1401/1513/1514, refer to *Method 6* on page 119.

**Method 1**

**To configure MicroAutoBox as the LIN master**

1. Disconnect MicroAutoBox from the power supply.
2. Solder the series connection of a diode and a 1 kΩ resistor between the VBAT and the LIN signal. See the following illustration.




**NOTICE**

Do not exceed a maximum supply voltage of 32 V. Higher supply voltages can damage MicroAutoBox's LIN transceiver.

The pinout depends on the MicroAutoBox variant. Refer to:

- MicroAutoBox II 1401/1501: *ZIF I/O Connector* on page 224*ZIF I/O Connector* on page 224
- MicroAutoBox II 1401/1504: *ZIF I/O Connector* on page 258*ZIF I/O Connector* on page 258
- MicroAutoBox II 1401/1505/1507: *ZIF I/O Connector* on page 291*ZIF I/O Connector* on page 291
- MicroAutoBox II 1401/1507: *Sub-D I/O Connector* on page 331*Sub-D I/O Connector* on page 331

- MicroAutoBox II 1401/1511: *ZIF I/O Connector* on page 354*ZIF I/O Connector* on page 354
- MicroAutoBox II 1401/1511/1512: *DS1511 ZIF I/O Connector* on page 387*DS1511 ZIF I/O Connector* on page 387
- MicroAutoBox II 1401/1511/1514: *DS1511 ZIF I/O Connector* on page 431*DS1511 ZIF I/O Connector* on page 431
- MicroAutoBox II 1401/1512/1513: *DS1513 ZIF I/O Connector* on page 476*DS1513 ZIF I/O Connector* on page 476
- MicroAutoBox II 1401/1513: *ZIF I/O Connector* on page 514*ZIF I/O Connector* on page 514
- MicroAutoBox II 1401/1513/1514: *DS1513 ZIF I/O Connector* on page 551

**Tip**

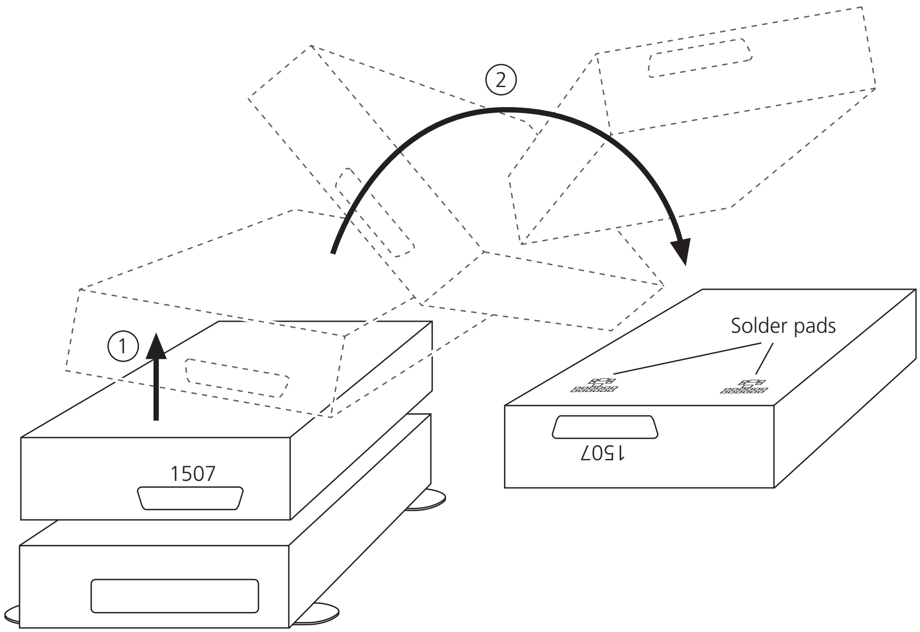
You can connect the diode directly to a VBAT pin on the ZIF I/O connectors of MicroAutoBox II 1401/1501, 1401/1504, and 1401/1505/1507.

**Method 2**

**To configure MicroAutoBox II 1401/1505/1507 as the LIN master by soldering a pull-up resistor**

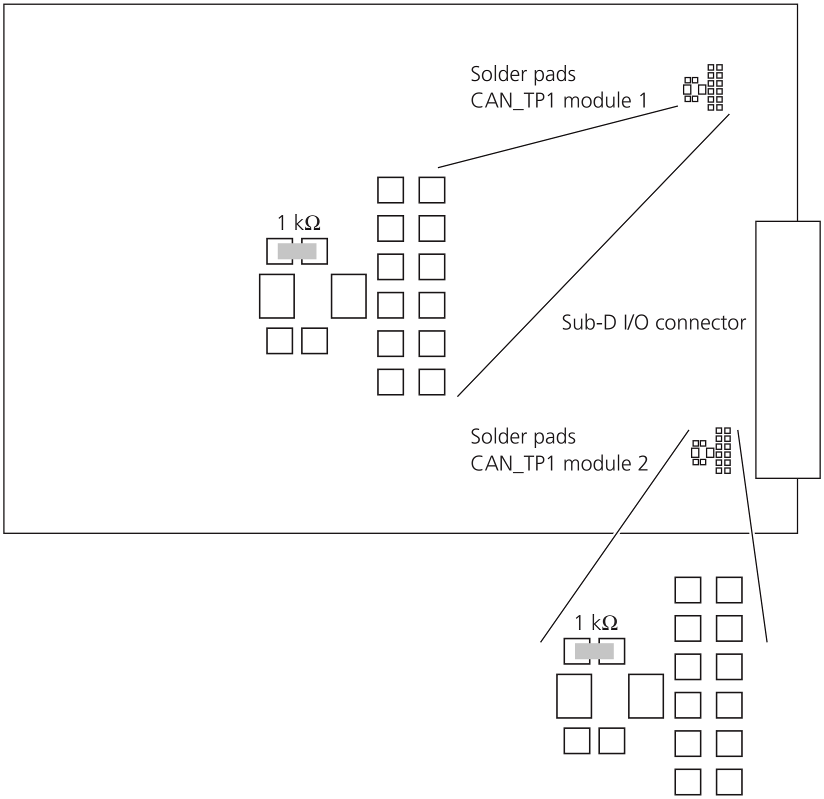
1. Disconnect MicroAutoBox from the power supply.
2. Unbolt the screws of the cover with a 2.5 mm hexagon socket wrench and remove the cover.

**3** Remove the upper unit of the MicroAutoBox, which contains the DS1507.




The solder pads of the two CAN_TP1 modules are on the bottom of the removed unit.

**4** Solder 1 kΩ 0805 SMD resistors to the marked solder pads (see illustration below) as the LIN master pull-up.



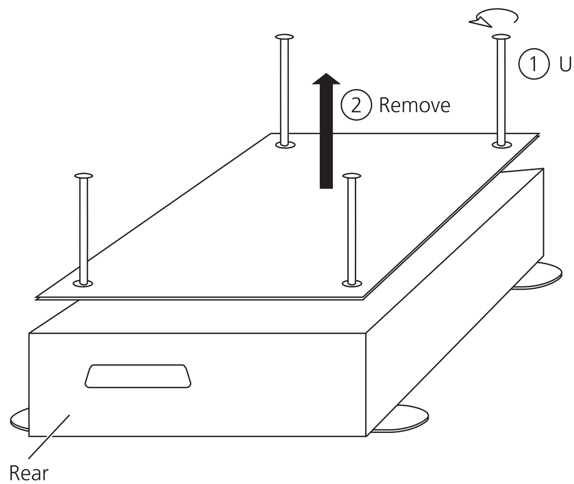

**5** Install the DS1507 again.

**6** Mount the cover of the MicroAutoBox.

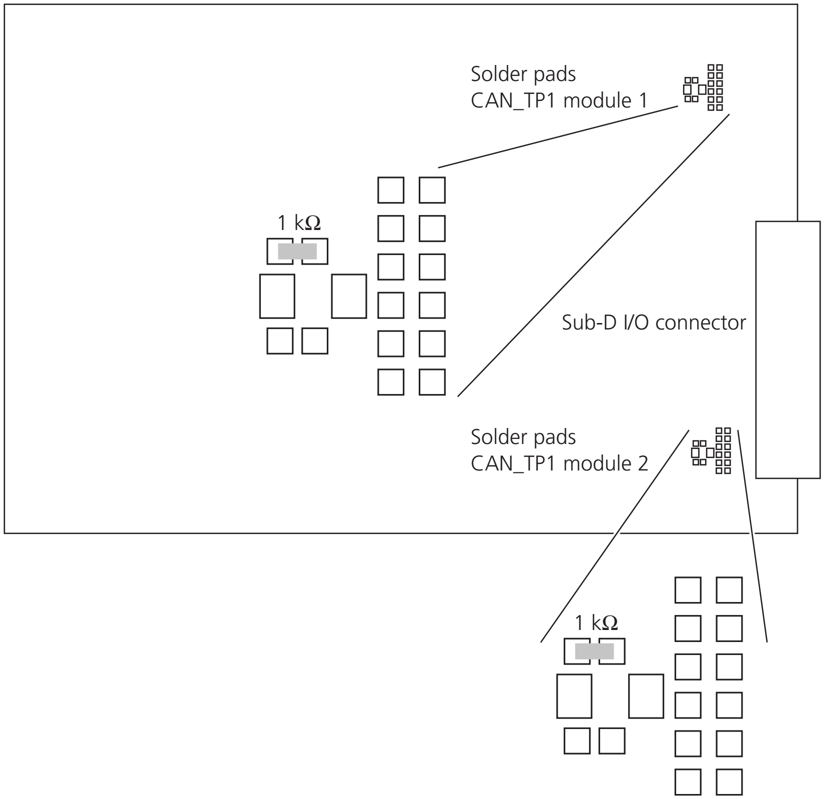
**Method 3**

**To configure MicroAutoBox II 1401/1507 as the LIN master by soldering a pull-up resistor**

1. Disconnect MicroAutoBox from the power supply.
2. Open the enclosure of MicroAutoBox as shown in the illustration below. Use a 2.5 mm hexagon socket wrench.




3. The solder pads of the two CAN_TP1 modules are on the top. Solder 1 kΩ 0805 SMD resistors to the marked solder pads (see illustration below) as the master pull-up.



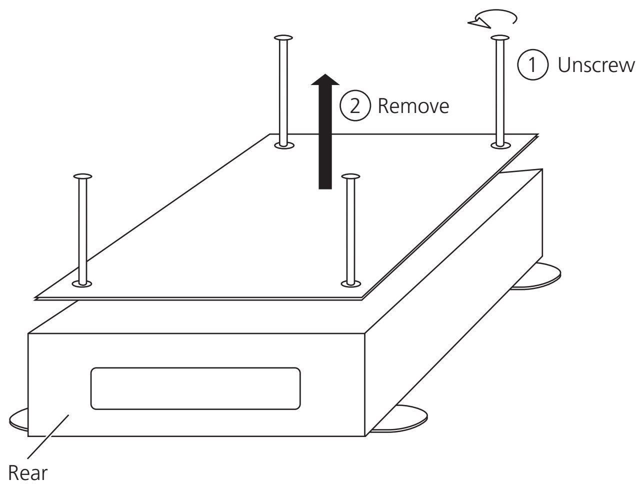

**4** Mount the cover of the MicroAutoBox.

**Method 4**

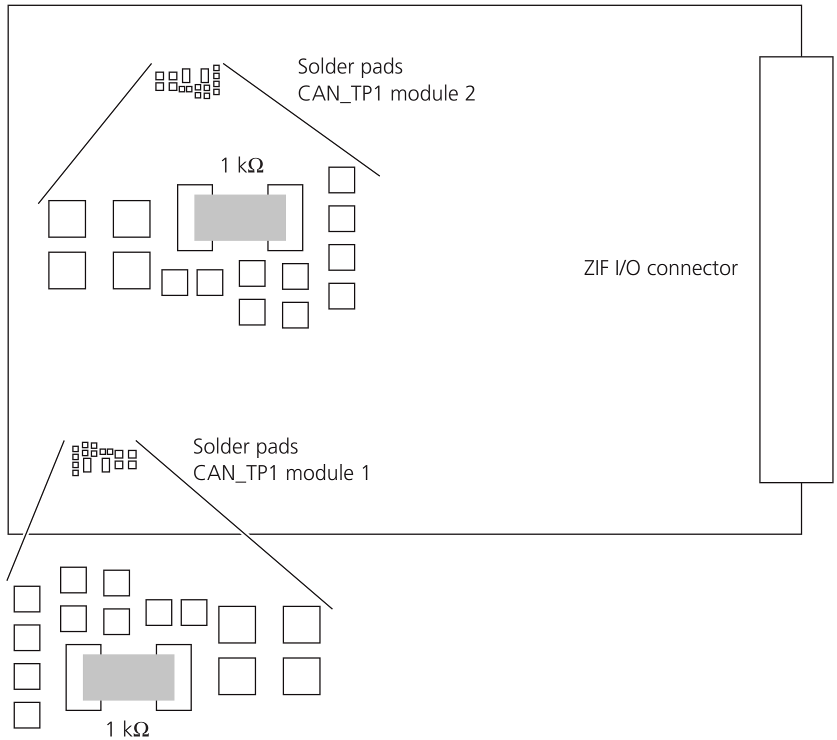
**To configure MicroAutoBox II 1401/1511 as the LIN master by soldering a pull-up resistor**

1 Disconnect MicroAutoBox from the power supply.

2 Open the enclosure of MicroAutoBox as shown in the illustration below. Use a 2.5 mm hexagon socket wrench.




3 The solder pads of the two CAN_TP1 modules are on the top. Solder 1 kΩ 2512 SMD resistors to the marked solder pads (see illustration below) as the LIN master pull-up.



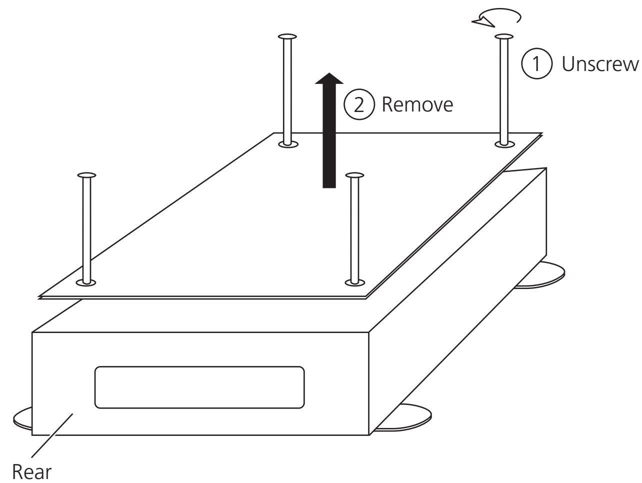

**4** Mount the cover of the MicroAutoBox.

**Method 5**

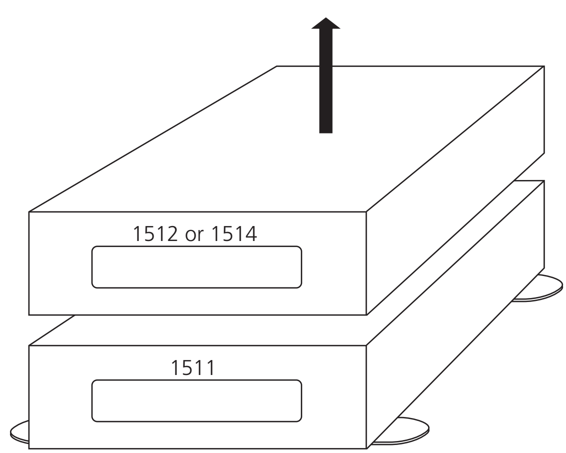
**To configure MicroAutoBox II 1401/1511/1512 or 1401/1511/1514 as the LIN master by soldering a pull-up resistor**

1 Disconnect MicroAutoBox from the power supply.

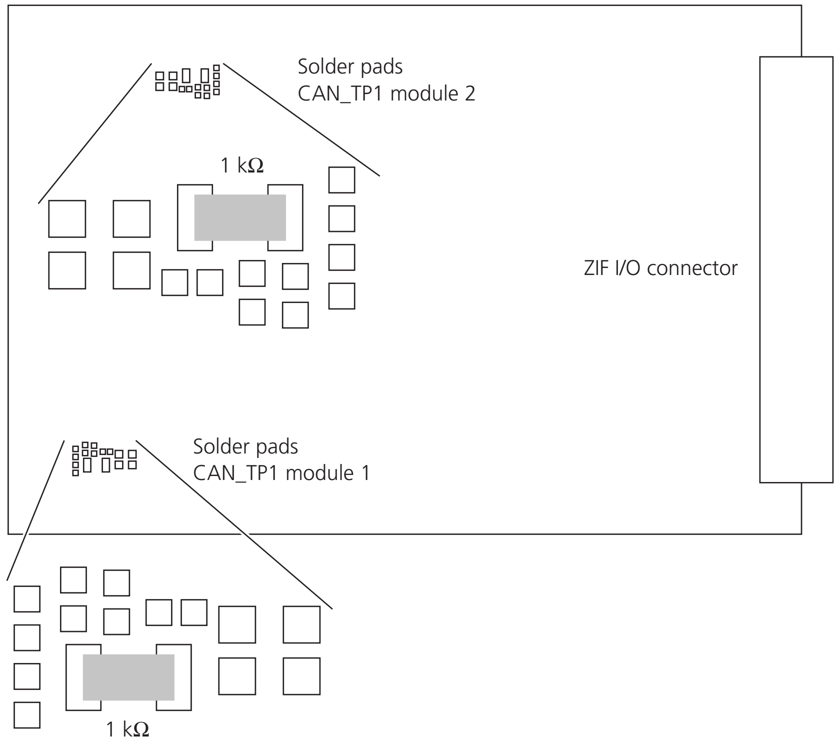
2 Open the enclosure of MicroAutoBox as shown in the illustration below (on the example of MicroAutoBox II 1401/1511). Use a 2.5 mm hexagon socket wrench.




3 Remove the upper unit of the MicroAutoBox (DS1512 or DS1514).




4 The solder pads of the two CAN_TP1 modules are on the top of the DS1511. Solder 1 kΩ 2512 SMD resistors to the marked solder pads (see illustration below) as the LIN master pull-up.




**5** Install the removed unit (DS1512 or DS1514).

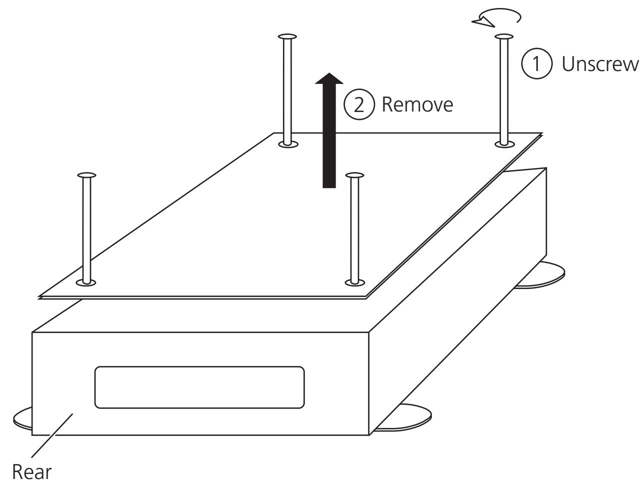
**6** Mount the cover of the MicroAutoBox.

**Method 6**

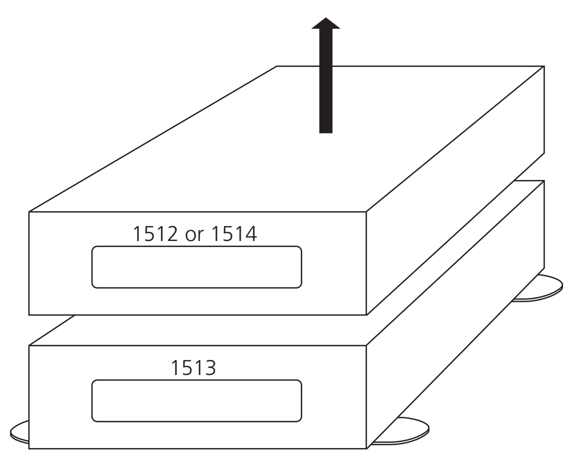
**To configure MicroAutoBox II 1401/1512/1513 or 1401/1513/1514 as the LIN master by soldering a pull-up resistor**

1 Disconnect MicroAutoBox from the power supply.

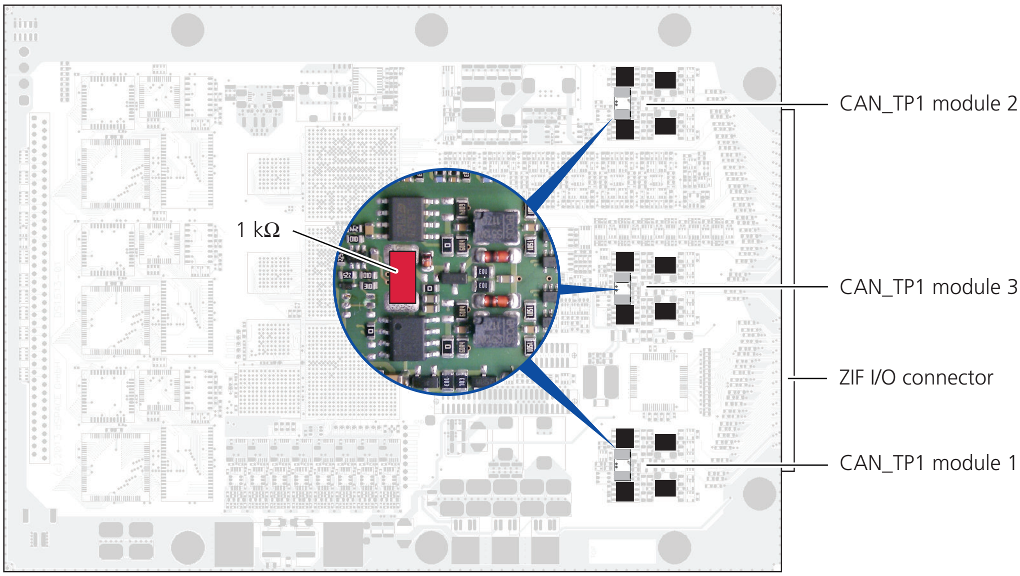
2 Open the enclosure of MicroAutoBox as shown in the illustration below (on the example of MicroAutoBox II 1401/1513). Use a 2.5 mm hexagon socket wrench.




3 Remove the upper unit of the MicroAutoBox (DS1512 or DS1514).




4 The solder pads of the three CAN_TP1 modules are on the top of the DS1513. Solder 1 kΩ 2512 SMD resistors to the marked solder pads (see illustration below) as the LIN master pull-up.




5 Install the removed unit (DS1512 or DS1514).

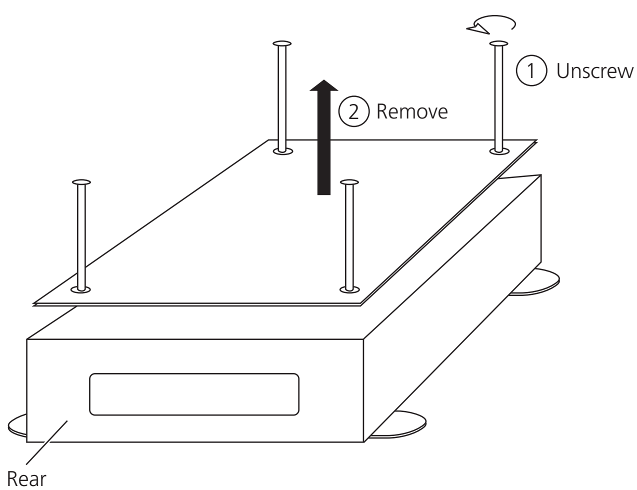
6 Mount the cover of the MicroAutoBox.

**Method 7**

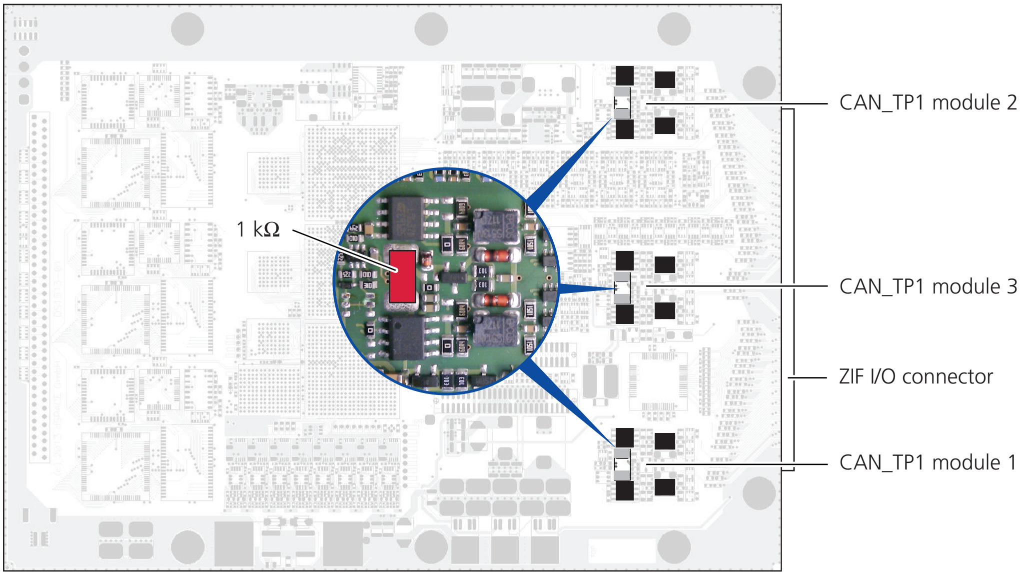
**To configure MicroAutoBox II 1401/1513 as the LIN master by soldering a pull-up resistor**

1 Disconnect MicroAutoBox from the power supply.

2 Open the enclosure of MicroAutoBox as shown in the illustration below. Use a 2.5 mm hexagon socket wrench.



**3** The solder pads of the three CAN_TP1 modules are on the top of the DS1513. Solder 1 kΩ 2512 SMD resistors to the marked solder pads (see illustration below) as the LIN master pull-up.




**4** Mount the cover of the MicroAutoBox.

**Result** MicroAutoBox is configured as the LIN master.

# Connecting to a CAN Bus

**Objective**

You can connect MicroAutoBox to a CAN bus. MicroAutoBox II 1401/1505/1507, 1401/1507, 1401/1511/1512, 1401/1511/1514, 1401/1512/1513, and 1401/1513/1514 can also be equipped with CAN FD modules to support the CAN with Flexible Data-Rate (CAN FD) protocol.

**Where to go from here**

Information in this section



# General Information on CAN Bus Termination

**Where to go from here**

Information in this section

# Basics on CAN Bus Termination

**Objective**

A CAN bus must be terminated with an impedance to minimize signal reflection on the bus. It is recommended to terminate the beginning and the end of the bus. ISO-11898 requires that the CAN bus have a nominal characteristic line impedance of 120 Ω. So each end of the bus must be terminated with a 120 Ω resistor. MicroAutoBox II 1401/1511, 1401/1511/1512, and 1401/1511/1514 support two different termination methods located on the DS1511 I/O Board.

> **Note**
>
> The MicroAutoBox II 1401/1513, 1401/1512/1513, and 1401/1513/1514 provide a split termination. The CAN bus termination resistors are switchable by software. For further information, refer to *Setup Page (RTICANMM ControllerSetup)* (*RTI CAN MultiMessage Blockset Reference*) or *Unit Page (RTICAN CONTROLLER SETUP)* (*RTI CAN Reference*).

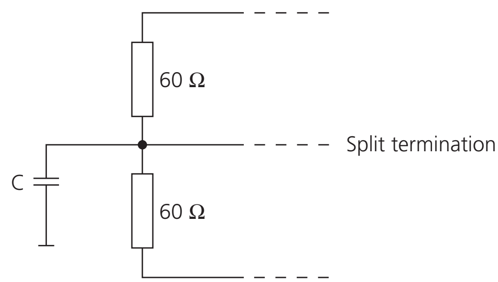
For all other MicroAutoBox variants, you have to terminate your CAN bus externally.

**Standard termination**

The standard termination uses a single 120 Ω resistor at each end of the bus. This method is used in many CAN systems.


**Split termination**

Emission reduction can be achieved with split termination. In contrast to the standard termination, the split termination splits the single 120 Ω resistor into two 60 Ω resistors, with a bypass capacitor tied between the resistors and to ground.




**Related topics**

HowTos

- *How to Terminate the CAN Bus* on page 124

## How to Terminate the CAN Bus

**Objective**

MicroAutoBox II 1401/1511, 1401/1511/1512, and 1401/1511/1514 provide solder pads for CAN bus termination resistors. These resistors are not equipped by default. If you need to terminate the CAN bus MicroAutoBox is connected to, you can easily solder resistors to the hardware.

> **Note**
>
> The MicroAutoBox II 1401/1513, 1401/1512/1513, and 1401/1513/1514 provide a split termination. The CAN bus termination resistors are switchable by software. For further information, refer to *Setup Page (RTICANMM ControllerSetup)* (📖 *RTI CAN MultiMessage Blockset Reference*) or *Unit Page (RTICAN CONTROLLER SETUP)* (📖 *RTI CAN Reference*).

**Possible methods**

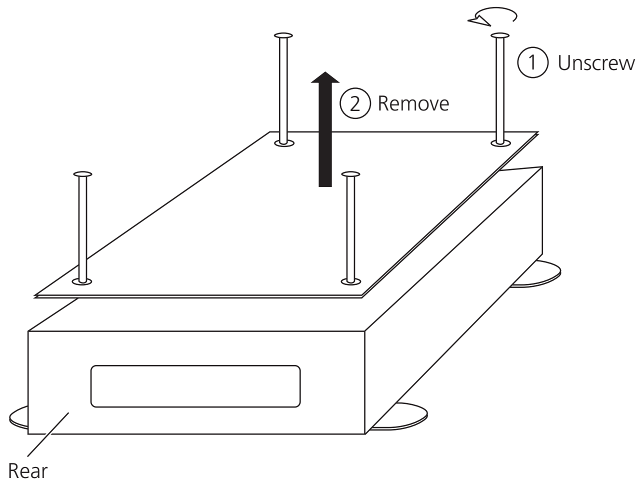
The configuration varies according to the MicroAutoBox variant.

- For MicroAutoBox II 1401/1511, you can add termination resistors internally. The capacitor for split termination is already soldered on the DS1511. Refer to Method 1.
- For MicroAutoBox II 1401/1511/1512 and 1401/1511/1514, you can add termination resistors internally. You have to uninstall either the DS1512 or the DS1514 before. The capacitor for split termination is already soldered on the DS1511. Refer to Method 2.

**Method 1**

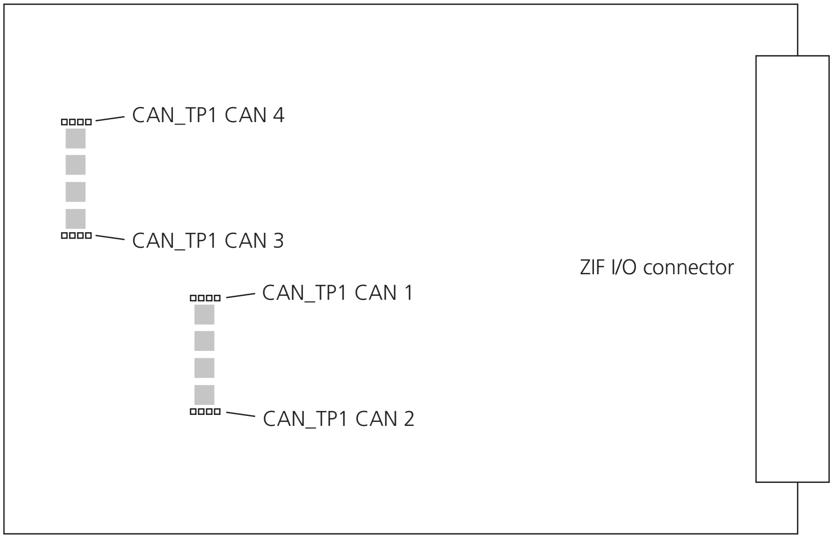
**To set termination resistors on MicroAutoBox II 1401/1511**

1 Disconnect MicroAutoBox from the power supply.

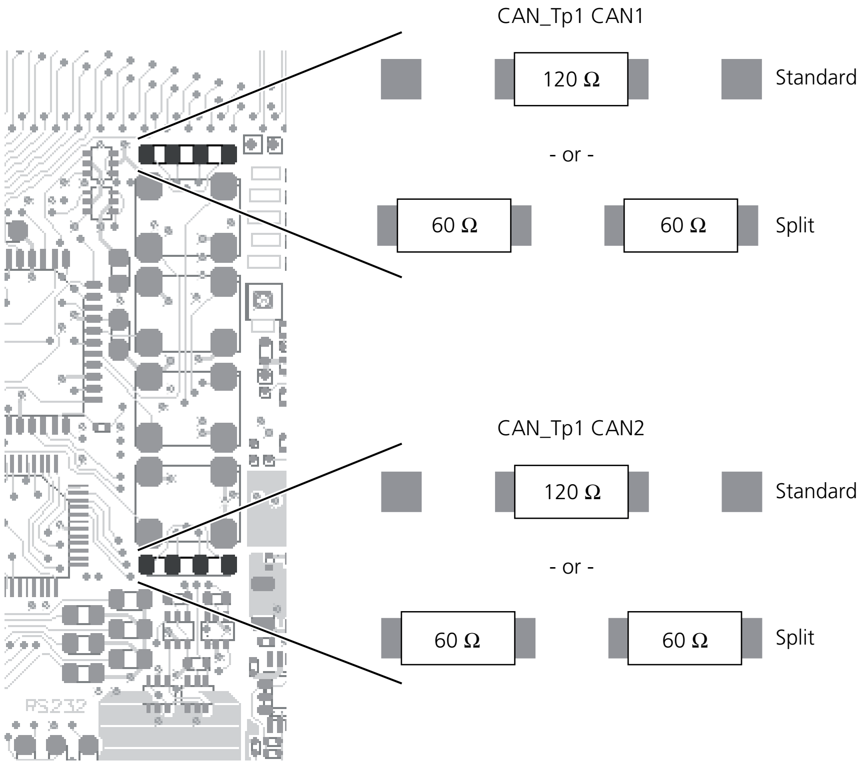


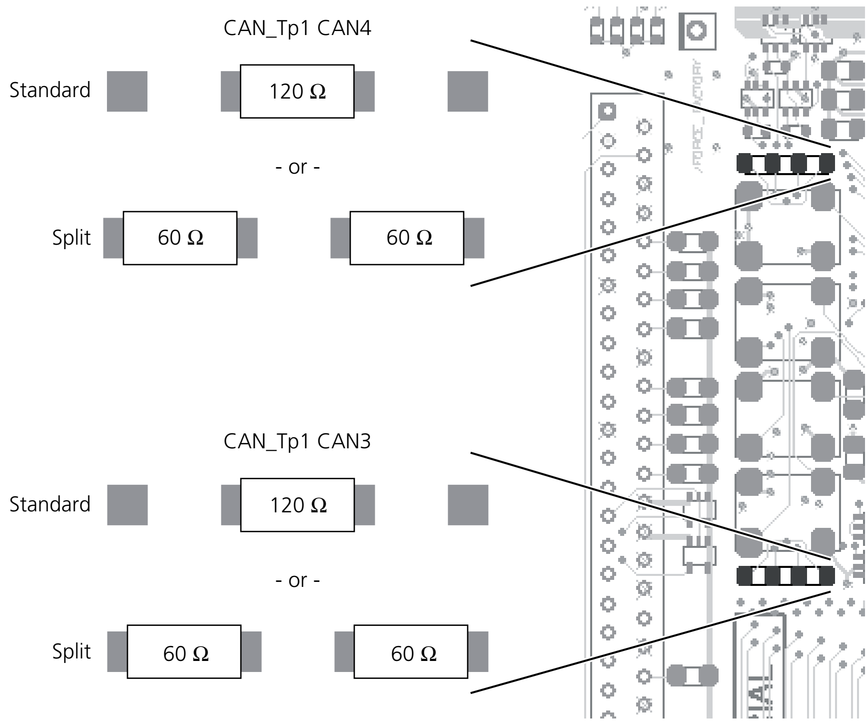

2 Unbolt the screws of the cover with a 2.5 mm hexagon socket wrench and remove the cover.

3 The two CAN_TP1 modules are on the top.



**4** Solder 0805 SMD resistors as termination.






**5** Mount the cover of the MicroAutoBox.

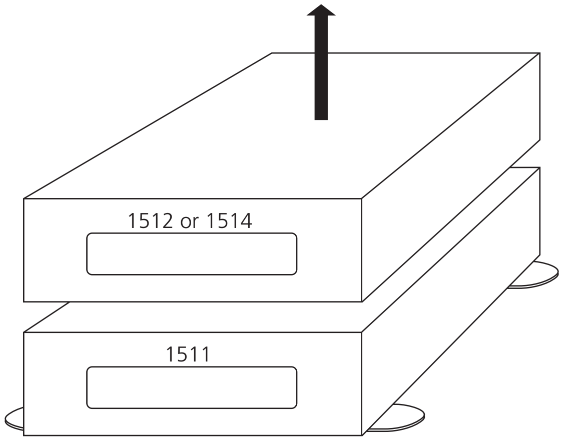
**Method 2**

**To set termination resistors on MicroAutoBox II 1401/1511/1512 and 1401/1511/1514**

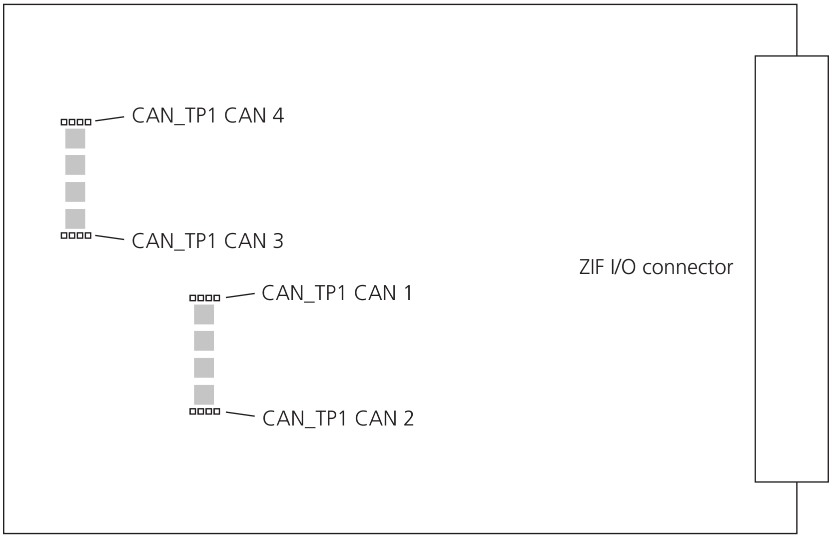
**1** Disconnect MicroAutoBox from the power supply.

**2** Unbolt the screws of the cover with a 2.5 mm hexagon socket wrench and remove the cover.

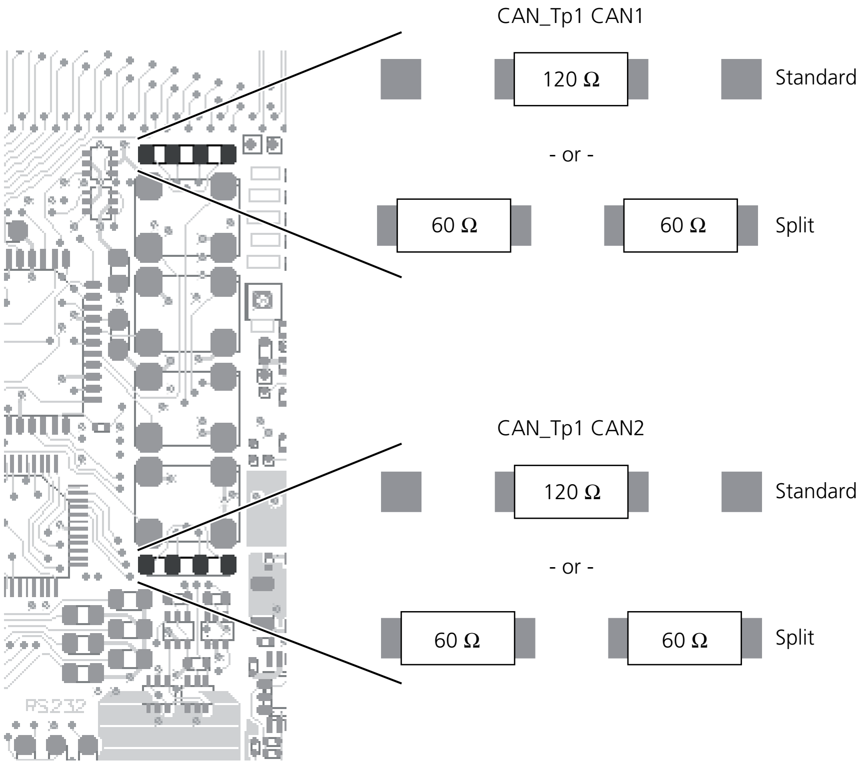
**3** Remove the upper unit of the MicroAutoBox (DS1512 or DS1514).

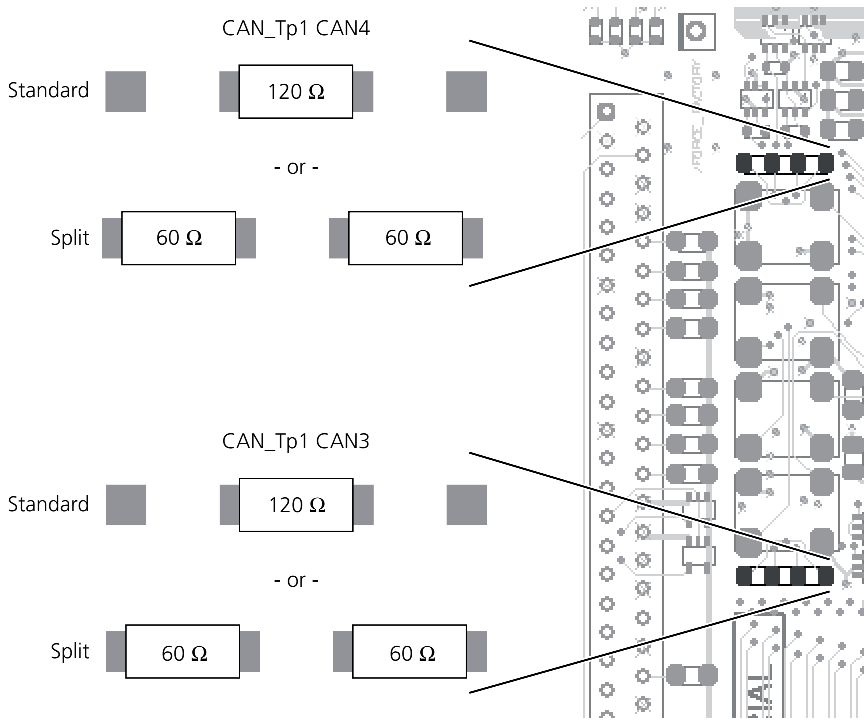



**4** The solder pads of the two CAN_TP1 modules are on the top of the DS1511.



**5** Solder 0805 SMD resistors as termination.






6 Install the removed unit (DS1512 or DS1514).

7 Mount the cover of the MicroAutoBox.

**Related topics**

Basics

- *Basics on CAN Bus Termination* on page 123

# General Information on CAN FD Modules

## Supported CAN FD Modules

**Objective**

This topic provides information on which MicroAutoBox variants are supported and which CAN FD modules can be used.

| | |
|---|---|
| **MicroAutoBox variants** | CAN FD modules can only be installed in<br>■ MicroAutoBox II 1401/1505/1507<br>■ MicroAutoBox II 1401/1507<br>■ MicroAutoBox II 1401/1511/1512<br>■ MicroAutoBox II 1401/1511/1514<br>■ MicroAutoBox II 1401/1512/1513<br>■ MicroAutoBox II 1401/1513/1514 |
| **CAN FD modules** | The following CAN FD modules can be installed in MicroAutoBox and are supported by dSPACE implementation software:<br>■ DS4342 CAN FD Interface Module |
| **Software support** | The RTI CAN MultiMessage Blockset supports the CAN FD modules listed above. |
| **Related topics** | Basics<br>• *Using DS4342 Modules* on page 133 |

# CAN Partial Networking with the DS1513 I/O Board of MicroAutoBox

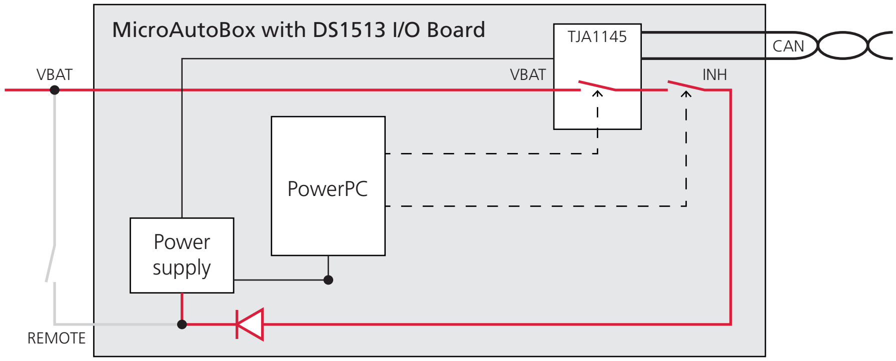
## How to Configure MicroAutoBox with the DS1513 I/O Board for CAN Partial Networking

| | |
|---|---|
| **Objective** | You can configure MicroAutoBox II 1401/1513, 1401/1512/1513 and 1401/1513/1514 to be woken up by CAN partial networking wake-up messages. |
| **Basics on the wake-up functionality** | Each CAN channel is equipped with a TJA1145T/FD transceiver supporting ISO 11898-6 compliant CAN partial networking. For detailed information on the TJA1145T/FD transceiver, refer to the TJA1145T/FD data sheet (at http://www.nxp.com). |

Partial networking lets you activate nodes in a CAN network selectively in response to dedicated CAN partial networking wake-up messages. Only required nodes are active on the CAN bus, while the other nodes remain in a sleep mode until they are needed.

Via a real-time application, MicroAutoBox II with DS1513 I/O Board can switch the transceiver into sleep mode and configure it to monitor the CAN bus for a wake-up request. Each transceiver has an internal inhibit pin (INH) to wake up MicroAutoBox. When a transceiver detects a wake-up message on the CAN bus, its inhibit pin is set to VBAT voltage level to wake up MicroAutoBox.

To use the wake-up functionality with the DS1513 I/O Board, the REMOTE input of MicroAutoBox must be disconnected from VBAT (see the following schematic).




The states of the internal switches and the transceiver configuration are kept as long as the VBAT voltage is connected to the transceiver(s).

**Method**

**To configure MicroAutoBox with DS1513 I/O Board for CAN partial networking**

1. The REMOTE input (KL15) of MicroAutoBox must be disconnected from VBAT.
2. The pins to be connected depend on the selected inhibit signal and module slot.
   - Connect the battery voltage to the VBAT pins of the power input connector.
   - Connect the battery ground to the GND pin of the power input connector.
   - Connect the CAN bus to the ZIF I/O connector (DS1513).

**Note**

The VBAT, GND and REMOTE pins are also located on the ZIF I/O connector. However, it is recommended to use the pins only on the power input connector. Do not use the pins on the power input connector and on the ZIF I/O connector at the same time.

**Tip**

For general information on connecting MicroAutoBox, refer to *Building the Power and I/O Connections* on page 43.

For information on the pinouts, refer to

- MicroAutoBox II 1401/1513: *Connector Pinouts* on page 514
- MicroAutoBox II 1401/1512/1513: *Connector Pinouts* on page 475
- MicroAutoBox II 1401/1513/1514: *Connector Pinouts* on page 551

**Result**

When a wake-up message is detected on the selected CAN channel, MicroAutoBox starts.

# Using DS4342 Modules

**Objective**

DS4342 CAN FD Interface Modules are CAN communication modules that support the CAN with Flexible Data-Rate (CAN FD) protocol.

Up to two DS4342 CAN FD Interface Modules can be installed in MicroAutoBox II 1401/1505/1507, 1401/1507, 1401/1511/1512, 1401/1511/1514, 1401/1512/1513, and 1401/1513/1514.

**Where to go from here**

Information in this section

## Basics on DS4342 CAN FD Interface Modules

**Objective**

Basic information on the DS4342's features, bus termination, feed-through lines, and connecting the bus lines is given below.

**Features of DS4342 modules**

DS4342 CAN FD Interface Modules are CAN communication modules that support the CAN with Flexible Data-Rate (CAN FD) protocol. A DS4342 module provides two CAN channels with the following features for each CAN channel:

- A CAN FD communication controller
- A physical layer interface with a TJA1145T/FD transceiver compliant to ISO11898-6 (partial networking)
- Feed-through wiring for CAN bus signals
- Switchable software-controlled termination circuit
- Transceiver inhibit signals on the I/O connector in order to power up a MicroAutoBox via the CAN bus

DS4342 modules are supported by the RTI CAN MultiMessage Blockset.

**Bus termination**

You can terminate the bus lines if the channels of the DS4342 module are connected at the end of the CAN bus. The termination is switched via software in the RTICANMM ControllerSetup block, refer to *Setup Page (RTICANMM ControllerSetup)* (📖 *RTI CAN*

*MultiMessage Blockset Reference*). For a detailed description of bus termination, refer to *DS4342 Connections in Different Topologies* on page 136.

**Feed-through lines**

If the DS4342 is not connected at an end of the CAN bus, but connected to a linear passive bus, you can use the feed-through bus lines to keep the stub length as short as possible. This improves the EMC robustness and signal integrity, especially in a topology consisting of many nodes and long distances between the splices or ECUs. For details, refer to *DS4342 Connections in Different Topologies* on page 136.

**Pinout, pin description**

If DS4342 modules are installed in MicroAutoBox, all their pins for the bus lines are connected to the I/O connector on the rear side (Sub-D or ZIF).

For details on the signals and pinouts, refer to *Data Sheet DS4342 CAN FD Interface Module* on page 639.

**Related topics**

Basics

- *Installing and Uninstalling IP Modules* on page 204

# DS4342 Module Overview and Connector Pinouts

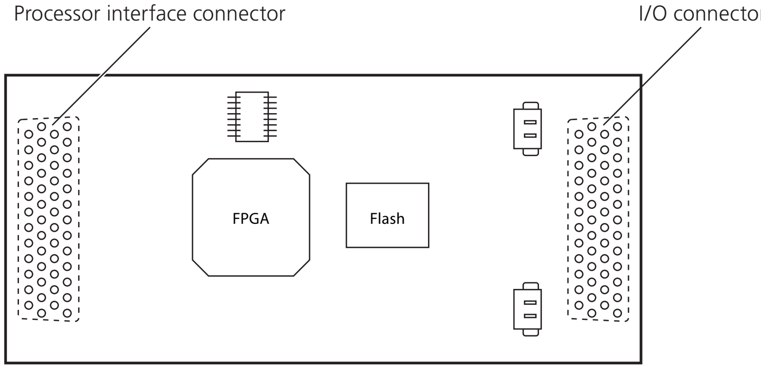
**Objective**

A DS4342 CAN FD Interface Module provides two 50-pin connectors for connecting a real-time processor to a CAN bus.

Each CAN (FD) channel has a CAN high (CANH), CAN low (CANL), ground (GND) and inhibit (INH) pin. To reduce the stub length, each CAN channel also provides a CAN high feedthrough (CANH_FT) and CAN low feedthrough (CANL_FT) pin.

**Overview illustration**

The illustration shows where the connectors are located on the module. The illustration is not to scale.




**Components**

The DS4342 CAN FD Interface Module has the following connectors:

- *Processor interface connector* for connecting the DS4342 module to the DS1507, DS1512, or DS1514 I/O Board of MicroAutoBox. The processor interface connector provides the signals for the real-time processor.
- *I/O connector* for connecting the DS4342 module to the DS1507, DS1512, or DS1514 I/O Board of MicroAutoBox. The I/O connector provides the signals that are routed to the I/O connector on the rear side of the MicroAutoBox.

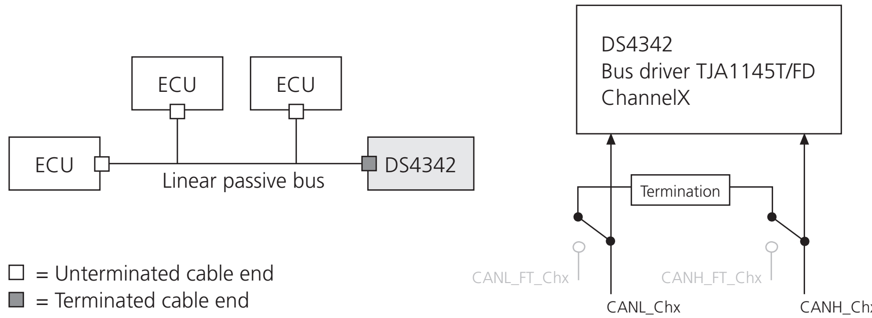
## DS4342 Connections in Different Topologies

**Objective**

You can terminate bus lines of the DS4342 CAN FD Interface Module or use them unterminated. You can use feed-through pins to shorten the stub length if the DS4342 is used in a linear passive bus. This topic gives you information on the bus topology and termination. You can configure the termination in the RTICANMM ControllerSetup block.

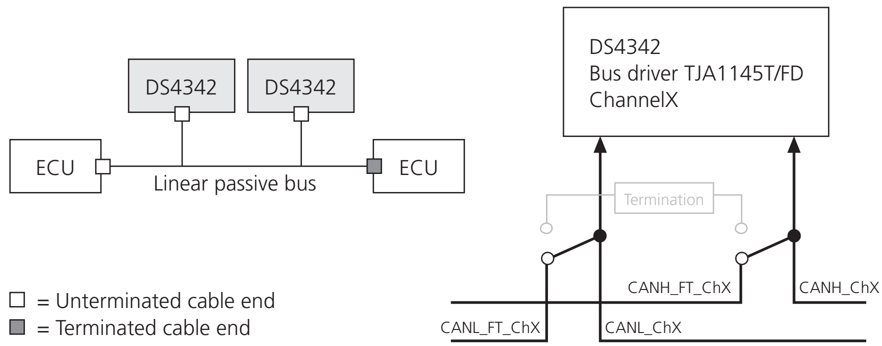
**Terminated cable end without feed-through**

If the DS4342 is connected at an end of the CAN bus, its bus lines must be terminated. The termination resistor is activated via software (see above).




**Unterminated cable end with feed-through**

If a DS4342 is connected at a linear passive bus, you can connect the feed-through bus lines to keep the stub length as short as possible. This improves the EMC robustness and bus signal integrity, especially in a topology consisting of many nodes and long distances between the splices or ECUs.



# Example of Connecting One DS4342 Module to a CAN Bus

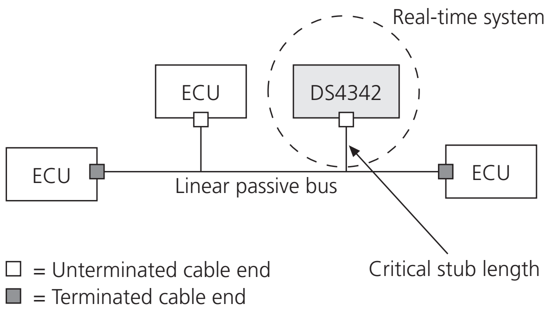
**Objective**

This example shows how one DS4342 module of MicroAutoBox can be connected to a linear CAN bus. The DS4342 module is not connected at the end of the bus. The termination resistor is therefore not activated.

> **Note**
>
> To keep the stub length as short as possible, the feed-through bus lines are used.

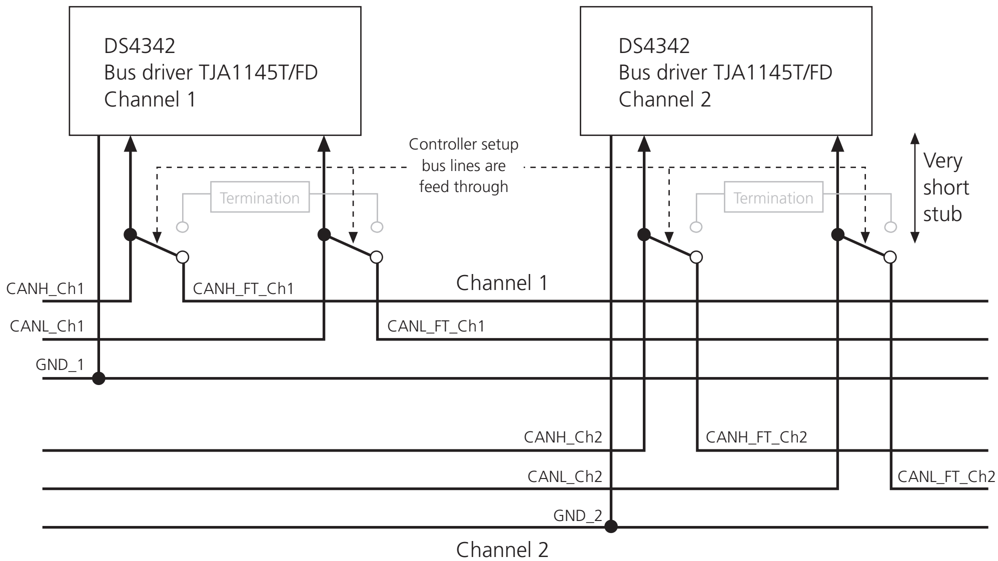
**Topology**

The following illustration shows the network that the DS4342 module of MicroAutoBox is connected to.




**Circuit**

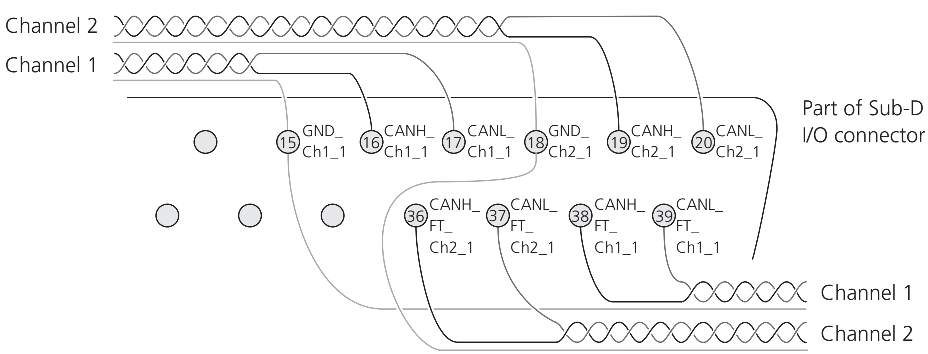
The following illustration shows the connection of the CAN high bus lines and CAN low bus lines. The incoming bus lines are connected to the CANH_Ch1 and CANL_Ch1 pins (CANH_Ch2 and CANL_Ch2, respectively). The outgoing bus lines are connected to the feed-through pins CANH_FT_Ch1 and CANL_FT_Ch1 (CANH_FT_Ch2 and CANL_FT_Ch2, respectively). The incoming and outgoing bus lines are connected directly on the DS4342 module, which results in a very short stub length from the connection to the transceiver. The switch for the connection is set via software (see *RTICANMM ControllerSetup* (📖 *RTI CAN MultiMessage Blockset Reference*)).



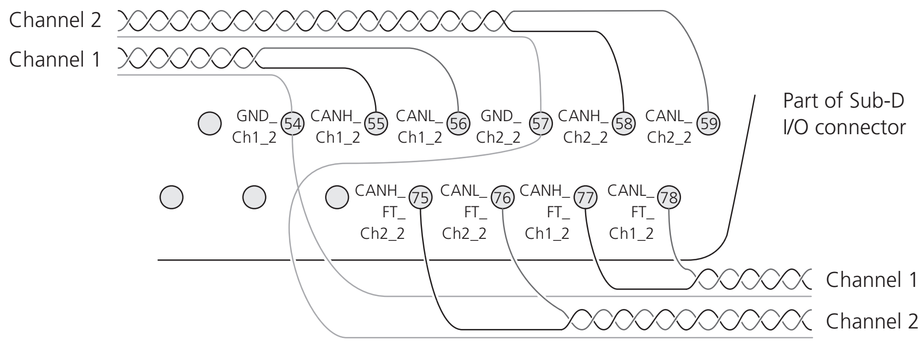

**Sub-D I/O connector**

MicroAutoBox II 1401/1505/1507 and 1401/1507 provide the CAN signals on a Sub-D connector.

**DS4342 installed in slot 1** The following illustration shows a part of the Sub-D I/O connector with the connected bus lines if the DS4342 is installed in slot 1.



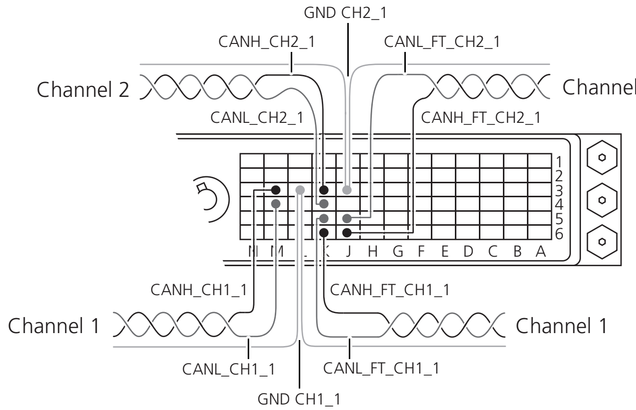
**DS4342 installed in slot 2** The following illustration shows a part of the Sub-D I/O connector with the connected bus lines if the DS4342 is installed in slot 2.



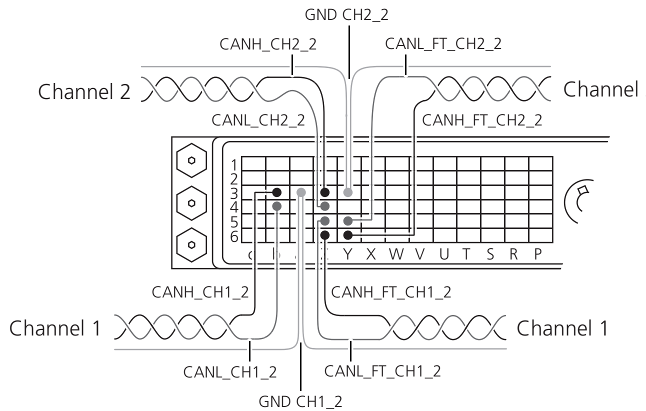

**ZIF I/O connector**

MicroAutoBox II 1401/1511/1512 and MicroAutoBox II 1401/1512/1513 provide the CAN signals on the DS1512 ZIF I/O connector. MicroAutoBox II 1401/1511/1514 and MicroAutoBox II 1401/1513/1514 provide the CAN signals on the DS1514 ZIF I/O connector.

**DS4342 installed in slot 1** The following illustration shows a part of the ZIF I/O connector with the connected bus lines if the DS4342 is installed in slot 1.



**DS4342 installed in slot 2** The following illustration shows a part of the ZIF I/O connector with the connected bus lines if the DS4342 is installed in slot 2.




# How to Configure MicroAutoBox and a DS4342 for CAN Partial Networking

| | |
|---|---|
| **Objective** | You can configure MicroAutoBox that is equipped with a DS4342 module to be woken up by CAN partial networking wake-up messages. |

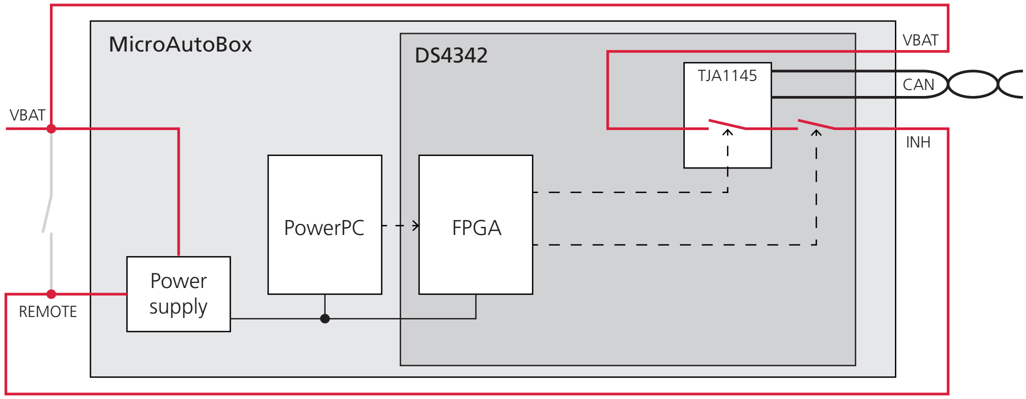
**Basics on the wake-up functionality of the DS4342**

Each CAN channel of a DS4342 CAN FD Interface Module is equipped with a TJA1145T/FD transceiver supporting ISO 11898-6 compliant CAN partial networking. For detailed information on the TJA1145T/FD transceiver, refer to the TJA1145T/FD data sheet (at http://www.nxp.com).

Partial networking lets you activate nodes in a CAN network selectively in response to dedicated CAN partial networking wake-up messages. Only required nodes are active on the CAN bus, while the other nodes remain in a sleep mode until they are needed.

Via a real-time application, MicroAutoBox can switch the transceiver into sleep mode and configure it to monitor the CAN bus for a wake-up request. Each transceiver provides an inhibit pin (INH) to wake up MicroAutoBox. When a transceiver detects a wake-up message on the CAN bus, its inhibit pin is set to VBAT voltage level to wake up MicroAutoBox.

To use the wake-up functionality of the DS4342 CAN FD Interface Module, you must prepare the wiring of the IP module and MicroAutoBox. The REMOTE input of MicroAutoBox must be disconnected from VBAT and connected to at least one of the INH pins to wake up the MicroAutoBox if a wake-up message was received (see the following schematic).




The states of the internal switches and the transceiver configuration are kept as long as the VBAT voltage is connected to the transceiver(s).

**Valid only for MicroAutoBox II 1401/1507**

**NOTICE**

**Do not configure IP modules that are installed in MicroAutoBox II 1401/1507 yourself. You might destroy parts of MicroAutoBox.**

All modules that are installed in MicroAutoBox II 1401/1507 must be configured by dSPACE. The assembling positions of the DS1401 Base Board and the DS1507 I/O Board in the MicroAutoBox housing do not allow direct access to the IP slots of the DS1507.

**Method**

**To configure MicroAutoBox and a DS4342 for CAN partial networking**

1 The REMOTE input (KL15) of MicroAutoBox must be disconnected from VBAT.

2 The pins to be connected depend on the selected inhibit signal and IP module slot.

- Connect the inhibit pin(s) of the Sub-D I/O connector (DS1507) or the ZIF I/O connector (DS1512 or DS1514) to the REMOTE pin of the power input connector.
- Connect the battery voltage to the VBAT pins of the power input connector.
- Connect the battery ground to the GND pin of the power input connector.
- Connect the CAN bus to the Sub-D I/O connector (DS1507) or the ZIF I/O connector (DS1512 or DS1514).
- Connect the battery voltage to the VBAT inputs of the DS4342 module.

**Note**

The VBAT, GND and REMOTE pins are also located on the ZIF I/O connector. However, it is recommended to use the pins only on the power input connector. Do not use the pins on the power input connector and on the ZIF I/O connector at the same time.

**Tip**

For general information on connecting MicroAutoBox, refer to *Building the Power and I/O Connections* on page 43.

For information on the pinouts, refer to


- MicroAutoBox II 1401/1505/1507: *Connector Pinouts* on page 291
- MicroAutoBox II 1401/1507: *Connector Pinouts* on page 331
- MicroAutoBox II 1401/1511/1512: *Connector Pinouts* on page 387
- MicroAutoBox II 1401/1511/1514: *Connector Pinouts* on page 431
- MicroAutoBox II 1401/1512/1513: *Connector Pinouts* on page 475
- MicroAutoBox II 1401/1513/1514: *Connector Pinouts* on page 551

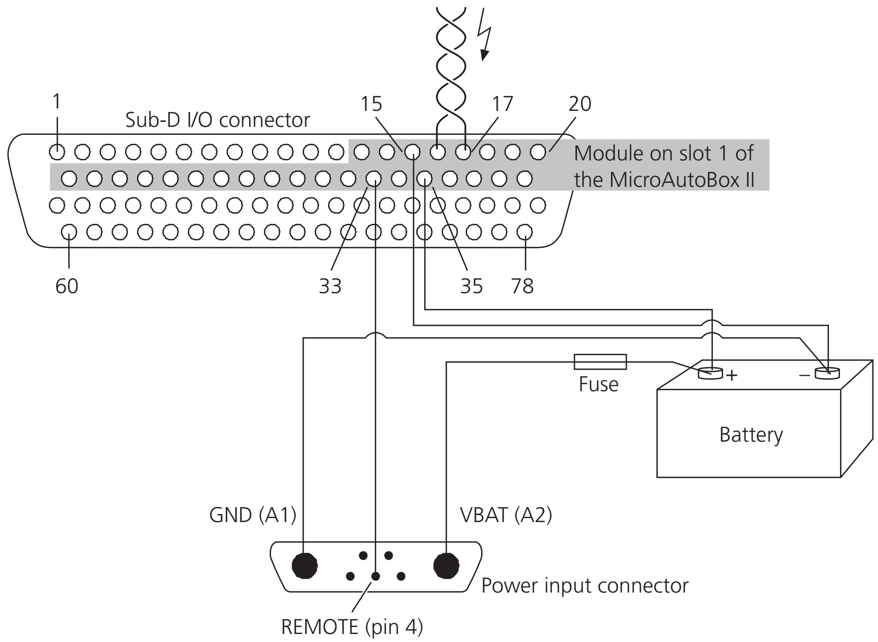
**Result**

When a wake-up message is detected on the selected CAN channel, MicroAutoBox starts.

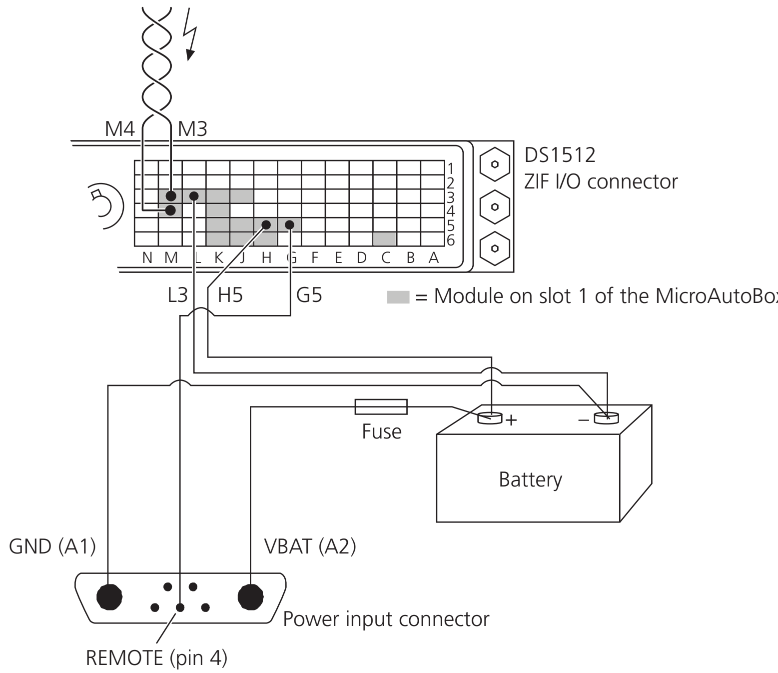
**Examples**

The following illustrations show examples of how MicroAutoBox can be connected to a CAN bus. In these examples, CAN channel 1 of the module in slot 1 is used for waking up. The inhibit signal INH1_1 (Sub-D pin 33)(1401/1511/1512, 1401/1511/1514, 1401/1512/1513, and 1401/1513/1514: ZIF pin G5) is connected to the REMOTE pin.

**Example 1 - for MicroAutoBox II 1401/1507 and MicroAutoBox II 1401/1505/1507**



**Example 2 - for MicroAutoBox II 1401/1511/1512, 1401/1511/1514, 1401/1512/1513, and 1401/1513/1514**



# MicroAutoBox in Use

**Objective**

Before working with MicroAutoBox in a vehicle you should put the system into operation in your laboratory to configure the dSPACE system and to get started with MicroAutoBox loading applications to the system.

**Where to go from here**

Information in this section



## Identifying Operation States of MicroAutoBox

**Objective**

MicroAutoBox provides LEDs to show you different states and potential malfunctions.

**Precondition**

To set MicroAutoBox into operation for the first time in your laboratory you have to connect the box to the power supply. For information, refer to *Basics on Connecting to Power Supply* on page 44.

**Status LED**

If battery power is switched on and the REMOTE signal/KL15 is activated (see *Basics on Connecting to Power Supply* on page 44), the status LED shows different states indicated by the LED color:

**LED is red** Reset state and no application is downloaded to the real-time processor.

**LED is green** Application is running.

**LED flashes red** MicroAutoBox is in secured mode. For further details, refer to *Checking MicroAutoBox* on page 672.

## How to Set the System Time on MicroAutoBox

**Objective**

Since flight recorder data has time stamps, it is recommended to have the same system time on both MicroAutoBox and the host PC.

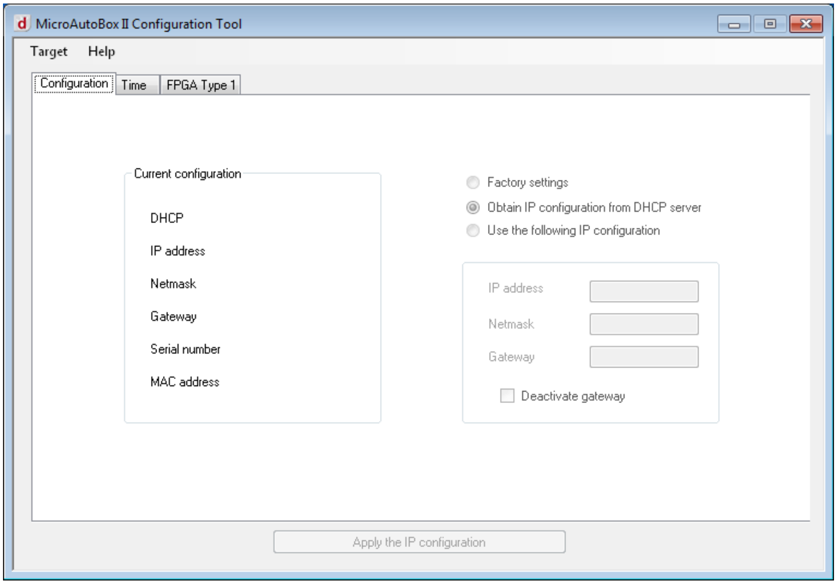
**Method**

**To set the system time on MicroAutoBox**

1 On the Start menu of Windows, select dSPACE RCP and HIL <Version> — Command Prompt for dSPACE RCP and HIL <Version>.

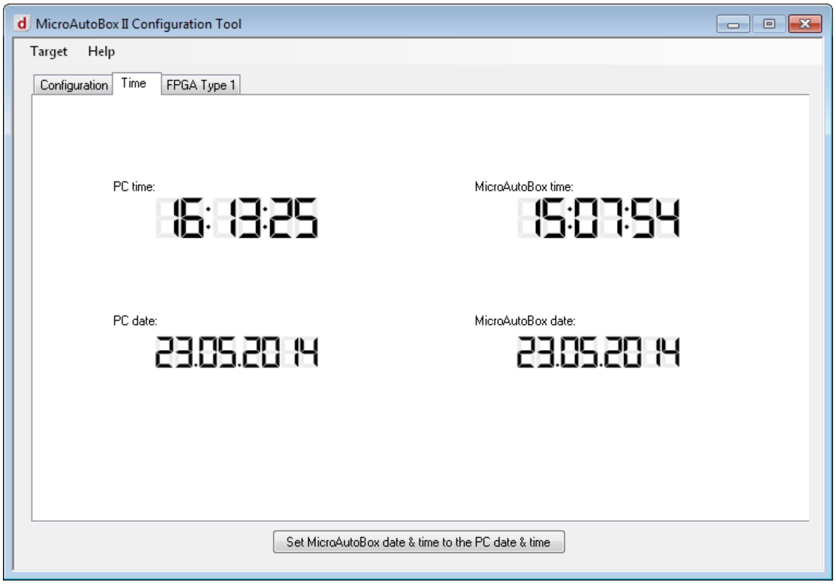
A Command Prompt window opens.

2 Enter **`ds1401configgui.exe`** to open the MicroAutoBox II Configuration Tool.




3 Choose Target — Show all MicroAutoBox II units, select your MicroAutoBox an click Connect.

4 Choose the Time page and click Set MicroAutoBox date & time to the PC date & time.




**Result**

The time and the date of your host PC and the MicroAutoBox are synchronized.

# Notes and Tips on Working with MicroAutoBox in a Vehicle

**Objective**

MicroAutoBox operates as a stand-alone system in a vehicle. You have to download the control model to the flash memory of MicroAutoBox.

**Safety precautions**

**WARNING**

**Even a brief disconnection of the battery while the engine is running results in a load dump of the car generator, producing hazardous voltages of more than 100 V.**

- Turn off the engine while connecting or disconnecting the car battery.

**Example of a working strategy**

The following list shows one of several strategies for working with MicroAutoBox in a vehicle.

- Prepare your application as usual on your PC in a laboratory. You may integrate the flight recorder function for data acquisition.
- Connect MicroAutoBox to the host PC, load the application to the global memory of MicroAutoBox, and use ControlDesk to check the application.
- Load the application to the flash memory of MicroAutoBox. Thus, the application will be started automatically on power-up.
- Install MicroAutoBox in the vehicle, connect MicroAutoBox to the power supply and to the I/O signals.

  Connect MicroAutoBox as described in *Basics on Connecting to Power Supply* on page 44 to start MicroAutoBox when starting the engine.
- Perform the tests with the vehicle: MicroAutoBox operates automatically and the flight recorder will collect the data.

**Using the host interface**

Best practices concerning the host interface of MicroAutoBox are described below.

**Host PC on company LAN - MicroAutoBox on Peer-to-peer** If you need to be connected to your company LAN with your host PC and you want to work with MicroAutoBox at the same time, it is recommended to install a second network adapter or to use a USB Ethernet adapter so you do not need to reconfigure the network connection settings of your PC.

**Moving MicroAutoBox from company LAN to the vehicle** If you move the MicroAutoBox from the company LAN to the vehicle you must reconfigure MicroAutoBox's Ethernet settings. This is because in most cases MicroAutoBox is connected to your portable PC in the vehicle peer-to-peer.

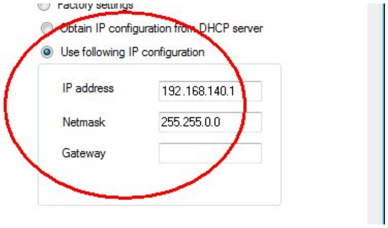
The easiest method is to reconfigure the MicroAutoBox while it is connected to your company LAN.

Use the MicroAutoBox II Configuration Tool.

Execute the **`ds1401configgui.exe`** to open the MicroAutoBox II Configuration Tool. It is located in `<RCP_HIL_InstallationPath>\Exe`.

Choose Target — Connect to MicroAutoBox II and enter either the current IP address or the serial number and the MAC address in the Connect to MicroAutoBox II window shown below and click Connect.

Choose Use the following IP configuration, change the settings in IP address and Netmask as shown in the illustration below and click Apply the IP configuration.




After this you can power off the MicroAutoBox and install it in the vehicle.

You have to restart MicroAutoBox so that the changes become effective.

**Moving MicroAutoBox from the vehicle to company LAN** To move the MicroAutoBox from the vehicle back to the company LAN, it is recommended to first activate the DHCP client on the MicroAutoBox.

Execute the **`ds1401configgui.exe`** to open the MicroAutoBox II Configuration Tool. It is located in `<RCP_HIL_InstallationPath>\Exe`.

Choose Target — Connect to MicroAutoBox II and enter either the current IP address or the serial number and the MAC address in the Connect to MicroAutoBox II window shown below and click Connect.

Choose Obtain IP configuration from DHCP server as shown in the illustration below and click Apply the IP configuration.


Then you are ready to work with MicroAutoBox on your company LAN.

You have to restart MicroAutoBox so that the changes become effective.

**Related topics**

HowTos

- *How to Change the IP Address of MicroAutoBox* on page 68
- *How to Get an IP Address from a DHCP Server* on page 71

# Notes on Updating the Firmware

**Objective**

After updating the firmware of MicroAutoBox (especially the System PLD, Host IF, Host IF PLD, ADC Type 4, FPGA Type 1, DIO Type 3, DIO Type 4, and AIO Type 1 firmware), you have to turn off MicroAutoBox. After a restart the firmware changes take effect.

For details on updating the firmware, refer to 🕮 *Firmware Manager Document*.

# How to Physically Combine RapidPro and MicroAutoBox

**Objective**

The following instructions show you how to use the dSPACE joining plates on the example of a two-unit RapidPro stack and a MicroAutoBox II 1401/1511.

**Preconditions**

Before doing any installation work, make sure that:

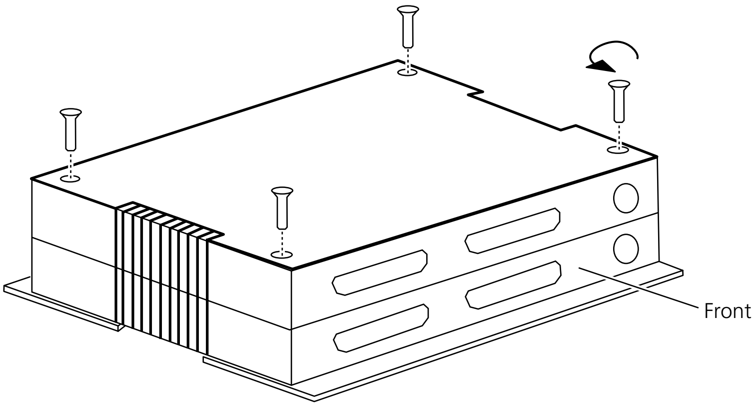
- The RapidPro system and MicroAutoBox are disconnected from the power supply.
- No external devices are connected to the RapidPro system and MicroAutoBox.
- You have all the items in the table below:

| Items | Count | Description |
|---|---|---|
| Hexagon socket wrench | 1 | 2.5 mm |
| Hexagon socket countersunk screw | 4 | To mount the joining plates on the cover of the RapidPro stack.<br>M4 X 18 mm |
| Phillips screwdriver | 1 | PH0 |
| Phillips screw | 4 | To attach MicroAutoBox to the RapidPro stack.<br>M5 X 10 mm |
| Spring lock washer | 4 | M5 |
| Joining plate | 2 | — |

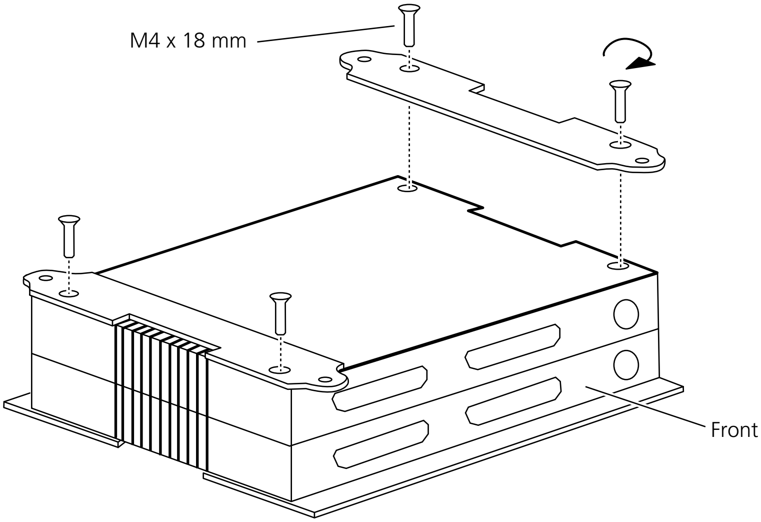
**Method**

### How to physically combine RapidPro and MicroAutoBox

1 Remove the cover screws of the RapidPro with a hexagon socket wrench.



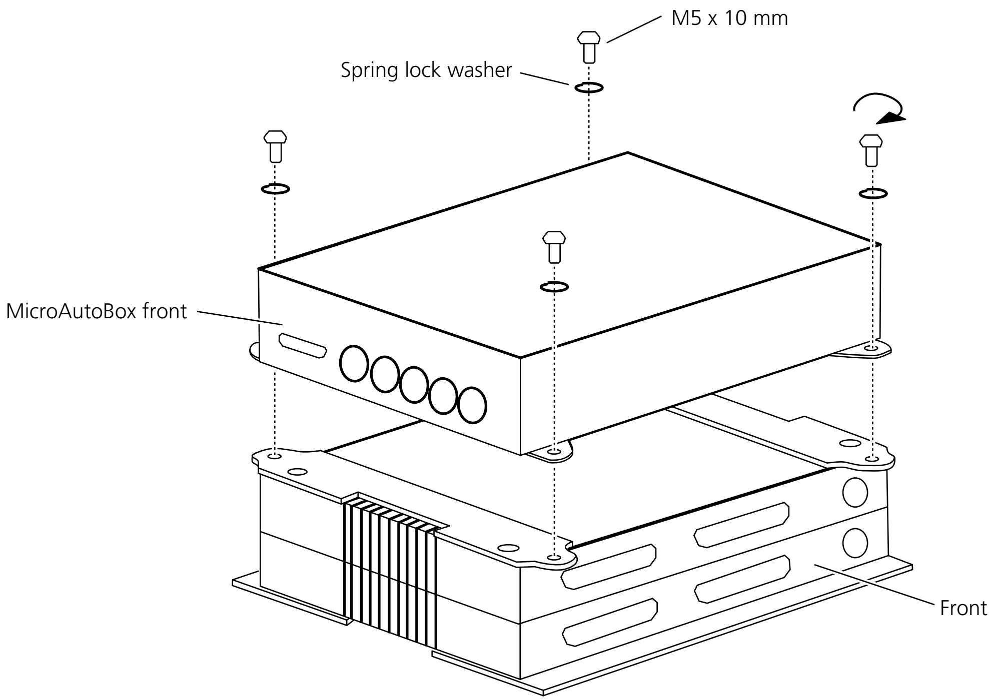

2 Mount the joining plates with the M4 X 18 mm hexagon socket countersunk screws on the top of the RapidPro stack.




**Note**

- The countersunks of the joining plates must point up.
- The gap of each joining plate must point outwards to avoid covering up the RapidPro's cooling ribs.

3 Fasten MicroAutoBox with the Phillips screws and the spring lock washers.




**Result**

MicroAutoBox and RapidPro stack are now physically connected as one unit.

**NOTICE**

The vibration and shock certifications listed in the data sheets of both products are not valid when the products are combined with the joining plates.

If the unit of MicroAutoBox and RapidPro stack is used under the constraint of vibration and shock load, you have to ensure a suitable mechanical locking of the unit to the place of installation.

If you mount the unit of MicroAutoBox and RapidPro stack in a vehicle, note the changed weight and chassis dimensions.

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.

# In-Vehicle Installation

## How to Mount MicroAutoBox in a Vehicle

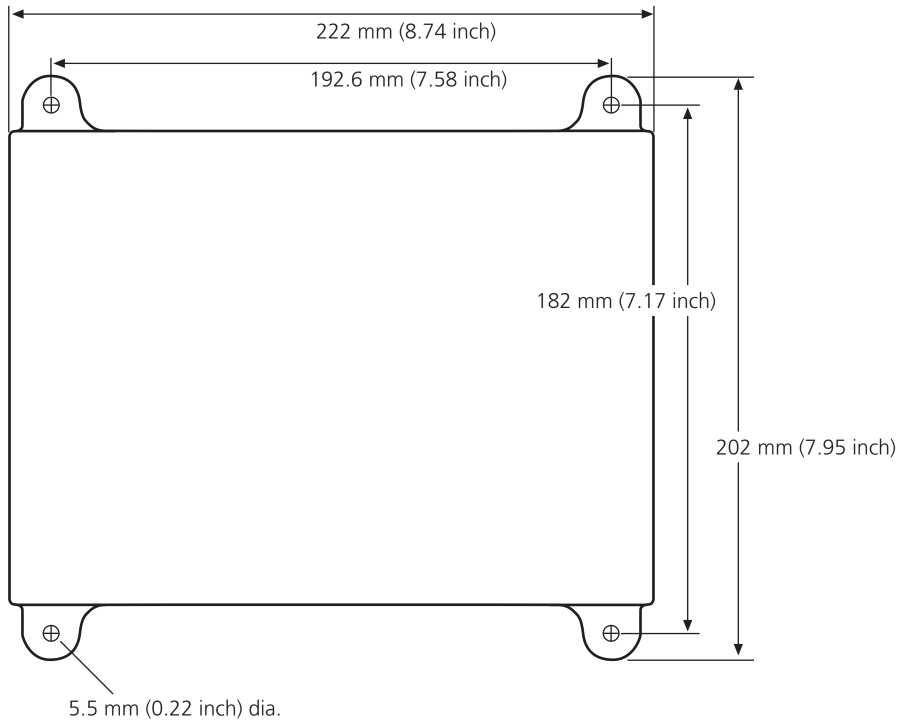
**Method**

**To mount MicroAutoBox in a vehicle**

1. Determine the place where you want to mount MicroAutoBox and clean the surface.
2. Use the following illustration to determine the positions of the bolts.

   **Note**

   The illustration is not to scale.




**3** Drill the four holes and prepare four threads.

Use four bolts – M5 is recommended – to fasten MicroAutoBox to the vehicle.

**Related topics**

Basics

- *Safety Precautions for Installing and Connecting the Hardware* on page 22

# Using MicroAutoBox Embedded PC

**Objective**

You can extend your MicroAutoBox system with the MicroAutoBox Embedded PC to use devices such as video cameras or human-machine interfaces (HMI) with your real-time system. The Embedded PC is mounted under MicroAutoBox to form a single, integrated unit. The connections for power input and data exchange are internal.

**Variants**

The MicroAutoBox Embedded PC is available with different CPUs:

- Intel® Atom™ Processor N270
- Intel® Core™ i7-3517UE Processor

Furthermore the variants differ in some technical details (USB, CFast slot, fan, etc.).

**Installation of dSPACE software**

**Note**

- To avoid data loss, back up the data of the MicroAutoBox Embedded PC periodically.
- Before installing software on the MicroAutoBox Embedded PC:
  - Stop the application on the MicroAutoBox and disconnect all I/O wiring from the system (LEMO, ZIF, Sub-D connectors).
- Contact your network administrator if you want to connect the MicroAutoBox Embedded PC to a company LAN.

You can install dSPACE software, such as ControlDesk, on the MicroAutoBox Embedded PC. For further information on the compatibility of dSPACE software and Microsoft operating systems and detailed instructions, refer to the *Software Installation and Management Guide*.

# MicroAutoBox Embedded PC

**Where to go from here**

Information in this section



## Features of MicroAutoBox Embedded PC

**Objective**

Any MicroAutoBox II variant can be used with the MicroAutoBox Embedded PC to increase the possible applications. For example, you can work with video processing or an electronic horizon.

**Variants**

The MicroAutoBox Embedded PC is available with different CPUs:

- Intel® Atom™ Processor N270
- Intel® Core™ i7-3517UE Processor

Furthermore the variants differ in some technical details (USB, CFast slot, fan, etc.).

**Feature Overview**

These are the main features of the MicroAutoBox Embedded PC:

- Compact system consisting of real-time hardware and PC

  All MicroAutoBox II variants can be enhanced with the MicroAutoBox Embedded PC.

- Common power input with remote inputs

  You can control the power-on and power-off behavior of the entire system. For further information, refer to *Power On/Off Behavior of MicroAutoBox Embedded PC and MicroAutoBox* on page 166.
- Three additional 100/1000 Mbit/s Ethernet connectors with internal gigabit Ethernet switch.
- DVI-I connector for graphical devices, such as a TFT monitor.

**Additional features of the MicroAutoBox Embedded PC with Intel® Atom™ Processor N270**

- Intel® Atom™ N270, 1.6 GHz, 512 kB cache, 533 MHz FSB
- Passive cooling, no fan
- 2 GB DDR2-RAM
- SATA interface to accommodate 2.5'' hard disk or solid-state drives (SSD). By default, a SSD with 64 GB is provided. (Note: dSPACE may change the hard disk type without notice.)
- One internal Mini PCI Express slot (for PCI Mini Card Electromechanical Specification 1.1)
- Four USB 2.0 connectors
- One ExpressCard slot, for example, to enhance the system with FireWire.

  The slots can take ExpressCards with form factors ExpressCard/34 and ExpressCard/54.
- Available operating systems:
  - Windows 7 (32 bit)
  - Ubuntu 10.4.2 LTS (Linux distribution)

**Additional features of the MicroAutoBox Embedded PC with Intel® Core™ i7-3517UE Processor**

- Intel® Core™ i7-3517UE Processor,2 x 1.7 / 2.8 GHz, 4 MB

  (support of OpenGL 3.1 and OpenCL 1.1)
- Acitve cooling with fan
- 8 GB DDR3-RAM
- Flash memory
  - integrated 64 GB mSATA SSD
  - 64 GB CFast card, exchangeable by the user
- One internal Mini PCI Express slot (for PCI Mini Card Electromechanical Specification 1.2)

- Four USB connectors
  - 2 x USB 2.0
  
    2 x USB 3.0
- One ExpressCard slot, for example, to enhance the system with FireWire.

  The slots can take ExpressCards with form factors ExpressCard/34.
- Operating systems:
  - Windows 7 Ultimate (64 bit, Service Pack1), installed by default
  - Ubuntu 14.04 LTS (Linux distribution) as image file on USB recovery stick

**Wake on LAN**

The built-in network adapter of the MicroAutoBox Embedded PC supports Wake on LAN (Magic Packet™).

**Note**

To use the Wake on LAN feature the supply voltage must be on at the MicroAutoBox Embedded PC.

**End user agreement**

The MicroAutoBox Embedded PC is an extension to the dSPACE MicroAutoBox and is manufactured by Janz Tec AG.

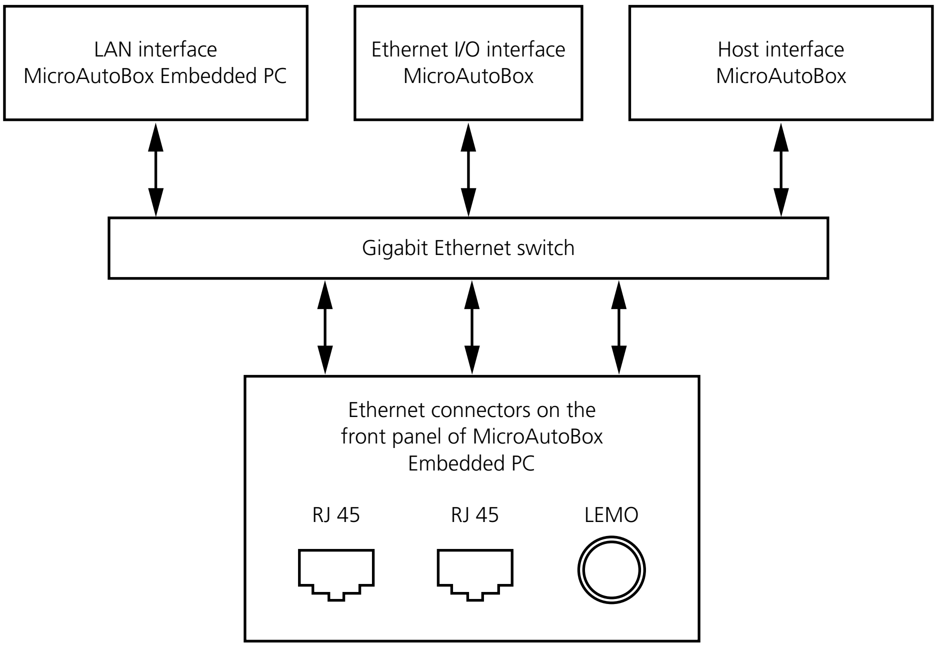
If the MicroAutoBox Embedded PC is delivered with a preinstalled Windows operating system, the EULA terms at http://www.dspace.com/goto?eula-epc apply.

## Integrating MicroAutoBox with MicroAutoBox Embedded PC into a Network

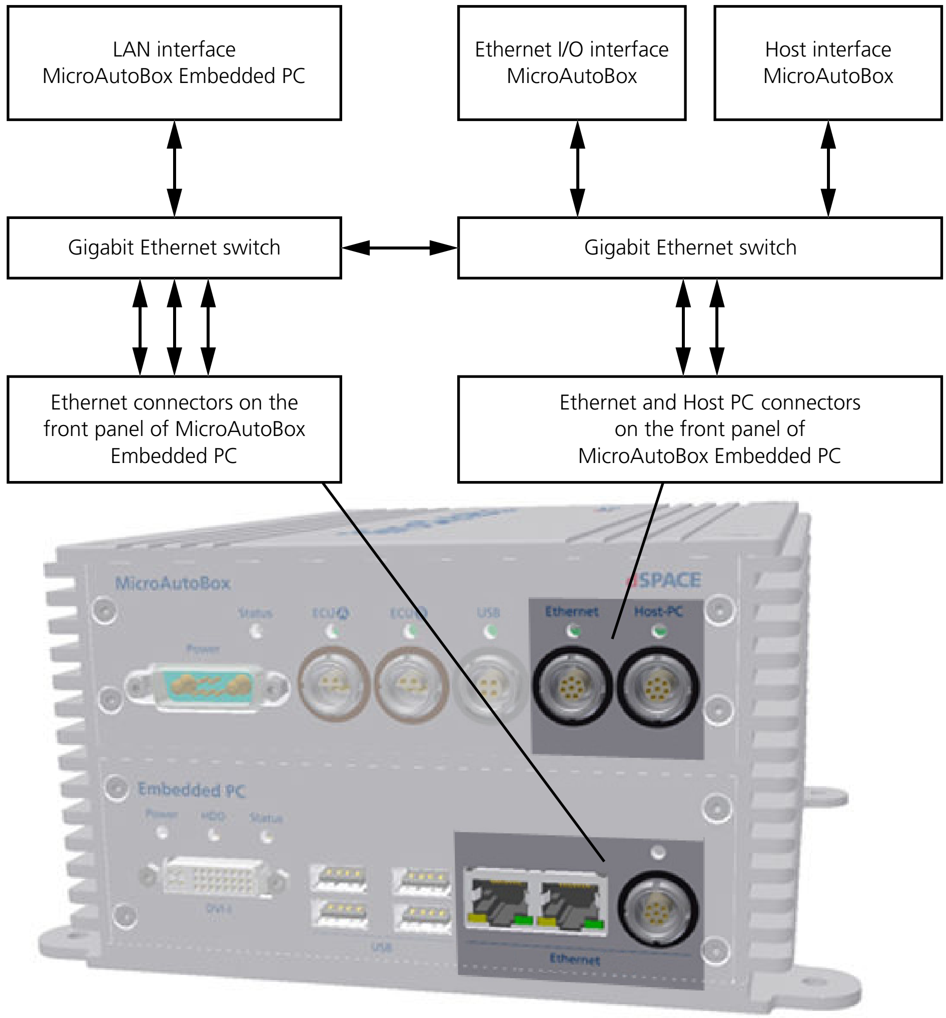
**Objective**

MicroAutoBox Embedded PC and MicroAutoBox form a single unit and are internally connected via a common gigabit Ethernet switch (DS1401-24 and earlier) or via two internally connected gigabit Ethernet switches (DS1401-25 and later). Keep this in mind when you connect the unit, for example, to your company LAN.

Valid for board revision DS1401 - 24 and earlier



Valid for board revision DS1401-25 and later




With the integrated Ethernet switches, both units can be accessed, for example, by the host PC via the same Ethernet connection.

**Connecting to company LAN**

If you need to be connected to your company LAN, note the existing IP address space and consult your system administrator.

Note that if you connect the MicroAutoBox Embedded PC to your company LAN, all the Ethernet devices which are connected to the switch of the Embedded PC are also connected to the company LAN.

**Status LED**

MicroAutoBox Embedded PC and MicroAutoBox provide LEDs to indicate data traffic on the Ethernet switch. For further information on these LEDs and all the unit's other status LEDs, refer to *Housing Components* on page 648.

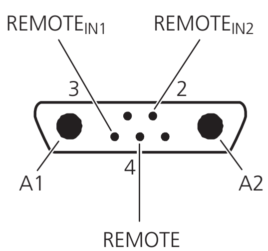
## Power On/Off Behavior of MicroAutoBox Embedded PC and MicroAutoBox

**Objective**

The MicroAutoBox Embedded PC and MicroAutoBox are joined to form a single unit and get their power via a common connector. Nevertheless, you can power them up and shut them down independently, for example, to boot the Embedded PC before the MicroAutoBox automatically starts its application on power-up.

**Remote inputs**

The remote inputs are located on the power input connector on the MicroAutoBox front panel as shown in the illustration below.




**NOTICE**

**Risk of material damage**

**Do not switch off MicroAutoBox and the MicroAutoBox Embedded PC by disconnecting the VBAT and/or GND connection or by pulling the power input connector when the operating system of the MicroAutoBox Embedded PC is running.**

You are strongly recommended to shut down the operating system of the MicroAutoBox Embedded PC via the remote inputs before the system is switched off.

For the complete pinout and further information on the characteristics of the inputs on the power input connector, refer to *Power Input Connector* on page 668.

**Logic switch conditions**

The $REMOTE_{IN2}$ let you decide whether the REMOTE input or the $REMOTE_{IN1}$ input triggers the power on/off behavior of the MicroAutoBox Embedded PC.

The following table lists several use scenarios. For the high/low levels descriptions, refer to *Power Input Connector* on page 668.

| Use Scenario | UBAT | REMOTE | $REMOTE_{IN1}$ [1)] | $REMOTE_{IN2}$ [1)] |
|---|---|---|---|---|
| Start both, DS1401 Base Board and Embedded PC | Low -> high | High | Don't care | Low |
| | High | Low -> high | Don't care | Low |
| Shutdown both, DS1401 Base Board and Embedded PC (after operating system shutdown time) | High | High -> low | Don't care | Low |
| Boot Embedded PC before starting the application on the DS1401 Base Board by means of the ignition key. | High | Low -> high | High | High |
| Start Embedded PC via the application on the DS1401 Base Board, for example, by controlling a digital output connected to REMOTE IN1. | High | High | Low -> high | High |
| Shut down Embedded PC via the application on the DS1401 Base Board, for example, by controlling a digital output connected to REMOTE IN1. | High | High | High -> low | High |
| Shut down DS1401 Base Board while the Embedded PC continues to run. | High | High -> low | High | High |

[1)] This input provides an internal pull-down resistor and is defined to low level if not connected. For further information on the characteristics, refer to *Power Input Connector* on page 668

# How to Secure an ExpressCard with the Embedded PC CardSafe

**Objective**

The rear panel of the MicroAutoBox Embedded PC provides an ExpressCard slot for ExpressCards.

- MicroAutoBox Embedded PC with Intel® Atom™ Processor N270:

  ExpressCards/34 or ExpressCards/54
- MicroAutoBox Embedded PC with Intel® Core™ i7-3517UE Processor:

  ExpressCards/34

You can secure the inserted ExpressCard against accidental disconnection with the Embedded PC CardSafe if the MicroAutoBox Embedded PC is exposed to environments where shock and vibration levels are high.

> **Note**
>
> The instructions refer to MicroAutoBox Embedded PC with Intel® Atom™ Processor N270 and are similar for MicroAutoBox Embedded PC with Intel® Core™ i7-3517UE Processor.

**Preconditions**

Before doing any installation work, make sure that:

- The MicroAutoBox Embedded PC is disconnected from the power supply.
- No external devices are connected to the MicroAutoBox Embedded PC and MicroAutoBox.
- You have all the items in the table below:

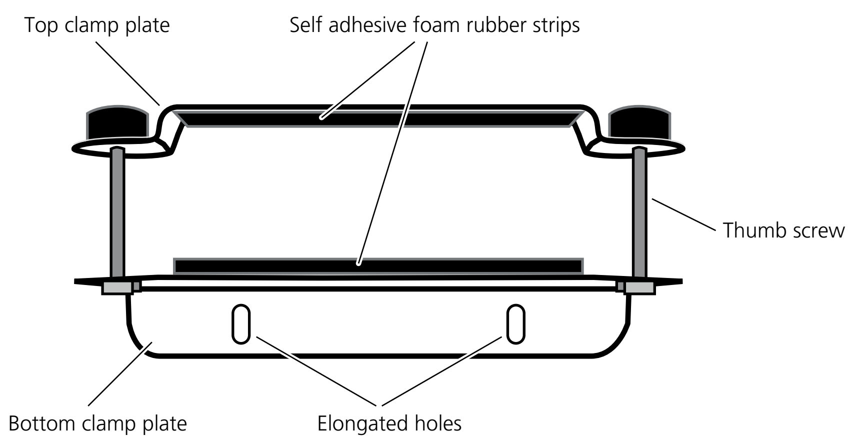
| Items | Count | Description |
|---|---|---|
| Phillips screwdriver | 1 | PH0 |
| Phillips screw [1)] | 2 | M3 X 8 mm |
| Spring lock washer [1)] | 2 | M5 |
| Spring washer [1)] | 2 | M5 |
| Top clamp plate | 1 | see illustration below |
| Bottom clamp plate | 1 | see illustration below |

| Items | Count | Description |
|---|---|---|
| Self adhesive foam rubber strips | 2 | - |
| Thumb screws | 2 | M2.5 X 20 mm |

[1] Already part of the MicroAutoBox Embedded PC to fix the plate which covers the ExpressCard slot.

The following illustration shows the parts of the Embedded PC CardSafe:

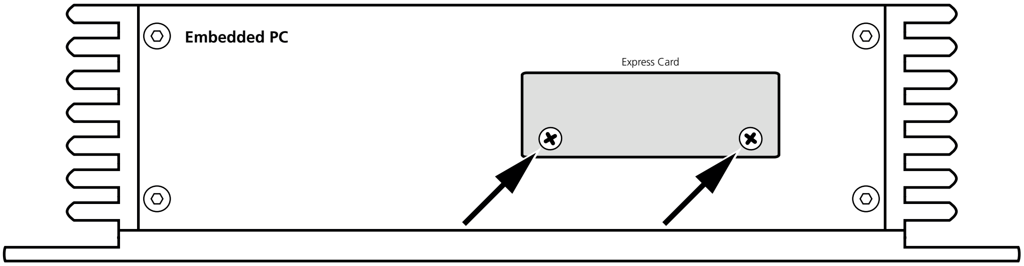
Front view



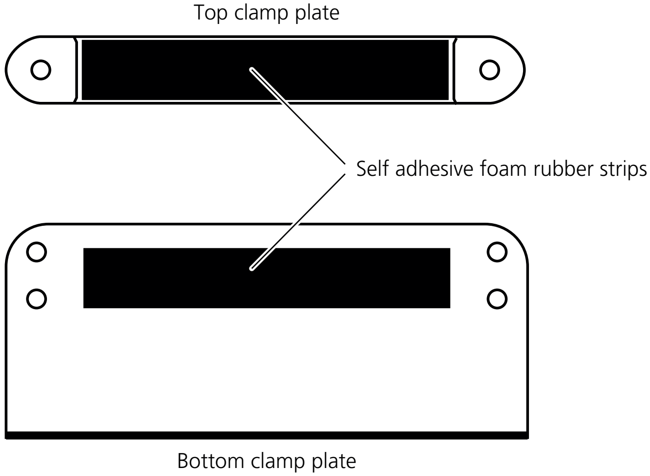

**Method**

### How to secure an ExpressCard with the Embedded PC CardSafe

**1** Remove the cover plate from the ExpressCard slot by removing the two screws, spring washers, and washers.



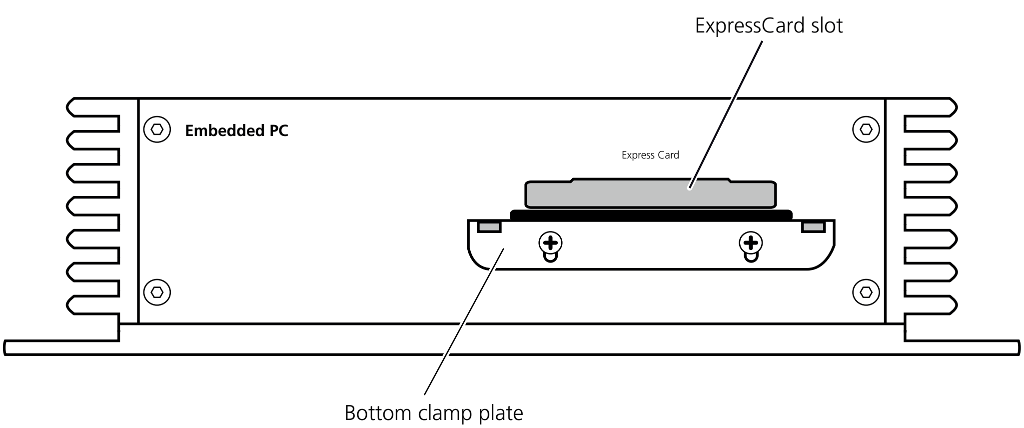
2 Put the self adhesive foam rubber strips on the top clamp plate and the bottom clamp plate of the CardSafe to avoid any damage to the ExpressCard.




3 Attach the bottom clamp plate of the CardSafe by using the previously removed screws, spring washers, and washers.

Tighten the screws that you can adjust the height of the bottom clamp plate with its elongated holes.

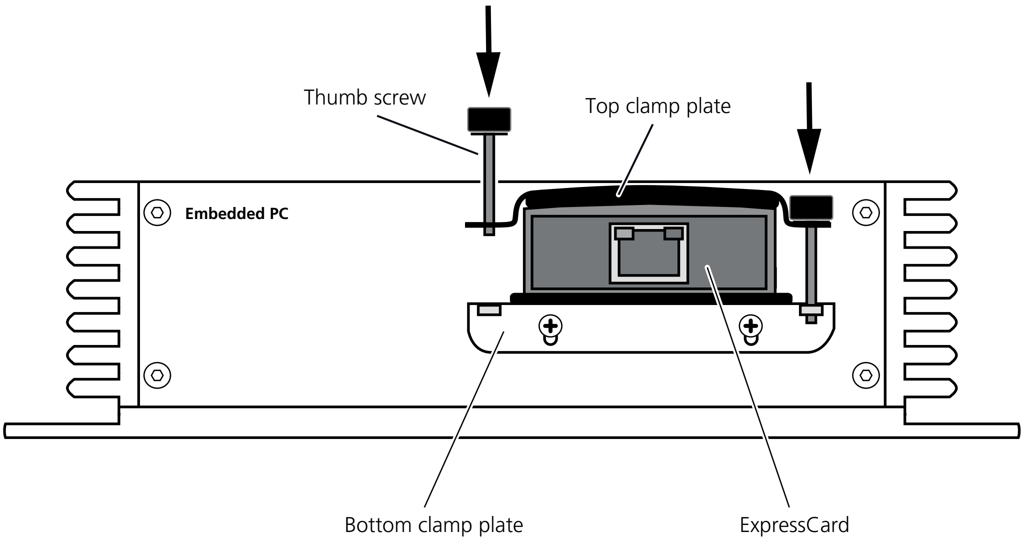
4 Insert the ExpressCard into the ExpressCard slot and adjust the height of the bottom clamp plate and tighten the screws.




**Note**

If you use an ExpressCards/34, insert it on the left side of the slot.

5 Fix the ExpressCard with the top clamp plate of the CardSafe by using the included thumb screws.




| | |
|---|---|
| **Result** | The ExpressCard is now protected against accidental disconnection. |

## How to Insert a CFast Card

**Objective**

The rear panel of the MicroAutoBox Embedded PC with Intel® Core™ i7-3517UE Processor provides a CFast slot to expand the storage capacity.

**Preconditions**

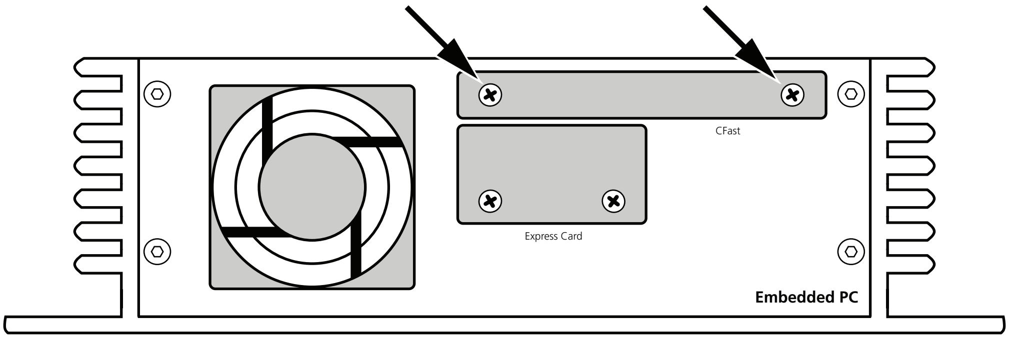
Before doing any installation work, make sure that:

- The MicroAutoBox Embedded PC is disconnected from the power supply.
- No external devices are connected to the MicroAutoBox Embedded PC and MicroAutoBox.
- You have Phillips screwdriver (PH0) ready to hand.

**Method**

**How to insert a CFast card**

1 Remove the cover plate from the CFast slot by removing the two screws, spring washers, and washers.




2 Insert the CFast card.

3 Mount the cover plate to the CFast slot with the two screws, spring washers, and washers.

**Result**

The storage capacity is expanded.

## How to Remove a CFast Card

**Objective**

These instructions refer to the MicroAutoBox Embedded PC with Intel® Core™ i7-3517UE Processor.

**Preconditions**

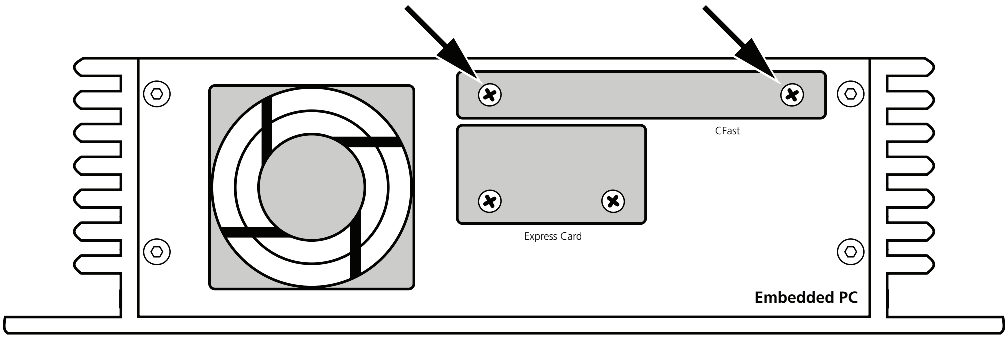
Before doing any installation work, make sure that:

- The MicroAutoBox Embedded PC is disconnected from the power supply.
- No external devices are connected to the MicroAutoBox Embedded PC and MicroAutoBox.
- You have Phillips screwdriver (PH0) ready to hand.

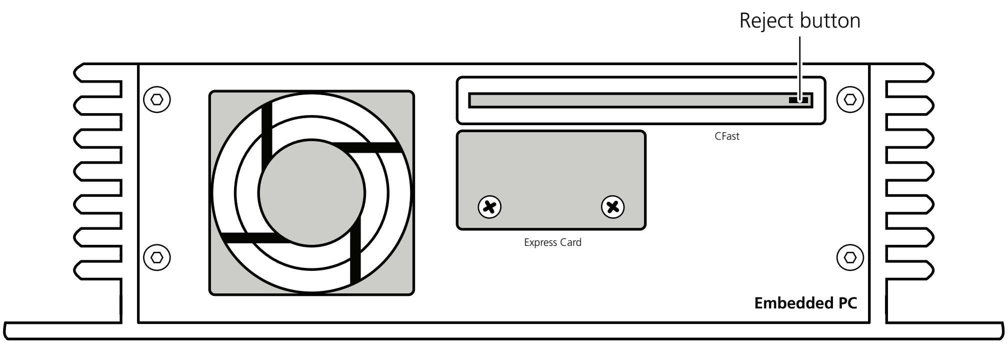
**Method**

### How to remove a CFast card

1 Remove the cover plate from the CFast slot by removing the two screws, spring washers, and washers.




2 Remove the CFast card with pushing the mechanical reject button shown in the illustration below.




3 Mount the cover plate to the CFast slot with the two screws, spring washers, and washers.

**Result**

The CFast Card is removed.

# Using MicroAutoBox Break-Out Boxes

**Objective**

**WARNING**

**Risk of injury and material damage**

Do not connect any of the following MicroAutoBox variants to a MicroAutoBox Break-Out Box DS5374:

- MicroAutoBox II 1401/1511
- MicroAutoBox II 1401/1511/1512
- MicroAutoBox II 1401/1511/1514
- MicroAutoBox II 1401/1512/1513
- MicroAutoBox II 1401/1513
- MicroAutoBox II 1401/1513/1514

These variants have deviating ZIF connector pinouts.

**⚠ WARNING**

**Risk of serious injury or death**

Changing the existing cable harness via a Break-Out Box can cause uncontrolled movements and/or damage to connected devices.

- 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.

The MicroAutoBox Break-Out Boxes are helpful tools for development with MicroAutoBox. They provide easy access to all the signals of MicroAutoBox. For example, you can:

- Check and/or reconnect signals without changing the existing cable harness
- Connect sensors and/or actuators
- Connect measurement devices

**Where to go from here**

Information in this section



Information in other sections

# MicroAutoBox Break-Out Box DS1541

**Objective**

Break-Out Box for all MicroAutoBox II variants with zero insertion force (ZIF) I/O connectors.

**Using cable harness of MicroAutoBox Break-Out Box DS5374**

***NOTICE***

**Risk of material damage**

**If MicroAutoBox is powered via a ZIF I/O connector, you must use several signal pins for Ubat and GND to spread the electrical load.**

**Where to go from here**

Information in this section



## Features of MicroAutoBox Break-Out Box DS1541

**Main features**

MicroAutoBox Break-Out Box DS1541 provides the following main features:

- Easily connected to all MicroAutoBox II variants.

  A connecting cable with zero insertion force (ZIF) I/O connectors belongs to the Break-Out Box DS1541.

- One labeled terminal for each signal of the ZIF I/O connector.

  Via terminals, you can:

  - Break the signal path with a isolating connector.
  - Connect test plug(s) and/or stripped wires on 6 points on each terminal.

**More features**

For a complete overview of the features, refer to *Data Overview - Break-Out Box DS1541* on page 687.

## Working Principles - MicroAutoBox Break-Out Box DS1541

**Objective**

You can connect signals to the terminal points of MicroAutoBox Break-Out Box DS1541 either with test plugs or with stripped wires. The signal paths can be interrupted via the isolating connector without disconnecting a test plug or wire.

**Notes**

**⚠ WARNING**

**Risk of serious injury or death due to electric shock**

Depending on the connected devices, there can be hazardous voltages on the contacts of the boxes caused by failures.

Do not touch bare contacts.

**⚠ WARNING**

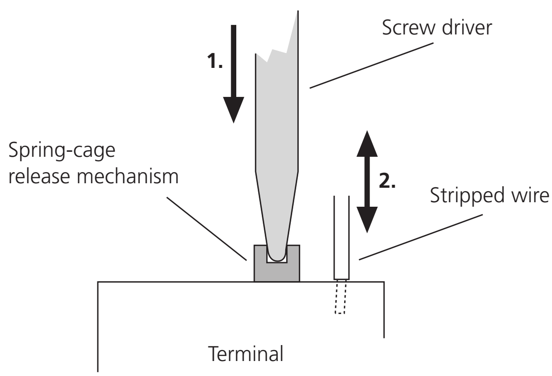
**Risk of serious injury or death**

Changing the existing cable harness via a Break-Out Box can cause uncontrolled movements and/or damage to connected devices.

- 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/disconnecting stripped wires**

Push down the spring-cage connection release mechanism to connect or disconnect the stripped end of a single wire as shown in the illustration below:




**Tip**

Use a 3 mm (0.12 in.) slotted screw driver to push down the spring-cage connection release mechanism.

**Wire dimensions** The spring-cage connection supports cable dimensions in the range AWG14 ... AWG24, as shown in the following table:

| AWG[1] | Diameter | | Cross-Section | |
|---|---|---|---|---|
| | mm | inch | $mm^2$ | $inch^2$ |
| 14 | 1.63 | 0.06 | 2.1 | 0.0032 |
| 24 | 0.511 | 0.02 | 0.205 | 0.0003 |

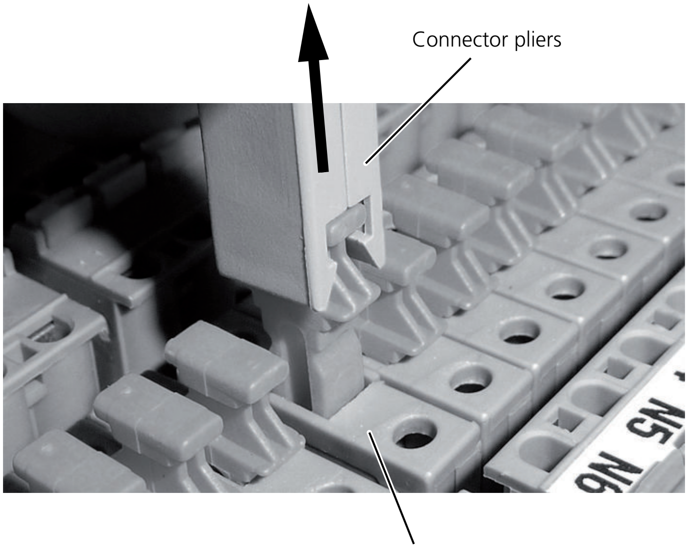
[1] AWG = American Wire Gauge

**Connecting test plugs**

You can connect the terminals with test plugs (banana plugs) that have a metal pin of 2.0 mm (0.08 in.) diameter.

**Interrupting the signal path**

Each terminal provides a isolating connector to interrupt a signal path, for example, for measuring purposes. The following illustration shows how to open a isolating connector:




**Tip**

Use the connector pliers to lift the isolating connectors.

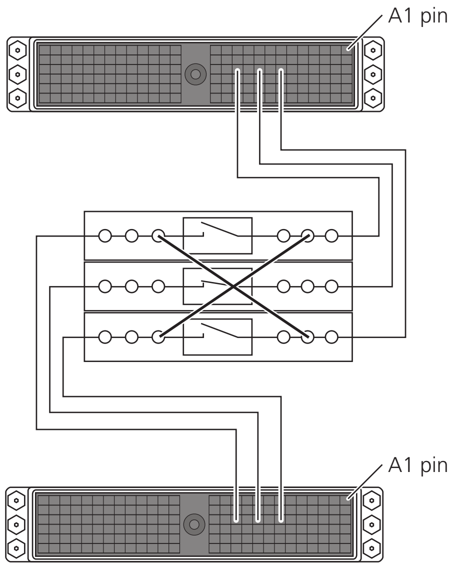
**Note**

Move the isolating connector to its upper position until it locks in place to ensure signal interruption.

## Connecting Examples - MicroAutoBox Break-Out Box DS1541

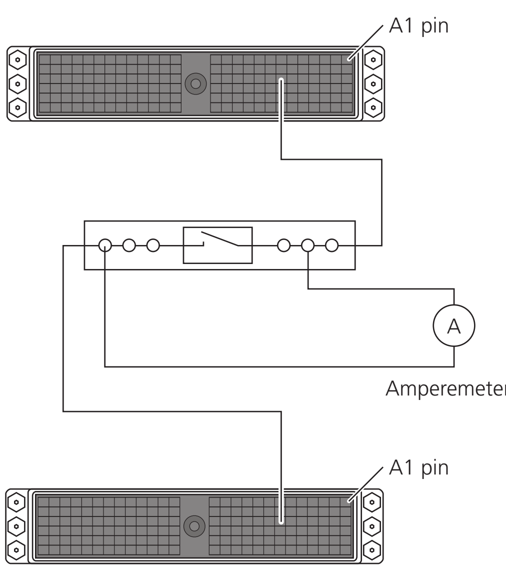
**Changing signal paths**

You can change signal paths if you open the isolating connectors of the signal terminals and reconnect the signals with test plugs or wires, as shown in the illustration below:




**Current measuring**

Open the isolating connector of a signal terminal and connect an ampere meter for current measuring, as shown in the illustration below:



# MicroAutoBox Break-Out Box DS5374

**Objective**

The MicroAutoBox Break-Out Box DS5374 provides easy access to signals on the I/O connectors only for the following MicroAutoBox variants:

- MicroAutoBox II 1401/1501
- MicroAutoBox II 1401/1504
- MicroAutoBox II 1401/1505/1507
- MicroAutoBox II 1401/1507

**Where to go from here**

Information in this section



## Features of MicroAutoBox Break-Out Box DS5374

**Main features**

MicroAutoBox Break-Out Box DS5374 provides the following main features:

- Easily connected to the following MicroAutoBox variants:
  - MicroAutoBox II 1401/1501
  - MicroAutoBox II 1401/1504
  - MicroAutoBox II 1401/1505/1507
  - MicroAutoBox II 1401/1507

  A connecting cable with zero insertion force (ZIF) I/O connectors belongs to the Break-Out Box.

- One labeled terminal for each signal of the ZIF I/O connector.

  Via terminals, you can:

  - Break the signal path with a knife disconnector.
  - Connect test plug(s) and/or stripped wires on 5 points on each terminal.
- All the CAN and FlexRay bus lines are connected to 9-pin Sub-D connectors.
- CAN and FlexRay buses can be terminated easily and quickly via termination switches. These buses have to be terminated according to their specifications to prevent wave reflections at the end.

  CAN bus lines can be terminated with 120 Ω, FlexRay bus lines with 94 Ω or 47 Ω (47 Ω for test purposes).

**More features**

For a complete overview of the features, refer to *Data Overview* on page 698.

# Working Principles - MicroAutoBox Break-Out Box DS5374

**Objective**

You can connect signals to the terminal points of MicroAutoBox Break-Out Box DS5374 either with test plugs or with stripped wires. The signal paths can be interrupted via the knife disconnectors without disconnecting a test plug or wire.

**Notes**

**⚠ WARNING**

**Risk of serious injury or death due to electric shock**

Depending on the connected devices, there can be hazardous voltages on the contacts of the boxes caused by failures.

Do not touch bare contacts.

**WARNING**

**Risk of injury and material damage**

Do not connect any of the following MicroAutoBox variants to a MicroAutoBox Break-Out Box DS5374:

- MicroAutoBox II 1401/1511
- MicroAutoBox II 1401/1511/1512
- MicroAutoBox II 1401/1511/1514
- MicroAutoBox II 1401/1512/1513
- MicroAutoBox II 1401/1513
- MicroAutoBox II 1401/1513/1514

These variants have deviating ZIF connector pinouts.

**WARNING**

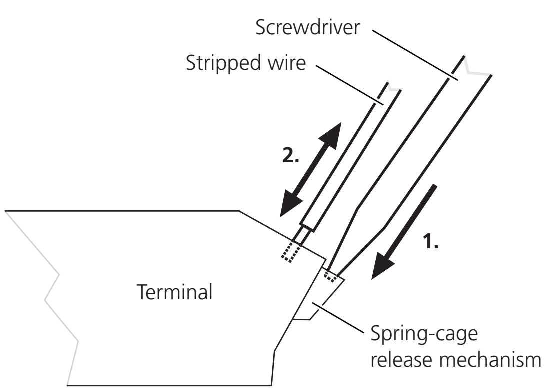
**Risk of serious injury or death**

Changing the existing cable harness via a Break-Out Box can cause uncontrolled movements and/or damage to connected devices.

- 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/disconnecting stripped wires**

Push down the spring-cage connection release mechanism to connect or disconnect the stripped end of a single wire as shown in the illustration below:



**Tip**

Use a 3 mm (0.12 in.) slotted screwdriver to push down the spring-cage connection release mechanism.

**Wire dimensions** The spring-cage connection supports cable dimensions in the range AWG16 ... AWG24, as shown in the following table:

| AWG[1] | Diameter | | Cross-Section | |
|---|---|---|---|---|
| | mm | inch | $mm^2$ | $inch^2$ |
| 16 | 1.29 | 0.05 | 1.3 | 0.002 |
| 24 | 0.511 | 0.02 | 0.205 | 0.0003 |

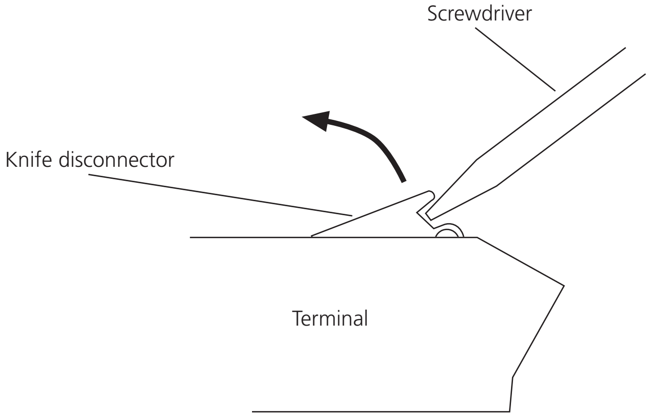
[1] AWG = American Wire Gauge

**Connecting test plugs**

You can connect the terminals with test plugs (banana plugs) that have a metal pin of 2.0 mm (0.08 in.) diameter.

**Interrupting the signal path**

Each terminal provides a knife disconnector to interrupt a signal path, for example, for measuring purposes. The following illustration shows how to open a knife disconnector:




**Tip**

Use a 3 mm (0.12 in.) slotted screwdriver to lift the knife disconnector.

**Note**

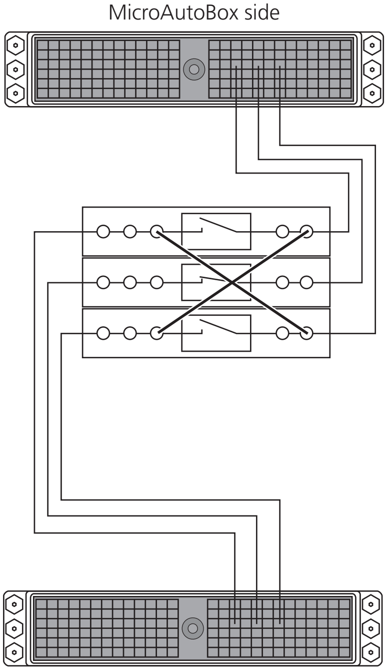
Move the knife disconnector to its upper position until it locks in place to ensure signal interruption.

# Connecting Examples - MicroAutoBox Break-Out Box DS5374

**Changing signal paths**

You can change signal paths if you open the knife disconnectors of the signal terminals and reconnect the signals with test plugs or wires, as shown in the illustration below:

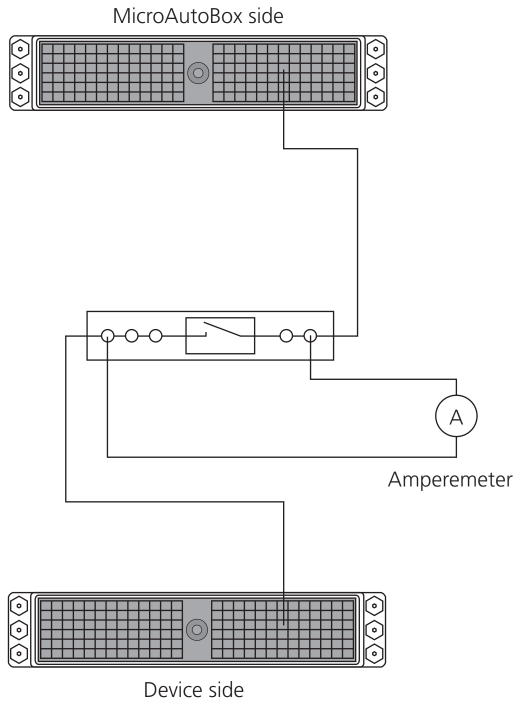
MicroAutoBox side



Device side

**Current measuring**

Open the knife disconnector of a signal terminal and connect an ampere meter for current measuring, as shown in the illustration below:




## Terminating CAN Bus Lines - MicroAutoBox Break-Out Box DS5374

**Note**

**⚠ WARNING**

**Risk of injury and material damage**

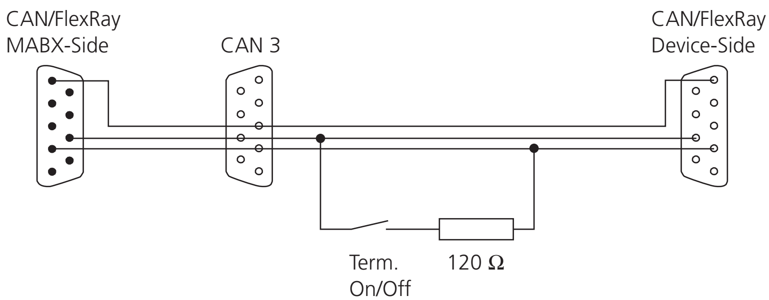
**Changing the termination of bus lines via termination switches can cause failures in bus communication. These failures might lead to uncontrolled movements of and/or damage to connected devices.**

To avoid risk of injury and material damage, ensure that the termination change complies with the bus specification.

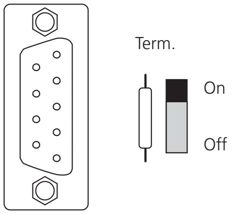
**Terminating the CAN bus lines**

You can easily terminate all CAN bus lines via termination switches. Each switch connects a 120 Ω resistor between the CAN high and low lines to terminate one end of a CAN bus with the recommended resistance value.

The following illustration shows an example of a terminating circuit.




The switches are located next to the Sub-D CAN connectors as the illustration shows below.




Push the termination switch to the On position to terminate the CAN bus lines.

# Terminating FlexRay Bus Lines - MicroAutoBox Break-Out Box DS5374

**Note**

**⚠ WARNING**

**Risk of injury and material damage**

**Changing the termination of bus lines via termination switches can cause failures in bus communication. These failures might lead to uncontrolled movements of and/or damage to connected devices.**

To avoid risk of injury and material damage, ensure that the termination change complies with the bus specification.

**Terminating the FlexRay bus lines**

You can easily terminate all FlexRay bus lines via termination switches. To terminate one end of the bus lines, the termination switches connect a resistor between the FlexRay high and low lines.

You can select between the following values for terminating:

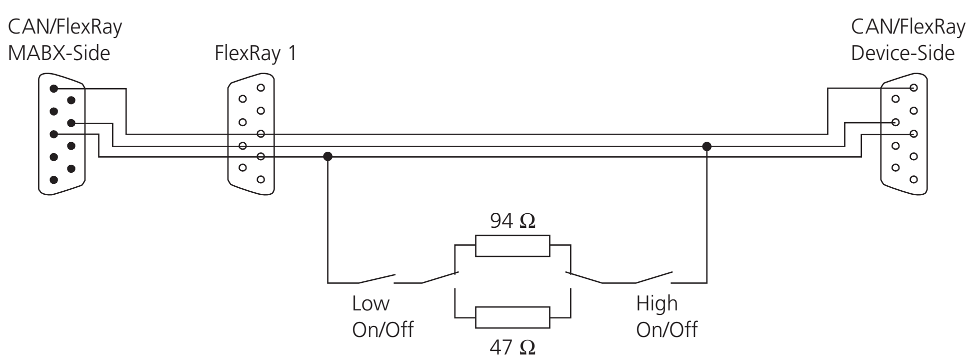
- 94 Ω

  This value is the recommended value to terminate the end of a FlexRay bus.

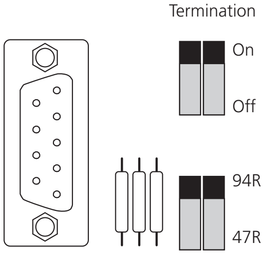
- 47 Ω

  This value is used for test purposes.

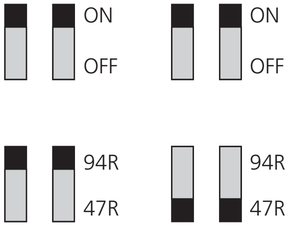
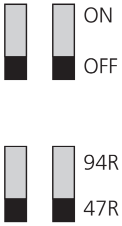
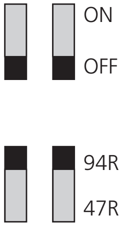
The following illustration shows an example of a terminating circuit.



The switches are located next to the Sub-D FlexRay connectors as the illustration shows below.




The following table shows the positions of the switches to configure the FlexRay bus lines termination.

| Switch Positions | Configured Termination |
|---|---|
|   | Not terminated |
|   | Terminated with 94 Ω |
|   | Terminated with 47 Ω |
| All other combinations are not recommended. | – |

# Installing and Uninstalling I/O Modules and IP Modules

**Objective**

You can add or replace one I/O module and up to two IP modules to adapt the I/O functionality of MicroAutoBox to your needs.

**Where to go from here**

Information in this section

# Installing and Uninstalling I/O Modules

**Objective**

I/O modules provide the I/O interfaces for the DS1512 and DS1514 I/O boards. I/O modules are, for example, the DS1552 Multi-I/O Module and the DS1554 Engine Control I/O Module.

**Where to go from here**

Information in this section



## How to Uninstall I/O Modules

**Objective**

The following instructions apply if you want to uninstall a DS1552 Multi-I/O Module or a DS1554 Engine Control I/O Module from MicroAutoBox. The I/O module is installed in the DS1512 or the DS1514 I/O Board.

**Preconditions**

- To avoid risk of injury and/or damage to the dSPACE hardware, read and ensure that you comply with the safety precautions, see *Safety Precautions for Installing and Connecting the Hardware* on page 22.
- Ensure you have all the items in the table below before starting:

| Items | Count | Description |
|---|---|---|
| Hexagon socket wrench | 1 | 2.5 mm |
| Philips screwdriver | 1 | PH0 |
| **Additional items to uninstall the DS1554 Engine Control I/O Module:** | | |
| Hexagon socket wrench | 1 | 2 mm |
| Hex nut screwdriver | 1 | 3/16 in. |

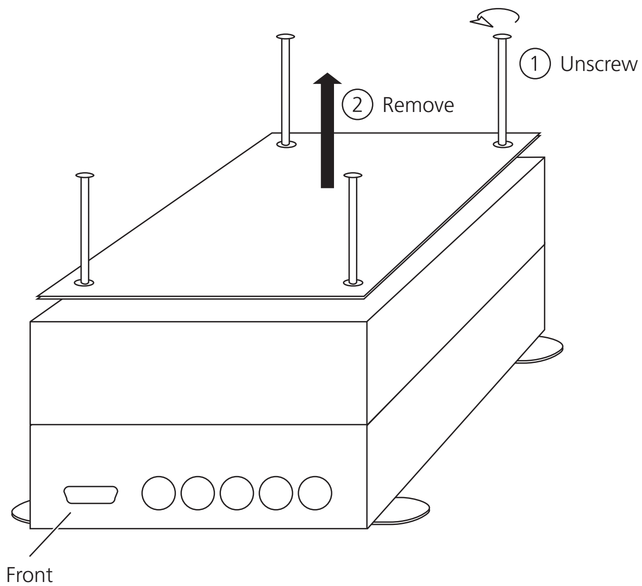
**Possible methods**

- To uninstall a DS1552 Multi-I/O Module, refer to *Method 1* on page 193.
- To uninstall a DS1554 Engine Control I/O Module, refer to *Method 2* on page 195.

**Method 1**

**To uninstall a DS1552 Multi-I/O Module**

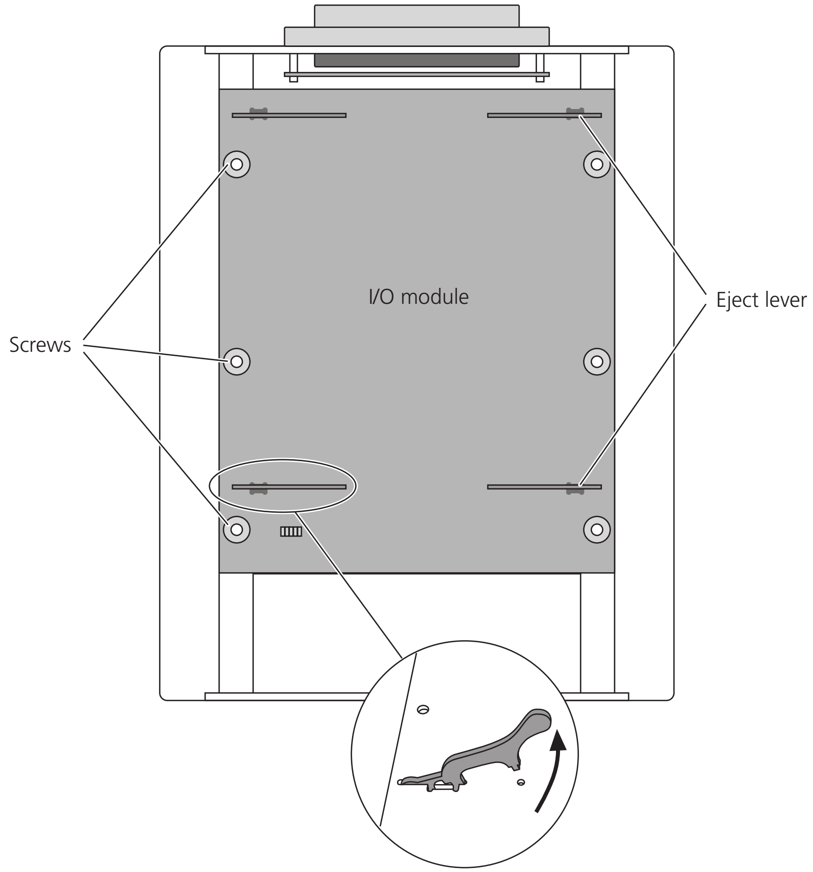
1. Disconnect MicroAutoBox from the power supply.
2. Remove the top cover of MicroAutoBox. Use a 2.5 mm hexagon socket wrench.




The DS1512 or DS1514 I/O board is on top.

3. Remove the six screws which secure the I/O module against accidental disconnection. Use a PH0 Philips screwdriver.

4 Carefully pull up the eject levers, first on the one side and then on the other.



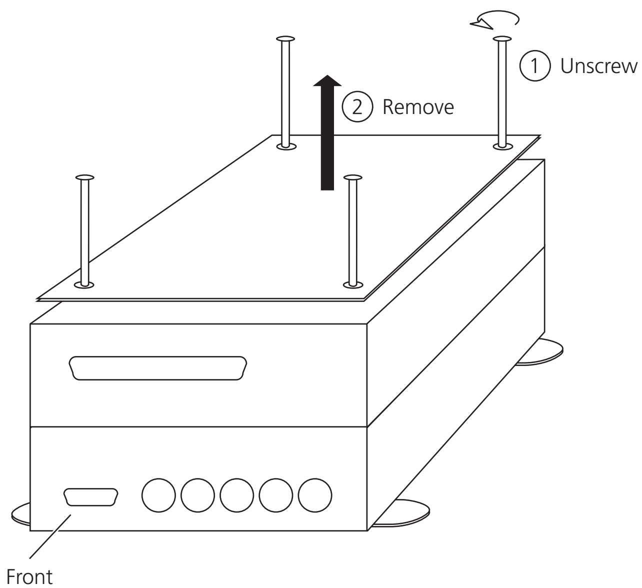

5 Remove the I/O board.

**Method 2**

**To uninstall a DS1554 Engine Control I/O Module**

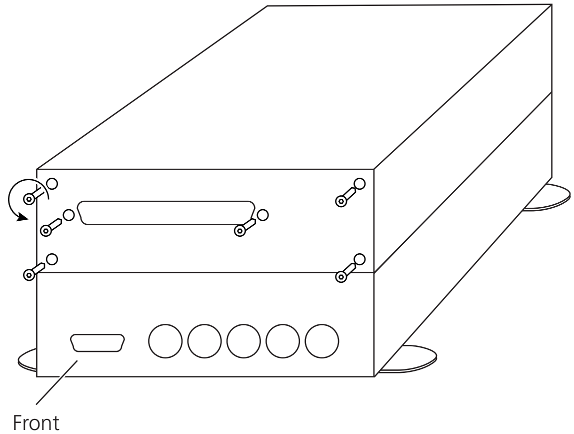
1 Disconnect MicroAutoBox from the power supply.

2 Remove the top cover of MicroAutoBox. Use a 2.5 mm hexagon socket wrench.

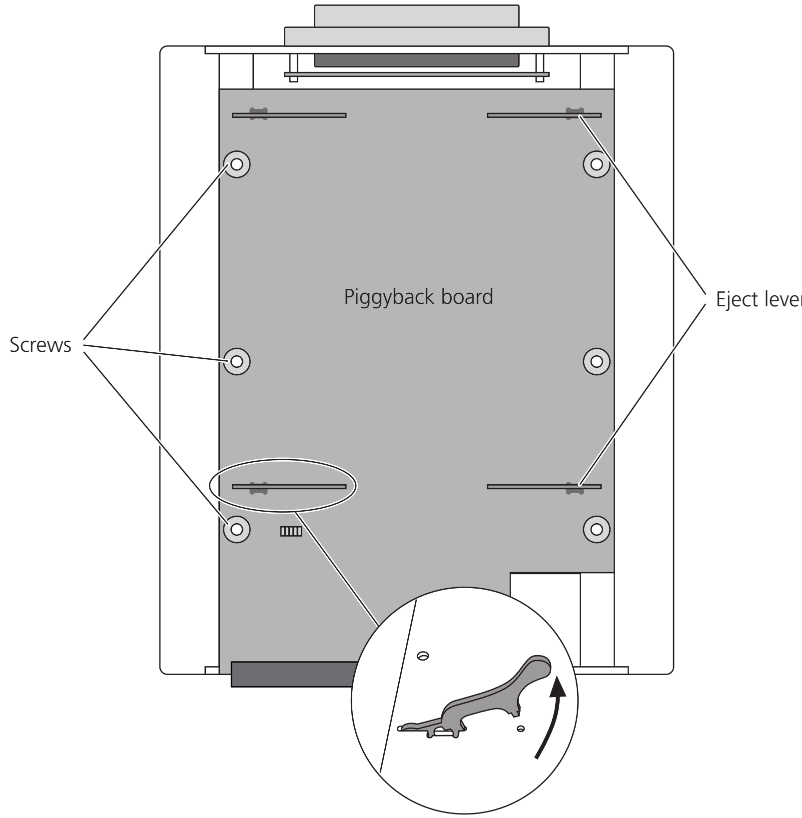



The DS1514 I/O board is on top.

3 Remove MicroAutoBox's upper front cover. Use a 2 mm hexagon socket wrench for the outer screws and a 3/16 in. hex nut screwdriver for the screws of the Sub-D I/O connector.



**4** Remove the six screws which secure the I/O module against accidental disconnection. Use a PH0 Philips screwdriver.




**5** Carefully pull up the eject levers, first on the one side and then on the other.

**6** Remove the I/O board.

| | |
|---|---|
| **Result** | The I/O module is uninstalled. |
| **Next steps** | You can install or uninstall IP modules, or you install another I/O module. |
| **Related topics** | HowTos<br>• *How to Install I/O Modules* on page 197<br>• *How to Install IP Modules* on page 204<br>• *How to Uninstall IP Modules* on page 208 |

## How to Install I/O Modules

**Objective**

The following instructions apply if you want to plug an I/O module into the DS1512 or DS1514 I/O board.

**Suitable I/O modules**

You can use the DS1552 Multi-I/O Module with the following MicroAutoBox variants:

- MicroAutoBox II 1401/1511/1512
- MicroAutoBox II 1401/1511/1514
- MicroAutoBox II 1401/1512/1513
- MicroAutoBox II 1401/1513/1514

You can use the DS1554 Engine Control I/O Module with the following MicroAutoBox variants:

- MicroAutoBox II 1401/1511/1514
- MicroAutoBox II 1401/1513/1514

**Preconditions**

- To avoid risk of injury and/or damage to the dSPACE hardware, read and ensure that you comply with the safety precautions, see *Safety Precautions for Installing and Connecting the Hardware* on page 22.
- MicroAutoBox is disconnected from the power supply.
- The top cover of MicroAutoBox is removed. For removing the top cover, refer to *How to Uninstall I/O Modules* on page 192.
- No I/O modul is installed. For uninstalling the I/O modul, refer to *How to Uninstall I/O Modules* on page 192.
- Ensure you have all the items in the table below before starting:

| Items | Count | Description |
|---|---|---|
| Hexagon socket wrench | 1 | 2.5 mm |
| Philips screwdriver | 1 | PH0 |
| **Additional item to install the DS1554 Engine Control I/O Module:** | | |
| Hexagon socket wrench | 1 | 2 mm |
| Hex nut screwdriver | 1 | 3/16 in. |

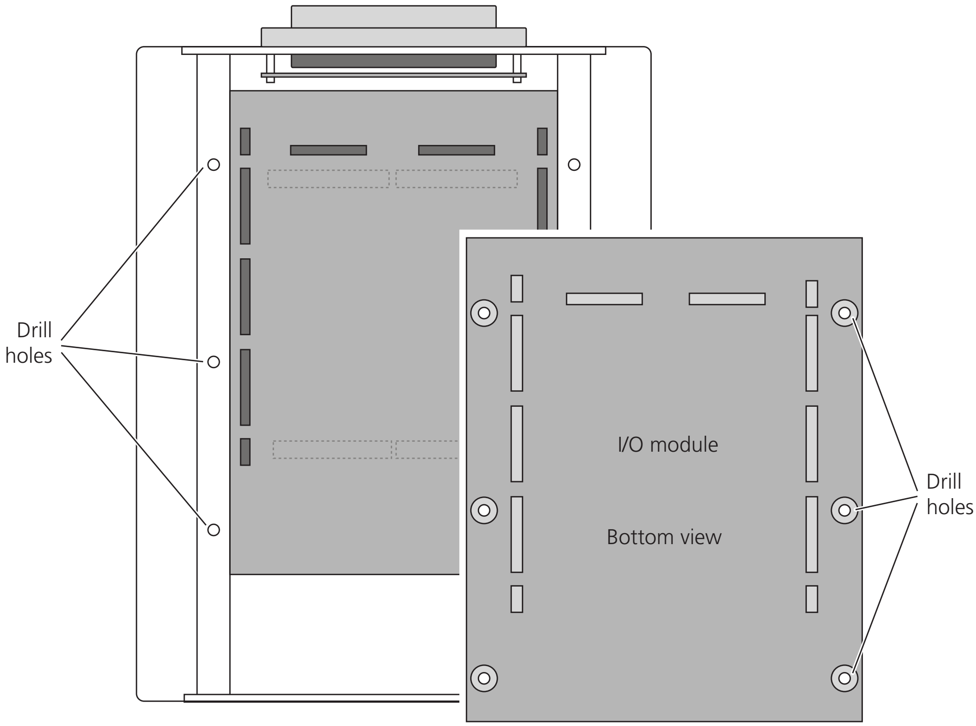
**Possible methods**

- To install a DS1552 Multi-I/O Module, refer to *Method 1* on page 198.
- To install a DS1554 Engine Control I/O Module, refer to *Method 2* on page 200.

**Method 1**

**To install a DS1552 Multi-I/O Module**

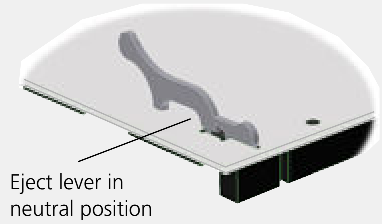
1 Consider the connectors at the bottom of the I/O module and on the I/O board to get the correct position for mounting as shown below.



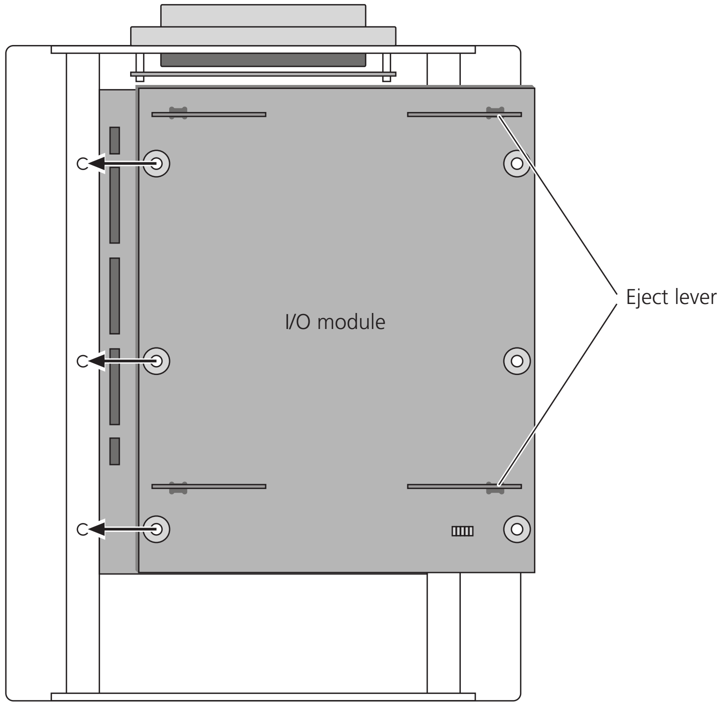
2

**Note**

Take care that the eject levers are in neutral position as shown in the illustration below.

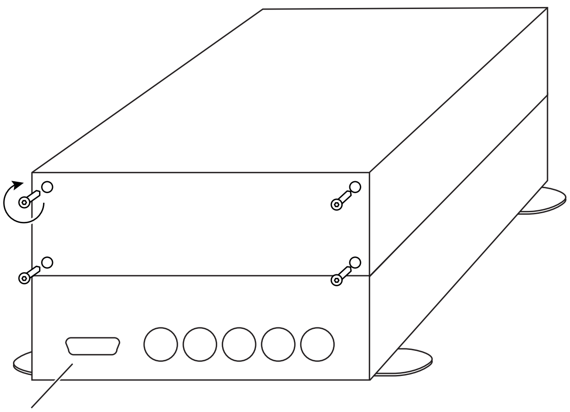



3 Align the drill holes of the module and the housing and insert the I/O module by pressing evenly on the six drill holes.




4 Tighten six screws to secure the I/O module against accidental disconnection. Use a PH0 Philips screwdriver.

5 If the upper front cover is removed, attach a blank front cover. Use a 2 mm hexagon socket wrench.




**Note**

Do not use MicroAutoBox with an open housing. Contact dSPACE Support if you do not have a suitable front cover.

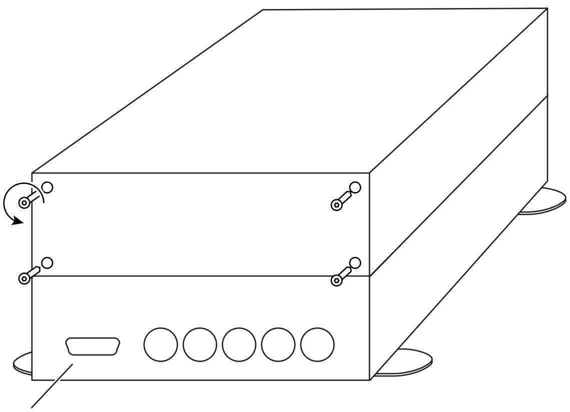
6 Attach the top cover of MicroAutoBox. Use a 2.5 mm hexagon socket wrench.

---

**Method 2**

**To install a DS1554 Engine Control I/O Module**

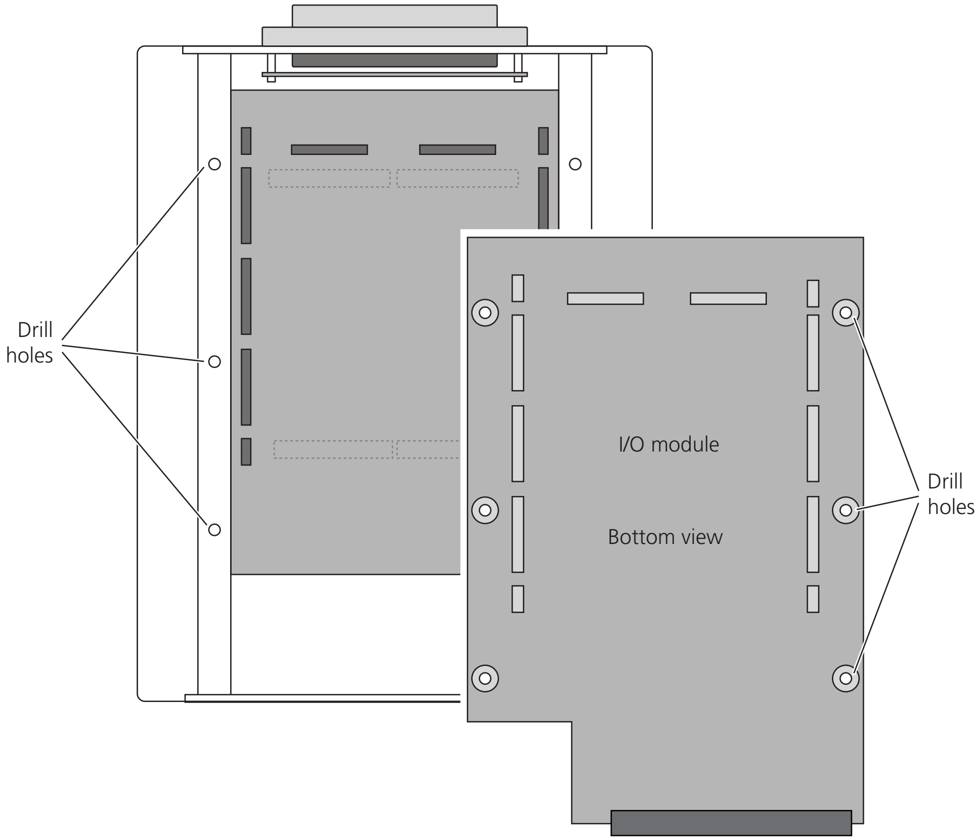
1 If the upper front cover is not removed, remove the front cover. Use a 2 mm hexagon socket wrench.



**Tip**

Keep the front cover you just removed. If you want to uninstall the I/O module, you need the cover to close the housing of MicroAutoBox.

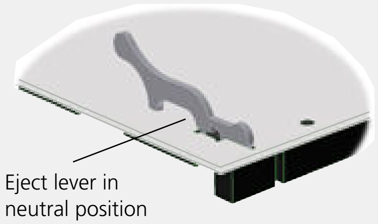
**2** Consider the connectors at the bottom of the I/O module and on the I/O board to get the correct position for mounting as shown below.



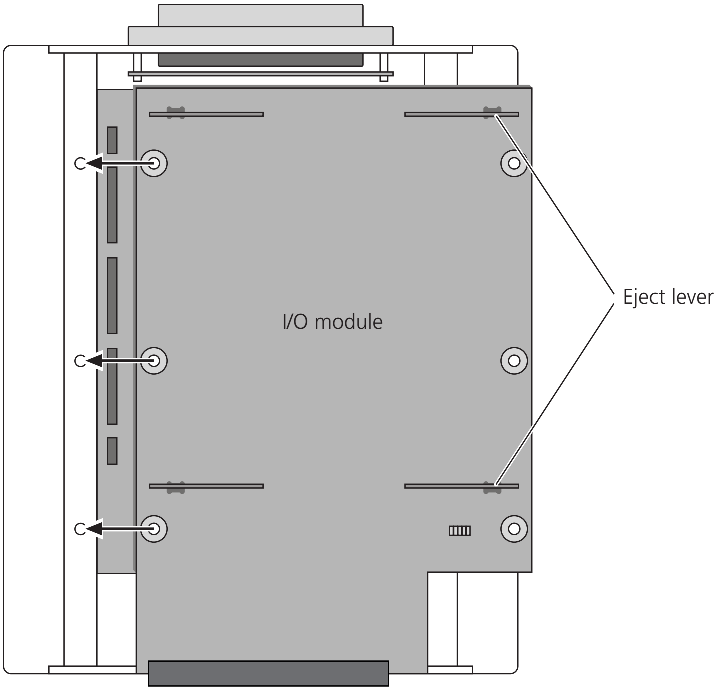
3

**Note**

Take care that the eject levers are in neutral position as shown in the illustration below.

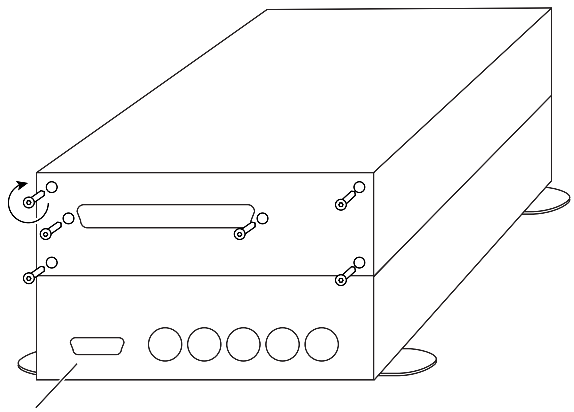



**4** Align the drill holes of the module and the housing and insert the I/O module by pressing evenly on the six drill holes.




**5** Tighten six screws to secure the I/O module against accidental disconnection. Use a PH0 Philips screwdriver.

**6** Attach the front cover by tightening the relevant screws. Use a 2 mm hexagon socket wrench for the outer screws and a 3/16 in. hex nut screwdriver for the screws of the I/O connector.




7 Attach the top cover of the MicroAutoBox. Use a 2.5 mm hexagon socket wrench.

**Result**

The I/O module is installed to MicroAutoBox.

**Related topics**

HowTos

- *How to Install IP Modules* on page 204

# Installing and Uninstalling IP Modules

**Objective**

MicroAutoBox II 1401/1505/1507, 1401/1507, 1401/1511/1512, 1401/1511/1514, 1401/1512/1513, and 1401/1513/1514 can be equipped with up to two IP modules. IP modules that are installed to MicroAutoBox provide additional interfaces to communication buses such as FlexRay or CAN.

**Where to go from here**

Information in this section



## How to Install IP Modules

**Objective**

MicroAutoBox II 1401/1505/1507, 1401/1507, 1401/1511/1512, 1401/1511/1514, 1401/1512/1513, and 1401/1513/1514 provide two IP slots (each with two AMP connectors) to install IP modules.

**Valid only for MicroAutoBox II 1401/1507**

***NOTICE***

**Do not install/uninstall IP modules to MicroAutoBox II 1401/1507 yourself. You may destroy parts of MicroAutoBox.**

If you want to use IP modules (DS4342, DS4340 or third-party) with your MicroAutoBox II 1401/1507, the IP modules must be installed by dSPACE. The assembling positions of the DS1401 Base Board and the DS1507 I/O Board in the MicroAutoBox housing do not allow direct access to the IP slots of the DS1507.

**Supported IP modules**

For information on which IP modules are supported, refer to:

- *Supported FlexRay IP Modules* on page 80
- *Supported CAN FD Modules* on page 130

**Preconditions**

- To avoid risk of injury and/or damage to the dSPACE hardware, read and ensure that you comply with the safety precautions, see *Safety Precautions for Installing and Connecting the Hardware* on page 22.
- Ensure you have all the items in the table below before starting:

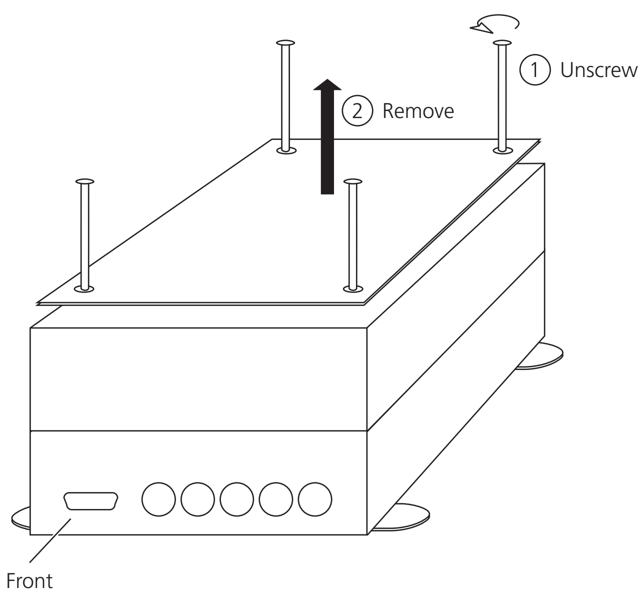
| Items | Count | Description |
|---|---|---|
| Hexagon socket wrench | 1 | 2.5 mm (0.1 in.) |
| Philips screwdriver | 1 | PH0 |

**Method**

**To install IP modules**

1 Disconnect MicroAutoBox from the power supply.

2 Open the housing of MicroAutoBox as shown in the illustration below. Use a 2.5 mm hexagon socket wrench.

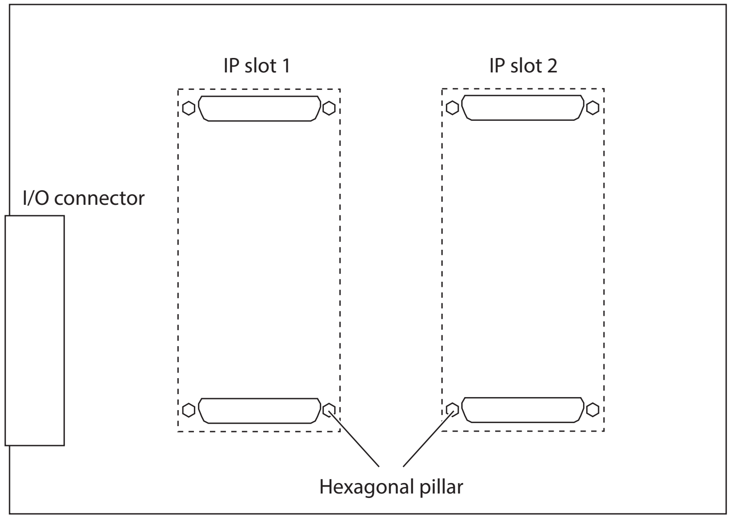



The DS1507, DS1512 or DS1514 I/O Board with the IP slots is on top.

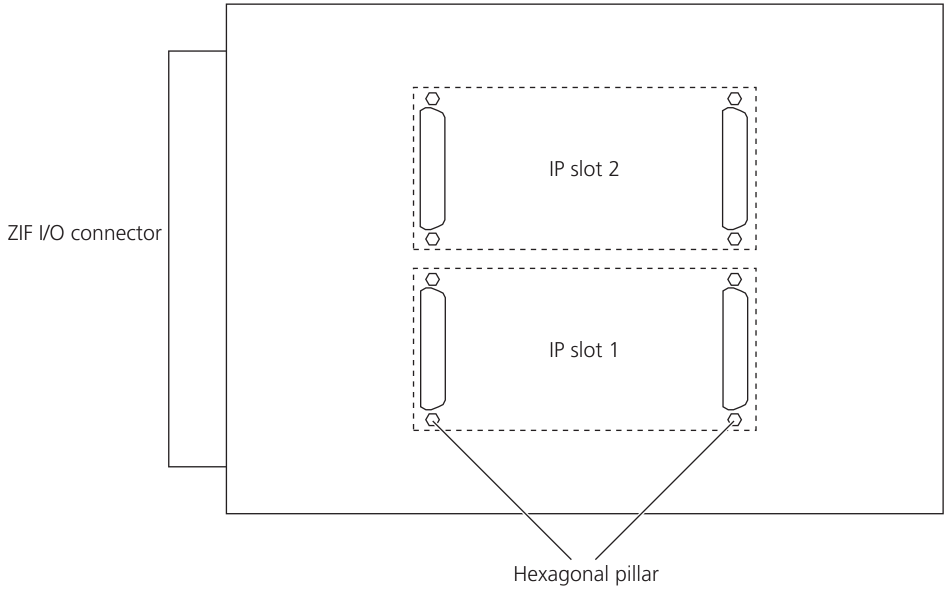
If an I/O module (such as the DS1552 Multi-I/O Module) is installed on the DS1512 or DS1514, remove it as described in *How to Uninstall I/O Modules* on page 192.

3 Install the IP modules. Secure the IP modules against accidental disconnection. Attach the IP modules by tightening the 4 delivered M2 Philips screws and washers to the hexagonal pillars. Use a PH0 Philips screwdriver.

The following illustration shows the IP slots on the DS1507:



The following illustration shows the IP slots on the DS1512 and DS1514:




4 If a I/O module was installed on the DS1512 or DS1514, install it again as described in *How to Install I/O Modules* on page 197.

5 Mount the cover of MicroAutoBox.

**Result**

The IP modules are installed in MicroAutoBox and the IP module signals are available at the 78-pin Sub-D connector (DS1507) or the ZIF I/O connector (DS1512 or DS1514) of the corresponding MicroAutoBox. Note that the pinouts differ depending on the IP module used. See:

- For the DS4340 FlexRay Interface Module: *Connector Pinouts* on page 633
- For the DS4342 CAN FD Interface Module: *Connector Pinouts* on page 641*Connector Pinouts* on page 641
- For third-party IP modules:
  - *Sub-D I/O Connector* on page 293 (for MicroAutoBox II 1401/1505/1507)
  - *Sub-D I/O Connector* on page 331 (for MicroAutoBox II 1401/1507)
  - *IP Module Connectors* on page 390 (for MicroAutoBox II 1401/1511/1512)

- *IP Module Connectors* on page 435 (for MicroAutoBox II 1401/1511/1514)
- *IP Module Connectors* on page 479 (for MicroAutoBox II 1401/1512/1513)
- *IP Module Connectors* on page 555 (for MicroAutoBox II 1401/1513/1514)

**Related topics**

HowTos

- *How to Install I/O Modules* on page 197

## How to Uninstall IP Modules

**Objective**

MicroAutoBox II 1401/1505/1507, 1401/1507, 1401/1511/1512, 1401/1511/1514, 1401/1512/1513, and 1401/1513/1514 might contain IP modules.

**Valid only for MicroAutoBox II 1401/1507**

**NOTICE**

**Do not install/uninstall IP modules to MicroAutoBox II 1401/1507 yourself. You may destroy parts of MicroAutoBox.**

If you want to use IP modules (DS4342, DS4340 or third-party) with your MicroAutoBox II 1401/1507, the IP modules must be installed by dSPACE. The assembling positions of the DS1401 Base Board and the DS1507 I/O Board in the MicroAutoBox housing do not allow direct access to the IP slots of the DS1507.

**Preconditions**

- To avoid risk of injury and/or damage to the dSPACE hardware, read and ensure that you comply with the safety precautions, see *Safety Precautions for Installing and Connecting the Hardware* on page 22.
- Ensure you have all the items in the table below before starting:

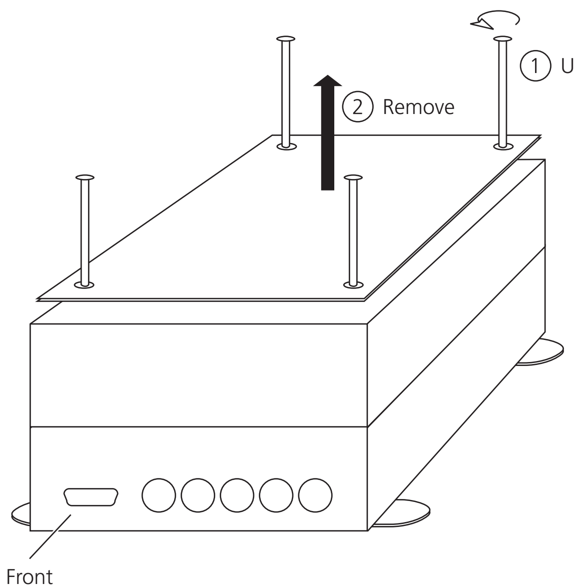
| Items | Count | Description |
|---|---|---|
| Hexagon socket wrench | 1 | 2.5 mm (0.1 in.) |
| Philips screwdriver | 1 | PH0 |

**Method**

**To uninstall IP modules**

1 Disconnect MicroAutoBox from the power supply.

2 Open the housing of MicroAutoBox as shown in the illustration below. Use a 2.5 mm hexagon socket wrench.

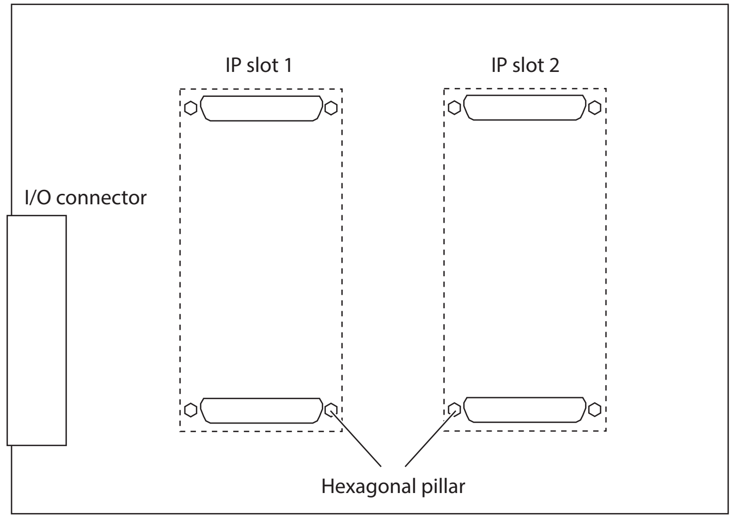



The DS1507, DS1512, or DS1514 I/O Board with the IP slots is on top.

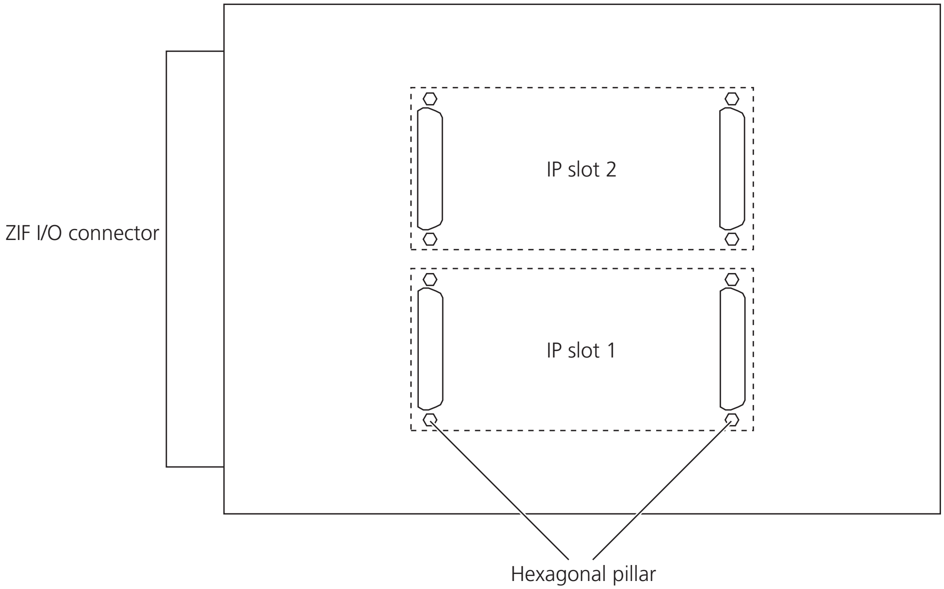
If an I/O module (such as the DS1552 Multi-I/O Module) is installed on the DS1512 or DS1514, remove it as described in *How to Uninstall I/O Modules* on page 192.

3 Uninstall the IP modules. Each module is screwed to the hexagonal pillars of the I/O board with 4 M2 Philips screws and washers. Use a PH0 Philips screwdriver to unscrew the modules and unplug the modules.

The following illustration shows the IP slots on the DS1507:




The following illustration shows the IP slots on the DS1512 and DS1514:




**4** If a I/O module was installed on the DS1512 or DS1514, install it again as described in *How to Install I/O Modules* on page 197.

**5** Mount the cover of the MicroAutoBox.

**Result** The IP modules are uninstalled.

# Uninstalling the System

**Uninstallation order**

All components of a dSPACE system, software and hardware, can be removed from the host PC in the following order:

1. You have first to remove the software.
2. Afterwards you can remove the hardware.

**Where to go from here**

Information in this section



Information in other sections


*Removing dSPACE Software* (📖 *Software Installation and Management Guide*)


## How to Remove the Hardware

**Objective**

Uninstalling the hardware means to remove MicroAutoBox from the vehicle.

**Method**

**To remove MicroAutoBox from a vehicle**

**⚠ WARNING**

**Even a brief disconnection of the battery while the engine is running results in a load dump of the car generator, producing hazardous voltages of more than 100 V.**

- Turn off the engine while connecting or disconnecting the car battery.

1 Turn off the vehicle engine.

2 Disconnect the MicroAutoBox from the power supply.

3 Disconnect the I/O wiring.

4 Remove the four bolts and remove the box from the vehicle.

# Data Sheet MicroAutoBox II 1401/1501

**Where to go from here**

Information in this section

# Overview and General Information

**Where to go from here**

Information in this section

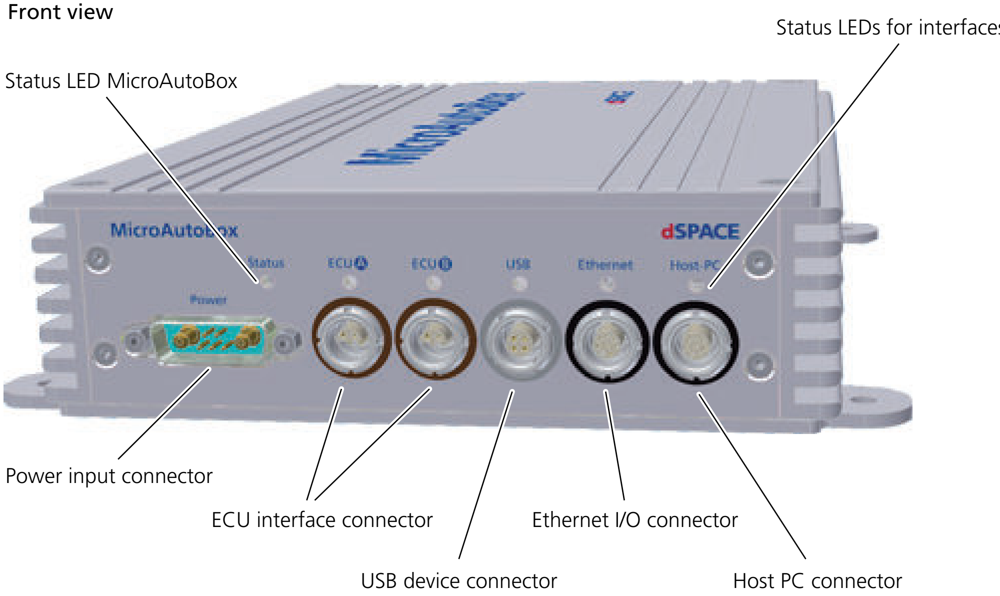


## Housing Components

**Connectors and status LEDs**

The illustrations show where the connectors and status LEDs are located on MicroAutoBox II 1401/1501.

Front view



Rear view


MicroAutoBox II 1401/1501 contains the following connectors and LEDs (from left to right):

**Power input connector** Supplies the required power to MicroAutoBox. It is a 7-pin, male Sub-D connector with two high-current pins.

A preconfigured cable with a matching connector and a separate power input connector are included in each MicroAutoBox package. For the pinout and further details on the preconfigured cable, refer to *Power Input Connector* on page 226.

**Status LED MicroAutoBox** Shows you different states and potential malfunctions.

If battery power is switched on and the REMOTE signal/KL15 is activated (see *Basics on Connecting to Power Supply* on page 44), the status LED (= dual LED) shows different states indicated by the LED color:

- LED is red: Reset state and no application is downloaded to the real-time processor.
- LED is green: Application is running.
- LED is flashing red: MicroAutoBox is in secured mode. For further instructions, refer to *Checking MicroAutoBox* on page 672.

The status LED on the front panel has the same functionality as the status LED on the rear panel of MicroAutoBox.

**ECU interface connectors** Provide communication to ECUs based on the LVDS standard, for example, in bypassing scenarios or to connect a RapidPro system (used as I/O subsystem). The ECU interface connectors are 4-pin LEMO connectors. Matching cables are supplied from dSPACE on request.

The corresponding LED is lit green, if power at both ends of the link is available and the relevant connection is serviceable. The LED flashes when data is being sent or received.

The table below shows the different ECU interfaces integrated into MicroAutoBox and the display names they are mapped to in the experiment software, for example, ControlDesk.

| Display Name in Software | Connectors Built-in at MicroAutoBox | | |
|---|---|---|---|
| | ECU A | ECU B | ZIF I/O |
| ECU 1 | – | – | ✓ |
| ECU 2 | ✓ | – | – |
| ECU 3 | – | ✓ | – |

**USB device connector** A 4-pin LEMO connector to connect an USB mass storage device to use the USB Flight Recorder feature of MicroAutoBox. A matching cable with a LEMO-USB adapter is supplied from dSPACE on request.

**Note**

To use the USB Flight Recorder, a separate license is required.

The possible states of the corresponding LED are listed in the table below:

| LED Status | Meaning |
|---|---|
| Off | No USB device is connected. |
| Green | USB device is connected and flight recorder is not running. |
| Green blinking | USB device is connected and flight recorder is running. |
| Orange | USB device is full and the active flight recorder is specified not to overwrite old files. |
| Red | Write error when accessing the USB device, for example, if the device was removed while the flight recorder was running. |

For further information, refer to *Flight Recorder* (📖 *MicroAutoBox Features*).

**Ethernet I/O connector** An 8-pin LEMO connector that provides communication to external devices, such as PCs or ECUs based on the UDP/IP Ethernet protocol, for example, in bypassing scenarios.

A matching cable with a LEMO-RJ45 adapter is supplied from dSPACE on request.

The corresponding LED is lit green if power is available at both ends of the link and the relevant connection is serviceable. The LED flashes green when data is being sent or received.

For installation instructions, refer to *How to Connect MicroAutoBox to the ECU via UDP/IP* (📖 *ECU Interfaces Hardware Installation and Configuration*).

**Host PC connector** Provides the communication between MicroAutoBox and your host PC based on the Ethernet TCP/IP protocol. The connector is a 8-pin LEMO connector. A matching cable is included in each MicroAutoBox package.

The corresponding LED is lit green if power is available at both ends of the link and the relevant connection is serviceable. The LED flashes green when data is being sent or received.

**Tip**

The Ethernet I/O connector and the Host PC connector are internally connected by a common gigabit Ethernet switch (valid for base board DS1401-25ff).

This simplifies the connection options. For an example, refer to *Connecting an ECU with DCI-GSI2 for Simultaneous Calibration and Bypassing* (📖 *ECU Interfaces Hardware Installation and Configuration*).

**ZIF I/O connector** The 156-pin zero insertion force (ZIF) I/O connector provides access to the most input and output signals provided by MicroAutoBox. A matching connector is included in each MicroAutoBox package.

For the pinout, refer to *ZIF I/O Connector* on page 224.

# General Data

**General characteristics**

The following table shows some general characteristics of MicroAutoBox:

| Parameter | | Specification[1)] |
|---|---|---|
| Base board (DS1401-20ff.) | Processor | ■ PPC750 GL Power PC<br>■ 900 MHz clock frequency<br>■ Real-time clock |
| | Memory | ■ 8 MB global RAM<br>■ 16 MB local RAM<br>■ 16 MB flash memory |
| | Onboard sensors[2)] | Pressure sensor:<br>■ Base board DS1401-23ff.<br>■ Range: 50 kPA ...115 kPa<br>■ Accuracy: 1 kPa<br>■ Sample rate: approx. 200 Hz<br>Acceleration sensor<br>■ Base board DS1401-23ff.<br>■ Range: ±2 g ... ±8 g in 3 axis (x/y/z)<br>■ Resolution: 10 bit per axis<br>■ Sample rate: max. 800 Hz<br>■ FIFO buffer: 512 words (to read and write bursts) |
| Communication interfaces | | ■ 1 x Host PC interface based on Ethernet TCP/IP protocol<br>■ 1 x Ethernet I/O interface based on Ethernet UDP/IP protocol for Ethernet bypassing scenarios<br>■ 3 x ECU interface based on LVDS standard (one interface is accessible via ZIF I/O connector)<br>■ 1 x USB interface for USB flight recording (separate license) |
| I/O connectors | | ■ 1 x 156-pin ZIF I/O connector<br>  ■ max. 15 mΩ contact resistance<br>  ■ 10000 cycles durability<br>  ■ max. 2.5 A continuous current per pin ($T_{ambient}$ = +85 °C)<br>■ 1 x 7-pin power supply input connector |

| Parameter | | Specification[1] |
|---|---|---|
| Chassis dimensions | Case width | 202 mm (7.95 in.) |
| | Case height | 50 mm (1.97 in.) |
| | Case depth | 222 mm (8.74 in.) |
| Weight | | About 2.1 kg (4.6 lb.) without external cables |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.
[2] For further information on the sensors, refer to *Onboard Sensors* (*MicroAutoBox Features*).

## Absolute Maximum Levels

**Avoiding damage to the system**

**NOTICE**

Do not exceed the maximum levels since this might permanently damage the system.

**Levels**

The following table shows the levels (for example, voltage, temperature) of the MicroAutoBox. All voltages are referenced to GND (unless otherwise noted).

| Parameter | Specification[1] | Description |
|---|---|---|
| VBAT | –40 V ... +100 V | Load dump- and reverse protection |
| VDRIVE | 0 V ... +45 V | |
| All digital output voltages | (VDRIVE – 45 V) ... +45 V | |
| All digital input voltages | (VDRIVE – 45 V) ... +45 V | |
| All analog input voltages | –40 V ... +40 V | |
| All analog output voltages | –30 V ... +40 V | |
| VSENS output | 0 V ... +40 V | VSENS is switched on and off with the REMOTE pin. |
| VBATprot output | 0 V ... +45 V | VBATprot follows VBAT within the specified range.<br>VBATprot is switched on and off with the REMOTE pin. |
| RS232 transceiver output | –30 V ... +30 V | |
| RS232 transceiver input | –30 V ... +30 V | |
| CAN transceiver | –60 V ... +60 V | |
| Serial 2 K / LIN | –20 V ... +32 V | But not more than VBAT |

| Parameter | Specification[1)] | Description |
|---|---|---|
| Serial 2 L<br>All outputs short circuit to GND<br>Continuous power dissipation ($T_{ambient}$ = +85 °C)<br>Operating temperature<br>Storage temperature | –24 V ... +30 V<br>continuous<br>max. 25 W<br><br>–40 °C ... +85 °C<br>–55 °C ... +125 °C | But not more than VBAT |

[1)] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

# Certifications

**CE compliance**

MicroAutoBox meets the requirements of the European directive 2004/108/EG (Electromagnetic Compatibility Directive) for CE marking.

**Vibration and shock tests**

To verify the reliability of MicroAutoBox under realistic operating conditions, it was exposed to vibration and shock tests. During the tests, MicroAutoBox executed a program without any failures.

**Applied standards**

The characteristics of MicroAutoBox were tested according to the standards shown in the following table:

| Tested Characteristics | Applied Standard | Description |
|---|---|---|
| Electromagnetic compatibility (EMC) | EN 61326-1 Table 2 | Immunity standard for industrial environments[1)] |
| | CISPR 11, EN 55011 Group 1, Class A | Emission standard for industrial environments |
| Vibration | ISO 16750-3:2007 / 4.1.2.4 Test IV | Test conditions: Broad band noise, 2h per axis, RMS-acceleration 27.8 m/s$^2$ |
| | EN 60068-2-6 | Test conditions:<br>■ Swept sine, 1 octave per minute, 3-axis test<br>■ 5 ... 2000 Hz, up to 5 g, 2 sweeps per axis<br>■ Operating |
| Shock | ISO 16750-3:2007 / 4.2.2. | ■ Linear shock (1/2 sine pulse), 6-axis<br>■ 500 m/s$^2$, 6 ms, 10 pulses per axis<br>■ Operating |

[1)] Tested with an I/O cable length < 3 m.

# Connector Pinouts

**Where to go from here**

Information in this section



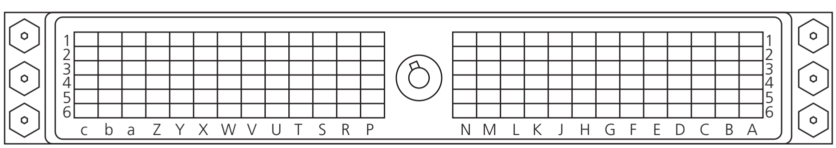
## ZIF I/O Connector

**Objective**

The I/O connector is a 156-pin zero insertion force (ZIF) connector giving access to the most input and output signals provided by MicroAutoBox.

**Pinout**

The following illustration shows the pin numbering of the I/O connector (rear view of MicroAutoBox):

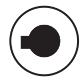



**Note**

There are pins identified by uppercase letters (A, B, C, etc.) and pins identified by lowercase letters (a, b, c).

The following table shows the signals of the I/O connector:

| **1** | | **2** | | **3** | | **4** | | **5** | | **6** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DAC 7 | out | DAC 8 | out | Group 1 ch 1 | out | Group 1 ch 2 | out | Group 1 ch 3 | out | Group 1 ch 4 | out | *A* |
| DAC 5 | out | DAC 6 | out | Group 1 ch 5 | out | Group 1 ch 6 | out | Group 1 ch 7 | out | CTM ch 1 | out | *B* |
| DAC 3 | out | DAC 4 | out | CTM ch 2 | out | CTM ch 5 | out | CTM ch 6 | out | CTM ch 7 | out | *C* |
| DAC 1 | out | DAC 2 | out | CTM ch 8 | out | CTM ch 3 | out | CTM ch 4 | out | Group 6 ch 1 | out | *D* |
| VDRIVE | in | VSENS | out | Group 6 ch 2 | out | Group 6 ch 3 | out | Group 6 ch 4 | out | Group 6 ch 5 | out | *E* |
| Group 6 ch 6 | out | Group 6 ch 7 | out | GND | in | GND | in | Group 6 ch 8 | out | TPU ch 1 | out | *F* |
| TPU ch 2 | out | TPU ch 3 | out | GND | in | GND | in | GND | in | TPU ch 4 | out | *G* |
| TPU ch 5 | out | TPU ch 6 | out | GND | in | GND | in | TPU ch 7 | out | TPU ch 8 | out | *H* |
| TPU ch 9 | out | TPU ch 10 | out | TPU ch 11 | out | TPU ch 12 | out | TPU ch 13 | out | TPU ch 14 | out | *J* |

| 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TPU ch 15 | out | TPU ch 16 | out | Group 2 ch 1 | out | Group 2 ch 2 | out | Group 2 ch 3 | out | Group 2 ch 4 | out | *K* |
| Group 2 ch 5 | out | Group 2 ch 6 | out | Group 2 ch 7 | out | Group 2 ch 8 | out | Group 3 ch 1 | out | Group 3 ch 2 | out | *L* |
| Group 3 ch 3 | out | CTM ch 1 | in | REMOTE | in | CTM ch 2 | in | CTM ch 3 | in | CTM ch 4 | in | *M* |
| Group 6 ch 1 | in | Group 6 ch 2 | in | Group 6 ch 3 | in | Group 6 ch 4 | in | Group 6 ch 5 | in | Group 6 ch 6 | in | *N* |
| | | | | | |  | | | | | | |
| Group 6 ch 7 | in | Group 6 ch 8 | in | TPU ch 1 | in | TPU ch 2 | in | TPU ch 3 | in | TPU ch 4 | in | *P* |
| TPU ch 5 | in | TPU ch 6 | in | TPU ch 7 | in | TPU ch 8 | in | TPU ch 9 | in | TPU ch 10 | in | *R* |
| TPU ch 11 | in | TPU ch 12 | in | TPU ch 13 | in | TPU ch 14 | in | TPU ch 15 | in | TPU ch 16 | in | *S* |
| Group 2 ch 1 | in | Group 2 ch 2 | in | Group 2 ch 3 | in | Group 2 ch 4 | in | Group 2 ch 5 | in | Group 2 ch 6 | in | *T* |
| Group 2 ch 7 | in | ADC Type 1 Con 4 Ch 4 | in | Serial 2 K / LIN | i/o | Serial 2 L | in | Serial 1 TXD | out | Serial 1 RXD | in | *U* |
| ADC Type 1 Con 2 Ch 4 | in | ADC Type 1 Con 3 Ch 4 | in | VBAT | in | VBAT | in | CAN 1 low | i/o | CAN 1 high | i/o | *V* |
| ADC Type 1 Con 1 Ch 4 | in | ADC Type 1 Con 4 Ch 3 | in | VBAT | in | VBAT | in | VBAT | in | Group 2 ch 8 | in | *W* |
| ADC Type 1 Con 2 Ch 3 | in | ADC Type 1 Con 3 Ch 3 | in | VBAT | in | VBAT | in | CAN 2 low | i/o | CAN 2 high | i/o | *X* |
| ADC Type 1 Con 1 Ch 3 | in | ADC Type 1 Con 4 Ch 2 | in | Group 4 ch 1 | in | Group 4 ch 2 | in | ECU / IF RX+ | in | Group 4 ch 3 | in | *Y* |
| ADC Type 1 Con 2 Ch 2 | in | ADC Type 1 Con 3 Ch 2 | in | Group 4 ch 4 | in | Group 4 ch 5 | in | ECU / IF RX- | in | Group 4 ch 6 | in | *Z* |
| ADC Type 1 Con 1 Ch 2 | in | ADC Type 1 Con 4 Ch 1 | in | Group 4 ch 7 | in | Group 4 ch 8 | in | ECU / IF TX- | out | Group 5 ch 1 | in | *a* |
| ADC Type 1 Con 2 Ch 1 | in | ADC Type 1 Con 3 Ch 1 | in | Group 5 ch 2 | in | Group 5 ch 3 | in | ECU / IF TX+ | out | Group 5 ch 4 | in | *b* |
| ADC Type 1 Con 1 Ch 1 | in | VBAT prot | out | Group 5 ch 5 | in | Group 5 ch 6 | in | Group 5 ch 7 | in | Group 5 ch 8 | in | *c* |

**Tip**

To use the digital inputs and outputs, you have to connect the VDRIVE pin inside the ZIF I/O connector according to the logic level needed. *This pin is not preconfigured in the ZIF I/O connector delivered with MicroAutoBox.* You have to connect VDRIVE (pin E1) to VSENS (pin E2) or VBATprot (pin c2). Use the preconfigured jumper cable which is included in the MicroAutoBox package.

**Signal descriptions**

For descriptions of the signals which are available on the ZIF I/O connector, refer to:

- *Digital Inputs* on page 232
- *Digital Outputs* on page 236
- *Analog Inputs* on page 241
- *Analog Outputs* on page 243
- ECU, CAN, LIN, Serial: *Interfaces* on page 244

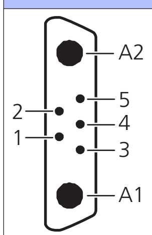
# Power Input Connector

**Objective**

MicroAutoBox provides a power input connector. It is a 7-pin, male connector with two high-current pins. It is a special variant of a 15-pin Sub-D connector (mixed-layout 7W2 Sub-D).

**Pinout**

The following illustration shows the pinout (front view of MicroAutoBox).

| Connector | Pin | Signal | Pin | Signal |
|---|---|---|---|---|
|  | A2[1] | VBAT (6 V … 40 V DC) | | |
| | | | 5 | REMOTE_PULLUP |
| | 2 | Do not connect | 4 | REMOTE[2] |
| | 1 | Do not connect | 3 | Do not connect |
| | A1 | GND | | |

[1] NOTE: It is highly recommended to insert a fuse into the main power supply input wire (close to battery). Choose the value of the fuse according to the maximum current. A 10 A fuse is recommended.

[2] The REMOTE input must be connected via switch or bridge to UBAT to run the MicroAutoBox. For example, you can use it for switching MicroAutoBox with KL15 (output of the ignition/driving switch). So, you can use the nonvolatile data feature to store data you may want to use again when restarting the application. For further information, refer to *Nonvolatile Data Handling* (📖 *MicroAutoBox RTLib Reference*).

**NOTICE**

**Risk of material damage**

**If MicroAutoBox is powered via a ZIF I/O connector, the applied voltages are also available at the pins of the power input connector.**

Do not remove the protective cap of the connector when it is unconnected.

**Matching cable**

A preconfigured cable for the supply voltage is provided by dSPACE. This cable is for running MicroAutoBox with a laboratory power supply during development. Therefore, REMOTE (pin 4) is shorted to VBAT (pin A2) inside the connector in order to save a separate switch. Do not use this cable in the vehicle. Otherwise, MicroAutoBox will always be turned on.

The VBAT wire (red) contains a melting fuse. Each wire has a cross-section of 1.5 $mm^2$.

Fuse specification:

- Cable delivered through dSPACE Release 2013-B: 7.5 A, time lag
- Cable delivered as of dSPACE Release 2014-A: 10 A, time lag

# Signal Descriptions

**Where to go from here**

Information in this section



## Power Inputs and Outputs

**Power input connector vs. ZIF I/O connector**

The pins VBAT, GND and REMOTE are located on the power input connector and on the ZIF I/O connector. It is recommended to use the pins on the power input connector.

**NOTICE**

**Risk of material damage**

**If MicroAutoBox is powered via a ZIF I/O connector, the applied voltages are also available at the pins of the power input connector.**

Do not remove the protective cap of the connector when it is unconnected.

**Note**

If you use the VBAT, GND and REMOTE pins on the ZIF I/O connector, do not use these pins on the power input connector at the same time, and vice versa.

The pinout of the ZIF I/O connector on MicroAutoBox II is fully compatible to earlier MicroAutoBox revisions. This means you can use a cable harness which has been built for earlier MicroAutoBox revisions also for MicroAutoBox II. Thus you can power MicroAutoBox II via the power supply pins on the ZIF I/O connector.

However, the compatibility is valid only for the same MicroAutoBox variants. For example, the pinout of MicroAutoBox 1401/1501 is compatible with MicroAutoBox II 1401/1501.

**Pin description**

The following table gives a description of the pins used for power input, remote input and supply of digital I/O circuits.

| Connector | Pins | Signal | Description / Function |
|---|---|---|---|
| Power input connector | A2 | VBAT | Main power supply input. Connect this pin to the positive pole of your car battery. |
| | A1 | GND | Main power supply return and reference for all input and output signals. Connect this pin to the minus pole of your car battery. The case of MicroAutoBox is also connected to GND. |
| | 4 | REMOTE | ■ The REMOTE input may be used for starting MicroAutoBox with a remote switch, for example KL15 (output of the ignition/driving switch).<br>■ If you connect the remote pin to the plus pole of the car battery directly, MicroAutoBox will always be turned on, and the car battery will soon be exhausted if the engine is not running. Thus, a switch is highly recommended.<br>■ The voltage connected to the REMOTE pin should not exceed the supply voltage. |
| | 5 | REMOTE_Pullup | You can use this output to connect a remote switch between REMOTE and this pin. REMOTE_Pullup is internally connected to VBAT via 39 kΩ pull-up resistor. |
| ZIF I/O connector | V3, V4, W3, W4, W5, X3, X4 | VBAT | Main power supply input. Connect at least 2 pins to the plus of your car battery. |
| | F3, F4, G3, G4, G5, H3, H4 | GND | Main power supply return and reference for all input and output signals. Use the nearest possible GND pin as reference for your signals in order to keep noise levels at minimum. The case of MicroAutoBox is also connected to GND. |

| Connector | Pins | Signal | Description / Function |
|---|---|---|---|
| | E1 | VDRIVE | This input supplies all digital input and output circuits.<br>■ Connect this input to VSENS to set TTL-compatible logic levels for your inputs/outputs.<br>■ Connect this input to VBATprot to set automotive-compatible logic levels for your inputs/outputs.<br>■ Do not connect this pin directly to VBAT, because the input and output circuits are not load-dump-protected or reverse-voltage-protected at this signal.<br>■ While MicroAutoBox is being powered down, the output stages may have pull-up behavior to VDRIVE. So the outputs may reach the level of VDRIVE. If this behavior is critical in your application, you have to power down your external devices or VDRIVE before powering down MicroAutoBox. You can also use the REMOTE signal (Kl. 15) with the power control software functionality to first switch off VDRIVE via a relay. |
| | E2 | VSENS | Sensor supply output.<br>Use this output to supply your sensors and/or VDRIVE. If you need CMOS/TTL-compatible logic levels at the inputs/outputs connect VSENS to VDRIVE. |
| | c2 | VBAT prot | Protected VBAT output.<br>Use this output to supply VDRIVE when automotive logic levels are needed. |
| | M3 | REMOTE | ■ The remote voltage may be used for starting MicroAutoBox with a remote switch: KL15, for example (output of the ignition/driving switch).<br>■ If you connect the remote pin to the car battery directly, MicroAutoBox will always be turned on, and the car battery will soon be exhausted if the engine is not running. Thus, a switch is highly recommended.<br>■ The remote voltage should not exceed the supply voltage. |

**Tip**

To use the digital inputs and outputs, you have to connect the VDRIVE pin inside the ZIF I/O connector according to the logic level needed. *This pin is not preconfigured in the ZIF I/O connector delivered with MicroAutoBox.* You have to connect VDRIVE (pin E1) to VSENS (pin E2) or VBATprot (pin c2). Use the preconfigured jumper cable which is included in the MicroAutoBox package.

**Characteristics**

The characteristics are specified for the following conditions:

- $V_{BAT}$=+12 V (unless otherwise noted)
  $T_{CASE}$=+25 °C (unless otherwise noted)
  All voltages are referenced to GND (unless otherwise noted).

| Signal[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Power** | | | | | | |
| Operating voltage | VBAT | For start-up | 6 | | 40 | V |
| | VBAT | Operating | 4 | | 40 | V |
| | VBAT | Reverse protection | | | -40 | V |
| | VBAT | Load dump protection | | | +100 | V |
| **Inputs** | | | | | | |
| Operating current | $I_{VBAT}$ | REMOTE ≥ $V_{iHRemote}$ | | 1.3 | | A |
| | $I_{VBAT}$ | REMOTE ≤ $V_{iLRemote}$ | | 5 | | mA |
| REMOTE voltage input | $V_{iHRemote}$ | Input high voltage | 4.7 | | | V |
| | $V_{iLRemote}$ | Input low voltage | | | 0.8 | V |
| | $V_{iHysRemote}$ | Input hysteresis voltage | 0.5 | 1 | | V |
| | $R_{inRemote}$ | Input impedance | 60 | | 185 | kΩ |
| Inrush current | $I_{VBAT\ inrush}$ | All inputs/outputs unconnected | see *Power supply* on page 40 | | | |
| Digital I/O voltage supply input | VDRIVE | Supply for digital input/output circuits | | | 45 | V |
| | $I_{VDRIVE\ no\ load}$ | All inputs/outputs unconnected | | 10 | | mA |
| | $I_{VDRIVE\ maximum\ load}$ | All outputs shorted to GND | | 500 | | mA |
| **Outputs** | | | | | | |
| Sensor supply output | VSENS | Output voltage | 4.84 | 5.05 | 5.25 | V |
| | VSENS = f(T) | Temperature caused voltage drift $T_{CASE}$ = –40 °C ... +85 °C | –2 | | 2 | % |
| | $I_{VSENS,\ max}$ | Maximum output current | 750 | | | mA |
| Protected VBAT output | VBATprot | IL = 1A; VBAT = 12 V | 11.56 | 11.78 | 12 | V |
| | $I_{VBATprot,\ max}$ | Maximum output current | | | 1000 | mA |
| | $I_{ProtPeak}$ | overload current limit (–40 °C ... 85 °C) | 4 | | 9 | A |
| | t(overload) | time to shut off $I_{ProtPeak}$ | | | 5 | ms |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

# Digital Inputs

**General behavior of digital signals**

Most digital signals have separate input and output pins. If your software defines a signal for output, the corresponding input has no function. If the software defines a signal as input the corresponding output pin has the same level as the corresponding input pin.

When software does not control the digital I/O signals (during reset or before correct initialization) each output will be in the same state as the corresponding input. This allows you to define the default (reset) state of each output by driving the input with an external signal.

**Note**

If you use this feature ensure that your software initializes your output signal to the same state you defined for the input.

**Pin description**

The following table gives a description of the digital input pins:

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| M2, M4, M5, M6 | CTM ch 1 … 4 | DIO | Capture/compare inputs with pull-up. Inputs for frequency or pulse-width measurement. |
| N1 ... P2 | Group 6 ch 1 ... 8 | DIO | Standard discrete digital input with pull-up. |
| P3 | TPU ch 1 | DIO | This input drives the first channel of the internal Time Processing Unit of the DIO module, which is useful for motor management. Therefore, the signal is conditioned by an adaptive Schmitt trigger, which generates one single impulse whenever the input voltage crosses 0 V to negative voltages. This single impulse is also used for driving the main CPU INT13. |
| P4 | TPU ch 2 | DIO | ■ Also drives the main CPU INT4 [1)] even when a corresponding out is used<br>■ Provides a pull-up |
| P5 | TPU ch 3 | DIO | ■ Also drives the main CPU INT5 [1)] even when a corresponding out is used<br>■ Provides a pull-up |
| P6 | TPU ch 4 | DIO | ■ Also drives the main CPU INT6 [1)] even when a corresponding out is used<br>■ Provides a pull-up |
| R1 | TPU ch 5 | DIO | ■ Also drives the main CPU INT7 [1)] even when a corresponding out is used<br>■ Provides a pull-up |

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| R2 | TPU ch 6 | DIO | ■ Also drives the main CPU INT8 [1)] even when a corresponding out is used<br>■ Provides a pull-up |
| R3 | TPU ch 7 | DIO | ■ Also drives the main CPU INT9 even when a corresponding out is used<br>■ Provides a pull-up<br>■ Can generate external interrupt [1)] |
| R4 | TPU ch 8 | DIO | ■ Also drives the main CPU INT11 [1)] even when a corresponding out is used<br>■ Provides a pull-up |
| R5 | TPU ch 9 | DIO | ■ Also drives the main CPU INT15 [1)] even when a corresponding out is used<br>■ Provides a pull-up |
| R6 ... S6 | TPU ch 10 ... 16 | DIO | Like TPU ch 2 ... 9 in, but no additional function. TPU ch 10 ... 16 in have pull-ups. |
| T1 ... U1, W6 | Group 2 ch 1 ... 8 | DIO | Standard discrete digital input with pull-up |
| a6, b3, b4, b6, c3 ... c6 | Group 5 ch 1 ... 8 | DIO | Standard discrete digital input without pull-up/pull-down<br>These signals can also be analog to digital converted (10-bit resolution) by the DIO module. |
| Y3, Y4, Y6, Z3, Z4, Z6, a3, a4 | Group 4 ch 1 ... 8 | DIO | |

[1)] See *Basics on Interrupt Handling* (📖 *MicroAutoBox Features*)

**Characteristics**

The characteristics are specified for the following conditions:

- $V_{BAT}$=+12 V (unless otherwise noted)

  $T_{CASE}$=+25 °C (unless otherwise noted)

  All voltages are referenced to GND (unless otherwise noted).

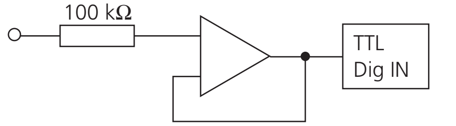
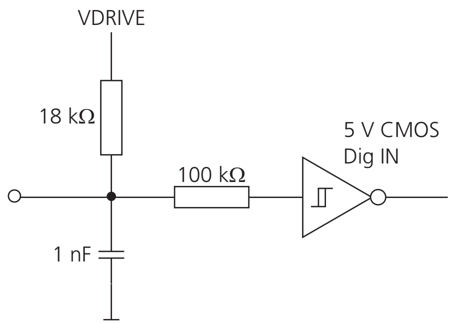
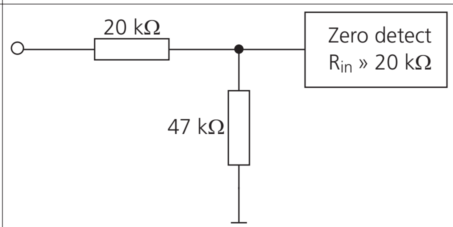
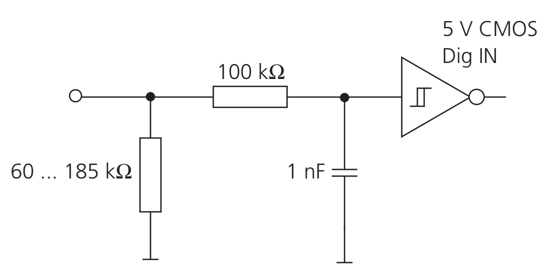
| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC characteristics** | | | | | | |
| Group 4 & Group 5 | $V_{iHG45}$ | Input high voltage | 3.9 | | | V |
| | $V_{iLG45}$ | Input low voltage | | | 0.8 | V |
| | $R_{inG45}$ | Input impedance | 100 | | | kΩ |
| CTM & Group 2 & Group 6 & TPU 2 ... 16 | $V_{iH}$ | Input high voltage | 3.5 | | | V |
| | $V_{iL}$ | Input low voltage | | | 1.2 | V |
| | $V_{iHys}$ | Input hysteresis voltage | 0.5 | 1 | | V |
| | $R_{digin}$ | Pull-up resistor to VDRIVE | 17 | 18 | 19 | kΩ |
| | $C_{digin}$ | Input capacitance | 0.9 | 1 | 1.1 | nF |

| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| TPU1 | $R_{inTPU1}$ | Input impedance<br>TPU1 is signal conditioned by an adaptive sense amplifier optimized for automotive crankshaft sensors | 19 | | | kΩ |
| REMOTE | $V_{iHRemote}$ | Input high voltage | 4.7 | | | V |
| | $V_{iLRemote}$ | Input low voltage | | | 0.8 | V |
| | $V_{iHysRemote}$ | Input hysteresis voltage | 0.5 | 1 | | V |
| | $R_{Remote}$ | Pull-down resistor to GND | 60 | 170 | 190 | kΩ |
| **AC characteristics** | | | | | | |
| Inputs (except Group 4 & 5) | $t_{PDInLH}$ | Low-high propagation delay of input signals | | | 1 | µs |
| | $t_{PDInHL}$ | High-low delay of input signals | | | 1 | µs |
| Inputs Group 4 & 5 | $t_{PDInG45LH}$ | Low-high delay of input signals | | | 1 | µs |
| | $t_{PDInG45HL}$ | High-low delay of input signals | | | 1 | µs |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagrams**

The following table shows *simplified* diagrams of the I/O circuitry of the digital inputs:

| Signal | | I/O Circuit |
|---|---|---|
| Digital inputs | Group 4 & Group 5 | <br> |
| | Group 2 & Group 6 & CTM & TPU2 … TPU16 | <br><br>For proper operation, VDRIVE must have a level above the maximum input voltage. |
| | TPU1 | <br> |
| | Remote | <br> |

# Digital Outputs

**General behavior of digital signals**

Most digital signals have separate input and output pins. If your software defines a signal for output, the corresponding input has no function. If the software defines a signal as input the corresponding output pin has the same level as the corresponding input pin.

When software does not control the digital I/O signals (during reset or before correct initialization) each output will be in the same state as the corresponding input. This allows you to define the default (reset) state of each output by driving the input with an external signal.

**Note**

If you use this feature ensure that your software initializes your output signal to the same state you defined for the input.

**Pin description**

The following table gives a description of the digital output pins:

| Pins | Signal | Module | Default state | Description / Function |
|---|---|---|---|---|
| A3 ... A6, B3 ... B5 | Group 1 ch 1 ... 7 | DIO Type 1 | low | Standard discrete digital output.<br>Group 1 is for output only. You cannot change the default state of the signal because there is no corresponding input pin. |
| C3, D5 | CTM ch 2 and CTM ch 4 | DIO Type 1 | high | PWM outputs of the DIO-Capture/Compare unit.<br>CTM ch 2 and CTM ch 4 used as PWM outputs are supported only in the extended engine control boot mode. |
| C4 ... C6, D3 | CTM ch 5 ... CTM ch 8 | DIO Type 1 | high | PWM outputs of the DIO-Capture/Compare unit. |
| D6, E3 ... F2, F5 | Group 6 ch 1 ... 8 | DIO Type 1 | high | Standard discrete digital output. |
| F6 | TPU ch 1 | DIO Type 1 | high | DIO-Time Processing Unit output 1.<br>Due to the special "TPU ch 1 input" this signal will not directly follow its input. It rather shows the single impulse created by this input signal conditioning. |

| Pins | Signal | Module | Default state | Description / Function |
|---|---|---|---|---|
| G1, G2, G6 ... H2, H5 ... K2 | TPU ch 2 ... 16 | DIO Type 1 | high | DIO-Time Processing Unit output 2 ... 16.<br>Depending on the DIO TPU firmware the TPU outputs can perform a complete motor management or simply generate PWM or discrete output signals. |
| K3 | Group 2 ch 1 | DIO Type 1 | high | Standard discrete digital output.<br>*While resetting the DIO module this signal is high, independent from the state of "Group 2 ch 1 in".* |
| K4 ... L4 | Group 2 ch 2 ... 8 | DIO Type 1 | high | Standard discrete digital output. |
| L5 ... M1 | Group 3 ch 1 ... 3 | DIO Type 1 | low | Standard discrete digital output.<br>Group 3 is for output only. You cannot change the default state of the signal because there is no corresponding input pin. |

*Default state* means the state of the signal without any connection to the corresponding input and/or without any output action by the software.

**Characteristics**

The characteristics are specified for the following conditions:

- $V_{BAT}$=+12 V (unless otherwise noted)

  $T_{CASE}$=+25 °C (unless otherwise noted)

  All voltages are referenced to GND (unless otherwise noted).

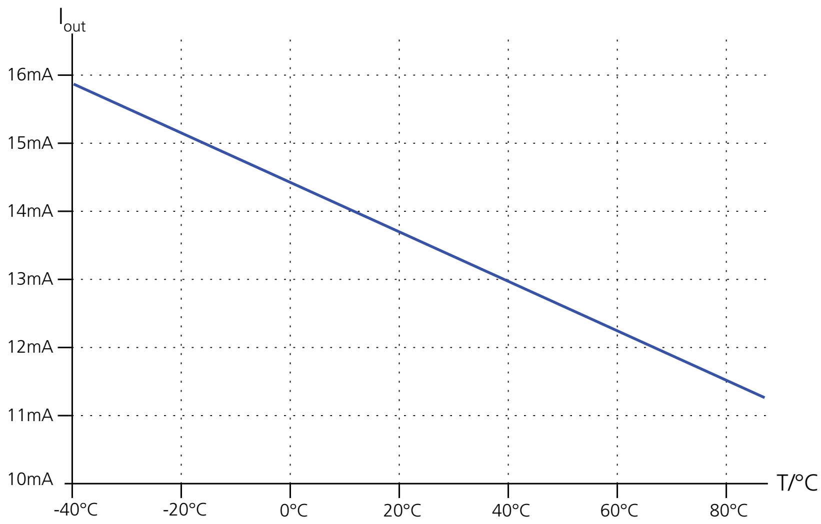
| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC Characteristics** | | | | | | |
| CTM & Group 1 & Group 2 & Group 3 & Group 6 & TPU | $V_{oH}$ | IL = 0 mA; VDRIVE = 5 V | 3.1 | 4.5 | | V |
| | $V_{oL}$ | IL = 0 mA; VDRIVE = 5 V | | 0.2 | 0.85 | V |
| | $V_{oH}$ | IL = 5 mA; VDRIVE = 5 V | 3.1 | 3.4 | | V |
| | $V_{oL}$ | IL = –5 mA; VDRIVE = 5 V | | 0.6 | 0.85 | V |
| | $V_{oH}$ | IL = 0 mA; VDRIVE = 12 V | 10.1 | 11.5 | | V |
| | $V_{oL}$ | IL = 0 mA; VDRIVE = 12 V | | 0.25 | 0.85 | V |
| | $V_{oH}$ | IL = 5 mA; VDRIVE = 12 V | 10.1 | 10.4 | | V |
| | $V_{oL}$ | IL = –5 mA; VDRIVE = 12 V | | 0.6 | 0.85 | V |
| | $\lvert I_{OHmax} \rvert$ | Output current high<br>$T_{CASE}$ = –40 °C ... +85 °C | 5 | 12.5 | | mA |
| | $\lvert I_{OLmax} \rvert$ | Output current low<br>$T_{CASE}$ = –40 °C ... +85 °C | 5 | 13 | | mA |

| Signal[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **AC Characteristics** | | | | | | |
| Outputs | $t_{PDOutLH}$ | Low-high delay of output signals | | 0.5 | 1 | µs |
| | $t_{PDOutHL}$ | High-low delay of output signals | | 0.5 | 1 | µs |

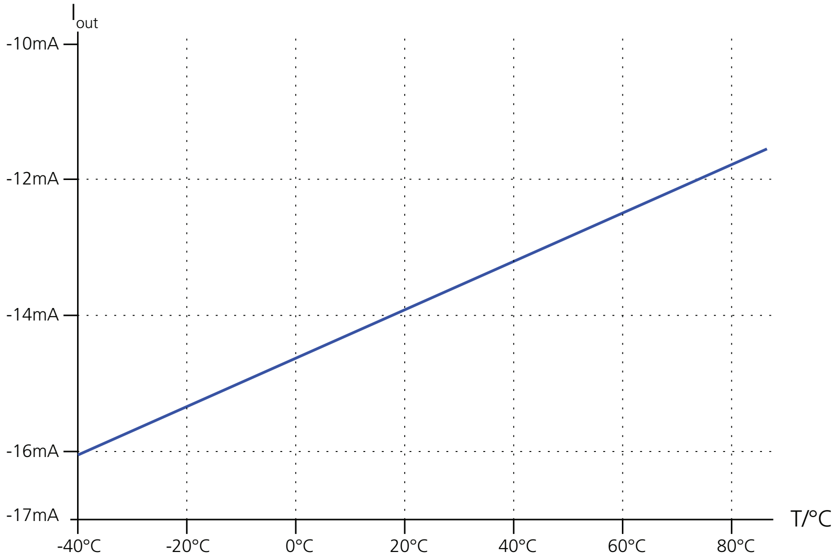
[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

The following illustrations show the maximum output current of a digital output circuit as a function of ambient temperature (VDRIVE = 12 V; output is shorted to 6 V):

- Output high

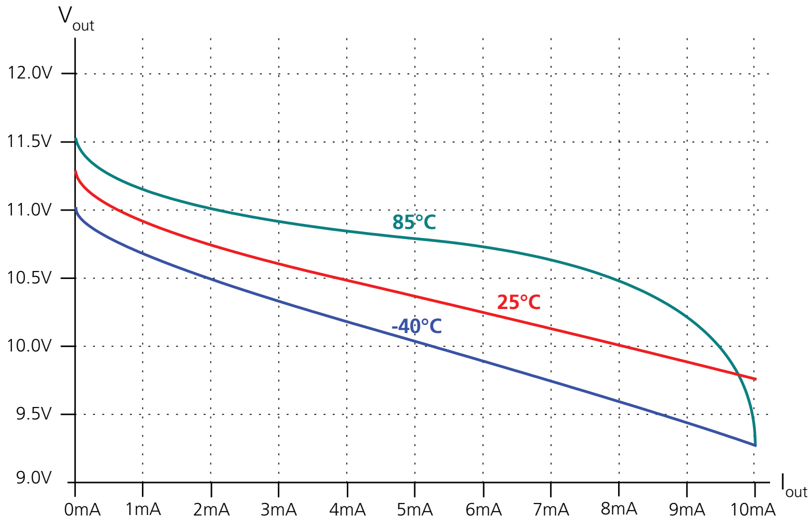


- Output low

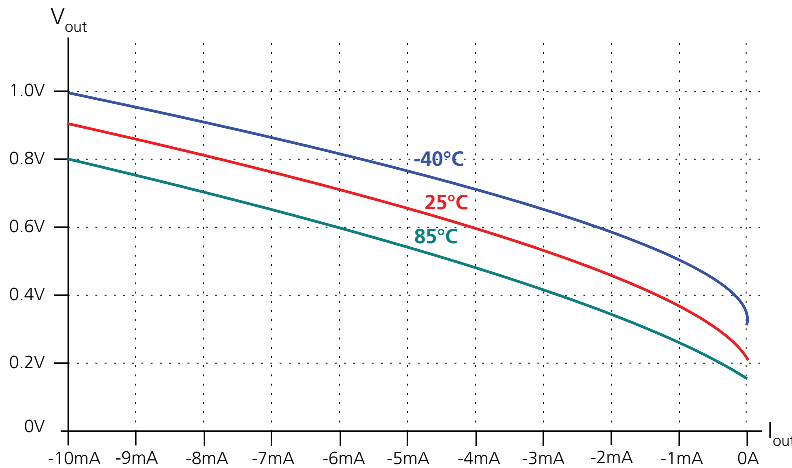



The following illustrations show the typical digital output voltage as a function of the output current (VDRIVE = 12 V):

- Output high

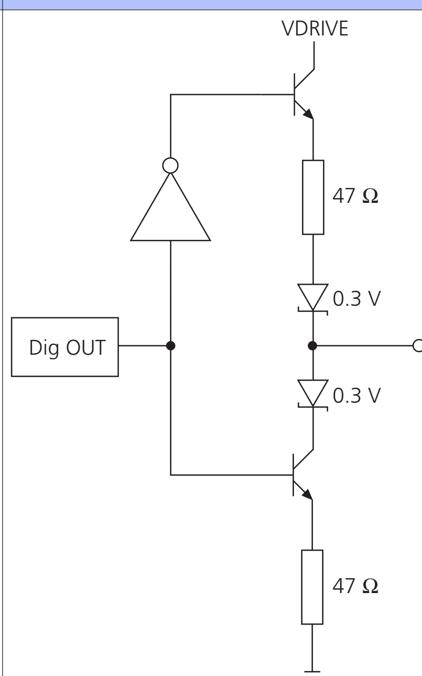


- Output low




**Circuit diagrams**

The following table shows a *simplified* diagram of the I/O circuitry of the digital outputs:

| Signal | | I/O Circuit |
|---|---|---|
| Digital outputs | Group 1 &<br>Group 2 &<br>Group 3 &<br>Group 6 &<br>CTM &<br>TPU | <br> |

# Analog Inputs

**Pin description**

The following table gives a description of the analog input pins:

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| c1, a1<br>Y1, W1<br>b1, Z1<br>b2, Z2<br>X1, V1<br>X2, V2<br>a2, Y2<br>W2, U2 | ADC Type 1 (all 16 channels) | ADC Type 1 (refer to *ADC Unit Type 1* (📖 *MicroAutoBox Features*)) | Standard analog inputs<br>These analog inputs are converted to a 12-bit digital value by the ADC module. |
| a6, b3, b4, b6, c3, c4, c5, c6, Y3, Y4, Y6, Z3, Z4, Z6, a3, a4 | Group 4 & 5 | DIO Type 1 ADC (refer to *DIO Type 1 ADC Unit* (📖 *MicroAutoBox Features*)) | Analog inputs, 10-bit resolution. |

**Characteristics**

The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25 °C; all voltages are referenced to GND.

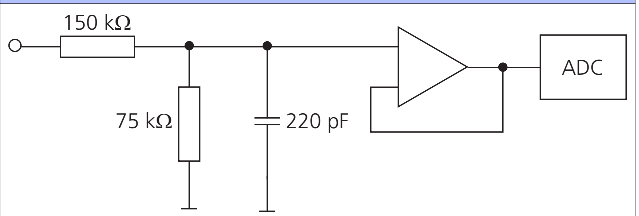
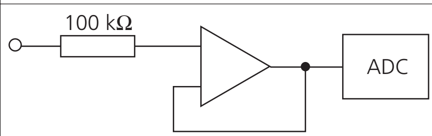
| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC characteristics** | | | | | | |
| ADC Type 1 (all 16 channels) | $V_{maxADC}$ | | 0 … 4.84 | 0 … 5.00 | 0 … 5.16 | V |
| | Resolution | No missing codes | 12 | | | bit |
| | Gain factor | | 4095/5 | | | LSB/V |
| | Offset error | Delivery state; $T_{CASE}$ = 25 °C | | 0.5 | | LSB |
| | Gain error | | | 0.5 | | LSB |
| | Offset error | $T_{CASE}$ = –40 °C … +85 °C | –10 | | +10 | LSB |
| | Gain error | | –1.25 | | 1.25 | % |
| | $Z_{inADC}$ | Input impedance | 150kΩ + 75kΩ‖220pF | | | typ. |
| Group 4 & Group 5 | $V_{maxADCG45}$ | | 0 … 4.7 | 0 … 5.0 | 0 … 5.3 | V |
| | Resolution | | 10 | | | bit |
| | Gain factor | | 1023/5 | | | LSB/V |
| | Offset error | Delivery state; $T_{CASE}$ = 25 °C | | 0.5 | | LSB |
| | Gain error | | | 0.5 | | LSB |
| | Offset error | $T_{CASE}$ = –40 °C … +85 °C | –10 | | +10 | LSB |
| | Gain error | | –5 | | 5 | % |
| | $R_{inG45}$ | Input impedance | 100 | | | kΩ |

| Signal[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **AC Characteristics** | | | | | | |
| ADC Type 1 (all 16 channels) | Conversion time | For all 16 channels (simultaneous sample) | 6.6 | | | µs |
| | $f_{gADC}$ | Low-pass cutoff frequency (3 dB) | 9.1 | 9.6 | 10.2 | kHz |
| Group 4 & 5 | Conversion time | Per channel (sequentially sample); | 10 | 17 | | µs |
| | No low-pass filter implemented | | | | | |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagrams**

The following table shows *simplified* diagrams of the I/O circuitry of the analog inputs:

| Signal | | I/O Circuit |
|---|---|---|
| Analog inputs | ADC Type 1 Channel 1 … 16 |  |
| | Group 4 & Group 5 |  |

**Related topics**

Basics

- *ADC Unit Type 1* (*MicroAutoBox Features*)
- *DIO Type 1 ADC Unit* (*MicroAutoBox Features*)

# Analog Outputs

**Pin description**

The following table gives a description of the analog output pins:

| Pins | Signal | Module | Default state | Description / Function |
|---|---|---|---|---|
| D1, D2<br>C1, C2<br>B1, B2<br>A1, A2 | DAC1 … DAC8 | DAC Type 1 (refer to *DAC Unit Type 1* (📖 *MicroAutoBox Features*)) | 0 V | Standard analog outputs<br>12-bit digital values are converted to analog outputs by the DAC module. |

*Default state* means the state of the signal during reset.

**Characteristics**

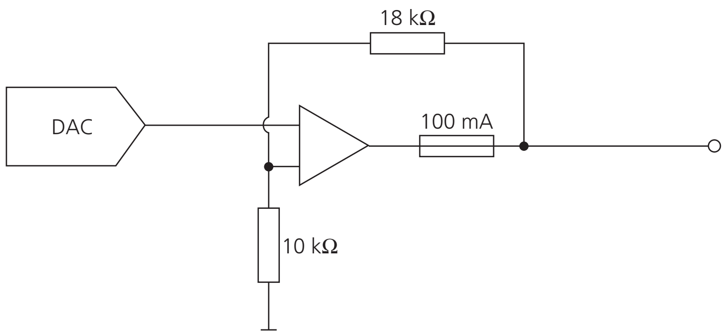
The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25 °C; all voltages are referenced to GND.

| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC characteristics** | | | | | | |
| DAC1 … DAC8 | $V_{DAC}$ | Full scale | 4.44 | 4.50 | 4.56 | V |
| | Resolution | Fully monotonic | 12 | | | bit |
| | Offset error | Delivery state; $T_{CASE}$ = 25 °C | | 2 | | mV |
| | Gain error | | | 0.5 | | LSB |
| | Offset error | $T_{CASE}$ = –40 °C ... +85 °C | –10 | | +10 | LSB |
| | Gain error | | –0.5 | | 0.5 | % |
| | $I_{DACout}$ | max. sink/ source current | –5 | | 5 | mA |
| | $V_{DACSAT}$ | Output voltage when sinking $I_{DACout}$ = –5 mA and CODE = 000H | | | 0.3 | V |
| **AC characteristics** | | | | | | |
| DAC1 … DAC8 | Settling time | Settling time of output (to 1 LSB) | | | 150 | µs |
| | $f_{gDAC}$ | Low-pass cutoff frequency of reconstruction filter (3 dB) | 10.2 | 10.8 | 11.4 | kHz |

[1)] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagrams**

The following table shows a *simplified* diagram of the I/O circuitry of the analog outputs:

| Signal | | I/O Circuit |
|---|---|---|
| Analog outputs | DAC1 … DAC8 (DAC Type 1) |  |

**Related topics**

Basics

- *DAC Unit Type 1* ( *MicroAutoBox Features*)

# Interfaces

**Pin description**

The following table gives a description of the interface pins available at the ZIF I/O connector.

**Tip**

The pinout of the ECU interface connectors, USB device connector, and Ethernet I/O connector is not documented. Use a suitable dSPACE connection cable.

| Pins | Signal | Module Type | Description / Function |
|---|---|---|---|
| Y5 | ECU / IF RX + | ECU Type 1 | ECU-bypassing interface. This reflective memory-based ECU-bypassing interface is proprietary to dSPACE. Connect the MicroAutoBox-RX pair to the ECU-TX pair and the MicroAutoBox-TX pair to the ECU-RX pair. Always use a CAT5 twisted-pair cable for this connection. |
| Z5 | ECU / IF RX - | | |
| b5 | ECU / IF TX + | | |
| a5 | ECU / IF TX - | | |

| Pins | Signal | Module Type | Description / Function |
|---|---|---|---|
| V5 | CAN 1 low | CAN Type 1 | CAN controller:<br>■ CAN 1 high = CAN high of module number 1, channel number 1<br>■ CAN 2 high = CAN high of module number 1, channel number 2<br>■ ISO 11898 interface<br>■ The MicroAutoBox CAN buses are not equipped with bus termination by default. For information on terminating the CAN buses, refer to *How to Terminate the CAN Bus* on page 124. |
| V6 | CAN 1 high | | |
| X5 | CAN 2 low | CAN Type 1 | |
| X6 | CAN 2 high | | |
| U6 | Serial 1 RXD | CAN Type 1 | RS232 interface |
| U5 | Serial 1 TXD | | |
| U3 | Serial 2 K / LIN | CAN Type 1 | LIN or ISO 9141 interface<br>The K line/LIN interface is bidirectional. The L line is input only. Both lines have no pull-up. For proper function of the K line connect an external pull-up resistor (4.7 kΩ) from this line to VBAT.<br>For information on configuring a LIN master, refer to *Connecting to a LIN Bus* on page 108. |
| U4 | Serial 2 L | | |

**Characteristics**

The interface characteristics are specified for the following conditions: $V_{BAT}$ = +12 V; $T_{CASE}$ = +25 °C; all voltages are referenced to GND.

| Interface | Parameter[1] | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Host PC | Protocol | TCP/IP | | | | |
| | Bitrate | | | ■ 10/1000[2]<br>■ 10/100[3] | | Mbit |
| | Data throughput | | | | 2.6 | MB/s |
| | Voltage levels | Ethernet standard | | | | |
| Ethernet I/O | Protocol | UDP/IP | | | | |
| | Bitrate | | | 1000 | | Mbit |
| | Voltage levels | Ethernet standard | | | | |
| USB | USB 2.0 standard (USB Flight Recording) | | | | | |
| | Data throughput | without connected host tool | | | 1280 | kB/sec |
| | | with connected host tool | | | 1024 | kB/sec |
| | | without data loss during cold start (dependent on the boot time of the host interface) | | | 640 | kB/sec |
| | Current | | | | 1.3 | A |
| | Voltage | | | | 5 | V |

| Interface | Parameter[1] | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| ECU | Bit rate | LVDS mode | | | 250 | MBit |
| | | LVDS2 mode | | | 560 | |
| | Cable length | 2-paired twisted pair | | | 5 | m |
| | Cable type | | CAT5 | | | |
| | Voltage levels | LVDS standard | | | | |
| | Full duplex data rate [4] | LVDS mode, Single transfer | | | 5 | MWord/s |
| | | LVDS2 mode, Single transfer | | | 11.2 | MWord/s |
| | | LVDS2 mode, Block transfer | | | 28 | MWord/s |
| | RAM size [4] | LVDS / LVDS2 mode | 16 | | | kWord |
| | FIFO size[4] | LVDS / LVDS2 mode (Transmit buffer) | 1 | | | kWord |
| CAN | Bit rate | ISO 11898 interface | | | 1 | MBaud |
| Serial 1 RS232-Interface | Bit rate | | 5 | | 115.2k | Baud |
| | TX output voltage swing | 3 kΩ load | ±5 | ±9 | | V |
| | $V_{RxinLow}$ | RX input threshold low | | 1.4 | 0.8 | V |
| | $V_{RxinHigh}$ | RX input threshold high | 2.0 | 1.4 | | V |
| | Word length | | 5 | | 8 | bit |
| Serial 2 ISO9141-Interface | Bit rate | $R_{KO}$ = 510 Ω; $C_K \leq$ 1.3 nF | 5 | | 50k | Baud |
| | Word length | | 5 | | 8 | bit |
| Serial 2 LIN Interface | Bit rate | | 5 | | 20k | Baud |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.
2) Since board revision DS1401-23 (available since dSPACE Release 7.2).
3) Before board revision DS1401-23
4) Word is 16-bit wide

**Baud rate calculation of the serial interface**

**Note**

Due to the limitations of the UART baud rate generator, not all baud rates can be programmed exactly to the desired baud rate without error.

The UART baud rate generator provides several baud rates:

*To calculate the divisor T for a chosen baud rate*

$$T = \mathrm{Round}\left(\frac{230400}{\mathrm{BR\ (chosen)}}\right)$$

BR (chosen) = The baudrate to be generated
T = The baudrate generator divisor ($2 \leq T \leq 65535$)

*To calculate the real baud rate from a given divisor T*

$$\frac{\text{BR (real)}}{\text{Baud}} = \frac{230400}{\text{T}}$$

BR (real) = The baudrate you get
T = The baudrate generator divisor ($2 \leq T \leq 65535$)

*To calculate the resulting error*

$$\frac{\text{Error}_{\text{BR}}}{100\%} = \frac{\text{BR (real)} - \text{BR (chosen)}}{\text{BR (chosen)}}$$

**Note**

If $\text{Error}_{\text{BR}} \leq 2\%$, messages will be transferred and received correctly.

# Data Sheet MicroAutoBox II 1401/1504

**Where to go from here**

Information in this section

# Overview and General Information

**Where to go from here**

Information in this section

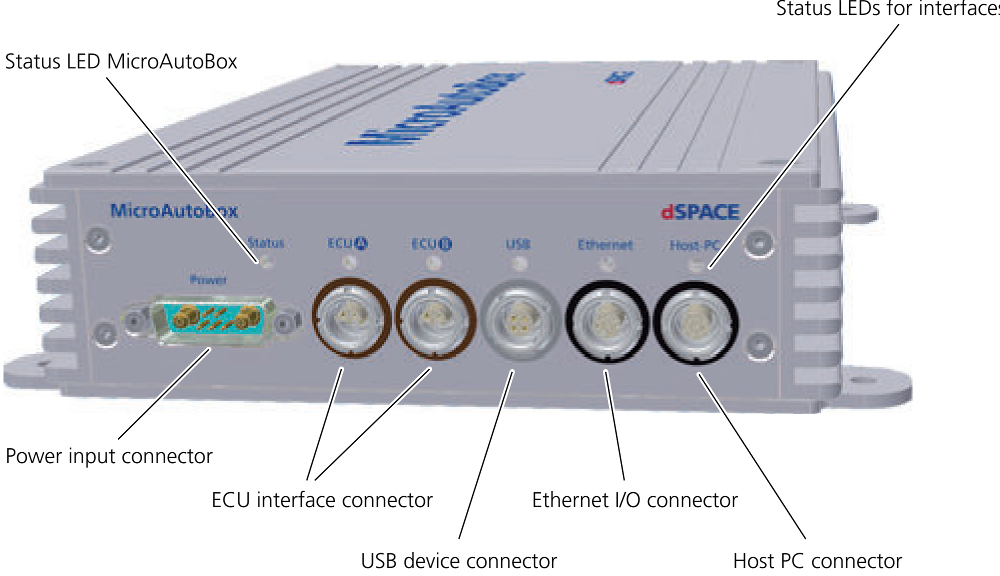


## Housing Components

**Connectors and status LEDs**

The illustrations where the connectors and status LEDs are located on MicroAutoBox II 1401/1504.

Front view



Rear view


MicroAutoBox II 1401/1504 contains the following connectors and LEDs (from left to right):

**Power input connector** Supplies the required power to MicroAutoBox. It is a 7-pin, male Sub-D connector with two high-current pins.

A preconfigured cable with a matching connector and a separate power input connector are included in each MicroAutoBox package. For the pinout and further details on the preconfigured cable, refer to *Power Input Connector* on page 260.

**Status LED MicroAutoBox** Shows you different states and potential malfunctions.

If battery power is switched on and the REMOTE signal/KL15 is activated (see *Basics on Connecting to Power Supply* on page 44), the status LED (= dual LED) shows different states indicated by the LED color:

- LED is red: Reset state and no application is downloaded to the real-time processor.
- LED is green: Application is running.
- LED is flashing red: MicroAutoBox is in secured mode. For further instructions, refer to *Checking MicroAutoBox* on page 672.

The status LED on the front panel has the same functionality as the status LED on the rear panel of MicroAutoBox.

**ECU interface connectors** Provide communication to ECUs based on the LVDS standard, for example, in bypassing scenarios or to connect a RapidPro system (used as I/O subsystem). The ECU interface connectors are 4-pin LEMO connectors. Matching cables are supplied from dSPACE on request.

The corresponding LED is lit green, if power at both ends of the link is available and the relevant connection is serviceable. The LED flashes when data is being sent or received.

The table below shows the different ECU interfaces integrated into MicroAutoBox and the display names they are mapped to in the experiment software, for example, ControlDesk.

| Display Name in Software | Connectors Built-in at MicroAutoBox | |
|---|---|---|
| | ECU A | ECU B |
| ECU 1 | ✓ | – |
| ECU 2 | – | ✓ |

**USB device connector** A 4-pin LEMO connector to connect an USB mass storage device to use the USB Flight Recorder feature of MicroAutoBox. A matching cable with a LEMO-USB adapter is supplied from dSPACE on request.

**Note**

To use the USB Flight Recorder, a separate license is required.

The possible states of the corresponding LED are listed in the table below:

| LED Status | Meaning |
|---|---|
| Off | No USB device is connected. |
| Green | USB device is connected and flight recorder is not running. |
| Green blinking | USB device is connected and flight recorder is running. |
| Orange | USB device is full and the active flight recorder is specified not to overwrite old files. |
| Red | Write error when accessing the USB device, for example, if the device was removed while the flight recorder was running. |

For further information, refer to *Flight Recorder* (📖 *MicroAutoBox Features*).

**Ethernet I/O connector** An 8-pin LEMO connector that provides communication to external devices, such as PCs or ECUs based on the UDP/IP Ethernet protocol, for example, in bypassing scenarios.

A matching cable with a LEMO-RJ45 adapter is supplied from dSPACE on request.

The corresponding LED is lit green if power is available at both ends of the link and the relevant connection is serviceable. The LED flashes green when data is being sent or received.

For installation instructions, refer to *How to Connect MicroAutoBox to the ECU via UDP/IP* (*ECU Interfaces Hardware Installation and Configuration*).

**Host PC connector** Provides the communication between MicroAutoBox and your host PC based on the Ethernet TCP/IP protocol. The connector is a 8-pin LEMO connector. A matching cable is included in each MicroAutoBox package.

The corresponding LED is lit green if power is available at both ends of the link and the relevant connection is serviceable. The LED flashes green when data is being sent or received.

**Tip**

The Ethernet I/O connector and the Host PC connector are internally connected by a common gigabit Ethernet switch (valid for base board DS1401-25ff).

This simplifies the connection options. For an example, refer to *Connecting an ECU with DCI-GSI2 for Simultaneous Calibration and Bypassing* (*ECU Interfaces Hardware Installation and Configuration*).

**ZIF I/O connector** The 156-pin zero insertion force (ZIF) I/O connector provides access to the most input and output signals provided by MicroAutoBox. A matching connector is included in each MicroAutoBox package.

For the pinout, refer to *ZIF I/O Connector* on page 258.

# General Data

**General characteristics**

The following table shows some general characteristics of MicroAutoBox:

| Parameter | | Specification[1] |
|---|---|---|
| Base board (DS1401-20ff.) | Processor | ■ PPC750 GL Power PC<br>■ 900 MHz clock frequency<br>■ Real-time clock |
| | Memory | ■ 8 MB global RAM<br>■ 16 MB local RAM<br>■ 16 MB flash memory |
| | Onboard sensors[2] | Pressure sensor:<br>■ Base board DS1401-23ff.<br>■ Range: 50 kPA ...115 kPa<br>■ Accuracy: 1 kPa<br>■ Sample rate: approx. 200 Hz<br>Acceleration sensor<br>■ Base board DS1401-23ff.<br>■ Range: ±2 g ... ±8 g in 3 axis (x/y/z)<br>■ Resolution: 10 bit per axis<br>■ Sample rate: max. 800 Hz<br>■ FIFO buffer: 512 words (to read and write bursts) |
| Communication interfaces | | ■ 1 x Host PC interface based on Ethernet TCP/IP protocol<br>■ 1 x Ethernet I/O interface based on Ethernet UDP/IP protocol for Ethernet bypassing scenarios<br>■ 2 x ECU interface based on LVDS standard<br>■ 1 x USB interface for USB flight recording (separate license) |
| I/O connectors | | ■ 1 x 156-pin ZIF I/O connector<br>  ■ max. 15 mΩ contact resistance<br>  ■ 10000 cycles durability<br>  ■ max. 2.5 A continuous current per pin ($T_{ambient}$ = +85 °C)<br>■ 1 x 7-pin power supply input connector |

| Parameter | | Specification[1] |
|---|---|---|
| Chassis dimensions | Case width | 202 mm (7.95 in.) |
| | Case height | 50 mm (1.97 in.) |
| | Case depth | 222 mm (8.74 in.) |
| Weight | | About 2.1 kg (4.6 lb.) without external cables |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

[2] For further information on the sensors, refer to *Onboard Sensors* (📖 *MicroAutoBox Features*).

# Absolute Maximum Levels

**Avoiding damage to the system**

**NOTICE**

Do not exceed the maximum levels since this might permanently damage the system.

**Levels**

The following table shows the levels (for example, voltage, temperature) of the MicroAutoBox. All voltages are referenced to GND (unless otherwise noted).

| Parameter | Specification[1] | Description |
|---|---|---|
| VBAT | –40 V ... +100 V | Load dump- and reverse protection |
| VDRIVE | 0 V ... +45 V | |
| All digital output voltages | (VDRIVE – 45 V) ... +45 V | |
| All digital input voltages | (VDRIVE – 45 V) ... +45 V | |
| All analog input voltages | –40 V ... +40 V | |
| All analog output voltages | –30 V ... +40 V | |
| VSENS output | 0 V ... +40 V | VSENS is switched on and off with the REMOTE pin. |
| VBATprot output | 0 V ... +45 V | VBATprot follows VBAT within the specified range.<br>VBATprot is switched on and off with the REMOTE pin. |
| RS232 transceiver output | –30 V ... +30 V | |
| RS232 transceiver input | –30 V ... +30 V | |
| CAN transceiver | –60 V ... +60 V | |
| Serial 2 K / LIN | –20 V ... +32 V | But not more than VBAT |

| Parameter | Specification[1] | Description |
|---|---|---|
| Serial 2 L | –24 V ... +30 V | But not more than VBAT |
| All outputs short circuit to GND | continuous | |
| Continuous power dissipation ($T_{ambient}$ = +85 °C) | max. 25 W | |
| Operating temperature | –40 °C ... +85 °C | |
| Storage temperature | –55 °C ... +125 °C | |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

# Certifications

**CE compliance**

MicroAutoBox meets the requirements of the European directive 2004/108/EG (Electromagnetic Compatibility Directive) for CE marking.

**Vibration and shock tests**

To verify the reliability of MicroAutoBox under realistic operating conditions, it was exposed to vibration and shock tests. During the tests, MicroAutoBox executed a program without any failures.

**Applied standards**

The characteristics of MicroAutoBox were tested according to the standards shown in the following table:

| Tested Characteristics | Applied Standard | Description |
|---|---|---|
| Electromagnetic compatibility (EMC) | EN 61326-1 Table 2 | Immunity standard for industrial environments[1] |
| | CISPR 11, EN 55011 Group 1, Class A | Emission standard for industrial environments |
| Vibration | ISO 16750-3:2007 / 4.1.2.4 Test IV | Test conditions: Broad band noise, 2h per axis, RMS-acceleration 27.8 m/s$^2$ |
| | EN 60068-2-6 | Test conditions:<br>■ Swept sine, 1 octave per minute, 3-axis test<br>■ 5 ... 2000 Hz, up to 5 g, 2 sweeps per axis<br>■ Operating |
| Shock | ISO 16750-3:2007 / 4.2.2. | ■ Linear shock (1/2 sine pulse), 6-axis<br>■ 500 m/s$^2$, 6 ms, 10 pulses per axis<br>■ Operating |

[1] Tested with an I/O cable length < 3 m.

# Connector Pinouts

**Where to go from here**

Information in this section



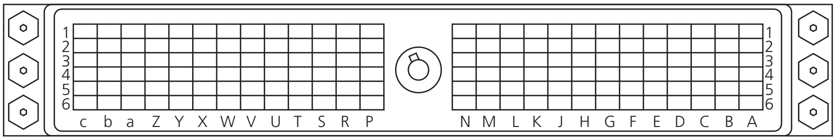
## ZIF I/O Connector

**Objective**

The I/O connector is a 156-pin zero insertion force (ZIF) connector giving access to the most input and output signals provided by MicroAutoBox.

**Pinout**

The following illustration shows the pin numbering of the I/O connector (rear view of MicroAutoBox):




> **Note**
>
> There are pins identified by uppercase letters (A, B, C, etc.) and pins identified by lowercase letters (a, b, c).

The following table shows the signals of the I/O connector:

| 1 | 2 | 3 | 4 | 5 | 6 | |
|---|---|---|---|---|---|---|
| ADC Type 3 Con 1 Ch 4 in | ADC Type 3 Con 2 Ch 4 in | Group 1 ch 1 out | Group 1 ch 2 out | Group 1 ch 3 out | Group 1 ch 4 out | *A* |
| ADC Type 3 Con 1 Ch 3 in | ADC Type 3 Con 2 Ch 3 in | Group 1 ch 5 out | Group 1 ch 6 out | Group 1 ch 7 out | CTM ch 1 out | *B* |
| ADC Type 3 Con 1 Ch 2 in | ADC Type 3 Con 2 Ch 2 in | CTM ch 2 out | CTM ch 5 out | CTM ch 6 out | CTM ch 7 out | *C* |
| ADC Type 3 Con 1 Ch 1 in | ADC Type 3 Con 2 Ch 1 in | CTM ch 8 out | CTM ch 3 out | CTM ch 4 out | Group 6 ch 1 out | *D* |
| VDRIVE in | VSENS out | Group 6 ch 2 out | Group 6 ch 3 out | Group 6 ch 4 out | Group 6 ch 5 out | *E* |
| Group 6 ch 6 out | Group 6 ch 7 out | GND in | GND in | Group 6 ch 8 out | TPU ch 1 out | *F* |

| 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TPU ch 2 | out | TPU ch 3 | out | GND | in | GND | in | GND | in | TPU ch 4 | out | *G* |
| TPU ch 5 | out | TPU ch 6 | out | GND | in | GND | in | TPU ch 7 | out | TPU ch 8 | out | *H* |
| TPU ch 9 | out | TPU ch 10 | out | TPU ch 11 | out | TPU ch 12 | out | TPU ch 13 | out | TPU ch 14 | out | *J* |
| TPU ch 15 | out | TPU ch 16 | out | Group 2 ch 1 | out | Group 2 ch 2 | out | Group 2 ch 3 | out | Group 2 ch 4 | out | *K* |
| Group 2 ch 5 | out | Group 2 ch 6 | out | Group 2 ch 7 | out | Group 2 ch 8 | out | Group 3 ch 1 | out | Group 3 ch 2 | out | *L* |
| Group 3 ch 3 | out | CTM ch 1 | in | REMOTE | in | CTM ch 2 | in | CTM ch 3 | in | CTM ch 4 | in | *M* |
| Group 6 ch 1 | in | Group 6 ch 2 | in | Group 6 ch 3 | in | Group 6 ch 4 | in | Group 6 ch 5 | in | Group 6 ch 6 | in | *N* |
| | | | | | | | | | | | | |
| Group 6 ch 7 | in | Group 6 ch 8 | in | TPU ch 1 | in | TPU ch 2 | in | TPU ch 3 | in | TPU ch 4 | in | *P* |
| TPU ch 5 | in | TPU ch 6 | in | TPU ch 7 | in | TPU ch 8 | in | TPU ch 9 | in | TPU ch 10 | in | *R* |
| TPU ch 11 | in | TPU ch 12 | in | TPU ch 13 | in | TPU ch 14 | in | TPU ch 15 | in | TPU ch 16 | in | *S* |
| Group 2 ch 1 | in | Group 2 ch 2 | in | Group 2 ch 3 | in | Group 2 ch 4 | in | Group 2 ch 5 | in | Group 2 ch 6 | in | *T* |
| Group 2 ch 7 | in | ADC Type 1 Con 4 Ch 4 | in | Serial 2 K / LIN | i/o | Serial 2 L | in | Serial 1 TXD | out | Serial 1 RXD | in | *U* |
| ADC Type 1 Con 2 Ch 4 | in | ADC Type 1 Con 3 Ch 4 | in | VBAT | in | VBAT | in | CAN 1 low | i/o | CAN 1 high | i/o | *V* |
| ADC Type 1 Con 1 Ch 4 | in | ADC Type 1 Con 4 Ch 3 | in | VBAT | in | VBAT | in | VBAT | in | Group 2 ch 8 | in | *W* |
| ADC Type 1 Con 2 Ch 3 | in | ADC Type 1 Con 3 Ch 3 | in | VBAT | in | VBAT | in | CAN 2 low | i/o | CAN 2 high | i/o | *X* |
| ADC Type 1 Con 1 Ch 3 | in | ADC Type 1 Con 4 Ch 2 | in | Group 4 ch 1 | in | Group 4 ch 2 | in | CAN 3 high | i/o | Group 4 ch 3 | in | *Y* |
| ADC Type 1 Con 2 Ch 2 | in | ADC Type 1 Con 3 Ch 2 | in | Group 4 ch 4 | in | Group 4 ch 5 | in | CAN 3 low | i/o | Group 4 ch 6 | in | *Z* |
| ADC Type 1 Con 1 Ch 2 | in | ADC Type 1 Con 4 Ch 1 | in | Group 4 ch 7 | in | Group 4 ch 8 | in | CAN 4 low | i/o | Group 5 ch 1 | in | *a* |
| ADC Type 1 Con 2 Ch 1 | in | ADC Type 1 Con 3 Ch 1 | in | Group 5 ch 2 | in | Group 5 ch 3 | in | CAN 4 high | i/o | Group 5 ch 4 | in | *b* |
| ADC Type 1 Con 1 Ch 1 | in | VBAT prot | out | Group 5 ch 5 | in | Group 5 ch 6 | in | Group 5 ch 7 | in | Group 5 ch 8 | in | *c* |

**Tip**

To use the digital inputs and outputs, you have to connect the VDRIVE pin inside the ZIF I/O connector according to the logic level needed. *This pin is not preconfigured in the ZIF I/O connector delivered with MicroAutoBox.* You have to connect VDRIVE (pin E1) to VSENS (pin E2) or VBATprot (pin c2). Use the preconfigured jumper cable which is included in the MicroAutoBox package.

**Signal descriptions**

For descriptions of the signals which are available on the ZIF I/O connector, refer to:

- *Digital Inputs* on page 266
- *Digital Outputs* on page 270
- *Analog Inputs* on page 275
- CAN, LIN, serial: *Interfaces* on page 277

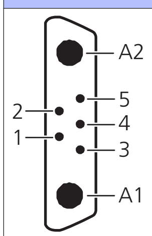
## Power Input Connector

**Objective**

MicroAutoBox provides a power input connector. It is a 7-pin, male connector with two high-current pins. It is a special variant of a 15-pin Sub-D connector (mixed-layout 7W2 Sub-D).

**Pinout**

The following illustration shows the pinout (front view of MicroAutoBox).

| Connector | Pin | Signal | Pin | Signal |
|---|---|---|---|---|
|  | A2[1] | VBAT (6 V … 40 V DC) | | |
| | | | 5 | REMOTE_PULLUP |
| | 2 | Do not connect | 4 | REMOTE[2] |
| | 1 | Do not connect | 3 | Do not connect |
| | A1 | GND | | |

[1] NOTE: It is highly recommended to insert a fuse into the main power supply input wire (close to battery). Choose the value of the fuse according to the maximum current. A 10 A fuse is recommended.

[2] The REMOTE input must be connected via switch or bridge to UBAT to run the MicroAutoBox. For example, you can use it for switching MicroAutoBox with KL15 (output of the ignition/driving switch). So, you can use the nonvolatile data feature to store data you may want to use again when restarting the application. For further information, refer to *Nonvolatile Data Handling* (📖 *MicroAutoBox RTLib Reference*).

**NOTICE**

**Risk of material damage**

**If MicroAutoBox is powered via a ZIF I/O connector, the applied voltages are also available at the pins of the power input connector.**

Do not remove the protective cap of the connector when it is unconnected.

**Matching cable**

A preconfigured cable for the supply voltage is provided by dSPACE. This cable is for running MicroAutoBox with a laboratory power supply during development. Therefore, REMOTE (pin 4) is shorted to VBAT (pin A2) inside the connector in order to save a separate switch. Do not use this cable in the vehicle. Otherwise, MicroAutoBox will always be turned on.

The VBAT wire (red) contains a melting fuse. Each wire has a cross-section of 1.5 mm².

Fuse specification:

- Cable delivered through dSPACE Release 2013-B: 7.5 A, time lag
- Cable delivered as of dSPACE Release 2014-A: 10 A, time lag

# Signal Descriptions

**Where to go from here**

Information in this section



## Power Inputs and Outputs

**Power input connector vs. ZIF I/O connector**

The pins VBAT, GND and REMOTE are located on the power input connector and on the ZIF I/O connector. It is recommended to use the pins on the power input connector.

**NOTICE**

**Risk of material damage**

**If MicroAutoBox is powered via a ZIF I/O connector, the applied voltages are also available at the pins of the power input connector.**

Do not remove the protective cap of the connector when it is unconnected.

**Note**

If you use the VBAT, GND and REMOTE pins on the ZIF I/O connector, do not use these pins on the power input connector at the same time, and vice versa.

The pinout of the ZIF I/O connector on MicroAutoBox II is fully compatible to earlier MicroAutoBox revisions. This means you can use a cable harness which has been built for earlier MicroAutoBox revisions also for MicroAutoBox II. Thus you can power MicroAutoBox II via the power supply pins on the ZIF I/O connector.

However, the compatibility is valid only for the same MicroAutoBox variants. For example, the pinout of MicroAutoBox 1401/1501 is compatible with MicroAutoBox II 1401/1501.

**Pin description**

The following table gives a description of the pins used for power input, remote input and supply of digital I/O circuits.

| Connector | Pins | Signal | Description / Function |
|---|---|---|---|
| Power input connector | A2 | VBAT | Main power supply input. Connect this pin to the positive pole of your car battery. |
| | A1 | GND | Main power supply return and reference for all input and output signals. Connect this pin to the minus pole of your car battery. The case of MicroAutoBox is also connected to GND. |
| | 4 | REMOTE | ■ The REMOTE input may be used for starting MicroAutoBox with a remote switch, for example KL15 (output of the ignition/driving switch).<br>■ If you connect the remote pin to the plus pole of the car battery directly, MicroAutoBox will always be turned on, and the car battery will soon be exhausted if the engine is not running. Thus, a switch is highly recommended.<br>■ The voltage connected to the REMOTE pin should not exceed the supply voltage. |
| | 5 | REMOTE_Pullup | You can use this output to connect a remote switch between REMOTE and this pin. REMOTE_Pullup is internally connected to VBAT via 39 kΩ pull-up resistor. |
| ZIF I/O connector | V3, V4, W3, W4, W5, X3, X4 | VBAT | Main power supply input. Connect at least 2 pins to the plus of your car battery. |
| | F3, F4, G3, G4, G5, H3, H4 | GND | Main power supply return and reference for all input and output signals. Use the nearest possible GND pin as reference for your signals in order to keep noise levels at minimum. The case of MicroAutoBox is also connected to GND. |

| Connector | Pins | Signal | Description / Function |
|---|---|---|---|
| | E1 | VDRIVE | This input supplies all digital input and output circuits.<br>■ Connect this input to VSENS to set CMOS/TTL-compatible logic levels for your inputs/outputs.<br>■ Connect this input to VBATprot to set automotive-compatible logic levels to your inputs/outputs.<br>■ Do not connect this pin directly to VBAT, because the input and output circuits are not load-dump-protected or reverse-voltage-protected at this signal.<br>■ While MicroAutoBox is being powered down, the output stages may have pull-up behavior to VDRIVE. So the outputs may reach the level of VDRIVE. If this behavior is critical in your application, you have to power down your external devices or VDRIVE before powering down MicroAutoBox. You can also use the REMOTE signal (Kl. 15) with the power control software functionality to first switch off VDRIVE via a relay. |
| | E2 | VSENS | Sensor supply output.<br>Use this output to supply your sensors and/or VDRIVE. If you need CMOS/TTL-compatible logic levels at the inputs/outputs connect VSENS to VDRIVE. |
| | c2 | VBAT prot | Protected VBAT output.<br>Use this output to supply VDRIVE when automotive logic levels are needed. |
| | M3 | REMOTE | ■ The remote voltage may be used for starting MicroAutoBox with a remote switch: KL15, for example (output of the ignition/driving switch).<br>■ If you connect the remote pin to the car battery directly, MicroAutoBox will always be turned on, and the car battery will soon be exhausted if the engine is not running. Thus, a switch is highly recommended.<br>■ The remote voltage should not exceed the supply voltage. |

**Tip**

To use the digital inputs and outputs, you have to connect the VDRIVE pin inside the ZIF I/O connector according to the logic level needed. *This pin is not preconfigured in the ZIF I/O connector delivered with MicroAutoBox.* You have to connect VDRIVE (pin E1) to VSENS (pin E2) or VBATprot (pin c2). Use the preconfigured jumper cable which is included in the MicroAutoBox package.

**Characteristics**

The characteristics are specified for the following conditions:

- $V_{BAT}$=+12 V (unless otherwise noted)
  $T_{CASE}$=+25 °C (unless otherwise noted)
  All voltages are referenced to GND (unless otherwise noted).

| Signal[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Power** | | | | | | |
| Operating voltage | VBAT | For start-up | 6 | | 40 | V |
| | VBAT | Operating | 4 | | 40 | V |
| | VBAT | Reverse protection | | | -40 | V |
| | VBAT | Load dump protection | | | +100 | V |
| **Inputs** | | | | | | |
| Operating current | $I_{VBAT}$ | REMOTE ≥ $V_{iHRemote}$ | | 1.3 | | A |
| | $I_{VBAT}$ | REMOTE ≤ $V_{iLRemote}$ | | 5 | | mA |
| REMOTE voltage input | $V_{iHRemote}$ | Input high voltage | 4.7 | | | V |
| | $V_{iLRemote}$ | Input low voltage | | | 0.8 | V |
| | $V_{iHysRemote}$ | Input hysteresis voltage | 0.5 | 1 | | V |
| | $R_{inRemote}$ | Input impedance | 60 | | 185 | kΩ |
| Inrush current | $I_{VBAT\ inrush}$ | All inputs/outputs unconnected | see *Power supply* on page 40 | | | |
| Digital I/O voltage supply input | VDRIVE | Supply for digital input/output circuits | | | 45 | V |
| | $I_{VDRIVE\ no\ load}$ | All inputs/outputs unconnected | | 10 | | mA |
| | $I_{VDRIVE\ maximum\ load}$ | All outputs shorted to GND | | 500 | | mA |
| **Outputs** | | | | | | |
| Sensor supply output | VSENS | Output voltage | 4.84 | 5.05 | 5.25 | V |
| | VSENS = f(T) | Temperature caused voltage drift $T_{CASE}$ = –40 °C ... +85 °C | –2 | | 2 | % |
| | $I_{VSENS,\ max}$ | Maximum output current | 750 | | | mA |
| Protected VBAT output | VBATprot | IL = 1A; VBAT = 12 V | 11.56 | 11.78 | 12 | V |
| | $I_{VBATprot,\ max}$ | Maximum output current | | | 1000 | mA |
| | $I_{ProtPeak}$ | overload current limit (–40 °C ... 85 °C) | 4 | | 9 | A |
| | t(overload) | time to shut off $I_{ProtPeak}$ | | | 5 | ms |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

# Digital Inputs

**General behavior of digital signals**

Most digital signals have separate input and output pins. If your software defines a signal for output, the corresponding input has no function. If the software defines a signal as input the corresponding output pin has the same level as the corresponding input pin.

When software does not control the digital I/O signals (during reset or before correct initialization) each output will be in the same state as the corresponding input. This allows you to define the default (reset) state of each output by driving the input with an external signal.

**Note**

If you use this feature ensure that your software initializes your output signal to the same state you defined for the input.

**Pin description**

The following table gives a description of the digital input pins:

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| M3 | REMOTE | - | Start signal of entire system (active high) with pull-down. |
| M2, M4, M5, M6 | CTM ch 1 … 4 | DIO Type 1 | Capture/compare inputs with pull-up. Inputs for frequency or pulse-width measurement. |
| N1 ... P2 | Group 6 ch 1 ... 8 | DIO Type 1 | Standard discrete digital input with pull-up. |
| P3 | TPU ch 1 | DIO Type 1 | This input drives the first channel of the internal Time Processing Unit of the DIO module, which is useful for motor management. Therefore, the signal is conditioned by an adaptive Schmitt trigger, which generates one single impulse whenever the input voltage crosses 0 V to negative voltages. This single impulse is also used for driving the main CPU INT13. |
| P4 | TPU ch 2 | DIO Type 1 | - also drives the main CPU INT4[1)] even when a corresponding out is used<br>- provides a pull-up |
| P5 | TPU ch 3 | DIO Type 1 | - also drives the main CPU INT5[1)] even when a corresponding out is used<br>- provides a pull-up |
| P6 | TPU ch 4 | DIO Type 1 | - also drives the main CPU INT6[1)] even when a corresponding out is used<br>- provides a pull-up |

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| R1 | TPU ch 5 | DIO Type 1 | - also drives the main CPU INT7[1] even when a corresponding out is used<br>- provides a pull-up |
| R2 | TPU ch 6 | DIO Type 1 | - also drives the main CPU INT8[1] even when a corresponding out is used<br>- provides a pull-up |
| R3 | TPU ch 7 | DIO Type 1 | - also drives the main CPU INT9[1] even when a corresponding out is used<br>- provides a pull-up |
| R4 | TPU ch 8 | DIO Type 1 | also drives the main CPU INT11[1] even when a corresponding out is used<br>- provides a pull-up |
| R5 | TPU ch 9 | DIO Type 1 | - also drives the main CPU INT15[1] even when a corresponding out is used<br>- provides a pull-up |
| R6 ... S6 | TPU ch 10 ... 16 | DIO Type 1 | Like TPU ch 2 ... 9 in, but no additional function. TPU ch 10 ... 16 in have pull-ups. |
| T1 ... U1, W6 | Group 2 ch 1 ... 8 | DIO Type 1 | Standard discrete digital input with pull-up |
| a6, b3, b4, b6, c3 ... c6 | Group 5 ch 1 ... 8 | DIO Type 1 | Standard discrete digital input without pull-up/pull-down. These signals can also be analog to digital converted (10-bit resolution) by the DIO module. |
| Y3, Y4, Y6, Z3, Z4, Z6, a3, a4 | Group 4 ch 1 ... 8 | DIO Type 1 | |

[1] See *Basics on Interrupt Handling* (📖 *MicroAutoBox Features*)

**Characteristics**

The characteristics are specified for the following conditions:

- $V_{BAT}$=+12 V (unless otherwise noted)

  $T_{CASE}$=+25 °C (unless otherwise noted)

  All voltages are referenced to GND (unless otherwise noted).

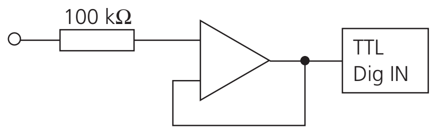
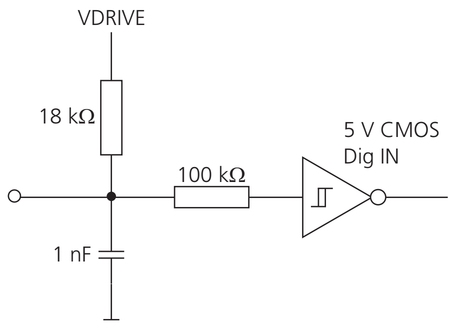
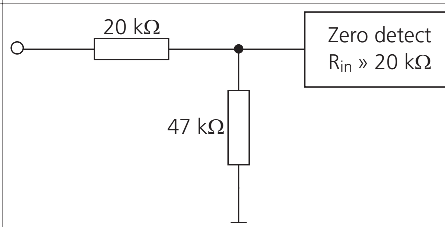
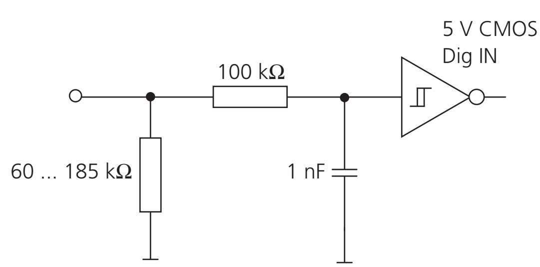
| Signal[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC characteristics** | | | | | | |
| Group 4 & Group 5 | $V_{iHG45}$ | Input high voltage | 3.9 | | | V |
| | $V_{iLG45}$ | Input low voltage | | | 0.8 | V |
| | $R_{inG45}$ | Input impedance | 100 | | | kΩ |

| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| CTM &<br>Group 2 &<br>Group 6 &<br>TPU 2 ... 16 | $V_{iH}$ | Input high voltage | 3.5 | | | V |
| | $V_{iL}$ | Input low voltage | | | 1.2 | V |
| | $V_{iHys}$ | Input hysteresis voltage | 0.5 | 1 | | V |
| | $R_{digin}$ | Pull-up resistor to VDRIVE | 17 | 18 | 19 | kΩ |
| | $C_{digin}$ | Input capacitance | 0.9 | 1 | 1.1 | nF |
| TPU1 | $R_{inTPU1}$ | Input impedance<br>TPU1 is signal conditioned by an adaptive sense amplifier optimized for automotive crankshaft sensors | 19 | | | kΩ |
| REMOTE | $V_{iHRemote}$ | Input high voltage | 4.7 | | | V |
| | $V_{iLRemote}$ | Input low voltage | | | 0.8 | V |
| | $V_{iHysRemote}$ | Input hysteresis voltage | 0.5 | 1 | | V |
| | $R_{Remote}$ | Pull-down resistor to GND | 60 | 170 | 190 | kΩ |
| **AC characteristics** | | | | | | |
| Inputs (except Group 4 & 5) | $t_{PDInLH}$ | Low-high propagation delay of input signals | | | 1 | µs |
| | $t_{PDInHL}$ | High-low delay of input signals | | | 1 | µs |
| Inputs Group 4 & 5 | $t_{PDInG45LH}$ | Low-high delay of input signals | | | 1 | µs |
| | $t_{PDInG45HL}$ | High-low delay of input signals | | | 1 | µs |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagrams**

The following table shows *simplified* diagrams of the I/O circuitry of the digital inputs:

| Signal | | I/O Circuit |
|---|---|---|
| Digital inputs | Group 4 & Group 5 |  |
| | Group 2 & Group 6 & CTM & TPU2 … TPU16 | <br>For proper operation, VDRIVE must have a level above the maximum input voltage. |
| | TPU1 |  |
| | Remote |  |

# Digital Outputs

**General behavior of digital signals**

Most digital signals have separate input and output pins. If your software defines a signal for output, the corresponding input has no function. If the software defines a signal as input the corresponding output pin has the same level as the corresponding input pin.

When software does not control the digital I/O signals (during reset or before correct initialization) each output will be in the same state as the corresponding input. This allows you to define the default (reset) state of each output by driving the input with an external signal.

**Note**

If you use this feature ensure that your software initializes your output signal to the same state you defined for the input.

**Pin description**

The following table gives a description of the digital output pins:

| Pins | Signal | Module | Default state | Description / Function |
|---|---|---|---|---|
| A3 ... A6, B3 ... B5 | Group 1 ch 1 ... 7 | DIO | low | Standard discrete digital output.<br>Group 1 is for output only. You cannot change the default state of the signal because there is no corresponding input pin. |
| C3, D5 | CTM ch 2 and CTM ch 4 | DIO | high | PWM outputs of the DIO-Capture/Compare unit.<br>CTM ch 2 and CTM ch 4 used as PWM outputs are supported only in the extended engine control boot mode. |
| C4 ... C6, D3 | CTM ch 5 ... CTM ch 8 | DIO Type 1 | high | PWM outputs of the DIO-Capture/Compare unit. |
| D6, E3 ... F2, F5 | Group 6 ch 1 ... 8 | DIO | high | Standard discrete digital output. |
| F6 | TPU ch 1 | DIO | high | DIO-Time Processing Unit output 1.<br>Due to the special "TPU ch 1 input" this signal will not directly follow its input. It rather shows the single impulse created by this input signal conditioning. |

| Pins | Signal | Module | Default state | Description / Function |
|---|---|---|---|---|
| G1, G2, G6 ... H2, H5 ... K2 | TPU ch 2 ... 16 | DIO | high | DIO-Time Processing Unit output 2 ... 16. Depending on the DIO TPU firmware the TPU outputs can perform a complete motor management or simply generate PWM or discrete output signals. |
| K3 | Group 2 ch 1 | DIO | high | Standard discrete digital output. *While resetting the DIO module this signal is high, independent from the state of "Group 2 ch 1 in".* |
| K4 ... L4 | Group 2 ch 2 ... 8 | DIO | high | Standard discrete digital output. |
| L5 ... M1 | Group 3 ch 1 … 3 | DIO | low | Standard discrete digital output. Group 3 is for output only. You cannot change the default state of the signal because there is no corresponding input pin. |

*Default state* means the state of the signal without any connection to the corresponding input and/or without any output action by the software.

**Characteristics**

The characteristics are specified for the following conditions:

- $V_{BAT}$=+12 V (unless otherwise noted)

  $T_{CASE}$=+25 °C (unless otherwise noted)

  All voltages are referenced to GND (unless otherwise noted).

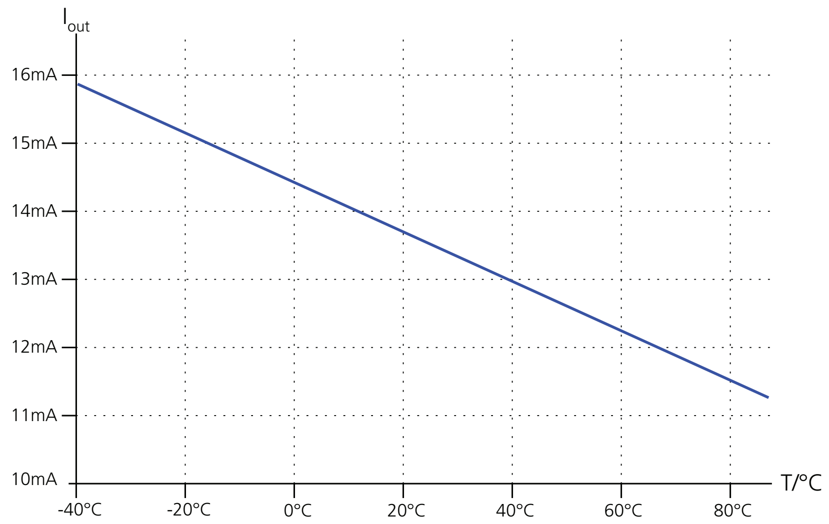
| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC Characteristics** | | | | | | |
| CTM & Group 1 & Group 2 & Group 3 & Group 6 & TPU | $V_{oH}$ | IL = 0 mA; VDRIVE = 5 V | 3.1 | 4.5 | | V |
| | $V_{oL}$ | IL = 0 mA; VDRIVE = 5 V | | 0.2 | 0.85 | V |
| | $V_{oH}$ | IL = 5 mA; VDRIVE = 5 V | 3.1 | 3.4 | | V |
| | $V_{oL}$ | IL = –5 mA; VDRIVE = 5 V | | 0.6 | 0.85 | V |
| | $V_{oH}$ | IL = 0 mA; VDRIVE = 12 V | 10.1 | 11.5 | | V |
| | $V_{oL}$ | IL = 0 mA; VDRIVE = 12 V | | 0.25 | 0.85 | V |
| | $V_{oH}$ | IL = 5 mA; VDRIVE = 12 V | 10.1 | 10.4 | | V |
| | $V_{oL}$ | IL = –5 mA; VDRIVE = 12 V | | 0.6 | 0.85 | V |
| | $\lvert I_{OHmax} \rvert$ | Output current high $T_{CASE}$ = –40 °C ... +85 °C | 5 | 12.5 | | mA |
| | $\lvert I_{OLmax} \rvert$ | Output current low $T_{CASE}$ = –40 °C ... +85 °C | 5 | 13 | | mA |

| Signal[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **AC Characteristics** | | | | | | |
| Outputs | $t_{PDOutLH}$ | Low-high delay of output signals | | 0.5 | 1 | µs |
| | $t_{PDOutHL}$ | High-low delay of output signals | | 0.5 | 1 | µs |

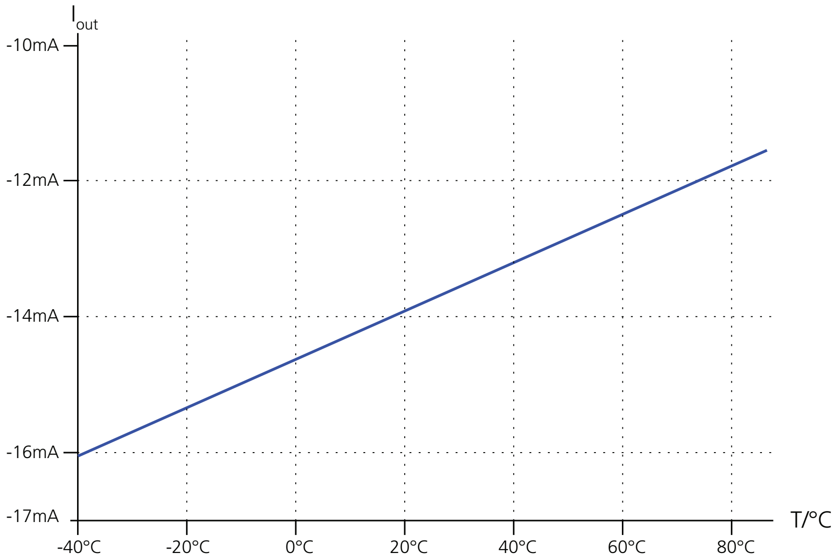
[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

The following illustrations show the maximum output current of a digital output circuit as a function of ambient temperature (VDRIVE = 12 V; output is shorted to 6 V):

- Output high

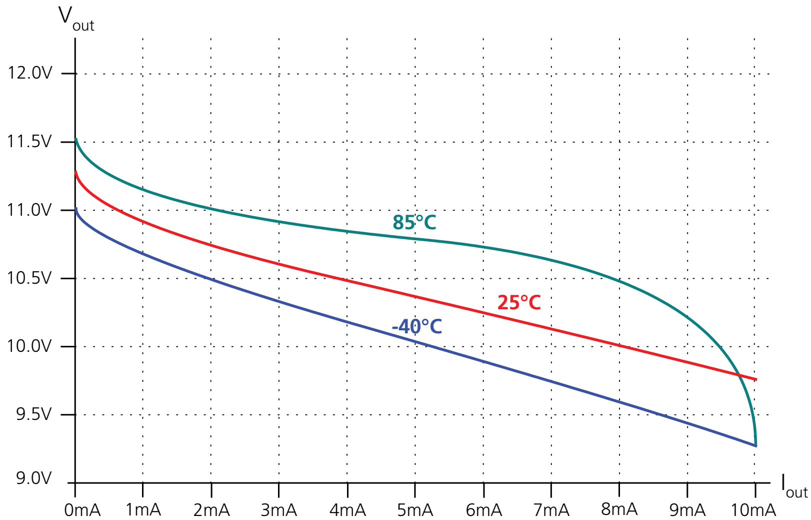


- Output low

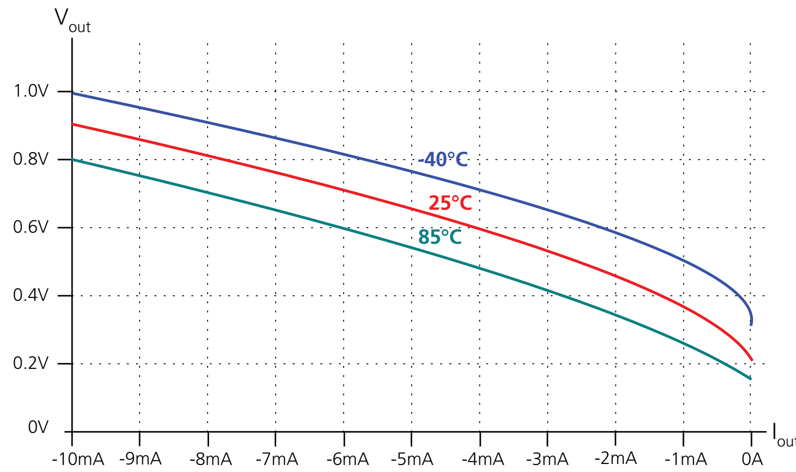



The following illustrations show the typical digital output voltage as a function of the output current (VDRIVE = 12 V):

- Output high

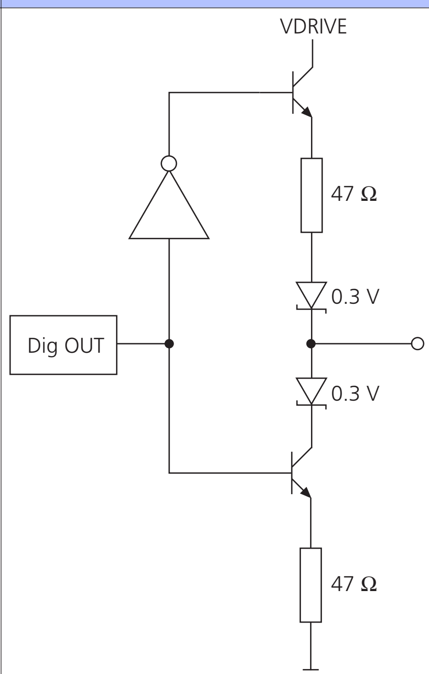


■ Output low




**Circuit diagrams**

The following table shows a *simplified* diagram of the I/O circuitry of the digital outputs:

| Signal | | I/O Circuit |
|---|---|---|
| Digital outputs | Group 1 &<br>Group 2 &<br>Group 3 &<br>Group 6 &<br>CTM &<br>TPU |  |

# Analog Inputs

**Pin description** The following table gives a description of the analog input pins:

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| c1, a1<br>Y1, W1<br>b1, Z1<br>b2, Z2<br>X1, V1<br>X2, V2<br>a2, Y2<br>W2, U2 | ADC Type 1<br>Con 1 ... 4<br>Ch 1 ... 4 | ADC Type 1 (refer to *ADC Unit Type 1* ( *MicroAutoBox Features*)) | Standard analog inputs<br>These analog inputs are converted to a 12-bit digital value by the first ADC module (type 1). |
| D1, C1<br>B1, A1<br>D2, C2<br>B2, A2 | ADC Type 3<br>Con 1 ... 2<br>Ch 1 ... 4 | ADC Type 3 (refer to *ADC Unit Type 3* ( *MicroAutoBox Features*)) | Standard analog inputs<br>These inputs are analog to 12-bit digital converted by the second ADC module (type 3). |
| a6, b3, b4, b6, c3, c4, c5, c6, Y3, Y4, Y6, Z3, Z4, Z6, a3, a4 | Group 4 & 5 | DIO Type 1 ADC (refer to *DIO Type 1 ADC Unit* ( *MicroAutoBox Features*)) | Analog inputs, 10-bit resolution. |

**Characteristics** The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25 °C; all voltages are referenced to GND.

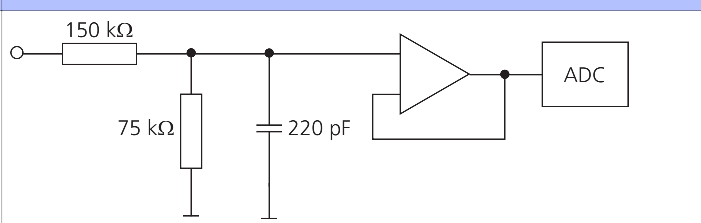
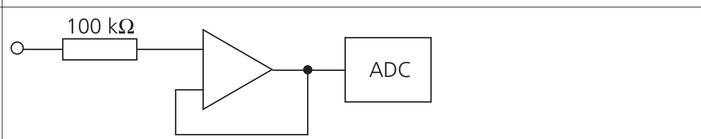
| Parameter[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC characteristics** | | | | | | |
| ADC Type 1<br>(all 16 channels)<br>ADC Type 3<br>(all 8 channels) | $V_{maxADC}$ | | 0 … 4.84 | 0 … 5.00 | 0 … 5.16 | V |
| | Resolution | No missing codes | 12 | | | bit |
| | Gain factor | | 4095/5 | | | LSB/V |
| | Offset error | Delivery state; $T_{CASE}$ = 25 °C | | 0.5 | | LSB |
| | Gain error | | | 0.5 | | LSB |
| | Offset error | $T_{CASE}$ = –40 °C ... +85 °C | –10 | | +10 | LSB |
| | Gain error | | –1.25 | | 1.25 | % |
| | $Z_{inADC}$ | Input impedance | $150k\Omega + 75k\Omega \| 220pF$ | | | typ. |

| Parameter[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Group 4 & Group 5 | $V_{maxADCG45}$ | | 0 … 4.7 | 0 … 5.0 | 0 … 5.3 | V |
| | Resolution | | 10 | | | bit |
| | Gain factor | | 1023/5 | | | LSB/V |
| | Offset error | Delivery state; $T_{CASE}$ = 25 °C | | 0.5 | | LSB |
| | Gain error | | | 0.5 | | LSB |
| | Offset error | $T_{CASE}$ = –40 °C … +85 °C | –10 | | +10 | LSB |
| | Gain error | | –5 | | 5 | % |
| | $R_{inG45}$ | Input impedance | 100 | | | kΩ |
| **AC characteristics** | | | | | | |
| ADC Type 1 (all 16 channels)<br>ADC Type 3 (all 8 channels) | Conversion time | For all channels of one module (simultaneous sample) | 6.6 | | | µs |
| | $f_{gADC}$ | Low-pass cutoff frequency (3 dB) | 9.1 | 9.6 | 10.2 | kHz |
| Group 4 & 5 | Conversion time | Per channel (sequentially sample) | 10 | | 17 | µs |
| | No low-pass filter implemented | | | | | |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagrams**

The following table shows *simplified* diagrams of the I/O circuitry of the analog inputs:

| Signal | | I/O Circuit |
|---|---|---|
| Analog inputs | ADC Type 1<br>ADC Type 3 |   |
| | Group 4 &<br>Group 5 |   |

**Related topics**

Basics

- *ADC Unit Type 1* (📖 *MicroAutoBox Features*)
- *ADC Unit Type 3* (📖 *MicroAutoBox Features*)
- *DIO Type 1 ADC Unit* (📖 *MicroAutoBox Features*)

# Interfaces

**Pin description**

The following table gives a description of the interface pins available at the ZIF I/O connector.

> **Tip**
>
> The pinout of the ECU interface connectors, USB device connector, and Ethernet I/O connector is not documented. Use a suitable dSPACE connection cable.

| Pins | Signal | Module Type | Module Number | Description / Function |
|---|---|---|---|---|
| V5 | CAN 1 low | CAN Type 1 | Module 1 | CAN controller:<br>■ CAN 1 high = CAN high of module number 1, channel number 1<br>■ CAN 2 high = CAN high of module number 1, channel number 2<br>■ CAN 3 high = CAN high of module number 2, channel number 1<br>■ CAN 4 high = CAN high of module number 2, channel number 2<br>■ ISO 11898 interface<br>■ The MicroAutoBox CAN buses are not equipped with bus termination by default. For information on terminating the CAN buses, refer to *How to Terminate the CAN Bus* on page 124. |
| V6 | CAN 1 high | | | |
| X5 | CAN 2 low | CAN Type 1 | | |
| X6 | CAN 2 high | | | |
| Z5 | CAN 3 low | CAN Type 1 | Module 2 | |
| Y5 | CAN 3 high | | | |
| a5 | CAN 4 low | CAN Type 1 | | |
| b5 | CAN 4 high | | | |
| U6 | Serial 1 RXD | CAN Type 1 | Module 1 | RS232 interface |
| U5 | Serial 1 TXD | | | |
| U3 | Serial 2 K/LIN | CAN Type 1 | Module 1 | LIN or ISO 9141 interface<br>The K line/LIN interface is bidirectional. The L line is input only. Both lines have no pull-up. For proper function of the K line connect an external pull-up resistor (4.7 kΩ) from this line to VBAT.<br>For information on configuring a LIN master, refer to *Connecting to a LIN Bus* on page 108. |
| U4 | Serial 2 L | | | |

**Characteristics**

The interface characteristics are specified for the following conditions: $V_{BAT}$ = +12 V; $T_{CASE}$ = +25 °C; all voltages are referenced to GND.

| Parameter[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Host PC | Protocol | TCP/IP | | | | |
| | Bitrate | | | ■ 10/1000[2)]<br>■ 10/100[3)] | | Mbit |
| | Data throughput | | | | 2.6 | MB/s |
| | Voltage levels | Ethernet standard | | | | |
| Ethernet I/O | Protocol | UDP/IP | | | | |
| | Bitrate | | | 1000 | | Mbit |
| | Voltage levels | Ethernet standard | | | | |

| Parameter[1] | Symbol | Conditions / Comments | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| USB | USB 2.0 standard (USB Flight Recording) | | | | | | |
| | Data throughput | without connected host tool | | | | 1280 | kB/sec |
| | | with connected host tool | | | | 1024 | kB/sec |
| | | without data loss during cold start (dependent on the boot time of the host interface) | | | | 640 | kB/sec |
| | Current | | | | | 1.3 | A |
| | Voltage | | | | | 5 | V |
| ECU | Bit rate | LVDS mode | | | | 250 | MBit |
| | | LVDS2 mode | | | | 560 | |
| | Cable length | 2-paired twisted pair | | | | 5 | m |
| | Cable type | | | CAT5 | | | |
| | Voltage levels | LVDS standard | | | | | |
| | Full duplex data rate[4] | LVDS mode | Single transfer | | | 5 | MWord/s |
| | | LVDS2 mode | Single transfer | | | 11.2 | MWord/s |
| | | | Block transfer | | | 28 | MWord/s |
| | RAM size[4] | LVDS / LVDS2 mode | | 16 | | | kWord |
| | FIFO size[4] | LVDS / LVDS2 mode (Transmit buffer) | | 1 | | | kWord |
| CAN | Bit rate | ISO 11898 interface | | | | 1 | MBaud |
| Serial 1 RS232-Interface | Bit rate | | | 5 | | 115.2k | Baud |
| | TX output voltage swing | 3 kΩ load | | ±5 | ±9 | | V |
| | $V_{RxinLow}$ | RX input threshold low | | | 1.4 | 0.8 | V |
| | $V_{RxinHigh}$ | RX input threshold high | | 2.0 | 1.4 | | V |
| | Word length | | | 5 | | 8 | bit |
| Serial 2 ISO9141-Interface | Bit rate | $R_{KO} = 510\ \Omega$; $C_K \le 1.3$ nF | | 5 | | 50k | Baud |
| | Word length | | | 5 | | 8 | bit |
| Serial 2 LIN Interface | Bit rate | | | 5 | | 20k | Baud |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.
2) Since board revision DS1401-23 (available since dSPACE Release 7.2).
3) Before board revision DS1401-23
4) Word is 16-bit wide

**Baud rate calculation of the serial interface**

**Note**

Due to the limitations of the UART baud rate generator, not all baud rates can be programmed exactly to the desired baud rate without error.

The UART baud rate generator provides several baud rates:

*To calculate the divisor T for a chosen baud rate*

$$T = \text{Round}\left(\frac{230400}{\text{BR (chosen)}}\right)$$

BR (chosen) = The baudrate to be generated
T = The baudrate generator divisor ($2 \leq T \leq 65535$)

*To calculate the real baud rate from a given divisor T*

$$\frac{\text{BR (real)}}{\text{Baud}} = \frac{230400}{T}$$

BR (real) = The baudrate you get
T = The baudrate generator divisor ($2 \leq T \leq 65535$)

*To calculate the resulting error*

$$\frac{\text{Error}_{BR}}{100\%} = \frac{\text{BR (real)} - \text{BR (chosen)}}{\text{BR (chosen)}}$$

**Note**

If $\text{Error}_{BR} \leq 2\%$, messages will be transferred and received correctly.

# Data Sheet MicroAutoBox II 1401/1505/1507

**Where to go from here**

Information in this section

# Overview and General Information

**Where to go from here**

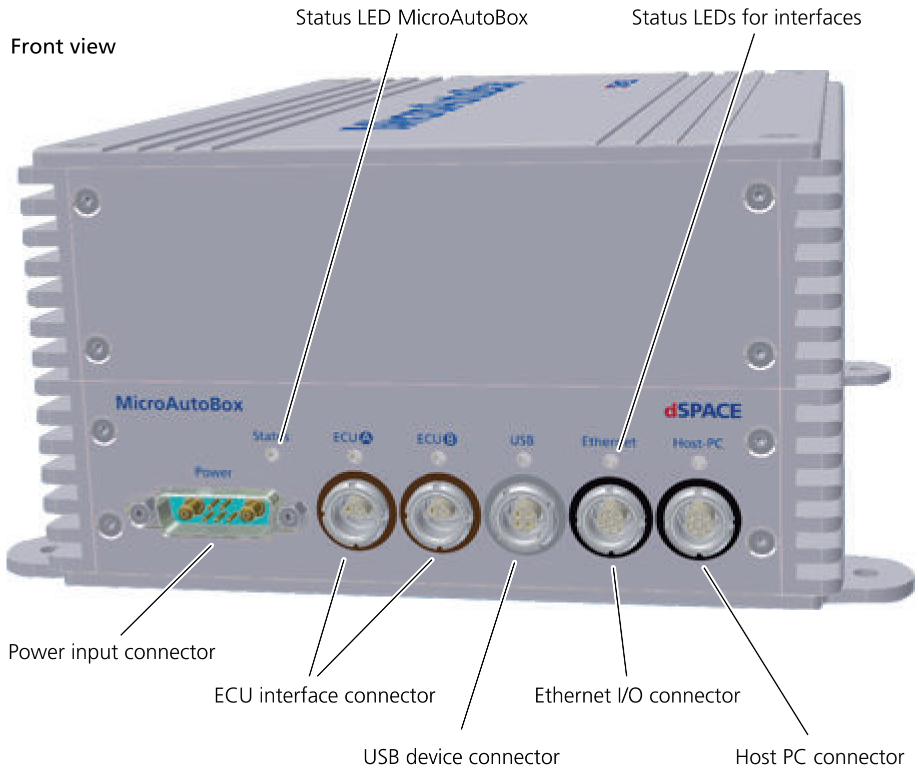
Information in this section

# Housing Components

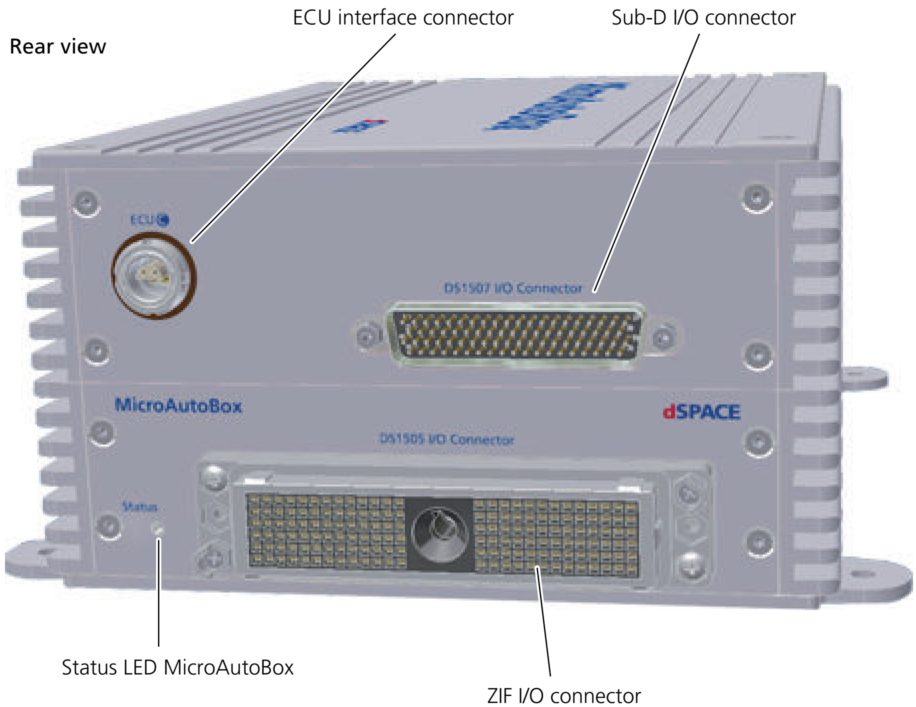
**Connectors and status LEDs**

The illustrations show where the connectors and status LEDs are located on MicroAutoBox II 1401/1505/1507.

Front view



Rear view




MicroAutoBox II 1401/1505/1507 contains the following connectors and LEDs:

**Power input connector** Supplies the required power to MicroAutoBox. It is a 7-pin, male Sub-D connector with two high-current pins.

A preconfigured cable with a matching connector and a separate power input connector are included in each MicroAutoBox package. For the pinout and further details on the preconfigured cable, refer to *Power Input Connector* on page 298.

**Status LED MicroAutoBox** Shows you different states and potential malfunctions.

If battery power is switched on and the REMOTE signal/KL15 is activated (see *Basics on Connecting to Power Supply* on page 44), the status LED (= dual LED) shows different states indicated by the LED color:

- LED is red: Reset state and no application is downloaded to the real-time processor.
- LED is green: Application is running.

- LED is flashing red: MicroAutoBox is in secured mode. For further instructions, refer to *Checking MicroAutoBox* on page 672.

The status LED on the front panel has the same functionality as the status LED on the rear panel of MicroAutoBox.

**ECU interface connectors** Provide communication to ECUs based on the LVDS standard, for example, in bypassing scenarios or to connect a RapidPro system (used as I/O subsystem). The ECU interface connectors are 4-pin LEMO connectors. Matching cables are supplied from dSPACE on request.

The corresponding LED is lit green, if power at both ends of the link is available and the relevant connection is serviceable. The LED flashes when data is being sent or received.

The table below shows the different ECU interfaces integrated into MicroAutoBox and the display names they are mapped to in the experiment software, for example, ControlDesk.

| Display Name in Software | Connectors Built-in at MicroAutoBox | | | |
|---|---|---|---|---|
| | ECU A | ECU B | ECU C | ZIF I/O |
| ECU 1 | – | – | – | ✓ |
| ECU 2 | – | – | ✓ | – |
| ECU 3 | ✓ | – | – | – |
| ECU 4 | – | ✓ | – | – |

**USB device connector** A 4-pin LEMO connector to connect an USB mass storage device to use the USB Flight Recorder feature of MicroAutoBox. A matching cable with a LEMO-USB adapter is supplied from dSPACE on request.

**Note**

To use the USB Flight Recorder, a separate license is required.

The possible states of the corresponding LED are listed in the table below:

| LED Status | Meaning |
|---|---|
| Off | No USB device is connected. |
| Green | USB device is connected and flight recorder is not running. |
| Green blinking | USB device is connected and flight recorder is running. |
| Orange | USB device is full and the active flight recorder is specified not to overwrite old files. |

| LED Status | Meaning |
|---|---|
| Red | Write error when accessing the USB device, for example, if the device was removed while the flight recorder was running. |

For further information, refer to *Flight Recorder* (📖 *MicroAutoBox Features*).

**Ethernet I/O connector** An 8-pin LEMO connector that provides communication to external devices, such as PCs or ECUs based on the UDP/IP Ethernet protocol, for example, in bypassing scenarios.

A matching cable with a LEMO-RJ45 adapter is supplied from dSPACE on request.

The corresponding LED is lit green if power is available at both ends of the link and the relevant connection is serviceable. The LED flashes green when data is being sent or received.

For installation instructions, refer to *How to Connect MicroAutoBox to the ECU via UDP/IP* (📖 *ECU Interfaces Hardware Installation and Configuration*).

**Host PC connector** Provides the communication between MicroAutoBox and your host PC based on the Ethernet TCP/IP protocol. The connector is a 8-pin LEMO connector. A matching cable is included in each MicroAutoBox package.

The corresponding LED is lit green if power is available at both ends of the link and the relevant connection is serviceable. The LED flashes green when data is being sent or received.

**Tip**

The Ethernet I/O connector and the Host PC connector are internally connected by a common gigabit Ethernet switch (valid for base board DS1401-25ff).

This simplifies the connection options. For an example, refer to *Connecting an ECU with DCI-GSI2 for Simultaneous Calibration and Bypassing* (📖 *ECU Interfaces Hardware Installation and Configuration*).

**Sub-D I/O connector** The 78-pin Sub-D I/O connector is used to connect CAN, LIN, FlexRay and the IP modules. For the pinout, refer to *Sub-D I/O Connector* on page 293.

**ZIF I/O connector** The 156-pin zero insertion force (ZIF) I/O connector provides access to the most input and output signals provided by MicroAutoBox. A matching connector is included in each MicroAutoBox package.

For the pinout, refer to *ZIF I/O Connector* on page 291.

## General Data

**General characteristics** The following table shows some general characteristics of MicroAutoBox:

| Parameter | | Specification[1] |
|---|---|---|
| Base board (DS1401-20ff.) | Processor | ■ PPC750 GL Power PC<br>■ 900 MHz clock frequency<br>■ Real-time clock |
| | Memory | ■ 8 MB global RAM<br>■ 16 MB local RAM<br>■ 16 MB flash memory |
| | Onboard sensors[2] | Pressure sensor:<br>■ Base board DS1401-23ff.<br>■ Range: 50 kPA ...115 kPa<br>■ Accuracy: 1 kPa<br>■ Sample rate: approx. 200 Hz<br>Acceleration sensor<br>■ Base board DS1401-23ff.<br>■ Range: ±2 g ... ±8 g in 3 axis (x/y/z)<br>■ Resolution: 10 bit per axis<br>■ Sample rate: max. 800 Hz<br>■ FIFO buffer: 512 words (to read and write bursts) |
| Communication interfaces | | ■ 1 x Host PC interface based on Ethernet TCP/IP protocol<br>■ 1 x Ethernet I/O interface based on Ethernet UDP/IP protocol for Ethernet bypassing scenarios<br>■ 4 x ECU interface based on LVDS standard (one interface is accessible via ZIF I/O connector)<br>■ 1 x USB interface for USB flight recording (separate license) |

| Parameter | | Specification[1] |
|---|---|---|
| I/O connectors | | ■ 1 x 156-pin ZIF I/O connector<br>■ max. 15 mΩ contact resistance<br>■ 10000 cycles durability<br>■ max. 2.5 A continuous current per pin ($T_{ambient}$ = +85 °C)<br>■ 1 x 78-pin Sub-D I/O connector<br>■ 1 x 7-pin power supply input connector |
| Chassis dimensions | Case width | 202 mm (7.95 in.) |
| | Case height | 96 mm (3.78 in.) |
| | Case depth | 222 mm (8.74 in.) |
| Weight | | About 3.2 kg (7.05 lb.) without external cables |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

[2] For further information on the sensors, refer to *Onboard Sensors* (📖 *MicroAutoBox Features*).

# Absolute Maximum Levels

**Avoiding damage to the system**

**NOTICE**

Do not exceed the maximum levels since this might permanently damage the system.

**Levels**

The following table shows the levels (for example, voltage, temperature) of the MicroAutoBox. All voltages are referenced to GND (unless otherwise noted).

| Parameter | Specification[1] | Description |
|---|---|---|
| VBAT | –40 V ... +100 V | Load dump- and reverse protection |
| VDRIVE | 0 V ... +45 V | |
| All digital output voltages | (VDRIVE – 45 V) ... +45 V | |
| All digital input voltages | (VDRIVE – 45 V) ... +45 V | |
| All analog input voltages | –40 V ... +40 V | |
| All analog output voltages | –30 V ... +40 V | |
| VSENS output | 0 V ... +40 V | VSENS is switched on and off with the REMOTE pin. |

| Parameter | Specification[1] | Description |
|---|---|---|
| VBATprot output | 0 V ... +45 V | VBATprot follows VBAT within the specified range. VBATprot is switched on and off with the REMOTE pin. |
| RS232 transceiver output | –30 V ... +30 V | |
| RS232 transceiver input | –30 V ... +30 V | |
| CAN transceiver[2] | –60 V ... +60 V | |
| Serial K / LIN | –20 V ... +32 V | but not more than VBAT |
| Serial L | –24 V ... +30 V | but not more than VBAT |
| All outputs short circuit to GND | continuous | |
| Continuous power dissipation ($T_{ambient}$ = +85 °C) | max. 25 W | |
| Operating temperature | –40 °C ... +85 °C | |
| Storage temperature | –55 °C ... +125 °C | |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

2) If the DS4342 CAN FD Interface Module is installed on the DS1507 I/O Board, the I/O connectors provide additional CAN interfaces. For maximum absolute levels, refer to *Absolute Maximum Levels* on page 640.

## Certifications

**CE compliance**

MicroAutoBox meets the requirements of the European directive 2004/108/EG (Electromagnetic Compatibility Directive) for CE marking.

**Vibration and shock tests**

To verify the reliability of MicroAutoBox under realistic operating conditions, it was exposed to vibration and shock tests. During the tests, MicroAutoBox executed a program without any failures.

**Applied standards**

The characteristics of MicroAutoBox were tested according to the standards shown in the following table:

| Tested Characteristics | Applied Standard | Description |
|---|---|---|
| Electromagnetic compatibility (EMC) | EN 61326-1 Table 2 | Immunity standard for industrial environments[1] |
| | CISPR 11, EN 55011 Group 1, Class A | Emission standard for industrial environments |

| Tested Characteristics | Applied Standard | Description |
|---|---|---|
| Vibration | ISO 16750-3:2007 / 4.1.2.4 Test IV | Test conditions: Broad band noise, 2h per axis, RMS-acceleration 27.8 $m/s^2$ |
| | EN 60068-2-6 | Test conditions:<br>■ Swept sine, 1 octave per minute, 3-axis test<br>■ 5 ... 2000 Hz, up to 5 g, 2 sweeps per axis<br>■ Operating |
| Shock | ISO 16750-3:2007 / 4.2.2. | ■ Linear shock (1/2 sine pulse), 6-axis<br>■ 500 $m/s^2$, 6 ms, 10 pulses per axis<br>■ Operating |

1) Tested with an I/O cable length < 3 m.

# Connector Pinouts

**Where to go from here**

Information in this section



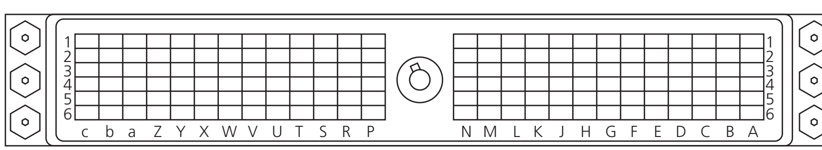
## ZIF I/O Connector

**Objective**

The I/O connector is a 156-pin zero insertion force (ZIF) connector giving access to the most input and output signals provided by MicroAutoBox.

**Pinout**

The following illustration shows the pin numbering of the I/O connector (rear view of MicroAutoBox):




**Note**

There are pins identified by uppercase letters (A, B, C, etc.) and pins identified by lowercase letters (a, b, c).

The following table shows the signals of the I/O connector:

| 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DAC 7 | out | DAC 8 | out | Group 1 ch 1 | out | Group 1 ch 2 | out | Group 1 ch 3 | out | Group 1 ch 4 | out | *A* |
| DAC 5 | out | DAC 6 | out | Group 1 ch 5 | out | Group 1 ch 6 | out | Group 1 ch 7 | out | CTM ch 1 | out | *B* |
| DAC 3 | out | DAC 4 | out | CTM ch 2 | out | CTM ch 5 | out | CTM ch 6 | out | CTM ch 7 | out | *C* |
| DAC 1 | out | DAC 2 | out | CTM ch 8 | out | CTM ch 3 | out | CTM ch 4 | out | Group 6 ch 1 | out | *D* |
| VDRIVE | in | VSENS | out | Group 6 ch 2 | out | Group 6 ch 3 | out | Group 6 ch 4 | out | Group 6 ch 5 | out | *E* |
| Group 6 ch 6 | out | Group 6 ch 7 | out | GND | in | GND | in | Group 6 ch 8 | out | TPU ch 1 | out | *F* |
| TPU ch 2 | out | TPU ch 3 | out | GND | in | GND | in | GND | in | TPU ch 4 | out | *G* |

| 1 | 2 | 3 | 4 | 5 | 6 | |
|---|---|---|---|---|---|---|
| TPU ch 5 out | TPU ch 6 out | GND in | GND in | TPU ch 7 out | TPU ch 8 out | *H* |
| TPU ch 9 out | TPU ch 10 out | TPU ch 11 out | TPU ch 12 out | TPU ch 13 out | TPU ch 14 out | *J* |
| TPU ch 15 out | TPU ch 16 out | Group 2 ch 1 out | Group 2 ch 2 out | Group 2 ch 3 out | Group 2 ch 4 out | *K* |
| Group 2 ch 5 out | Group 2 ch 6 out | Group 2 ch 7 out | Group 2 ch 8 out | Group 3 ch 1 out | Group 3 ch 2 out | *L* |
| Group 3 ch 3 out | CTM ch 1 in | REMOTE in | CTM ch 2 in | CTM ch 3 in | CTM ch 4 in | *M* |
| Group 6 ch 1 in | Group 6 ch 2 in | Group 6 ch 3 in | Group 6 ch 4 in | Group 6 ch 5 in | Group 6 ch 6 in | *N* |
| Group 6 ch 7 in | Group 6 ch 8 in | TPU ch 1 in | TPU ch 2 in | TPU ch 3 in | TPU ch 4 in | *P* |
| TPU ch 5 in | TPU ch 6 in | TPU ch 7 in | TPU ch 8 in | TPU ch 9 in | TPU ch 10 in | *R* |
| TPU ch 11 in | TPU ch 12 in | TPU ch 13 in | TPU ch 14 in | TPU ch 15 in | TPU ch 16 in | *S* |
| Group 2 ch 1 in | Group 2 ch 2 in | Group 2 ch 3 in | Group 2 ch 4 in | Group 2 ch 5 in | Group 2 ch 6 in | *T* |
| Group 2 ch 7 in | ADC Type 1 Con 4 Ch 4 in | Serial 2 K / LIN i/o | Serial 2 L in | Serial 1 TXD out | Serial 1 RXD in | *U* |
| ADC Type 1 Con 2 Ch 4 in | ADC Type 1 Con 3 Ch 4 in | VBAT in | VBAT in | CAN 1 low i/o | CAN 1 high i/o | *V* |
| ADC Type 1 Con 1 Ch 4 in | ADC Type 1 Con 4 Ch 3 in | VBAT in | VBAT in | VBAT in | Group 2 ch 8 in | *W* |
| ADC Type 1 Con 2 Ch 3 in | ADC Type 1 Con 3 Ch 3 in | VBAT in | VBAT in | CAN 2 low i/o | CAN 2 high i/o | *X* |
| ADC Type 1 Con 1 Ch 3 in | ADC Type 1 Con 4 Ch 2 in | Group 4 ch 1 in | Group 4 ch 2 in | ECU / IF1 RX+ in | Group 4 ch 3 in | *Y* |
| ADC Type 1 Con 2 Ch 2 in | ADC Type 1 Con 3 Ch 2 in | Group 4 ch 4 in | Group 4 ch 5 in | ECU / IF1 RX- in | Group 4 ch 6 in | *Z* |
| ADC Type 1 Con 1 Ch 2 in | ADC Type 1 Con 4 Ch 1 in | Group 4 ch 7 in | Group 4 ch 8 in | ECU / IF1 TX- out | Group 5 ch 1 in | *a* |
| ADC Type 1 Con 2 Ch 1 in | ADC Type 1 Con 3 Ch 1 in | Group 5 ch 2 in | Group 5 ch 3 in | ECU / IF1 TX+ out | Group 5 ch 4 in | *b* |
| ADC Type 1 Con 1 Ch 1 in | VBAT prot out | Group 5 ch 5 in | Group 5 ch 6 in | Group 5 ch 7 in | Group 5 ch 8 in | c |

**Tip**

To use the digital inputs and outputs, you have to connect the VDRIVE pin inside the ZIF I/O connector according to the logic level needed. *This pin is not preconfigured in the ZIF I/O connector delivered with MicroAutoBox.* You have to connect VDRIVE (pin E1) to VSENS (pin E2) or VBATprot (pin c2). Use the preconfigured jumper cable which is included in the MicroAutoBox package.

**Signal descriptions**

For descriptions of the signals which are available on the ZIF I/O connector, refer to:

- *Digital Inputs* on page 304
- *Digital Outputs* on page 308
- *Analog Inputs* on page 313
- *Analog Outputs* on page 315
- ECU, CAN, LIN, serial: *Interfaces* on page 316

**Note**

The following signals are available on the Sub-D I/O connector as well as on the zero insertion force (ZIF) connector:

- CAN channel 1 (CAN 1 low, CAN 1 high)
- CAN channel 2 (CAN 2 low, CAN 2 high)
- Serial channel 1 (Serial 1 TXD, Serial 1 RXD)
- Serial channel 2 (Serial 2K/LIN, Serial 2 L)

The accompanying pins are internally connected on MicroAutoBox. Use these pins only on one connector. Do not use them on both connectors at the same time.

## Sub-D I/O Connector

**Objective**

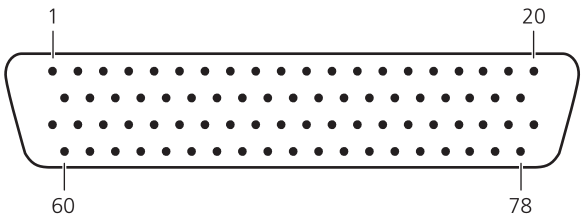
MicroAutoBox II 1401/1505/1507 provides a 78-pin, male Sub-D connector that grants access to various I/O signals provided by the DS1507 I/O Board and the optional IP modules (DS4340, DS4342, or third-party modules).

**Pinout**

The table below shows the pinout and the signal mapping to the I/O connectors of the IP slots. The pin numbering used for Sub-D connectors is not standardized. The following illustration shows the numbering used (front view).

**Note**

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




| Pin | Signal | Pin | Signal | Pin | Signal | Pin | Signal |
|---|---|---|---|---|---|---|---|
| 1 | CAN 1 high | | | 40 | CAN 3 high | | |
| 2 | CAN 1 low | 21 | GND | 41 | CAN 3 low | 60 | GND |
| 3 | GND | 22 | GND | 42 | GND | 61 | GND |
| 4 | CAN 2 high | 23 | GND | 43 | CAN 4 high | 62 | GND |
| 5 | CAN 2 low | *24* | IP slot 1, pin 5 (I/O) | 44 | CAN 4 low | *63* | IP slot 2, pin 5 (I/O) |
| 6 | GND | 25 | GND | 45 | GND | 64 | GND |
| 7 | Serial 1 TXD | 26 | GND | 46 | Serial 3 TXD | 65 | GND |
| 8 | Serial 1 RXD | 27 | GND | 47 | Serial 3 RXD | 66 | GND |
| 9 | GND | 28 | GND | 48 | GND | 67 | GND |
| 10 | Serial 2 K/LIN | 29 | GND | 49 | Serial 4 K/LIN | 68 | GND |
| 11 | Serial 2 L | 30 | GND | 50 | Serial 4 L | 69 | GND |
| 12 | GND | 31 | GND | 51 | GND | 70 | GND |
| 13 | Reserved | 32 | GND | 52 | Reserved | 71 | GND |
| 14 | GND | *33* | IP slot 1, pin 14 (I/O) | 53 | GND | *72* | IP slot 2, pin 14 (I/O) |
| *15* | IP slot 1, pin 48 (I/O) | *34* | IP slot 1, pin 15 (I/O) | *54* | IP slot 2, pin 48 (I/O) | *73* | IP slot 2, pin 15 (I/O) |
| *16* | IP slot 1, pin 50 (I/O) | *35* | IP slot 1, pin 16 (I/O) | *55* | IP slot 2, pin 50 (I/O) | *74* | IP slot 2, pin 16 (I/O) |
| *17* | IP slot 1, pin 49 (I/O) | *36* | IP slot 1, pin 17 (I/O) | *56* | IP slot 2, pin 49 (I/O) | *75* | IP slot 2, pin 17 (I/O) |
| *18* | IP slot 1, pin 44 (I/O) | *37* | IP slot 1, pin 18 (I/O) | 57 | IP slot 2, pin 44 (I/O) | *76* | IP slot 2, pin 18 (I/O) |
| *19* | IP slot 1, pin 46 (I/O) | *38* | IP slot 1, pin 19 (I/O) | *58* | IP slot 2, pin 46 (I/O) | *77* | IP slot 2, pin 19 (I/O) |
| *20* | IP slot 1, pin 45 (I/O) | *39* | IP slot 1, pin 20 (I/O) | *59* | IP slot 2, pin 45 (I/O) | *78* | IP slot 2, pin 20 (I/O) |

**Note**

The following signals are available on the Sub-D I/O connector as well as on the zero insertion force (ZIF) connector:

- CAN channel 1 (CAN 1 low, CAN 1 high)
- CAN channel 2 (CAN 2 low, CAN 2 high)
- Serial channel 1 (Serial 1 TXD, Serial 1 RXD)
- Serial channel 2 (Serial 2K/LIN, Serial 2 L)

The accompanying pins are internally connected on MicroAutoBox. Use these pins only on one connector. Do not use them on both connectors at the same time.

**Pinout for using IP modules**

For the pinout of the IP modules' signals, refer to the following topics:

- DS4340 FlexRay Interface Module: *DS1507 Sub-D I/O Connector* on page 633
- DS4342 CAN FD Interface Module: *DS1507 Sub-D I/O Connector* on page 641

**Signal descriptions**

For descriptions of the signals which are available on the Sub-D I/O connector, refer to *Interfaces* on page 316.

**Related topics**

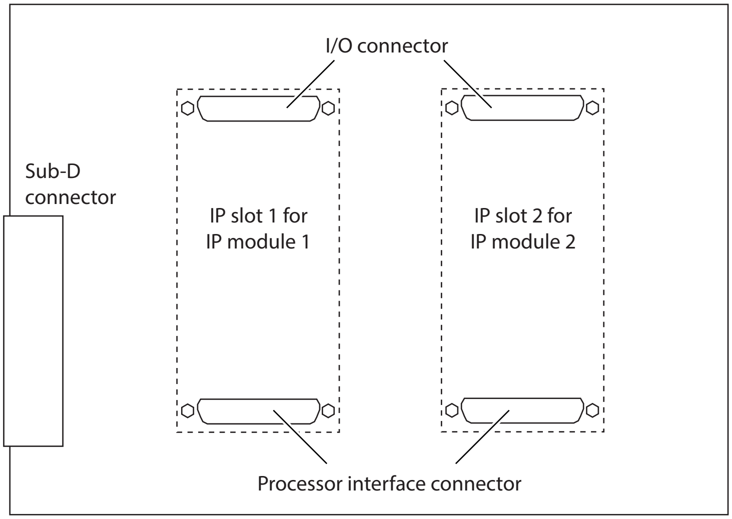
References

- *IP Module Connectors* on page 295

# IP Module Connectors

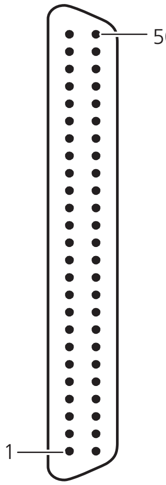
**Objective**

The DS1507 provides two slots to install IP modules. Each slot provides two AMP connectors: I/O connector and processor interface connector. The following illustration shows the top view of MicroAutoBox.

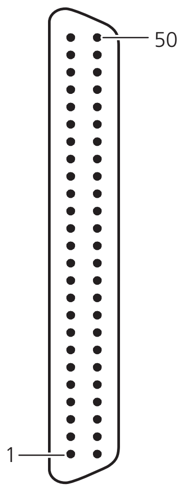


**Signal Mapping**

**I/O connector - IP module slot 1** The following table shows the signal mapping of the IP module I/O connector on slot 1 to the Sub-D I/O Connector:

| IP Module I/O Connector | Pin | Sub-D Connector Pin | Pin | Sub-D Connector Pin |
|---|---|---|---|---|
|  | 25 | - | 50 | 16 |
| | 24 | - | 49 | 17 |
| | 23 | - | 48 | 15 |
| | 22 | - | 47 | - |
| | 21 | - | 46 | 19 |
| | 20 | 39 | 45 | 20 |
| | 19 | 38 | 44 | 18 |
| | 18 | 37 | 43 | - |
| | 17 | 36 | 42 | - |
| | 16 | 35 | 41 | - |
| | 15 | 34 | 40 | - |
| | 14 | 33 | 39 | - |
| | 13 | - | 38 | - |
| | 12 | - | 37 | - |
| | 11 | - | 36 | - |
| | 10 | - | 35 | - |
| | 9 | - | 34 | - |
| | 8 | - | 33 | - |
| | 7 | - | 32 | - |
| | 6 | - | 31 | - |
| | 5 | 24 | 30 | - |
| | 4 | - | 29 | - |
| | 3 | - | 28 | - |
| | 2 | - | 27 | - |
| | 1 | - | 26 | - |

**I/O connector - IP module slot 2** The following table shows the signal mapping of the IP module I/O connector on slot 2 to the Sub-D I/O Connector:

| IP Module I/O Connector | Pin | Sub-D Connector Pin | Pin | Sub-D Connector Pin |
|---|---|---|---|---|
|  | 25 | - | 50 | 55 |
| | 24 | - | 49 | 56 |
| | 23 | - | 48 | 54 |
| | 22 | - | 47 | - |
| | 21 | - | 46 | 58 |
| | 20 | 78 | 45 | 59 |
| | 19 | 77 | 44 | 57 |
| | 18 | 76 | 43 | - |
| | 17 | 75 | 42 | - |
| | 16 | 74 | 41 | - |
| | 15 | 73 | 40 | - |
| | 14 | 72 | 39 | - |
| | 13 | - | 38 | - |
| | 12 | - | 37 | - |
| | 11 | - | 36 | - |
| | 10 | - | 35 | - |
| | 9 | - | 34 | - |
| | 8 | - | 33 | - |
| | 7 | - | 32 | - |
| | 6 | - | 31 | - |
| | 5 | 63 | 30 | - |
| | 4 | - | 29 | - |
| | 3 | - | 28 | - |
| | 2 | - | 27 | - |
| | 1 | - | 26 | - |

**Processor interface connector - slot 1 and slot 2** The pinout of the processor interface connector (slot 1 and slot 2) complies with IP Modules Draft Standard VITA 4-1995. For further information, refer to the documentation of the standard.

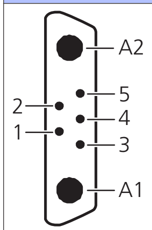
# Power Input Connector

**Objective**

MicroAutoBox provides a power input connector. It is a 7-pin, male connector with two high-current pins. It is a special variant of a 15-pin Sub-D connector (mixed-layout 7W2 Sub-D).

**Pinout**

The following illustration shows the pinout (front view of MicroAutoBox).

| Connector | Pin | Signal | Pin | Signal |
|---|---|---|---|---|
|   | A2[1] | VBAT (6 V … 40 V DC) | | |
| | | | 5 | REMOTE_PULLUP |
| | 2 | Do not connect | 4 | REMOTE[2] |
| | 1 | Do not connect | 3 | Do not connect |
| | A1 | GND | | |

[1] NOTE: It is highly recommended to insert a fuse into the main power supply input wire (close to battery). Choose the value of the fuse according to the maximum current. A 10 A fuse is recommended.

[2] The REMOTE input must be connected via switch or bridge to UBAT to run the MicroAutoBox. For example, you can use it for switching MicroAutoBox with KL15 (output of the ignition/driving switch). So, you can use the nonvolatile data feature to store data you may want to use again when restarting the application. For further information, refer to *Nonvolatile Data Handling* (📖 *MicroAutoBox RTLib Reference*).

**NOTICE**

**Risk of material damage**

**If MicroAutoBox is powered via a ZIF I/O connector, the applied voltages are also available at the pins of the power input connector.**

Do not remove the protective cap of the connector when it is unconnected.

**Matching cable**

A preconfigured cable for the supply voltage is provided by dSPACE. This cable is for running MicroAutoBox with a laboratory power supply during development. Therefore, REMOTE (pin 4) is shorted to VBAT (pin A2) inside the connector in order to save a separate switch. Do not use this cable in the vehicle. Otherwise, MicroAutoBox will always be turned on.

The VBAT wire (red) contains a melting fuse. Each wire has a cross-section of 1.5 mm².

Fuse specification:

- Cable delivered through dSPACE Release 2013-B: 7.5 A, time lag
- Cable delivered as of dSPACE Release 2014-A: 10 A, time lag

# Signal Descriptions

**Where to go from here**

Information in this section



## Power Inputs and Outputs

**Power input connector vs. ZIF I/O connector**

The pins VBAT, GND and REMOTE are located on the power input connector and on the ZIF I/O connector. It is recommended to use the pins on the power input connector.

**NOTICE**

**Risk of material damage**

**If MicroAutoBox is powered via a ZIF I/O connector, the applied voltages are also available at the pins of the power input connector.**

Do not remove the protective cap of the connector when it is unconnected.

**Note**

If you use the VBAT, GND and REMOTE pins on the ZIF I/O connector, do not use these pins on the power input connector at the same time, and vice versa.

The pinout of the ZIF I/O connector on MicroAutoBox II is fully compatible to earlier MicroAutoBox revisions. This means you can use a cable harness which has been built for earlier MicroAutoBox revisions also for MicroAutoBox II. Thus you can power MicroAutoBox II via the power supply pins on the ZIF I/O connector.

However, the compatibility is valid only for the same MicroAutoBox variants. For example, the pinout of MicroAutoBox 1401/1501 is compatible with MicroAutoBox II 1401/1501.

**Pin description**

The following table gives a description of the pins used for power input, remote input and supply of digital I/O circuits.

| Connector | Pins | Signal | Description / Function |
|---|---|---|---|
| Power input connector | A2 | VBAT | Main power supply input. Connect this pin to the positive pole of your car battery. |
| | A1 | GND | Main power supply return and reference for all input and output signals. Connect this pin to the minus pole of your car battery. The case of MicroAutoBox is also connected to GND. |
| | 4 | REMOTE | ■ The REMOTE input may be used for starting MicroAutoBox with a remote switch, for example KL15 (output of the ignition/driving switch).<br>■ If you connect the remote pin to the plus pole of the car battery directly, MicroAutoBox will always be turned on, and the car battery will soon be exhausted if the engine is not running. Thus, a switch is highly recommended.<br>■ The voltage connected to the REMOTE pin should not exceed the supply voltage. |
| | 5 | REMOTE_Pullup | You can use this output to connect a remote switch between REMOTE and this pin. REMOTE_Pullup is internally connected to VBAT via 39 kΩ pull-up resistor. |
| ZIF I/O connector | V3, V4, W3, W4, W5, X3, X4 | VBAT | Main power supply input. Connect at least 2 pins to the plus of your car battery. |
| | F3, F4, G3, G4, G5, H3, H4 | GND | Main power supply return and reference for all input and output signals. Use the nearest possible GND pin as reference for your signals in order to keep noise levels at minimum. The case of MicroAutoBox is also connected to GND. |

| Connector | Pins | Signal | Description / Function |
|---|---|---|---|
| | E1 | VDRIVE | This input supplies all digital input and output circuits.<br>■ Connect this input to VSENS to set CMOS/TTL-compatible logic levels for your inputs/outputs.<br>■ Connect this input to VBATprot to set automotive-compatible logic levels for your inputs/outputs.<br>■ Do not connect this pin directly to VBAT, because the input and output circuits are not load-dump-protected or reverse-voltage-protected at this signal.<br>■ While MicroAutoBox is being powered down, the output stages may have pull-up behavior to VDRIVE. So the outputs may reach the level of VDRIVE. If this behavior is critical in your application, you have to power down your external devices or VDRIVE before powering down MicroAutoBox. You can also use the REMOTE signal (Kl. 15) with the power control software functionality to first switch off VDRIVE via a relay. |
| | E2 | VSENS | Sensor supply output.<br>Use this output to supply your sensors and/or VDRIVE. If you need CMOS/TTL-compatible logic levels at the inputs/outputs connect VSENS to VDRIVE. |
| | c2 | VBAT prot | Protected VBAT output.<br>Use this output to supply VDRIVE when automotive logic levels are needed. |
| | M3 | REMOTE | ■ The remote voltage may be used for starting MicroAutoBox with a remote switch: KL15, for example (output of the ignition/driving switch).<br>■ If you connect the remote pin to the car battery directly, MicroAutoBox will always be turned on, and the car battery will soon be exhausted if the engine is not running. Thus, a switch is highly recommended.<br>■ The remote voltage should not exceed the supply voltage. |

**Tip**

To use the digital inputs and outputs, you have to connect the VDRIVE pin inside the ZIF I/O connector according to the logic level needed. *This pin is not preconfigured in the ZIF I/O connector delivered with MicroAutoBox.* You have to connect VDRIVE (pin E1) to VSENS (pin E2) or VBATprot (pin c2). Use the preconfigured jumper cable which is included in the MicroAutoBox package.

**Characteristics**

The characteristics are specified for the following conditions:

- $V_{BAT}$=+12 V (unless otherwise noted)
  $T_{CASE}$=+25 °C (unless otherwise noted)
  All voltages are referenced to GND (unless otherwise noted).

| Signal[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Power** | | | | | | |
| Operating voltage | VBAT | For start-up | 6 | | 40 | V |
| | VBAT | Operating | 4 | | 40 | V |
| | VBAT | Reverse protection | | | -40 | V |
| | VBAT | Load dump protection | | | +100 | V |
| **Inputs** | | | | | | |
| Operating current | $I_{VBAT}$ | REMOTE ≥ $V_{iHRemote}$ | | 1.3 | | A |
| | $I_{VBAT}$ | REMOTE ≤ $V_{iLRemote}$ | | 5 | | mA |
| REMOTE voltage input | $V_{iHRemote}$ | Input high voltage | 4.7 | | | V |
| | $V_{iLRemote}$ | Input low voltage | | | 0.8 | V |
| | $V_{iHysRemote}$ | Input hysteresis voltage | 0.5 | 1 | | V |
| | $R_{inRemote}$ | Input impedance | 60 | | 185 | kΩ |
| Inrush current | $I_{VBAT\ inrush}$ | All inputs/outputs unconnected | see *Power supply* on page 40 | | | |
| Digital I/O voltage supply input | VDRIVE | Supply for digital input/output circuits | | | 45 | V |
| | $I_{VDRIVE\ no\ load}$ | All inputs/outputs unconnected | | 10 | | mA |
| | $I_{VDRIVE\ maximum\ load}$ | All outputs shorted to GND | | 500 | | mA |
| **Outputs** | | | | | | |
| Sensor supply output | VSENS | Output voltage | 4.84 | 5.05 | 5.25 | V |
| | VSENS = f(T) | Temperature caused voltage drift $T_{CASE}$ = –40 °C ... +85 °C | –2 | | 2 | % |
| | $I_{VSENS,\ max}$ | Maximum output current | 750 | | | mA |
| Protected VBAT output | VBATprot | IL = 1A; VBAT = 12 V | 11.56 | 11.78 | 12 | V |
| | $I_{VBATprot,\ max}$ | Maximum output current | | | 1000 | mA |
| | $I_{ProtPeak}$ | overload current limit (–40 °C ... 85 °C) | 4 | | 9 | A |
| | t(overload) | time to shut off $I_{ProtPeak}$ | | | 5 | ms |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

# Digital Inputs

**General behavior of digital signals**

Most digital signals have separate input and output pins. If your software defines a signal for output, the corresponding input has no function. If the software defines a signal as input the corresponding output pin has the same level as the corresponding input pin.

When software does not control the digital I/O signals (during reset or before correct initialization) each output will be in the same state as the corresponding input. This allows you to define the default (reset) state of each output by driving the input with an external signal.

**Note**

If you use this feature ensure that your software initializes your output signal to the same state you defined for the input.

**Pin description**

The following table gives a description of the digital input pins:

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| M2, M4, M5, M6 | CTM ch 1 … 4 | DIO Type 1 | Capture/compare inputs with pull-up. Inputs for frequency or pulse-width measurement. |
| N1 ... P2 | Group 6 ch 1 ... 8 | DIO Type 1 | Standard discrete digital input with pull-up. |
| P3 | TPU ch 1 | DIO Type 1 | This input drives the first channel of the internal Time Processing Unit of the DIO module, which is useful for motor management. Therefore, the signal is conditioned by an adaptive Schmitt trigger, which generates one single impulse whenever the input voltage crosses 0 V to negative voltages. This single impulse is also used for driving the main CPU INT13. |
| P4 | TPU ch 2 | DIO Type 1 | ■ Also drives the main CPU INT4 [1)] even when a corresponding out is used<br>■ Provides a pull-up |
| P5 | TPU ch 3 | DIO Type 1 | ■ Also drives the main CPU INT5 [1)] even when a corresponding out is used<br>■ Provides a pull-up |
| P6 | TPU ch 4 | DIO Type 1 | ■ Also drives the main CPU INT6 [1)] even when a corresponding out is used<br>■ Provides a pull-up |

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| R1 | TPU ch 5 | DIO Type 1 | ■ Also drives the main CPU INT7 [1)] even when a corresponding out is used<br>■ Provides a pull-up |
| R2 | TPU ch 6 | DIO Type 1 | ■ Also drives the main CPU INT8 [1)] even when a corresponding out is used<br>■ Provides a pull-up |
| R3 | TPU ch 7 | DIO Type 1 | ■ Also drives the main CPU INT9 even when a corresponding out is used<br>■ Provides a pull-up<br>■ Can generate external interrupt [1)] |
| R4 | TPU ch 8 | DIO Type 1 | ■ Also drives the main CPU INT11 [1)] even when a corresponding out is used<br>■ Provides a pull-up |
| R5 | TPU ch 9 | DIO Type 1 | ■ Also drives the main CPU INT15 [1)] even when a corresponding out is used<br>■ Provides a pull-up |
| R6 ... S6 | TPU ch 10 ... 16 | DIO Type 1 | Like TPU ch 2 ... 9 in, but no additional function. TPU ch 10 ... 16 in have pull-ups. |
| T1 ... U1, W6 | Group 2 ch 1 ... 8 | DIO Type 1 | Standard discrete digital input with pull-up |
| a6, b3, b4, b6, c3 ... c6 | Group 5 ch 1 ... 8 | DIO Type 1 | Standard discrete digital input without pull-up/pull-down<br>These signals can also be analog to digital converted (10-bit resolution) by the DIO module. |
| Y3, Y4, Y6, Z3, Z4, Z6, a3, a4 | Group 4 ch 1 ... 8 | DIO Type 1 | |

[1)] See *Basics on Interrupt Handling* (📖 *MicroAutoBox Features*)

**Characteristics**

The characteristics are specified for the following conditions:

- $V_{BAT}$=+12 V (unless otherwise noted)

  $T_{CASE}$=+25 °C (unless otherwise noted)

  All voltages are referenced to GND (unless otherwise noted).

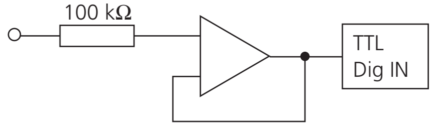
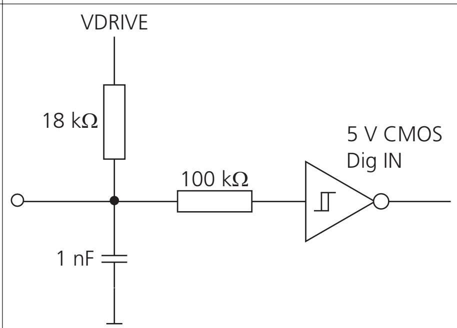
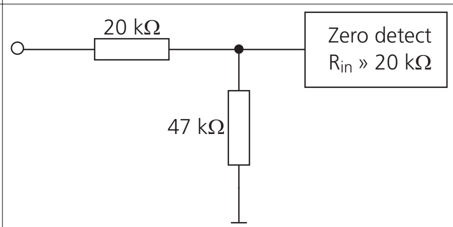
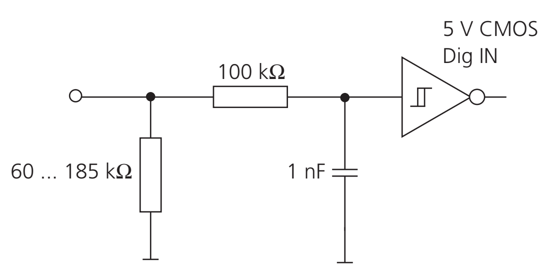
| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC characteristics** | | | | | | |
| Group 4 & Group 5 | $V_{iHG45}$ | Input high voltage | 3.9 | | | V |
| | $V_{iLG45}$ | Input low voltage | | | 0.8 | V |
| | $R_{inG45}$ | Input impedance | 100 | | | kΩ |

| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| CTM & Group 2 & Group 6 & TPU 2 ... 16 | $V_{iH}$ | Input high voltage | 3.5 | | | V |
| | $V_{iL}$ | Input low voltage | | | 1.2 | V |
| | $V_{iHys}$ | Input hysteresis voltage | 0.5 | 1 | | V |
| | $R_{digin}$ | Pull-up resistor to VDRIVE | 17 | 18 | 19 | kΩ |
| | $C_{digin}$ | Input capacitance | 0.9 | 1 | 1.1 | nF |
| TPU1 | $R_{inTPU1}$ | Input impedance<br>TPU1 is signal conditioned by an adaptive sense amplifier optimized for automotive crankshaft sensors | 19 | | | kΩ |
| REMOTE | $V_{iHRemote}$ | Input high voltage | 4.7 | | | V |
| | $V_{iLRemote}$ | Input low voltage | | | 0.8 | V |
| | $V_{iHysRemote}$ | Input hysteresis voltage | 0.5 | 1 | | V |
| | $R_{Remote}$ | Pull-down resistor to GND | 60 | 170 | 190 | kΩ |
| **AC characteristics** | | | | | | |
| Inputs (except Group 4 & 5) | $t_{PDInLH}$ | Low-high propagation delay of input signals | | | 1 | µs |
| | $t_{PDInHL}$ | High-low delay of input signals | | | 1 | µs |
| Inputs Group 4 & 5 | $t_{PDInG45LH}$ | Low-high delay of input signals | | | 1 | µs |
| | $t_{PDInG45HL}$ | High-low delay of input signals | | | 1 | µs |

[1)] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagrams**

The following table shows *simplified* diagrams of the I/O circuitry of the digital inputs:

| Signal | | I/O Circuit |
|---|---|---|
| Digital inputs | Group 4 & Group 5 |   |
| | Group 2 & Group 6 & CTM & TPU2 … TPU16 |   For proper operation, VDRIVE must have a level above the maximum input voltage. |
| | TPU1 |   |
| | Remote |   |

# Digital Outputs

**General behavior of digital signals**

Most digital signals have separate input and output pins. If your software defines a signal for output, the corresponding input has no function. If the software defines a signal as input the corresponding output pin has the same level as the corresponding input pin.

When software does not control the digital I/O signals (during reset or before correct initialization) each output will be in the same state as the corresponding input. This allows you to define the default (reset) state of each output by driving the input with an external signal.

**Note**

If you use this feature ensure that your software initializes your output signal to the same state you defined for the input.

**Pin description**

The following table gives a description of the digital output pins:

| Pins | Signal | Module | Default state | Description / Function |
|---|---|---|---|---|
| A3 ... A6, B3 ... B5 | Group 1 ch 1 ... 7 | DIO Type 1 | low | Standard discrete digital output.<br>Group 1 is for output only. You cannot change the default state of the signal because there is no corresponding input pin. |
| C3, D5 | CTM ch 2 and CTM ch 4 | DIO Type 1 | high | PWM outputs of the DIO-Capture/Compare unit.<br>CTM ch 2 and CTM ch 4 used as PWM outputs are supported only in the extended engine control boot mode. |
| C4 ... C6, D3 | CTM ch 5 ... CTM ch 8 | DIO Type 1 | high | PWM outputs of the DIO-Capture/Compare unit. |
| D6, E3 ... F2, F5 | Group 6 ch 1 ... 8 | DIO Type 1 | high | Standard discrete digital output. |
| F6 | TPU ch 1 | DIO Type 1 | high | DIO-Time Processing Unit output 1.<br>Due to the special "TPU ch 1 input" this signal will not directly follow its input. It rather shows the single impulse created by this input signal conditioning. |

| Pins | Signal | Module | Default state | Description / Function |
|---|---|---|---|---|
| G1, G2, G6 ... H2, H5 ... K2 | TPU ch 2 ... 16 | DIO Type 1 | high | DIO-Time Processing Unit output 2 ... 16.<br>Depending on the DIO TPU firmware the TPU outputs can perform a complete motor management or simply generate PWM or discrete output signals. |
| K3 | Group 2 ch 1 | DIO Type 1 | high | Standard discrete digital output.<br>*While resetting the DIO module this signal is high, independent from the state of "Group 2 ch 1 in".* |
| K4 ... L4 | Group 2 ch 2 ... 8 | DIO Type 1 | high | Standard discrete digital output. |
| L5 ... M1 | Group 3 ch 1 ... 3 | DIO Type 1 | low | Standard discrete digital output.<br>Group 3 is for output only. You cannot change the default state of the signal because there is no corresponding input pin. |

*Default state* means the state of the signal without any connection to the corresponding input and/or without any output action by the software.

**Characteristics**

The characteristics are specified for the following conditions:

- $V_{BAT}$=+12 V (unless otherwise noted)

  $T_{CASE}$=+25 °C (unless otherwise noted)

  All voltages are referenced to GND (unless otherwise noted).

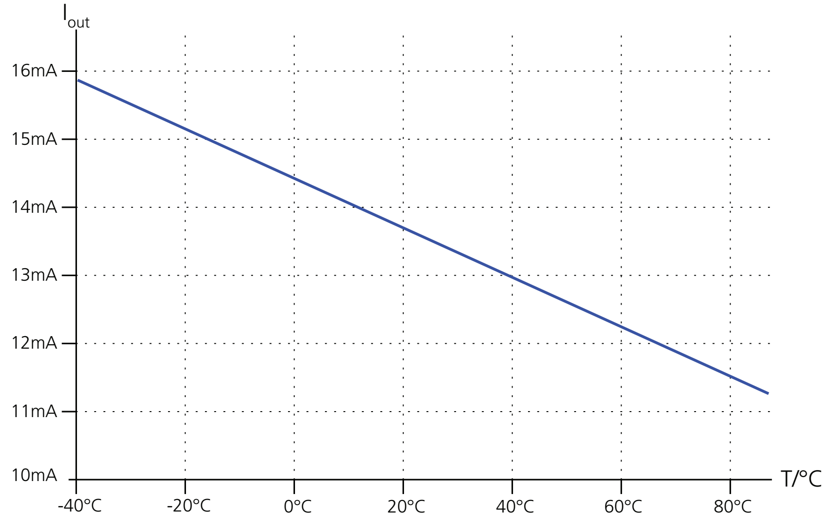
| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC Characteristics** | | | | | | |
| CTM & Group 1 & Group 2 & Group 3 & Group 6 & TPU | $V_{oH}$ | IL = 0 mA; VDRIVE = 5 V | 3.1 | 4.5 | | V |
| | $V_{oL}$ | IL = 0 mA; VDRIVE = 5 V | | 0.2 | 0.85 | V |
| | $V_{oH}$ | IL = 5 mA; VDRIVE = 5 V | 3.1 | 3.4 | | V |
| | $V_{oL}$ | IL = –5 mA; VDRIVE = 5 V | | 0.6 | 0.85 | V |
| | $V_{oH}$ | IL = 0 mA; VDRIVE = 12 V | 10.1 | 11.5 | | V |
| | $V_{oL}$ | IL = 0 mA; VDRIVE = 12 V | | 0.25 | 0.85 | V |
| | $V_{oH}$ | IL = 5 mA; VDRIVE = 12 V | 10.1 | 10.4 | | V |
| | $V_{oL}$ | IL = –5 mA; VDRIVE = 12 V | | 0.6 | 0.85 | V |
| | $\lvert I_{OHmax} \rvert$ | Output current high<br>$T_{CASE}$ = –40 °C ... +85 °C | 5 | 12.5 | | mA |
| | $\lvert I_{OLmax} \rvert$ | Output current low<br>$T_{CASE}$ = –40 °C ... +85 °C | 5 | 13 | | mA |

| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **AC Characteristics** | | | | | | |
| Outputs | $t_{PDOutLH}$ | Low-high delay of output signals | | 0.5 | 1 | µs |
| | $t_{PDOutHL}$ | High-low delay of output signals | | 0.5 | 1 | µs |

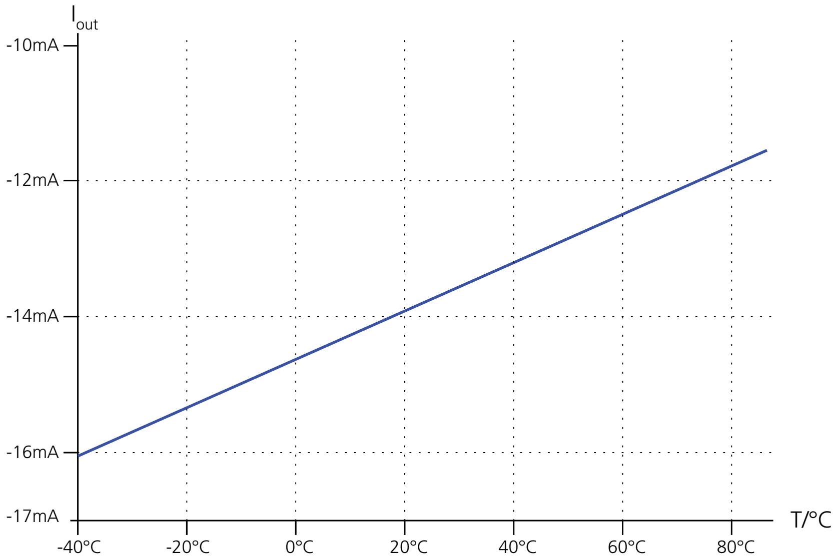
1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

The following illustrations show the maximum output current of a digital output circuit as a function of ambient temperature (VDRIVE = 12 V; output is shorted to 6 V):

- Output high

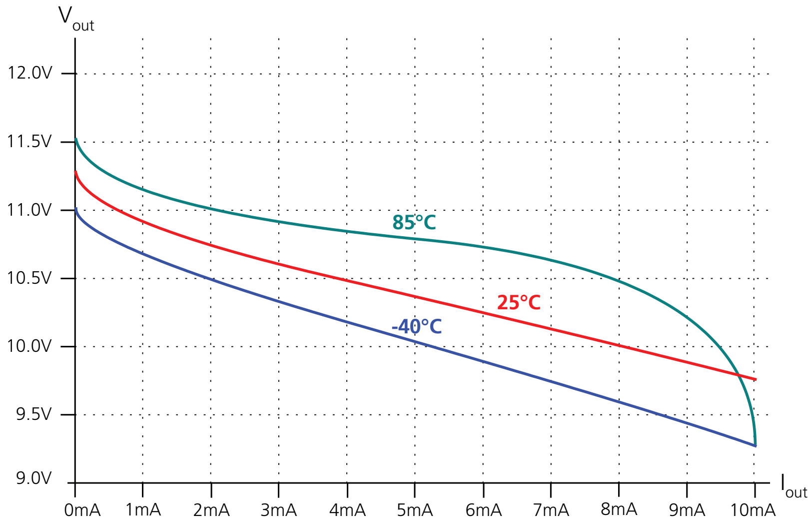


- Output low

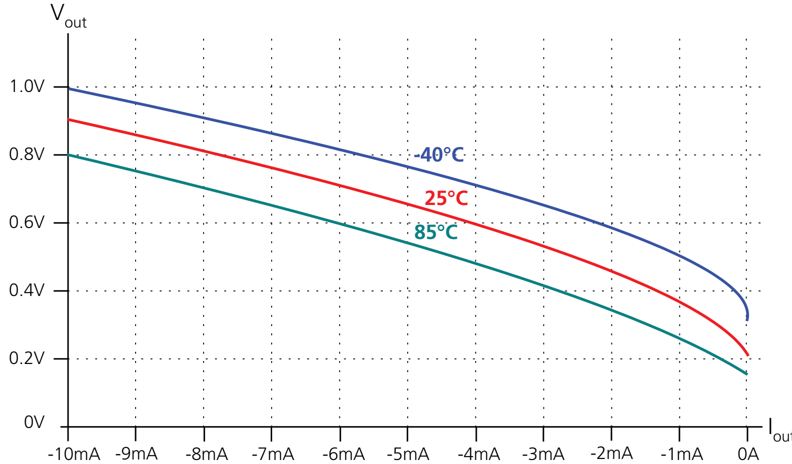



The following illustrations show the typical digital output voltage as a function of the output current (VDRIVE = 12 V):

- Output high

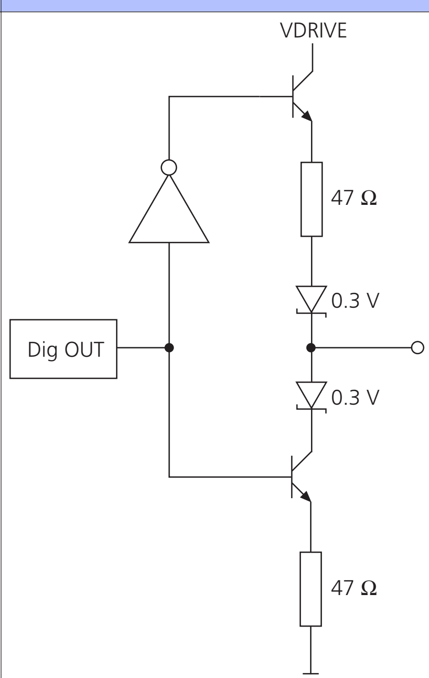


- Output low




**Circuit diagrams**

The following table shows a *simplified* diagram of the I/O circuitry of the digital outputs:

| Signal | | I/O Circuit |
|---|---|---|
| Digital outputs | Group 1 &<br>Group 2 &<br>Group 3 &<br>Group 6 &<br>CTM &<br>TPU |  |

# Analog Inputs

**Pin description**

The following table gives a description of the analog input pins:

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| c1, a1<br>Y1, W1<br>b1, Z1<br>b2, Z2<br>X1, V1<br>X2, V2<br>a2, Y2<br>W2, U2 | ADC Type 1 (all 16 channels) | ADC Type 1 (refer to *ADC Unit Type 1* (*MicroAutoBox Features*)) | Standard analog inputs<br>These analog inputs are converted to a 12-bit digital value by the ADC module. |
| a6, b3, b4, b6, c3, c4, c5, c6, Y3, Y4, Y6, Z3, Z4, Z6, a3, a4 | Group 4 & 5 | DIO Type 1 ADC (refer to *DIO Type 1 ADC Unit* (*MicroAutoBox Features*)) | Analog inputs, 10-bit resolution. |

**Characteristics**

The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25 °C; all voltages are referenced to GND.

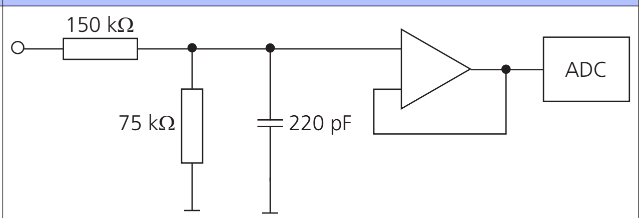
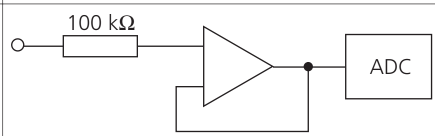
| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC characteristics** | | | | | | |
| ADC Type 1 (all 16 channels) | $V_{maxADC}$ | | 0 … 4.84 | 0 … 5.00 | 0 … 5.16 | V |
| | Resolution | No missing codes | 12 | | | bit |
| | Gain factor | | 4095/5 | | | LSB/V |
| | Offset error | Delivery state; $T_{CASE}$ = 25 °C | | 0.5 | | LSB |
| | Gain error | | | 0.5 | | LSB |
| | Offset error | $T_{CASE}$ = –40 °C … +85 °C | –10 | | +10 | LSB |
| | Gain error | | –1.25 | | 1.25 | % |
| | $Z_{inADC}$ | Input impedance | 150kΩ + 75kΩ‖220pF | | | typ. |
| Group 4 & Group 5 | $V_{maxADCG45}$ | | 0 … 4.7 | 0 … 5.0 | 0 … 5.3 | V |
| | Resolution | | 10 | | | bit |
| | Gain factor | | 1023/5 | | | LSB/V |
| | Offset error | Delivery state; $T_{CASE}$ = 25 °C | | 0.5 | | LSB |
| | Gain error | | | 0.5 | | LSB |
| | Offset error | $T_{CASE}$ = –40 °C … +85 °C | –10 | | +10 | LSB |
| | Gain error | | –5 | | 5 | % |
| | $R_{inG45}$ | Input impedance | 100 | | | kΩ |

| Signal[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **AC Characteristics** | | | | | | |
| ADC Type 1 (all 16 channels) | Conversion time | For all 16 channels (simultaneous sample) | 6.6 | | | µs |
| | $f_{gADC}$ | Low-pass cutoff frequency (3 dB) | 9.1 | 9.6 | 10.2 | kHz |
| Group 4 & 5 | Conversion time | Per channel (sequentially sample); | 10 | 17 | µs | |
| | No low-pass filter implemented | | | | | |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagrams**

The following table shows *simplified* diagrams of the I/O circuitry of the analog inputs:

| Signal | | I/O Circuit |
|---|---|---|
| Analog inputs | ADC Type 1 Channel 1 … 16 |  |
| | Group 4 & Group 5 |  |

**Related topics**

Basics

- *ADC Unit Type 1* (*MicroAutoBox Features*)
- *DIO Type 1 ADC Unit* (*MicroAutoBox Features*)

# Analog Outputs

**Pin description**

The following table gives a description of the analog output pins:

| Pins | Signal | Module | Default state | Description / Function |
|---|---|---|---|---|
| D1, D2<br>C1, C2<br>B1, B2<br>A1, A2 | DAC1 … DAC8 | DAC Type 1 (refer to *DAC Unit Type 1* (📖 *MicroAutoBox Features*)) | 0 V | Standard analog outputs<br>12-bit digital values are converted to analog outputs by the DAC module. |

*Default state* means the state of the signal during reset.

**Characteristics**

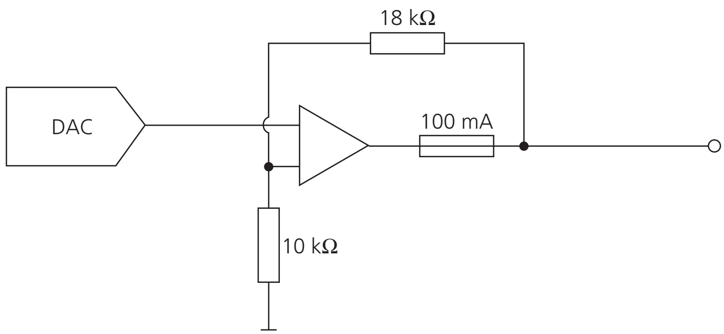
The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25 °C; all voltages are referenced to GND.

| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC characteristics** | | | | | | |
| DAC1 … DAC8 | $V_{DAC}$ | Full scale | 4.44 | 4.50 | 4.56 | V |
| | Resolution | Fully monotonic | 12 | | | bit |
| | Offset error | Delivery state; $T_{CASE}$ = 25 °C | | 2 | | mV |
| | Gain error | | | 0.5 | | LSB |
| | Offset error | $T_{CASE}$ = –40 °C ... +85 °C | –10 | | +10 | LSB |
| | Gain error | | –0.5 | | 0.5 | % |
| | $I_{DACout}$ | max. sink/ source current | –5 | | 5 | mA |
| | $V_{DACSAT}$ | Output voltage when sinking $I_{DACout}$ = –5 mA and CODE = 000H | | | 0.3 | V |
| **AC characteristics** | | | | | | |
| DAC1 … DAC8 | Settling time | Settling time of output (to 1 LSB) | | | 150 | µs |
| | $f_{gDAC}$ | Low-pass cutoff frequency of reconstruction filter (3 dB) | 10.2 | 10.8 | 11.4 | kHz |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagrams**

The following table shows a *simplified* diagram of the I/O circuitry of the analog outputs:

| Signal | | I/O Circuit |
|---|---|---|
| Analog outputs | DAC1 … DAC8 (DAC Type 1) |  |

**Related topics**

Basics

- *DAC Unit Type 1* (*MicroAutoBox Features*)

# Interfaces

**Pin description**

The following table gives a description of the interface pins for ECU interface connector, and 78-pin Sub-D connector. Which I/O signals are available depends on the IP module you use (DS4340, DS4342, or third-party).

**Tip**

The pinout of the ECU interface connectors, USB device connector, and Ethernet I/O connector is not documented. Use a suitable dSPACE connection cable.

**ZIF connector**

The following table gives a description of the interface pins for the ECU interface which can be accessed via a ZIF connector:

| Pins | Signal | Module type | Module Number | Description / Function |
|---|---|---|---|---|
| a5 | ECU / IF1 TX - | ECU Type 1 | Module 1 | ECU-bypassing interface. This reflective memory-based ECU-bypassing interface is proprietary to dSPACE.<br>Connect the MicroAutoBox-RX pair to the ECU-TX pair and the MicroAutoBox-TX pair to the ECU-RX pair. Always use a CAT5 twisted-pair cable for this connection. For the ECU interface connector, use mass-produced cables provided by dSPACE. |
| b5 | ECU / IF1 TX + | | | |
| Y5 | ECU / IF1 RX + | | | |
| Z5 | ECU / IF1 RX - | | | |

**78-pin Sub-D connector**

The following tables give a description of the interface pins provided by the 78-pin Sub-D connector. The installed CAN_TP1 Modules provides the basic communication interfaces of the Sub-D I/O connector.

You can add communication interfaces by installing IP modules of various types to the DS1507:

- DS4340 FlexRay Interface Module
- DS4342 CAN FD Interface Module
- Third-party FlexRay IP module

**CAN_TP1 Module 1** The CAN_TP1 Module 1 has the following pins:

**Note**

Due to the limitations of the UART baud rate generator, not all baud rates can be programmed exactly to the desired baud rate without error (see Baud rate calculation of the serial interface).

| Pins | Signal | Module Type | Module Number | Description / Function |
|---|---|---|---|---|
| 1 | CAN 1 high | CAN Type 1 | Module 1 | ■ CAN 1 high = CAN high of CAN controller 1, module 1<br>■ CAN 2 high = CAN high of CAN controller 2, module 1<br>■ ISO 11898 interface<br>■ The MicroAutoBox CAN buses do not have integrated bus termination. |
| 2 | CAN 1 low | | | |
| 4 | CAN 2 high | CAN Type 1 | | |
| 5 | CAN 2 low | | | |

| Pins | Signal | Module Type | Module Number | Description / Function |
|---|---|---|---|---|
| 7 | Serial 1 TXD | CAN Type 1 | Module 1 | RS232 interface |
| 8 | Serial 1 RXD | | | |
| 10 | Serial 2 K/LIN | CAN Type 1 | Module 1 | LIN or ISO 9141 interface<br>The K line/LIN interface is bidirectional. The L line is input only. Both lines have no pull-up. For proper function of the K line connect an external pull-up resistor (4.7 kΩ) from this line to VBAT.<br>For information on configuring a LIN master, refer to *Connecting to a LIN Bus* on page 108. |
| 11 | Serial 2 L | | | |

**CAN_TP1 Module 2** The CAN_TP1 Module 2 has the following pins:

**Note**

Due to the limitations of the UART baud rate generator, not all baud rates can be programmed exactly to the desired baud rate without error (see Baud rate calculation of the serial interface).

| Pins | Signal | Module Type | Module Number | Description / Function |
|---|---|---|---|---|
| 40 | CAN 3 high | CAN Type 1 | Module 2 | CAN controller:<br>■ CAN 3 high = CAN high of CAN controller 1, module 2<br>■ CAN 4 high = CAN high of CAN controller 2, module 2<br><br>■ ISO 11898 interface<br>■ The MicroAutoBox CAN buses are not equipped with bus termination by default. For information on terminating the CAN buses, refer to *How to Terminate the CAN Bus* on page 124. |
| 41 | CAN 3 low | | | |
| 43 | CAN 4 high | CAN Type 1 | | |
| 44 | CAN 4 low | | | |
| 46 | Serial 3 TXD | CAN Type 1 | Module 2 | RS232 interface |
| 47 | Serial 3 RXD | | | |
| 49 | Serial 4 K/LIN | CAN Type 1 | Module 2 | LIN or ISO 9141 interface<br>The K line/LIN interface is bidirectional. The L line is input only. Both lines have no pull-up. For proper function of the K line connect an external pull-up resistor (4.7 kΩ) from this line to VBAT. |
| 50 | Serial 4 L | | | |

**DS4340 FlexRay Interface Module** For a description of the interface pins of the DS4340 FlexRay Interface Module, refer to *Interfaces* on page 637.

**DS4342 CAN FD Interface Module** For a description of the interface pins of the DS4342 CAN FD Interface Module, refer to *Interfaces* on page 645.

**(FlexRay) IP Module 1** The table describes the pins when a third-party FlexRay IP module is installed.

**Note**

The Sub-D connector can also be used to access the signals of a standard IP module installed on the DS1507. Because the connector is primarily used for FlexRay, not all signals of the IP modules are available. See *Sub-D I/O Connector* on page 293.

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| 13 | IP wakeup 1 | IP_Type1 | You do not need to connect this pin because wake-up functionality is not supported. |
| 14 | IP $\overline{\text{reset 1}}$ | IP_Type1 | ■ Only valid for third-party IP modules<br>■ You do not need to connect this pin because MicroAutoBox handles reset functionality itself. |
| 15 | IP GND 1 | IP_Type1 | Connection to GND |
| 16 | IP bus high/A 1 | IP_Type1 | FlexRay 1 high in/out (FlexRay-H) |
| 17 | IP bus low/B 1 | IP_Type1 | FlexRay 1 low in/out (FlexRay-L) |
| 18 | IP GND 2 | IP_Type1 | Connection to GND |
| 19 | IP bus high/A 2 | IP_Type1 | FlexRay 2 high in/out (FlexRay-H) |
| 20 | IP bus low/B 2 | IP_Type1 | FlexRay 2 low in/out (FlexRay-L) |
| 33 | Reserved | - | Do not connect |
| 34 | Reserved | - | Do not connect |
| 35 | Reserved | - | Do not connect |
| 36 | Reserved | - | Do not connect |
| 37 | Reserved | - | Do not connect |
| 38 | Reserved | - | Do not connect |
| 39 | Reserved | - | Do not connect |

**(FlexRay) IP Module 2** The table describes the pins when a third-party FlexRay IP module is installed.

**Note**

The Sub-D connector can also be used to access the signals of a standard IP module installed on the DS1507. Because the connector is primarily used for FlexRay, not all signals of the IP modules are available. See *Sub-D I/O Connector* on page 293.

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| 52 | IP wakeup 2 | IP_Type1 | You do not need to connect this pin because wake-up functionality is not supported. |
| 53 | IP $\overline{\text{reset}}$ 2 | IP_Type1 | ■ Only valid for third-party IP modules<br>■ You do not need to connect this pin because MicroAutoBox handles reset functionality itself. |
| 54 | IP GND 3 | IP_Type1 | Connection to GND |
| 55 | IP bus high/A 3 | IP_Type1 | FlexRay 1 high in/out (FlexRay-H) |
| 56 | IP bus low/B 3 | IP_Type1 | FlexRay 1 low in/out (FlexRay-L) |
| 57 | IP GND 4 | IP_Type1 | Connection to GND |
| 58 | IP bus high/A 4 | IP_Type1 | FlexRay 2 high in/out (FlexRay-H) |
| 59 | IP bus low/B 4 | IP_Type1 | FlexRay 2 low in/out (FlexRay-L) |
| 72 | Reserved | - | Do not connect |
| 73 | Reserved | - | Do not connect |
| 74 | Reserved | - | Do not connect |
| 75 | Reserved | - | Do not connect |
| 76 | Reserved | - | Do not connect |
| 77 | Reserved | - | Do not connect |
| 78 | Reserved | - | Do not connect |

**Characteristics**

The interface characteristics are specified for the following conditions: $V_{BAT}$ = +12 V; $T_{CASE}$ = +25 °C; all voltages are referenced to GND.

| Interface | Parameter[1] | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Host PC | Protocol | TCP/IP | | | | |
| | Bitrate | | | ■ 10/1000[2]<br>■ 10/100[3] | | Mbit |
| | Data throughput | | | | 2.6 | MB/s |
| | Voltage levels | Ethernet standard | | | | |
| Ethernet I/O | Protocol | UDP/IP | | | | |
| | Bitrate | | | 1000 | | Mbit |
| | Voltage levels | Ethernet standard | | | | |
| USB | USB 2.0 standard (USB Flight Recording) | | | | | |
| | Data throughput | without connected host tool | | | 1280 | kB/sec |
| | | with connected host tool | | | 1024 | kB/sec |
| | | without data loss during cold start (dependent on the boot time of the host interface) | | | 640 | kB/sec |
| | Current | | | | 1.3 | A |
| | Voltage | | | | 5 | V |

| Interface | Parameter[1] | Conditions / Comments | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| ECU | Bit rate | LVDS mode | | | | 250 | MBit |
| | | LVDS2 mode | | | | 560 | |
| | Cable length | 2-paired twisted pair | | | | 5 | m |
| | Cable type | | | CAT5 | | | |
| | Voltage levels | LVDS standard | | | | | |
| | Full duplex data rate[4] | LVDS mode | Single transfer | | | 5 | MWord/s |
| | | LVDS2 mode | Single transfer | | | 11.2 | MWord/s |
| | | | Block transfer | | | 28 | MWord/s |
| | RAM size[4] | LVDS / LVDS2 mode | | 16 | | | kWord |
| | FIFO size[4] | LVDS / LVDS2 mode (Transmit buffer) | | 1 | | | kWord |
| CAN | Bit rate | ISO 11898 interface | | | | 1 | MBaud |
| CAN FD (with DS4342) | Bit rate | ISO 11898 interface | | | | > 2 | MBaud |
| Serial 1 RS232-Interface | Bit rate | | | 5 | | 115.2k | Baud |
| | TX output voltage swing | 3 kΩ load | | ±5 | ±9 | | V |
| | $V_{RxinLow}$ | RX input threshold low | | | 1.4 | 0.8 | V |
| | $V_{RxinHigh}$ | RX input threshold high | | 2.0 | 1.4 | | V |
| | Word length | | | 5 | | 8 | bit |
| Serial 2 ISO9141-Interface | Bit rate | $R_{KO}$ = 510 Ω; $C_K$ ≤ 1.3 nF | | 5 | | 50k | Baud |
| | Word length | | | 5 | | 8 | bit |
| Serial 2 LIN Interface | Bit rate | | | 5 | | 20k | Baud |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.
2) Since board revision DS1401-23 (available since dSPACE Release 7.2).
3) Before board revision DS1401-23
4) Word is 16-bit wide

**Baud rate calculation of the serial interface**

**Note**

Due to the limitations of the UART baud rate generator, not all baud rates can be programmed exactly to the desired baud rate without error.

The UART baud rate generator provides several baud rates:

*To calculate the divisor T for a chosen baud rate*

$$T = \text{Round}\left(\frac{230400}{\text{BR (chosen)}}\right)$$

BR (chosen) = The baudrate to be generated
T = The baudrate generator divisor (2 ≤ T ≤ 65535)

*To calculate the real baud rate from a given divisor T*

$$\frac{\text{BR (real)}}{\text{Baud}} = \frac{230400}{T}$$

BR (real) = The baudrate you get
T = The baudrate generator divisor (2 ≤ T ≤ 65535)

*To calculate the resulting error*

$$\frac{\text{Error}_{BR}}{100\%} = \frac{\text{BR (real)} - \text{BR (chosen)}}{\text{BR (chosen)}}$$

**Note**

If $\text{Error}_{BR} \leq 2\%$, messages will be transferred and received correctly.

# Data Sheet MicroAutoBox II 1401/1507

**Where to go from here**

Information in this section

# Overview and General Information

**Where to go from here**

Information in this section

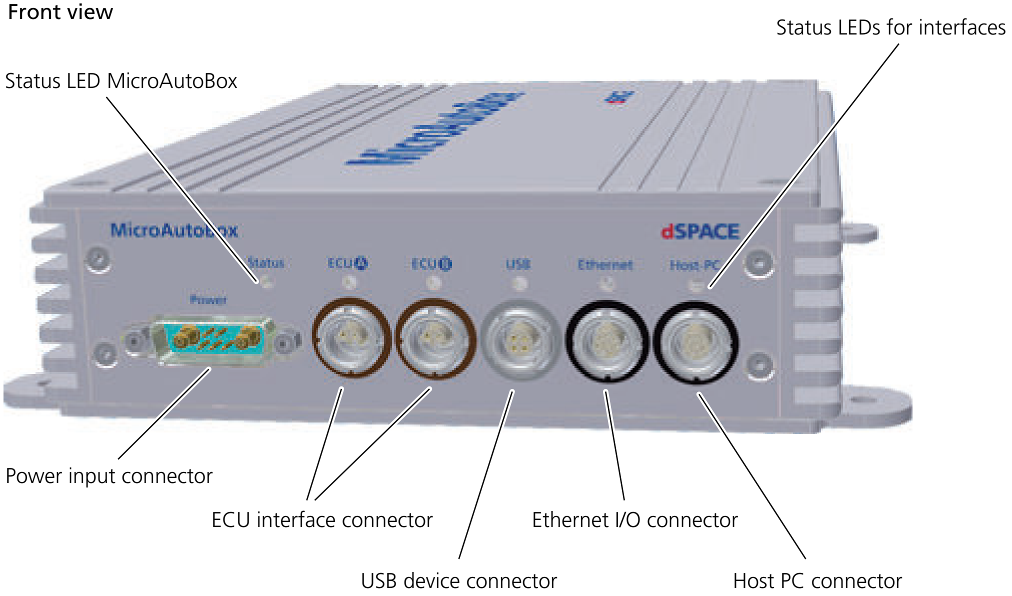


## Housing Components

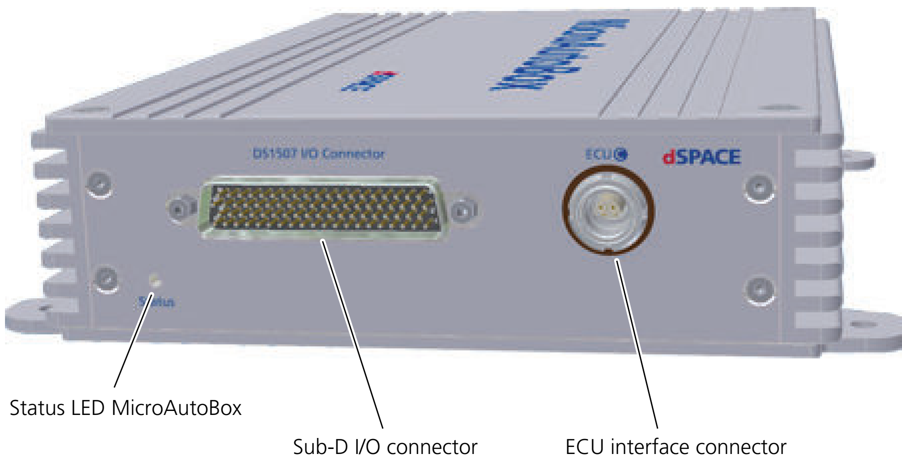
**Connectors and status LEDs**

The illustrations show where the connectors and status LEDs are located on MicroAutoBox II 1401/1507.

Front view



Rear view




MicroAutoBox II 1401/1507 contains the following connectors and LEDs (from left to right):

**Power input connector** Supplies the required power to MicroAutoBox. It is a 7-pin, male Sub-D connector with two high-current pins.

A preconfigured cable with a matching connector and a separate power input connector are included in each MicroAutoBox package. For the pinout and further details on the preconfigured cable, refer to *Power Input Connector* on page 336.

**Status LED MicroAutoBox** Shows you different states and potential malfunctions.

If battery power is switched on and the REMOTE signal/KL15 is activated (see *Basics on Connecting to Power Supply* on page 44), the status LED (= dual LED) shows different states indicated by the LED color:

- LED is red: Reset state and no application is downloaded to the real-time processor.
- LED is green: Application is running.
- LED is flashing red: MicroAutoBox is in secured mode. For further instructions, refer to *Checking MicroAutoBox* on page 672.

The status LED on the front panel has the same functionality as the status LED on the rear panel of MicroAutoBox.

**ECU interface connectors** Provide communication to ECUs based on the LVDS standard, for example, in bypassing scenarios or to connect a RapidPro system (used as I/O subsystem). The ECU interface connectors are 4-pin LEMO connectors. Matching cables are supplied from dSPACE on request.

The corresponding LED is lit green, if power at both ends of the link is available and the relevant connection is serviceable. The LED flashes when data is being sent or received.

The table below shows the different ECU interfaces integrated into MicroAutoBox and the display names they are mapped to in the experiment software, for example, ControlDesk.

| Display Name in Software | Connectors Built-in at MicroAutoBox | | |
|---|---|---|---|
| | ECU A | ECU B | ECU C |
| ECU 1 | – | – | ✓ |
| ECU 2 | ✓ | – | – |
| ECU 3 | – | ✓ | – |

**USB device connector** A 4-pin LEMO connector to connect an USB mass storage device to use the USB Flight Recorder feature of MicroAutoBox. A matching cable with a LEMO-USB adapter is supplied from dSPACE on request.

**Note**

To use the USB Flight Recorder, a separate license is required.

The possible states of the corresponding LED are listed in the table below:

| LED Status | Meaning |
|---|---|
| Off | No USB device is connected. |
| Green | USB device is connected and flight recorder is not running. |
| Green blinking | USB device is connected and flight recorder is running. |
| Orange | USB device is full and the active flight recorder is specified not to overwrite old files. |
| Red | Write error when accessing the USB device, for example, if the device was removed while the flight recorder was running. |

For further information, refer to *Flight Recorder* (📖 *MicroAutoBox Features*).

**Ethernet I/O connector** An 8-pin LEMO connector that provides communication to external devices, such as PCs or ECUs based on the UDP/IP Ethernet protocol, for example, in bypassing scenarios.

A matching cable with a LEMO-RJ45 adapter is supplied from dSPACE on request.

The corresponding LED is lit green if power is available at both ends of the link and the relevant connection is serviceable. The LED flashes green when data is being sent or received.

For installation instructions, refer to *How to Connect MicroAutoBox to the ECU via UDP/IP* (📖 *ECU Interfaces Hardware Installation and Configuration*).

**Host PC connector** Provides the communication between MicroAutoBox and your host PC based on the Ethernet TCP/IP protocol. The connector is a 8-pin LEMO connector. A matching cable is included in each MicroAutoBox package.

The corresponding LED is lit green if power is available at both ends of the link and the relevant connection is serviceable. The LED flashes green when data is being sent or received.

**Tip**

The Ethernet I/O connector and the Host PC connector are internally connected by a common gigabit Ethernet switch (valid for base board DS1401-25ff).

This simplifies the connection options. For an example, refer to *Connecting an ECU with DCI-GSI2 for Simultaneous Calibration and Bypassing* (📖 *ECU Interfaces Hardware Installation and Configuration*).

**Sub-D I/O connector** The 78-pin Sub-D I/O connector is used to connect CAN, LIN, FlexRay and the IP modules. For the pinout, refer to *Sub-D I/O Connector* on page 331.

# General Data

**General characteristics**

The following table shows some general characteristics of MicroAutoBox:

| Parameter | | Specification[1] |
|---|---|---|
| Base board (DS1401-20ff.) | Processor | ■ PPC750 GL Power PC<br>■ 900 MHz clock frequency<br>■ Real-time clock |
| | Memory | ■ 8 MB global RAM<br>■ 16 MB local RAM<br>■ 16 MB flash memory |
| | Onboard sensors[2] | Pressure sensor:<br>■ Base board DS1401-23ff.<br>■ Range: 50 kPA ...115 kPa<br>■ Accuracy: 1 kPa<br>■ Sample rate: approx. 200 Hz<br>Acceleration sensor<br>■ Base board DS1401-23ff.<br>■ Range: ±2 g ... ±8 g in 3 axis (x/y/z)<br>■ Resolution: 10 bit per axis<br>■ Sample rate: max. 800 Hz<br>■ FIFO buffer: 512 words (to read and write bursts) |
| Communication interfaces | | ■ 1 x Host PC interface based on Ethernet TCP/IP protocol<br>■ 1 x Ethernet I/O interface based on Ethernet UDP/IP protocol for Ethernet bypassing scenarios<br>■ 3 x ECU interface based on LVDS standard<br>■ 1 x USB interface for USB flight recording (separate license) |
| I/O connectors | | ■ 1 x 78-pin Sub-D I/O connector<br>■ 1 x 7-pin power supply input connector |
| Chassis dimensions | Case width | 202 mm (7.95 in.) |
| | Case height | 50 mm (1.97 in.) |
| | Case depth | 222 mm (8.74 in.) |
| Weight | | About 2.1 kg (4.6 lb.) without external cables |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

[2] For further information on the sensors, refer to *Onboard Sensors* (*MicroAutoBox Features*).

## Absolute Maximum Levels

**Avoiding damage to the system**

**NOTICE**

Do not exceed the maximum levels since this might permanently damage the system.

**Levels**

The following table shows the levels (for example, voltage, temperature) of the MicroAutoBox. All voltages are referenced to GND (unless otherwise noted).

| Parameter | Specification[1)] | Description |
|---|---|---|
| VBAT | –40 V ... +100 V | Load dump- and reverse protection |
| REMOTE | –40 V ... +100 V | |
| RS232 transceiver output | –30 V ... +30 V | |
| RS232 transceiver input | –30 V ... +30 V | |
| CAN transceiver[2)] | –60 V ... +60 V | |
| Serial K/ LIN | –20 V ... +32 V | But not more than VBAT |
| Serial L | –24 V ... +30 V | But not more than VBAT |
| FlexRay bus lines (with DS4340 FlexRay Interface Module) | –60 V ... +60 V | |
| All outputs short circuit to GND | continuous | |
| Continuous power dissipation ($T_{ambient}$ = +85 °C) | max. 25 W | |
| Operating temperature | –40 °C ... +85 °C | |
| Storage temperature | –55 °C ... +125 °C | |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

2) If the DS4342 CAN FD Interface Module is installed on the DS1507 I/O Board, the I/O connectors provide additional CAN interfaces. For maximum absolute levels, refer to *Absolute Maximum Levels* on page 640.

## Certifications

**CE compliance**

MicroAutoBox meets the requirements of the European directive 2014/30/EU (Electromagnetic Compatibility Directive) for CE marking.

**Vibration and shock tests**

To verify the reliability of MicroAutoBox under realistic operating conditions, it was exposed to vibration and shock tests. During the tests, MicroAutoBox executed a program without any failures.

**Applied standards**

The characteristics of MicroAutoBox were tested according to the standards shown in the following table:

| Tested Characteristics | Applied Standard | Description |
|---|---|---|
| Electromagnetic compatibility (EMC) | EN 61326-1 Table 2 | Immunity standard for industrial environments[1)] |
| | CISPR 11, EN 55011 Group 1, Class A | Emission standard for industrial environments |
| Vibration | ISO 16750-3:2007 / 4.1.2.4 Test IV | Test conditions: Broad band noise, 2h per axis, RMS-acceleration 27.8 $m/s^2$ |
| | EN 60068-2-6 | Test conditions:<br>■ Swept sine, 1 octave per minute, 3-axis test<br>■ 5 ... 2000 Hz, up to 5 g, 2 sweeps per axis<br>■ Operating |
| Shock | ISO 16750-3:2007 / 4.2.2. | ■ Linear shock (1/2 sine pulse), 6-axis<br>■ 500 $m/s^2$, 6 ms, 10 pulses per axis<br>■ Operating |

1) Tested with an I/O cable length < 3 m.

# Connector Pinouts

**Where to go from here**

Information in this section



## Sub-D I/O Connector

**Objective**

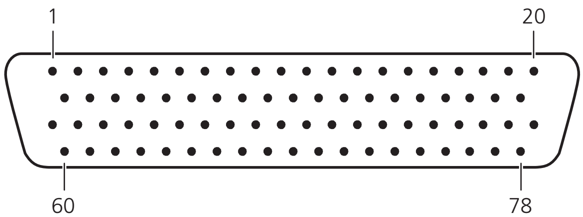
MicroAutoBox II 1401/1507 provides a 78-pin, male Sub-D connector that grants access to various I/O signals provided by the DS1507 I/O Board and the optional IP modules (DS4340, DS4342, or third-party modules).

**Pinout**

The table below shows the pinout and the signal mapping to the I/O connectors of the IP slots. The pin numbering used for Sub-D connectors is not standardized. The following illustration shows the numbering used (front view).

**Note**

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




| Pin | Signal | Pin | Signal | Pin | Signal | Pin | Signal |
|---|---|---|---|---|---|---|---|
| 1 | CAN 1 high | | | 40 | CAN 3 high | | |
| 2 | CAN 1 low | 21 | GND | 41 | CAN 3 low | 60 | GND |
| 3 | GND | 22 | GND | 42 | GND | 61 | GND |
| 4 | CAN 2 high | 23 | GND | 43 | CAN 4 high | 62 | GND |
| 5 | CAN 2 low | *24* | IP slot 1, pin 5 (I/O) | 44 | CAN 4 low | *63* | IP slot 2, pin 5 (I/O) |
| 6 | GND | 25 | GND | 45 | GND | 64 | GND |
| 7 | Serial 1 TXD | 26 | GND | 46 | Serial 3 TXD | 65 | GND |
| 8 | Serial 1 RXD | 27 | GND | 47 | Serial 3 RXD | 66 | GND |
| 9 | GND | 28 | GND | 48 | GND | 67 | GND |
| 10 | Serial 2 K/LIN | 29 | GND | 49 | Serial 4 K/LIN | 68 | GND |
| 11 | Serial 2 L | 30 | GND | 50 | Serial 4 L | 69 | GND |
| 12 | GND | 31 | GND | 51 | GND | 70 | GND |
| 13 | Reserved | 32 | GND | 52 | Reserved | 71 | GND |
| 14 | GND | *33* | IP slot 1, pin 14 (I/O) | 53 | GND | *72* | IP slot 2, pin 14 (I/O) |
| *15* | IP slot 1, pin 48 (I/O) | *34* | IP slot 1, pin 15 (I/O) | *54* | IP slot 2, pin 48 (I/O) | *73* | IP slot 2, pin 15 (I/O) |
| *16* | IP slot 1, pin 50 (I/O) | *35* | IP slot 1, pin 16 (I/O) | *55* | IP slot 2, pin 50 (I/O) | *74* | IP slot 2, pin 16 (I/O) |
| *17* | IP slot 1, pin 49 (I/O) | *36* | IP slot 1, pin 17 (I/O) | *56* | IP slot 2, pin 49 (I/O) | *75* | IP slot 2, pin 17 (I/O) |
| *18* | IP slot 1, pin 44 (I/O) | *37* | IP slot 1, pin 18 (I/O) | 57 | IP slot 2, pin 44 (I/O) | *76* | IP slot 2, pin 18 (I/O) |
| *19* | IP slot 1, pin 46 (I/O) | *38* | IP slot 1, pin 19 (I/O) | *58* | IP slot 2, pin 46 (I/O) | *77* | IP slot 2, pin 19 (I/O) |
| *20* | IP slot 1, pin 45 (I/O) | *39* | IP slot 1, pin 20 (I/O) | *59* | IP slot 2, pin 45 (I/O) | *78* | IP slot 2, pin 20 (I/O) |

**Pinout for using IP modules**

For the pinout of the IP modules' signals, refer to the following topics:

- DS4340 FlexRay Interface Module: *DS1507 Sub-D I/O Connector* on page 633
- DS4342 CAN FD Interface Module: *DS1507 Sub-D I/O Connector* on page 641

**Signal descriptions**

For descriptions of the signals which are available on the Sub-D I/O connector, refer to *Interfaces* on page 338.

**Related topics**

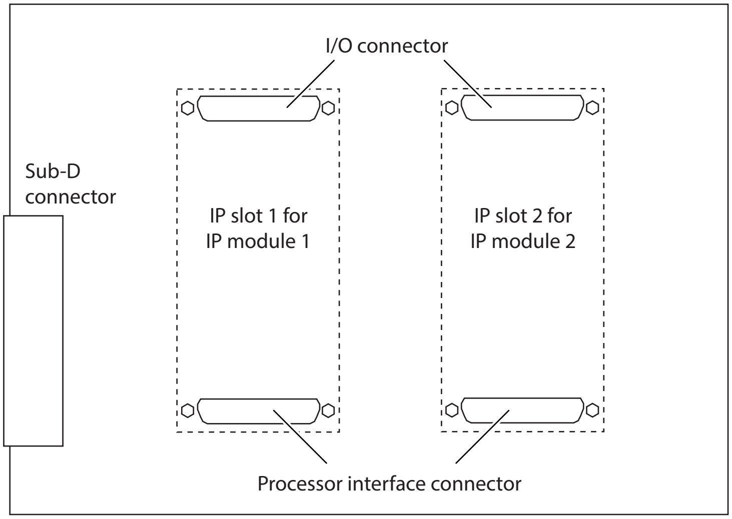
References

- *IP Module Connectors* on page 333

# IP Module Connectors

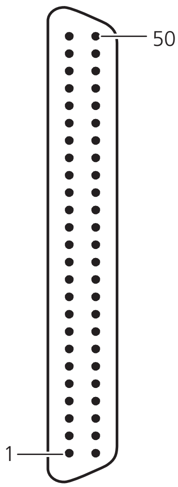
**Objective**

The DS1507 provides two slots to install IP modules. Each slot provides two AMP connectors: I/O connector and processor interface connector. The following illustration shows the top view of MicroAutoBox.

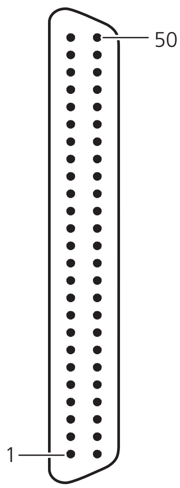


**Signal Mapping**

**I/O connector - IP module slot 1** The following table shows the signal mapping of the IP module I/O connector on slot 1 to the Sub-D I/O Connector:

| IP Module I/O Connector | Pin | Sub-D Connector Pin | | Pin | Sub-D Connector Pin |
|---|---|---|---|---|---|
|  | 25 | - | | 50 | 16 |
| | 24 | - | | 49 | 17 |
| | 23 | - | | 48 | 15 |
| | 22 | - | | 47 | - |
| | 21 | - | | 46 | 19 |
| | 20 | 39 | | 45 | 20 |
| | 19 | 38 | | 44 | 18 |
| | 18 | 37 | | 43 | - |
| | 17 | 36 | | 42 | - |
| | 16 | 35 | | 41 | - |
| | 15 | 34 | | 40 | - |
| | 14 | 33 | | 39 | - |
| | 13 | - | | 38 | - |
| | 12 | - | | 37 | - |
| | 11 | - | | 36 | - |
| | 10 | - | | 35 | - |
| | 9 | - | | 34 | - |
| | 8 | - | | 33 | - |
| | 7 | - | | 32 | - |
| | 6 | - | | 31 | - |
| | 5 | 24 | | 30 | - |
| | 4 | - | | 29 | - |
| | 3 | - | | 28 | - |
| | 2 | - | | 27 | - |
| | 1 | - | | 26 | - |

**I/O connector - IP module slot 2** The following table shows the signal mapping of the IP module I/O connector on slot 2 to the Sub-D I/O Connector:

| IP Module I/O Connector | Pin | Sub-D Connector Pin | Pin | Sub-D Connector Pin |
|---|---|---|---|---|
|   | 25 | - | 50 | 55 |
| | 24 | - | 49 | 56 |
| | 23 | - | 48 | 54 |
| | 22 | - | 47 | - |
| | 21 | - | 46 | 58 |
| | 20 | 78 | 45 | 59 |
| | 19 | 77 | 44 | 57 |
| | 18 | 76 | 43 | - |
| | 17 | 75 | 42 | - |
| | 16 | 74 | 41 | - |
| | 15 | 73 | 40 | - |
| | 14 | 72 | 39 | - |
| | 13 | - | 38 | - |
| | 12 | - | 37 | - |
| | 11 | - | 36 | - |
| | 10 | - | 35 | - |
| | 9 | - | 34 | - |
| | 8 | - | 33 | - |
| | 7 | - | 32 | - |
| | 6 | - | 31 | - |
| | 5 | 63 | 30 | - |
| | 4 | - | 29 | - |
| | 3 | - | 28 | - |
| | 2 | - | 27 | - |
| | 1 | - | 26 | - |

**Processor interface connector - slot 1 and slot 2** The pinout of the processor interface connector (slot 1 and slot 2) complies with IP Modules Draft Standard VITA 4-1995. For further information, refer to the documentation of the standard.

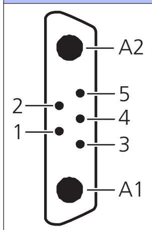
# Power Input Connector

**Objective**

MicroAutoBox provides a power input connector. It is a 7-pin, male connector with two high-current pins. It is a special variant of a 15-pin Sub-D connector (mixed-layout 7W2 Sub-D).

**Pinout**

The following illustration shows the pinout (front view of MicroAutoBox).

| Connector | Pin | Signal | Pin | Signal |
|---|---|---|---|---|
|  | A2[1] | VBAT (6 V … 40 V DC) | | |
| | | | 5 | REMOTE_PULLUP |
| | 2 | Do not connect | 4 | REMOTE[2] |
| | 1 | Do not connect | 3 | Do not connect |
| | A1 | GND | | |

[1] NOTE: It is highly recommended to insert a fuse into the main power supply input wire (close to battery). Choose the value of the fuse according to the maximum current. A 10 A fuse is recommended.

[2] The REMOTE input must be connected via switch or bridge to UBAT to run the MicroAutoBox. For example, you can use it for switching MicroAutoBox with KL15 (output of the ignition/driving switch). So, you can use the nonvolatile data feature to store data you may want to use again when restarting the application. For further information, refer to *Nonvolatile Data Handling* (📖 *MicroAutoBox RTLib Reference*).

**Matching cable**

A preconfigured cable for the supply voltage is provided by dSPACE. This cable is for running MicroAutoBox with a laboratory power supply during development. Therefore, REMOTE (pin 4) is shorted to VBAT (pin A2) inside the connector in order to save a separate switch. Do not use this cable in the vehicle. Otherwise, MicroAutoBox will always be turned on.

The VBAT wire (red) contains a melting fuse. Each wire has a cross-section of 1.5 mm².

Fuse specification:

- Cable delivered through dSPACE Release 2013-B: 7.5 A, time lag
- Cable delivered as of dSPACE Release 2014-A: 10 A, time lag

# Signal Descriptions

**Where to go from here**

Information in this section



## Power Inputs and Outputs

**Pin description**

The following table gives a description of the pins used for power input, remote input and supply of digital I/O circuits.

| Connector | Pins | Signal | Description / Function |
|---|---|---|---|
| Power input connector | A2 | VBAT | Main power supply input. Connect this pin to the positive pole of your car battery. |
| | A1 | GND | Main power supply return and reference for all input and output signals. Connect this pin to the minus pole of your car battery. This signal is also connected to the case of MicroAutoBox. |
| | 4 | REMOTE | ■ The REMOTE input may be used for starting MicroAutoBox with a remote switch, for example KL15 (output of the ignition/driving switch).<br>■ If you connect the remote pin to the plus pole of the car battery directly, MicroAutoBox will always be turned on, and the car battery will soon be exhausted if the engine is not running. Thus, a switch is highly recommended.<br>■ The voltage connected to the REMOTE pin should not exceed the supply voltage. |
| | 5 | REMOTE_Pullup | You can use this output to connect a remote switch between REMOTE and this pin. REMOTE_Pullup is internally connected to VBAT via 39 kΩ pull-up resistor. |

**Characteristics**

The characteristics are specified for the following conditions:

- $V_{BAT}$=+12 V (unless otherwise noted)

  $T_{CASE}$=+25 °C (unless otherwise noted)

  All voltages are referenced to GND (unless otherwise noted).

| Signal[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Power** | | | | | | |
| Operating voltage | VBAT | For start-up | 6 | | 40 | V |
| | VBAT | Operating | 4 | | 40 | V |
| | VBAT | Reverse protection | | | -40 | V |
| | VBAT | Load dump protection | | | +100 | V |
| **Inputs** | | | | | | |
| Operating current | $I_{VBAT}$ | REMOTE ≥ $V_{iHRemote}$ | | 1.3 | | A |
| | $I_{VBAT}$ | REMOTE ≤ $V_{iLRemote}$ | | 5 | | mA |
| REMOTE voltage input | $V_{iHRemote}$ | Input high voltage | 4.7 | | | V |
| | $V_{iLRemote}$ | Input low voltage | | | 0.8 | V |
| | $V_{iHysRemote}$ | Input hysteresis voltage | 0.5 | 1 | | V |
| | $R_{inRemote}$ | Input impedance | 60 | | 185 | kΩ |
| Inrush current | $I_{VBAT\ inrush}$ | All inputs/outputs unconnected | see *Power supply* on page 40 | | | |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

# Interfaces

**Pin description**

The following table gives a description of the pins of the 78-pin Sub-D I/O connector. Which I/O signals are available depends on the IP module you use (DS4340, DS4342, or third-party).

**Tip**

The pinout of the ECU interface connectors, USB device connector, and Ethernet I/O connector is not documented. Use a suitable dSPACE connection cable.

**Sub-D I/O connector**

The following tables give a description of the interface pins provided by the 78-pin Sub-D I/O connector. The installed CAN_TP1 Modules provides the basic communication interfaces of the Sub-D I/O connector.

You can add communication interfaces by installing IP modules of various types to the DS1507:

- DS4340 FlexRay Interface Module
- DS4342 CAN FD Interface Module
- Third-party FlexRay IP module

**CAN_TP1 Module 1** The CAN_TP1 Module 1 has the following pins:

> **Note**
>
> Due to the limitations of the UART baud rate generator, not all baud rates can be programmed exactly to the desired baud rate without error (see below).

| Pin | Signal | Module type | Module Number | Description / Function |
|---|---|---|---|---|
| 1 | CAN 1 high | CAN Type 1 | Module 1 | CAN controller:<br>■ CAN 1 high = CAN high of module number 1, channel number 1<br>■ CAN 2 high = CAN high of module number 1, channel number 2<br><br>■ ISO 11898 interface<br>■ The MicroAutoBox CAN buses are not equipped with bus termination by default. For information on terminating the CAN buses, refer to *How to Terminate the CAN Bus* on page 124. |
| 2 | CAN 1 low | | | |
| 4 | CAN 2 high | CAN Type 1 | | |
| 5 | CAN 2 low | | | |
| 7 | Serial 1 TXD | CAN Type 1 | Module 1 | RS232 interface |
| 8 | Serial 1 RXD | | | |
| 10 | Serial 2 K/LIN | CAN Type 1 | Module 1 | LIN or ISO 9141 interface<br>The K line/LIN interface is bidirectional. The L line is input only. Both lines have no pull-up. For proper function of the K line connect an external pull-up resistor (4.7 kΩ) from this line to VBAT.<br>For information on configuring a LIN master, refer to *Connecting to a LIN Bus* on page 108. |
| 11 | Serial 2 L | | | |

**CAN_TP1 Module 2** The CAN_TP1 Module 2 has the following pins:

> **Note**
>
> Due to the limitations of the UART baud rate generator, not all baud rates can be programmed exactly to the desired baud rate without error (see below).

| Pin | Signal | Module type | Module Number | Description / Function |
|---|---|---|---|---|
| 40 | CAN 3 high | CAN Type 1 | Module 2 | ■ CAN 3 high = CAN high of CAN controller 1, module 2<br>■ CAN 4 high = CAN high of CAN controller 2, module 2<br>■ ISO 11898 interface<br>■ The MicroAutoBox CAN buses do not have integrated bus termination. |
| 41 | CAN 3 low | | | |
| 43 | CAN 4 high | CAN Type 1 | | |
| 44 | CAN 4 low | | | |
| 46 | Serial 3 TXD | CAN Type 1 | Module 2 | RS232 interface |
| 47 | Serial 3 RXD | | | |

| Pin | Signal | Module type | Module Number | Description / Function |
|---|---|---|---|---|
| 49 | Serial 4 K/LIN | CAN Type 1 | Module 2 | LIN or ISO 9141 interface<br>The K line/LIN interface is bidirectional. The L line is input only. Both lines have no pull-up. For proper function of the K line connect an external pull-up resistor (4.7 kΩ) from this line to VBAT. |
| 50 | Serial 4 L | | | |

**DS4340 FlexRay Interface Module** For a description of the interface pins of the DS4340 FlexRay Interface Module, refer to *Interfaces* on page 637.

**DS4342 CAN FD Interface Module** For a description of the interface pins of the DS4342 CAN FD Interface Module, refer to *Interfaces* on page 645.

**(FlexRay) IP Module 1** The table describes the pins if a third-party FlexRay IP module or is installed in slot 1.

**Note**

The Sub-D connector can also be used to access the signals of a standard IP module installed on the DS1507. Because the connector is primarily used for FlexRay, not all signals of the IP modules are available. See *Sub-D I/O Connector* on page 331.

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| 13 | IP wakeup 1 | IP_Type1 | You do not need to connect this pin because wake-up functionality is not supported. |
| 14 | IP reset 1 | IP_Type1 | ■ Only valid for third-party IP modules<br>■ You do not need to connect this pin because MicroAutoBox handles reset functionality itself. |
| 15 | IP GND 1 | IP_Type1 | Connection to GND |
| 16 | IP bus high/A 1 | IP_Type1 | FlexRay 1 high in/out (FlexRay-H) |
| 17 | IP bus low/B 1 | IP_Type1 | FlexRay 1 low in/out (FlexRay-L) |
| 18 | IP GND 2 | IP_Type1 | Connection to GND |
| 19 | IP bus high/A 2 | IP_Type1 | FlexRay 2 high in/out (FlexRay-H) |
| 20 | IP bus low/B 2 | IP_Type1 | FlexRay 2 low in/out (FlexRay-L) |
| 33 | Reserved | - | Do not connect |
| 34 | Reserved | - | Do not connect |
| 35 | Reserved | - | Do not connect |
| 36 | Reserved | - | Do not connect |
| 37 | Reserved | - | Do not connect |
| 38 | Reserved | - | Do not connect |
| 39 | Reserved | - | Do not connect |

**(FlexRay) IP Module 2** The table describes the pins if a third-party FlexRay IP module is installed in slot 2.

**Note**

The Sub-D connector can also be used to access the signals of a standard IP module installed on the DS1507. Because the connector is primarily used for FlexRay, not all signals of the IP modules are available. See *Sub-D I/O Connector* on page 331.

| Pin | Signal | Module | Description / Function |
|---|---|---|---|
| 52 | IP wakeup 2 | IP_Type1 | You do not need to connect this pin because wake-up functionality is not supported. |
| 53 | IP $\overline{\text{reset 2}}$ | IP_Type1 | ■ Only valid for third-party IP modules<br>■ You do not need to connect this pin because MicroAutoBox handles reset functionality itself. |
| 54 | IP GND 3 | IP_Type1 | Connection to GND |
| 55 | IP bus high/A 3 | IP_Type1 | FlexRay 1 high in/out (FlexRay-H) |
| 56 | IP bus low/B 3 | IP_Type1 | FlexRay 1 low in/out (FlexRay-L) |
| 57 | IP GND 4 | IP_Type1 | Connection to GND |
| 58 | IP bus high/A 4 | IP_Type1 | FlexRay 2 high in/out (FlexRay-H) |
| 59 | IP bus low/B 4 | IP_Type1 | FlexRay 2 low in/out (FlexRay-L) |
| 72 | Reserved | - | Do not connect |
| 73 | Reserved | - | Do not connect |
| 74 | Reserved | - | Do not connect |
| 75 | Reserved | - | Do not connect |
| 76 | Reserved | - | Do not connect |
| 77 | Reserved | - | Do not connect |
| 78 | Reserved | - | Do not connect |

**Characteristics**

The interface characteristics are specified for the following conditions: $V_{BAT}$ = +12 V; $T_{CASE}$ = +25 °C; all voltages are referenced to the A1 pin (GND) on the power input connector, unless otherwise noted.

| Interface | Parameter[1] | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Host PC | Protocol | TCP/IP | | | | |
| | Bitrate | | | ■ 10/1000[2]<br>■ 10/100[3] | | Mbit |
| | Data throughput | | | | 2.6 | MB/s |
| | Voltage levels | Ethernet standard | | | | |

| Interface | Parameter[1)] | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Ethernet I/O | Protocol | UDP/IP | | | | |
| | Bitrate | | | 1000 | | Mbit |
| | Voltage levels | Ethernet standard | | | | |
| USB | USB 2.0 standard (USB Flight Recording) | | | | | |
| | Data throughput | without connected host tool | | | 1280 | kB/sec |
| | | with connected host tool | | | 1024 | kB/sec |
| | | without data loss during cold start (dependent on the boot time of the host interface) | | | 640 | kB/sec |
| | Current | | | | 1.3 | A |
| | Voltage | | | | 5 | V |
| ECU | Bit rate | LVDS mode | | | 250 | MBit |
| | | LVDS2 mode | | | 560 | |
| | Cable length | 2-paired twisted pair | | | 5 | m |
| | Cable type | | CAT5 | | | |
| | Voltage levels | LVDS standard | | | | |
| | Full duplex data rate[4)] | LVDS mode<br>Single transfer | | | 5 | MWord /s |
| | | LVDS2 mode<br>Single transfer | | | 11.2 | MWord /s |
| | | Block transfer | | | 28 | MWord /s |
| | RAM size[4)] | LVDS / LVDS2 mode | 16 | | | kWord |
| | FIFO size[4)] | LVDS / LVDS2 mode (Transmit buffer) | 1 | | | kWord |
| CAN | Bit rate | ISO 11898 interface | | | 1 | MBaud |
| CAN FD (with DS4342) | Bit rate | ISO 11898 interface | | | > 2 | MBaud |
| Serial 1 RS232-Interface | Bit rate | | 5 | | 115.2k | Baud |
| | TX output voltage swing | 3 kΩ load | ±5 | ±9 | | V |
| | $V_{RxinLow}$ | RX input threshold low | | 1.4 | 0.8 | V |
| | $V_{RxinHigh}$ | RX input threshold high | 2.0 | 1.4 | | V |
| | Word length | | 5 | | 8 | bit |
| Serial 2 ISO9141-Interface | Bit rate | $R_{KO}$ = 510 Ω; $C_K \leq$ 1.3 nF | 5 | | 50k | Baud |
| | Word length | | 5 | | 8 | bit |
| LIN ISO9141-Interface | Bit rate | | 1 | | 20k | Baud |
| | Node type | 30 kΩ resistor for LIN slave | | | | |
| | | 1 kΩ pull-up resistor for LIN master | | | | |
| FlexRay (with DS4340) | Bit rate | | | | 2 x 10 | MBaud |
| | Frame length | | | | 12 | byte |

| Interface | Parameter[1] | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| IP module carrier | Clocking | | 8 | | 32 | MHz |
| | Access type | | | byte / word | | |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.
[2] Since board revision DS1401-23 (available since dSPACE Release 7.2).
[3] Before board revision DS1401-23
[4] Word is 16-bit wide

**Baud rate calculation of the serial interface**

> **Note**
>
> Due to the limitations of the UART baud rate generator, not all baud rates can be programmed exactly to the desired baud rate without error.

The UART baud rate generator provides several baud rates:

*To calculate the divisor T for a chosen baud rate*

$$T = \mathrm{Round}\left(\frac{230400}{\mathrm{BR\ (chosen)}}\right)$$

BR (chosen) = The baudrate to be generated
T = The baudrate generator divisor ($2 \leq T \leq 65535$)

*To calculate the real baud rate from a given divisor T*

$$\frac{\mathrm{BR\ (real)}}{\mathrm{Baud}} = \frac{230400}{T}$$

BR (real) = The baudrate you get
T = The baudrate generator divisor ($2 \leq T \leq 65535$)

*To calculate the resulting error*

$$\frac{\mathrm{Error}_{BR}}{100\%} = \frac{\mathrm{BR\ (real)} - \mathrm{BR\ (chosen)}}{\mathrm{BR\ (chosen)}}$$

> **Note**
>
> If $\mathrm{Error}_{BR} \leq 2\%$, messages will be transferred and received correctly.

# Data Sheet MicroAutoBox II 1401/1511

**Where to go from here**

Information in this section

# Overview and General Information

**Where to go from here**

Information in this section



## Housing Components

**Connectors and status LEDs**

The illustrations show where the connectors and status LEDs are located on MicroAutoBox II 1401/1511.

Front view

Status LEDs for interfaces

Status LED MicroAutoBox


Power input connector

ECU interface connector

Ethernet I/O connector

USB device connector

Host PC connector

Rear view


MicroAutoBox II 1401/1511 contains the following connectors and LEDs (from left to right):

**Power input connector** Supplies the required power to MicroAutoBox. It is a 7-pin, male Sub-D connector with two high-current pins.

A preconfigured cable with a matching connector and a separate power input connector are included in each MicroAutoBox package. For the pinout and further details on the preconfigured cable, refer to *Power Input Connector* on page 356.

**Status LED MicroAutoBox** Shows you different states and potential malfunctions.

If battery power is switched on and the REMOTE signal/KL15 is activated (see *Basics on Connecting to Power Supply* on page 44), the status LED (= dual LED) shows different states indicated by the LED color:

- LED is red: Reset state and no application is downloaded to the real-time processor.
- LED is green: Application is running.
- LED is flashing red: MicroAutoBox is in secured mode. For further instructions, refer to *Checking MicroAutoBox* on page 672.

The status LED on the front panel has the same functionality as the status LED on the rear panel of MicroAutoBox.

**ECU interface connectors** Provide communication to ECUs based on the LVDS standard, for example, in bypassing scenarios or to connect a RapidPro system (used as I/O subsystem). The ECU interface connectors are 4-pin LEMO connectors. Matching cables are supplied from dSPACE on request.

The corresponding LED is lit green, if power at both ends of the link is available and the relevant connection is serviceable. The LED flashes when data is being sent or received.

The table below shows the different ECU interfaces integrated into MicroAutoBox and the display names they are mapped to in the experiment software, for example, ControlDesk.

| **Display Name in Software** | **Connectors Built-in at MicroAutoBox** | |
|---|---|---|
| | **ECU A** | **ECU B** |
| ECU 1 | ✓ | – |
| ECU 2 | – | ✓ |

**USB device connector** A 4-pin LEMO connector to connect an USB mass storage device to use the USB Flight Recorder feature of MicroAutoBox. A matching cable with a LEMO-USB adapter is supplied from dSPACE on request.

**Note**

To use the USB Flight Recorder, a separate license is required.

The possible states of the corresponding LED are listed in the table below:

| **LED Status** | **Meaning** |
|---|---|
| Off | No USB device is connected. |
| Green | USB device is connected and flight recorder is not running. |
| Green blinking | USB device is connected and flight recorder is running. |
| Orange | USB device is full and the active flight recorder is specified not to overwrite old files. |
| Red | Write error when accessing the USB device, for example, if the device was removed while the flight recorder was running. |

For further information, refer to *Flight Recorder* (📖 *MicroAutoBox Features*).

**Ethernet I/O connector** An 8-pin LEMO connector that provides communication to external devices, such as PCs or ECUs based on the UDP/IP Ethernet protocol, for example, in bypassing scenarios.

A matching cable with a LEMO-RJ45 adapter is supplied from dSPACE on request.

The corresponding LED is lit green if power is available at both ends of the link and the relevant connection is serviceable. The LED flashes green when data is being sent or received.

For installation instructions, refer to *How to Connect MicroAutoBox to the ECU via UDP/IP* (📖 *ECU Interfaces Hardware Installation and Configuration*).

**Host PC connector** Provides the communication between MicroAutoBox and your host PC based on the Ethernet TCP/IP protocol. The connector is a 8-pin LEMO connector. A matching cable is included in each MicroAutoBox package.

The corresponding LED is lit green if power is available at both ends of the link and the relevant connection is serviceable. The LED flashes green when data is being sent or received.

**Tip**

The Ethernet I/O connector and the Host PC connector are internally connected by a common gigabit Ethernet switch (valid for base board DS1401-25ff).

This simplifies the connection options. For an example, refer to *Connecting an ECU with DCI-GSI2 for Simultaneous Calibration and Bypassing* (📖 *ECU Interfaces Hardware Installation and Configuration*).

**ZIF I/O connector** The 156-pin zero insertion force (ZIF) I/O connector provides access to the most input and output signals provided by MicroAutoBox. A matching connector is included in each MicroAutoBox package.

For the pinout, refer to *ZIF I/O Connector* on page 354.

# General Data

**General characteristics** The following table shows some general characteristics of MicroAutoBox:

| Parameter | | Specification[1] |
|---|---|---|
| Base board (DS1401-20ff.) | Processor | ■ PPC750 GL Power PC<br>■ 900 MHz clock frequency<br>■ Real-time clock |
| | Memory | ■ 8 MB global RAM<br>■ 16 MB local RAM<br>■ 16 MB flash memory |
| | Onboard sensors[2] | Pressure sensor:<br>■ Base board DS1401-23ff.<br>■ Range: 50 kPA ...115 kPa<br>■ Accuracy: 1 kPa<br>■ Sample rate: approx. 200 Hz<br>Acceleration sensor<br>■ Base board DS1401-23ff.<br>■ Range: ±2 g ... ±8 g in 3 axis (x/y/z)<br>■ Resolution: 10 bit per axis<br>■ Sample rate: max. 800 Hz<br>■ FIFO buffer: 512 words (to read and write bursts) |
| Communication interfaces | | ■ 1 x Host PC interface based on Ethernet TCP/IP protocol<br>■ 1 x Ethernet I/O interface based on Ethernet UDP/IP protocol for Ethernet bypassing scenarios<br>■ 2 x ECU interface based on LVDS standard<br>■ 1 x USB interface for USB flight recording (separate license) |
| I/O connectors | | ■ 1 x 156-pin ZIF I/O connector<br>  ■ max. 15 mΩ contact resistance<br>  ■ 10000 cycles durability<br>  ■ max. 2.5 A continuous current per pin ($T_{ambient}$ = +85 °C)<br>■ 1 x 7-pin power supply input connector |

| Parameter | | Specification[1] |
|---|---|---|
| Chassis dimensions | Case width | 202 mm (7.95 in.) |
| | Case height | 50 mm (1.97 in.) |
| | Case depth | 222 mm (8.74 in.) |
| Weight | | About 2.1 kg (4.6 lb.) without external cables |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

[2] For further information on the sensors, refer to *Onboard Sensors* (📖 *MicroAutoBox Features*).

**Functional I/O units on the I/O board**

The following table shows a mapping of the input/output units on the I/O board which is part of MicroAutoBox:

| dSPACE I/O board | Functional Unit |
|---|---|
| DS1511 | *ADC Unit Type 4* (📖 *MicroAutoBox Features*) |
| | *DAC Unit Type 3* (📖 *MicroAutoBox Features*) |
| | *Bit I/O Unit (DIO Type 3)* (📖 *MicroAutoBox Features*) |

# Absolute Maximum Levels

**Avoiding damage to the system**

**NOTICE**

Do not exceed the maximum levels since this might permanently damage the system.

**Levels**

The following table shows the levels (for example, voltage, temperature) of the MicroAutoBox. All voltages are referenced to GND (unless otherwise noted).

| Parameter | Specification[1] | Description |
|---|---|---|
| VBAT | –40 V ... +100 V | Load dump- and reverse protection |
| VDRIVE | 0 V ... +45 V | |
| All digital output voltages | (VDRIVE – 45 V) ... +45 V | |
| All digital input voltages | (VDRIVE – 45 V) ... +45 V | |
| All analog input voltages | –40 V ... +40 V | |
| All analog output voltages | –30 V ... +40 V | |

| Parameter | Specification[1] | Description |
|---|---|---|
| VSENS output | 0 V ... +40 V | VSENS is switched on and off with the REMOTE pin. |
| VBATprot output | 0 V ... +45 V | VBATprot follows VBAT within the specified range.<br>VBATprot is switched on and off with the REMOTE pin. |
| RS232 transceiver output | –30 V ... +30 V | |
| RS232 transceiver input | –30 V ... +30 V | |
| $V_{\text{CAN high}}$, $V_{\text{CAN low}}$ | –60 V ... +60 V | Voltage level on CAN high and CAN low pins. |
| $V_{\text{Diff (CAN high - CAN low)}}$ | –3.5 V ... +3.5 V | Voltage difference between CAN high and CAN low pins (due to termination resistors). |
| Serial 2 K / LIN | –20 V ... +32 V | But not more than VBAT |
| Serial 2 L | –24 V ... +30 V | But not more than VBAT |
| All outputs short circuit to GND | continuous | |
| Continuous power dissipation ($T_{\text{ambient}}$ = +85 °C) | max. 25 W | |
| Operating temperature | –40 °C ... +85 °C | |
| Storage temperature | –55 °C ... +125 °C | |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

# Certifications

**CE compliance**

MicroAutoBox meets the requirements of the European directive 2014/30/EU (Electromagnetic Compatibility Directive) for CE marking.

**Applied standards**

The characteristics of MicroAutoBox were tested according to the standards shown in the following table:

| Tested Characteristics | Applied Standard | Description |
|---|---|---|
| Electromagnetic compatibility (EMC) | EN 61326-1 Table 2 | Immunity standard for industrial environments[1] |
| | CISPR 11, EN 55011 Group 1, Class A | Emission standard for industrial environments |
| | RTCA/DO160G: Dec. 2010: Section 21.4 | Environmental conditions and test procedures for airborne equipment: Conducted RF Emissions, Category: B, L, M&H[2] |
| | RTCA/DO160G: Dec. 2010: Section 21.5 | Environmental conditions and test procedures for airborne equipment: Radiated RF Emissions, Category: M[2] |
| Vibration | ISO 16750-3:2007 / 4.1.2.4 Test IV | Test conditions: Broad band noise, 4h per axis, RMS-acceleration 27,8 $m/s^2$ |
| | DO-160F.8 / B1 Test Conditions | Test conditions: Broad band noise, 2h per axis, based on DO160F Section 8, Category B1 |
| | EN 60068-2-6 | Test conditions:<br>■ Swept sine, 1 octave per minute, 3-axis test<br>■ 5 ... 2000 Hz, up to 5 g, 2 sweeps per axis<br>■ Operating |
| Shock | ISO 16750-3:2007 / 4.2.2. | ■ Linear shock (1/2 sine pulse), 6-axis<br>■ 500 $m/s^2$, 6 ms, 10 pulses per axis<br>■ Operating |
| | RTCA / DO-160F Section 7 Test 7.2 Category A Test type R | Operational shocks test (standard):<br>■ Saw-tooth wave, 6-axis<br>■ 200 $m/s^2$, 11 ms, 10 pulses per axis<br>■ Operating |
| | RTCA / DO-160F Section 7 Test 7.2 Category D Test type R | Operational shocks test (low frequency):<br>■ Saw-tooth wave, 6-axis<br>■ 200 $m/s^2$, 20 ms, 10 pulses per axis<br>■ Operating |

1) Tested with an I/O cable length < 3 m.
2) For further information, refer to dSPACE Support.

**Vibration and shock tests**

To verify the reliability of MicroAutoBox under realistic operating conditions, it was exposed to vibration and shock tests. During the tests, MicroAutoBox executed a program without any failures.

# Connector Pinouts

**Where to go from here**

Information in this section



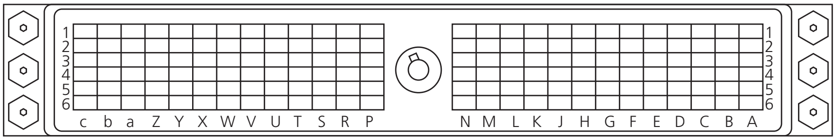
## ZIF I/O Connector

**Objective**

The I/O connector is a 156-pin zero insertion force (ZIF) connector giving access to the most input and output signals provided by MicroAutoBox.

**Pinout**

The following illustration shows the pin numbering of the I/O connector (front view of MicroAutoBox):




**Note**

There are pins identified by uppercase letters (A, B, C, etc.) and pins identified by lowercase letters (a, b, c).

The following table shows the signals of the I/O connector:

| **1** | | **2** | | **3** | | **4** | | **5** | | **6** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GND | in | CAN 4 high | i/o | CAN 4 low | i/o | GND | in | Serial 4 K / LIN[1)] | i/o | Serial 4 L[1)] | in | *A* |
| GND | in | CAN 3 high | i/o | CAN 3 low | i/o | GND | in | Serial 3TXD[1)] | out | Serial 3 RXD[1)] | in | *B* |
| GND | in | GND | in | GND | in | GND | in | GND | in | GND | in | *C* |
| GND | in | DigP 1 ch 8[2)] | out | DigP 1 ch 16 | out | DigP 2 ch 8[2)] | out | DigP 2 ch 16 | out | DigP 3 ch 8 | out | *D* |
| GND | in | DigP 1 ch 7 | out | DigP 1 ch 15 | out | DigP 2 ch 7 | out | DigP 2 ch 15 | out | DigP 3 ch 7 | out | *E* |
| GND | in | DigP 1 ch 6 | out | DigP 1 ch 14 | out | DigP 2 ch 6 | out | DigP 2 ch 14 | out | DigP 3 ch 6 | out | *F* |
| GND | in | DigP 1 ch 5 | out | DigP 1 ch 13 | out | DigP 2 ch 5 | out | DigP 2 ch 13 | out | DigP 3 ch 5 | out | *G* |
| GND | in | DigP 1 ch 4 | out | DigP 1 ch 12 | out | DigP 2 ch 4 | out | DigP 2 ch 12 | out | DigP 3 ch 4 | out | *H* |

| 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GND | in | DigP 1 ch 3 | out | DigP 1 ch 11 | out | DigP 2 ch 3 | out | DigP 2 ch 11 | out | DigP 3 ch 3 | out | *J* |
| GND | in | DigP 1 ch 2 | out | DigP 1 ch 10 | out | DigP 2 ch 2 | out | DigP 2 ch 10 | out | DigP 3 ch 2 | out | *K* |
| GND | in | DigP 1 ch 1 | out | DigP 1 ch 9 | out | DigP 2 ch 1 | out | DigP 2 ch 9 | out | DigP 3 ch 1 | out | *L* |
| VSENS | out | DigP 1 ch 8[2] | in | DigP 1 ch 16 | in | DigP 2 ch 8[2] | in | DigP 2 ch 16 | in | DigP 3 ch 8 | in | *M* |
| VDRIVE | in | DigP 1 ch 7 | in | DigP 1 ch 15 | in | DigP 2 ch 7 | in | DigP 2 ch 15 | in | DigP 3 ch 7 | in | *N* |
| | | | | | | | | | | | | |
| VBAT prot | out | DigP 1 ch 6 | in | DigP 1 ch 14 | in | DigP 2 ch 6 | in | DigP 2 ch 14 | in | DigP 3 ch 6 | in | *P* |
| REMOTE | in | DigP 1 ch 5 | in | DigP 1 ch 13 | in | DigP 2 ch 5 | in | DigP 2 ch 13 | in | DigP 3 ch 5 | in | *R* |
| GND | in | DigP 1 ch 4 | in | DigP 1 ch 12 | in | DigP 2 ch 4 | in | DigP 2 ch 12 | in | DigP 3 ch 4 | in | *S* |
| GND | in | DigP 1 ch 3 | in | DigP 1 ch 11 | in | DigP 2 ch 3 | in | DigP 2 ch 11 | in | DigP 3 ch 3 | in | *T* |
| GND | in | DigP 1 ch 2 | in | DigP 1 ch 10 | in | DigP 2 ch 2 | in | DigP 2 ch 10 | in | DigP 3 ch 2 | in | *U* |
| GND | in | DigP 1 ch 1 | in | DigP 1 ch 9 | in | DigP 2 ch 1 | in | DigP 2 ch 9 | in | DigP 3 ch 1 | in | *V* |
| GND | in | Analog ch 4 | out | Analog ch 4 | in | Analog ch 8 | in | Analog ch 12 | in | Analog ch 16 | in | *W* |
| GND | in | Analog ch 3 | out | Analog ch 3 | in | Analog ch 7 | in | Analog ch 11 | in | Analog ch 15 | in | *X* |
| GND | in | Analog ch 2 | out | Analog ch 2 | in | Analog ch 6 | in | Analog ch 10 | in | Analog ch 14 | in | *Y* |
| GND | in | Analog ch 1 | out | Analog ch 1 | in | Analog ch 5 | in | Analog ch 9 | in | Analog ch 13 | in | *Z* |
| GND | in | SGND | in | Ana trigger 1 | in | Ana trigger 2 | in | Ana trigger 3 | in | Ana trigger 4 | in | *a* |
| GND | in | CAN 2 high | i/o | CAN 2 low | i/o | GND | in | Serial 2 K / LIN[1] | i/o | Serial 2 L[1] | in | *b* |
| GND | in | CAN 1 high | i/o | CAN 1 low | i/o | GND | in | Serial 1 TXD[1] | out | Serial 1 RXD[1] | in | *c* |

[1] For a mapping of converter and channel numbers, as used in RTI and RTLib, refer to *Basics on Serial Interface* (*MicroAutoBox Features*).

[2] DigP = Port number; ch = Channel number

**Tip**

To use the digital inputs and outputs, you have to connect the VDRIVE pin inside the ZIF I/O connector according to the logic level needed. *This pin is not preconfigured in the ZIF I/O connector delivered with each MicroAutoBox II.* You have to connect VDRIVE (pin N1) to VSENS (pin M1) or VBATprot (pin P1). Use the preconfigured jumper cable which is included in the MicroAutoBox package.

**Signal descriptions**

For descriptions of the signals which are available on the ZIF I/O connector, refer to:


- *Power Inputs and Outputs* on page 357
- *Digital Inputs* on page 360
- *Digital Outputs* on page 362

- *Analog Inputs* on page 366
- *Analog Outputs* on page 369
- CAN, LIN, serial: *Interfaces* on page 370

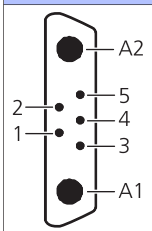

## Power Input Connector

**Objective**

MicroAutoBox provides a power input connector. It is a 7-pin, male connector with two high-current pins. It is a special variant of a 15-pin Sub-D connector (mixed-layout 7W2 Sub-D).

**Pinout**

The following illustration shows the pinout (front view of MicroAutoBox).

| Connector | Pin | Signal | Pin | Signal |
|---|---|---|---|---|
|  | A2[1] | VBAT (6 V … 40 V DC) | | |
| | | | 5 | REMOTE_PULLUP |
| | 2 | Do not connect | 4 | REMOTE[2] |
| | 1 | Do not connect | 3 | Do not connect |
| | A1 | GND | | |

[1] NOTE: It is highly recommended to insert a fuse into the main power supply input wire (close to battery). Choose the value of the fuse according to the maximum current. A 10 A fuse is recommended.

[2] The REMOTE input must be connected via switch or bridge to UBAT to run the MicroAutoBox. For example, you can use it for switching MicroAutoBox with KL15 (output of the ignition/driving switch). So, you can use the nonvolatile data feature to store data you may want to use again when restarting the application. For further information, refer to *Nonvolatile Data Handling* (📖 *MicroAutoBox RTLib Reference*).

**Matching cable**

A preconfigured cable for the supply voltage is provided by dSPACE. This cable is for running MicroAutoBox with a laboratory power supply during development. Therefore, REMOTE (pin 4) is shorted to VBAT (pin A2) inside the connector in order to save a separate switch. Do not use this cable in the vehicle. Otherwise, MicroAutoBox will always be turned on.

The VBAT wire (red) contains a melting fuse. Each wire has a cross-section of 1.5 mm².

Fuse specification:

- Cable delivered through dSPACE Release 2013-B: 7.5 A, time lag
- Cable delivered as of dSPACE Release 2014-A: 10 A, time lag

# Signal Descriptions

**Where to go from here**

Information in this section



## Power Inputs and Outputs

**Pin description**

The following table gives a description of the pins used for power input, remote input and supply of digital I/O circuits.

| Connector | Pins | Signal | Description / Function |
|---|---|---|---|
| Power input connector | A2 | VBAT | Main power supply input. Connect this pin to the positive pole of your car battery. |
| | A1 | GND | Main power supply return and reference for all input and output signals. Connect this pin to the minus pole of your car battery. The case of MicroAutoBox is also connected to GND. |
| | 4 | REMOTE | ■ The REMOTE input may be used for starting MicroAutoBox with a remote switch, for example KL15 (output of the ignition/driving switch).<br>■ If you connect the remote pin to the plus pole of the car battery directly, MicroAutoBox will always be turned on, and the car battery will soon be exhausted if the engine is not running. Thus, a switch is highly recommended.<br>■ The voltage connected to the REMOTE pin should not exceed the supply voltage. |
| | 5 | REMOTE_Pullup | You can use this output to connect a remote switch between REMOTE and this pin. REMOTE_Pullup is internally connected to VBAT via 39 kΩ pull-up resistor. |

| Connector | Pins | Signal | Description / Function |
|---|---|---|---|
| ZIF I/O connector | A1, A4, B1, B4, C1 ... C6, D1, E1, F1, G1, H1, J1, K1, L1, S1, T1, U1, V1, W1, X1, Y1, Z1, a1, b1, b4, c1, c4 | GND | Main power supply return and reference for all input and output signals. Use the nearest possible GND pin as reference for your signals in order to keep noise levels at minimum. The case of MicroAutoBox is also connected to GND. |
| | N1 | VDRIVE | This input supplies all digital input and output circuits.<br>■ Connect this input to VSENS to set CMOS/TTL-compatible logic levels for your inputs/outputs.<br>■ Connect this input to VBATprot to set automotive-compatible logic levels for your inputs/outputs.<br>■ Do not connect this pin directly to VBAT, because the input and output circuits are not load-dump-protected or reverse-voltage-protected at this signal. |
| | M1 | VSENS | Sensor supply output.<br>Use this output to supply your sensors and/or VDRIVE. If you need CMOS/TTL-compatible logic levels at the inputs/outputs connect VSENS to VDRIVE. |
| | P1 | VBAT prot | Protected VBAT output.<br>Use this output to supply VDRIVE when automotive logic levels are needed. |
| | R1 | REMOTE | ■ The remote voltage may be used for starting MicroAutoBox with a remote switch: KL15, for example (output of the ignition/driving switch).<br>■ If you connect the remote pin to the car battery directly, MicroAutoBox will always be turned on, and the car battery will soon be exhausted if the engine is not running. Thus, a switch is highly recommended.<br>■ The remote voltage should not exceed the supply voltage. |

**Tip**

To use the digital inputs and outputs, you have to connect the VDRIVE pin inside the ZIF I/O connector according to the logic level needed. *This pin is not preconfigured in the ZIF I/O connector delivered with each MicroAutoBox II.* You have to connect VDRIVE (pin N1) to VSENS (pin M1) or VBATprot (pin P1). Use the preconfigured jumper cable which is included in the MicroAutoBox package.

**Characteristics**

The characteristics are specified for the following conditions:

- $V_{BAT}$=+12 V (unless otherwise noted)

  $T_{CASE}$=+25 °C (unless otherwise noted)

  All voltages are referenced to GND (unless otherwise noted).

| Signal[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Power** | | | | | | |
| Operating voltage | VBAT | For start-up | 6 | | 40 | V |
| | VBAT | Operating | 4 | | 40 | V |
| | VBAT | Reverse protection | | | -40 | V |
| | VBAT | Load dump protection | | | +100 | V |
| **Inputs** | | | | | | |
| Operating current | $I_{VBAT}$ | REMOTE ≥ $V_{iHRemote}$ | | 1.3 | | A |
| | $I_{VBAT}$ | REMOTE ≤ $V_{iLRemote}$ | | 5 | | mA |
| REMOTE voltage input | $V_{iHRemote}$ | Input high voltage | 4.7 | | | V |
| | $V_{iLRemote}$ | Input low voltage | | | 0.8 | V |
| | $V_{iHysRemote}$ | Input hysteresis voltage | 0.5 | 1 | | V |
| | $R_{inRemote}$ | Input impedance | 60 | | 185 | kΩ |
| Inrush current | $I_{VBAT\ inrush}$ | All inputs/outputs unconnected | see *Power supply* on page 40 | | | |
| Digital I/O voltage supply input | VDRIVE | Supply for digital input/output circuits | | | 45 | V |
| | $I_{VDRIVE\ no\ load}$ | All inputs/outputs unconnected | | 20 | | mA |
| | $I_{VDRIVE\ maximum\ load}$ | All outputs shorted to GND | | 1 | | A |
| **Outputs** | | | | | | |
| Sensor supply output | VSENS | Output voltage | 4.84 | 5.05 | 5.25 | V |
| | VSENS = f(T) | Temperature caused voltage drift $T_{CASE}$ = –40 °C ... +85 °C | –2 | | 2 | % |
| | $I_{VSENS,\ max}$ | Maximum output current | 750 | | | mA |

| Signal[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Protected VBAT output | VBATprot | IL = 1A; VBAT = 12 V | 11.56 | 11.78 | 12 | V |
| | $I_{VBATprot, max}$ | Maximum output current | | | 1000 | mA |
| | $I_{ProtPeak}$ | Overload current limit (–40 °C ... 85 °C) | 4 | | 9 | A |
| | t(overload) | Time to shut off $I_{ProtPeak}$ | | | 5 | ms |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

# Digital Inputs

**Pin description**

The following table gives a description of the digital input pins:

| Pins (DS1511) | Port Number | Signal | Description/ Function |
|---|---|---|---|
| V2, U2, T2, S2, R2, P2, N2, M2, V3, U3, T3, S3, R3, P3, N3, M3 | 1 | Channel 1 ... 16<br>DIO Type 3 | Standard discrete digital input with pull-up. |
| V4, U4, T4, S4, R4, P4, N4, M4, V5, U5, T5, S5, R5, P5, N5, M5 | 2 | Channel 1 ... 16<br>DIO Type 3 | |
| V6, U6, T6, S6, R6, P6, N6, M6 | 3 | Channel 1 ... 8<br>DIO Type 3 | |

**Characteristics**

The characteristics are specified for the following conditions:

- $V_{BAT}$=+12 V (unless otherwise noted)

  $T_{CASE}$=+25 °C (unless otherwise noted)

  All voltages are referenced to GND (unless otherwise noted).

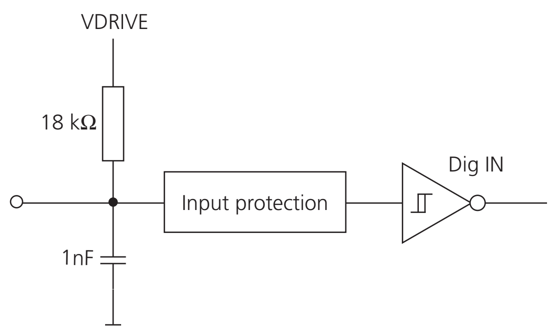
| Signal[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC characteristics** | | | | | | |
| Digital input channel 1 ... 40 | $V_{iH}$ | Input high voltage | 3.1 | | | V |
| | $V_{iL}$ | Input low voltage | | | 1.2 | V |
| | $V_{iHys}$ | Input hysteresis voltage | | 1 | | V |
| | $R_{DigIn}$ | Pull-up resistor to VDRIVE | 17 | 18 | 19 | kΩ |
| | $C_{DigIn}$ | Input capacitance | | 1 | | nF |
| REMOTE | $V_{iHRemote}$ | Input high voltage | 4.7 | | | V |
| | $V_{iLRemote}$ | Input low voltage | | | 0.8 | V |
| | $V_{iHysRemote}$ | Input hysteresis voltage | 0.5 | 1 | | V |
| | $R_{inRemote}$ | Input impedance | 60 | | 185 | kΩ |

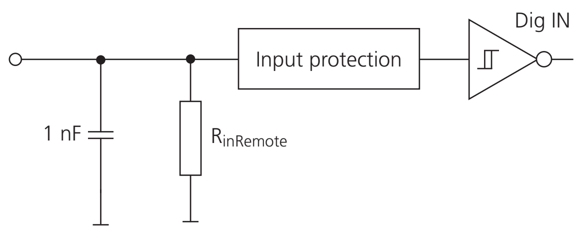
| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **AC characteristics** | | | | | | |
| Inputs | $t_{LowMin}$ | Minimum pulse width low | | 250 | 500 | ns |
| | $t_{HighMin}$ | Minimum pulse width high | | 300 | 600 | ns |
| | $F_{max}$ | Duty cycle: 50 % | | 1.8 | | MHz |
| | | Duty cycle: 1 % or 99 % | | 33 | | kHz |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagrams**

The following table shows *simplified* diagrams of the I/O circuitry of the digital inputs:

<table>
<tr><th colspan="2">Signal</th><th>I/O Circuit</th></tr>
<tr><td rowspan="2">Digital inputs</td><td>Channel 1 ... 40</td><td>

For proper operation, VDRIVE must have a level above the maximum input voltage.</td></tr>
<tr><td>Remote</td><td>
</td></tr>
</table>

**Related topics**

Basics

- *Bit I/O Unit (DIO Type 3)* (*MicroAutoBox Features*)

# Digital Outputs

**General behavior of digital signals**

All digital outputs are set to high impedance (tristate) until the application is started. Then the outputs follow the states defined in your application. Unused outputs remain in tristate mode.

**Pin description**

The following table gives a description of the digital output pins:

| Pins (DS1511) | Port Number | Signal | Default state | Description / Function |
|---|---|---|---|---|
| L2, K2, J2, H2, G2, F2, E2, D2, L3, K3, J3, H3, G3, F3, E3, D3 | 1 | Channel 1 ... 16<br>DIO Type 3 | Tristate | Standard discrete digital output. |
| L4, K4, J4, H4, G4, F4, E4, D4, L5, K5, J5, H5, G5, F5, E5, D5 | 2 | Channel 1 ... 16<br>DIO Type 3 | | |
| L6, K6, J6, H6, G6, F6, E6, D6 | 3 | Channel 1 ... 8<br>DIO Type 3 | | |

**Characteristics**

The characteristics are specified for the following conditions:

- $V_{BAT}$=+12 V (unless otherwise noted)

  $T_{CASE}$=+25 °C (unless otherwise noted)

  All voltages are referenced to GND (unless otherwise noted).

| Signal[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC Characteristics** | | | | | | |
| Digital output channel 1 ... 40 | $V_{oH}$ | IL = 0 mA; VDRIVE = 5 V | 4.4 | 4.6 | | V |
| | $V_{oL}$ | IL = 0 mA; VDRIVE = 5 V | | 0.1 | 0.3 | V |
| | $V_{oH}$ | IL = 5 mA; VDRIVE = 5 V | 3.2 | 3.4 | | V |
| | $V_{oL}$ | IL = –5 mA; VDRIVE = 5 V | | 0.7 | 0.9 | V |
| | $V_{oH}$ | IL = 0 mA; VDRIVE = 12 V | 11.3 | 11.6 | | V |
| | $V_{oL}$ | IL = 0 mA; VDRIVE = 12 V | | 0.1 | 0.3 | V |
| | $V_{oH}$ | IL = 5 mA; VDRIVE = 12 V | 10.3 | 10.5 | | V |
| | $V_{oL}$ | IL = –5 mA; VDRIVE = 12 V | | 0.7 | 0.9 | V |
| | $\lvert I_{OHmax} \rvert$ | Current limit high<br>$T_{CASE}$ = –40 °C ... +85 °C | 5 | 13 | 17 | mA |
| | $\lvert I_{OLmax} \rvert$ | Current limit low<br>$T_{CASE}$ = –40 °C ... +85 °C | 5 | 14 | 18 | mA |
| | $\lvert I_{OTLeak} \rvert$ | Leakage current tristate<br>$T_{CASE}$ = -40 °C ... +85 °C | | | 100 | µA |

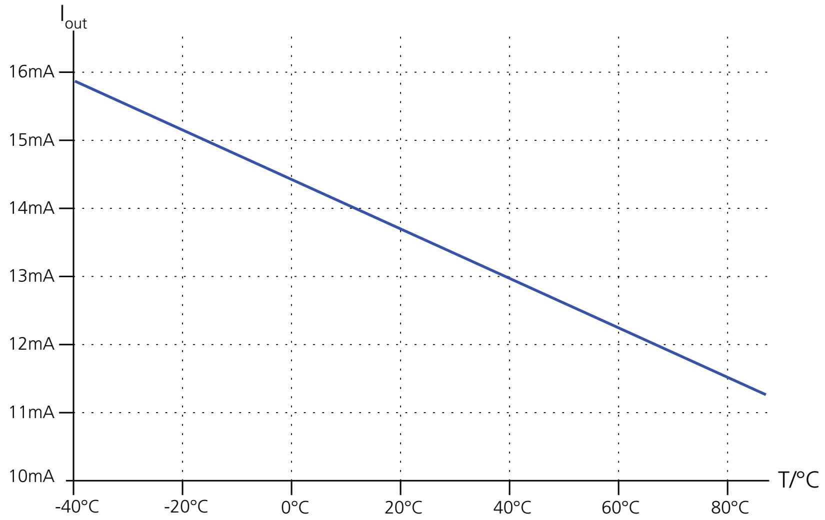
| Signal[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **AC Characteristics** | | | | | | |
| Outputs | $t_{minPulseHigh}$ | Minimum pulse width high,<br>VDRIVE = 5 V or 12 V, RL=1 kΩ | | 700 | 1400 | ns |
| | $t_{minPulseLow}$ | Minimum pulse width low,<br>VDRIVE = 5 V or 12 V, RL=1 kΩ | | 200 | 400 | ns |
| | $F_{max}$ | Duty cycle: 50 %<br>VDRIVE = 5 V or 12 V | | 0.7[2] | | MHz |
| | | Duty cycle: 1 % or 99 %<br>VDRIVE = 5 V or 12 V | | 14 | | kHz |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

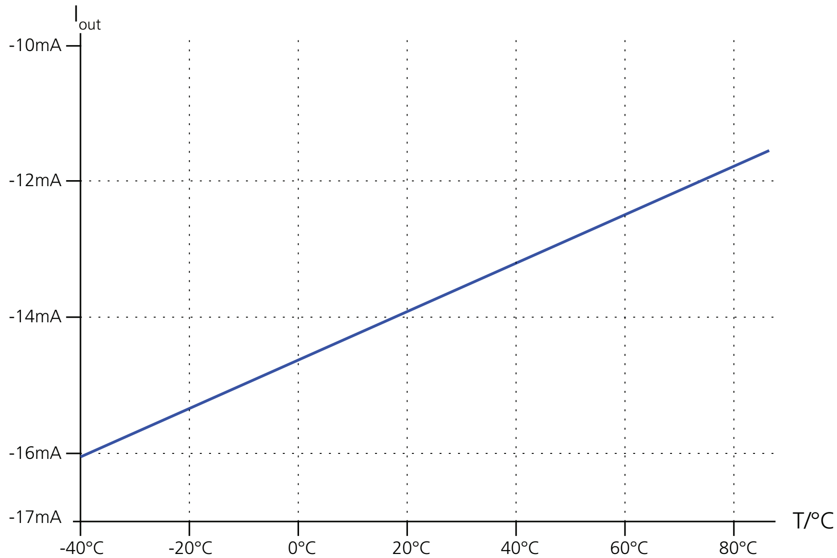
2) Limited by software to 150 kHz

The following illustrations show the maximum output current of a digital output circuit as a function of ambient temperature (VDRIVE = 12 V; output is shorted to 6 V):

- Output high

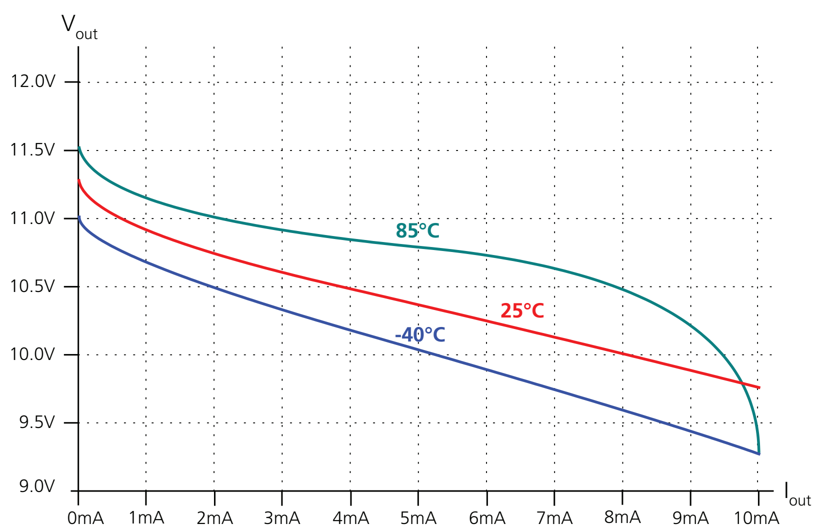


- Output low

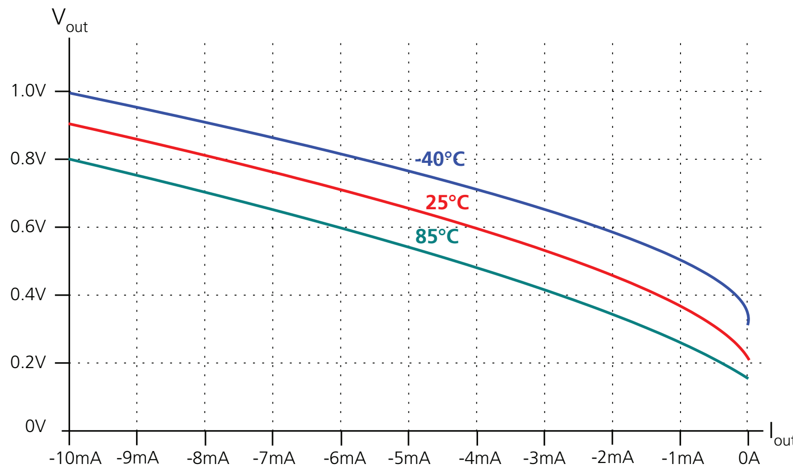



The following illustrations show the typical digital output voltage as a function of the output current (VDRIVE = 12 V):

- Output high

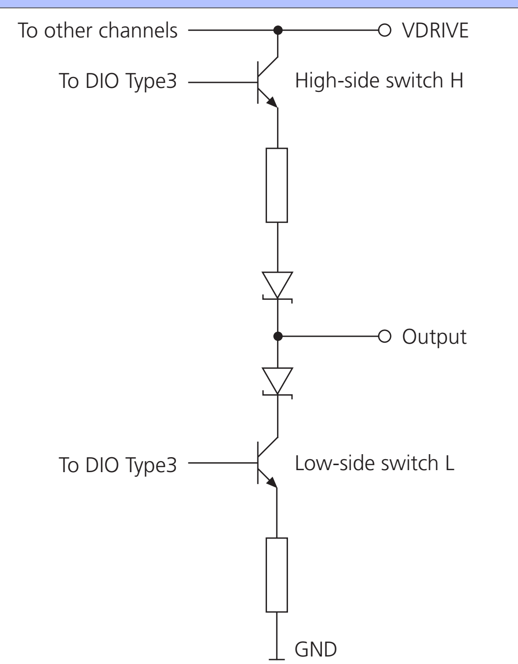


- Output low




**Circuit diagrams**

The following table shows a *simplified* diagram of the I/O circuitry of the digital outputs:

| Signal | I/O Circuit |
|---|---|
| Digital outputs |  |

**Related topics**

Basics

- *Bit I/O Unit (DIO Type 3)* (*MicroAutoBox Features*)

# Analog Inputs

**Pin description**

The following table gives a description of the analog input pins:

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| Z3, Y3, X3, W3, Z4, Y4, X4, W4, Z5, Y5, X5, W5, Z6, Y6, X6, W6 | ADC channel 1 ... 16 | ADC Type 4 | Analog inputs:<br>■ DS1511: 0 V ... 5 V<br>■ DS1511B1: -10 V ... +10 V |
| a3, a4, a5, a6 | External trigger 1 ... 4 | | For information on function of the trigger signals, refer to *Trigger signals* (*MicroAutoBox Features*). |

**Characteristics**

The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25° C; all voltages are referenced to SGND pin a2, unless otherwise noted.

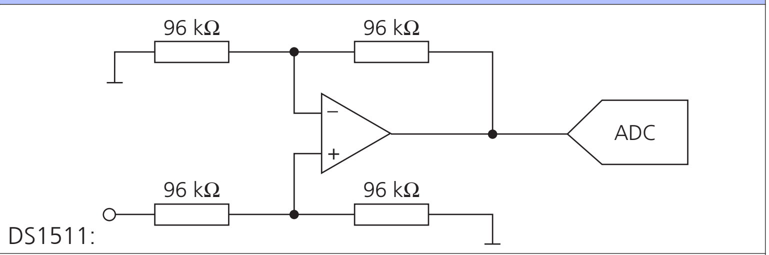
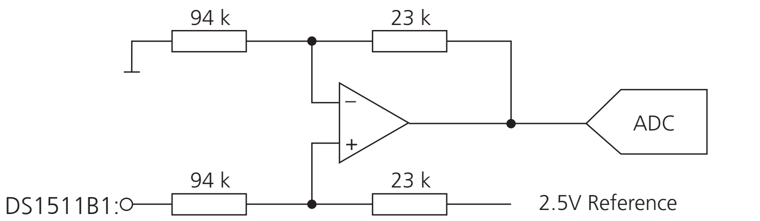
| Signal[1)] | Parameter | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **General characteristics** | | | | | | |
| ADC (all 16 channels) | Number of independent input channels | | | 16 | | |
| | Resolution | | | 16 | | bit |
| | Sample rate | Burst mode with more than 1 sample | | | 1 | MSPS |
| | Input voltage range | DS1511 | 0 | | 5 | V |
| | | DS1511B1 | -10 | | 10 | V |
| | Conversion timer | Separate for each channel. | | | | |
| | | Width | 27 | | | bit |
| | | Resolution | 10 | | | ns |
| | | Interval | | | 1.342 | s |
| | Timer for time stamping | Common for all channels. Two channels are required to carry one 32 bit value. | | | | |
| | | Width | 32 | | | bit |
| | | Resolution | 10 | | | ns |
| | | Interval | | | 42.9 | s |
| | Buffer size | Software-configurable | 1 | | 8192 | Samples |
| | Buffers per channel | | 3 | | | |
| | Number of external trigger inputs | | 4 | | | |
| **DC characteristics - DS1511** | | | | | | |
| ADC (all 16 channels) | Initial offset error | Below 750 KSPs | -0.5 | | 0.5 | mV |
| | Initial gain error | Below 750 KSPs | -0.25 | | 0.25 | % |
| | Input impedance | | | 192 | | kΩ |
| | Offset drift | | | ±10 | | µV/K |
| | Gain drift | | | ±6 | | ppm/K |
| | Overvoltage protection | Continuous | -20 | | +30 | |
| | | Short term | -50 | | 50 | V |
| External trigger | Input voltage | $V_{iH}$ | 2.3 | | | V |
| | | $V_{iL}$ | | | 0.4 | V |
| | Period | | | | 1 | MHz |
| | Overvoltage protection | Continuous | -48 | | 50 | V |
| **DC characteristics - DS1511B1** | | | | | | |
| ADC (all 16 channels) | Initial offset error | Below 750 KSPs | -3 | | 3 | mV |
| | Initial gain error | Below 750 KSPs | -0.25 | | 0.25 | % |
| | Input impedance | | | 117 | | kΩ |
| | Offset drift | | | ±40 | | µV/K |
| | Gain drift | | | ±6 | | ppm/K |
| | Overvoltage protection | Continuous | -30 | | +30 | |
| | | Short term | -50 | | 50 | V |

| Signal[1] | Parameter | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| External trigger | Input voltage | $V_{iH}$ | 2.3 | | | V |
| | | $V_{iL}$ | | | 0.4 | V |
| | Period | | | | 1 | MHz |
| | Overvoltage protection | Continuous | -48 | | 50 | V |
| **AC Characteristics** | | | | | | |
| ADC Type 4 (all 16 channels) | No missing codes | | 15 | | | bit |
| | SNR | 12.4 kHz signal @ 200 KSPs | 80 | | | dB |
| | Input bandwidth | Full power bandwidth | 400 | | | kHz |
| | Channel crosstalk | 100 kHz | | | -96 | dB |
| | | 200 kHz | | | -92 | dB |
| | | 400 kHz | | | -90 | dB |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagrams**

The following table shows *simplified* diagrams of the I/O circuitry of the analog inputs:

| Signal | | I/O Circuit |
|---|---|---|
| Analog inputs | ADC Type 4 channel 1 … 16 |  |
| | |  |

**Related topics**

Basics

- *ADC Unit Type 4* (*MicroAutoBox Features*)

# Analog Outputs

**Pin description**

The following table gives a description of the analog output pins:

| Pins | Signal | Module | Default state | Description / Function |
|---|---|---|---|---|
| Z2, Y2, X2, W2 | DAC1 … DAC4 | DAC Type 3 | 0 V | Standard analog outputs<br>12-bit digital values are converted to analog ouputs by the DAC module. |

*Default state* means the state of the signal during reset.

**Characteristics**

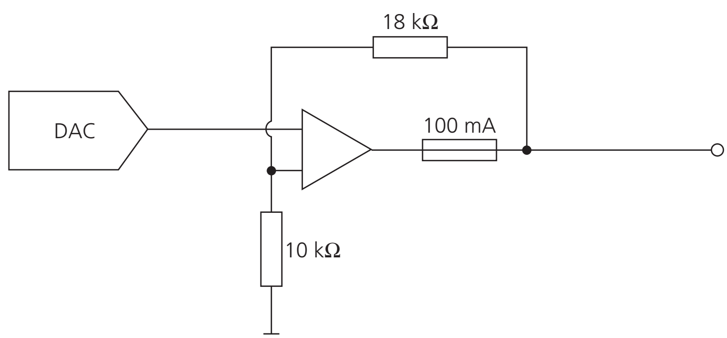
The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25 °C; all voltages are referenced to SGND pin a2, unless otherwise noted.

| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC characteristics** | | | | | | |
| DAC1 … DAC4 | $V_{DAC}$ | Full scale | 4.44 | 4.50 | 4.56 | V |
| | Resolution | Fully monotonic | 12 | | | bit |
| | Offset error | Delivery state; $T_{CASE}$ = 25 °C | | 2 | | mV |
| | Gain error | | | 0.5 | | LSB |
| | Offset error | $T_{CASE}$ = –40 °C ... +85 °C | –10 | | +10 | LSB |
| | Gain error | | –0.5 | | 0.5 | % |
| | $I_{DACout}$ | max. sink/ source current | –5 | | 5 | mA |
| | $V_{DACSAT}$ | Output voltage when sinking $I_{DACout}$ = –5 mA and CODE = 000H | | | 0.3 | V |
| **AC characteristics** | | | | | | |
| DAC1 … DAC4 | Settling time | Settling time of output (to 1 LSB) | | | 150 | µs |
| | $f_{gDAC}$ | Low-pass cutoff frequency of reconstruction filter (3 dB) | 10.2 | 10.8 | 11.4 | kHz |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagrams**

The following table shows a *simplified* diagram of the I/O circuitry of the analog outputs:

| Signal | | I/O Circuit |
|---|---|---|
| Analog outputs | DAC1 … DAC4 (DAC Type 3) |   |

**Related topics**

Basics

- *DAC Unit Type 3* (📖 *MicroAutoBox Features*)

# Interfaces

**Pin description**

The following table gives a description of the interface pins available at the ZIF I/O connector.

> **Tip**
>
> The pinout of the ECU interface connectors, USB device connector, and Ethernet I/O connector is not documented. Use a suitable dSPACE connection cable.

| Pins | Signal | Module Type | Description / Function |
|---|---|---|---|
| c3 | CAN 1 low | CAN Type 1 | CAN controller:<br>■ CAN 1 high = CAN high of module number 1, channel number 1<br>■ CAN 2 high = CAN high of module number 1, channel number 2<br>■ CAN 3 high = CAN high of module number 2, channel number 1<br>■ CAN 4 high = CAN high of module number 2, channel number 2<br><br>■ ISO 11898 interface<br>■ The MicroAutoBox CAN buses are not equipped with bus termination by default. For information on terminating the CAN buses, refer to *How to Terminate the CAN Bus* on page 124. |
| c2 | CAN 1 high | | |
| b3 | CAN 2 low | | |
| b2 | CAN 2 high | | |
| B3 | CAN 3 low | | |
| B2 | CAN 3 high | | |
| A3 | CAN 4 low | | |
| A2 | CAN 4 high | | |
| c6 | Serial 1 RXD[1)] | | RS232 interface |
| c5 | Serial 1 TXD[1)] | | |
| b5 | Serial 2 K / LIN[1)] | | |
| b6 | Serial 2 L[1)] | | |
| B6 | Serial 3 RXD[1)] | | LIN or ISO 9141 interface<br>The K line/LIN interface is bidirectional. The L line is input only. Both lines have no pull-up. For proper function of the K line connect an external pull-up resistor (4.7 kΩ) from this line to VBAT.<br>For information on configuring a LIN master, refer to *Connecting to a LIN Bus* on page 108. |
| B5 | Serial 3 TXD[1)] | | |
| A5 | Serial 4 K / LIN[1)] | | |
| A6 | Serial 4 L[1)] | | |

[1)] For a mapping of converter and channel numbers, as used in RTI and RTLib, refer to *Basics on Serial Interface* (📖 *MicroAutoBox Features*).

**Characteristics**

The interface characteristics are specified for the following conditions: $V_{BAT}$ = +12 V; $T_{CASE}$ = +25 °C; all voltages are referenced to GND pins, unless otherwise noted.

| Interface[1)] | Parameter | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Host PC | Protocol | TCP/IP | | | | |
| | Bitrate | | | ■ 10/1000[2)]<br>■ 10/100[3)] | | Mbit |
| | Data throughput | | | | 2.6 | MB/sec |
| | Voltage levels | Ethernet standard | | | | |

| Interface[1] | Parameter | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Ethernet I/O | Protocol | UDP/IP | | | | |
| | Bitrate | | | 1000 | | Mbit |
| | Voltage levels | Ethernet standard | | | | |
| USB | USB 2.0 standard (USB Flight Recording) | | | | | |
| | Data throughput | without connected host tool | | | 1280 | kB/sec |
| | | with connected host tool | | | 1024 | kB/sec |
| | | without data loss during cold start (dependent on the boot time of the host interface) | | | 640 | kB/sec |
| | Current | | | | 1.3 | A |
| | Voltage | | | | 5 | V |
| ECU | Bit rate | LVDS mode | | | 250 | MBit |
| | | LVDS2 mode | | | 560 | |
| | Cable length | 2-paired twisted pair | | | 5 | m |
| | Cable type | | CAT5 | | | |
| | Voltage levels | LVDS standard | | | | |
| | Full duplex data rate[4] | LVDS mode, Single transfer | | | 5 | MWord /s |
| | | LVDS2 mode, Single transfer | | | 11.2 | MWord /s |
| | | LVDS2 mode, Block transfer | | | 28 | MWord /s |
| | RAM size[4] | LVDS / LVDS2 mode | 16 | | | kWord |
| | FIFO size[4] | LVDS / LVDS2 mode (Transmit buffer) | 1 | | | kWord |
| CAN | Bit rate | ISO 11898 interface | | | 1 | MBaud |
| Serial 1/3 RS232-Interface | Bit rate | | 14 | | 115.2k | Baud |
| | TX output voltage swing | 3 kΩ load | ±5 | ±9 | | V |
| | $V_{RxinLow}$ | RX input threshold low | | 1.4 | 0.8 | V |
| | $V_{RxinHigh}$ | RX input threshold high | 2.0 | 1.4 | | V |
| | Word length | | 5 | | 8 | bit |
| Serial 2/4 ISO9141-Interface | Bit rate | $R_{KO}$ = 510 Ω; $C_K \leq$ 1.3 nF | 14 | | 50k | Baud |
| | Word length | | 5 | | 8 | bit |
| Serial 2/4 LIN Interface | Bit rate | | 14 | | 20k | Baud |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.
2) Since board revision DS1401-23 (available since dSPACE Release 7.2).
3) Before board revision DS1401-23
4) Word is 16-bit wide

**Baud rate calculation of the serial interface**

**Note**

Due to the limitations of the UART baud rate generator, not all baud rates can be programmed exactly to the desired baud rate without error.

The UART baud rate generator provides several baud rates:

*To calculate the divisor T for a chosen baud rate*

$$T = \text{Round}\left(\frac{921600}{\text{BR (chosen)}}\right)$$

BR (chosen) = The baudrate to be generated
T = The baudrate generator divisor ($8 \leq T \leq 65535$)

*To calculate the real baud rate from a given divisor T*

$$\frac{\text{BR (real)}}{\text{Baud}} = \frac{921600}{T}$$

BR (real) = The baudrate you get
T = The baudrate generator divisor ($8 \leq T \leq 65535$)

*To calculate the resulting error*

$$\frac{\text{Error}_{BR}}{100\%} = \frac{\text{BR (real)} - \text{BR (chosen)}}{\text{BR (chosen)}}$$

**Note**

If $\text{Error}_{BR} \leq 2\%$, messages will be transferred and received correctly.

# Data Sheet MicroAutoBox II 1401/1511/1512

**Where to go from here**

Information in this section

# Overview and General Information

**Where to go from here**

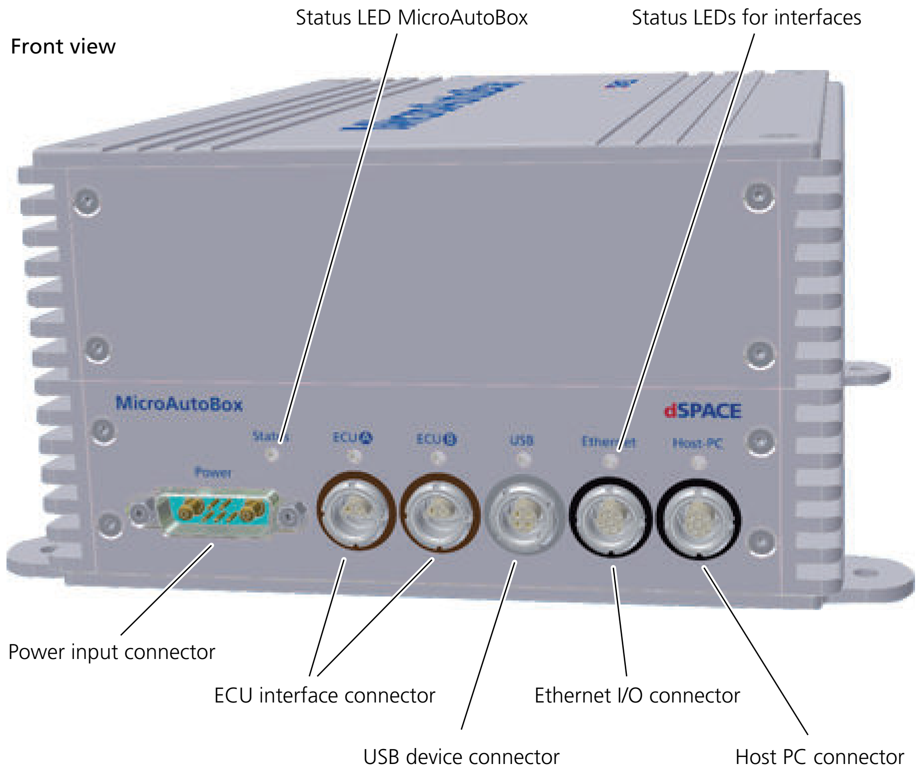
Information in this section

# Housing Components

**Connectors and status LEDs**

The illustrations show where the connectors and status LEDs are located on MicroAutoBox II 1401/1511/1512.

Front view




MicroAutoBox II 1401/1511/1512 contains the following connectors and LEDs:

**Power input connector** Supplies the required power to MicroAutoBox. It is a 7-pin, male Sub-D connector with two high-current pins.

A preconfigured cable with a matching connector and a separate power input connector are included in each MicroAutoBox package. For the pinout and further details on the preconfigured cable, refer to *Power Input Connector* on page 394.

**Status LED MicroAutoBox** Shows you different states and potential malfunctions.

If battery power is switched on and the REMOTE signal/KL15 is activated (see *Basics on Connecting to Power Supply* on page 44), the status LED (= dual LED) shows different states indicated by the LED color:

- LED is red: Reset state and no application is downloaded to the real-time processor.
- LED is green: Application is running.

- LED is flashing red: MicroAutoBox is in secured mode. For further instructions, refer to *Checking MicroAutoBox* on page 672.

The status LED on the front panel has the same functionality as the status LED on the rear panel of MicroAutoBox.

**ECU interface connectors** Provide communication to ECUs based on the LVDS standard, for example, in bypassing scenarios or to connect a RapidPro system (used as I/O subsystem). The ECU interface connectors are 4-pin LEMO connectors. Matching cables are supplied from dSPACE on request.

The corresponding LED is lit green, if power at both ends of the link is available and the relevant connection is serviceable. The LED flashes when data is being sent or received.

The table below shows the different ECU interfaces integrated into MicroAutoBox and the display names they are mapped to in the experiment software, for example, ControlDesk.

| Display Name in Software | Connectors Built-in at MicroAutoBox | |
|---|---|---|
| | ECU A | ECU B |
| ECU 1 | ✓ | – |
| ECU 2 | – | ✓ |

**USB device connector** A 4-pin LEMO connector to connect an USB mass storage device to use the USB Flight Recorder feature of MicroAutoBox. A matching cable with a LEMO-USB adapter is supplied from dSPACE on request.

**Note**

To use the USB Flight Recorder, a separate license is required.

The possible states of the corresponding LED are listed in the table below:

| LED Status | Meaning |
|---|---|
| Off | No USB device is connected. |
| Green | USB device is connected and flight recorder is not running. |
| Green blinking | USB device is connected and flight recorder is running. |
| Orange | USB device is full and the active flight recorder is specified not to overwrite old files. |

| LED Status | Meaning |
|---|---|
| Red | Write error when accessing the USB device, for example, if the device was removed while the flight recorder was running. |

For further information, refer to *Flight Recorder* (📖 *MicroAutoBox Features*).

**Ethernet I/O connector** An 8-pin LEMO connector that provides communication to external devices, such as PCs or ECUs based on the UDP/IP Ethernet protocol, for example, in bypassing scenarios.

A matching cable with a LEMO-RJ45 adapter is supplied from dSPACE on request.

The corresponding LED is lit green if power is available at both ends of the link and the relevant connection is serviceable. The LED flashes green when data is being sent or received.

For installation instructions, refer to *How to Connect MicroAutoBox to the ECU via UDP/IP* (📖 *ECU Interfaces Hardware Installation and Configuration*).

**Host PC connector** Provides the communication between MicroAutoBox and your host PC based on the Ethernet TCP/IP protocol. The connector is a 8-pin LEMO connector. A matching cable is included in each MicroAutoBox package.

The corresponding LED is lit green if power is available at both ends of the link and the relevant connection is serviceable. The LED flashes green when data is being sent or received.

**Tip**

The Ethernet I/O connector and the Host PC connector are internally connected by a common gigabit Ethernet switch (valid for base board DS1401-25ff).

This simplifies the connection options. For an example, refer to *Connecting an ECU with DCI-GSI2 for Simultaneous Calibration and Bypassing* (📖 *ECU Interfaces Hardware Installation and Configuration*).

**DS1511 ZIF I/O connector** The 156-pin zero insertion force (ZIF) I/O connector provides access to the most input and output signals provided by MicroAutoBox. A matching connector is included in each MicroAutoBox package. For the pinout, refer to *DS1511 ZIF I/O Connector* on page 387.

**DS1512 ZIF I/O connector** The 156-pin zero insertion force (ZIF) I/O connector provides the signals of the installed I/O module and IP modules.

For the pinout, refer to *DS1512 ZIF I/O Connector* on page 389.

**Status LED FPGA**

- If the DS1552 Multi-I/O Module is installed, the possible states of the corresponding LED are listed in the table below:

| LED Status | Meaning |
|---|---|
| Off | FPGA is not configured. |
| Green | Correct behavior. |
| Yellow | ■ Malfunction<br>■ Overload<br>■ One or more supply voltages on the DS1552 Multi-I/O Board are beyond a rated value. |

- If the DS1552 Multi-I/O Module is installed and you use the RTI FPGA Programming Blockset, you can control the LED to light orange. For further information, refer to *Parameters Page (FPGA_IO_WRITE_BL)* (📖 *RTI FPGA Programming Blockset - FPGA Interface Reference*).

# General Data

**General characteristics**

The following table shows some general characteristics of MicroAutoBox:

| Parameter | | Specification[1] |
|---|---|---|
| Base board (DS1401-20ff.) | Processor | ■ PPC750 GL Power PC<br>■ 900 MHz clock frequency<br>■ Real-time clock |
| | Memory | ■ 8 MB global RAM<br>■ 16 MB local RAM<br>■ 16 MB flash memory |
| | Onboard sensors[2] | Pressure sensor:<br>■ Base board DS1401-23ff.<br>■ Range: 50 kPA ...115 kPa<br>■ Accuracy: 1 kPa<br>■ Sample rate: approx. 200 Hz<br>Acceleration sensor<br>■ Base board DS1401-23ff.<br>■ Range: ±2 g ... ±8 g in 3 axis (x/y/z)<br>■ Resolution: 10 bit per axis<br>■ Sample rate: max. 800 Hz<br>■ FIFO buffer: 512 words (to read and write bursts) |
| Communication interfaces | | ■ 1 x Host PC interface based on Ethernet TCP/IP protocol<br>■ 1 x Ethernet I/O interface based on Ethernet UDP/IP protocol for Ethernet bypassing scenarios<br>■ 2 x ECU interface based on LVDS standard<br>■ 1 x USB interface for USB flight recording (separate license) |
| I/O connectors | | ■ 2 x 156-pin ZIF I/O connector<br>  ■ Contact resistance: max. 15 mΩ<br>  ■ Durability: 10000 cycles<br>  ■ Continuous current per pin ($T_{ambient}$ = +85 °C): max. 2.5 A<br>■ 1 x 7-pin power supply input connector |
| FPGA (on DS1512 I/O Board)[3] | | Xilinx® Spartan 6 FPGA XC6SLX150FGG676-2 |

| Parameter | | Specification[1] |
|---|---|---|
| Chassis dimensions | Case width | 202 mm (7.95 in.) |
| | Case height | 96 mm (3.78 in.) |
| | Case depth | 222 mm (8.74 in.) |
| Weight | | About 3.2 kg (7.05 lb.) without external cables and modules |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

[2] For further information on the sensors, refer to *Onboard Sensors* (📖 *MicroAutoBox Features*).

[3] Due to the introduction of Xilinx Vivado, the RTI FPGA Programming Blockset as of version 3.0 only let you use existing FPGA model INI files to build the processor interface. You cannot model new FPGA applications.

**Functional I/O units on the I/O boards**

The following table shows a mapping of the input/output units on the I/O boards which are part of MicroAutoBox:

| dSPACE I/O board | Functional Unit |
|---|---|
| DS1511 | *ADC Unit Type 4* (📖 *MicroAutoBox Features*) |
| | *DAC Unit Type 3* (📖 *MicroAutoBox Features*) |
| | *Bit I/O Unit (DIO Type 3)* (📖 *MicroAutoBox Features*) |
| DS1512 (with installed DS1552 Multi-I/O Module) | *ADC 1552 Type 1 Unit* (📖 *MicroAutoBox Features*) |
| | *ADC 1552 Type 2 Unit* (📖 *MicroAutoBox Features*) |
| | *DAC 1552 Type 1 Unit* (📖 *MicroAutoBox Features*) |
| | *Bit I/O Unit (DIO 1552 Type 1)* (📖 *MicroAutoBox Features*) |
| | DIO 1552 Type 2[1] |
| | Digital Crank/Cam Inputs[1] |
| | Inductive Zero Voltage Detector[1] |

[1] Only available via the RTI FPGA Programming Blockset up to version 2.9 (see RTI Block Settings for the FPGA1401Tp1 with Multi-I/O Module Frameworks).

# Absolute Maximum Levels

**Avoiding damage to the system**

**NOTICE**

Do not exceed the maximum levels since this might permanently damage the system.

**Levels**

The following table shows the levels (for example, voltage, temperature) of the MicroAutoBox. All voltages are referenced to GND (unless otherwise noted).

| Parameter | Specification[1)] | Description |
|---|---|---|
| VBAT | –40 V ... +100 V | Load dump- and reverse protection |
| VDRIVE | 0 V ... +45 V | |
| All digital output voltages | (VDRIVE – 45 V) ... +45 V | |
| All digital input voltages | (VDRIVE – 45 V) ... +45 V | |
| All analog input voltages | –40 V ... +40 V | |
| All analog output voltages | –30 V ... +40 V | |
| VSENS output | 0 V ... +40 V | VSENS is switched on and off with the REMOTE pin. |
| VBATprot output | 0 V ... +45 V | VBATprot follows VBAT within the specified range.<br>VBATprot is switched on and off with the REMOTE pin. |
| RS232 transceiver output on the DS1511 ZIF I/O connector[2)] | –30 V ... +30 V | |
| RS232 transceiver input on the DS1511 ZIF I/O connector[2)] | –30 V ... +30 V | |
| $V_{CAN\ high}$, $V_{CAN\ low}$ on the DS1511 ZIF I/O connector[3)] | –60 V ... +60 V | Voltage level on CAN high and CAN low pins. |
| $V_{Diff\ (CAN\ high\ -\ CAN\ low)}$ on the DS1511 ZIF I/O connector[3)] | –3.5 V ... +3.5 V | Voltage level difference between CAN high and CAN low pins (due to termination resistors). |
| Serial K / LIN | –20 V ... +32 V | but not more than VBAT |
| Serial L | –24 V ... +30 V | but not more than VBAT |
| All outputs short circuit to GND | continuous | |
| Continuous power dissipation ($T_{ambient}$ = +85 °C) | max. 50 W | |

| Parameter | Specification[1] | Description |
|---|---|---|
| Operating temperature | –40 °C ... +85 °C | |
| Storage temperature | –55 °C ... +125 °C | |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.
[2] On the DS1512 I/O connector, the DS1552 Multi-I/O Module also provides a serial interface. For absolute maximum levels, refer to *Absolute Maximum Levels* on page 584.
[3] If the DS4342 CAN FD Interface Module is installed, the DS1512 I/O connector also provides a CAN interface. For maximum absolute levels, refer to *Absolute Maximum Levels* on page 640.

# Certifications

**CE compliance**

MicroAutoBox meets the requirements of the European directive 2014/30/EU (Electromagnetic Compatibility Directive) for CE marking.

**Applied standards**

The characteristics of MicroAutoBox were tested according to the standards shown in the following table:

| Tested Characteristics | Applied Standard | Description |
|---|---|---|
| Electromagnetic compatibility (EMC) | EN 61326-1 Table 2 | Immunity standard for industrial environments[1] |
| | CISPR 11, EN 55011 Group 1, Class A | Emission standard for industrial environments |
| | RTCA/DO160G: Dec. 2010: Section 21.4 | Environmental conditions and test procedures for airborne equipment: Conducted RF Emissions, Category: B, L, M&H[2] |
| | RTCA/DO160G: Dec. 2010: Section 21.5 | Environmental conditions and test procedures for airborne equipment: Radiated RF Emissions, Category: M[2] |
| Vibration | ISO 16750-3:2007 / 4.1.2.4 Test IV | Test conditions: Broad band noise, 4h per axis, RMS-acceleration 27,8 m/s$^2$ |
| | DO-160F.8 / B1 Test Conditions | Test conditions: Broad band noise, 2h per axis, based on DO160F Section 8, Category B1 |
| | EN 60068-2-6 | Test conditions:<br>■ Swept sine, 1 octave per minute, 3-axis test<br>■ 5 ... 2000 Hz, up to 5 g, 2 sweeps per axis<br>■ Operating |

| Tested Characteristics | Applied Standard | Description |
|---|---|---|
| Shock | ISO 16750-3:2007 / 4.2.2. | ■ Linear shock (1/2 sine pulse), 6-axis<br>■ 500 m/s$^2$, 6 ms, 10 pulses per axis<br>■ Operating |
| | RTCA / DO-160F<br>Section 7 Test 7.2<br>Category A<br>Test type R | Operational shocks test (standard):<br>■ Saw-tooth wave, 6-axis<br>■ 200 m/s$^2$, 11 ms, 10 pulses per axis<br>■ Operating |
| | RTCA / DO-160F<br>Section 7 Test 7.2<br>Category D<br>Test type R | Operational shocks test (low frequency):<br>■ Saw-tooth wave, 6-axis<br>■ 200 m/s$^2$, 20 ms, 10 pulses per axis<br>■ Operating |

1) Tested with an I/O cable length < 3 m.
2) For further information, refer to dSPACE Support.

**Vibration and shock tests**

To verify the reliability of MicroAutoBox under realistic operating conditions, it was exposed to vibration and shock tests. During the tests, MicroAutoBox executed a program without any failures.

# Connector Pinouts

**Where to go from here**

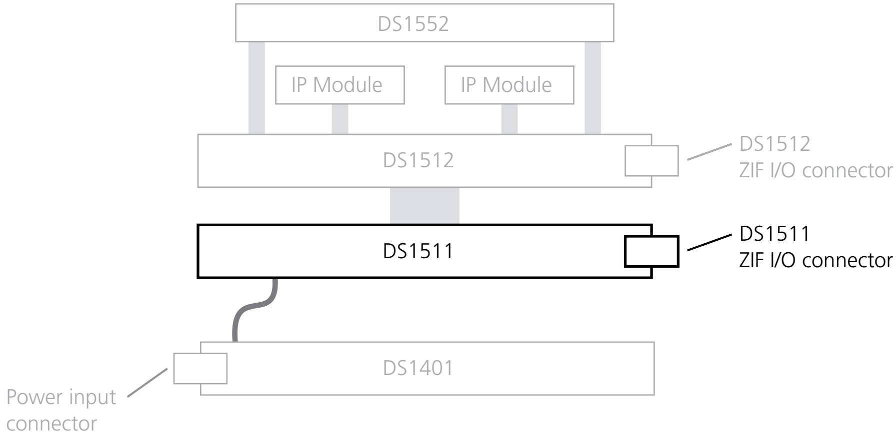
Information in this section



## DS1511 ZIF I/O Connector

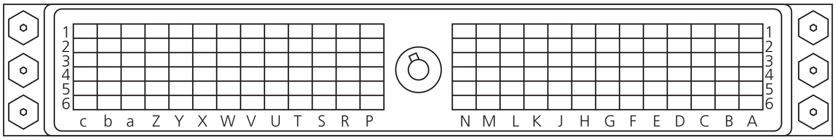
**Objective**

The DS1511 I/O connector is a 156-pin zero insertion force (ZIF) connector giving access to the input and output signals provided by the DS1511 I/O Board. The illustration below shows the internal assembly of the MicroAutoBox II 1401/1511/1512.



**Pinout**

The following illustration shows the pin numbering of the I/O connector (front view of MicroAutoBox):




## Note

There are pins identified by uppercase letters (A, B, C, etc.) and pins identified by lowercase letters (a, b, c).

The following table shows the signals of the I/O connector:

| 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GND | in | CAN 4 high | i/o | CAN 4 low | i/o | GND | in | Serial 4 K / LIN[1] | i/o | Serial 4 L[1] | in | *A* |
| GND | in | CAN 3 high | i/o | CAN 3 low | i/o | GND | in | Serial 3TXD[1] | out | Serial 3 RXD[1] | in | *B* |
| GND | in | GND | in | GND | in | GND | in | GND | in | GND | in | *C* |
| GND | in | DigP 1 ch 8[2] | out | DigP 1 ch 16 | out | DigP 2 ch 8[2] | out | DigP 2 ch 16 | out | DigP 3 ch 8 | out | *D* |
| GND | in | DigP 1 ch 7 | out | DigP 1 ch 15 | out | DigP 2 ch 7 | out | DigP 2 ch 15 | out | DigP 3 ch 7 | out | *E* |
| GND | in | DigP 1 ch 6 | out | DigP 1 ch 14 | out | DigP 2 ch 6 | out | DigP 2 ch 14 | out | DigP 3 ch 6 | out | *F* |
| GND | in | DigP 1 ch 5 | out | DigP 1 ch 13 | out | DigP 2 ch 5 | out | DigP 2 ch 13 | out | DigP 3 ch 5 | out | *G* |
| GND | in | DigP 1 ch 4 | out | DigP 1 ch 12 | out | DigP 2 ch 4 | out | DigP 2 ch 12 | out | DigP 3 ch 4 | out | *H* |
| GND | in | DigP 1 ch 3 | out | DigP 1 ch 11 | out | DigP 2 ch 3 | out | DigP 2 ch 11 | out | DigP 3 ch 3 | out | *J* |
| GND | in | DigP 1 ch 2 | out | DigP 1 ch 10 | out | DigP 2 ch 2 | out | DigP 2 ch 10 | out | DigP 3 ch 2 | out | *K* |
| GND | in | DigP 1 ch 1 | out | DigP 1 ch 9 | out | DigP 2 ch 1 | out | DigP 2 ch 9 | out | DigP 3 ch 1 | out | *L* |
| VSENS | out | DigP 1 ch 8[2] | in | DigP 1 ch 16 | in | DigP 2 ch 8[2] | in | DigP 2 ch 16 | in | DigP 3 ch 8 | in | *M* |
| VDRIVE | in | DigP 1 ch 7 | in | DigP 1 ch 15 | in | DigP 2 ch 7 | in | DigP 2 ch 15 | in | DigP 3 ch 7 | in | *N* |
| | | | | | | | | | | | | |
| VBAT prot | out | DigP 1 ch 6 | in | DigP 1 ch 14 | in | DigP 2 ch 6 | in | DigP 2 ch 14 | in | DigP 3 ch 6 | in | *P* |
| REMOTE | in | DigP 1 ch 5 | in | DigP 1 ch 13 | in | DigP 2 ch 5 | in | DigP 2 ch 13 | in | DigP 3 ch 5 | in | *R* |
| GND | in | DigP 1 ch 4 | in | DigP 1 ch 12 | in | DigP 2 ch 4 | in | DigP 2 ch 12 | in | DigP 3 ch 4 | in | *S* |
| GND | in | DigP 1 ch 3 | in | DigP 1 ch 11 | in | DigP 2 ch 3 | in | DigP 2 ch 11 | in | DigP 3 ch 3 | in | *T* |
| GND | in | DigP 1 ch 2 | in | DigP 1 ch 10 | in | DigP 2 ch 2 | in | DigP 2 ch 10 | in | DigP 3 ch 2 | in | *U* |
| GND | in | DigP 1 ch 1 | in | DigP 1 ch 9 | in | DigP 2 ch 1 | in | DigP 2 ch 9 | in | DigP 3 ch 1 | in | *V* |
| GND | in | Analog ch 4 | out | Analog ch 4 | in | Analog ch 8 | in | Analog ch 12 | in | Analog ch 16 | in | *W* |
| GND | in | Analog ch 3 | out | Analog ch 3 | in | Analog ch 7 | in | Analog ch 11 | in | Analog ch 15 | in | *X* |
| GND | in | Analog ch 2 | out | Analog ch 2 | in | Analog ch 6 | in | Analog ch 10 | in | Analog ch 14 | in | *Y* |
| GND | in | Analog ch 1 | out | Analog ch 1 | in | Analog ch 5 | in | Analog ch 9 | in | Analog ch 13 | in | *Z* |
| GND | in | SGND | in | Ana trigger 1 | in | Ana trigger 2 | in | Ana trigger 3 | in | Ana trigger 4 | in | *a* |

| 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GND | in | CAN 2 high | i/o | CAN 2 low | i/o | GND | in | Serial 2 K / LIN[1] | i/o | Serial 2 L[1] | in | *b* |
| GND | in | CAN 1 high | i/o | CAN 1 low | i/o | GND | in | Serial 1 TXD[1] | out | Serial 1 RXD[1] | in | c |

[1] For a mapping of converter and channel numbers, as used in RTI and RTLib, refer to *Basics on Serial Interface* (📖 *MicroAutoBox Features*).

[2] DigP = Port number; ch = Channel number

**Tip**

To use the digital inputs and outputs, you have to connect the VDRIVE pin inside the ZIF I/O connector according to the logic level needed. *This pin is not preconfigured in the ZIF I/O connector delivered with each MicroAutoBox II.* You have to connect VDRIVE (pin N1) to VSENS (pin M1) or VBATprot (pin P1). Use the preconfigured jumper cable which is included in the MicroAutoBox package.

**Signal descriptions**

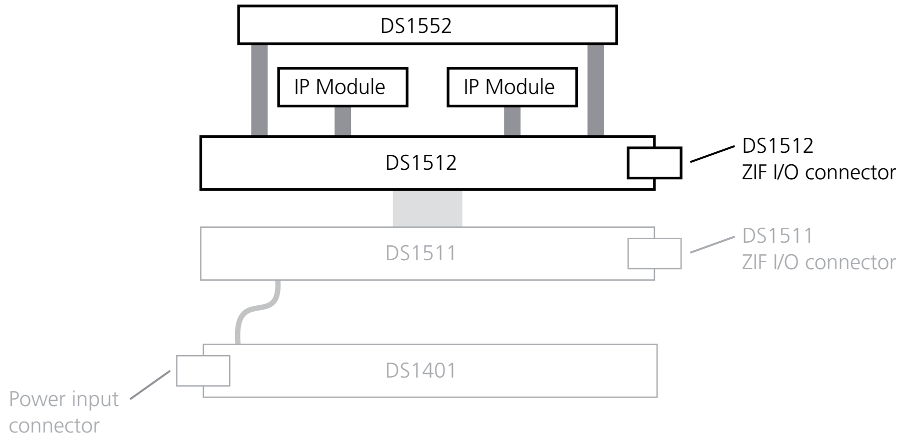
For descriptions of the signals which are available on the DS1511 ZIF I/O connector, refer to:

- *Digital Inputs* on page 398
- *Digital Outputs* on page 401
- *Analog Inputs* on page 406
- *Analog Outputs* on page 409
- CAN, LIN, serial: *Interfaces* on page 410

# DS1512 ZIF I/O Connector

**Objective**

The DS1512 I/O connector is a 156-pin zero insertion force (ZIF) connector giving access to various I/O signals if a IP module and/or an I/O module are/is installed. The illustration below shows an example of the internal assembly of the MicroAutoBox II 1401/1511/1512 with a DS1552 Multi-I/O Module installed.




**Pinout**

The DS1512 ZIF I/O connector provides only signals of the installed I/O module and IP modules.

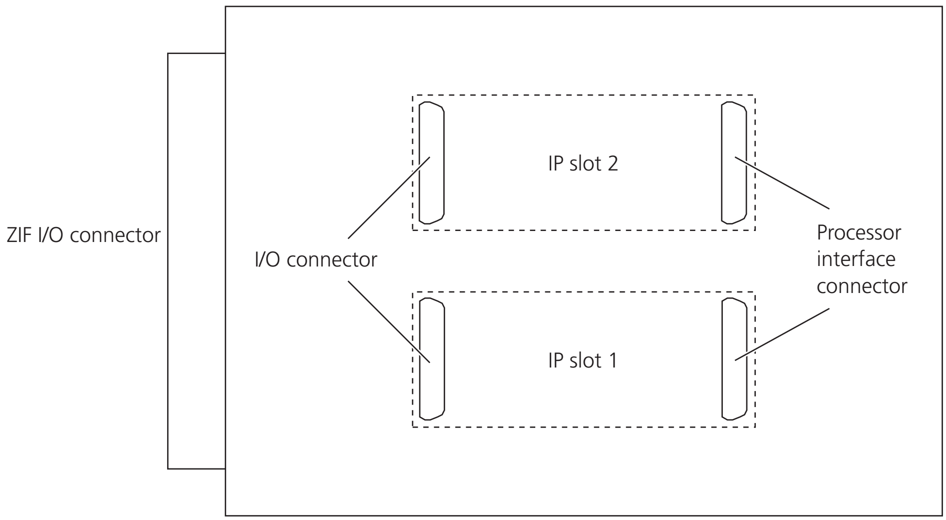
For pinouts of the DS1512 ZIF I/O connector, refer to the following topics:

- DS1552 Multi-I/O Module: *DS1512 and DS1514 ZIF I/O Connectors* on page 585
- DS4340 FlexRay Interface Module: *DS1512 and DS1514 ZIF I/O Connectors* on page 634
- DS4342 CAN FD Interface Module: *DS1512 and DS1514 ZIF I/O Connectors* on page 642

## IP Module Connectors

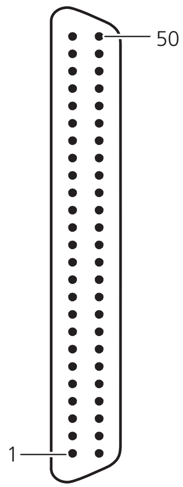
**Objective**

The DS1512 provides two slots to install IP modules. Each slot provides two AMP connectors: I/O connector and processor interface connector. The following illustration shows the top view of MicroAutoBox.

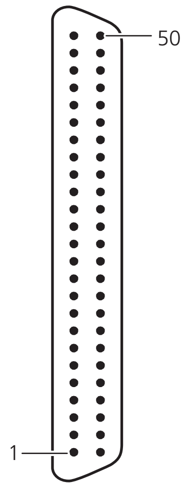

ZIF I/O connector
IP slot 2
I/O connector
Processor
interface
connector
IP slot 1

**Pinout**

**I/O connector - IP module slot 1** The following table shows the signal mapping of the IP module I/O connector on slot 1 to the DS1512 ZIF I/O connector (rear of MicroAutoBox):

| IP Module I/O Connector | Pin | ZIF Pin for IP Slot 1 | Pin | ZIF Pin for IP Slot 1 |
|---|---|---|---|---|
|  | 25 | - | 50 | M3 |
| | 24 | - | 49 | M4 |
| | 23 | - | 48 | L3 |
| | 22 | - | 47 | - |
| | 21 | - | 46 | K3 |
| | 20 | K5 | 45 | K4 |
| | 19 | K6 | 44 | J3 |
| | 18 | J5 | 43 | - |
| | 17 | J6 | 42 | - |
| | 16 | H5 | 41 | - |
| | 15 | H6 | 40 | - |
| | 14 | G5 | 39 | - |
| | 13 | - | 38 | - |
| | 12 | - | 37 | - |
| | 11 | - | 36 | - |
| | 10 | - | 35 | - |
| | 9 | - | 34 | - |
| | 8 | - | 33 | - |
| | 7 | - | 32 | - |
| | 6 | - | 31 | - |
| | 5 | C6 | 30 | - |
| | 4 | - | 29 | - |
| | 3 | - | 28 | - |
| | 2 | - | 27 | - |
| | 1 | - | 26 | - |

**I/O connector - IP module slot 2** The following table shows the signal mapping of the IP module I/O connector on slot 2 to the DS1512 ZIF I/O connector (rear of MicroAutoBox):

| IP Module I/O Connector | Pin | ZIF Pin for IP Slot 2 | Pin | ZIF Pin for IP Slot 2 |
|---|---|---|---|---|
|   | 25 | - | 50 | b3 |
| | 24 | - | 49 | b4 |
| | 23 | - | 48 | a3 |
| | 22 | - | 47 | - |
| | 21 | - | 46 | Z3 |
| | 20 | Z5 | 45 | Z4 |
| | 19 | Z6 | 44 | Y3 |
| | 18 | Y5 | 43 | - |
| | 17 | Y6 | 42 | - |
| | 16 | X5 | 41 | - |
| | 15 | X6 | 40 | - |
| | 14 | W5 | 39 | - |
| | 13 | - | 38 | - |
| | 12 | - | 37 | - |
| | 11 | - | 36 | - |
| | 10 | - | 35 | - |
| | 9 | - | 34 | - |
| | 8 | - | 33 | - |
| | 7 | - | 32 | - |
| | 6 | - | 31 | - |
| | 5 | S6 | 30 | - |
| | 4 | - | 29 | - |
| | 3 | - | 28 | - |
| | 2 | - | 27 | - |
| | 1 | - | 26 | - |

**Processor interface connector - slot 1 and slot 2** The pinout of the processor interface connector (slot 1 and slot 2) complies with IP Modules Draft Standard VITA 4-1995. For further information, refer to the documentation of the standard.

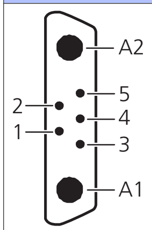
# Power Input Connector

**Objective**

MicroAutoBox provides a power input connector. It is a 7-pin, male connector with two high-current pins. It is a special variant of a 15-pin Sub-D connector (mixed-layout 7W2 Sub-D).

**Pinout**

The following illustration shows the pinout (front view of MicroAutoBox).

| Connector | Pin | Signal | Pin | Signal |
|---|---|---|---|---|
|  | A2[1] | VBAT (6 V … 40 V DC) | | |
| | | | 5 | REMOTE_PULLUP |
| | 2 | Do not connect | 4 | REMOTE[2] |
| | 1 | Do not connect | 3 | Do not connect |
| | A1 | GND | | |

[1] NOTE: It is highly recommended to insert a fuse into the main power supply input wire (close to battery). Choose the value of the fuse according to the maximum current. A 10 A fuse is recommended.

[2] The REMOTE input must be connected via switch or bridge to UBAT to run the MicroAutoBox. For example, you can use it for switching MicroAutoBox with KL15 (output of the ignition/driving switch). So, you can use the nonvolatile data feature to store data you may want to use again when restarting the application. For further information, refer to *Nonvolatile Data Handling* (📖 *MicroAutoBox RTLib Reference*).

**Matching cable**

A preconfigured cable for the supply voltage is provided by dSPACE. This cable is for running MicroAutoBox with a laboratory power supply during development. Therefore, REMOTE (pin 4) is shorted to VBAT (pin A2) inside the connector in order to save a separate switch. Do not use this cable in the vehicle. Otherwise, MicroAutoBox will always be turned on.

The VBAT wire (red) contains a melting fuse. Each wire has a cross-section of 1.5 mm².

Fuse specification:

- Cable delivered through dSPACE Release 2013-B: 7.5 A, time lag
- Cable delivered as of dSPACE Release 2014-A: 10 A, time lag

# Signal Descriptions

**Where to go from here**

Information in this section



## Power Inputs and Outputs

**Pin description**

The following table gives a description of the pins used for power input, remote input and supply of digital I/O circuits.

**Power input connector** The following table lists the pin description of the power input connector on the front:

| Pins | Signal | Description / Function |
|---|---|---|
| A2 | VBAT | Main power supply input. Connect this pin to the positive pole of your car battery. |
| A1 | GND | Main power supply return and reference for all input and output signals. Connect this pin to the minus pole of your car battery. The case of MicroAutoBox is also connected to GND. |
| 4 | REMOTE | ■ The REMOTE input may be used for starting MicroAutoBox with a remote switch, for example KL15 (output of the ignition/driving switch).<br>■ If you connect the remote pin to the plus pole of the car battery directly, MicroAutoBox will always be turned on, and the car battery will soon be exhausted if the engine is not running. Thus, a switch is highly recommended.<br>■ The voltage connected to the REMOTE pin should not exceed the supply voltage. |

| Pins | Signal | Description / Function |
|---|---|---|
| 5 | REMOTE_Pullup | You can use this output to connect a remote switch between REMOTE and this pin. REMOTE_Pullup is internally connected to VBAT via 39 kΩ pull-up resistor. |

**DS1511 ZIF I/O connector** The following table lists the pin description of the DS1511 I/O Boards ZIF I/O connector on the rear:

| Pins | Signal | Description / Function |
|---|---|---|
| A1, A4, B1, B4, C1 ... C6, D1, E1, F1, G1, H1, J1, K1, L1, S1, T1, U1, V1, W1, X1, Y1, Z1, a1, b1, b4, c1, c4 | GND | Main power supply return and reference for all input and output signals. Use the nearest possible GND pin as reference for your signals in order to keep noise levels at minimum. The case of MicroAutoBox is also connected to GND. |
| a2 | SGND | Connected to GND internally.<br>Use the SGND signal pin as reference for ADC- and DAC-channels of the DS1511 I/O Board to get the optimum analog performance. |
| N1 | VDRIVE | This input supplies all digital input and output circuits located on the DS1511 I/O Board.<br>■ Connect this input to VSENS to set CMOS/TTL-compatible logic levels for your inputs/outputs.<br>■ Connect this input to VBATprot to set automotive-compatible logic levels for your inputs/outputs.<br>■ Do not connect this pin directly to VBAT, because the input and output circuits are not load-dump-protected or reverse-voltage-protected at this signal. |
| M1 | VSENS | Sensor supply output.<br>Use this output to supply your sensors and/or VDRIVE. If you need CMOS/TTL-compatible logic levels at the inputs/outputs connect VSENS to VDRIVE. |
| P1 | VBAT prot | Protected VBAT output.<br>Use this output to supply VDRIVE when automotive logic levels are needed. |
| R1 | REMOTE | ■ The remote voltage may be used for starting MicroAutoBox with a remote switch: KL15, for example (output of the ignition/driving switch).<br>■ If you connect the remote pin to the car battery directly, MicroAutoBox will always be turned on, and the car battery will soon be exhausted if the engine is not running. Thus, a switch is highly recommended.<br>■ The remote voltage should not exceed the supply voltage. |

**DS1512 ZIF I/O connector** For the pin description of the DS1512 I/O board's ZIF I/O connector if the DS1552 Multi-I/O Module is installed, refer to *Power Inputs and Outputs* on page 588.

**Tip**

To use the digital inputs and outputs, you have to connect the VDRIVE pin inside the ZIF I/O connector according to the logic level needed. *This pin is not preconfigured in the ZIF I/O connector delivered with each MicroAutoBox II.* You have to connect VDRIVE to VBATprot or VSENS+. If you use VSENS+, you have to connect VSENS- to ground.

**Characteristics**

The characteristics are specified for the following conditions:

- $V_{BAT}$=+12 V (unless otherwise noted)

  $T_{CASE}$=+25 °C (unless otherwise noted)

  All voltages are referenced to GND (unless otherwise noted).

| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Power** | | | | | | |
| Operating voltage | VBAT | For start-up with an input power consumption < 35 W | 6 | | 40 | V |
| | VBAT | Operating | 4.5 | | 40 | V |
| | VBAT | Reverse protection | | | -40 | V |
| | VBAT | Load dump protection | | | +100 | V |
| **Inputs** | | | | | | |
| Operating current | $I_{VBAT}$ | REMOTE ≥ $V_{iHRemote}$ | | 2 | | A |
| | $I_{VBAT}$ | REMOTE ≤ $V_{iLRemote}$ | | 5 | | mA |
| REMOTE voltage input | $V_{iHRemote}$ | Input high voltage | 4.7 | | | V |
| | $V_{iLRemote}$ | Input low voltage | | | 0.8 | V |
| | $V_{iHysRemote}$ | Input hysteresis voltage | 0.5 | 1 | | V |
| | $R_{inRemote}$ | Input impedance | 60 | | 185 | kΩ |
| Inrush current | $I_{VBAT\ inrush}$ | All inputs/outputs unconnected | see *Power supply* on page 40 | | | |
| Digital I/O voltage supply input on DS1511 ZIF I/O connector | VDRIVE | Supply for digital input/output circuits | | | 45 | V |
| | $I_{VDRIVE\ no\ load}$ | All inputs/outputs unconnected | | 20 | | mA |
| | $I_{VDRIVE\ maximum\ load}$ | All outputs shorted to GND | | 1 | | A |
| Digital I/O voltage supply input on DS1512 ZIF I/O connector | VDRIVE | Supply for digital input/output circuits | | | 45 | V |
| | $I_{VDRIVE\ no\ load}$ | All inputs/outputs unconnected | | 10 | | mA |
| | $I_{VDRIVE\ maximum\ load}$ | All outputs shorted to GND | | 500 | | mA |

| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Outputs** | | | | | | |
| Sensor supply output on DS1511 ZIF I/O connector | VSENS | Output voltage | 4.84 | 5.05 | 5.25 | V |
| | VSENS = f(T) | Temperature caused voltage drift $T_{CASE}$ = –40 °C ... +85 °C | –2 | | 2 | % |
| | $I_{VSENS,\ max}$ | Maximum output current | 750 | | | mA |
| Sensor supply output on DS1512 ZIF I/O connector | VSENS+ | Output voltage, isolated and adjustable, controlled by a DAC (relative to VSENS-) | 2 | | 20 | V |
| | $P_{VSENS,\ max}$ | Maximum output power (if VSENS+ is in range 5..20V and VSENS- is connected to GND) | | 1 | | W |
| Protected VBAT output | VBATprot | IL = 1A; VBAT = 12 V | 11.56 | 11.78 | 12 | V |
| | $I_{VBATprot,\ max}$ | Maximum output current | | | 1000 | mA |
| | $I_{ProtPeak}$ | Overload current limit (–40 °C ... 85 °C) | 4 | | 9 | A |
| | t(overload) | Time to shut off $I_{ProtPeak}$ | | | 5 | ms |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

# Digital Inputs

**Note on the cable harness**

> **Note**
>
> To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the DS1511 ZIF I/O connector and the DS1512 ZIF I/O connector. For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**Pin description**

The following table gives a description of the digital input pins of the DS1511 ZIF I/O connector:

| Pins | Port Number | Signal | Description / Function |
|---|---|---|---|
| V2, U2, T2, S2, R2, P2, N2, M2, V3, U3, T3, S3, R3, P3, N3, M3 | 1 | Channel 1 ... 16<br>DIO Type 3 | Standard discrete digital input with pull-up. |
| V4, U4, T4, S4, R4, P4, N4, M4, V5, U5, T5, S5, R5, P5, N5, M5 | 2 | Channel 1 ... 16<br>DIO Type 3 | |
| V6, U6, T6, S6, R6, P6, N6, M6 | 3 | Channel 1 ... 8<br>DIO Type 3 | |

**Characteristics**

The characteristics are specified for the following conditions:

- $V_{BAT}$=+12 V (unless otherwise noted)

  $T_{CASE}$=+25 °C (unless otherwise noted)

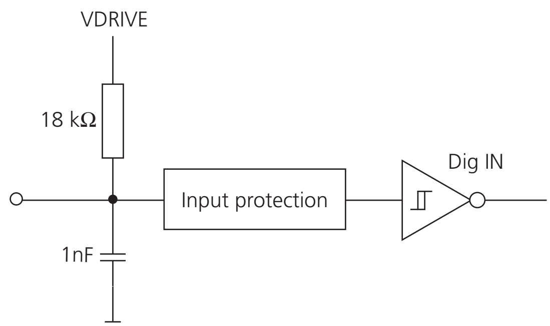
  All voltages are referenced to GND (unless otherwise noted).

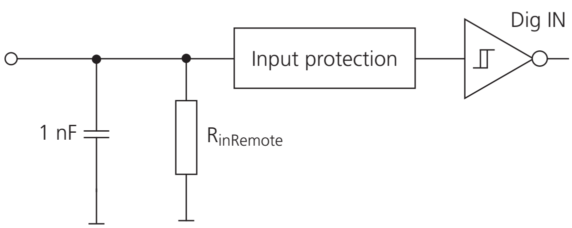
| Signal[1)] | | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| **DC characteristics** | | | | | | | |
| Digital input channel 1 ... 40<br>DIO Type 3 | | $V_{iH}$ | Input high voltage | 3.1 | | | V |
| | | $V_{iL}$ | Input low voltage | | | 1.2 | V |
| | | $V_{iHys}$ | Input hysteresis voltage | | 1 | | V |
| | | $R_{DigIn}$ | Pull-up resistor to VDRIVE | 17 | 18 | 19 | kΩ |
| | | $C_{DigIn}$ | Input capacitance | | 1 | | nF |
| DIO Type 3 | REMOTE | $V_{iHRemote}$ | Input high voltage | 4.7 | | | V |
| | | $V_{iLRemote}$ | Input low voltage | | | 0.8 | V |
| | | $V_{iHysRemote}$ | Input hysteresis voltage | 0.5 | 1 | | V |
| | | $R_{inRemote}$ | Input impedance | 60 | | 185 | kΩ |
| **AC characteristics** | | | | | | | |
| DIO Type 3 | Inputs | $t_{LowMin}$ | Minimum pulse width low | | 250 | 500 | ns |
| | | $t_{HighMin}$ | Minimum pulse width high | | 300 | 600 | ns |
| | | $F_{max}$ | Duty cycle: 50 % | | 1.8 | | MHz |
| | | | Duty cycle: 1 % or 99 % | | 33 | | kHz |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagrams**

The following table shows *simplified* diagrams of the I/O circuitry of the digital inputs:

<table>
<tr><th colspan="2">Signal</th><th>I/O Circuit</th></tr>
<tr><td rowspan="2">DIO<br>Type 3</td><td>Channel<br>1 ... 40</td><td>

For proper operation, VDRIVE must have a level above the maximum input voltage.</td></tr>
<tr><td>Remote</td><td>
</td></tr>
</table>

**Digital inputs on the DS1512 ZIF I/O connector**

Only I/O modules can provide digital inputs on the DS1512 ZIF I/O connector. For signal descriptions of the DS1552 Multi-I/O Module, refer to *Digital Inputs* on page 590.

**Related topics**

Basics

- *Bit I/O Unit (DIO Type 3)* (📖 *MicroAutoBox Features*)

# Digital Outputs

**Note on the cable harness**

> **Note**
>
> To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the DS1511 ZIF I/O connector and the DS1512 ZIF I/O connector. For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**General behavior of digital signals**

All digital outputs are set to high impedance (tristate) until the application is started. Then the outputs follow the states defined in your application. Unused outputs remain in tristate mode.

**Pin description**

The following table gives a description of the digital output pins on the DS1511 ZIF I/O connector:

| Pins | Port Number | Signal | Default state | Description / Function |
|---|---|---|---|---|
| L2, K2, J2, H2, G2, F2, E2, D2, L3, K3, J3, H3, G3, F3, E3, D3 | 1 | Channel 1 ... 16 DIO Type 3 | Tristate | Standard discrete digital output. |
| L4, K4, J4, H4, G4, F4, E4, D4, L5, K5, J5, H5, G5, F5, E5, D5 | 2 | Channel 1 ... 16 DIO Type 3 | | |
| L6, K6, J6, H6, G6, F6, E6, D6 | 3 | Channel 1 ... 8 DIO Type 3 | | |

**Characteristics**

The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25 °C; all voltages are referenced to GND, unless otherwise noted.

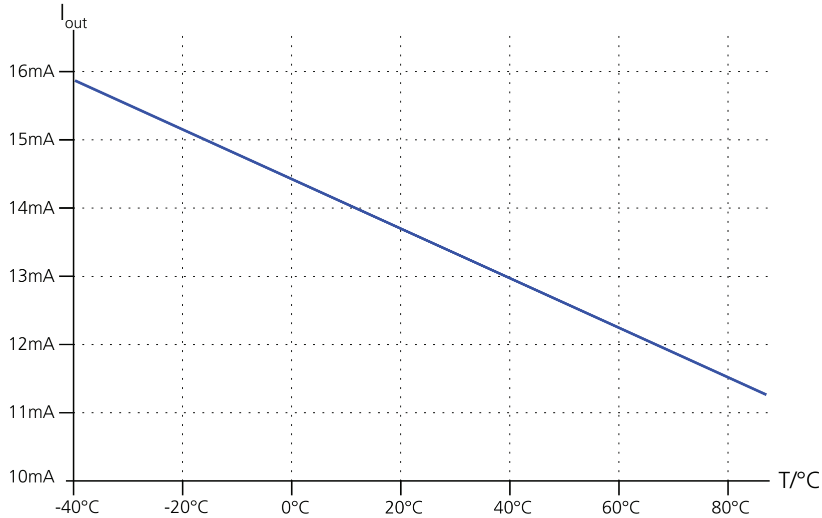
| Signal[1)] | | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| **DC Characteristics** | | | | | | | |
| Digital output channel 1 ... 40<br>DIO Type 3 | | $V_{oH}$ | IL = 0 mA; VDRIVE = 5 V | 4.4 | 4.6 | | V |
| | | $V_{oL}$ | IL = 0 mA; VDRIVE = 5 V | | 0.1 | 0.3 | V |
| | | $V_{oH}$ | IL = 5 mA; VDRIVE = 5 V | 3.2 | 3.4 | | V |
| | | $V_{oL}$ | IL = –5 mA; VDRIVE = 5 V | | 0.7 | 0.9 | V |
| | | $V_{oH}$ | IL = 0 mA; VDRIVE = 12 V | 11.3 | 11.6 | | V |
| | | $V_{oL}$ | IL = 0 mA; VDRIVE = 12 V | | 0.1 | 0.3 | V |
| | | $V_{oH}$ | IL = 5 mA; VDRIVE = 12 V | 10.3 | 10.5 | | V |
| | | $V_{oL}$ | IL = –5 mA; VDRIVE = 12 V | | 0.7 | 0.9 | V |
| | | $\lvert I_{OHmax} \rvert$ | Current limit high<br>$T_{CASE}$ = –40 °C ... +85 °C | 5 | 13 | 17 | mA |
| | | $\lvert I_{OLmax} \rvert$ | Current limit low<br>$T_{CASE}$ = –40 °C ... +85 °C | 5 | 14 | 18 | mA |
| | | $\lvert I_{OTLeak} \rvert$ | Leakage current tristate<br>$T_{CASE}$ = -40 °C ... +85 °C | | | 100 | µA |
| **AC Characteristics** | | | | | | | |
| DIO Type 3 | Outputs | $t_{minPulseHigh}$ | Minimum pulse width high,<br>VDRIVE = 5 V or 12 V, RL=1 kΩ | | 700 | 1400 | ns |
| | | $t_{minPulseLow}$ | Minimum pulse width low,<br>VDRIVE = 5 V or 12 V, RL=1 kΩ | | 200 | 400 | ns |
| | | $F_{max}$ | Duty cycle: 50 %<br>VDRIVE = 5 V or 12 V | | 0.7 [2)] | | MHz |
| | | | Duty cycle: 1 % or 99 %<br>VDRIVE = 5 V or 12 V | | 14 | | kHz |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

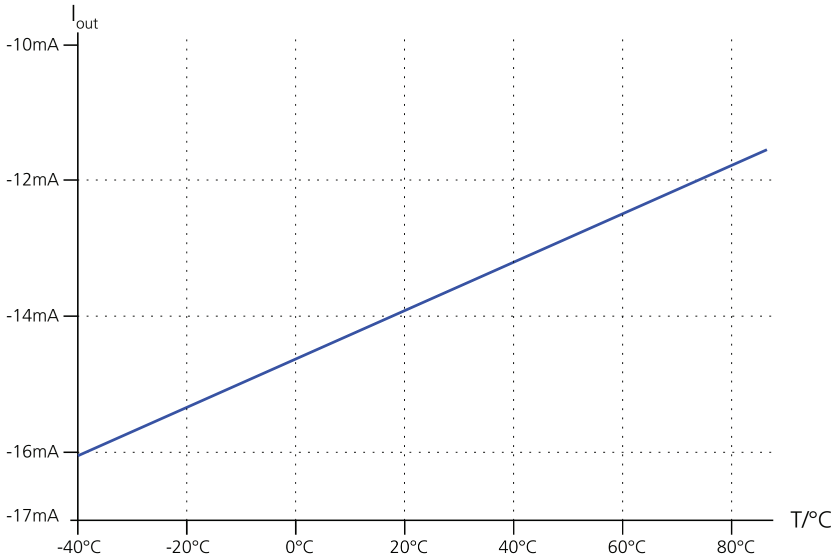
2) Limited by software to 150 kHz

The following illustrations are valid for DIO Type 3 and DIO 1552 Type 1, and show the maximum output current of a digital output circuit as a function of ambient temperature (VDRIVE = 12 V; output is shorted to 6 V):

- Output high

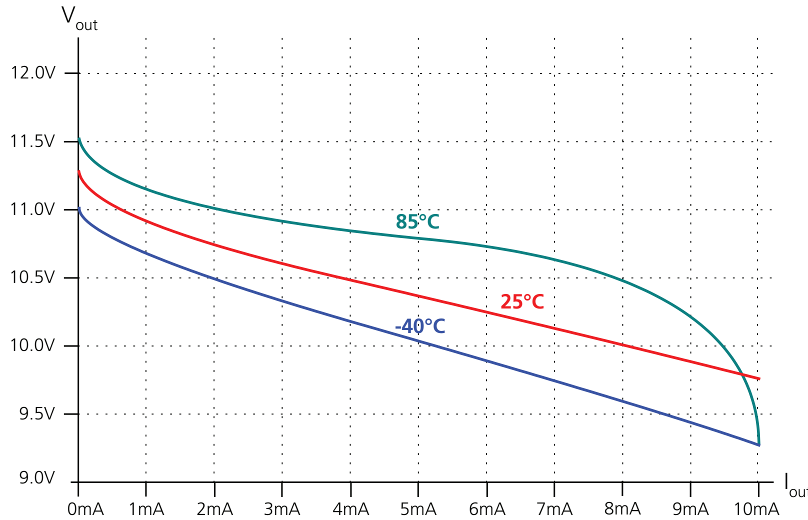



- Output low

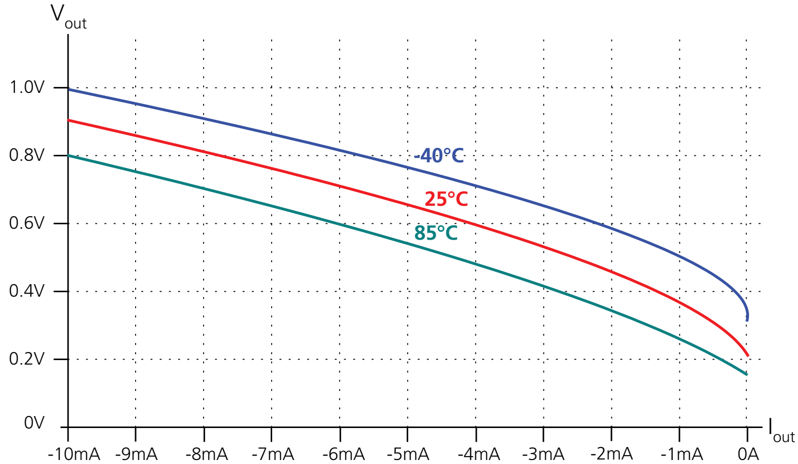


The following illustrations show the typical digital output voltage as a function of the output current (VDRIVE = 12 V):

- Output high

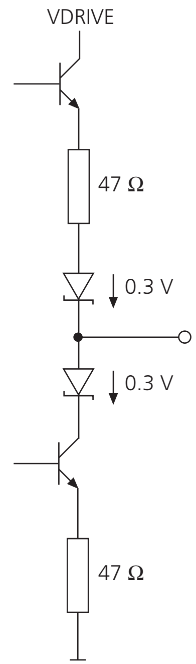



- Output low



**Circuit diagrams**

The following table shows a *simplified* diagram of the I/O circuitry of the digital outputs:

| Signal | I/O Circuit |
|---|---|
| Digital outputs:<br>DIO Type 3 |  |

**Digital outputs on the DS1512 ZIF I/O connector**

Only I/O modules provide digital outputs on the DS1512 ZIF I/O connector. For signal descriptions, refer to *Digital Outputs* on page 592.

**Related topics**

Basics

- *Bit I/O Unit (DIO Type 3)* (*MicroAutoBox Features*)

# Digital I/O (Bidirectional)

**Objective**

The information on the digital bidirectional I/O channels is only relevant if the DS1512 I/O Board is equipped with a DS1552 Multi-I/O Module. For further information, refer to *Digital I/O (Bidirectional)* on page 595.

# Analog Inputs

**Note on the cable harness**

**Note**

To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the two ZIF I/O connectors (DS1511 and DS1512). For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**Pin description**

The following table gives a description of the analog input pins on the DS1511 ZIF I/O connector:

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| Z3, Y3, X3, W3, Z4, Y4, X4, W4, Z5, Y5, X5, W5, Z6, Y6, X6, W6 | ADC channel 1 ... 16 | ADC Type 4 | Analog inputs:<br>■ DS1511: 0 V ... 5 V<br>■ DS1511B1: -10 V ... +10 V |
| a3, a4, a5, a6 | External trigger 1 ... 4 | | For information on function of the ADC Type 4 module's trigger signals, refer to *Trigger signals* (📖 *MicroAutoBox Features*). |

**Characteristics**

The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25 °C; all voltages are referenced to SGND pin a2, unless otherwise noted.

**ADC Type 4 module** The following table shows the characteristics of the ADC Type 4 module of the DS1511 I/O Board.

| Signal[1)] | Parameter | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **General characteristics** | | | | | | |
| ADC (all 16 channels) | Number of independent input channels | | | 16 | | |
| | Resolution | | | 16 | | bit |
| | Sample rate | Burst mode with more than 1 sample | | | 1 | MSPs |
| | Input voltage range | DS1511 | 0 | | 5 | V |
| | | DS1511B1 | -10 | | 10 | V |

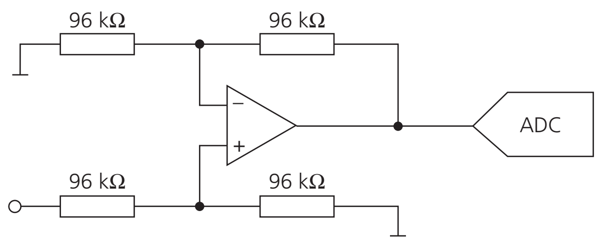
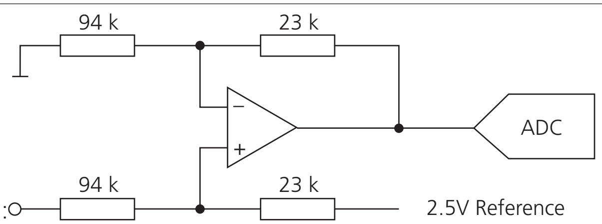
| Signal[1)] | Parameter | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| | Conversion timer | Separate for each channel. | | | | |
| | | Width | 27 | | | bit |
| | | Resolution | 10 | | | ns |
| | | Interval | | | 1.342 | s |
| | Timer for time stamping | Common for all channels. Two channels are required to carry one 32 bit value. | | | | |
| | | Width | 32 | | | bit |
| | | Resolution | 10 | | | ns |
| | | Interval | | | 42.9 | s |
| | Buffer size | Software-configurable | 1 | | 8192 | Samples |
| | Buffers per channel | | 3 | | | |
| | Number of external trigger inputs | | 4 | | | |
| **DC characteristics - DS1511** | | | | | | |
| ADC (all 16 channels) | Initial offset error | Below 750 KSPs | -0.5 | | 0.5 | mV |
| | Initial gain error | Below 750 KSPs | -0.25 | | 0.25 | % |
| | Input impedance | | | 192 | | kΩ |
| | Offset drift | | | ±10 | | µV/K |
| | Gain drift | | | ±6 | | ppm/K |
| | Overvoltage protection | Continuous | -20 | | +30 | |
| | | Short term | -50 | | 50 | V |
| External trigger | Input voltage | $V_{iH}$ | 2.3 | | | V |
| | | $V_{iL}$ | | | 0.4 | V |
| | Period | | | | 1 | MHz |
| | Overvoltage protection | Continuous | -48 | | 50 | V |
| **DC characteristics - DS1511B1** | | | | | | |
| ADC (all 16 channels) | Initial offset error | Below 750 KSPs | -3 | | 3 | mV |
| | Initial gain error | Below 750 KSPs | -0.25 | | 0.25 | % |
| | Input impedance | | | 117 | | kΩ |
| | Offset drift | | | ±40 | | µV/K |
| | Gain drift | | | ±6 | | ppm/K |
| | Overvoltage protection | Continuous | -30 | | +30 | |
| | | Short term | -50 | | 50 | V |
| External trigger | Input voltage | $V_{iH}$ | 2.3 | | | V |
| | | $V_{iL}$ | | | 0.4 | V |
| | Period | | | | 1 | MHz |
| | Overvoltage protection | Continuous | -48 | | 50 | V |
| **AC Characteristics** | | | | | | |
| ADC Type 4 (all 16 channels) | No missing codes | | 15 | | | bit |
| | SNR | 12.4 kHz signal @ 200 KSPs | 80 | | | dB |

| Signal[1)] | Parameter | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| | Input bandwidth | Full power bandwidth | 400 | | | kHz |
| | Channel crosstalk | 100 kHz | | | -96 | dB |
| | | 200 kHz | | | -92 | dB |
| | | 400 kHz | | | -90 | dB |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagrams**

The following table shows *simplified* diagrams of the I/O circuitry of the analog inputs:

| Signal | | I/O Circuit |
|---|---|---|
| Analog inputs | ADC Type 4 channel 1 … 16 | DS1511:   |
| | | DS1511B1:   |

**Analog inputs on the DS1512 ZIF I/O connector**

Only I/O modules provide analog inputs on the DS1512 ZIF I/O connector. For signal descriptions, refer to *Analog Inputs* on page 597.

**Related topics**

Basics

- *ADC Unit Type 4* (📖 *MicroAutoBox Features*)

# Analog Outputs

**Note on the cable harness**

> **Note**
>
> To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the two ZIF I/O connectors (DS1511 and DS1512). For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**Pin description**

The following table gives a description of the analog output pins on the DS1511 ZIF I/O connector:

| Pins | Signal | Module | Default state | Description / Function |
|---|---|---|---|---|
| Z2, Y2, X2, W2 | DAC1 … DAC4 | DAC Type 3 | 0 V | Standard analog outputs<br>12-bit digital values are converted to analog outputs by the DAC module. |

*Default state* means the state of the signal during reset.

**Characteristics**

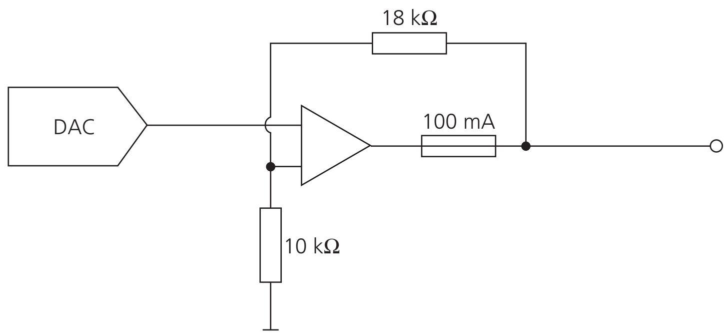
The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25 °C; all voltages are referenced to SGND pin a2, unless otherwise noted.

| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC characteristics** | | | | | | |
| DAC Type 3 | $V_{DAC}$ | Full scale | 4.44 | 4.50 | 4.56 | V |
| | Resolution | Fully monotonic | 12 | | | bit |
| | Offset error | Delivery state; $T_{CASE}$ = 25 °C | | 2 | | mV |
| | Gain error | | | 0.5 | | LSB |
| | Offset error | $T_{CASE}$ = –40 °C ... +85 °C | –10 | | +10 | LSB |
| | Gain error | | –0.5 | | 0.5 | % |
| | $I_{DACout}$ | max. sink/ source current | –5 | | 5 | mA |
| | $V_{DACSAT}$ | Output voltage when sinking $I_{DACout}$ = –5 mA and CODE = 000H | | | 0.3 | V |
| **AC characteristics** | | | | | | |
| DAC Type 3 | Settling time | Settling time of output (to 1 LSB) | | | 150 | µs |
| | $f_{gDAC}$ | Low-pass cutoff frequency of reconstruction filter (3 dB) | 10.2 | 10.8 | 11.4 | kHz |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagram**

The following table shows a *simplified* diagram of the I/O circuitry of the analog outputs:

| Signal | I/O Circuit |
|---|---|
| DAC Type 3 DAC1 … DAC4 |  |

**Analog outputs on the DS1512 ZIF I/O connector**

Only I/O modules provide analog outputs on the DS1512 ZIF I/O connector. For signal descriptions of the DS1552 Multi-I/O Module, refer to *Analog Outputs* on page 602.

**Related topics**

Basics

- *DAC Unit Type 3* (📖 *MicroAutoBox Features*)

# Interfaces

**Pin description**

The following tables give a description of the interface pins provided by the two ZIF connectors.

> **Tip**
>
> The pinout of the ECU interface connectors, USB device connector, and Ethernet I/O connector is not documented. Use a suitable dSPACE connection cable.

**DS1511 ZIF I/O connector**

The DS1511 ZIF I/O connector provides the interface pins to connect CAN bus interfaces, LIN bus interfaces, or for serial communication.

| Pins | Signal | Module Type | Description / Function |
|---|---|---|---|
| c3 | CAN 1 low | CAN Type 1 | CAN controller:<br>■ CAN 1 high = CAN high of module number 1, channel number 1<br>■ CAN 2 high = CAN high of module number 1, channel number 2<br>■ CAN 3 high = CAN high of module number 2, channel number 1<br>■ CAN 4 high = CAN high of module number 2, channel number 2<br>■ ISO 11898 interface<br>■ The MicroAutoBox CAN buses are not equipped with bus termination by default. For information on terminating the CAN buses, refer to *How to Terminate the CAN Bus* on page 124. |
| c2 | CAN 1 high | | |
| b3 | CAN 2 low | | |
| b2 | CAN 2 high | | |
| B3 | CAN 3 low | | |
| B2 | CAN 3 high | | |
| A3 | CAN 4 low | | |
| A2 | CAN 4 high | | |
| c6 | Serial 1 RXD[1)] | | RS232 interface |
| c5 | Serial 1 TXD[1)] | | |
| b5 | Serial 2 K / LIN[1)] | | |
| b6 | Serial 2 L[1)] | | |
| B6 | Serial 3 RXD[1)] | | LIN or ISO 9141 interface<br>The K line/LIN interface is bidirectional. The L line is input only. Both lines have no pull-up. For proper function of the K line connect an external pull-up resistor (4.7 kΩ) from this line to VBAT.<br>For information on configuring a LIN master, refer to *Connecting to a LIN Bus* on page 108. |
| B5 | Serial 3 TXD[1)] | | |
| A5 | Serial 4 K / LIN[1)] | | |
| A6 | Serial 4 L[1)] | | |

[1)] For a mapping of converter and channel numbers, as used in RTI and RTLib, refer to *Basics on Serial Interface* (📖 *MicroAutoBox Features*).

**Note**

Due to the limitations of the UART baud rate generator, not all baud rates can be programmed exactly to the desired baud rate without error (see Baud rate calculation of the serial interface).

**DS1512 ZIF I/O connector**

The following tables give a description of the interface pins provided by the DS1512 ZIF I/O connector.

You can install IP modules of various types to the DS1512:

- DS4340 FlexRay Interface Modules
- DS4342 CAN FD Interface Modules
- Third-party FlexRay IP modules
- Standard IP modules

**DS4340 FlexRay Interface Module** For a description of the interface pins of the DS4340 FlexRay Interface Module, refer to *Interfaces* on page 637.

**DS4342 CAN FD Interface Module** For a description of the interface pins of the DS4342 CAN FD Interface Module, refer to *Interfaces* on page 645.

**(FlexRay) IP Module 1** The table describes the pins when a third-party FlexRay IP module is installed.

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| C6 | IP wakeup 1 | IP_Type1 | You do not need to connect this pin because wake-up functionality is not supported. |
| L3 | IP GND 1 | IP_Type1 | Connection to GND |
| M3 | IP bus high/A 1 | IP_Type1 | FlexRay 1 high in/out (FlexRay-H) |
| M4 | IP bus low/B 1 | IP_Type1 | FlexRay 1 low in/out (FlexRay-L) |
| J3 | IP GND 2 | IP_Type1 | Connection to GND |
| K3 | IP bus high/A 2 | IP_Type1 | FlexRay 2 high in/out (FlexRay-H) |
| K4 | IP bus low/B 2 | IP_Type1 | FlexRay 2 low in/out (FlexRay-L) |
| G5 | Reserved | - | Do not connect |
| H6 | Reserved | - | Do not connect |
| H5 | Reserved | - | Do not connect |
| J6 | Reserved | - | Do not connect |
| J5 | Reserved | - | Do not connect |
| K6 | Reserved | - | Do not connect |
| K5 | Reserved | - | Do not connect |

**(FlexRay) IP Module 2** The table describes the pins when a third-party FlexRay IP module is installed.

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| S6 | IP wakeup 1 | IP_Type1 | You do not need to connect this pin because wake-up functionality is not supported. |
| a3 | IP GND 3 | IP_Type1 | Connection to GND |
| b3 | IP bus high/A 3 | IP_Type1 | FlexRay 1 high in/out (FlexRay-H) |
| b4 | IP bus low/B 3 | IP_Type1 | FlexRay 1 low in/out (FlexRay-L) |

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| Y3 | IP GND 4 | IP_Type1 | Connection to GND |
| Z3 | IP bus high/A 4 | IP_Type1 | FlexRay 2 high in/out (FlexRay-H) |
| Z4 | IP bus low/B 4 | IP_Type1 | FlexRay 2 low in/out (FlexRay-L) |
| W5 | Reserved | - | Do not connect |
| X6 | Reserved | - | Do not connect |
| X5 | Reserved | - | Do not connect |
| Y6 | Reserved | - | Do not connect |
| Y5 | Reserved | - | Do not connect |
| Z6 | Reserved | - | Do not connect |
| Z5 | Reserved | - | Do not connect |

**Characteristics**

The interface characteristics are specified for the following conditions: $V_{BAT}$ = +12 V; $T_{CASE}$ = +25 °C; all voltages are referenced to GND pins of the ZIF connectors, unless otherwise noted.

| dSPACE Board | Interface | Parameter | Conditions / Comments | Specification[1)] |
|---|---|---|---|---|
| DS1401 | Host PC | Protocol | TCP/IP | — |
| | | Bitrate | — | ■ 10/1000[2)]<br>■ 10/100[3)] |
| | | Data throughput | — | max. 2.6 MB/sec |
| | | Voltage levels | Ethernet standard | — |
| | Ethernet I/O | Protocol | UDP/IP | — |
| | | Bitrate | — | typ. 1000 Mbit |
| | | Voltage levels | Ethernet standard | — |
| | USB | USB 2.0 standard (USB Flight Recording) | | |
| | | Data throughput | without connected host tool | max. 1280 kB/sec |
| | | | with connected host tool | max. 1024 kB/sec |
| | | | without data loss during cold start (dependend on the boot time of the host interface) | max. 640 kB/sec |
| | | Current | — | max. 1.3 A |
| | | Voltage | — | max. 5 V |

| dSPACE Board | Interface | Parameter | Conditions / Comments | | Specification[1] |
|---|---|---|---|---|---|
| DS1511 | ECU | Bit rate | LVDS mode | | max. 250 Mbit |
| | | | LVDS2 mode | | max. 500 Mbit |
| | | Cable length | 2-paired twisted pair | | max. 5 m (16.4 ft.) |
| | | Cable type | | | CAT5 |
| | | Voltage levels | LVDS standard | | — |
| | | Full duplex data rate[4] | LVDS mode | Single transfer | max. 5 MWord/s |
| | | | LVDS2 mode | Single transfer | max. 11.2 MWord/s |
| | | | | Block transfer | max. 28 MWord/s |
| | | RAM size[4] | LVDS / LVDS2 mode | | 16 kWord |
| | | FIFO size[4] | LVDS / LVDS2 mode (Transmit buffer) | | 1 kWord |
| | CAN | Bit rate | ISO 11898 interface | | max. 1 MBaud |
| | Serial 1/3 RS232-Interface | Bit rate | — | | ■ min. 14 Baud<br>■ max. 115.2 kBaud |
| | | TX output voltage swing | 3 kΩ load | | ■ min. ±5 V<br>■ typ. ±9 V |
| | | $V_{RxinLow}$ | RX input threshold low | | ■ typ. 1.4 V<br>■ max. 0.8 V |
| | | $V_{RxinHigh}$ | RX input threshold high | | ■ min. 2.0 V<br>■ typ. 1.4 V |
| | | Word length | — | | ■ min. 5 bit<br>■ max. 8 bit |
| | Serial 2/4 ISO9141-Interface | Bit rate | $R_{KO}$ = 510 Ω; $C_K \leq$ 1.3 nF | | ■ min. 14 Baud<br>■ max. 50 kBaud |
| | | Word length | — | | ■ min. 5 bit<br>■ max. 8 bit |
| | Serial 2/4 LIN Interface | Bit rate | — | | ■ min. 14 Baud<br>■ max. 20 kBaud |
| DS1512 | FlexRay | Bit rate | — | | max. 2 x 10 MBaud |
| | | Frame length | — | | max. 12 byte |
| | CAN FD | Bit rate | ISO 11898 interface | | max. 2 x > 2 MBaud |
| | IP module carrier | Clocking | — | | ■ min. 8 MHz<br>■ max. 32 MHz |
| | | Access type | — | | byte / word |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.
2) Since board revision DS1401-23 (available since dSPACE Release 7.2).
3) Before board revision DS1401-23
4) Word is 16-bit wide

**Baud rate calculation of the serial interface**

**Note**

Due to the limitations of the UART baud rate generator, not all baud rates can be programmed exactly to the desired baud rate without error.

The UART baud rate generator provides several baud rates:

*To calculate the divisor T for a chosen baud rate*

$$T = \text{Round}\left(\frac{921600}{\text{BR (chosen)}}\right)$$

BR (chosen) = The baudrate to be generated
T = The baudrate generator divisor ($8 \le T \le 65535$)

*To calculate the real baud rate from a given divisor T*

$$\frac{\text{BR (real)}}{\text{Baud}} = \frac{921600}{T}$$

BR (real) = The baudrate you get
T = The baudrate generator divisor ($8 \le T \le 65535$)

*To calculate the resulting error*

$$\frac{\text{Error}_{BR}}{100\%} = \frac{\text{BR (real)} - \text{BR (chosen)}}{\text{BR (chosen)}}$$

**Note**

If $\text{Error}_{BR} \le 2\%$, messages will be transferred and received correctly.

# Data Sheet MicroAutoBox II 1401/1511/1514

**Where to go from here**

Information in this section

# Overview and General Information

**Where to go from here**

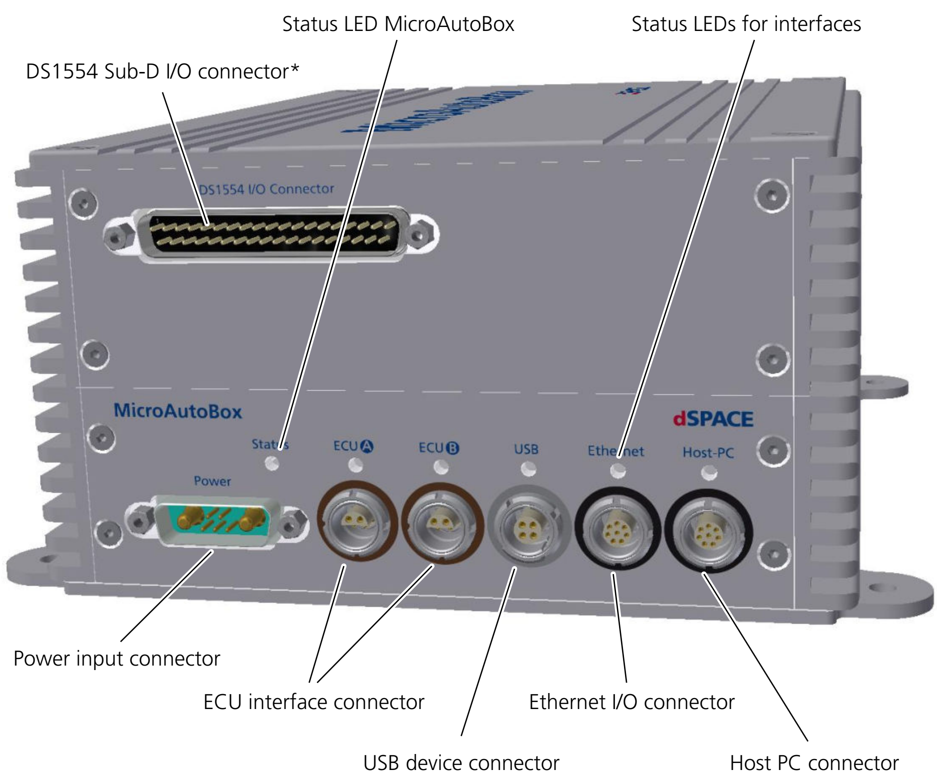
Information in this section

# Housing Components

**Connectors and status LEDs**

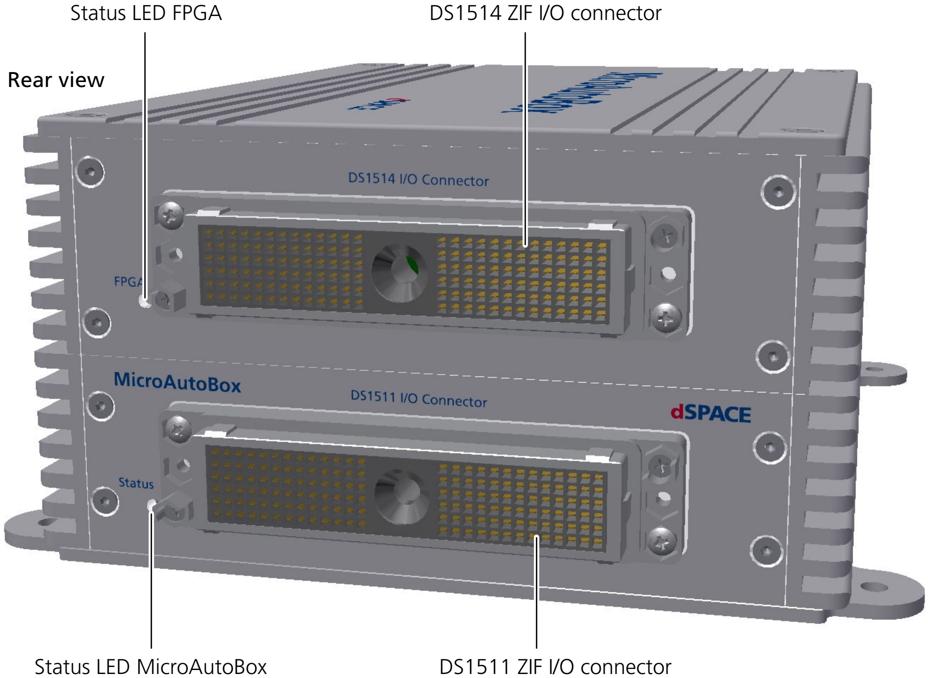
The illustrations show where the connectors and status LEDs are located on MicroAutoBox II 1401/1511/1514.

Front view




* Only with DS1554 Engine Control I/O Module

Rear view




MicroAutoBox II 1401/1511/1514 contains the following connectors and LEDs:

**Power input connector** Supplies the required power to MicroAutoBox. It is a 7-pin, male Sub-D connector with two high-current pins.

A preconfigured cable with a matching connector and a separate power input connector are included in each MicroAutoBox package. For the pinout and further details on the preconfigured cable, refer to *Power Input Connector* on page 439.

**Status LED MicroAutoBox** Shows you different states and potential malfunctions.

If battery power is switched on and the REMOTE signal/KL15 is activated (see *Basics on Connecting to Power Supply* on page 44), the status LED (= dual LED) shows different states indicated by the LED color:

- LED is red: Reset state and no application is downloaded to the real-time processor.
- LED is green: Application is running.

- LED is flashing red: MicroAutoBox is in secured mode. For further instructions, refer to *Checking MicroAutoBox* on page 672.

The status LED on the front panel has the same functionality as the status LED on the rear panel of MicroAutoBox.

**ECU interface connectors** Provide communication to ECUs based on the LVDS standard, for example, in bypassing scenarios or to connect a RapidPro system (used as I/O subsystem). The ECU interface connectors are 4-pin LEMO connectors. Matching cables are supplied from dSPACE on request.

The corresponding LED is lit green, if power at both ends of the link is available and the relevant connection is serviceable. The LED flashes when data is being sent or received.

The table below shows the different ECU interfaces integrated into MicroAutoBox and the display names they are mapped to in the experiment software, for example, ControlDesk.

| Display Name in Software | Connectors Built-in at MicroAutoBox | |
|---|---|---|
| | ECU A | ECU B |
| ECU 1 | ✓ | – |
| ECU 2 | – | ✓ |

**USB device connector** A 4-pin LEMO connector to connect an USB mass storage device to use the USB Flight Recorder feature of MicroAutoBox. A matching cable with a LEMO-USB adapter is supplied from dSPACE on request.

**Note**

To use the USB Flight Recorder, a separate license is required.

The possible states of the corresponding LED are listed in the table below:

| LED Status | Meaning |
|---|---|
| Off | No USB device is connected. |
| Green | USB device is connected and flight recorder is not running. |
| Green blinking | USB device is connected and flight recorder is running. |
| Orange | USB device is full and the active flight recorder is specified not to overwrite old files. |

| LED Status | Meaning |
|---|---|
| Red | Write error when accessing the USB device, for example, if the device was removed while the flight recorder was running. |

For further information, refer to *Flight Recorder* (📖 *MicroAutoBox Features*).

**Ethernet I/O connector** An 8-pin LEMO connector that provides communication to external devices, such as PCs or ECUs based on the UDP/IP Ethernet protocol, for example, in bypassing scenarios.

A matching cable with a LEMO-RJ45 adapter is supplied from dSPACE on request.

The corresponding LED is lit green if power is available at both ends of the link and the relevant connection is serviceable. The LED flashes green when data is being sent or received.

For installation instructions, refer to *How to Connect MicroAutoBox to the ECU via UDP/IP* (📖 *ECU Interfaces Hardware Installation and Configuration*).

**Host PC connector** Provides the communication between MicroAutoBox and your host PC based on the Ethernet TCP/IP protocol. The connector is a 8-pin LEMO connector. A matching cable is included in each MicroAutoBox package.

The corresponding LED is lit green if power is available at both ends of the link and the relevant connection is serviceable. The LED flashes green when data is being sent or received.

**Tip**

The Ethernet I/O connector and the Host PC connector are internally connected by a common gigabit Ethernet switch (valid for base board DS1401-25ff).

This simplifies the connection options. For an example, refer to *Connecting an ECU with DCI-GSI2 for Simultaneous Calibration and Bypassing* (📖 *ECU Interfaces Hardware Installation and Configuration*).

**DS1554 Sub-D I/O connector** The 37-pin Sub-D I/O connector is used to connect the following sensors to the DS1554 Engine Control I/O Module:

- Crankshaft and camshaft sensors
- Knock sensors

This connector is available only if the DS1554 Engine Control I/O Module is installed.

For the pinout, refer to *DS1554 Sub-D I/O Connector* on page 613.

**Status LED FPGA**

- If the DS1552 Multi-I/O Module is installed and you use the RTI DS1552 I/O Extension Blockset the possible states of the corresponding LED are listed in the table below:

| LED Status | Meaning |
|---|---|
| Off | FPGA is not configured. |
| Green | Correct behavior. |
| Yellow | ■ Malfunction<br>■ Overload<br>■ One or more supply voltages on the I/O module are beyond a rated value. |

- If you use the RTI FPGA Programming Blockset the possible states of the corresponding LED are listed in the table below:

| LED Status | Meaning |
|---|---|
| Off | FPGA is not configured. |
| Green | Correct behavior. |
| Orange | The FPGA application can control the LED to light orange. For further information, refer to *FPGA_IO_WRITE_BL (FPGA1401Tp1 with Multi-I/O Module Settings)* (📖 *RTI FPGA Programming Blockset - FPGA Interface Reference*) or *FPGA_IO_WRITE_BL (FPGA1401Tp1 with Engine Control I/O Module Settings)* (📖 *RTI FPGA Programming Blockset - FPGA Interface Reference*). |
| Yellow | ■ Malfunction<br>■ Overload<br>■ One or more supply voltages on the I/O module are beyond a rated value. |

| LED Status | Meaning |
|---|---|
| Flashing blue | The FPGA die temperature reaches a critical range for operating.<br>A high ambient temperature and an FPGA application with a very high FPGA utilization and/or toggle rate increase the FPGA die temperature (internal chip temperature). If the die temperature exceeds 105 °C, the FPGA might work incorrectly.[1)] |
| Blue | The FPGA die temperature is too hot for operating.<br>If the die temperature exceeds 125 °C, the FPGA resets itself. The reset stays active until the die temperature falls below 85 °C and you restart MicroAutoBox or reload the user application. |

[1)] For details on reading the die temperature measurement, refer to *FPGA_IO_READ_BL (FPGA1401Tp1 with Multi-I/O Module Settings)* (📖 *RTI FPGA Programming Blockset - FPGA Interface Reference*) or *FPGA_IO_READ_BL (FPGA1401Tp1 with Engine Control I/O Module Settings)* (📖 *RTI FPGA Programming Blockset - FPGA Interface Reference*).

**DS1511 ZIF I/O connector** The 156-pin zero insertion force (ZIF) I/O connector provides access to the most input and output signals provided by MicroAutoBox. A matching connector is included in each MicroAutoBox package. For the pinout, refer to *DS1511 ZIF I/O Connector* on page 431.

**DS1514 ZIF I/O connector** The 156-pin zero insertion force (ZIF) I/O connector provides the signals of the installed I/O module and IP modules. For the pinout, refer to *DS1514 ZIF I/O Connector* on page 433.

# General Data

**General characteristics** The following table shows some general characteristics of MicroAutoBox:

| Parameter | | Specification[1] |
|---|---|---|
| Base board (DS1401-20ff.) | Processor | ■ PPC750 GL Power PC<br>■ 900 MHz clock frequency<br>■ Real-time clock |
| | Memory | ■ 8 MB global RAM<br>■ 16 MB local RAM<br>■ 16 MB flash memory |
| | Onboard sensors[2] | Pressure sensor:<br>■ Base board DS1401-23ff.<br>■ Range: 50 kPA ...115 kPa<br>■ Accuracy: 1 kPa<br>■ Sample rate: approx. 200 Hz<br>Acceleration sensor<br>■ Base board DS1401-23ff.<br>■ Range: ±2 g ... ±8 g in 3 axis (x/y/z)<br>■ Resolution: 10 bit per axis<br>■ Sample rate: max. 800 Hz<br>■ FIFO buffer: 512 words (to read and write bursts) |
| Communication interfaces | | ■ 1 x Host PC interface based on Ethernet TCP/IP protocol<br>■ 1 x Ethernet I/O interface based on Ethernet UDP/IP protocol for Ethernet bypassing scenarios<br>■ 2 x ECU interface based on LVDS standard<br>■ 1 x USB interface for USB flight recording (separate license) |
| I/O connectors | | ■ 2 x 156-pin ZIF I/O connector<br>  ■ Contact resistance: max. 15 mΩ<br>  ■ Durability: 10000 cycles<br>  ■ Continuous current per pin ($T_{ambient}$ = +85 °C): max. 2.5 A<br>■ 1 x 7-pin power supply input connector |
| FPGA (on DS1514 I/O Board) | | Xilinx® Kintex®-7 FPGA XC7K325T |

| Parameter | | Specification[1] |
|---|---|---|
| Chassis dimensions | Case width | 202 mm (7.95 in.) |
| | Case height | 96 mm (3.78 in.) |
| | Case depth | 222 mm (8.74 in.) |
| Weight | | About 3.2 kg (7.05 lb.) without external cables and modules |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

[2] For further information on the sensors, refer to *Onboard Sensors* (*MicroAutoBox Features*).

**Functional I/O units on the I/O boards**

The following table shows a mapping of the input/output units on the I/O boards which are part of the MicroAutoBox II:

| dSPACE I/O Board | Functional Unit |
|---|---|
| DS1511 | *ADC Unit Type 4* (*MicroAutoBox Features*) |
| | *DAC Unit Type 3* (*MicroAutoBox Features*) |
| | *Bit I/O Unit (DIO Type 3)* (*MicroAutoBox Features*) |
| DS1514 (with installed DS1552 Multi-I/O Module) | *ADC 1552 Type 1 Unit* (*MicroAutoBox Features*) |
| | *ADC 1552 Type 2 Unit* (*MicroAutoBox Features*) |
| | *DAC 1552 Type 1 Unit* (*MicroAutoBox Features*) |
| | *Bit I/O Unit (DIO 1552 Type 1)* (*MicroAutoBox Features*) |
| | Digital In (Type B) (refer to *Parameters Page (FPGA_IO_READ_BL)* (*RTI FPGA Programming Blockset - FPGA Interface Reference*))[1] |
| | Digital Out (Type B) (refer to *Parameters Page (FPGA_IO_WRITE_BL)* (*RTI FPGA Programming Blockset - FPGA Interface Reference*))[1] |
| | Digital Crank/Cam Inputs (refer to *Parameters Page (FPGA_IO_READ_BL)* (*RTI FPGA Programming Blockset - FPGA Interface Reference*)) [1] |
| | Inductive Zero Voltage Detector (refer to *Parameters Page (FPGA_IO_READ_BL)* (*RTI FPGA Programming Blockset - FPGA Interface Reference*)) [1] |

| dSPACE I/O Board | Functional Unit |
|---|---|
| DS1514 (with installed DS1554 Engine Control I/O Module) | Knock Sensor Input (refer to *Parameters Page (FPGA_IO_READ_BL)* (*RTI FPGA Programming Blockset - FPGA Interface Reference*)) [2] |
| | ADC (Type A) (refer to *Parameters Page (FPGA_IO_READ_BL)* (*RTI FPGA Programming Blockset - FPGA Interface Reference*)) [2] |
| | Digital Crank/Cam Inputs (refer to *Parameters Page (FPGA_IO_READ_BL)* (*RTI FPGA Programming Blockset - FPGA Interface Reference*)) [2] |
| | Inductive Zero Voltage Detector (refer to *Parameters Page (FPGA_IO_READ_BL)* (*RTI FPGA Programming Blockset - FPGA Interface Reference*)) [2] |
| | Digital In (Type B) (refer to *Parameters Page (FPGA_IO_READ_BL)* (*RTI FPGA Programming Blockset - FPGA Interface Reference*)) |
| | Digital Out (Type A) (refer to *Parameters Page (FPGA_IO_WRITE_BL)* (*RTI FPGA Programming Blockset - FPGA Interface Reference*)) [2] |
| | Digital Out (Type B) (refer to *Parameters Page (FPGA_IO_WRITE_BL)* (*RTI FPGA Programming Blockset - FPGA Interface Reference*)) [2] |

1) Only available via the RTI FPGA Programming Blockset (see *RTI Block Settings for the FPGA1401Tp1 with Multi-I/O Module Frameworks* (*RTI FPGA Programming Blockset - FPGA Interface Reference*)).

2) Only available via the RTI FPGA Programming Blockset (see *RTI Block Settings for the FPGA1401Tp1 with Engine Control I/O Module Framework* (*RTI FPGA Programming Blockset - FPGA Interface Reference*)).

# Absolute Maximum Levels

**Avoiding damage to the system**

**NOTICE**

Do not exceed the maximum levels since this might permanently damage the system.

**Levels**

The following table shows the levels (for example, voltage, temperature) of the MicroAutoBox. All voltages are referenced to GND (unless otherwise noted).

| Parameter | Specification[1] | Description |
|---|---|---|
| VBAT | –40 V ... +100 V | Load dump- and reverse protection |
| VDRIVE | 0 V ... +45 V | |
| All digital output voltages | (VDRIVE – 45 V) ... +45 V | |
| All digital input voltages | (VDRIVE – 45 V) ... +45 V | |
| All analog input voltages | –40 V ... +40 V | |
| All analog output voltages | –30 V ... +40 V | |
| VSENS output | 0 V ... +40 V | VSENS is switched on and off with the REMOTE pin. |
| VBATprot output | 0 V ... +45 V | VBATprot follows VBAT within the specified range.<br>VBATprot is switched on and off with the REMOTE pin. |
| RS232 transceiver output on the DS1511 ZIF I/O connector[2] | –30 V ... +30 V | |
| RS232 transceiver input on the DS1511 ZIF I/O connector[2] | –30 V ... +30 V | |
| $V_{CAN\ high}$, $V_{CAN\ low}$ on the DS1511 ZIF I/O connector[3] | –60 V ... +60 V | Voltage level on CAN high and CAN low pins. |
| $V_{Diff\ (CAN\ high\ -\ CAN\ low)}$ on the DS1511 ZIF I/O connector[3] | –3.5 V ... +3.5 V | Voltage difference between CAN high and CAN low pins (due to termination resistors). |
| Serial K / LIN | –20 V ... +32 V | but not more than VBAT |
| Serial L | –24 V ... +30 V | but not more than VBAT |
| All outputs short circuit to GND | continuous | |
| Continuous power dissipation ($T_{ambient}$ = +85 °C) | max. 50 W | |
| Operating temperature | –40 °C ... +85 °C [4] | |
| Storage temperature | –55 °C ... +125 °C | |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

[2] If the DS1552 Multi-I/O Module is installed, the DS1514 ZIF I/O connector also provides a serial interface. For absolute maximum levels, refer to *Absolute Maximum Levels* on page 584.

[3] If the DS4342 CAN FD Interface Module is installed, the DS1514 I/O connector also provides a CAN interface. For maximum absolute levels, refer to *Absolute Maximum Levels* on page 640.

[4] Mounted modules and a FPGA application with a high FPGA utilization or toggle rate increase the power dissipation. This might lead to a reset of the FPGA while the ambient temperature is less than 85 °C. For details, refer to *Parameters Page (FPGA_IO_READ_BL)* (*RTI FPGA Programming Blockset - FPGA Interface Reference*).

# Certifications

**CE compliance**

MicroAutoBox meets the requirements of the European directive 2014/30/EU (Electromagnetic Compatibility Directive) for CE marking.

**Applied standards**

The characteristics of MicroAutoBox were tested according to the standards shown in the following table:

| Tested Characteristics | Applied Standard | Description |
|---|---|---|
| Electromagnetic compatibility (EMC) | EN 61326-1 Table 2 | Immunity standard for industrial environments[1)] |
| | CISPR 11, EN 55011 Group 1, Class A | Emission standard for industrial environments |
| | RTCA/DO160G: Dec. 2010: Section 21.4 | Environmental conditions and test procedures for airborne equipment: Conducted RF Emissions, Category: B, L, M&H[2)] |
| | RTCA/DO160G: Dec. 2010: Section 21.5 | Environmental conditions and test procedures for airborne equipment: Radiated RF Emissions, Category: M[2)] |
| Vibration | ISO 16750-3:2007 / 4.1.2.4 Test IV | Test conditions: Broad band noise, 4h per axis, RMS-acceleration 27,8 $m/s^2$ |
| | DO-160F.8 / B1 Test Conditions | Test conditions: Broad band noise, 2h per axis, based on DO160F Section 8, Category B1 |
| | EN 60068-2-6 | Test conditions:<br>■ Swept sine, 1 octave per minute, 3-axis test<br>■ 5 ... 2000 Hz, up to 5 g, 2 sweeps per axis<br>■ Operating |

| Tested Characteristics | Applied Standard | Description |
|---|---|---|
| Shock | ISO 16750-3:2007 / 4.2.2. | ■ Linear shock (1/2 sine pulse), 6-axis<br>■ 500 m/s$^2$, 6 ms, 10 pulses per axis<br>■ Operating |
| | RTCA / DO-160F<br>Section 7 Test 7.2<br>Category A<br>Test type R | Operational shocks test (standard):<br>■ Saw-tooth wave, 6-axis<br>■ 200 m/s$^2$, 11 ms, 10 pulses per axis<br>■ Operating |
| | RTCA / DO-160F<br>Section 7 Test 7.2<br>Category D<br>Test type R | Operational shocks test (low frequency):<br>■ Saw-tooth wave, 6-axis<br>■ 200 m/s$^2$, 20 ms, 10 pulses per axis<br>■ Operating |

1) Tested with an I/O cable length < 3 m.
2) For further information, refer to dSPACE Support.

**Vibration and shock tests**

To verify the reliability of MicroAutoBox under realistic operating conditions, it was exposed to vibration and shock tests. During the tests, MicroAutoBox executed a program without any failures.

# Connector Pinouts

**Where to go from here**

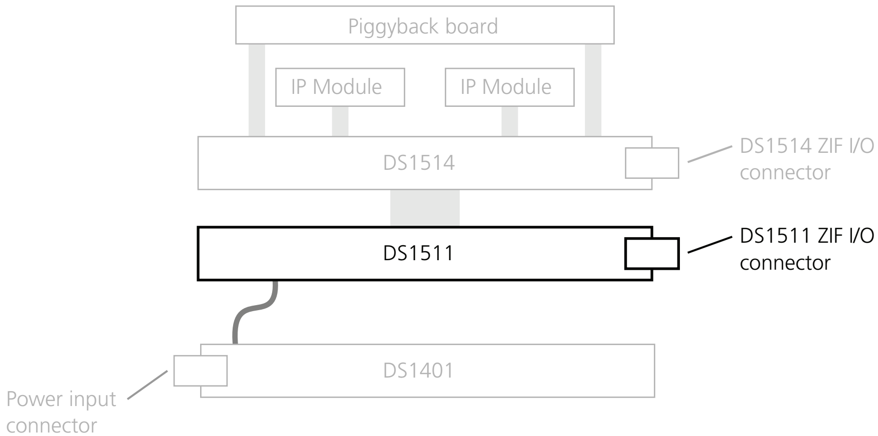
Information in this section



## DS1511 ZIF I/O Connector

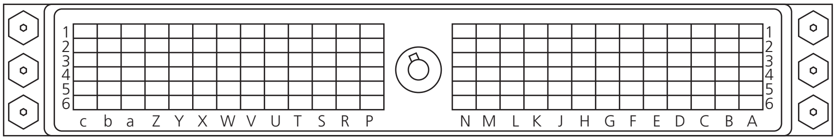
**Objective**

The DS1511 I/O connector is a 156-pin zero insertion force (ZIF) connector giving access to the input and output signals provided by DS1511 I/O Board. The illustration below shows the internal assembly of the MicroAutoBox II 1401/1511/1514.



**Pinout**

The following illustration shows the pin numbering of the I/O connector (front view of MicroAutoBox):




> **Note**
>
> There are pins identified by uppercase letters (A, B, C, etc.) and pins identified by lowercase letters (a, b, c).

The following table shows the signals of the I/O connector:

| 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GND | in | CAN 4 high | i/o | CAN 4 low | i/o | GND | in | Serial 4 K / LIN[1] | i/o | Serial 4 L[1] | in | *A* |
| GND | in | CAN 3 high | i/o | CAN 3 low | i/o | GND | in | Serial 3TXD[1] | out | Serial 3 RXD[1] | in | *B* |
| GND | in | GND | in | GND | in | GND | in | GND | in | GND | in | *C* |
| GND | in | DigP 1 ch 8[2] | out | DigP 1 ch 16 | out | DigP 2 ch 8[2] | out | DigP 2 ch 16 | out | DigP 3 ch 8 | out | *D* |
| GND | in | DigP 1 ch 7 | out | DigP 1 ch 15 | out | DigP 2 ch 7 | out | DigP 2 ch 15 | out | DigP 3 ch 7 | out | *E* |
| GND | in | DigP 1 ch 6 | out | DigP 1 ch 14 | out | DigP 2 ch 6 | out | DigP 2 ch 14 | out | DigP 3 ch 6 | out | *F* |
| GND | in | DigP 1 ch 5 | out | DigP 1 ch 13 | out | DigP 2 ch 5 | out | DigP 2 ch 13 | out | DigP 3 ch 5 | out | *G* |
| GND | in | DigP 1 ch 4 | out | DigP 1 ch 12 | out | DigP 2 ch 4 | out | DigP 2 ch 12 | out | DigP 3 ch 4 | out | *H* |
| GND | in | DigP 1 ch 3 | out | DigP 1 ch 11 | out | DigP 2 ch 3 | out | DigP 2 ch 11 | out | DigP 3 ch 3 | out | *J* |
| GND | in | DigP 1 ch 2 | out | DigP 1 ch 10 | out | DigP 2 ch 2 | out | DigP 2 ch 10 | out | DigP 3 ch 2 | out | *K* |
| GND | in | DigP 1 ch 1 | out | DigP 1 ch 9 | out | DigP 2 ch 1 | out | DigP 2 ch 9 | out | DigP 3 ch 1 | out | *L* |
| VSENS | out | DigP 1 ch 8[2] | in | DigP 1 ch 16 | in | DigP 2 ch 8[2] | in | DigP 2 ch 16 | in | DigP 3 ch 8 | in | *M* |
| VDRIVE | in | DigP 1 ch 7 | in | DigP 1 ch 15 | in | DigP 2 ch 7 | in | DigP 2 ch 15 | in | DigP 3 ch 7 | in | *N* |
| | | | | | | | | | | | | |
| VBAT prot | out | DigP 1 ch 6 | in | DigP 1 ch 14 | in | DigP 2 ch 6 | in | DigP 2 ch 14 | in | DigP 3 ch 6 | in | *P* |
| REMOTE | in | DigP 1 ch 5 | in | DigP 1 ch 13 | in | DigP 2 ch 5 | in | DigP 2 ch 13 | in | DigP 3 ch 5 | in | *R* |
| GND | in | DigP 1 ch 4 | in | DigP 1 ch 12 | in | DigP 2 ch 4 | in | DigP 2 ch 12 | in | DigP 3 ch 4 | in | *S* |
| GND | in | DigP 1 ch 3 | in | DigP 1 ch 11 | in | DigP 2 ch 3 | in | DigP 2 ch 11 | in | DigP 3 ch 3 | in | *T* |
| GND | in | DigP 1 ch 2 | in | DigP 1 ch 10 | in | DigP 2 ch 2 | in | DigP 2 ch 10 | in | DigP 3 ch 2 | in | *U* |
| GND | in | DigP 1 ch 1 | in | DigP 1 ch 9 | in | DigP 2 ch 1 | in | DigP 2 ch 9 | in | DigP 3 ch 1 | in | *V* |
| GND | in | Analog ch 4 | out | Analog ch 4 | in | Analog ch 8 | in | Analog ch 12 | in | Analog ch 16 | in | *W* |
| GND | in | Analog ch 3 | out | Analog ch 3 | in | Analog ch 7 | in | Analog ch 11 | in | Analog ch 15 | in | *X* |
| GND | in | Analog ch 2 | out | Analog ch 2 | in | Analog ch 6 | in | Analog ch 10 | in | Analog ch 14 | in | *Y* |
| GND | in | Analog ch 1 | out | Analog ch 1 | in | Analog ch 5 | in | Analog ch 9 | in | Analog ch 13 | in | *Z* |
| GND | in | SGND | in | Ana trigger 1 | in | Ana trigger 2 | in | Ana trigger 3 | in | Ana trigger 4 | in | *a* |

| 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GND | in | CAN 2 high | i/o | CAN 2 low | i/o | GND | in | Serial 2 K / LIN[1)] | i/o | Serial 2 L[1)] | in | *b* |
| GND | in | CAN 1 high | i/o | CAN 1 low | i/o | GND | in | Serial 1 TXD[1)] | out | Serial 1 RXD[1)] | in | c |

[1)] For a mapping of converter and channel numbers, as used in RTI and RTLib, refer to *Basics on Serial Interface* (📖 *MicroAutoBox Features*).

[2)] DigP = Port number; ch = Channel number

**Tip**

To use the digital inputs and outputs, you have to connect the VDRIVE pin inside the ZIF I/O connector according to the logic level needed. *This pin is not preconfigured in the ZIF I/O connector delivered with each MicroAutoBox II.* You have to connect VDRIVE (pin N1) to VSENS (pin M1) or VBATprot (pin P1). Use the preconfigured jumper cable which is included in the MicroAutoBox package.

**Signal descriptions**

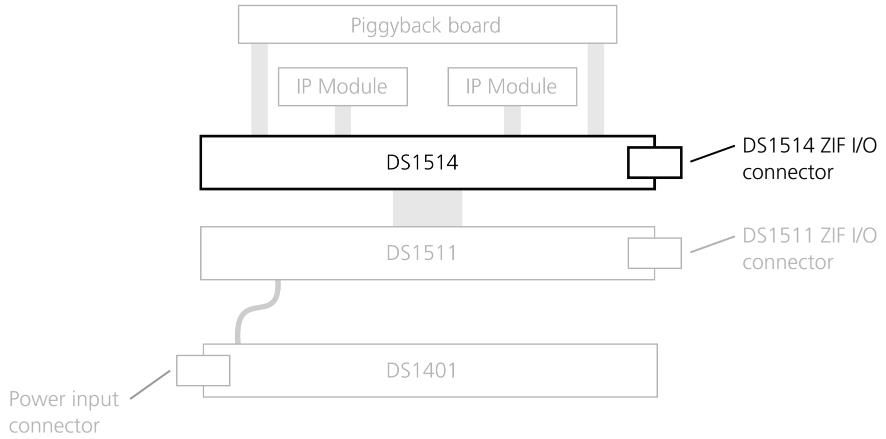
For descriptions of the signals which are available on the DS1511 ZIF I/O connector, refer to:

- *Digital Inputs* on page 443
- *Digital Outputs* on page 446
- *Analog Inputs* on page 451
- *Analog Outputs* on page 454
- CAN, LIN, serial: *Interfaces* on page 456

# DS1514 ZIF I/O Connector

**Objective**

The DS1514 I/O connector is a 156-pin zero insertion force (ZIF) connector giving access to various I/O signals if an IP module and/or an I/O module are/is installed. The following illustration shows the internal assembly of the MicroAutoBox II 1401/1511/1514 with IP modules and an I/O module installed.




**Pinout**

The DS1514 ZIF I/O connector provides only signals of the installed I/O module and IP modules.

For pinouts of the DS1514 ZIF I/O connector, refer to the following topics:

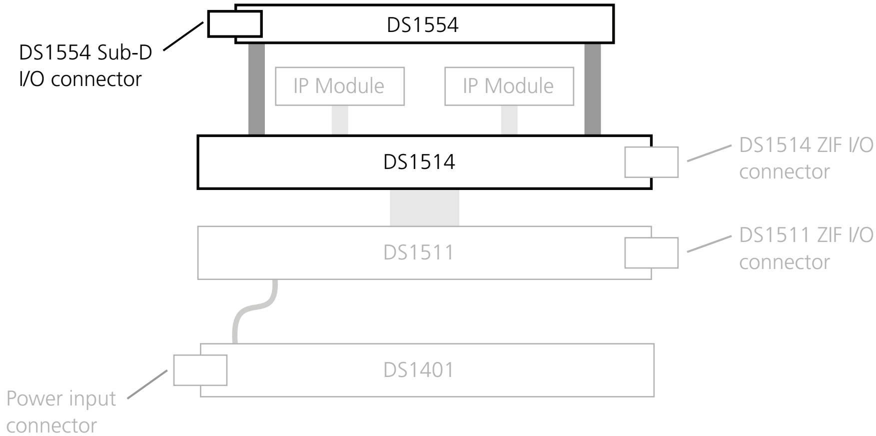
- DS1552 Multi-I/O Module: *DS1512 and DS1514 ZIF I/O Connectors* on page 585
- DS1554 Engine Control I/O Module: *DS1514 ZIF I/O Connector* on page 611
- DS4340 FlexRay Interface Module: *DS1512 and DS1514 ZIF I/O Connectors* on page 634
- DS4342 CAN FD Interface Module: *DS1512 and DS1514 ZIF I/O Connectors* on page 642

# DS1554 Sub-D I/O Connector

**Objective**

The DS1554 Engine Control I/O Module provides a 37-pin, male Sub-D connector at the front of MicroAutoBox.

The illustration below shows the internal assembly of a MicroAutoBox II 1401/1511/1514 with a DS1554 Engine Control I/O Module installed.



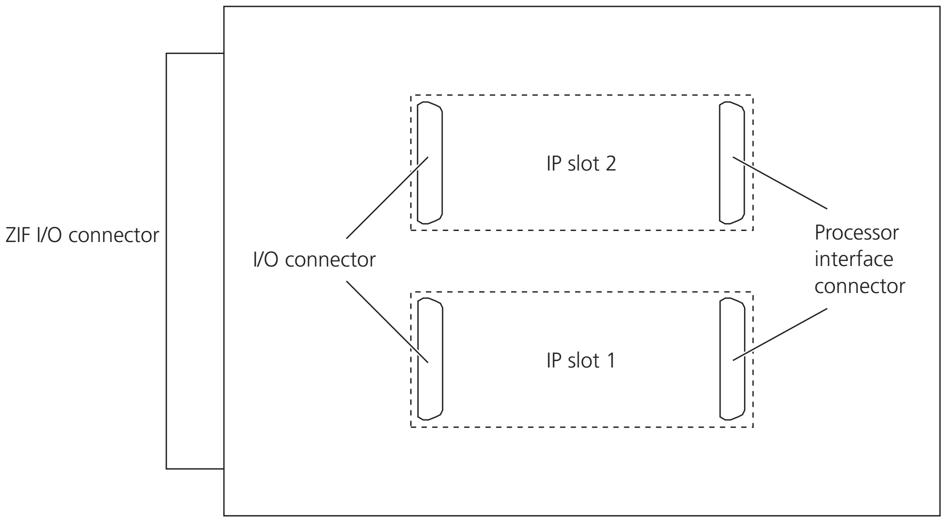

**Pinout**

The DS1554 Sub-D I/O connector only provides signals of the installed DS1554 Engine Control I/O Module. For the pinout, refer to *DS1554 Sub-D I/O Connector* on page 613.

# IP Module Connectors

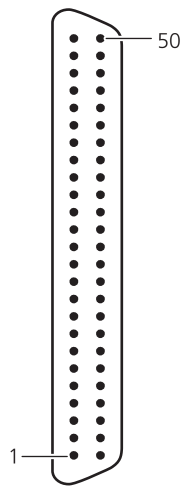
**Objective**

The DS1514 provides two slots to install IP modules. Each slot provides two AMP connectors: I/O connector and processor interface connector. The following illustration shows the top view of MicroAutoBox.

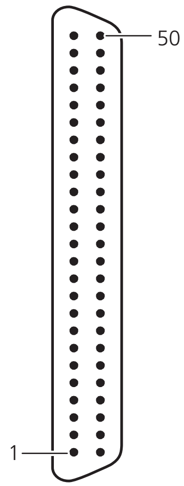

ZIF I/O connector
IP slot 2
I/O connector
Processor
interface
connector
IP slot 1

**Pinout**

**I/O connector - IP module slot 1** The following table shows the signal mapping of the IP module I/O connector on slot 1 to the DS1514 ZIF I/O connector (rear of MicroAutoBox):

| IP Module I/O Connector | Pin | ZIF Pin for IP Slot 1 | | Pin | ZIF Pin for IP Slot 1 |
|---|---|---|---|---|---|
|   | 25 | - | | 50 | M3 |
| | 24 | - | | 49 | M4 |
| | 23 | - | | 48 | L3 |
| | 22 | - | | 47 | - |
| | 21 | - | | 46 | K3 |
| | 20 | K5 | | 45 | K4 |
| | 19 | K6 | | 44 | J3 |
| | 18 | J5 | | 43 | - |
| | 17 | J6 | | 42 | - |
| | 16 | H5 | | 41 | - |
| | 15 | H6 | | 40 | - |
| | 14 | G5 | | 39 | - |
| | 13 | - | | 38 | - |
| | 12 | - | | 37 | - |
| | 11 | - | | 36 | - |
| | 10 | - | | 35 | - |
| | 9 | - | | 34 | - |
| | 8 | - | | 33 | - |
| | 7 | - | | 32 | - |
| | 6 | - | | 31 | - |
| | 5 | C6 | | 30 | - |
| | 4 | - | | 29 | - |
| | 3 | - | | 28 | - |
| | 2 | - | | 27 | - |
| | 1 | - | | 26 | - |

**I/O connector - IP module slot 2** The following table shows the signal mapping of the IP module I/O connector on slot 2 to the DS1514 ZIF I/O connector (rear of MicroAutoBox):

| IP Module I/O Connector | Pin | ZIF Pin for IP Slot 2 | | Pin | ZIF Pin for IP Slot 2 |
|---|---|---|---|---|---|
|  | 25 | - | | 50 | b3 |
| | 24 | - | | 49 | b4 |
| | 23 | - | | 48 | a3 |
| | 22 | - | | 47 | - |
| | 21 | - | | 46 | Z3 |
| | 20 | Z5 | | 45 | Z4 |
| | 19 | Z6 | | 44 | Y3 |
| | 18 | Y5 | | 43 | - |
| | 17 | Y6 | | 42 | - |
| | 16 | X5 | | 41 | - |
| | 15 | X6 | | 40 | - |
| | 14 | W5 | | 39 | - |
| | 13 | - | | 38 | - |
| | 12 | - | | 37 | - |
| | 11 | - | | 36 | - |
| | 10 | - | | 35 | - |
| | 9 | - | | 34 | - |
| | 8 | - | | 33 | - |
| | 7 | - | | 32 | - |
| | 6 | - | | 31 | - |
| | 5 | S6 | | 30 | - |
| | 4 | - | | 29 | - |
| | 3 | - | | 28 | - |
| | 2 | - | | 27 | - |
| | 1 | - | | 26 | - |

**Processor interface connector - slot 1 and slot 2** The pinout of the processor interface connector (slot 1 and slot 2) complies with IP Modules Draft Standard VITA 4-1995. For further information, refer to the documentation of the standard.

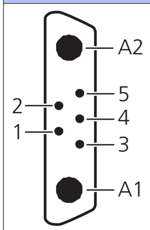
# Power Input Connector

**Objective**

MicroAutoBox provides a power input connector. It is a 7-pin, male connector with two high-current pins. It is a special variant of a 15-pin Sub-D connector (mixed-layout 7W2 Sub-D).

**Pinout**

The following illustration shows the pinout (front view of MicroAutoBox).

| Connector | Pin | Signal | Pin | Signal |
|---|---|---|---|---|
|  | A2[1] | VBAT (6 V … 40 V DC) | | |
| | | | 5 | REMOTE_PULLUP |
| | 2 | Do not connect | 4 | REMOTE[2] |
| | 1 | Do not connect | 3 | Do not connect |
| | A1 | GND | | |

[1] NOTE: It is highly recommended to insert a fuse into the main power supply input wire (close to battery). Choose the value of the fuse according to the maximum current. A 10 A fuse is recommended.

[2] The REMOTE input must be connected via switch or bridge to UBAT to run the MicroAutoBox. For example, you can use it for switching MicroAutoBox with KL15 (output of the ignition/driving switch). So, you can use the nonvolatile data feature to store data you may want to use again when restarting the application. For further information, refer to *Nonvolatile Data Handling* (📖 *MicroAutoBox RTLib Reference*).

**Matching cable**

A preconfigured cable for the supply voltage is provided by dSPACE. This cable is for running MicroAutoBox with a laboratory power supply during development. Therefore, REMOTE (pin 4) is shorted to VBAT (pin A2) inside the connector in order to save a separate switch. Do not use this cable in the vehicle. Otherwise, MicroAutoBox will always be turned on.

The VBAT wire (red) contains a melting fuse. Each wire has a cross-section of 1.5 mm².

Fuse specification:

- Cable delivered through dSPACE Release 2013-B: 7.5 A, time lag
- Cable delivered as of dSPACE Release 2014-A: 10 A, time lag

# Signal Descriptions

**Where to go from here**

Information in this section



## Power Inputs and Outputs

**Pin description**

The following table gives a description of the pins used for power input, remote input and supply of digital I/O circuits.

**Power input connector** The following table lists the pin description of the power input connector on the front:

| Pins | Signal | Description / Function |
|---|---|---|
| A2 | VBAT | Main power supply input. Connect this pin to the positive pole of your car battery. |
| A1 | GND | Main power supply return and reference for all input and output signals. Connect this pin to the minus pole of your car battery. The case of MicroAutoBox is also connected to GND. |
| 4 | REMOTE | ■ The REMOTE input may be used for starting MicroAutoBox with a remote switch, for example KL15 (output of the ignition/driving switch).<br>■ If you connect the remote pin to the plus pole of the car battery directly, MicroAutoBox will always be turned on, and the car battery will soon be exhausted if the engine is not running. Thus, a switch is highly recommended.<br>■ The voltage connected to the REMOTE pin should not exceed the supply voltage. |
| 5 | REMOTE_Pullup | You can use this output to connect a remote switch between REMOTE and this pin. REMOTE_Pullup is internally connected to VBAT via 39 kΩ pull-up resistor. |

**DS1511 ZIF I/O connector** The following table lists the pin description of the DS1511 I/O Boards ZIF I/O connector on the rear:

| Pins | Signal | Description / Function |
|---|---|---|
| A1, A4, B1, B4, C1 ... C6, D1, E1, F1, G1, H1, J1, K1, L1, S1, T1, U1, V1, W1, X1, Y1, Z1, a1, b1, b4, c1, c4 | GND | Main power supply return and reference for all input and output signals. Use the nearest possible GND pin as reference for your signals in order to keep noise levels at minimum. The case of MicroAutoBox is also connected to GND. |
| a2 | SGND | Connected to GND internally.<br>Use the SGND signal pin as reference for ADC- and DAC-channels of the DS1511 I/O Board to get the optimum analog performance. |
| N1 | VDRIVE | This input supplies all digital input and output circuits located on the DS1511 I/O Board.<br>■ Connect this input to VSENS to set CMOS/TTL-compatible logic levels for your inputs/outputs.<br>■ Connect this input to VBATprot to set automotive-compatible logic levels for your inputs/outputs.<br>■ Do not connect this pin directly to VBAT, because the input and output circuits are not load-dump-protected or reverse-voltage-protected at this signal. |
| M1 | VSENS | Sensor supply output.<br>Use this output to supply your sensors and/or VDRIVE. If you need CMOS/TTL-compatible logic levels at the inputs/outputs connect VSENS to VDRIVE. |
| P1 | VBAT prot | Protected VBAT output.<br>Use this output to supply VDRIVE when automotive logic levels are needed. |
| R1 | REMOTE | ■ The remote voltage may be used for starting MicroAutoBox with a remote switch: KL15, for example (output of the ignition/driving switch).<br>■ If you connect the remote pin to the car battery directly, MicroAutoBox will always be turned on, and the car battery will soon be exhausted if the engine is not running. Thus, a switch is highly recommended.<br>■ The remote voltage should not exceed the supply voltage. |

**DS1514 ZIF I/O connector** For the pin description of the DS1514 I/O board's ZIF I/O connector if the DS1552 Multi-I/O Module is installed, refer to *Power Inputs and Outputs* on page 588.

**Tip**

To use the digital inputs and outputs, you have to connect the VDRIVE pin inside the ZIF I/O connector according to the logic level needed. *This pin is not preconfigured in the ZIF I/O connector delivered with each MicroAutoBox II.* You have to connect VDRIVE to VBATprot or VSENS+. If you use VSENS+, you have to connect VSENS- to ground.

**Characteristics**

The characteristics are specified for the following conditions:

- $V_{BAT}$=+12 V (unless otherwise noted)

  $T_{CASE}$=+25 °C (unless otherwise noted)

  All voltages are referenced to GND (unless otherwise noted).

| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Power** | | | | | | |
| Operating voltage | VBAT | For start-up with an input power consumption < 35 W | 6 | | 40 | V |
| | VBAT | Operating | 4.5 | | 40 | V |
| | VBAT | Reverse protection | | | -40 | V |
| | VBAT | Load dump protection | | | +100 | V |
| **Inputs** | | | | | | |
| Operating current | $I_{VBAT}$ | REMOTE ≥ $V_{iHRemote}$ | | 2 | | A |
| | $I_{VBAT}$ | REMOTE ≤ $V_{iLRemote}$ | | 5 | | mA |
| REMOTE voltage input | $V_{iHRemote}$ | Input high voltage | 4.7 | | | V |
| | $V_{iLRemote}$ | Input low voltage | | | 0.8 | V |
| | $V_{iHysRemote}$ | Input hysteresis voltage | 0.5 | 1 | | V |
| | $R_{inRemote}$ | Input impedance | 60 | | 185 | kΩ |
| Inrush current | $I_{VBAT\ inrush}$ | All inputs/outputs unconnected | see *Power supply* on page 40 | | | |
| Digital I/O voltage supply input on DS1511 ZIF I/O connector | VDRIVE | Supply for digital input/output circuits | | | 45 | V |
| | $I_{VDRIVE\ no\ load}$ | All inputs/outputs unconnected | | 20 | | mA |
| | $I_{VDRIVE\ maximum\ load}$ | All outputs shorted to GND | | 1 | | A |
| Digital I/O voltage supply input on DS1514 ZIF I/O connector | VDRIVE | Supply for digital input/output circuits | | | 45 | V |
| | $I_{VDRIVE\ no\ load}$ | All inputs/outputs unconnected | | 10 | | mA |
| | $I_{VDRIVE\ maximum\ load}$ | All outputs shorted to GND | | 500 | | mA |
| **Outputs** | | | | | | |
| Sensor supply output on DS1511 ZIF I/O connector | VSENS | Output voltage | 4.84 | 5.05 | 5.25 | V |
| | VSENS = f(T) | Temperature caused voltage drift $T_{CASE}$ = –40 °C ... +85 °C | –2 | | 2 | % |
| | $I_{VSENS,\ max}$ | Maximum output current | 750 | | | mA |

| Signal[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Sensor supply output of DS1552 Multi-I/O Module on DS1514 ZIF I/O connector | VSENS+ | Output voltage, isolated and adjustable, controlled by a DAC (relative to VSENS-) | 2 | | 20 | V |
| | $P_{VSENS,\ max}$ | Maximum output power (if VSENS+ is in range 5...20V and VSENS- is connected to GND) | | 1 | | W |
| Sensor supply output of DS1554 Engine Control I/O Module on DS1514 ZIF I/O connector | VSENS+ | Fixed and isolated output voltage relative to VSENS- | 4.75 | 5 | 5.25 | V |
| | $P_{VSENS,\ max}$ | Maximum output power | | 2 | | W |
| Protected VBAT output | VBATprot | IL = 1A; VBAT = 12 V | 11.56 | 11.78 | 12 | V |
| | $I_{VBATprot,\ max}$ | Maximum output current | | | 1000 | mA |
| | $I_{ProtPeak}$ | Overload current limit (–40 °C ... 85 °C) | 4 | | 9 | A |
| | t(overload) | Time to shut off $I_{ProtPeak}$ | | | 5 | ms |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

# Digital Inputs

**Note on the cable harness**

**Note**

To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the DS1511 ZIF I/O connector and the DS1514 ZIF I/O connector. For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**Pin description**

The following table gives a description of the digital input pins of the DS1511 ZIF I/O connector:

| Pins | Port Number | Signal | Description / Function |
|---|---|---|---|
| V2, U2, T2, S2, R2, P2, N2, M2, V3, U3, T3, S3, R3, P3, N3, M3 | 1 | Channel 1 ... 16<br>DIO Type 3 | Standard discrete digital input with pull-up. |
| V4, U4, T4, S4, R4, P4, N4, M4, V5, U5, T5, S5, R5, P5, N5, M5 | 2 | Channel 1 ... 16<br>DIO Type 3 | |
| V6, U6, T6, S6, R6, P6, N6, M6 | 3 | Channel 1 ... 8<br>DIO Type 3 | |

**Characteristics**

The characteristics are specified for the following conditions:

- $V_{BAT}$=+12 V (unless otherwise noted)

  $T_{CASE}$=+25 °C (unless otherwise noted)

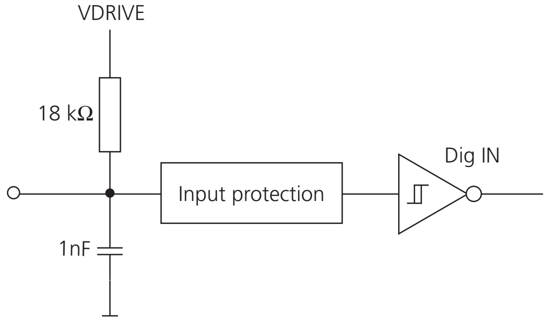
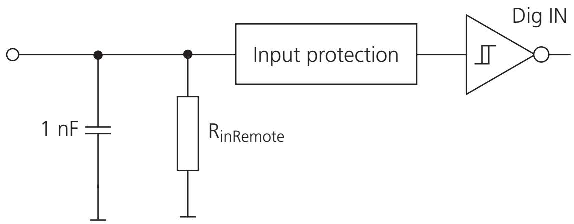
  All voltages are referenced to GND (unless otherwise noted).

| Signal[1)] | | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| **DC characteristics** | | | | | | | |
| Digital input channel 1 ... 40<br>DIO Type 3 | | $V_{iH}$ | Input high voltage | 3.1 | | | V |
| | | $V_{iL}$ | Input low voltage | | | 1.2 | V |
| | | $V_{iHys}$ | Input hysteresis voltage | | 1 | | V |
| | | $R_{DigIn}$ | Pull-up resistor to VDRIVE | 17 | 18 | 19 | kΩ |
| | | $C_{DigIn}$ | Input capacitance | | 1 | | nF |
| DIO Type 3 | REMOTE | $V_{iHRemote}$ | Input high voltage | 4.7 | | | V |
| | | $V_{iLRemote}$ | Input low voltage | | | 0.8 | V |
| | | $V_{iHysRemote}$ | Input hysteresis voltage | 0.5 | 1 | | V |
| | | $R_{inRemote}$ | Input impedance | 60 | | 185 | kΩ |
| **AC characteristics** | | | | | | | |
| DIO Type 3 | Inputs | $t_{LowMin}$ | Minimum pulse width low | | 250 | 500 | ns |
| | | $t_{HighMin}$ | Minimum pulse width high | | 300 | 600 | ns |
| | | $F_{max}$ | Duty cycle: 50 % | | 1.8 | | MHz |
| | | | Duty cycle: 1 % or 99 % | | 33 | | kHz |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagrams**

The following table shows *simplified* diagrams of the I/O circuitry of the digital inputs:

| Signal | | I/O Circuit |
|---|---|---|
| DIO Type 3 | Channel 1 ... 40 |   For proper operation, VDRIVE must have a level above the maximum input voltage. |
| | Remote |   |

**Digital inputs on the DS1514 ZIF I/O connector**

Only I/O modules can provide digital inputs on the DS1514 ZIF I/O connector. For signal descriptions of the DS1552 Multi-I/O Module, refer to *Digital Inputs* on page 590.

**Related topics**

Basics

- *Bit I/O Unit (DIO Type 3)* (📖 *MicroAutoBox Features*)

# Digital Outputs

**Note on the cable harness**

**Note**

To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the DS1511 ZIF I/O connector and the DS1514 ZIF I/O connector. For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**General behavior of digital signals**

All digital outputs are set to high impedance (tristate) until the application is started. Then the outputs follow the states defined in your application. Unused outputs remain in tristate mode.

**Pin description**

The following table gives a description of the digital output pins on the DS1511 ZIF I/O connector:

| Pins | Port Number | Signal | Default state | Description / Function |
|---|---|---|---|---|
| L2, K2, J2, H2, G2, F2, E2, D2, L3, K3, J3, H3, G3, F3, E3, D3 | 1 | Channel 1 ... 16 DIO Type 3 | Tristate | Standard discrete digital output. |
| L4, K4, J4, H4, G4, F4, E4, D4, L5, K5, J5, H5, G5, F5, E5, D5 | 2 | Channel 1 ... 16 DIO Type 3 | | |
| L6, K6, J6, H6, G6, F6, E6, D6 | 3 | Channel 1 ... 8 DIO Type 3 | | |

**Characteristics**

The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25 °C; all voltages are referenced to GND, unless otherwise noted.

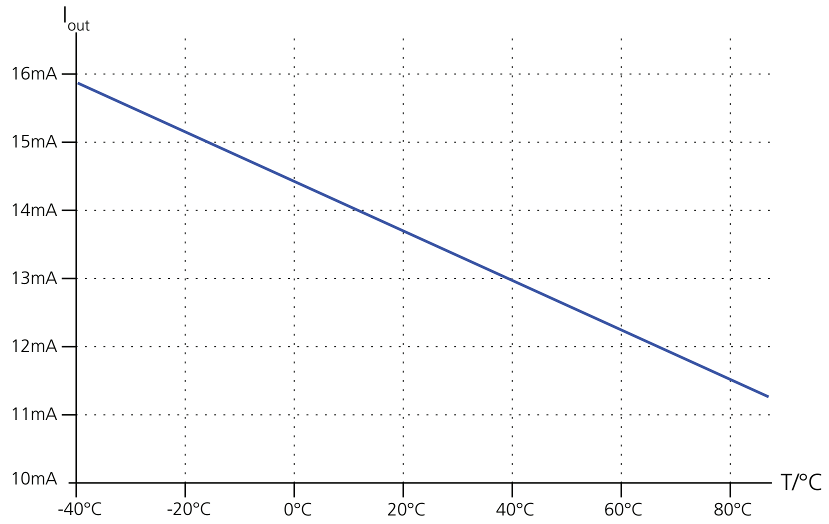
| Signal[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC Characteristics** | | | | | | |
| Digital output channel 1 ... 40<br>DIO Type 3 | $V_{oH}$ | IL = 0 mA; VDRIVE = 5 V | 4.4 | 4.6 | | V |
| | $V_{oL}$ | IL = 0 mA; VDRIVE = 5 V | | 0.1 | 0.3 | V |
| | $V_{oH}$ | IL = 5 mA; VDRIVE = 5 V | 3.2 | 3.4 | | V |
| | $V_{oL}$ | IL = –5 mA; VDRIVE = 5 V | | 0.7 | 0.9 | V |
| | $V_{oH}$ | IL = 0 mA; VDRIVE = 12 V | 11.3 | 11.6 | | V |
| | $V_{oL}$ | IL = 0 mA; VDRIVE = 12 V | | 0.1 | 0.3 | V |
| | $V_{oH}$ | IL = 5 mA; VDRIVE = 12 V | 10.3 | 10.5 | | V |
| | $V_{oL}$ | IL = –5 mA; VDRIVE = 12 V | | 0.7 | 0.9 | V |
| | $\lvert I_{OHmax} \rvert$ | Current limit high<br>$T_{CASE}$ = –40 °C ... +85 °C | 5 | 13 | 17 | mA |
| | $\lvert I_{OLmax} \rvert$ | Current limit low<br>$T_{CASE}$ = –40 °C ... +85 °C | 5 | 14 | 18 | mA |
| | $\lvert I_{OTLeak} \rvert$ | Leakage current tristate<br>$T_{CASE}$ = -40 °C ... +85 °C | | | 100 | µA |
| **AC Characteristics** | | | | | | |
| DIO Type 3 Outputs | $t_{minPulseHigh}$ | Minimum pulse width high,<br>VDRIVE = 5 V or 12 V, RL=1 kΩ | | 700 | 1400 | ns |
| | $t_{minPulseLow}$ | Minimum pulse width low,<br>VDRIVE = 5 V or 12 V, RL=1 kΩ | | 200 | 400 | ns |
| | $F_{max}$ | Duty cycle: 50 %<br>VDRIVE = 5 V or 12 V | | 0.7 [2] | | MHz |
| | | Duty cycle: 1 % or 99 %<br>VDRIVE = 5 V or 12 V | | 14 | | kHz |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

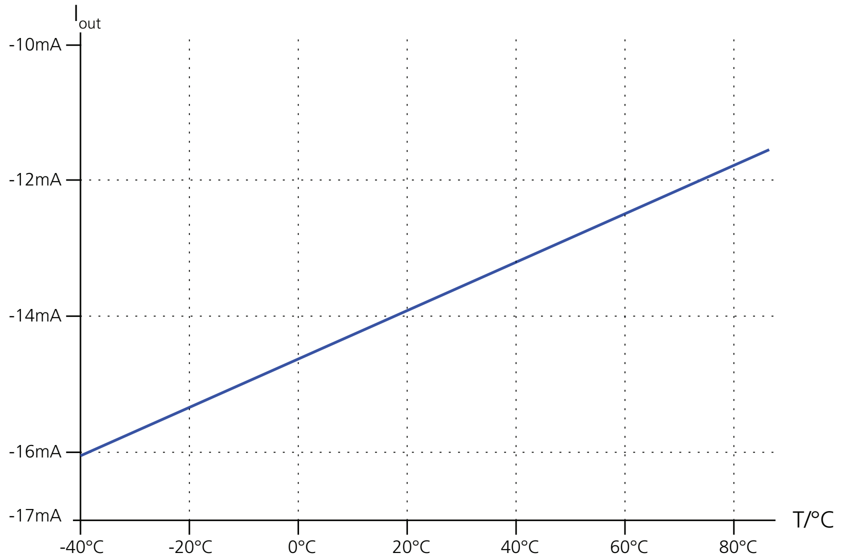
[2] Limited by software to 150 kHz

The following illustrations are valid for DIO Type 3 and DIO 1552 Type 1, and show the maximum output current of a digital output circuit as a function of ambient temperature (VDRIVE = 12 V; output is shorted to 6 V):

- Output high

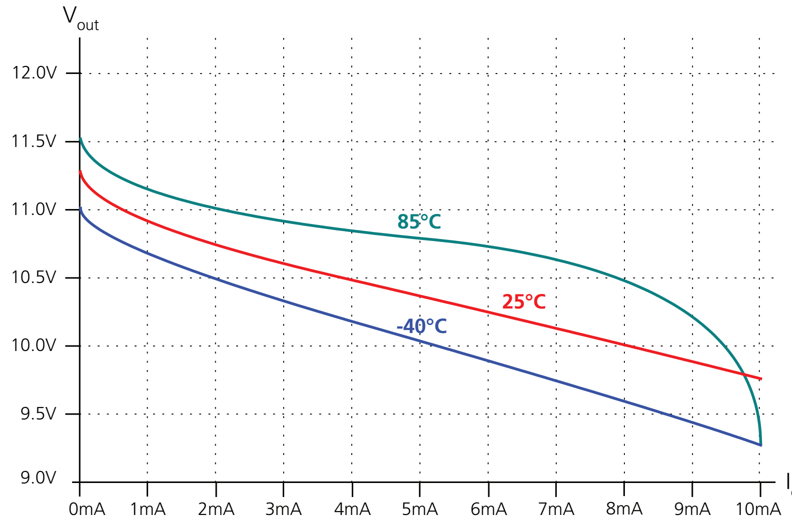



- Output low

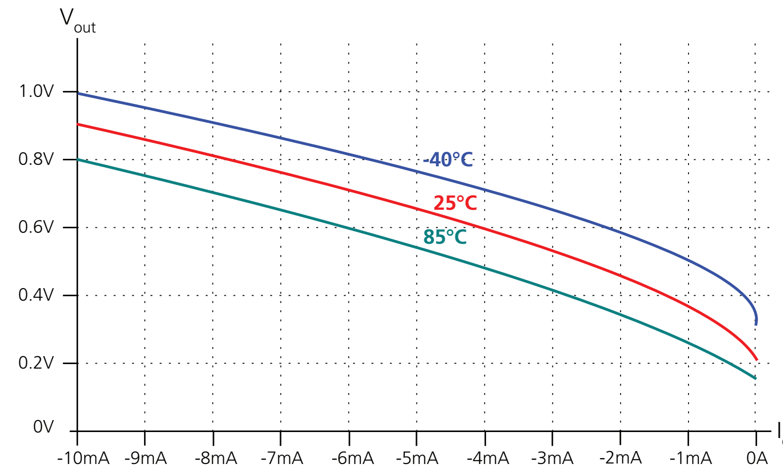


The following illustrations show the typical digital output voltage as a function of the output current (VDRIVE = 12 V):

- Output high

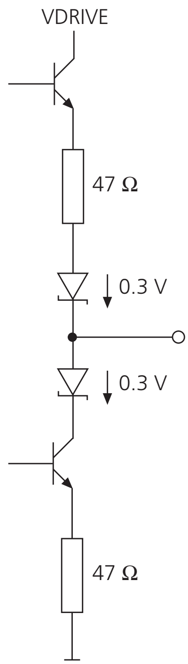



- Output low



**Circuit diagrams**

The following table shows a *simplified* diagram of the I/O circuitry of the digital outputs:

| Signal | I/O Circuit |
|---|---|
| Digital outputs: DIO Type 3 |   |

**Digital outputs on the DS1514 ZIF I/O connector**

Only I/O modules provide digital outputs on the DS1514 ZIF I/O connector.

For signal descriptions, refer to the following topics:

- If you use a DS1552 Multi-I/O Module, refer to *Digital Outputs* on page 592.
- If you use a DS1554 Engine Control I/O Module, refer to *Digital Outputs* on page 618.

**Related topics**

Basics

- *Bit I/O Unit (DIO Type 3)* (📖 *MicroAutoBox Features*)

## Digital I/O (Bidirectional)

**Objective**

The information on the digital bidirectional I/O channels is relevant only if the DS1514 I/O Board is equipped with an I/O module.

For information on the digital bidirectional I/O channels, refer to the following topics:

- If you use a DS1552 Multi-I/O Module, refer to *Digital I/O (Bidirectional)* on page 595.
- If you use a DS1554 Engine Control I/O Module, refer to *Digital I/O (Bidirectional)* on page 622.

## Analog Inputs

**Note on the cable harness**

**Note**

To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the two ZIF I/O connectors (DS1511 and DS1514). For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**Pin description**

The following table gives a description of the analog input pins on the DS1511 ZIF I/O connector:

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| Z3, Y3, X3, W3, Z4, Y4, X4, W4, Z5, Y5, X5, W5, Z6, Y6, X6, W6 | ADC channel 1 ... 16 | ADC Type 4 | Analog inputs:<br>■ DS1511: 0 V ... 5 V<br>■ DS1511B1: -10 V ... +10 V |
| a3, a4, a5, a6 | External trigger 1 ... 4 | | For information on function of the ADC Type 4 module's trigger signals, refer to *Trigger signals* (📖 *MicroAutoBox Features*). |

**Characteristics**

The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25 °C; all voltages are referenced to SGND pin a2, unless otherwise noted.

**ADC Type 4 module** The following table shows the characteristics of the ADC Type 4 module of the DS1511 I/O Board.

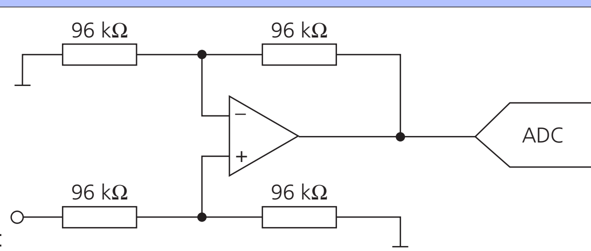
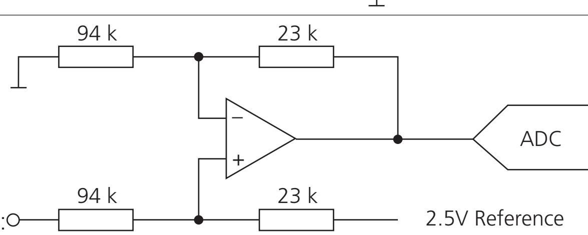
| Signal[1] | Parameter | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **General characteristics** | | | | | | |
| ADC (all 16 channels) | Number of independent input channels | | | 16 | | |
| | Resolution | | | 16 | | bit |
| | Sample rate | Burst mode with more than 1 sample | | | 1 | MSPs |
| | Input voltage range | DS1511 | 0 | | 5 | V |
| | | DS1511B1 | -10 | | 10 | V |
| | Conversion timer | Separate for each channel. | | | | |
| | | Width | 27 | | | bit |
| | | Resolution | 10 | | | ns |
| | | Interval | | | 1.342 | s |
| | Timer for time stamping | Common for all channels. Two channels are required to carry one 32 bit value. | | | | |
| | | Width | 32 | | | bit |
| | | Resolution | 10 | | | ns |
| | | Interval | | | 42.9 | s |
| | Buffer size | Software-configurable | 1 | | 8192 | Samples |
| | Buffers per channel | | 3 | | | |
| | Number of external trigger inputs | | 4 | | | |
| **DC characteristics - DS1511** | | | | | | |
| ADC (all 16 channels) | Initial offset error | Below 750 KSPs | -0.5 | | 0.5 | mV |
| | Initial gain error | Below 750 KSPs | -0.25 | | 0.25 | % |
| | Input impedance | | | 192 | | kΩ |
| | Offset drift | | | ±10 | | µV/K |
| | Gain drift | | | ±6 | | ppm/K |
| | Overvoltage protection | Continuous | -20 | | +30 | |
| | | Short term | -50 | | 50 | V |
| External trigger | Input voltage | $V_{iH}$ | 2.3 | | | V |
| | | $V_{iL}$ | | | 0.4 | V |
| | Period | | | | 1 | MHz |
| | Overvoltage protection | Continuous | -48 | | 50 | V |
| **DC characteristics - DS1511B1** | | | | | | |
| ADC (all 16 channels) | Initial offset error | Below 750 KSPs | -3 | | 3 | mV |
| | Initial gain error | Below 750 KSPs | -0.25 | | 0.25 | % |
| | Input impedance | | | 117 | | kΩ |
| | Offset drift | | | ±40 | | µV/K |
| | Gain drift | | | ±6 | | ppm/K |

| Signal[1] | Parameter | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| | Overvoltage protection | Continuous | -30 | | +30 | |
| | | Short term | -50 | | 50 | V |
| External trigger | Input voltage | $V_{iH}$ | 2.3 | | | V |
| | | $V_{iL}$ | | | 0.4 | V |
| | Period | | | | 1 | MHz |
| | Overvoltage protection | Continuous | -48 | | 50 | V |
| **AC Characteristics** | | | | | | |
| ADC Type 4 (all 16 channels) | No missing codes | | 15 | | | bit |
| | SNR | 12.4 kHz signal @ 200 KSPs | 80 | | | dB |
| | Input bandwidth | Full power bandwidth | 400 | | | kHz |
| | Channel crosstalk | 100 kHz | | | -96 | dB |
| | | 200 kHz | | | -92 | dB |
| | | 400 kHz | | | -90 | dB |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagrams**

The following table shows *simplified* diagrams of the I/O circuitry of the analog inputs:

| Signal | | I/O Circuit |
|---|---|---|
| Analog inputs | ADC Type 4 channel 1 … 16 | DS1511:   |
| | | DS1511B1:   |

**Analog inputs on the DS1514 ZIF I/O connector**

Only I/O modules provide analog inputs on the DS1514 ZIF I/O connector.

For signal descriptions, refer to the following topics:

- If you use a DS1552 Multi-I/O Module, refer to *Analog Inputs* on page 597.
- If you use a DS1554 Engine Control I/O Module, refer to *Analog Inputs* on page 624.

**Related topics**

Basics

- *ADC Unit Type 4* (*MicroAutoBox Features*)

References

- *Analog Inputs* on page 624

# Analog Outputs

**Note on the cable harness**

**Note**

To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the two ZIF I/O connectors (DS1511 and DS1514). For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**Pin description**

The following table gives a description of the analog output pins on the DS1511 ZIF I/O connector:

| Pins | Signal | Module | Default state | Description / Function |
|---|---|---|---|---|
| Z2, Y2, X2, W2 | DAC1 … DAC4 | DAC Type 3 | 0 V | Standard analog outputs<br>12-bit digital values are converted to analog outputs by the DAC module. |

*Default state* means the state of the signal during reset.

**Characteristics**

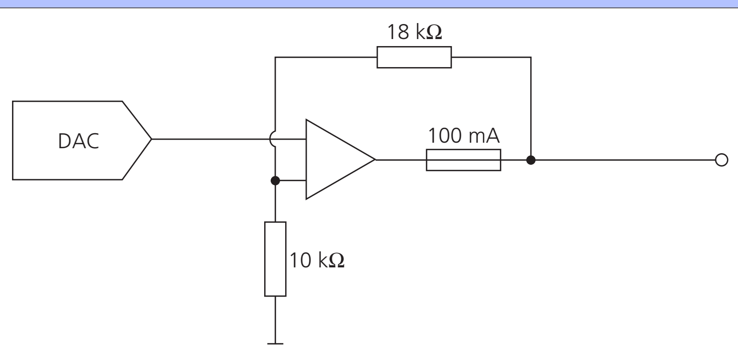
The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25 °C; all voltages are referenced to SGND pin a2, unless otherwise noted.

| Signal[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC characteristics** | | | | | | |
| DAC Type 3 | $V_{DAC}$ | Full scale | 4.44 | 4.50 | 4.56 | V |
| | Resolution | Fully monotonic | 12 | | | bit |
| | Offset error | Delivery state; $T_{CASE}$ = 25 °C | | 2 | | mV |
| | Gain error | | | 0.5 | | LSB |
| | Offset error | $T_{CASE}$ = –40 °C ... +85 °C | –10 | | +10 | LSB |
| | Gain error | | –0.5 | | 0.5 | % |
| | $I_{DACout}$ | max. sink/ source current | –5 | | 5 | mA |
| | $V_{DACSAT}$ | Output voltage when sinking $I_{DACout}$ = –5 mA and CODE = 000H | | | 0.3 | V |
| **AC characteristics** | | | | | | |
| DAC Type 3 | Settling time | Settling time of output (to 1 LSB) | | | 150 | µs |
| | $f_{gDAC}$ | Low-pass cutoff frequency of reconstruction filter (3 dB) | 10.2 | 10.8 | 11.4 | kHz |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagram**

The following table shows a *simplified* diagram of the I/O circuitry of the analog outputs:

| Signal | I/O Circuit |
|---|---|
| DAC Type 3 DAC1 … DAC4 |  |

**Analog outputs on the DS1514 ZIF I/O connector**

Only I/O modules provide analog outputs on the DS1514 ZIF I/O connector. For signal descriptions of the DS1552 Multi-I/O Module, refer to *Analog Outputs* on page 602.

**Related topics**

Basics

- *DAC Unit Type 3* (📖 *MicroAutoBox Features*)

# Interfaces

**Pin description**

The following tables give a description of the interface pins provided by the two ZIF connectors.

> **Tip**
>
> The pinout of the ECU interface connectors, USB device connector, and Ethernet I/O connector is not documented. Use a suitable dSPACE connection cable.

**DS1511 ZIF I/O connector**

The DS1511 ZIF I/O connector provides the interface pins to connect CAN bus interfaces, LIN bus interfaces, or for serial communication.

<table>
<tr><th>Pins</th><th>Signal</th><th>Module Type</th><th>Description / Function</th></tr>
<tr><td>c3</td><td>CAN 1 low</td><td rowspan="12">CAN Type 1</td><td rowspan="8">CAN controller:<br>■ CAN 1 high = CAN high of module number 1, channel number 1<br>■ CAN 2 high = CAN high of module number 1, channel number 2<br>■ CAN 3 high = CAN high of module number 2, channel number 1<br>■ CAN 4 high = CAN high of module number 2, channel number 2<br>■ ISO 11898 interface<br>■ The MicroAutoBox CAN buses are not equipped with bus termination by default. For information on terminating the CAN buses, refer to How to Terminate the CAN Bus on page 124.</td></tr>
<tr><td>c2</td><td>CAN 1 high</td></tr>
<tr><td>b3</td><td>CAN 2 low</td></tr>
<tr><td>b2</td><td>CAN 2 high</td></tr>
<tr><td>B3</td><td>CAN 3 low</td></tr>
<tr><td>B2</td><td>CAN 3 high</td></tr>
<tr><td>A3</td><td>CAN 4 low</td></tr>
<tr><td>A2</td><td>CAN 4 high</td></tr>
<tr><td>c6</td><td>Serial 1 RXD[1)]</td><td rowspan="4">RS232 interface</td></tr>
<tr><td>c5</td><td>Serial 1 TXD[1)]</td></tr>
<tr><td>b5</td><td>Serial 2 K / LIN[1)]</td></tr>
<tr><td>b6</td><td>Serial 2 L[1)]</td></tr>
</table>

| Pins | Signal | Module Type | Description / Function |
|---|---|---|---|
| B6 | Serial 3 RXD[1)] | | LIN or ISO 9141 interface<br>The K line/LIN interface is bidirectional. The L line is input only. Both lines have no pull-up. For proper function of the K line connect an external pull-up resistor (4.7 kΩ) from this line to VBAT.<br>For information on configuring a LIN master, refer to *Connecting to a LIN Bus* on page 108. |
| B5 | Serial 3 TXD[1)] | | |
| A5 | Serial 4 K / LIN[1)] | | |
| A6 | Serial 4 L[1)] | | |

[1)] For a mapping of converter and channel numbers, as used in RTI and RTLib, refer to *Basics on Serial Interface* (*MicroAutoBox Features*).

**Note**

Due to the limitations of the UART baud rate generator, not all baud rates can be programmed exactly to the desired baud rate without error (see Baud rate calculation of the serial interface).

**DS1514 ZIF I/O connector**

The following tables give a description of the interface pins provided by the DS1514 ZIF I/O connector.

You can install IP modules of various types to the DS1514:

- DS4340 FlexRay Interface Modules
- DS4342 CAN FD Interface Modules
- Third-party FlexRay IP modules
- Standard IP modules

**DS4340 FlexRay Interface Module** For a description of the interface pins of the DS4340 FlexRay Interface Module, refer to *Interfaces* on page 637.

**DS4342 CAN FD Interface Module** For a description of the interface pins of the DS4342 CAN FD Interface Module, refer to *Interfaces* on page 645.

**(FlexRay) IP Module 1** The table describes the pins when a third-party FlexRay IP module is installed.

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| C6 | IP wakeup 1 | IP_Type1 | You do not need to connect this pin because wake-up functionality is not supported. |
| L3 | IP GND 1 | IP_Type1 | Connection to GND |
| M3 | IP bus high/A 1 | IP_Type1 | FlexRay 1 high in/out (FlexRay-H) |
| M4 | IP bus low/B 1 | IP_Type1 | FlexRay 1 low in/out (FlexRay-L) |
| J3 | IP GND 2 | IP_Type1 | Connection to GND |

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| K3 | IP bus high/A 2 | IP_Type1 | FlexRay 2 high in/out (FlexRay-H) |
| K4 | IP bus low/B 2 | IP_Type1 | FlexRay 2 low in/out (FlexRay-L) |
| G5 | Reserved | - | Do not connect |
| H6 | Reserved | - | Do not connect |
| H5 | Reserved | - | Do not connect |
| J6 | Reserved | - | Do not connect |
| J5 | Reserved | - | Do not connect |
| K6 | Reserved | - | Do not connect |
| K5 | Reserved | - | Do not connect |

**(FlexRay) IP Module 2** The table describes the pins when a third-party FlexRay IP module is installed.

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| S6 | IP wakeup 1 | IP_Type1 | You do not need to connect this pin because wake-up functionality is not supported. |
| a3 | IP GND 3 | IP_Type1 | Connection to GND |
| b3 | IP bus high/A 3 | IP_Type1 | FlexRay 1 high in/out (FlexRay-H) |
| b4 | IP bus low/B 3 | IP_Type1 | FlexRay 1 low in/out (FlexRay-L) |
| Y3 | IP GND 4 | IP_Type1 | Connection to GND |
| Z3 | IP bus high/A 4 | IP_Type1 | FlexRay 2 high in/out (FlexRay-H) |
| Z4 | IP bus low/B 4 | IP_Type1 | FlexRay 2 low in/out (FlexRay-L) |
| W5 | Reserved | - | Do not connect |
| X6 | Reserved | - | Do not connect |
| X5 | Reserved | - | Do not connect |
| Y6 | Reserved | - | Do not connect |
| Y5 | Reserved | - | Do not connect |
| Z6 | Reserved | - | Do not connect |
| Z5 | Reserved | - | Do not connect |

**Characteristics**

The interface characteristics are specified for the following conditions: $V_{BAT}$ = +12 V; $T_{CASE}$ = +25 °C; all voltages are referenced to GND pins of the ZIF connectors, unless otherwise noted.

| dSPACE Board | Interface | Parameter | Conditions / Comments | Specification[1)] |
|---|---|---|---|---|
| DS1401 | Host PC | Protocol | TCP/IP | — |
| | | Bitrate | — | ■ 10/1000[2)]<br>■ 10/100[3)] |
| | | Data throughput | — | max. 2.6 MB/sec |
| | | Voltage levels | Ethernet standard | — |
| | Ethernet I/O | Protocol | UDP/IP | — |
| | | Bitrate | — | typ. 1000 Mbit |
| | | Voltage levels | Ethernet standard | — |
| | USB | USB 2.0 standard (USB Flight Recording) | | |
| | | Data throughput | without connected host tool | max. 1280 kB/sec |
| | | | with connected host tool | max. 1024 kB/sec |
| | | | without data loss during cold start (depend on the boot time of the host interface) | max. 640 kB/sec |
| | | Current | — | max. 1.3 A |
| | | Voltage | — | max. 5 V |

| dSPACE Board | Interface | Parameter | Conditions / Comments | | Specification[1] |
|---|---|---|---|---|---|
| DS1511 | ECU | Bit rate | LVDS mode | | max. 250 Mbit |
| | | | LVDS2 mode | | max. 500 Mbit |
| | | Cable length | 2-paired twisted pair | | max. 5 m (16.4 ft.) |
| | | Cable type | | | CAT5 |
| | | Voltage levels | LVDS standard | | — |
| | | Full duplex data rate [4] | LVDS mode | Single transfer | max. 5 MWord/s |
| | | | LVDS2 mode | Single transfer | max. 11.2 MWord/s |
| | | | | Block transfer | max. 28 MWord/s |
| | | RAM size [4] | LVDS / LVDS2 mode | | 16 kWord |
| | | FIFO size[4] | LVDS / LVDS2 mode (Transmit buffer) | | 1 kWord |
| | CAN | Bit rate | ISO 11898 interface | | max. 1 MBaud |
| | Serial 1/3 RS232-Interface | Bit rate | — | | ■ min. 14 Baud<br>■ max. 115.2 kBaud |
| | | TX output voltage swing | 3 kΩ load | | ■ min. ±5 V<br>■ typ. ±9 V |
| | | $V_{RxinLow}$ | RX input threshold low | | ■ typ. 1.4 V<br>■ max. 0.8 V |
| | | $V_{RxinHigh}$ | RX input threshold high | | ■ min. 2.0 V<br>■ typ. 1.4 V |
| | | Word length | — | | ■ min. 5 bit<br>■ max. 8 bit |
| | Serial 2/4 ISO9141-Interface | Bit rate | $R_{KO}$ = 510 Ω; $C_K \leq$ 1.3 nF | | ■ min. 14 Baud<br>■ max. 50 kBaud |
| | | Word length | — | | ■ min. 5 bit<br>■ max. 8 bit |
| | Serial 2/4 LIN Interface | Bit rate | — | | ■ min. 14 Baud<br>■ max. 20 kBaud |
| DS1514 | FlexRay | Bit rate | — | | max. 2 x 10 MBaud |
| | | Frame length | — | | max. 12 byte |
| | CAN FD | Bit rate | ISO 11898 interface | | max. 2 x > 2 MBaud |
| | IP module carrier | Clocking | — | | ■ min. 8 MHz<br>■ max. 32 MHz |
| | | Access type | — | | byte / word |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

[2] Since board revision DS1401-23 (available since dSPACE Release 7.2).

[3] Before board revision DS1401-23

[4] Word is 16-bit wide

**Baud rate calculation of the serial interface**

**Note**

Due to the limitations of the UART baud rate generator, not all baud rates can be programmed exactly to the desired baud rate without error.

The UART baud rate generator provides several baud rates:

*To calculate the divisor T for a chosen baud rate*

$$T = \text{Round}\left(\frac{921600}{\text{BR (chosen)}}\right)$$

BR (chosen) = The baudrate to be generated
T = The baudrate generator divisor ($8 \leq T \leq 65535$)

*To calculate the real baud rate from a given divisor T*

$$\frac{\text{BR (real)}}{\text{Baud}} = \frac{921600}{T}$$

BR (real) = The baudrate you get
T = The baudrate generator divisor ($8 \leq T \leq 65535$)

*To calculate the resulting error*

$$\frac{\text{Error}_{BR}}{100\%} = \frac{\text{BR (real)} - \text{BR (chosen)}}{\text{BR (chosen)}}$$

**Note**

If $\text{Error}_{BR} \leq 2\%$, messages will be transferred and received correctly.

# Data Sheet MicroAutoBox II 1401/1512/1513

**Where to go from here**

Information in this section

# Overview and General Information

**Where to go from here**

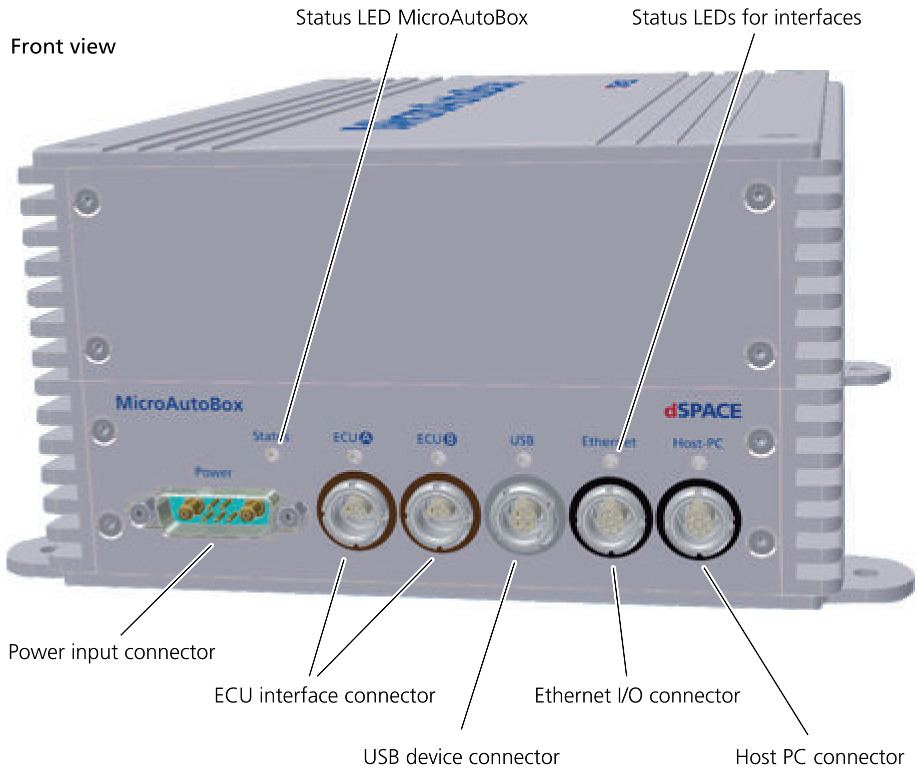
Information in this section

# Housing Components

**Connectors and status LEDs**

The illustrations show where the connectors and status LEDs are located on MicroAutoBox II 1401/1512/1513.

Front view




MicroAutoBox II 1401/1512/1513 contains the following connectors and LEDs:

**Power input connector** Supplies the required power to MicroAutoBox. It is a 7-pin, male Sub-D connector with two high-current pins.

A preconfigured cable with a matching connector and a separate power input connector are included in each MicroAutoBox package. For the pinout and further details on the preconfigured cable, refer to *Power Input Connector* on page 482.

**Status LED MicroAutoBox** Shows you different states and potential malfunctions.

If battery power is switched on and the REMOTE signal/KL15 is activated (see *Basics on Connecting to Power Supply* on page 44), the status LED (= dual LED) shows different states indicated by the LED color:

- LED is red: Reset state and no application is downloaded to the real-time processor.
- LED is green: Application is running.

- LED is flashing red: MicroAutoBox is in secured mode. For further instructions, refer to *Checking MicroAutoBox* on page 672.

The status LED on the front panel has the same functionality as the status LED on the rear panel of MicroAutoBox.

**ECU interface connectors** Provide communication to ECUs based on the LVDS standard, for example, in bypassing scenarios or to connect a RapidPro system (used as I/O subsystem). The ECU interface connectors are 4-pin LEMO connectors. Matching cables are supplied from dSPACE on request.

The corresponding LED is lit green, if power at both ends of the link is available and the relevant connection is serviceable. The LED flashes when data is being sent or received.

The table below shows the different ECU interfaces integrated into MicroAutoBox and the display names they are mapped to in the experiment software, for example, ControlDesk.

| Display Name in Software | Connectors Built-in at MicroAutoBox | |
|---|---|---|
| | ECU A | ECU B |
| ECU 1 | ✓ | – |
| ECU 2 | – | ✓ |

**USB device connector** A 4-pin LEMO connector to connect an USB mass storage device to use the USB Flight Recorder feature of MicroAutoBox. A matching cable with a LEMO-USB adapter is supplied from dSPACE on request.

**Note**

To use the USB Flight Recorder, a separate license is required.

The possible states of the corresponding LED are listed in the table below:

| LED Status | Meaning |
|---|---|
| Off | No USB device is connected. |
| Green | USB device is connected and flight recorder is not running. |
| Green blinking | USB device is connected and flight recorder is running. |
| Orange | USB device is full and the active flight recorder is specified not to overwrite old files. |

| LED Status | Meaning |
|---|---|
| Red | Write error when accessing the USB device, for example, if the device was removed while the flight recorder was running. |

For further information, refer to *Flight Recorder* (📖 *MicroAutoBox Features*).

**Ethernet I/O connector** An 8-pin LEMO connector that provides communication to external devices, such as PCs or ECUs based on the UDP/IP Ethernet protocol, for example, in bypassing scenarios.

A matching cable with a LEMO-RJ45 adapter is supplied from dSPACE on request.

The corresponding LED is lit green if power is available at both ends of the link and the relevant connection is serviceable. The LED flashes green when data is being sent or received.

For installation instructions, refer to *How to Connect MicroAutoBox to the ECU via UDP/IP* (📖 *ECU Interfaces Hardware Installation and Configuration*).

**Host PC connector** Provides the communication between MicroAutoBox and your host PC based on the Ethernet TCP/IP protocol. The connector is a 8-pin LEMO connector. A matching cable is included in each MicroAutoBox package.

The corresponding LED is lit green if power is available at both ends of the link and the relevant connection is serviceable. The LED flashes green when data is being sent or received.

**Tip**

The Ethernet I/O connector and the Host PC connector are internally connected by a common gigabit Ethernet switch (valid for base board DS1401-25ff).

This simplifies the connection options. For an example, refer to *Connecting an ECU with DCI-GSI2 for Simultaneous Calibration and Bypassing* (📖 *ECU Interfaces Hardware Installation and Configuration*).

**DS1512 ZIF I/O connector** The 156-pin zero insertion force (ZIF) I/O connector provides the signals of the installed I/O module and IP modules.

For the pinout, refer to *DS1512 ZIF I/O Connector* on page 475.

**DS1513 ZIF I/O connector** The 156-pin zero insertion force (ZIF) I/O connector provides access to the most input and output signals provided by MicroAutoBox. A matching connector is included in each MicroAutoBox package. For the pinout, refer to *DS1513 ZIF I/O Connector* on page 476.

**Status LED FPGA**

- If the DS1552 Multi-I/O Module is installed, the possible states of the corresponding LED are listed in the table below:

| LED Status | Meaning |
|---|---|
| Off | FPGA is not configured. |
| Green | Correct behavior. |
| Yellow | ■ Malfunction<br>■ Overload<br>■ One or more supply voltages on the DS1552 Multi-I/O Board are beyond a rated value. |

- If the DS1552 Multi-I/O Module is installed and you use the RTI FPGA Programming Blockset, you can control the LED to light orange. For further information, refer to *Parameters Page (FPGA_IO_WRITE_BL)* (📖 *RTI FPGA Programming Blockset - FPGA Interface Reference*).

# General Data

**General characteristics**

The following table shows some general characteristics of MicroAutoBox:

| **Parameter** | | **Specification**[1] |
|---|---|---|
| Base board (DS1401-20ff.) | Processor | ■ PPC750 GL Power PC<br>■ 900 MHz clock frequency<br>■ Real-time clock |
| | Memory | ■ 8 MB global RAM<br>■ 16 MB local RAM<br>■ 16 MB flash memory |
| | Onboard sensors[2] | Pressure sensor:<br>■ Base board DS1401-23ff.<br>■ Range: 50 kPA ...115 kPa<br>■ Accuracy: 1 kPa<br>■ Sample rate: approx. 200 Hz<br>Acceleration sensor<br>■ Base board DS1401-23ff.<br>■ Range: ±2 g ... ±8 g in 3 axis (x/y/z)<br>■ Resolution: 10 bit per axis<br>■ Sample rate: max. 800 Hz<br>■ FIFO buffer: 512 words (to read and write bursts) |
| Communication interfaces | | ■ 1 x Host PC interface based on Ethernet TCP/IP protocol<br>■ 1 x Ethernet I/O interface based on Ethernet UDP/IP protocol for Ethernet bypassing scenarios<br>■ 2 x ECU interface based on LVDS standard<br>■ 1 x USB interface for USB flight recording (separate license) |
| I/O connectors | | ■ 2 x 156-pin ZIF I/O connector<br>  ■ Contact resistance: max. 15 mΩ<br>  ■ Durability: 10000 cycles<br>  ■ Continuous current per pin ($T_{ambient}$ = +85 °C): max. 2.5 A<br>■ 1 x 7-pin power supply input connector |
| FPGA (on DS1512 I/O Board)[3] | | Xilinx® Spartan 6 FPGA XC6SLX150FGG676-2 |

| Parameter | | Specification[1] |
|---|---|---|
| Chassis dimensions | Case width | 202 mm (7.95 in.) |
| | Case height | 96 mm (3.78 in.) |
| | Case depth | 222 mm (8.74 in.) |
| Weight | | About 3.2 kg (7.05 lb.) without external cables and modules |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

2) For further information on the sensors, refer to *Onboard Sensors* (📖 *MicroAutoBox Features*).

3) Due to the introduction of Xilinx Vivado, the RTI FPGA Programming Blockset as of version 3.0 only let you use existing FPGA model INI files to build the processor interface. You cannot model new FPGA applications.

**Functional I/O units on the I/O boards**

The following table shows a mapping of the input/output units on the I/O boards which are part of the MicroAutoBox:

| dSPACE I/O Board | Functional Unit |
|---|---|
| DS1512 (with installed DS1552 Multi-I/O Module) | *ADC 1552 Type 1 Unit* (📖 *MicroAutoBox Features*) |
| | *ADC 1552 Type 2 Unit* (📖 *MicroAutoBox Features*) |
| | *DAC 1552 Type 1 Unit* (📖 *MicroAutoBox Features*) |
| | *Bit I/O Unit (DIO 1552 Type 1)* (📖 *MicroAutoBox Features*) |
| | DIO 1552 Type 2 [1] |
| | Digital Crank/Cam Inputs [1] |
| | Inductive Zero Voltage Detector [1] |
| DS1513 | *ADC Unit Type 4* (📖 *MicroAutoBox Features*) |
| | *AIO Unit Type 1 (ADC)* (📖 *MicroAutoBox Features*) |
| | *AIO Unit Type 1 (DAC)* (📖 *MicroAutoBox Features*) |
| | *Bit I/O Unit (DIO Type 4)* (📖 *MicroAutoBox Features*) |

1) Only available via the RTI FPGA Programming Blockset up to version 2.9 (see RTI Block Settings for the FPGA1401Tp1 with Multi-I/O Module Frameworks).

# Absolute Maximum Levels

**Avoiding damage to the system**

**NOTICE**

Do not exceed the maximum levels since this might permanently damage the system.

**Levels**

The following table shows the levels (for example, voltage, temperature) of the MicroAutoBox. All voltages are referenced to GND (unless otherwise noted).

| Parameter | Specification[1)] | Description |
|---|---|---|
| VBAT | –40 V ... +100 V | Load dump- and reverse protection |
| VDRIVE | 0 V ... +45 V | |
| All digital output voltages | (VDRIVE – 45 V) ... +45 V | |
| All digital input voltages | (VDRIVE – 45 V) ... +45 V | |
| All analog input voltages | –40 V ... +40 V | |
| All analog output voltages | –30 V ... +40 V | |
| VSENS output | 0 V ... +40 V | VSENS is switched on and off with the REMOTE pin. |
| VBATprot output | 0 V ... +45 V | VBATprot follows VBAT within the specified range.<br>VBATprot is switched on and off with the REMOTE pin. |
| RS232 transceiver output on the DS1513 ZIF I/O connector[2)] | –30 V ... +30 V | |
| RS232 transceiver input on the DS1513 ZIF I/O connector[2)] | –30 V ... +30 V | |
| $V_{CAN\ high}$, $V_{CAN\ low}$ on the DS1513 ZIF I/O connector[3)] | –58 V ... +58 V | Voltage level on CAN high and CAN low pins. |
| $V_{Diff\ (CAN\ high\ -\ CAN\ low)}$ on the DS1513 ZIF I/O connector[3)] | –5 V ... +5 V | Voltage difference between CAN high and CAN low pins (due to termination resistors). |
| Serial K / LIN | –20 V ... +32 V | but not more than VBAT |
| Serial L | –24 V ... +30 V | but not more than VBAT |
| All outputs short circuit to GND | continuous | |
| Continuous power dissipation ($T_{ambient}$ = +85 °C) | max. 50 W | |

| Parameter | Specification[1] | Description |
|---|---|---|
| Operating temperature | –40 °C ... +85 °C | |
| Storage temperature | –55 °C ... +125 °C | |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.
[2] On the DS1512 I/O connector, the DS1552 Multi-I/O Module also provides a serial interface. For absolute maximum levels, refer to *Absolute Maximum Levels* on page 584.
[3] If the DS4342 CAN FD Interface Module is installed on the DS1512 I/O Board, the DS1512 I/O connector also provides a CAN interface. For maximum absolute levels, refer to *Absolute Maximum Levels* on page 640.

# Certifications

**CE compliance**

MicroAutoBox meets the requirements of the European directive 2014/30/EU (Electromagnetic Compatibility Directive) for CE marking.

**Applied standards**

The characteristics of MicroAutoBox were tested according to the standards shown in the following table:

| Tested Characteristics | Applied Standard | Description |
|---|---|---|
| Electromagnetic compatibility (EMC) | EN 61326-1 Table 2 | Immunity standard for industrial environments[1] |
| | CISPR 11, EN 55011 Group 1, Class A | Emission standard for industrial environments |
| | RTCA/DO160G: Dec. 2010: Section 21.4 | Environmental conditions and test procedures for airborne equipment: Conducted RF Emissions, Category: B, L, M&H[2] |
| | RTCA/DO160G: Dec. 2010: Section 21.5 | Environmental conditions and test procedures for airborne equipment: Radiated RF Emissions, Category: M[2] |
| Vibration | ISO 16750-3:2007 / 4.1.2.4 Test IV | Test conditions: Broad band noise, 4h per axis, RMS-acceleration 27,8 m/s$^2$ |
| | DO-160F.8 / B1 Test Conditions | Test conditions: Broad band noise, 2h per axis, based on DO160F Section 8, Category B1 |
| | EN 60068-2-6 | Test conditions:<br>■ Swept sine, 1 octave per minute, 3-axis test<br>■ 5 ... 2000 Hz, up to 5 g, 2 sweeps per axis<br>■ Operating |

| Tested Characteristics | Applied Standard | Description |
|---|---|---|
| Shock | ISO 16750-3:2007 / 4.2.2. | ■ Linear shock (1/2 sine pulse), 6-axis<br>■ 500 m/s$^2$, 6 ms, 10 pulses per axis<br>■ Operating |
| | RTCA / DO-160F<br>Section 7 Test 7.2<br>Category A<br>Test type R | Operational shocks test (standard):<br>■ Saw-tooth wave, 6-axis<br>■ 200 m/s$^2$, 11 ms, 10 pulses per axis<br>■ Operating |
| | RTCA / DO-160F<br>Section 7 Test 7.2<br>Category D<br>Test type R | Operational shocks test (low frequency):<br>■ Saw-tooth wave, 6-axis<br>■ 200 m/s$^2$, 20 ms, 10 pulses per axis<br>■ Operating |

1) Tested with an I/O cable length < 3 m.
2) For further information, refer to dSPACE Support.

**Vibration and shock tests**

To verify the reliability of MicroAutoBox under realistic operating conditions, it was exposed to vibration and shock tests. During the tests, MicroAutoBox executed a program without any failures.

# Connector Pinouts

**Where to go from here**

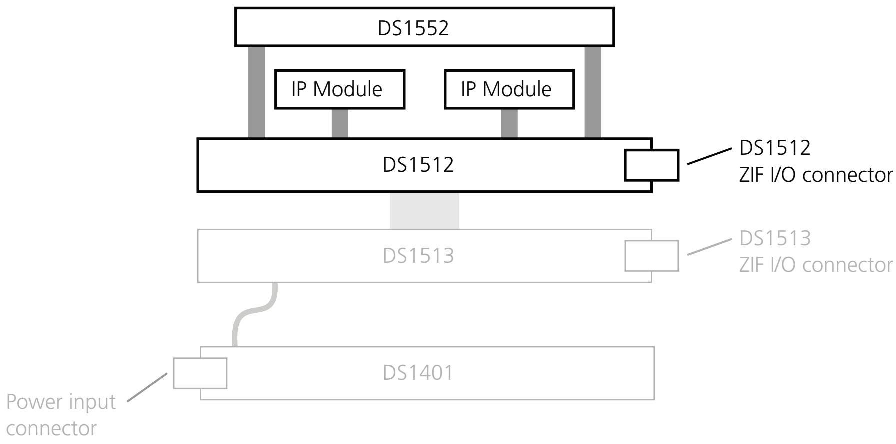
Information in this section



## DS1512 ZIF I/O Connector

**Objective**

The DS1512 I/O connector is a 156-pin zero insertion force (ZIF) connector that grants access to various I/O signals if a FlexRay IP module (DS4340 or third-party) and/or an I/O module are/is installed. The illustration below shows an example of the internal assembly of the MicroAutoBox II 1401/1512/1513 with a DS1552 Multi-I/O Module installed.




**Pinout**

The DS1512 ZIF I/O connector provides only signals of the installed I/O module and IP modules.

For pinouts of the DS1512 ZIF I/O connector, refer to the following topics:

- DS1552 Multi-I/O Module: *DS1512 and DS1514 ZIF I/O Connectors* on page 585
- DS4340 FlexRay Interface Module: *DS1512 and DS1514 ZIF I/O Connectors* on page 634
- DS4342 CAN FD Interface Module: *DS1512 and DS1514 ZIF I/O Connectors* on page 642

**Signal descriptions**

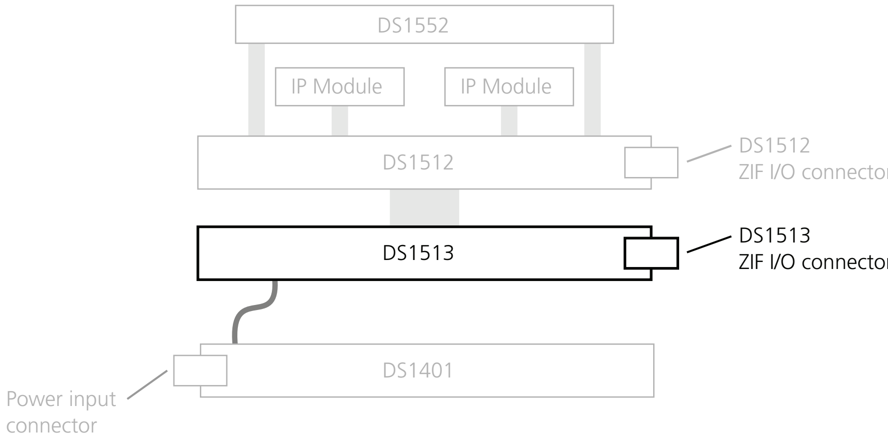
For descriptions of the signals which are available on the DS1512 ZIF I/O connector, refer to:

- *Digital Inputs* on page 590
- *Digital Outputs* on page 592
- *Digital I/O (Bidirectional)* on page 595
- *Analog Inputs* on page 597
- *Analog Outputs* on page 602
- *Digital Crank/Cam Inputs* on page 603
- *Inductive Zero Voltage Detector* on page 605
- Serial: *Interfaces* on page 607

## DS1513 ZIF I/O Connector

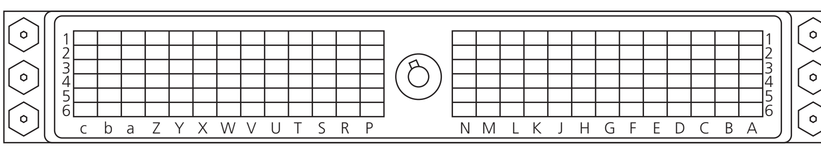
**Objective**

The DS1513 I/O connector is a 156-pin zero insertion force (ZIF) connector giving access to the input and output signals provided by DS1513 I/O Board. The illustration below shows the internal assembly of the MicroAutoBox II 1401/1512/1513.




**Pinout**

The following illustration shows the pin numbering of the I/O connector (front view of MicroAutoBox):




> **Note**
>
> There are pins identified by uppercase letters (A, B, C, etc.) and pins identified by lowercase letters (a, b, c).

The following table shows the signals of the I/O connector:

| 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GND | in | CAN 4 high | i/o | CAN 4 low | i/o | GND | in | Serial 4 K / LIN[1)] | i/o | Serial 4 L[1)] | in | *A* |
| GND | in | CAN 3 high | i/o | CAN 3 low | i/o | GND | in | Serial 3 TXD[1)] | out | Serial 3 RXD[1)] | in | *B* |
| GND | in | DigP 1 ch 5[2)] | out | DigP 1 ch 10 | out | DigP 1 ch 15 | out | DigP 2 ch 4 | out | GND | in | *C* |
| GND | in | DigP 1 ch 4 | out | DigP 1 ch 9 | out | DigP 1 ch 14 | out | DigP 2 ch 3 | out | DigP 2 ch 8 | out | *D* |
| GND | in | DigP 1 ch 3 | out | DigP 1 ch 8 | out | DigP 1 ch 13 | out | DigP 2 ch 2 | out | DigP 2 ch 7 | out | *E* |
| GND | in | DigP 1 ch 2 | out | DigP 1 ch 7 | out | DigP 1 ch 12 | out | DigP 2 ch 1 | out | DigP 2 ch 6 | out | *F* |
| GND | in | DigP 1 ch 1 | out | DigP 1 ch 6 | out | DigP 1 ch 11 | out | DigP 1 ch 16 | out | DigP 2 ch 5 | out | *G* |
| GND | in | DigP 1 ch 5 | in | DigP 1 ch 10 | in | DigP 1 ch 15 | in | DigP 2 ch 4 | in | GND | in | *H* |
| GND | in | DigP 1 ch 4 | in | DigP 1 ch 9 | in | DigP 1 ch 14 | in | DigP 2 ch 3 | in | DigP 2 ch 8 | in | *J* |
| GND | in | DigP 1 ch 3 | in | DigP 1 ch 8 | in | DigP 1 ch 13 | in | DigP 2 ch 2 | in | DigP 2 ch 7 | in | *K* |
| GND | in | DigP 1 ch 2 | in | DigP 1 ch 7 | in | DigP 1 ch 12 | in | DigP 2 ch 1 | in | DigP 2 ch 6 | in | *L* |

| 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VSENS | out | DigP 1 ch 1[2] | in | DigP 1 ch 6 | in | DigP 1 ch 11[2] | in | DigP 1 ch 16 | in | DigP 2 ch 5 | in | *M* |
| VDRIVE | in | CAN 6 high | i/o | CAN 6 low | i/o | GND | in | Serial 6 K / LIN[1] | i/o | Serial 6 L[1] | in | *N* |
| VBAT prot | out | CAN 5 high | i/o | CAN 5 low | i/o | GND | in | Serial 5 TXD[1] | out | Serial 5 RXD[1] | in | *P* |
| REMOTE | in | GND | in | GND | in | GND | in | GND | in | GND | in | *R* |
| GND | in | AnalogOut ch 8 | out | AnalogIn ch 4 | in | AnalogIn ch 8 | in | AnalogIn ch 12 | in | AnalogIn ch 16 | in | *S* |
| GND | in | AnalogOut ch 7 | out | AnalogIn ch 3 | in | AnalogIn ch 7 | in | AnalogIn ch 11 | in | AnalogIn ch 15 | in | *T* |
| GND | in | AnalogOut ch 6 | out | AnalogIn ch 2 | in | AnalogIn ch 6 | in | AnalogIn ch 10 | in | AnalogIn ch 14 | in | *U* |
| GND | in | AnalogOut ch 5 | out | AnalogIn ch 1 | in | AnalogIn ch 5 | in | AnalogIn ch 9 | in | AnalogIn ch 13 | in | *V* |
| GND | in | AnalogOut ch 4 | out | Analog ch 4 | in | Analog ch 8 | in | Analog ch 12 | in | Analog ch 16 | in | *W* |
| GND | in | AnalogOut ch 3 | out | Analog ch 3 | in | Analog ch 7 | in | Analog ch 11 | in | Analog ch 15 | in | *X* |
| GND | in | AnalogOut ch 2 | out | Analog ch 2 | in | Analog ch 6 | in | Analog ch 10 | in | Analog ch 14 | in | *Y* |
| GND | in | AnalogOut ch 1 | out | Analog ch 1 | in | Analog ch 5 | in | Analog ch 9 | in | Analog ch 13 | in | *Z* |
| GND | in | SGND | in | Ana trigger 1 | in | Ana trigger 2 | in | Ana trigger 3 | in | Ana trigger 4 | in | *a* |
| GND | in | CAN 2 high | i/o | CAN 2 low | i/o | GND | in | Serial 2 K / LIN[1] | i/o | Serial 2 L[1] | in | *b* |
| GND | in | CAN 1 high | i/o | CAN 1 low | i/o | GND | in | Serial 1 TXD[1] | out | Serial 1 RXD[1] | in | *c* |

[1] For a mapping of converter and channel numbers, as used in RTI and RTLib, refer to *Basics on Serial Interface* (*MicroAutoBox Features*).

[2] DigP = Port number; ch = Channel number

**Tip**

To use the digital inputs and outputs, you have to connect the VDRIVE pin inside the ZIF I/O connector according to the logic level needed. *This pin is not preconfigured in the ZIF I/O connector delivered with each MicroAutoBox II.* You have to connect VDRIVE (pin N1) to VSENS (pin M1) or VBATprot (pin P1). Use the preconfigured jumper cable which is included in the MicroAutoBox package.

**Signal descriptions**

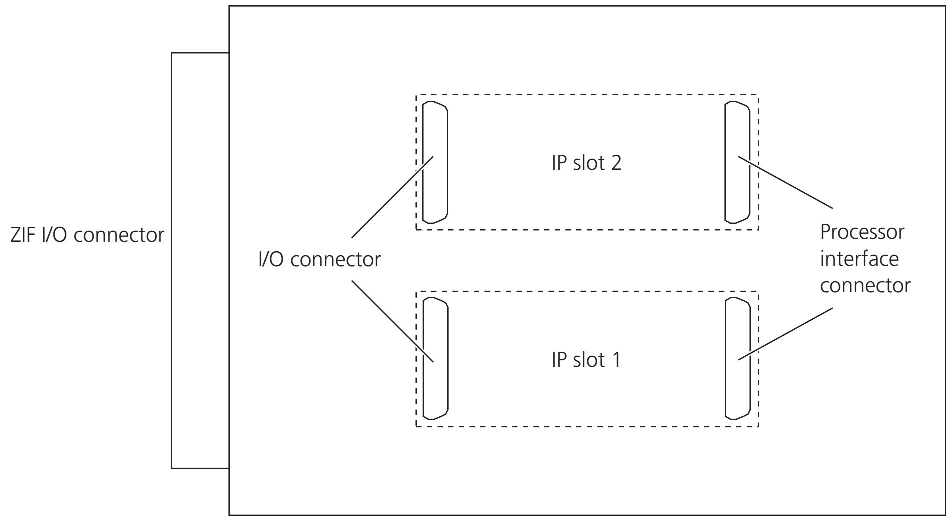
For descriptions of the signals which are available on the DS1513 ZIF I/O connector, refer to:

- *Digital Inputs* on page 487
- *Digital Outputs* on page 489
- *Analog Inputs* on page 494
- *Analog Outputs* on page 497
- CAN, LIN, serial: *Interfaces* on page 499

# IP Module Connectors

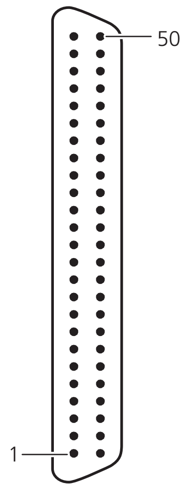
**Objective**

The DS1512 provides two slots to install IP modules. Each slot provides two AMP connectors: I/O connector and processor interface connector. The following illustration shows the top view of MicroAutoBox.

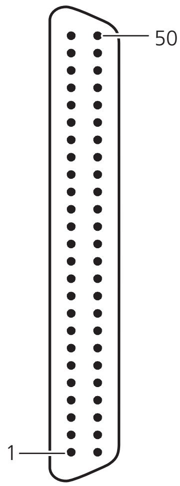


**Pinout**

**I/O connector - IP module slot 1** The following table shows the signal mapping of the IP module I/O connector on slot 1 to the DS1512 ZIF I/O connector (rear of MicroAutoBox):

| IP Module I/O Connector | Pin | ZIF Pin for IP Slot 1 | Pin | ZIF Pin for IP Slot 1 |
|---|---|---|---|---|
|  | 25 | - | 50 | M3 |
| | 24 | - | 49 | M4 |
| | 23 | - | 48 | L3 |
| | 22 | - | 47 | - |
| | 21 | - | 46 | K3 |
| | 20 | K5 | 45 | K4 |
| | 19 | K6 | 44 | J3 |
| | 18 | J5 | 43 | - |
| | 17 | J6 | 42 | - |
| | 16 | H5 | 41 | - |
| | 15 | H6 | 40 | - |
| | 14 | G5 | 39 | - |
| | 13 | - | 38 | - |
| | 12 | - | 37 | - |
| | 11 | - | 36 | - |
| | 10 | - | 35 | - |
| | 9 | - | 34 | - |
| | 8 | - | 33 | - |
| | 7 | - | 32 | - |
| | 6 | - | 31 | - |
| | 5 | C6 | 30 | - |
| | 4 | - | 29 | - |
| | 3 | - | 28 | - |
| | 2 | - | 27 | - |
| | 1 | - | 26 | - |

**I/O connector - IP module slot 2** The following table shows the signal mapping of the IP module I/O connector on slot 2 to the DS1512 ZIF I/O connector (rear of MicroAutoBox):

| IP Module I/O Connector | Pin | ZIF Pin for IP Slot 2 | Pin | ZIF Pin for IP Slot 2 |
|---|---|---|---|---|
|  | 25 | - | 50 | b3 |
| | 24 | - | 49 | b4 |
| | 23 | - | 48 | a3 |
| | 22 | - | 47 | - |
| | 21 | - | 46 | Z3 |
| | 20 | Z5 | 45 | Z4 |
| | 19 | Z6 | 44 | Y3 |
| | 18 | Y5 | 43 | - |
| | 17 | Y6 | 42 | - |
| | 16 | X5 | 41 | - |
| | 15 | X6 | 40 | - |
| | 14 | W5 | 39 | - |
| | 13 | - | 38 | - |
| | 12 | - | 37 | - |
| | 11 | - | 36 | - |
| | 10 | - | 35 | - |
| | 9 | - | 34 | - |
| | 8 | - | 33 | - |
| | 7 | - | 32 | - |
| | 6 | - | 31 | - |
| | 5 | S6 | 30 | - |
| | 4 | - | 29 | - |
| | 3 | - | 28 | - |
| | 2 | - | 27 | - |
| | 1 | - | 26 | - |

**Processor interface connector - slot 1 and slot 2** The pinout of the processor interface connector (slot 1 and slot 2) complies with IP Modules Draft Standard VITA 4-1995. For further information, refer to the documentation of the standard.

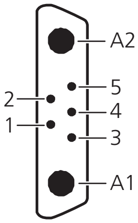
# Power Input Connector

**Objective**

MicroAutoBox provides a power input connector. It is a 7-pin, male connector with two high-current pins. It is a special variant of a 15-pin Sub-D connector (mixed-layout 7W2 Sub-D).

**Pinout**

The following illustration shows the pinout (front view of MicroAutoBox).

| Connector | Pin | Signal | Pin | Signal |
|---|---|---|---|---|
|   | A2[1] | VBAT (6 V … 40 V DC) | | |
| | | | 5 | REMOTE_PULLUP |
| | 2 | Do not connect | 4 | REMOTE[2] |
| | 1 | Do not connect | 3 | Do not connect |
| | A1 | GND | | |

[1] NOTE: It is highly recommended to insert a fuse into the main power supply input wire (close to battery). Choose the value of the fuse according to the maximum current. A 10 A fuse is recommended.

[2] The REMOTE input must be connected via switch or bridge to UBAT to run the MicroAutoBox. For example, you can use it for switching MicroAutoBox with KL15 (output of the ignition/driving switch). So, you can use the nonvolatile data feature to store data you may want to use again when restarting the application. For further information, refer to *Nonvolatile Data Handling* (📖 *MicroAutoBox RTLib Reference*).

**Matching cable**

A preconfigured cable for the supply voltage is provided by dSPACE. This cable is for running MicroAutoBox with a laboratory power supply during development. Therefore, REMOTE (pin 4) is shorted to VBAT (pin A2) inside the connector in order to save a separate switch. Do not use this cable in the vehicle. Otherwise, MicroAutoBox will always be turned on.

The VBAT wire (red) contains a melting fuse. Each wire has a cross-section of 1.5 mm².

Fuse specification:

- Cable delivered through dSPACE Release 2013-B: 7.5 A, time lag
- Cable delivered as of dSPACE Release 2014-A: 10 A, time lag

# Signal Descriptions

**Where to go from here**

Information in this section



## Power Inputs and Outputs

**Pin description**

The following table gives a description of the pins used for power input, remote input and supply of digital I/O circuits.

**Power input connector** The following table lists the pin description of the power input connector on the front:

| Pins | Signal | Description / Function |
|---|---|---|
| A2 | VBAT | Main power supply input. Connect this pin to the positive pole of your car battery. |
| A1 | GND | Main power supply return and reference for all input and output signals. Connect this pin to the minus pole of your car battery. The case of MicroAutoBox is also connected to GND. |

| Pins | Signal | Description / Function |
|---|---|---|
| 4 | REMOTE | ■ The REMOTE input may be used for starting MicroAutoBox with a remote switch, for example KL15 (output of the ignition/driving switch).<br>■ If you connect the remote pin to the plus pole of the car battery directly, MicroAutoBox will always be turned on, and the car battery will soon be exhausted if the engine is not running. Thus, a switch is highly recommended.<br>■ The voltage connected to the REMOTE pin should not exceed the supply voltage.<br>■ To wake up MicroAutoBox via CAN messages, the REMOTE pin must be left open when MicroAutoBox is powered down. This is due to the fact that there is an additional internal connection to the REMOTE pin. Nevertheless, you can always use a remote switch to supply voltage (e.g., VBAT) to start MicroAutoBox. |
| 5 | REMOTE_Pullup | You can use this output to connect a remote switch between REMOTE and this pin. REMOTE_Pullup is internally connected to VBAT via 39 kΩ pull-up resistor. |

**DS1513 ZIF I/O connector** The following table lists the pin description of the DS1513 I/O Boards ZIF I/O connector on the rear:

| Pins | Signal | Description / Function |
|---|---|---|
| A1, A4, B1, B4, C1, C6, D1, E1, F1, G1, H1, H6, J1, K1, L1, N4, P4, R2 ... R6, S1, T1, U1, V1, W1, X1, Y1, Z1, a1, b1, b4, c1, c4 | GND | Main power supply return and reference for all input and output signals. Use the nearest possible GND pin as reference for your signals in order to keep noise levels at minimum. The case of MicroAutoBox is also connected to GND. |
| a2 | SGND | Connected to GND internally.<br>Use the SGND signal pin as reference for ADC- and DAC-channels of the DS1513 I/O Board to get the optimum analog performance. |
| N1 | VDRIVE | This input supplies all digital input and output circuits located on the DS1513 I/O Board.<br>■ Connect this input to VSENS to set CMOS/TTL-compatible logic levels to your inputs/outputs.<br>■ Connect this input to VBATprot to set automotive-compatible logic levels to your inputs/outputs.<br>■ Do not connect this pin directly to VBAT, because the input and output circuits are not load-dump-protected or reverse-voltage-protected at this signal. |

| Pins | Signal | Description / Function |
|---|---|---|
| M1 | VSENS | Sensor supply output.<br>Use this output to supply your sensors and/or VDRIVE. If you need CMOS/TTL-compatible logic levels at the inputs/outputs connect VSENS to VDRIVE. |
| P1 | VBAT prot | Protected VBAT output.<br>Use this output to supply VDRIVE when automotive logic levels are needed. |
| R1 | REMOTE | ■ The remote voltage may be used for starting MicroAutoBox with a remote switch: KL15, for example (output of the ignition/driving switch).<br>■ If you connect the remote pin to the car battery directly, MicroAutoBox will always be turned on, and the car battery will soon be exhausted if the engine is not running. Thus, a switch is highly recommended.<br>■ The remote voltage should not exceed the supply voltage. |

**DS1512 ZIF I/O connector** For the pin description of the DS1512 I/O Board's ZIF I/O connector if the DS1552 Multi-I/O Module is installed, refer to *Power Inputs and Outputs* on page 588.

**Tip**

To use the digital inputs and outputs, you have to connect the VDRIVE pin inside the ZIF I/O connector according to the logic level needed. *This pin is not preconfigured in the ZIF I/O connector delivered with each MicroAutoBox II.* You have to connect VDRIVE to VBATprot or VSENS+. If you use VSENS+, you have to connect VSENS- to ground.

**Characteristics**

The characteristics are specified for the following conditions:

- $V_{BAT}$=+12 V (unless otherwise noted)

  $T_{CASE}$=+25 °C (unless otherwise noted)

  All voltages are referenced to GND (unless otherwise noted).

| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Power** | | | | | | |
| Operating voltage | VBAT | For start-up with an input power consumption < 35 W | 6 | | 40 | V |
| | VBAT | Operating | 4.5 | | 40 | V |
| | VBAT | Reverse protection | | | -40 | V |
| | VBAT | Load dump protection | | | +100 | V |

| Signal[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Inputs** | | | | | | |
| Operating current | $I_{VBAT}$ | REMOTE ≥ $V_{iHRemote}$ | | 2 | | A |
| | $I_{VBAT}$ | REMOTE ≤ $V_{iLRemote}$ | | 5 | | mA |
| REMOTE voltage input | $V_{iHRemote}$ | Input high voltage | 4.7 | | | V |
| | $V_{iLRemote}$ | Input low voltage | | | 0.8 | V |
| | $V_{iHysRemote}$ | Input hysteresis voltage | 0.5 | 1 | | V |
| | $R_{inRemote}$ | Input impedance | 60 | | 185 | kΩ |
| Inrush current | $I_{VBAT\ inrush}$ | All inputs/outputs unconnected | see *Power supply* on page 40 | | | |
| Digital I/O voltage supply input on DS1513 ZIF I/O connector | VDRIVE | Supply for digital input/output circuits | | | 45 | V |
| | $I_{VDRIVE\ no\ load}$ | All inputs/outputs unconnected | | 20 | | mA |
| | $I_{VDRIVE\ maximum\ load}$ | All outputs shorted to GND | | 1 | | A |
| Digital I/O voltage supply input on DS1512 ZIF I/O connector | VDRIVE | Supply for digital input/output circuits | | | 45 | V |
| | $I_{VDRIVE\ no\ load}$ | All inputs/outputs unconnected | | 10 | | mA |
| | $I_{VDRIVE\ maximum\ load}$ | All outputs shorted to GND | | 500 | | mA |
| **Outputs** | | | | | | |
| Sensor supply output on DS1513 ZIF I/O connector | VSENS | Output voltage | 4.84 | 5.05 | 5.25 | V |
| | VSENS = f(T) | Temperature caused voltage drift $T_{CASE}$ = –40 °C ... +85 °C | –2 | | 2 | % |
| | $I_{VSENS,\ max}$ | Maximum output current | 750 | | | mA |
| Sensor supply output on DS1512 ZIF I/O connector | VSENS+ | Output voltage, isolated and adjustable, controlled by a DAC (relative to VSENS-) | 2 | | 20 | V |
| | $P_{VSENS,\ max}$ | Maximum output power (if VSENS+ is in range 5..20V and VSENS- is connected to GND) | | 1 | | W |
| Protected VBAT output | VBATprot | IL = 1A; VBAT = 12 V | 11.56 | 11.78 | 12 | V |
| | $I_{VBATprot,\ max}$ | Maximum output current | | | 1000 | mA |
| | $I_{ProtPeak}$ | Overload current limit (–40 °C ... 85 °C) | 4 | | 9 | A |
| | t(overload) | Time to shut off $I_{ProtPeak}$ | | | 5 | ms |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

# Digital Inputs

**Note on the cable harness**

> **Note**
>
> To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the DS1513 ZIF I/O connector and the DS1512 ZIF I/O connector. For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**Pin description**

The following table gives a description of the digital input pins on the DS1513 ZIF I/O connector:

| Pins | Port Number | Signal | Description / Function |
|---|---|---|---|
| M2, L2, K2, J2, H2, M3, L3, K3, J3, H3, M4, L4, K4, J4, H4, M5 | 1 | Channel 1 ... 16<br>DIO Type 4 | Standard discrete digital input with pull-up. |
| L5, K5, J5, H5, M6, L6, K6, J6 | 2 | Channel 1 ... 8<br>DIO Type 4 | |

**Characteristics**

The characteristics are specified for the following conditions:

- $V_{BAT}$=+12 V (unless otherwise noted)

  $T_{CASE}$=+25 °C (unless otherwise noted)

  All voltages are referenced to GND (unless otherwise noted).

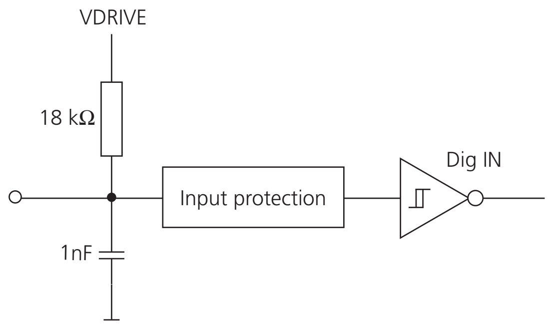
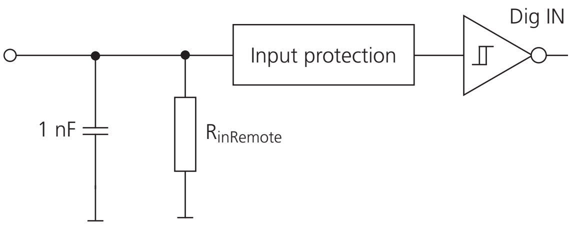
| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC characteristics** | | | | | | |
| Digital input channel 1 ... 24 | $V_{iH}$ | Input high voltage | 3.1 | | | V |
| | $V_{iL}$ | Input low voltage | | | 1.2 | V |
| | $V_{iHys}$ | Input hysteresis voltage | | 1 | | V |
| | $R_{DigIn}$ | Pull-up resistor to VDRIVE | 17 | 18 | 19 | kΩ |
| | $C_{DigIn}$ | Input capacitance | | 1 | | nF |
| REMOTE | $V_{iHRemote}$ | Input high voltage | 4.7 | | | V |
| | $V_{iLRemote}$ | Input low voltage | | | 0.8 | V |
| | $V_{iHysRemote}$ | Input hysteresis voltage | 0.5 | 1 | | V |
| | $R_{inRemote}$ | Input impedance | 60 | | 185 | kΩ |

| Signal[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **AC characteristics** | | | | | | |
| Inputs | $t_{LowMin}$ | Minimum pulse width low | | 250 | 500 | ns |
| | $t_{HighMin}$ | Minimum pulse width high | | 300 | 600 | ns |
| | $F_{max}$ | Duty cycle: 50 % | | 1.8 | | MHz |
| | | Duty cycle: 1 % or 99 % | | 33 | | kHz |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagrams**

The following table shows *simplified* diagrams of the I/O circuitry of the digital inputs:

| Signal | | I/O Circuit |
|---|---|---|
| Digital inputs | Channel 1 ... 24 | <br>For proper operation, VDRIVE must have a level above the maximum input voltage. |
| | Remote |  |

**Digital inputs on the DS1512 ZIF I/O connector**

Only I/O modules can provide digital inputs on the DS1512 ZIF I/O connector. For signal descriptions of the DS1552 Multi-I/O Module, refer to *Digital Inputs* on page 590.

**Related topics**

Basics

- *Bit I/O Unit (DIO Type 4)* (📖 *MicroAutoBox Features*)

## Digital Outputs

**Note on the cable harness**

> **Note**
>
> To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the DS1513 ZIF I/O connector and the DS1512 ZIF I/O connector. For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**General behavior of digital signals**

All digital outputs are set to high impedance (tristate) until the application is started. Then the outputs follow the states defined in your application. Unused outputs remain in tristate mode.

**Pin description**

The following table gives a description of the digital output pins on the DS1513 ZIF I/O connector:

| Pins | Port Number | Signal | Description / Function |
|---|---|---|---|
| G2, F2, E2, D2, C2, G3, F3, E3, D3, C3, G4, F4, E4, D4, C4, G5 | 1 | Channel 1 ... 16<br>DIO Type 4 | Standard discrete digital output. |
| F5, E5, D5, C5, G6, F6, E6, D6 | 2 | Channel 1 ... 8<br>DIO Type 4 | |

**Characteristics**

The characteristics are specified for the following conditions:

- $V_{BAT}$=+12 V (unless otherwise noted)

  $T_{CASE}$=+25 °C (unless otherwise noted)

  All voltages are referenced to GND (unless otherwise noted).

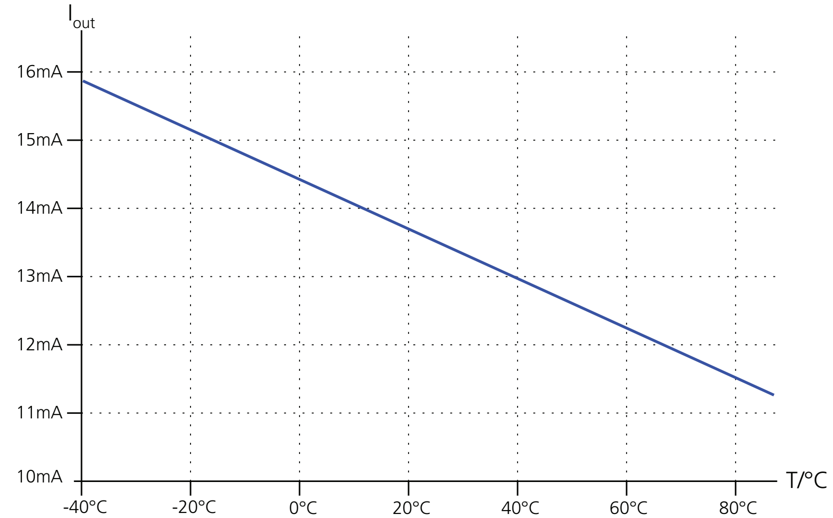
| Signal[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC Characteristics** | | | | | | |
| Digital output channel 1 … 24 | $V_{oH}$ | IL = 0 mA; VDRIVE = 5 V | 4.4 | 4.6 | | V |
| | $V_{oL}$ | IL = 0 mA; VDRIVE = 5 V | | 0.1 | 0.3 | V |
| | $V_{oH}$ | IL = 5 mA; VDRIVE = 5 V | 3.2 | 3.4 | | V |
| | $V_{oL}$ | IL = –5 mA; VDRIVE = 5 V | | 0.7 | 0.9 | V |
| | $V_{oH}$ | IL = 0 mA; VDRIVE = 12 V | 11.3 | 11.6 | | V |
| | $V_{oL}$ | IL = 0 mA; VDRIVE = 12 V | | 0.1 | 0.3 | V |
| | $V_{oH}$ | IL = 5 mA; VDRIVE = 12 V | 10.3 | 10.5 | | V |
| | $V_{oL}$ | IL = –5 mA; VDRIVE = 12 V | | 0.7 | 0.9 | V |
| | $\lvert I_{OHmax} \rvert$ | Current limit high<br>$T_{CASE}$ = –40 °C … +85 °C | 5 | 13 | 17 | mA |
| | $\lvert I_{OLmax} \rvert$ | Current limit low<br>$T_{CASE}$ = –40 °C … +85 °C | 5 | 14 | 18 | mA |
| | $\lvert I_{OTLeak} \rvert$ | Leakage current tristate<br>$T_{CASE}$ = -40 °C … +85 °C | | | 100 | µA |
| **AC Characteristics** | | | | | | |
| Outputs | $t_{minPulseHigh}$ | Minimum pulse width high,<br>VDRIVE = 5 V or 12 V, RL=1 kΩ | | 700 | 1400 | ns |
| | $t_{minPulseLow}$ | Minimum pulse width low,<br>VDRIVE = 5 V or 12 V, RL=1 kΩ | | 200 | 400 | ns |
| | $F_{max}$ | Duty cycle: 50 %<br>VDRIVE = 5 V or 12 V | | 0.7[2] | | MHz |
| | | Duty cycle: 1 % or 99 %<br>VDRIVE = 5 V or 12 V | | 14 | | kHz |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

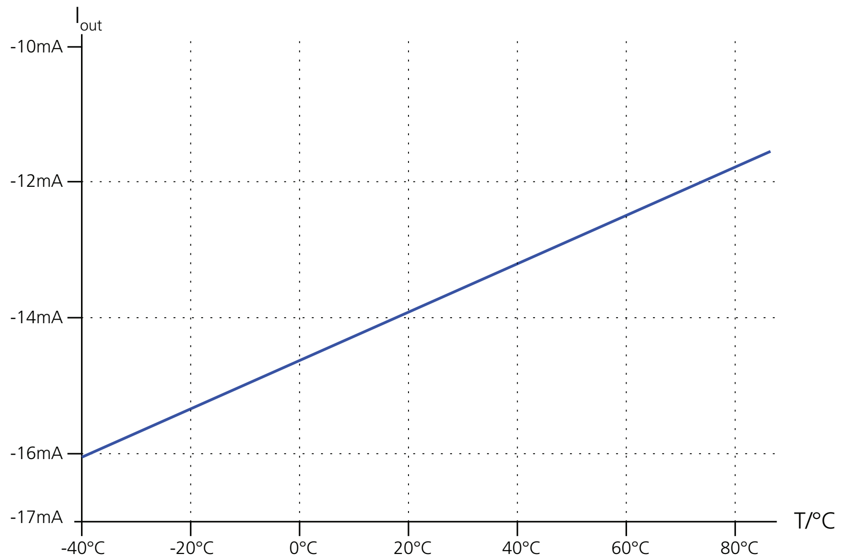
2) Limited by software to 150 kHz

The following illustrations show the maximum output current of a digital output circuit as a function of ambient temperature (VDRIVE = 12 V; output is shorted to 6 V):

- Output high

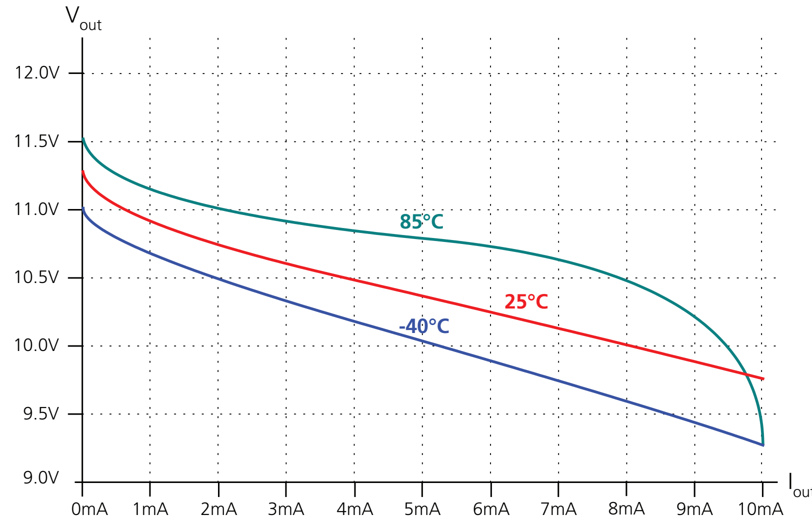



- Output low

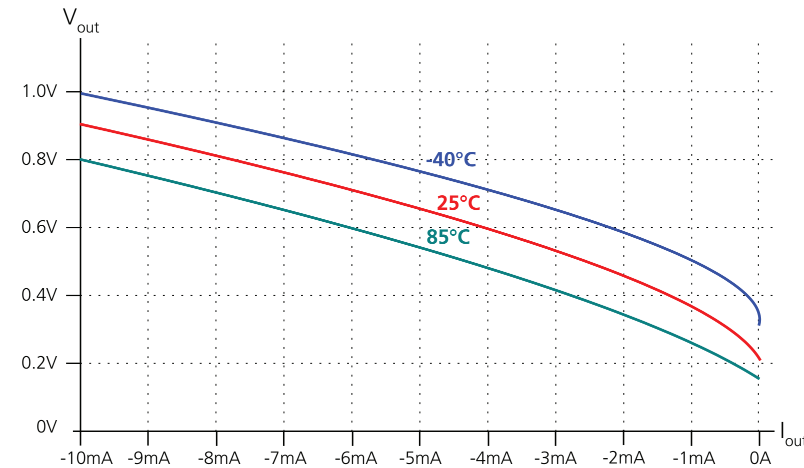


The following illustrations show the typical digital output voltage as a function of the output current (VDRIVE = 12 V):

- Output high

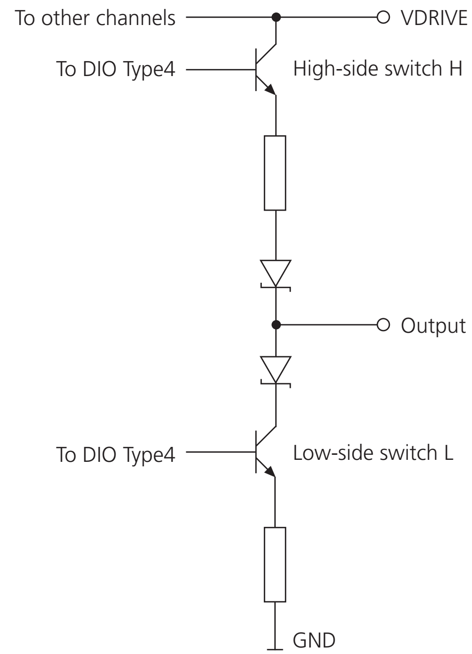



- Output low



**Circuit diagrams**

The following table shows a *simplified* diagram of the I/O circuitry of the digital outputs:

| Signal | I/O Circuit |
|---|---|
| Digital outputs |  |

**Digital outputs on the DS1512 ZIF I/O connector**

Only I/O modules provide digital outputs on the DS1512 ZIF I/O connector. For signal descriptions, refer to *Digital Outputs* on page 592.

**Related topics**

Basics

- *Bit I/O Unit (DIO Type 4)* (*MicroAutoBox Features*)

# Digital I/O (Bidirectional)

**Objective**

The information on the digital bidirectional I/O channels is only relevant if the DS1512 I/O Board is equipped with a DS1552 Multi-I/O Module. For further information, refer to *Digital I/O (Bidirectional)* on page 595.

# Analog Inputs

**Note on the cable harness**

> **Note**
>
> To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the two ZIF I/O connectors (DS1512 and DS1513). For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**Pin description**

The following table gives a description of the analog input pins on the DS1513 ZIF I/O connector:

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| Z3, Y3, X3, W3, Z4, Y4, X4, W4, Z5, Y5, X5, W5, Z6, Y6, X6, W6 | ADC channel 1 ... 16 | ADC Unit Type 4 | -10 V ... +10 V |
| a3, a4, a5, a6 | External trigger 1 ... 4 | | For information on function of the trigger signals, refer to *ADC Unit Type 4* (📖 *MicroAutoBox Features*). |
| V3, U3, T3, S3, V4, U4, T4, S4, V5, U5, T5, S5, V6, U6, T6, S6 | ADC channel 1 ... 16 | AIO Type 1 ADC Unit | -10 V ... +10 V |

**Characteristics**

The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25° C.

**ADC Unit Type 4** The following table shows the characteristics of the ADC Unit Type 4 channels. All voltages are referenced to SGND pin a2, unless otherwise noted.

| Signal[1)] | Parameter | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **General characteristics** | | | | | | |
| ADC (all 16 channels) | Number of independent input channels | | | 16 | | |
| | Resolution | | | 16 | | bit |
| | Sample rate | Burst mode with more than 1 sample | | | 1 | MSPS |
| | Input voltage range | | -10 | | 10 | V |
| | Conversion timer | Separate for each channel. | | | | |
| | | Width | 27 | | | bit |
| | | Resolution | 10 | | | ns |
| | | Interval | | | 1.342 | s |
| | Timer for time stamping | Common for all channels. Two channels are required to carry one 32 bit value. | | | | |
| | | Width | 32 | | | bit |
| | | Resolution | 10 | | | ns |
| | | Interval | | | 42.9 | s |
| | Buffer size | Software-configurable | 1 | | 8192 | Samples |
| | Buffers per channel | | 3 | | | |
| | Number of external trigger inputs | | 4 | | | |
| **DC characteristics** | | | | | | |
| ADC Type 4 (all 16 channels) | Initial offset error | Below 750 KSPs | -3 | | 3 | mV |
| | Initial gain error | Below 750 KSPs | -0.25 | | 0.25 | % |
| | Input impedance | | | 117 | | kΩ |
| | Offset drift | | | ±40 | | µV/K |
| | Gain drift | | | ±6 | | ppm/K |
| | Overvoltage protection | Continuous | -30 | | +30 | V |
| | | Short term | -50 | | 50 | V |
| External trigger | Input voltage | $V_{iH}$ | 2.3 | | | V |
| | | $V_{iL}$ | | | 0.4 | V |
| | Period | | | | 1 | MHz |
| | Overvoltage protection | Continuous | -48 | | 50 | V |

| Signal[1)] | Parameter | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **AC Characteristics** | | | | | | |
| ADC Type 4 (all 16 channels) | No missing codes | | 15 | | | bit |
| | SNR | 12.4 kHz signal @ 200 KSPs | 80 | | | dB |
| | Input bandwidth | Full power bandwidth | 400 | | | kHz |
| | Channel crosstalk | 100 kHz | | | -96 | dB |
| | | 200 kHz | | | -92 | dB |
| | | 400 kHz | | | -90 | dB |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

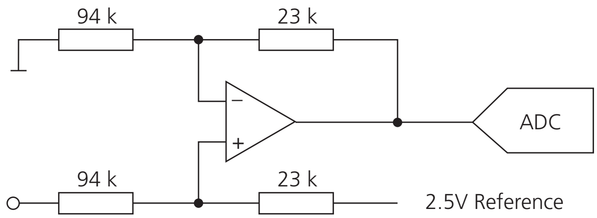
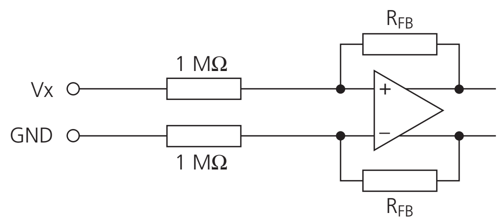
**AIO Type 1 ADC Unit** The following table shows the characteristics of the AIO Type 1 ADC Unit channels. All voltages are referenced to SGND pin a2, unless otherwise noted.

| Parameter[1)] | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| **General characteristics** | | | | | |
| Number of independent input channels | | | 16 | | |
| Resolution | | | 16 | | bit |
| Sample rate | | | | 200 | kSPs |
| Input voltage range | | -10 | | 10 | V |
| Conversion time | inclusive transfer time | | 5 | | µs |
| **DC characteristics** | | | | | |
| Offset error | | -2 | | 2 | mV |
| Gain error | | -1 | | 1 | % of FSR |
| Input impedance | | | 1 | | MΩ |
| **AC Characteristics** | | | | | |
| Low pass filter | 3 dB frequency | | 23 | | kHz |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagrams**

The following table shows *simplified* diagrams of the I/O circuitry of the analog inputs:

| **Signal** | | **I/O Circuit** |
|---|---|---|
| Analog inputs | ADC Type 4 |  |
| | AIO Type 1 ADC Unit |  |

**Analog inputs on the DS1512 ZIF I/O connector**

Only I/O modules provide analog inputs on the DS1512 ZIF I/O connector. For signal descriptions, refer to *Analog Inputs* on page 597.

**Related topics**

Basics

- *ADC Unit Type 4* (*MicroAutoBox Features*)
- *AIO Unit Type 1 (ADC)* (*MicroAutoBox Features*)

# Analog Outputs

**Note on the cable harness**

**Note**

To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the two ZIF I/O connectors (DS1512 and DS1513). For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**Pin description**

The following table gives a description of the analog output pins on the DS1513 ZIF I/O connector:

| Pins (DS1513) | Signal | Module | Default State | Description / Function |
|---|---|---|---|---|
| Z2, Y2, X2, W2, V2, U2, T2, S2 | DAC1 … DAC8 | AIO Type 1 DAC Unit | 0 V | Standard analog outputs<br>16-bit digital values are converted to analog outputs by the DAC module. |

*Default state* means the state of the signal during reset.

**Characteristics**

The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25 °C; all voltages are referenced to SGND pin a2, unless otherwise noted.

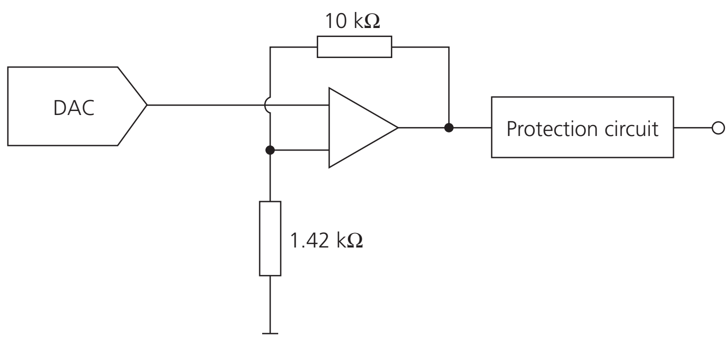
| Signal[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC characteristics** | | | | | | |
| DAC1 ... DAC8 | Output voltage range | | -10 | | +10 | V |
| | Resolution | | | 16 | | bit |
| | Offset error | | -4 | | 4 | mV |
| | Gain error | | -0.25 | | 0.25 | % |
| | $I_{DACout}$ | | -8 | | 8 | mA |
| | $C_{DACout}$ | Maximum load capacitance | | | 22 | nF |
| **AC characteristics** | | | | | | |
| DAC1 ... DAC8 | Settling time | Settling time of output (to 1 %) | | | 1 | µs |
| | $f_{gDAC}$ | Low-pass cutoff frequency of reconstruction filter (3 dB) | 500 | | | kHz |
| | $f_{out}$[2] | Square, ±10 V, $C_{DACout}$ = 1 nF | | | 150 | kHz |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

2) Utilizable output frequency depends on voltage swing and capacitive load.

**Circuit diagrams**

The following table shows a *simplified* diagram of the I/O circuitry of the analog outputs:

| Signal | | I/O Circuit |
|---|---|---|
| Analog outputs | DAC1 … DAC8 (AIO Type 1) |  |

**Analog outputs on the DS1512 ZIF I/O connector**

Only I/O modules provide analog outputs on the DS1512 ZIF I/O connector. For signal descriptions of the DS1552 Multi-I/O Module, refer to *Analog Outputs* on page 602.

**Related topics**

Basics

- *AIO Unit Type 1 (DAC)* (📖 *MicroAutoBox Features*)

# Interfaces

**Pin description**

The following tables give a description of the interface pins provided by the two ZIF connectors.

> **Tip**
>
> The pinout of the ECU interface connectors, USB device connector, and Ethernet I/O connector is not documented. Use a suitable dSPACE connection cable.

**DS1512 ZIF I/O connector**

The following tables give a description of the interface pins provided by the DS1512 ZIF I/O connector.

You can install IP modules of various types to the DS1512:

- DS4340 FlexRay Interface Modules
- DS4342 CAN FD Interface Modules

- Third-party FlexRay IP modules
- Standard IP modules

**DS4340 FlexRay Interface Module** For a description of the interface pins of the DS4340 FlexRay Interface Module, refer to *Interfaces* on page 637.

**DS4342 CAN FD Interface Module** For a description of the interface pins of the DS4342 CAN FD Interface Module, refer to *Interfaces* on page 645.

**(FlexRay) IP Module 1** The table describes the pins when a third-party FlexRay IP module is installed.

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| C6 | IP wakeup 1 | IP_Type1 | You do not need to connect this pin because wake-up functionality is not supported. |
| L3 | IP GND 1 | IP_Type1 | Connection to GND |
| M3 | IP bus high/A 1 | IP_Type1 | FlexRay 1 high in/out (FlexRay-H) |
| M4 | IP bus low/B 1 | IP_Type1 | FlexRay 1 low in/out (FlexRay-L) |
| J3 | IP GND 2 | IP_Type1 | Connection to GND |
| K3 | IP bus high/A 2 | IP_Type1 | FlexRay 2 high in/out (FlexRay-H) |
| K4 | IP bus low/B 2 | IP_Type1 | FlexRay 2 low in/out (FlexRay-L) |
| G5 | Reserved | - | Do not connect |
| H6 | Reserved | - | Do not connect |
| H5 | Reserved | - | Do not connect |
| J6 | Reserved | - | Do not connect |
| J5 | Reserved | - | Do not connect |
| K6 | Reserved | - | Do not connect |
| K5 | Reserved | - | Do not connect |

**(FlexRay) IP Module 2 and DS4340 Module 2** The table describes the pins when a third-party FlexRay IP module is installed.

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| S6 | IP wakeup 1 | IP_Type1 | You do not need to connect this pin because wake-up functionality is not supported. |
| a3 | IP GND 3 | IP_Type1 | Connection to GND |
| b3 | IP bus high/A 3 | IP_Type1 | FlexRay 1 high in/out (FlexRay-H) |
| b4 | IP bus low/B 3 | IP_Type1 | FlexRay 1 low in/out (FlexRay-L) |
| Y3 | IP GND 4 | IP_Type1 | Connection to GND |
| Z3 | IP bus high/A 4 | IP_Type1 | FlexRay 2 high in/out (FlexRay-H) |
| Z4 | IP bus low/B 4 | IP_Type1 | FlexRay 2 low in/out (FlexRay-L) |
| W5 | Reserved | - | Do not connect |

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| X6 | Reserved | - | Do not connect |
| X5 | Reserved | - | Do not connect |
| Y6 | Reserved | - | Do not connect |
| Y5 | Reserved | - | Do not connect |
| Z6 | Reserved | - | Do not connect |
| Z5 | Reserved | - | Do not connect |

**DS1513 ZIF I/O connector**

The DS1513 ZIF I/O connector provides the interface pins to connect CAN bus interfaces, LIN bus interfaces, or for serial communication.

| Pins | Signal | Module Type | Description / Function |
|---|---|---|---|
| c3 | CAN 1 low | CAN Type 1 | CAN controller:<br>■ CAN 1 high = CAN high of module number 1, channel number 1<br>■ CAN 2 high = CAN high of module number 1, channel number 2<br>■ CAN 3 high = CAN high of module number 2, channel number 1<br>■ CAN 4 high = CAN high of module number 2, channel number 2<br>■ CAN 5 high = CAN high of module number 3, channel number 1<br>■ CAN 6 high = CAN high of module number 3, channel number 2<br>■ ISO 11898 interface<br>■ The DS1513 provide a split termination. The CAN bus termination resistors are switchable by software. For further information, refer to *Setup Page (RTICANMM ControllerSetup)* (*RTI CAN MultiMessage Blockset Reference*) or *Unit Page (RTICAN CONTROLLER SETUP)* (*RTI CAN Reference*). |
| c2 | CAN 1 high | | |
| b3 | CAN 2 low | | |
| b2 | CAN 2 high | | |
| B3 | CAN 3 low | | |
| B2 | CAN 3 high | | |
| A3 | CAN 4 low | | |
| A2 | CAN 4 high | | |
| P3 | CAN 5 low | | |
| P2 | CAN 5 high | | |
| N3 | CAN 6 low | | |
| N2 | CAN 6 high | | |
| c6 | Serial 1 RXD[1)] | | RS232 interface |
| c5 | Serial 1 TXD[1)] | | |
| b5 | Serial 2 K / LIN[1)] | | |
| b6 | Serial 2 L[1)] | | |

| Pins | Signal | Module Type | Description / Function |
|---|---|---|---|
| B6 | Serial 3 RXD[1] | | LIN or ISO 9141 interface<br>The K line/LIN interface is bidirectional. The L line is input only. Both lines have no pull-up. For proper function of the K line connect an external pull-up resistor (4.7 kΩ) from this line to VBAT.<br>For information on configuring a LIN master, refer to *Connecting to a LIN Bus* on page 108. |
| B5 | Serial 3 TXD[1] | | |
| A5 | Serial 4 K / LIN[1] | | |
| A6 | Serial 4 L[1] | | |
| P6 | Serial 5 RXD[1] | | |
| P5 | Serial 5 TXD[1] | | |
| N5 | Serial 6 K / LIN[1] | | |
| N6 | Serial 6 L[1] | | |

1) For a mapping of converter and channel numbers, as used in RTI and RTLib, refer to *Basics on Serial Interface* (📖 *MicroAutoBox Features*).

**Note**

Due to the limitations of the UART baud rate generator, not all baud rates can be programmed exactly to the desired baud rate without error (see Baud rate calculation of the serial interface).

**Characteristics**

The interface characteristics are specified for the following conditions: $V_{BAT} = +12$ V; $T_{CASE} = +25$ °C; all voltages are referenced to GND pins of the ZIF connectors, unless otherwise noted.

| dSPACE Board | Interface | Parameter | Conditions / Comments | Specification[1] |
|---|---|---|---|---|
| DS1401 | Host PC | Protocol | TCP/IP | — |
| | | Bitrate | — | ■ 10/1000[2]<br>■ 10/100[3] |
| | | Data throughput | — | max. 2.6 MB/sec |
| | | Voltage levels | Ethernet standard | — |
| | Ethernet I/O | Protocol | UDP/IP | — |
| | | Bitrate | — | typ. 1000 Mbit |
| | | Voltage levels | Ethernet standard | — |
| | USB | USB 2.0 standard (USB Flight Recording) | | |
| | | Data throughput | without connected host tool | max. 1280 kB/sec |
| | | | with connected host tool | max. 1024 kB/sec |
| | | | without data loss during cold start (depends on the boot time of the host interface) | max. 640 kB/sec |
| | | Current | — | max. 1.3 A |
| | | Voltage | — | max. 5 V |

| dSPACE Board | Interface | Parameter | Conditions / Comments | | Specification[1] |
|---|---|---|---|---|---|
| DS1513 | ECU | Bit rate | LVDS mode | | max. 250 Mbit |
| | | | LVDS2 mode | | max. 500 Mbit |
| | | Cable length | 2-paired twisted pair | | max. 5 m (16.4 ft.) |
| | | Cable type | | | CAT5 |
| | | Voltage levels | LVDS standard | | — |
| | | Full duplex data rate [4] | LVDS mode | Single transfer | max. 5 MWord/s |
| | | | LVDS2 mode | Single transfer | max. 11.2 MWord/s |
| | | | | Block transfer | max. 28 MWord/s |
| | | RAM size [4] | LVDS / LVDS2 mode | | 16 kWord |
| | | FIFO size[4] | LVDS / LVDS2 mode<br>(Transmit buffer) | | 1 kWord |
| | CAN | Bit rate | ISO 11898 interface | | max. 1 MBaud |
| | Serial 1/3/5<br>RS232-Interface | Bit rate | — | | ■ min. 14 Baud<br>■ max. 115.2 kBaud |
| | | TX output voltage swing | 3 kΩ load | | ■ min. ±5 V<br>■ typ. ±9 V |
| | | $V_{RxinLow}$ | RX input threshold low | | ■ typ. 1.4 V<br>■ max. 0.8 V |
| | | $V_{RxinHigh}$ | RX input threshold high | | ■ min. 2.0 V<br>■ typ. 1.4 V |
| | | Word length | — | | ■ min. 5 bit<br>■ max. 8 bit |
| | Serial 2/4/6<br>ISO9141-Interface | Bit rate | $R_{KO}$ = 510 Ω; $C_K \leq$ 1.3 nF | | ■ min. 14 Baud<br>■ max. 50 kBaud |
| | | Word length | — | | ■ min. 5 bit<br>■ max. 8 bit |
| | Serial 2/4/6<br>LIN Interface | Bit rate | — | | ■ min. 14 Baud<br>■ max. 20 kBaud |
| DS1512 | FlexRay | Bit rate | — | | max. 2 x 10 MBaud |
| | | Frame length | — | | max. 12 byte |
| | CAN FD | Bit rate | ISO 11898 interface | | max. 2 x > 2 MBaud |
| | IP module carrier | Clocking | — | | ■ min. 8 MHz<br>■ max. 32 MHz |
| | | Access type | — | | byte / word |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.
2) Since board revision DS1401-23 (available since dSPACE Release 7.2).
3) Before board revision DS1401-23
4) Word is 16-bit wide

**Baud rate calculation of the serial interface**

**Note**

Due to the limitations of the UART baud rate generator, not all baud rates can be programmed exactly to the desired baud rate without error.

The UART baud rate generator provides several baud rates:

*To calculate the divisor T for a chosen baud rate*

$$T = \text{Round}\left(\frac{921600}{\text{BR (chosen)}}\right)$$

BR (chosen) = The baudrate to be generated
T = The baudrate generator divisor ($8 \leq T \leq 65535$)

*To calculate the real baud rate from a given divisor T*

$$\frac{\text{BR (real)}}{\text{Baud}} = \frac{921600}{T}$$

BR (real) = The baudrate you get
T = The baudrate generator divisor ($8 \leq T \leq 65535$)

*To calculate the resulting error*

$$\frac{\text{Error}_{BR}}{100\%} = \frac{\text{BR (real)} - \text{BR (chosen)}}{\text{BR (chosen)}}$$

**Note**

If $\text{Error}_{BR} \leq 2\%$, messages will be transferred and received correctly.

# Data Sheet MicroAutoBox II 1401/1513

**Where to go from here**

Information in this section

# Overview and General Information

**Where to go from here**

Information in this section

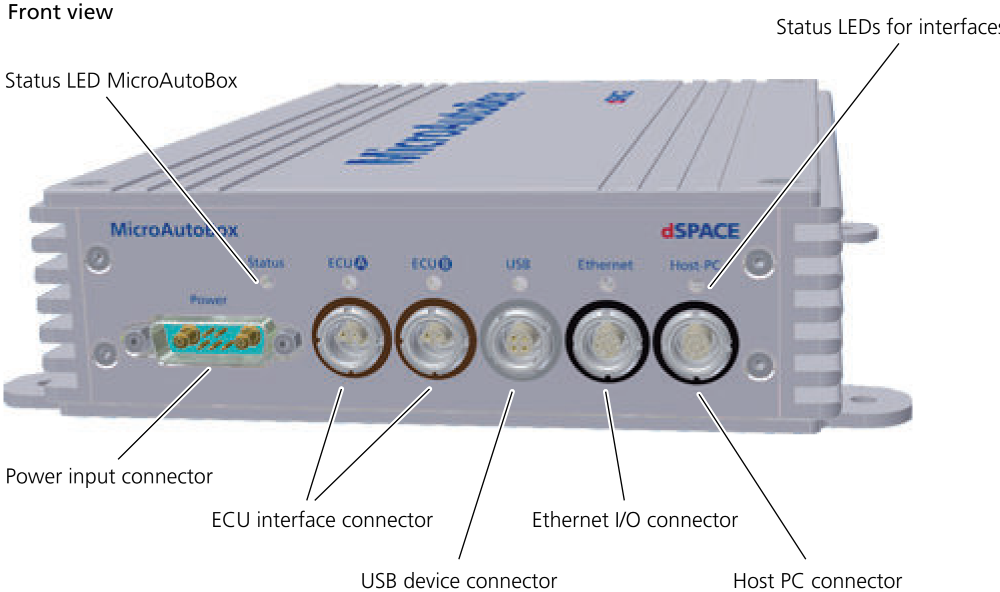


## Housing Components

**Connectors and status LEDs**

The illustrations show where the connectors and status LEDs are located on MicroAutoBox II 1401/1513.

Front view



Rear view


MicroAutoBox II 1401/1513 contains the following connectors and LEDs (from left to right):

**Power input connector** Supplies the required power to MicroAutoBox. It is a 7-pin, male Sub-D connector with two high-current pins.

A preconfigured cable with a matching connector and a separate power input connector are included in each MicroAutoBox package. For the pinout and further details on the preconfigured cable, refer to *Power Input Connector* on page 516.

**Status LED MicroAutoBox** Shows you different states and potential malfunctions.

If battery power is switched on and the REMOTE signal/KL15 is activated (see *Basics on Connecting to Power Supply* on page 44), the status LED (= dual LED) shows different states indicated by the LED color:

- LED is red: Reset state and no application is downloaded to the real-time processor.
- LED is green: Application is running.
- LED is flashing red: MicroAutoBox is in secured mode. For further instructions, refer to *Checking MicroAutoBox* on page 672.

The status LED on the front panel has the same functionality as the status LED on the rear panel of MicroAutoBox.

**ECU interface connectors** Provide communication to ECUs based on the LVDS standard, for example, in bypassing scenarios or to connect a RapidPro system (used as I/O subsystem). The ECU interface connectors are 4-pin LEMO connectors. Matching cables are supplied from dSPACE on request.

The corresponding LED is lit green, if power at both ends of the link is available and the relevant connection is serviceable. The LED flashes when data is being sent or received.

The table below shows the different ECU interfaces integrated into MicroAutoBox and the display names they are mapped to in the experiment software, for example, ControlDesk.

| Display Name in Software | Connectors Built-in at MicroAutoBox | |
|---|---|---|
| | ECU A | ECU B |
| ECU 1 | ✓ | – |
| ECU 2 | – | ✓ |

**USB device connector** A 4-pin LEMO connector to connect an USB mass storage device to use the USB Flight Recorder feature of MicroAutoBox. A matching cable with a LEMO-USB adapter is supplied from dSPACE on request.

**Note**

To use the USB Flight Recorder, a separate license is required.

The possible states of the corresponding LED are listed in the table below:

| LED Status | Meaning |
|---|---|
| Off | No USB device is connected. |
| Green | USB device is connected and flight recorder is not running. |
| Green blinking | USB device is connected and flight recorder is running. |
| Orange | USB device is full and the active flight recorder is specified not to overwrite old files. |
| Red | Write error when accessing the USB device, for example, if the device was removed while the flight recorder was running. |

For further information, refer to *Flight Recorder* (📖 *MicroAutoBox Features*).

**Ethernet I/O connector** An 8-pin LEMO connector that provides communication to external devices, such as PCs or ECUs based on the UDP/IP Ethernet protocol, for example, in bypassing scenarios.

A matching cable with a LEMO-RJ45 adapter is supplied from dSPACE on request.

The corresponding LED is lit green if power is available at both ends of the link and the relevant connection is serviceable. The LED flashes green when data is being sent or received.

For installation instructions, refer to *How to Connect MicroAutoBox to the ECU via UDP/IP* (📖 *ECU Interfaces Hardware Installation and Configuration*).

**Host PC connector** Provides the communication between MicroAutoBox and your host PC based on the Ethernet TCP/IP protocol. The connector is a 8-pin LEMO connector. A matching cable is included in each MicroAutoBox package.

The corresponding LED is lit green if power is available at both ends of the link and the relevant connection is serviceable. The LED flashes green when data is being sent or received.

**Tip**

The Ethernet I/O connector and the Host PC connector are internally connected by a common gigabit Ethernet switch (valid for base board DS1401-25ff).

This simplifies the connection options. For an example, refer to *Connecting an ECU with DCI-GSI2 for Simultaneous Calibration and Bypassing* (📖 *ECU Interfaces Hardware Installation and Configuration*).

**ZIF I/O connector** The 156-pin zero insertion force (ZIF) I/O connector provides access to the most input and output signals provided by MicroAutoBox. A matching connector is included in each MicroAutoBox package.

For the pinout, refer to *ZIF I/O Connector* on page 514.

# General Data

**General characteristics** The following table shows some general characteristics of MicroAutoBox:

| Parameter | | Specification[1] |
|---|---|---|
| Base board (DS1401-20ff.) | Processor | ■ PPC750 GL Power PC<br>■ 900 MHz clock frequency<br>■ Real-time clock |
| | Memory | ■ 8 MB global RAM<br>■ 16 MB local RAM<br>■ 16 MB flash memory |
| | Onboard sensors[2] | Pressure sensor:<br>■ Base board DS1401-23ff.<br>■ Range: 50 kPA ...115 kPa<br>■ Accuracy: 1 kPa<br>■ Sample rate: approx. 200 Hz<br>Acceleration sensor<br>■ Base board DS1401-23ff.<br>■ Range: ±2 g ... ±8 g in 3 axis (x/y/z)<br>■ Resolution: 10 bit per axis<br>■ Sample rate: max. 800 Hz<br>■ FIFO buffer: 512 words (to read and write bursts) |
| Communication interfaces | | ■ 1 x Host PC interface based on Ethernet TCP/IP protocol<br>■ 1 x Ethernet I/O interface based on Ethernet UDP/IP protocol for Ethernet bypassing scenarios<br>■ 2 x ECU interface based on LVDS standard<br>■ 1 x USB interface for USB flight recording (separate license) |
| I/O connectors | | ■ 1 x 156-pin ZIF I/O connector<br>  ■ max. 15 mΩ contact resistance<br>  ■ 10000 cycles durability<br>  ■ max. 2.5 A continuous current per pin ($T_{ambient}$ = +85 °C)<br>■ 1 x 7-pin power supply input connector |

| Parameter | | Specification[1] |
|---|---|---|
| Chassis dimensions | Case width | 202 mm (7.95 in.) |
| | Case height | 50 mm (1.97 in.) |
| | Case depth | 222 mm (8.74 in.) |
| Weight | | About 2.1 kg (4.6 lb.) without external cables |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.
[2] For further information on the sensors, refer to *Onboard Sensors* (📖 *MicroAutoBox Features*).

**Functional I/O units on the I/O board**

The following table shows a mapping of the input/output units on the I/O board which is part of the MicroAutoBox:

| dSPACE I/O board | Functional Unit |
|---|---|
| DS1513 | *ADC Unit Type 4* (📖 *MicroAutoBox Features*) |
| | *AIO Unit Type 1 (ADC)* (📖 *MicroAutoBox Features*) |
| | *AIO Unit Type 1 (DAC)* (📖 *MicroAutoBox Features*) |
| | *Bit I/O Unit (DIO Type 4)* (📖 *MicroAutoBox Features*) |

# Absolute Maximum Levels

**Avoiding damage to the system**

**NOTICE**

Do not exceed the maximum levels since this might permanently damage the system.

**Levels**

The following table shows the levels (for example, voltage, temperature) of the MicroAutoBox. All voltages are referenced to GND (unless otherwise noted).

| Parameter | Specification[1] | Description |
|---|---|---|
| VBAT | –40 V ... +100 V | Load dump- and reverse protection |
| VDRIVE | 0 V ... +45 V | |
| All digital output voltages | (VDRIVE – 45 V) ... +45 V | |
| All digital input voltages | (VDRIVE – 45 V) ... +45 V | |
| All analog input voltages | –40 V ... +40 V | |

| Parameter | Specification[1] | Description |
|---|---|---|
| All analog output voltages | –30 V ... +40 V | |
| VSENS output | 0 V ... +40 V | VSENS is switched on and off with the REMOTE pin. |
| VBATprot output | 0 V ... +45 V | VBATprot follows VBAT within the specified range.<br>VBATprot is switched on and off with the REMOTE pin. |
| RS232 transceiver output | –30 V ... +30 V | |
| RS232 transceiver input | –30 V ... +30 V | |
| $V_{\text{CAN high}}$, $V_{\text{CAN low}}$ | –58 V ... +58 V | Voltage level on CAN high and CAN low pins. |
| $V_{\text{Diff (CAN high - CAN low)}}$ | –5 V ... +5 V | Voltage difference between CAN high and CAN low pins (due to termination resistors). |
| Serial 2 K / LIN | –20 V ... +32 V | But not more than VBAT |
| Serial 2 L | –24 V ... +30 V | But not more than VBAT |
| All outputs short circuit to GND | continuous | |
| Continuous power dissipation ($T_{\text{ambient}}$ = +85 °C) | max. 25 W | |
| Operating temperature | –40 °C ... +85 °C | |
| Storage temperature | –55 °C ... +125 °C | |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

# Certifications

**CE compliance**

MicroAutoBox meets the requirements of the European directive 2014/30/EU (Electromagnetic Compatibility Directive) for CE marking.

**Applied standards**

The characteristics of MicroAutoBox were tested according to the standards shown in the following table:

| Tested Characteristics | Applied Standard | Description |
|---|---|---|
| Electromagnetic compatibility (EMC) | EN 61326-1 Table 2 | Immunity standard for industrial environments[1)] |
| | CISPR 11, EN 55011 Group 1, Class A | Emission standard for industrial environments |
| | RTCA/DO160G: Dec. 2010: Section 21.4 | Environmental conditions and test procedures for airborne equipment: Conducted RF Emissions, Category: B, L, M&H[2)] |
| | RTCA/DO160G: Dec. 2010: Section 21.5 | Environmental conditions and test procedures for airborne equipment: Radiated RF Emissions, Category: M[2)] |
| Vibration | ISO 16750-3:2007 / 4.1.2.4 Test IV | Test conditions: Broad band noise, 4h per axis, RMS-acceleration 27,8 $m/s^2$ |
| | DO-160F.8 / B1 Test Conditions | Test conditions: Broad band noise, 2h per axis, based on DO160F Section 8, Category B1 |
| | EN 60068-2-6 | Test conditions:<br>■ Swept sine, 1 octave per minute, 3-axis test<br>■ 5 ... 2000 Hz, up to 5 g, 2 sweeps per axis<br>■ Operating |
| Shock | ISO 16750-3:2007 / 4.2.2. | ■ Linear shock (1/2 sine pulse), 6-axis<br>■ 500 $m/s^2$, 6 ms, 10 pulses per axis<br>■ Operating |
| | RTCA / DO-160F Section 7 Test 7.2 Category A Test type R | Operational shocks test (standard):<br>■ Saw-tooth wave, 6-axis<br>■ 200 $m/s^2$, 11 ms, 10 pulses per axis<br>■ Operating |
| | RTCA / DO-160F Section 7 Test 7.2 Category D Test type R | Operational shocks test (low frequency):<br>■ Saw-tooth wave, 6-axis<br>■ 200 $m/s^2$, 20 ms, 10 pulses per axis<br>■ Operating |

[1)] Tested with an I/O cable length < 3 m.
[2)] For further information, refer to dSPACE Support.

**Vibration and shock tests**

To verify the reliability of MicroAutoBox under realistic operating conditions, it was exposed to vibration and shock tests. During the tests, MicroAutoBox executed a program without any failures.

# Connector Pinouts

**Where to go from here**

Information in this section



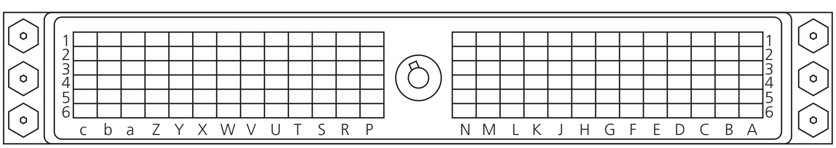
## ZIF I/O Connector

**Objective**

The I/O connector is a 156-pin zero insertion force (ZIF) connector giving access to the most input and output signals provided by MicroAutoBox.

**Pinout**

The following illustration shows the pin numbering of the I/O connector (front view of MicroAutoBox):




**Note**

There are pins identified by uppercase letters (A, B, C, etc.) and pins identified by lowercase letters (a, b, c).

The following table shows the signals of the I/O connector:

| 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GND | in | CAN 4 high | i/o | CAN 4 low | i/o | GND | in | Serial 4 K / LIN[1] | i/o | Serial 4 L[1] | in | *A* |
| GND | in | CAN 3 high | i/o | CAN 3 low | i/o | GND | in | Serial 3 TXD[1] | out | Serial 3 RXD[1] | in | *B* |
| GND | in | DigP 1 ch 5[2] | out | DigP 1 ch 10 | out | DigP 1 ch 15 | out | DigP 2 ch 4 | out | GND | in | *C* |
| GND | in | DigP 1 ch 4 | out | DigP 1 ch 9 | out | DigP 1 ch 14 | out | DigP 2 ch 3 | out | DigP 2 ch 8 | out | *D* |
| GND | in | DigP 1 ch 3 | out | DigP 1 ch 8 | out | DigP 1 ch 13 | out | DigP 2 ch 2 | out | DigP 2 ch 7 | out | *E* |
| GND | in | DigP 1 ch 2 | out | DigP 1 ch 7 | out | DigP 1 ch 12 | out | DigP 2 ch 1 | out | DigP 2 ch 6 | out | *F* |
| GND | in | DigP 1 ch 1 | out | DigP 1 ch 6 | out | DigP 1 ch 11 | out | DigP 1 ch 16 | out | DigP 2 ch 5 | out | *G* |
| GND | in | DigP 1 ch 5 | in | DigP 1 ch 10 | in | DigP 1 ch 15 | in | DigP 2 ch 4 | in | GND | in | *H* |

| 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GND | in | DigP 1 ch 4 | in | DigP 1 ch 9 | in | DigP 1 ch 14 | in | DigP 2 ch 3 | in | DigP 2 ch 8 | in | *J* |
| GND | in | DigP 1 ch 3 | in | DigP 1 ch 8 | in | DigP 1 ch 13 | in | DigP 2 ch 2 | in | DigP 2 ch 7 | in | *K* |
| GND | in | DigP 1 ch 2 | in | DigP 1 ch 7 | in | DigP 1 ch 12 | in | DigP 2 ch 1 | in | DigP 2 ch 6 | in | *L* |
| VSENS | out | DigP 1 ch 1[2)] | in | DigP 1 ch 6 | in | DigP 1 ch 11[2)] | in | DigP 1 ch 16 | in | DigP 2 ch 5 | in | *M* |
| VDRIVE | in | CAN 6 high | i/o | CAN 6 low | i/o | GND | in | Serial 6 K / LIN[1)] | i/o | Serial 6 L[1)] | in | *N* |
| VBAT prot | out | CAN 5 high | i/o | CAN 5 low | i/o | GND | in | Serial 5 TXD[1)] | out | Serial 5 RXD[1)] | in | *P* |
| REMOTE | in | GND | in | GND | in | GND | in | GND | in | GND | in | *R* |
| GND | in | AnalogOut ch 8 | out | AnalogIn ch 4 | in | AnalogIn ch 8 | in | AnalogIn ch 12 | in | AnalogIn ch 16 | in | *S* |
| GND | in | AnalogOut ch 7 | out | AnalogIn ch 3 | in | AnalogIn ch 7 | in | AnalogIn ch 11 | in | AnalogIn ch 15 | in | *T* |
| GND | in | AnalogOut ch 6 | out | AnalogIn ch 2 | in | AnalogIn ch 6 | in | AnalogIn ch 10 | in | AnalogIn ch 14 | in | *U* |
| GND | in | AnalogOut ch 5 | out | AnalogIn ch 1 | in | AnalogIn ch 5 | in | AnalogIn ch 9 | in | AnalogIn ch 13 | in | *V* |
| GND | in | AnalogOut ch 4 | out | Analog ch 4 | in | Analog ch 8 | in | Analog ch 12 | in | Analog ch 16 | in | *W* |
| GND | in | AnalogOut ch 3 | out | Analog ch 3 | in | Analog ch 7 | in | Analog ch 11 | in | Analog ch 15 | in | *X* |
| GND | in | AnalogOut ch 2 | out | Analog ch 2 | in | Analog ch 6 | in | Analog ch 10 | in | Analog ch 14 | in | *Y* |
| GND | in | AnalogOut ch 1 | out | Analog ch 1 | in | Analog ch 5 | in | Analog ch 9 | in | Analog ch 13 | in | *Z* |
| GND | in | SGND | in | Ana trigger 1 | in | Ana trigger 2 | in | Ana trigger 3 | in | Ana trigger 4 | in | *a* |
| GND | in | CAN 2 high | i/o | CAN 2 low | i/o | GND | in | Serial 2 K / LIN[1)] | i/o | Serial 2 L[1)] | in | *b* |
| GND | in | CAN 1 high | i/o | CAN 1 low | i/o | GND | in | Serial 1 TXD[1)] | out | Serial 1 RXD[1)] | in | *c* |

1) For a mapping of converter and channel numbers, as used in RTI and RTLib, refer to *Basics on Serial Interface* (*MicroAutoBox Features*).

2) DigP = Port number; ch = Channel number

**Tip**

To use the digital inputs and outputs, you have to connect the VDRIVE pin inside the ZIF I/O connector according to the logic level needed. *This pin is not preconfigured in the ZIF I/O connector delivered with each MicroAutoBox II.* You have to connect VDRIVE (pin N1) to VSENS (pin M1) or VBATprot (pin P1). Use the preconfigured jumper cable which is included in the MicroAutoBox package.

**Signal descriptions**

For descriptions of the signals which are available on the ZIF I/O connector, refer to:


- *Power Inputs and Outputs* on page 518
- *Digital Inputs* on page 521
- *Digital Outputs* on page 523
- *Analog Inputs* on page 528
- *Analog Outputs* on page 531
- CAN, LIN, serial: *Interfaces* on page 533

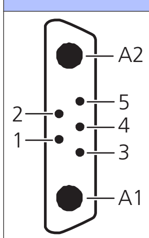

# Power Input Connector

**Objective**

MicroAutoBox provides a power input connector. It is a 7-pin, male connector with two high-current pins. It is a special variant of a 15-pin Sub-D connector (mixed-layout 7W2 Sub-D).

**Pinout**

The following illustration shows the pinout (front view of MicroAutoBox).

| Connector | Pin | Signal | Pin | Signal |
|---|---|---|---|---|
|   | A2[1] | VBAT (6 V … 40 V DC) | | |
| | | | 5 | REMOTE_PULLUP |
| | 2 | Do not connect | 4 | REMOTE[2] |
| | 1 | Do not connect | 3 | Do not connect |
| | A1 | GND | | |

1) NOTE: It is highly recommended to insert a fuse into the main power supply input wire (close to battery). Choose the value of the fuse according to the maximum current. A 10 A fuse is recommended.

2) The REMOTE input must be connected via switch or bridge to UBAT to run the MicroAutoBox. For example, you can use it for switching MicroAutoBox with KL15 (output of the ignition/driving switch). So, you can use the nonvolatile data feature to store data you may want to use again when restarting the application. For further information, refer to *Nonvolatile Data Handling* (📖 *MicroAutoBox RTLib Reference*).

**Matching cable**

A preconfigured cable for the supply voltage is provided by dSPACE. This cable is for running MicroAutoBox with a laboratory power supply during development. Therefore, REMOTE (pin 4) is shorted to VBAT (pin A2) inside the connector in order to save a separate switch.

Do not use this cable in the vehicle. Otherwise, MicroAutoBox will always be turned on.

The VBAT wire (red) contains a melting fuse. Each wire has a cross-section of 1.5 mm².

Fuse specification:

- Cable delivered through dSPACE Release 2013-B: 7.5 A, time lag
- Cable delivered as of dSPACE Release 2014-A: 10 A, time lag

# Signal Descriptions

**Where to go from here**

Information in this section



## Power Inputs and Outputs

**Pin description**

The following table gives a description of the pins used for power input, remote input and supply of digital I/O circuits.

| Connector | Pins | Signal | Description / Function |
|---|---|---|---|
| Power input connector | A2 | VBAT | Main power supply input. Connect this pin to the positive pole of your car battery. |
| | A1 | GND | Main power supply return and reference for all input and output signals. Connect this pin to the minus pole of your car battery. The case of MicroAutoBox is also connected to GND. |

| Connector | Pins | Signal | Description / Function |
|---|---|---|---|
| | 4 | REMOTE | ■ The REMOTE input may be used for starting MicroAutoBox with a remote switch, for example KL15 (output of the ignition/driving switch).<br>■ If you connect the remote pin to the plus pole of the car battery directly, MicroAutoBox will always be turned on, and the car battery will soon be exhausted if the engine is not running. Thus, a switch is highly recommended.<br>■ The voltage connected to the REMOTE pin should not exceed the supply voltage.<br>■ To wake up MicroAutoBox via CAN messages, the REMOTE pin must be left open when MicroAutoBox is powered down. This is due to the fact that there is an additional internal connection to the REMOTE pin. Nevertheless, you can always use a remote switch to supply voltage (e.g., VBAT) to start MicroAutoBox. |
| | 5 | REMOTE_Pullup | You can use this output to connect a remote switch between REMOTE and this pin. REMOTE_Pullup is internally connected to VBAT via 39 kΩ pull-up resistor. |
| ZIF I/O connector | A1, A4, B1, B4, C1, C6, D1, E1, F1, G1, H1, H6, J1, K1, L1, N4, P4, R2 ... R6, S1, T1, U1, V1, W1, X1, Y1, Z1, a1, b1, b4, c1, c4 | GND | Main power supply return and reference for all input and output signals. Use the nearest possible GND pin as reference for your signals in order to keep noise levels at minimum. The case of MicroAutoBox is also connected to GND. |
| | N1 | VDRIVE | This input supplies all digital input and output circuits.<br>■ Connect this input to VSENS to set CMOS/TTL-compatible logic levels for your inputs/outputs.<br>■ Connect this input to VBATprot to set automotive-compatible logic levels for your inputs/outputs.<br>■ Do not connect this pin directly to VBAT, because the input and output circuits are not load-dump-protected or reverse-voltage-protected at this signal. |

| Connector | Pins | Signal | Description / Function |
|---|---|---|---|
| | M1 | VSENS | Sensor supply output.<br>Use this output to supply your sensors and/or VDRIVE. If you need CMOS/TTL-compatible logic levels at the inputs/outputs connect VSENS to VDRIVE. |
| | P1 | VBAT prot | Protected VBAT output.<br>Use this output to supply VDRIVE when automotive logic levels are needed. |
| | R1 | REMOTE | ■ The remote voltage may be used for starting MicroAutoBox with a remote switch: KL15, for example (output of the ignition/driving switch).<br>■ If you connect the remote pin to the car battery directly, MicroAutoBox will always be turned on, and the car battery will soon be exhausted if the engine is not running. Thus, a switch is highly recommended.<br>■ The remote voltage should not exceed the supply voltage. |

**Tip**

To use the digital inputs and outputs, you have to connect the VDRIVE pin inside the ZIF I/O connector according to the logic level needed. *This pin is not preconfigured in the ZIF I/O connector delivered with each MicroAutoBox II.* You have to connect VDRIVE (pin N1) to VSENS (pin M1) or VBATprot (pin P1). Use the preconfigured jumper cable which is included in the MicroAutoBox package.

**Characteristics**

The characteristics are specified for the following conditions:

- $V_{BAT}$=+12 V (unless otherwise noted)

  $T_{CASE}$=+25 °C (unless otherwise noted)

  All voltages are referenced to GND (unless otherwise noted).

| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Power** | | | | | | |
| Operating voltage | VBAT | For start-up | 6 | | 40 | V |
| | VBAT | Operating | 4 | | 40 | V |
| | VBAT | Reverse protection | | | -40 | V |
| | VBAT | Load dump protection | | | +100 | V |

| Signal[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Inputs** | | | | | | |
| Operating current | $I_{VBAT}$ | REMOTE ≥ $V_{iHRemote}$ | | 1.3 | | A |
| | $I_{VBAT}$ | REMOTE ≤ $V_{iLRemote}$ | | 5 | | mA |
| REMOTE voltage input | $V_{iHRemote}$ | Input high voltage | 4.7 | | | V |
| | $V_{iLRemote}$ | Input low voltage | | | 0.8 | V |
| | $V_{iHysRemote}$ | Input hysteresis voltage | 0.5 | 1 | | V |
| | $R_{inRemote}$ | Input impedance | 60 | | 185 | kΩ |
| Inrush current | $I_{VBAT\ inrush}$ | All inputs/outputs unconnected | see *Power supply* on page 40 | | | |
| Digital I/O voltage supply input | VDRIVE | Supply for digital input/output circuits | | | 45 | V |
| | $I_{VDRIVE\ no\ load}$ | All inputs/outputs unconnected | | 20 | | mA |
| | $I_{VDRIVE\ maximum\ load}$ | All outputs shorted to GND | | 1 | | A |
| **Outputs** | | | | | | |
| Sensor supply output | VSENS | Output voltage | 4.84 | 5.05 | 5.25 | V |
| | VSENS = f(T) | Temperature caused voltage drift $T_{CASE}$ = –40 °C ... +85 °C | –2 | | 2 | % |
| | $I_{VSENS,\ max}$ | Maximum output current | 750 | | | mA |
| Protected VBAT output | VBATprot | IL = 1A; VBAT = 12 V | 11.56 | 11.78 | 12 | V |
| | $I_{VBATprot,\ max}$ | Maximum output current | | | 1000 | mA |
| | $I_{ProtPeak}$ | Overload current limit (–40 °C ... 85 °C) | 4 | | 9 | A |
| | t(overload) | Time to shut off $I_{ProtPeak}$ | | | 5 | ms |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

# Digital Inputs

**Pin description**

The following table gives a description of the digital input pins:

| Pins (DS1513) | Port Number | Signal | Description / Function |
|---|---|---|---|
| M2, L2, K2, J2, H2, M3, L3, K3, J3, H3, M4, L4, K4, J4, H4, M5 | 1 | Channel 1 ... 16 DIO Type 4 | Standard discrete digital input with pull-up. |
| L5, K5, J5, H5, M6, L6, K6, J6 | 2 | Channel 1 ... 8 DIO Type 4 | |

**Characteristics**

The characteristics are specified for the following conditions:

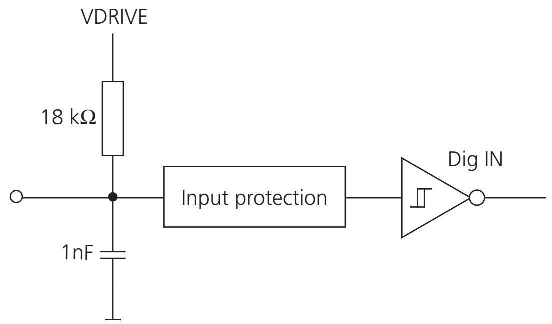
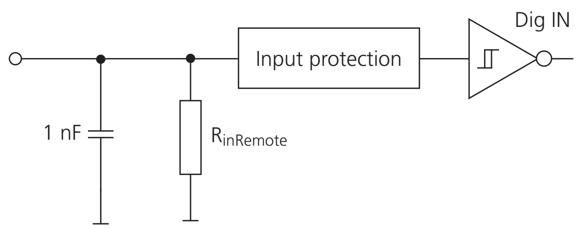
- $V_{BAT}$=+12 V (unless otherwise noted)
  $T_{CASE}$=+25 °C (unless otherwise noted)
  All voltages are referenced to GND (unless otherwise noted).

| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC characteristics** | | | | | | |
| Digital input channel 1 ... 24 | $V_{iH}$ | Input high voltage | 3.1 | | | V |
| | $V_{iL}$ | Input low voltage | | | 1.2 | V |
| | $V_{iHys}$ | Input hysteresis voltage | | 1 | | V |
| | $R_{DigIn}$ | Pull-up resistor to VDRIVE | 17 | 18 | 19 | kΩ |
| | $C_{DigIn}$ | Input capacitance | | 1 | | nF |
| REMOTE | $V_{iHRemote}$ | Input high voltage | 4.7 | | | V |
| | $V_{iLRemote}$ | Input low voltage | | | 0.8 | V |
| | $V_{iHysRemote}$ | Input hysteresis voltage | 0.5 | 1 | | V |
| | $R_{inRemote}$ | Input impedance | 60 | | 185 | kΩ |
| **AC characteristics** | | | | | | |
| Inputs | $t_{LowMin}$ | Minimum pulse width low | | 250 | 500 | ns |
| | $t_{HighMin}$ | Minimum pulse width high | | 300 | 600 | ns |
| | $F_{max}$ | Duty cycle: 50 % | | 1.8 | | MHz |
| | | Duty cycle: 1 % or 99 % | | 33 | | kHz |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagrams**

The following table shows *simplified* diagrams of the I/O circuitry of the digital inputs:

| **Signal** | | **I/O Circuit** |
|---|---|---|
| Digital inputs | Channel 1 ... 24 | <br>For proper operation, VDRIVE must have a level above the maximum input voltage. |
| | Remote |  |

**Related topics**

Basics

- *Bit I/O Unit (DIO Type 4)* (*MicroAutoBox Features*)

# Digital Outputs

**General behavior of digital signals**

All digital outputs are set to high impedance (tristate) until the application is started. Then the outputs follow the states defined in your application. Unused outputs remain in tristate mode.

**Pin description**

The following table gives a description of the digital output pins:

| Pins (DS1513) | Port Number | Signal | Default state | Description / Function |
|---|---|---|---|---|
| G2, F2, E2, D2, C2, G3, F3, E3, D3, C3, G4, F4, E4, D4, C4, G5 | 1 | Channel 1 ... 16<br>DIO Type 4 | Tristate | Standard discrete digital output. |
| F5, E5, D5, C5, G6, F6, E6, D6 | 2 | Channel 1 ... 8<br>DIO Type 4 | | |

**Characteristics**

The characteristics are specified for the following conditions:

- $V_{BAT}$=+12 V (unless otherwise noted)

  $T_{CASE}$=+25 °C (unless otherwise noted)

  All voltages are referenced to GND (unless otherwise noted).

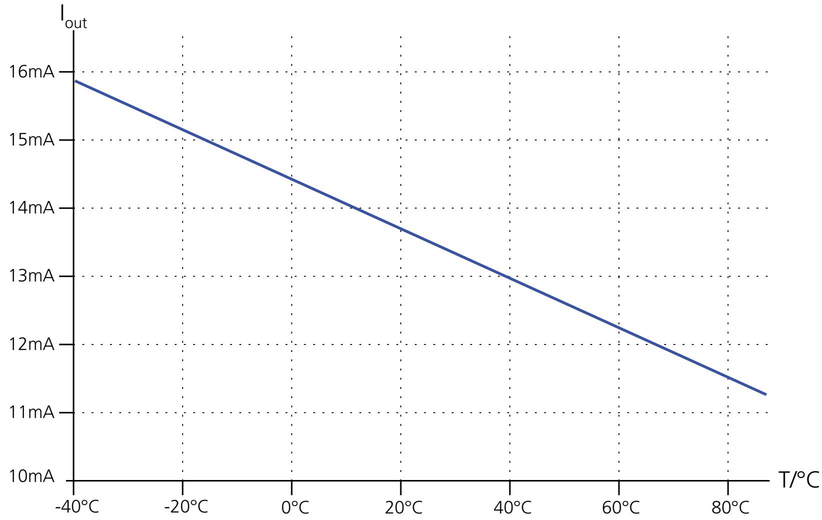
| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC Characteristics** | | | | | | |
| Digital output channel 1 ... 24 | $V_{oH}$ | IL = 0 mA; VDRIVE = 5 V | 4.4 | 4.6 | | V |
| | $V_{oL}$ | IL = 0 mA; VDRIVE = 5 V | | 0.1 | 0.3 | V |
| | $V_{oH}$ | IL = 5 mA; VDRIVE = 5 V | 3.2 | 3.4 | | V |
| | $V_{oL}$ | IL = –5 mA; VDRIVE = 5 V | | 0.7 | 0.9 | V |
| | $V_{oH}$ | IL = 0 mA; VDRIVE = 12 V | 11.3 | 11.6 | | V |
| | $V_{oL}$ | IL = 0 mA; VDRIVE = 12 V | | 0.1 | 0.3 | V |
| | $V_{oH}$ | IL = 5 mA; VDRIVE = 12 V | 10.3 | 10.5 | | V |
| | $V_{oL}$ | IL = –5 mA; VDRIVE = 12 V | | 0.7 | 0.9 | V |
| | $\lvert I_{OHmax} \rvert$ | Current limit high<br>$T_{CASE}$ = –40 °C ... +85 °C | 5 | 13 | 17 | mA |
| | $\lvert I_{OLmax} \rvert$ | Current limit low<br>$T_{CASE}$ = –40 °C ... +85 °C | 5 | 14 | 18 | mA |
| | $\lvert I_{OTLeak} \rvert$ | Leakage current tristate<br>$T_{CASE}$ = -40 °C ... +85 °C | | | 100 | µA |
| **AC Characteristics** | | | | | | |
| Outputs | $t_{minPulseHigh}$ | Minimum pulse width high,<br>VDRIVE = 5 V or 12 V, RL=1 kΩ | | 700 | 1400 | ns |
| | $t_{minPulseLow}$ | Minimum pulse width low,<br>VDRIVE = 5 V or 12 V, RL=1 kΩ | | 200 | 400 | ns |
| | $F_{max}$ | Duty cycle: 50 %<br>VDRIVE = 5 V or 12 V | | 0.7[2)] | | MHz |
| | | Duty cycle: 1 % or 99 %<br>VDRIVE = 5 V or 12 V | | 14 | | kHz |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

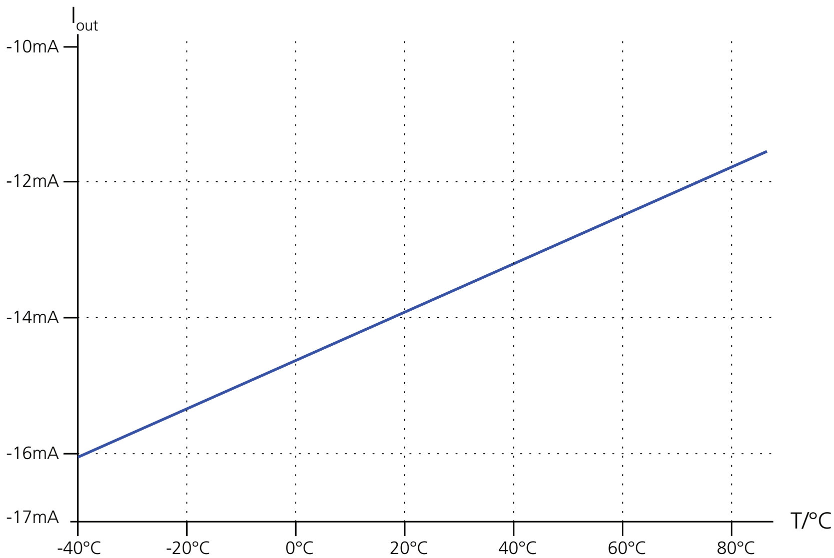
2) Limited by software to 150 kHz

The following illustrations show the maximum output current of a digital output circuit as a function of ambient temperature (VDRIVE = 12 V; output is shorted to 6 V):

- Output high

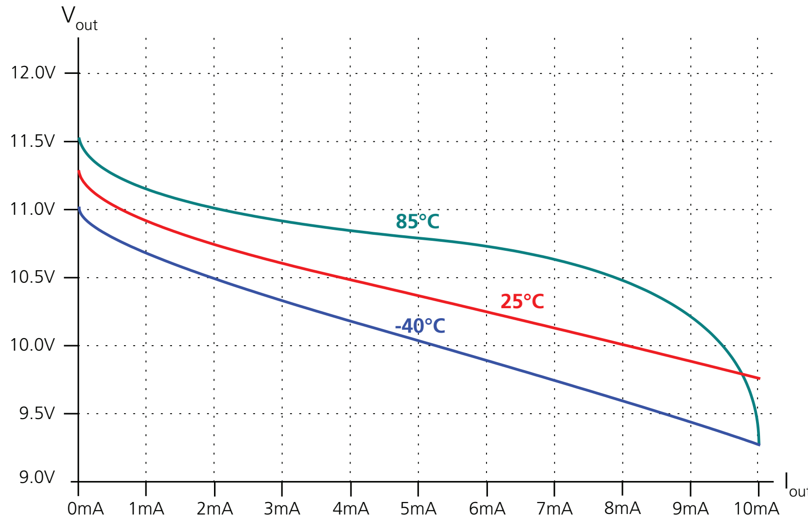



- Output low

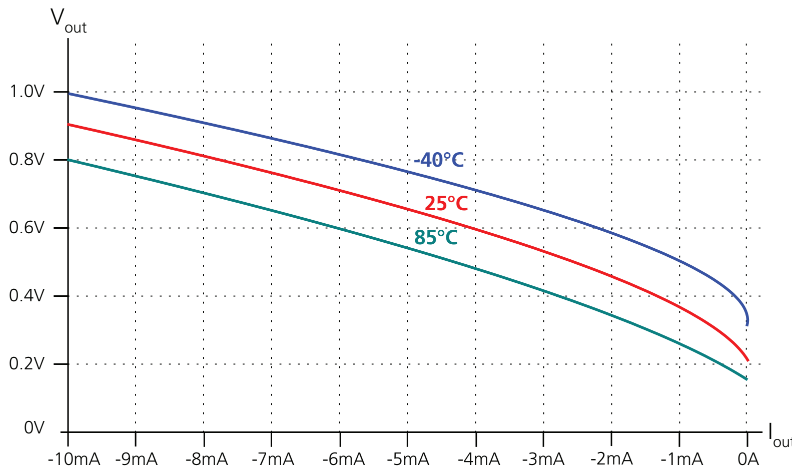


The following illustrations show the typical digital output voltage as a function of the output current (VDRIVE = 12 V):

- Output high

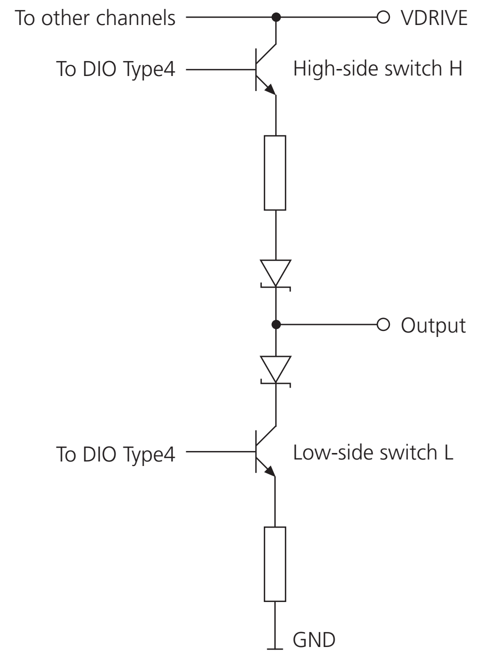



- Output low



**Circuit diagrams**

The following table shows a *simplified* diagram of the I/O circuitry of the digital outputs:

| Signal | I/O Circuit |
|---|---|
| Digital outputs |  |

**Related topics**

Basics

- *Bit I/O Unit (DIO Type 4)* (*MicroAutoBox Features*)

# Analog Inputs

**Pin description**

The following table gives a description of the analog input pins:

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| Z3, Y3, X3, W3, Z4, Y4, X4, W4, Z5, Y5, X5, W5, Z6, Y6, X6, W6 | ADC channel 1 ... 16 | ADC Unit Type 4 | -10 V ... +10 V |
| a3, a4, a5, a6 | External trigger 1 ... 4 | | For information on function of the trigger signals, refer to *Trigger signals* (📖 *MicroAutoBox Features*). |
| V3, U3, T3, S3, V4, U4, T4, S4, V5, U5, T5, S5, V6, U6, T6, S6 | ADC channel 1 ... 16 | AIO Type 1 ADC Unit | -10 V ... +10 V |

**Characteristics**

The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25° C.

**ADC Unit Type 4** The following table shows the characteristics of the ADC Unit Type 4 channels. All voltages are referenced to SGND pin a2, unless otherwise noted.

| Signal[1)] | Parameter | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **General characteristics** | | | | | | |
| ADC (all 16 channels) | Number of independent input channels | | | 16 | | |
| | Resolution | | | 16 | | bit |
| | Sample rate | Burst mode with more than 1 sample | | | 1 | MSPS |
| | Input voltage range | | -10 | | 10 | V |
| | Conversion timer | Separate for each channel. | | | | |
| | | Width | 27 | | | bit |
| | | Resolution | 10 | | | ns |
| | | Interval | | | 1.342 | s |
| | Timer for time stamping | Common for all channels. Two channels are required to carry one 32 bit value. | | | | |
| | | Width | 32 | | | bit |
| | | Resolution | 10 | | | ns |
| | | Interval | | | 42.9 | s |
| | Buffer size | Software-configurable | 1 | | 8192 | Samples |
| | Buffers per channel | | 3 | | | |
| | Number of external trigger inputs | | 4 | | | |
| **DC characteristics** | | | | | | |
| ADC Type 4 (all 16 channels) | Initial offset error | Below 750 KSPs | -3 | | 3 | mV |
| | Initial gain error | Below 750 KSPs | -0.25 | | 0.25 | % |
| | Input impedance | | | 117 | | kΩ |
| | Offset drift | | | ±40 | | µV/K |
| | Gain drift | | | ±6 | | ppm/K |
| | Overvoltage protection | Continuous | -30 | | +30 | V |
| | | Short term | -50 | | 50 | V |
| External trigger | Input voltage | $V_{iH}$ | 2.3 | | | V |
| | | $V_{iL}$ | | | 0.4 | V |
| | Period | | | | 1 | MHz |
| | Overvoltage protection | Continuous | -48 | | 50 | V |

| Signal[1] | Parameter | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **AC Characteristics** | | | | | | |
| ADC Type 4 (all 16 channels) | No missing codes | | 15 | | | bit |
| | SNR | 12.4 kHz signal @ 200 KSPs | 80 | | | dB |
| | Input bandwidth | Full power bandwidth | 400 | | | kHz |
| | Channel crosstalk | 100 kHz | | | -96 | dB |
| | | 200 kHz | | | -92 | dB |
| | | 400 kHz | | | -90 | dB |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

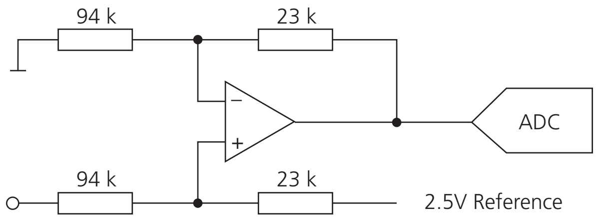
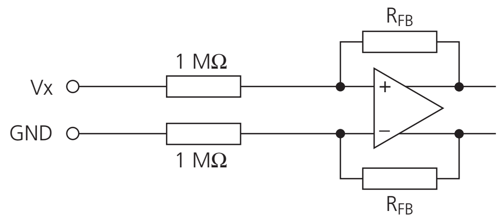
**AIO Type 1 ADC Unit** The following table shows the characteristics of the AIO Type 1 ADC Unit channels. All voltages are referenced to SGND pin a2, unless otherwise noted.

| Parameter[1] | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| **General characteristics** | | | | | |
| Number of independent input channels | | | 16 | | |
| Resolution | | | 16 | | bit |
| Sample rate | | | | 200 | kSPs |
| Input voltage range | | -10 | | 10 | V |
| Conversion time | inclusive transfer time | | 5 | | µs |
| **DC characteristics** | | | | | |
| Offset error | | -2 | | 2 | mV |
| Gain error | | -1 | | 1 | % of FSR |
| Input impedance | | | 1 | | MΩ |
| **AC Characteristics** | | | | | |
| Low pass filter | 3 dB frequency | | 23 | | kHz |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagrams**

The following table shows *simplified* diagrams of the I/O circuitry of the analog inputs:

| Signal | | I/O Circuit |
|---|---|---|
| Analog inputs | ADC Type 4 |  |
| | AIO Type 1 ADC Unit |  |

**Related topics**

Basics

- *ADC Unit Type 4* (*MicroAutoBox Features*)
- *AIO Unit Type 1 (ADC)* (*MicroAutoBox Features*)

# Analog Outputs

**Pin description**

The following table gives a description of the analog output pins:

| Pins | Signal | Module | Default state | Description / Function |
|---|---|---|---|---|
| Z2, Y2, X2, W2, V2, U2, T2, S2 | DAC1 … DAC8 | AIO Type 1 DAC Unit | 0 V | Standard analog outputs<br>16-bit digital values are converted to analog outputs by the DAC module. |

*Default state* means the state of the signal during reset.

**Characteristics**

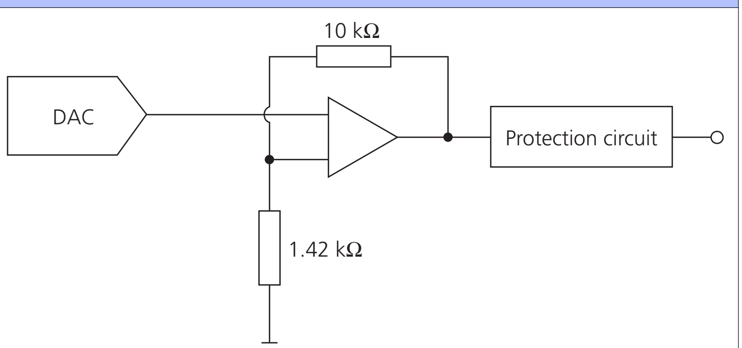
The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25 °C; all voltages are referenced to SGND pin a2, unless otherwise noted.

| Signal[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC characteristics** | | | | | | |
| DAC1 ... DAC8 | Output voltage range | | -10 | | +10 | V |
| | Resolution | | | 16 | | bit |
| | Offset error | | -4 | | 4 | mV |
| | Gain error | | -0.25 | | 0.25 | % |
| | $I_{DACout}$ | | -8 | | 8 | mA |
| | $C_{DACout}$ | Maximum load capacitance | | | 22 | nF |
| **AC characteristics** | | | | | | |
| DAC1 ... DAC8 | Settling time | Settling time of output (to 1 %) | | | 1 | µs |
| | $f_{gDAC}$ | Low-pass cutoff frequency of reconstruction filter (3 dB) | 500 | | | kHz |
| | $f_{out}$[2] | Square, ±10 V, $C_{DACout}$ = 1 nF | | | 150 | kHz |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.
2) Utilizable output frequency depends on voltage swing and capacitive load.

**Circuit diagrams**

The following table shows a *simplified* diagram of the I/O circuitry of the analog outputs:

| Signal | | I/O Circuit |
|---|---|---|
| Analog outputs | DAC1 … DAC8 (AIO Type 1) |  |

**Related topics**

Basics

- *AIO Unit Type 1 (DAC)* (📖 *MicroAutoBox Features*)

## Interfaces

**Pin description**

The following table gives a description of the interface pins available at the ZIF I/O connector.

> **Tip**
>
> The pinout of the ECU interface connectors, USB device connector, and Ethernet I/O connector is not documented. Use a suitable dSPACE connection cable.

| Pins | Signal | Module Type | Description / Function |
|---|---|---|---|
| c3 | CAN 1 low | CAN Type 1 | CAN controller:<br>■ CAN 1 high = CAN high of module number 1, channel number 1<br>■ CAN 2 high = CAN high of module number 1, channel number 2<br>■ CAN 3 high = CAN high of module number 2, channel number 1<br>■ CAN 4 high = CAN high of module number 2, channel number 2<br>■ CAN 5 high = CAN high of module number 3, channel number 1<br>■ CAN 6 high = CAN high of module number 3, channel number 2<br>■ ISO 11898 interface<br>■ The DS1513 provide a split termination. The CAN bus termination resistors are switchable by software. For further information, refer to *Setup Page (RTICANMM ControllerSetup)* (*RTI CAN MultiMessage Blockset Reference*) or *Unit Page (RTICAN CONTROLLER SETUP)* (*RTI CAN Reference*). |
| c2 | CAN 1 high | | |
| b3 | CAN 2 low | | |
| b2 | CAN 2 high | | |
| B3 | CAN 3 low | | |
| B2 | CAN 3 high | | |
| A3 | CAN 4 low | | |
| A2 | CAN 4 high | | |
| P3 | CAN 5 low | | |
| P2 | CAN 5 high | | |
| N3 | CAN 6 low | | |
| N2 | CAN 6 high | | |
| c6 | Serial 1 RXD[1)] | | RS232 interface |
| c5 | Serial 1 TXD[1)] | | |
| b5 | Serial 2 K / LIN[1)] | | |
| b6 | Serial 2 L[1)] | | |

| Pins | Signal | Module Type | Description / Function |
|---|---|---|---|
| B6 | Serial 3 RXD[1] | | LIN or ISO 9141 interface<br>The K line/LIN interface is bidirectional. The L line is input only. Both lines have no pull-up. For proper function of the K line connect an external pull-up resistor (4.7 kΩ) from this line to VBAT.<br>For information on configuring a LIN master, refer to *Connecting to a LIN Bus* on page 108. |
| B5 | Serial 3 TXD[1] | | |
| A5 | Serial 4 K / LIN[1] | | |
| A6 | Serial 4 L[1] | | |
| P6 | Serial 5 RXD[1] | | |
| P5 | Serial 5 TXD[1] | | |
| N5 | Serial 6 K / LIN[1] | | |
| N6 | Serial 6 L[1] | | |

1) For a mapping of converter and channel numbers, as used in RTI and RTLib, refer to *Basics on Serial Interface* (📖 *MicroAutoBox Features*).

**Characteristics**

The interface characteristics are specified for the following conditions: $V_{BAT}$ = +12 V; $T_{CASE}$ = +25 °C; all voltages are referenced to GND pins, unless otherwise noted.

| Interface | Parameter[1] | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Host PC | Protocol | TCP/IP | | | | |
| | Bitrate | | | ■ 10/1000[2]<br>■ 10/100[3] | | Mbit |
| | Data throughput | | | | 2.6 | MB/sec |
| | Voltage levels | Ethernet standard | | | | |
| Ethernet I/O | Protocol | UDP/IP | | | | |
| | Bitrate | | | 1000 | | Mbit |
| | Voltage levels | Ethernet standard | | | | |
| USB | USB 2.0 standard (USB Flight Recording) | | | | | |
| | Data throughput | without connected host tool | | | 1280 | kB/sec |
| | | with connected host tool | | | 1024 | kB/sec |
| | | without data loss during cold start (dependent on the boot time of the host interface) | | | 640 | kB/sec |
| | Current | | | | 1.3 | A |
| | Voltage | | | | 5 | V |

| Interface | Parameter[1] | Conditions / Comments | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| ECU | Bit rate | LVDS mode | | | | 250 | MBit |
| | | LVDS2 mode | | | | 560 | |
| | Cable length | 2-paired twisted pair | | | | 5 | m |
| | Cable type | | | CAT5 | | | |
| | Voltage levels | LVDS standard | | | | | |
| | Full duplex data rate [4] | LVDS mode | Single transfer | | | 5 | MWord /s |
| | | LVDS2 mode | Single transfer | | | 11.2 | MWord /s |
| | | | Block transfer | | | 28 | MWord /s |
| | RAM size [4] | LVDS / LVDS2 mode | | 16 | | | kWord |
| | FIFO size[4] | LVDS / LVDS2 mode (Transmit buffer) | | 1 | | | kWord |
| CAN | Bit rate | ISO 11898 interface | | | | 1 | MBaud |
| Serial 1/3/5 RS232-Interface | Bit rate | | | 14 | | 115.2k | Baud |
| | TX output voltage swing | 3 kΩ load | | ±5 | ±9 | | V |
| | $V_{RxinLow}$ | RX input threshold low | | | 1.4 | 0.8 | V |
| | $V_{RxinHigh}$ | RX input threshold high | | 2.0 | 1.4 | | V |
| | Word length | | | 5 | | 8 | bit |
| Serial 2/4/6 ISO9141-Interface | Bit rate | $R_{KO} = 510\ \Omega$; $C_K \leq 1.3$ nF | | 14 | | 50k | Baud |
| | Word length | | | 5 | | 8 | bit |
| Serial 2/4/6 LIN Interface | Bit rate | | | 14 | | 20k | Baud |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

2) Since board revision DS1401-23 (available since dSPACE Release 7.2).

3) Before board revision DS1401-23

4) Word is 16-bit wide

**Baud rate calculation of the serial interface**

**Note**

Due to the limitations of the UART baud rate generator, not all baud rates can be programmed exactly to the desired baud rate without error.

The UART baud rate generator provides several baud rates:

*To calculate the divisor T for a chosen baud rate*

$$T = \text{Round}\left(\frac{921600}{\text{BR (chosen)}}\right)$$

BR (chosen) = The baudrate to be generated
T = The baudrate generator divisor ($8 \leq T \leq 65535$)

*To calculate the real baud rate from a given divisor T*

$$\frac{\text{BR (real)}}{\text{Baud}} = \frac{921600}{T}$$

BR (real) = The baudrate you get
T = The baudrate generator divisor ($8 \leq T \leq 65535$)

*To calculate the resulting error*

$$\frac{\text{Error}_{BR}}{100\%} = \frac{\text{BR (real)} - \text{BR (chosen)}}{\text{BR (chosen)}}$$

**Note**

If $\text{Error}_{BR} \leq 2\%$, messages will be transferred and received correctly.

# Data Sheet MicroAutoBox II 1401/1513/1514

**Where to go from here**

Information in this section

# Overview and General Information

**Where to go from here**

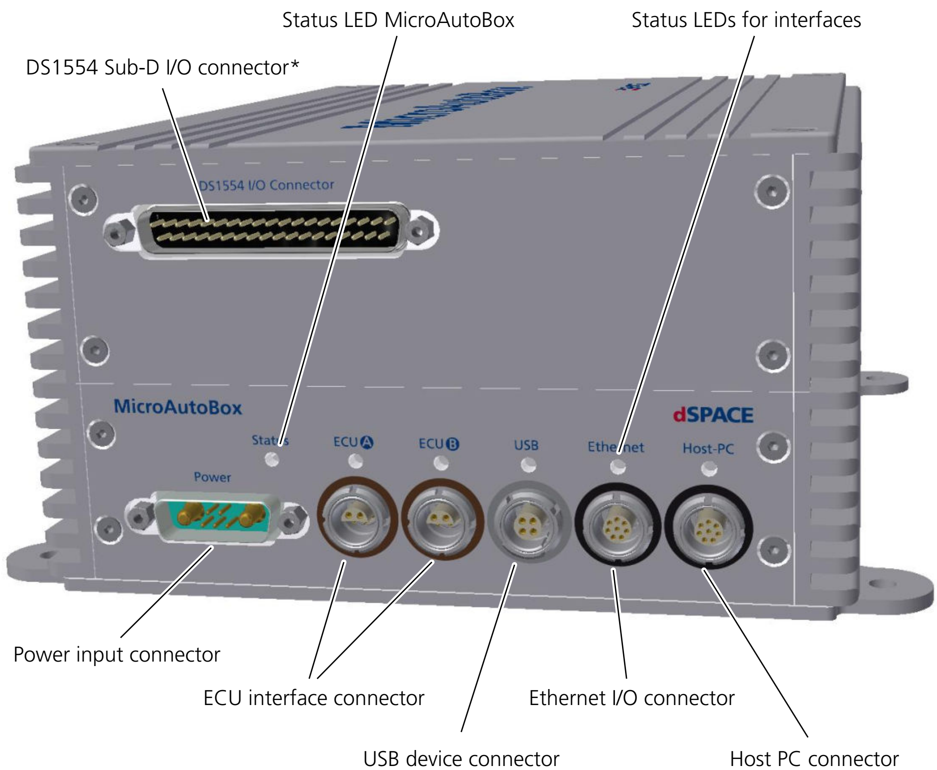
Information in this section

# Housing Components

**Connectors and status LEDs**

The illustrations show where the connectors and status LEDs are located on MicroAutoBox II 1401/1513/1514.

Front view




* Only with DS1554 Engine Control I/O Module


MicroAutoBox II 1401/1513/1514 contains the following connectors and LEDs:

**Power input connector** Supplies the required power to MicroAutoBox. It is a 7-pin, male Sub-D connector with two high-current pins.

A preconfigured cable with a matching connector and a separate power input connector are included in each MicroAutoBox package. For the pinout and further details on the preconfigured cable, refer to *Power Input Connector* on page 559.

**Status LED MicroAutoBox** Shows you different states and potential malfunctions.

If battery power is switched on and the REMOTE signal/KL15 is activated (see *Basics on Connecting to Power Supply* on page 44), the status LED (= dual LED) shows different states indicated by the LED color:

- LED is red: Reset state and no application is downloaded to the real-time processor.
- LED is green: Application is running.

- LED is flashing red: MicroAutoBox is in secured mode. For further instructions, refer to *Checking MicroAutoBox* on page 672.

The status LED on the front panel has the same functionality as the status LED on the rear panel of MicroAutoBox.

**ECU interface connectors** Provide communication to ECUs based on the LVDS standard, for example, in bypassing scenarios or to connect a RapidPro system (used as I/O subsystem). The ECU interface connectors are 4-pin LEMO connectors. Matching cables are supplied from dSPACE on request.

The corresponding LED is lit green, if power at both ends of the link is available and the relevant connection is serviceable. The LED flashes when data is being sent or received.

The table below shows the different ECU interfaces integrated into MicroAutoBox and the display names they are mapped to in the experiment software, for example, ControlDesk.

| Display Name in Software | Connectors Built-in at MicroAutoBox | |
|---|---|---|
| | ECU A | ECU B |
| ECU 1 | ✓ | – |
| ECU 2 | – | ✓ |

**USB device connector** A 4-pin LEMO connector to connect an USB mass storage device to use the USB Flight Recorder feature of MicroAutoBox. A matching cable with a LEMO-USB adapter is supplied from dSPACE on request.

**Note**

To use the USB Flight Recorder, a separate license is required.

The possible states of the corresponding LED are listed in the table below:

| LED Status | Meaning |
|---|---|
| Off | No USB device is connected. |
| Green | USB device is connected and flight recorder is not running. |
| Green blinking | USB device is connected and flight recorder is running. |
| Orange | USB device is full and the active flight recorder is specified not to overwrite old files. |

| LED Status | Meaning |
|---|---|
| Red | Write error when accessing the USB device, for example, if the device was removed while the flight recorder was running. |

For further information, refer to *Flight Recorder* (📖 *MicroAutoBox Features*).

**Ethernet I/O connector** An 8-pin LEMO connector that provides communication to external devices, such as PCs or ECUs based on the UDP/IP Ethernet protocol, for example, in bypassing scenarios.

A matching cable with a LEMO-RJ45 adapter is supplied from dSPACE on request.

The corresponding LED is lit green if power is available at both ends of the link and the relevant connection is serviceable. The LED flashes green when data is being sent or received.

For installation instructions, refer to *How to Connect MicroAutoBox to the ECU via UDP/IP* (📖 *ECU Interfaces Hardware Installation and Configuration*).

**Host PC connector** Provides the communication between MicroAutoBox and your host PC based on the Ethernet TCP/IP protocol. The connector is a 8-pin LEMO connector. A matching cable is included in each MicroAutoBox package.

The corresponding LED is lit green if power is available at both ends of the link and the relevant connection is serviceable. The LED flashes green when data is being sent or received.

**Tip**

The Ethernet I/O connector and the Host PC connector are internally connected by a common gigabit Ethernet switch (valid for base board DS1401-25ff).

This simplifies the connection options. For an example, refer to *Connecting an ECU with DCI-GSI2 for Simultaneous Calibration and Bypassing* (📖 *ECU Interfaces Hardware Installation and Configuration*).

**DS1554 Sub-D I/O connector** The 37-pin Sub-D I/O connector is used to connect the following sensors to the DS1554 Engine Control I/O Module:

- Crankshaft and camshaft sensors
- Knock sensors

This connector is available only if the DS1554 Engine Control I/O Module is installed.

For the pinout, refer to *DS1554 Sub-D I/O Connector* on page 613.

**Status LED FPGA**

- If the DS1552 Multi-I/O Module is installed and you use the RTI DS1552 I/O Extension Blockset the possible states of the corresponding LED are listed in the table below:

| LED Status | Meaning |
|---|---|
| Off | FPGA is not configured. |
| Green | Correct behavior. |
| Yellow | ■ Malfunction<br>■ Overload<br>■ One or more supply voltages on the I/O module are beyond a rated value. |

- If you use the RTI FPGA Programming Blockset the possible states of the corresponding LED are listed in the table below:

| LED Status | Meaning |
|---|---|
| Off | FPGA is not configured. |
| Green | Correct behavior. |
| Orange | The FPGA application can control the LED to light orange. For further information, refer to *FPGA_IO_WRITE_BL (FPGA1401Tp1 with Multi-I/O Module Settings)* (📖 *RTI FPGA Programming Blockset - FPGA Interface Reference*) or *FPGA_IO_WRITE_BL (FPGA1401Tp1 with Engine Control I/O Module Settings)* (📖 *RTI FPGA Programming Blockset - FPGA Interface Reference*). |
| Yellow | ■ Malfunction<br>■ Overload<br>■ One or more supply voltages on the I/O module are beyond a rated value. |

| LED Status | Meaning |
|---|---|
| Flashing blue | The FPGA die temperature reaches a critical range for operating.<br>A high ambient temperature and an FPGA application with a very high FPGA utilization and/or toggle rate increase the FPGA die temperature (internal chip temperature). If the die temperature exceeds 105 °C, the FPGA might work incorrectly.[1)] |
| Blue | The FPGA die temperature is too hot for operating.<br>If the die temperature exceeds 125 °C, the FPGA resets itself. The reset stays active until the die temperature falls below 85 °C and you restart MicroAutoBox or reload the user application. |

[1)] For details on reading the die temperature measurement, refer to *FPGA_IO_READ_BL (FPGA1401Tp1 with Multi-I/O Module Settings)* (📖 *RTI FPGA Programming Blockset - FPGA Interface Reference*) or *FPGA_IO_READ_BL (FPGA1401Tp1 with Engine Control I/O Module Settings)* (📖 *RTI FPGA Programming Blockset - FPGA Interface Reference*).

**DS1513 ZIF I/O connector** The 156-pin zero insertion force (ZIF) I/O connector provides access to the most input and output signals provided by MicroAutoBox. A matching connector is included in each MicroAutoBox package. For the pinout, refer to *DS1513 ZIF I/O Connector* on page 551.

**DS1514 ZIF I/O connector** The 156-pin zero insertion force (ZIF) I/O connector provides the signals of the installed I/O module and IP modules. For the pinout, refer to *DS1514 ZIF I/O Connector* on page 553.

# General Data

**General characteristics** The following table shows some general characteristics of MicroAutoBox:

| Parameter | | Specification[1] |
|---|---|---|
| Base board (DS1401-20ff.) | Processor | ■ PPC750 GL Power PC<br>■ 900 MHz clock frequency<br>■ Real-time clock |
| | Memory | ■ 8 MB global RAM<br>■ 16 MB local RAM<br>■ 16 MB flash memory |
| | Onboard sensors[2] | Pressure sensor:<br>■ Base board DS1401-23ff.<br>■ Range: 50 kPA ...115 kPa<br>■ Accuracy: 1 kPa<br>■ Sample rate: approx. 200 Hz<br>Acceleration sensor<br>■ Base board DS1401-23ff.<br>■ Range: ±2 g ... ±8 g in 3 axis (x/y/z)<br>■ Resolution: 10 bit per axis<br>■ Sample rate: max. 800 Hz<br>■ FIFO buffer: 512 words (to read and write bursts) |
| Communication interfaces | | ■ 1 x Host PC interface based on Ethernet TCP/IP protocol<br>■ 1 x Ethernet I/O interface based on Ethernet UDP/IP protocol for Ethernet bypassing scenarios<br>■ 2 x ECU interface based on LVDS standard<br>■ 1 x USB interface for USB flight recording (separate license) |
| I/O connectors | | ■ 2 x 156-pin ZIF I/O connector<br>  ■ Contact resistance: max. 15 mΩ<br>  ■ Durability: 10000 cycles<br>  ■ Continuous current per pin ($T_{ambient}$ = +85 °C): max. 2.5 A<br>■ 1 x 7-pin power supply input connector |
| FPGA (on DS1514 I/O Board) | | Xilinx® Kintex®-7 FPGA XC7K325T |

| Parameter | | Specification[1)] |
|---|---|---|
| Chassis dimensions | Case width | 202 mm (7.95 in.) |
| | Case height | 96 mm (3.78 in.) |
| | Case depth | 222 mm (8.74 in.) |
| Weight | | About 3.2 kg (7.05 lb.) without external cables and modules |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

2) For further information on the sensors, refer to *Onboard Sensors* (📖 *MicroAutoBox Features*).

**Functional I/O units on the I/O boards**

The following table shows a mapping of the input/output units on the I/O boards which are part of the MicroAutoBox:

| dSPACE I/O Board | Functional Unit |
|---|---|
| DS1513 | *ADC Unit Type 4* (📖 *MicroAutoBox Features*) |
| | *AIO Unit Type 1 (ADC)* (📖 *MicroAutoBox Features*) |
| | *AIO Unit Type 1 (DAC)* (📖 *MicroAutoBox Features*) |
| | *Bit I/O Unit (DIO Type 4)* (📖 *MicroAutoBox Features*) |
| DS1514 (with installed DS1552 Multi-I/O Module) | *ADC 1552 Type 1 Unit* (📖 *MicroAutoBox Features*) |
| | *ADC 1552 Type 2 Unit* (📖 *MicroAutoBox Features*) |
| | *DAC 1552 Type 1 Unit* (📖 *MicroAutoBox Features*) |
| | *Bit I/O Unit (DIO 1552 Type 1)* (📖 *MicroAutoBox Features*) |
| | Digital In (Type B) (refer to *Parameters Page (FPGA_IO_READ_BL)* (📖 *RTI FPGA Programming Blockset - FPGA Interface Reference*))[1)] |
| | Digital Out (Type B) (refer to *Parameters Page (FPGA_IO_WRITE_BL)* (📖 *RTI FPGA Programming Blockset - FPGA Interface Reference*))[1)] |
| | Digital Crank/Cam Inputs (refer to *Parameters Page (FPGA_IO_READ_BL)* (📖 *RTI FPGA Programming Blockset - FPGA Interface Reference*)) [1)] |

| dSPACE I/O Board | Functional Unit |
|---|---|
| | Inductive Zero Voltage Detector (refer to *Parameters Page (FPGA_IO_READ_BL)* (📖 *RTI FPGA Programming Blockset - FPGA Interface Reference*)) [1] |
| DS1514 (with installed DS1554 Engine Control I/O Module) | Knock Sensor Input (refer to *Parameters Page (FPGA_IO_READ_BL)* (📖 *RTI FPGA Programming Blockset - FPGA Interface Reference*)) [2] |
| | ADC (Type A) (refer to *Parameters Page (FPGA_IO_READ_BL)* (📖 *RTI FPGA Programming Blockset - FPGA Interface Reference*)) [2] |
| | Digital Crank/Cam Inputs (refer to *Parameters Page (FPGA_IO_READ_BL)* (📖 *RTI FPGA Programming Blockset - FPGA Interface Reference*)) [2] |
| | Inductive Zero Voltage Detector (refer to *Parameters Page (FPGA_IO_READ_BL)* (📖 *RTI FPGA Programming Blockset - FPGA Interface Reference*)) [2] |
| | Digital In (Type B) (refer to *Parameters Page (FPGA_IO_READ_BL)* (📖 *RTI FPGA Programming Blockset - FPGA Interface Reference*)) [2] |
| | Digital Out (Type A) (refer to *Parameters Page (FPGA_IO_WRITE_BL)* (📖 *RTI FPGA Programming Blockset - FPGA Interface Reference*)) [2] |
| | Digital Out (Type B) (refer to *Parameters Page (FPGA_IO_WRITE_BL)* (📖 *RTI FPGA Programming Blockset - FPGA Interface Reference*)) [2] |

[1] Only available via the RTI FPGA Programming Blockset (see *RTI Block Settings for the FPGA1401Tp1 with Multi-I/O Module Frameworks* (📖 *RTI FPGA Programming Blockset - FPGA Interface Reference*)).

[2] Only available via the RTI FPGA Programming Blockset (see *RTI Block Settings for the FPGA1401Tp1 with Engine Control I/O Module Framework* (📖 *RTI FPGA Programming Blockset - FPGA Interface Reference*)).

# Absolute Maximum Levels

**Avoiding damage to the system**

**NOTICE**

Do not exceed the maximum levels since this might permanently damage the system.

**Levels**

The following table shows the levels (for example, voltage, temperature) of the MicroAutoBox. All voltages are referenced to GND (unless otherwise noted).

| Parameter | Specification[1)] | Description |
|---|---|---|
| VBAT | –40 V ... +100 V | Load dump- and reverse protection |
| VDRIVE | 0 V ... +45 V | |
| All digital output voltages | (VDRIVE – 45 V) ... +45 V | |
| All digital input voltages | (VDRIVE – 45 V) ... +45 V | |
| All analog input voltages | –40 V ... +40 V | |
| All analog output voltages | –30 V ... +40 V | |
| VSENS output | 0 V ... +40 V | VSENS is switched on and off with the REMOTE pin. |
| VBATprot output | 0 V ... +45 V | VBATprot follows VBAT within the specified range.<br>VBATprot is switched on and off with the REMOTE pin. |
| RS232 transceiver output on the DS1513 ZIF I/O connector[2)] | –30 V ... +30 V | |
| RS232 transceiver input on the DS1513 ZIF I/O connector[2)] | –30 V ... +30 V | |
| $V_{CAN\ high}$, $V_{CAN\ low}$ on the DS1513 ZIF I/O connector[3)] | –58 V ... +58 V | Voltage level on CAN high and CAN low pins. |
| $V_{(Diff\ CAN\ high\ -\ CAN\ low)}$ on the DS1513 ZIF I/O connector[3)] | –5 V ... +5 V | Voltage difference between CAN high and CAN low pins (due to termination resistors). |
| Serial K / LIN | –20 V ... +32 V | but not more than VBAT |
| Serial L | –24 V ... +30 V | but not more than VBAT |
| All outputs short circuit to GND | continuous | |
| Continuous power dissipation ($T_{ambient}$ = +85 °C) | max. 50 W | |

| Parameter | Specification[1] | Description |
|---|---|---|
| Operating temperature | –40 °C ... +85 °C [4] | |
| Storage temperature | –55 °C ... +125 °C | |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.
[2] If the DS1552 Multi-I/O Module is installed, the DS1514 ZIF I/O connector also provides a serial interface. For absolute maximum levels, refer to *Absolute Maximum Levels* on page 584.
[3] If the DS4342 CAN FD Interface Module is installed, the DS1514 I/O connector also provides a CAN interface. For maximum absolute levels, refer to *Absolute Maximum Levels* on page 640.
[4] Mounted modules and a high FPGA utilization or toggle rate increase the power dissipation. This might lead to a reset of MicroAutoBox while the ambient temperature is less than 85 °C. For details, refer to *Parameters Page (FPGA_IO_READ_BL)* (*RTI FPGA Programming Blockset - FPGA Interface Reference*).

# Certifications

**CE compliance**

MicroAutoBox meets the requirements of the European directive 2014/30/EU (Electromagnetic Compatibility Directive) for CE marking.

**Applied standards**

The characteristics of MicroAutoBox were tested according to the standards shown in the following table:

| Tested Characteristics | Applied Standard | Description |
|---|---|---|
| Electromagnetic compatibility (EMC) | EN 61326-1 Table 2 | Immunity standard for industrial environments[1] |
| | CISPR 11, EN 55011 Group 1, Class A | Emission standard for industrial environments |
| | RTCA/DO160G: Dec. 2010: Section 21.4 | Environmental conditions and test procedures for airborne equipment: Conducted RF Emissions, Category: B, L, M&H[2] |
| | RTCA/DO160G: Dec. 2010: Section 21.5 | Environmental conditions and test procedures for airborne equipment: Radiated RF Emissions, Category: M[2] |
| Vibration | ISO 16750-3:2007 / 4.1.2.4 Test IV | Test conditions: Broad band noise, 4h per axis, RMS-acceleration 27,8 $m/s^2$ |
| | DO-160F.8 / B1 Test Conditions | Test conditions: Broad band noise, 2h per axis, based on DO160F Section 8, Category B1 |
| | EN 60068-2-6 | Test conditions:<br>■ Swept sine, 1 octave per minute, 3-axis test<br>■ 5 ... 2000 Hz, up to 5 g, 2 sweeps per axis<br>■ Operating |

| Tested Characteristics | Applied Standard | Description |
|---|---|---|
| Shock | ISO 16750-3:2007 / 4.2.2. | ■ Linear shock (1/2 sine pulse), 6-axis<br>■ 500 $m/s^2$, 6 ms, 10 pulses per axis<br>■ Operating |
| | RTCA / DO-160F Section 7 Test 7.2 Category A Test type R | Operational shocks test (standard):<br>■ Saw-tooth wave, 6-axis<br>■ 200 $m/s^2$, 11 ms, 10 pulses per axis<br>■ Operating |
| | RTCA / DO-160F Section 7 Test 7.2 Category D Test type R | Operational shocks test (low frequency):<br>■ Saw-tooth wave, 6-axis<br>■ 200 $m/s^2$, 20 ms, 10 pulses per axis<br>■ Operating |

1) Tested with an I/O cable length < 3 m.
2) For further information, refer to dSPACE Support.

**Vibration and shock tests**

To verify the reliability of MicroAutoBox under realistic operating conditions, it was exposed to vibration and shock tests. During the tests, MicroAutoBox executed a program without any failures.

# Connector Pinouts

**Where to go from here**

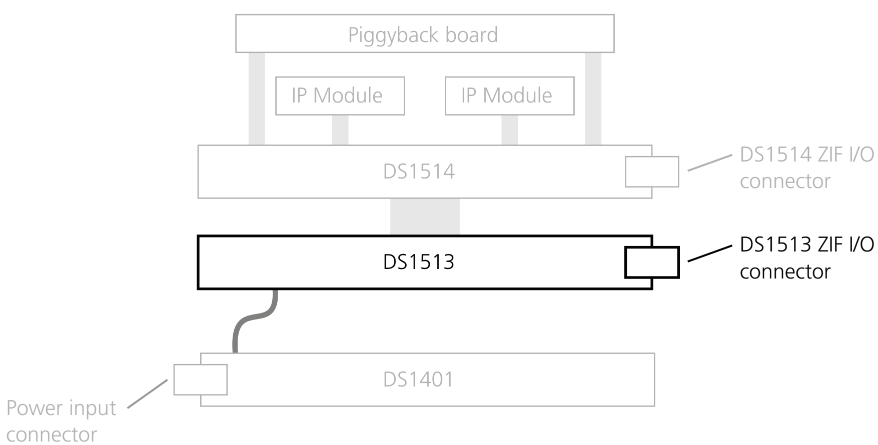
Information in this section



## DS1513 ZIF I/O Connector

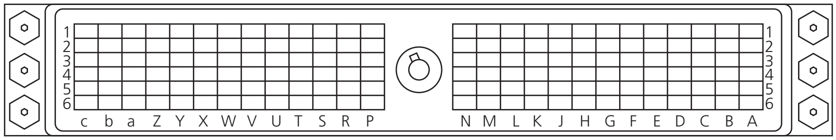
**Objective**

The DS1513 I/O connector is a 156-pin zero insertion force (ZIF) connector giving access to the input and output signals provided by DS1513 I/O Board. The illustration below shows the internal assembly of the MicroAutoBox II 1401/1513/1514.



**Pinout**

The following illustration shows the pin numbering of the I/O connector (front view of MicroAutoBox):




## Note

There are pins identified by uppercase letters (A, B, C, etc.) and pins identified by lowercase letters (a, b, c).

The following table shows the signals of the I/O connector:

| 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GND | in | CAN 4 high | i/o | CAN 4 low | i/o | GND | in | Serial 4 K / LIN[1] | i/o | Serial 4 L[1] | in | *A* |
| GND | in | CAN 3 high | i/o | CAN 3 low | i/o | GND | in | Serial 3 TXD[1] | out | Serial 3 RXD[1] | in | *B* |
| GND | in | DigP 1 ch 5[2] | out | DigP 1 ch 10 | out | DigP 1 ch 15 | out | DigP 2 ch 4 | out | GND | in | *C* |
| GND | in | DigP 1 ch 4 | out | DigP 1 ch 9 | out | DigP 1 ch 14 | out | DigP 2 ch 3 | out | DigP 2 ch 8 | out | *D* |
| GND | in | DigP 1 ch 3 | out | DigP 1 ch 8 | out | DigP 1 ch 13 | out | DigP 2 ch 2 | out | DigP 2 ch 7 | out | *E* |
| GND | in | DigP 1 ch 2 | out | DigP 1 ch 7 | out | DigP 1 ch 12 | out | DigP 2 ch 1 | out | DigP 2 ch 6 | out | *F* |
| GND | in | DigP 1 ch 1 | out | DigP 1 ch 6 | out | DigP 1 ch 11 | out | DigP 1 ch 16 | out | DigP 2 ch 5 | out | *G* |
| GND | in | DigP 1 ch 5 | in | DigP 1 ch 10 | in | DigP 1 ch 15 | in | DigP 2 ch 4 | in | GND | in | *H* |
| GND | in | DigP 1 ch 4 | in | DigP 1 ch 9 | in | DigP 1 ch 14 | in | DigP 2 ch 3 | in | DigP 2 ch 8 | in | *J* |
| GND | in | DigP 1 ch 3 | in | DigP 1 ch 8 | in | DigP 1 ch 13 | in | DigP 2 ch 2 | in | DigP 2 ch 7 | in | *K* |
| GND | in | DigP 1 ch 2 | in | DigP 1 ch 7 | in | DigP 1 ch 12 | in | DigP 2 ch 1 | in | DigP 2 ch 6 | in | *L* |
| VSENS | out | DigP 1 ch 1[2] | in | DigP 1 ch 6 | in | DigP 1 ch 11[2] | in | DigP 1 ch 16 | in | DigP 2 ch 5 | in | *M* |
| VDRIVE | in | CAN 6 high | i/o | CAN 6 low | i/o | GND | in | Serial 6 K / LIN[1] | i/o | Serial 6 L[1] | in | *N* |
| | | | | | | | | | | | | |
| VBAT prot | out | CAN 5 high | i/o | CAN 5 low | i/o | GND | in | Serial 5 TXD[1] | out | Serial 5 RXD[1] | in | *P* |
| REMOTE | in | GND | in | GND | in | GND | in | GND | in | GND | in | *R* |
| GND | in | AnalogOut ch 8 | out | AnalogIn ch 4 | in | AnalogIn ch 8 | in | AnalogIn ch 12 | in | AnalogIn ch 16 | in | *S* |
| GND | in | AnalogOut ch 7 | out | AnalogIn ch 3 | in | AnalogIn ch 7 | in | AnalogIn ch 11 | in | AnalogIn ch 15 | in | *T* |
| GND | in | AnalogOut ch 6 | out | AnalogIn ch 2 | in | AnalogIn ch 6 | in | AnalogIn ch 10 | in | AnalogIn ch 14 | in | *U* |
| GND | in | AnalogOut ch 5 | out | AnalogIn ch 1 | in | AnalogIn ch 5 | in | AnalogIn ch 9 | in | AnalogIn ch 13 | in | *V* |

| 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GND | in | AnalogOut ch 4 | out | Analog ch 4 | in | Analog ch 8 | in | Analog ch 12 | in | Analog ch 16 | in | *W* |
| GND | in | AnalogOut ch 3 | out | Analog ch 3 | in | Analog ch 7 | in | Analog ch 11 | in | Analog ch 15 | in | *X* |
| GND | in | AnalogOut ch 2 | out | Analog ch 2 | in | Analog ch 6 | in | Analog ch 10 | in | Analog ch 14 | in | *Y* |
| GND | in | AnalogOut ch 1 | out | Analog ch 1 | in | Analog ch 5 | in | Analog ch 9 | in | Analog ch 13 | in | *Z* |
| GND | in | SGND | in | Ana trigger 1 | in | Ana trigger 2 | in | Ana trigger 3 | in | Ana trigger 4 | in | *a* |
| GND | in | CAN 2 high | i/o | CAN 2 low | i/o | GND | in | Serial 2 K / LIN[1)] | i/o | Serial 2 L[1)] | in | *b* |
| GND | in | CAN 1 high | i/o | CAN 1 low | i/o | GND | in | Serial 1 TXD[1)] | out | Serial 1 RXD[1)] | in | c |

1) For a mapping of converter and channel numbers, as used in RTI and RTLib, refer to *Basics on Serial Interface* (📖 *MicroAutoBox Features*).

2) DigP = Port number; ch = Channel number

**Tip**

To use the digital inputs and outputs, you have to connect the VDRIVE pin inside the ZIF I/O connector according to the logic level needed. *This pin is not preconfigured in the ZIF I/O connector delivered with each MicroAutoBox II.* You have to connect VDRIVE (pin N1) to VSENS (pin M1) or VBATprot (pin P1). Use the preconfigured jumper cable which is included in the MicroAutoBox package.

**Signal descriptions**

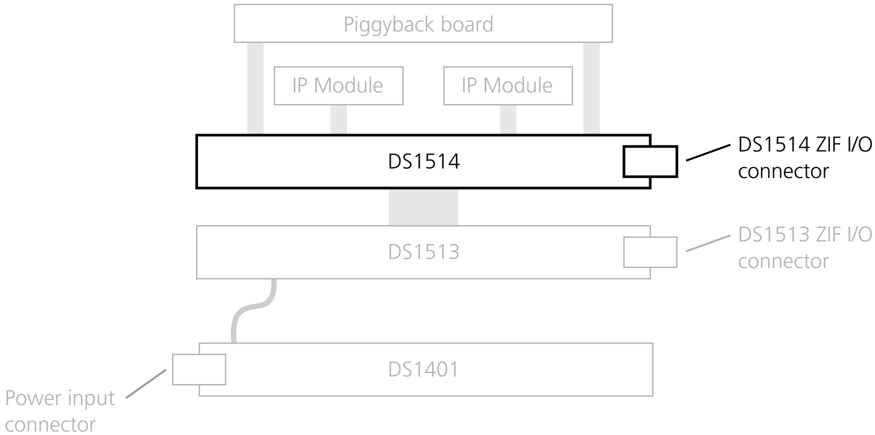
For descriptions of the signals which are available on the DS1513 ZIF I/O connector, refer to:

- *Digital Inputs* on page 564
- *Digital Outputs* on page 566
- *Analog Inputs* on page 571
- *Analog Outputs* on page 575
- CAN, LIN, serial: *Interfaces* on page 576

# DS1514 ZIF I/O Connector

**Objective**

The DS1514 I/O connector is a 156-pin zero insertion force (ZIF) connector giving access to various I/O signals if an IP module and/or an I/O module are/is installed. The illustration below shows the internal assembly of the MicroAutoBox II 1401/1513/1514 with a I/O module installed.




**Pinout**

The DS1514 ZIF I/O connector provides only signals of the installed I/O module and IP modules.

For pinouts of the DS1514 ZIF I/O connector, refer to the following topics:

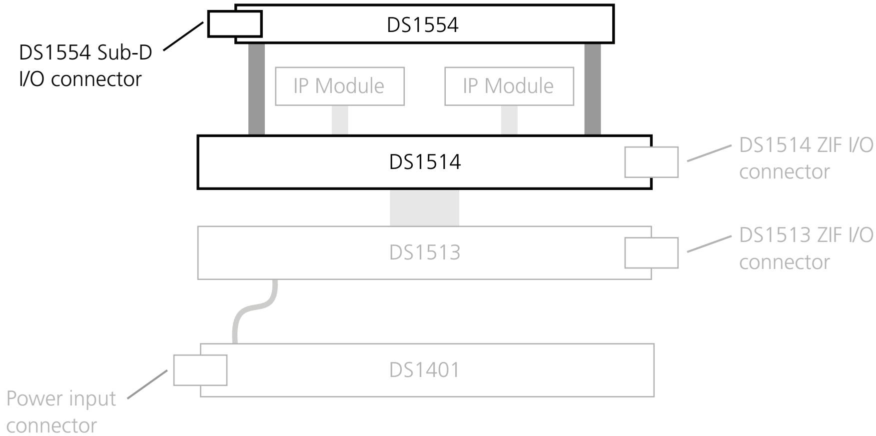
- DS1552 Multi-I/O Module: *DS1512 and DS1514 ZIF I/O Connectors* on page 585
- DS1554 Engine Control I/O Module: *DS1514 ZIF I/O Connector* on page 611
- DS4340 FlexRay Interface Module: *DS1512 and DS1514 ZIF I/O Connectors* on page 634
- DS4342 CAN FD Interface Module: *DS1512 and DS1514 ZIF I/O Connectors* on page 642

# DS1554 Sub-D I/O Connector

**Objective**

The DS1554 Engine Control I/O Module provides a 37-pin, male Sub-D connector at the front of MicroAutoBox.

The illustration below shows the internal assembly of a MicroAutoBox II 1401/1513/1514 with a DS1554 Engine Control I/O Module installed.



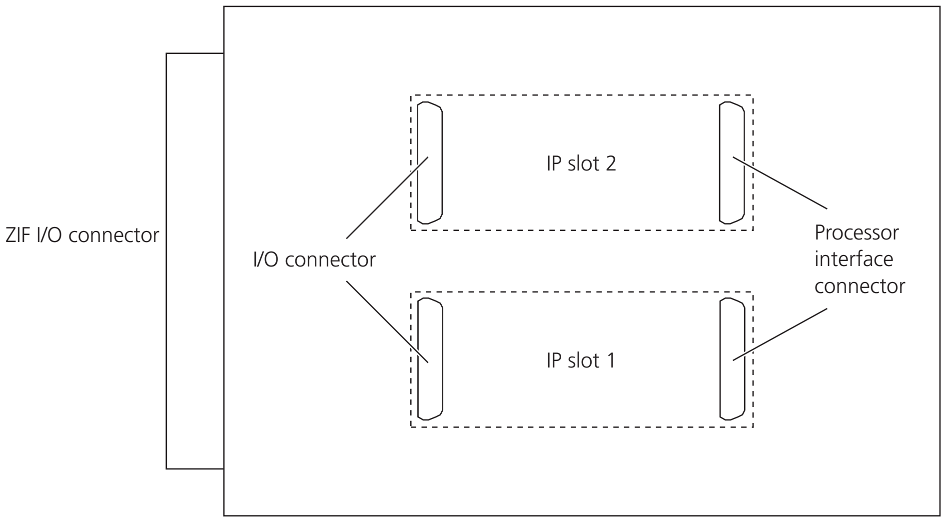

**Pinout**

The DS1554 Sub-D I/O connector only provides signals of the installed DS1554 Engine Control I/O Module. For the pinout, refer to *DS1554 Sub-D I/O Connector* on page 613.

# IP Module Connectors

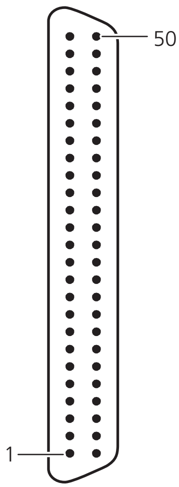
**Objective**

The DS1514 provides two slots to install IP modules. Each slot provides two AMP connectors: I/O connector and processor interface connector. The following illustration shows the top view of MicroAutoBox.

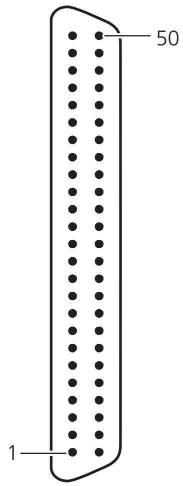

IP slot 2
ZIF I/O connector
I/O connector
Processor
interface
connector
IP slot 1

**Pinout**

**I/O connector - IP module slot 1** The following table shows the signal mapping of the IP module I/O connector on slot 1 to the DS1514 ZIF I/O connector (rear of MicroAutoBox):

| IP Module I/O Connector | Pin | ZIF Pin for IP Slot 1 | Pin | ZIF Pin for IP Slot 1 |
|---|---|---|---|---|
|  | 25 | - | 50 | M3 |
| | 24 | - | 49 | M4 |
| | 23 | - | 48 | L3 |
| | 22 | - | 47 | - |
| | 21 | - | 46 | K3 |
| | 20 | K5 | 45 | K4 |
| | 19 | K6 | 44 | J3 |
| | 18 | J5 | 43 | - |
| | 17 | J6 | 42 | - |
| | 16 | H5 | 41 | - |
| | 15 | H6 | 40 | - |
| | 14 | G5 | 39 | - |
| | 13 | - | 38 | - |
| | 12 | - | 37 | - |
| | 11 | - | 36 | - |
| | 10 | - | 35 | - |
| | 9 | - | 34 | - |
| | 8 | - | 33 | - |
| | 7 | - | 32 | - |
| | 6 | - | 31 | - |
| | 5 | C6 | 30 | - |
| | 4 | - | 29 | - |
| | 3 | - | 28 | - |
| | 2 | - | 27 | - |
| | 1 | - | 26 | - |

**I/O connector - IP module slot 2** The following table shows the signal mapping of the IP module I/O connector on slot 2 to the DS1514 ZIF I/O connector (rear of MicroAutoBox):

| IP Module I/O Connector | Pin | ZIF Pin for IP Slot 2 | Pin | ZIF Pin for IP Slot 2 |
|---|---|---|---|---|
|  | 25 | - | 50 | b3 |
| | 24 | - | 49 | b4 |
| | 23 | - | 48 | a3 |
| | 22 | - | 47 | - |
| | 21 | - | 46 | Z3 |
| | 20 | Z5 | 45 | Z4 |
| | 19 | Z6 | 44 | Y3 |
| | 18 | Y5 | 43 | - |
| | 17 | Y6 | 42 | - |
| | 16 | X5 | 41 | - |
| | 15 | X6 | 40 | - |
| | 14 | W5 | 39 | - |
| | 13 | - | 38 | - |
| | 12 | - | 37 | - |
| | 11 | - | 36 | - |
| | 10 | - | 35 | - |
| | 9 | - | 34 | - |
| | 8 | - | 33 | - |
| | 7 | - | 32 | - |
| | 6 | - | 31 | - |
| | 5 | S6 | 30 | - |
| | 4 | - | 29 | - |
| | 3 | - | 28 | - |
| | 2 | - | 27 | - |
| | 1 | - | 26 | - |

**Processor interface connector - slot 1 and slot 2** The pinout of the processor interface connector (slot 1 and slot 2) complies with IP Modules Draft Standard VITA 4-1995. For further information, refer to the documentation of the standard.

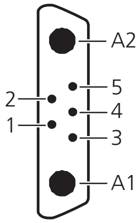
# Power Input Connector

**Objective**

MicroAutoBox provides a power input connector. It is a 7-pin, male connector with two high-current pins. It is a special variant of a 15-pin Sub-D connector (mixed-layout 7W2 Sub-D).

**Pinout**

The following illustration shows the pinout (front view of MicroAutoBox).

| Connector | Pin | Signal | Pin | Signal |
|---|---|---|---|---|
|  | A2[1] | VBAT (6 V … 40 V DC) | | |
| | | | 5 | REMOTE_PULLUP |
| | 2 | Do not connect | 4 | REMOTE[2] |
| | 1 | Do not connect | 3 | Do not connect |
| | A1 | GND | | |

[1] NOTE: It is highly recommended to insert a fuse into the main power supply input wire (close to battery). Choose the value of the fuse according to the maximum current. A 10 A fuse is recommended.

[2] The REMOTE input must be connected via switch or bridge to UBAT to run the MicroAutoBox. For example, you can use it for switching MicroAutoBox with KL15 (output of the ignition/driving switch). So, you can use the nonvolatile data feature to store data you may want to use again when restarting the application. For further information, refer to *Nonvolatile Data Handling* (📖 *MicroAutoBox RTLib Reference*).

**Matching cable**

A preconfigured cable for the supply voltage is provided by dSPACE. This cable is for running MicroAutoBox with a laboratory power supply during development. Therefore, REMOTE (pin 4) is shorted to VBAT (pin A2) inside the connector in order to save a separate switch. Do not use this cable in the vehicle. Otherwise, MicroAutoBox will always be turned on.

The VBAT wire (red) contains a melting fuse. Each wire has a cross-section of 1.5 mm².

Fuse specification:

- Cable delivered through dSPACE Release 2013-B: 7.5 A, time lag
- Cable delivered as of dSPACE Release 2014-A: 10 A, time lag

# Signal Descriptions

**Where to go from here**

Information in this section



## Power Inputs and Outputs

**Pin description**

The following table gives a description of the pins used for power input, remote input and supply of digital I/O circuits.

**Power input connector** The following table lists the pin description of the power input connector on the front:

| Pins | Signal | Description / Function |
|---|---|---|
| A2 | VBAT | Main power supply input. Connect this pin to the positive pole of your car battery. |
| A1 | GND | Main power supply return and reference for all input and output signals. Connect this pin to the minus pole of your car battery. The case of MicroAutoBox is also connected to GND. |

| Pins | Signal | Description / Function |
|---|---|---|
| 4 | REMOTE | ■ The REMOTE input may be used for starting MicroAutoBox with a remote switch, for example KL15 (output of the ignition/driving switch).<br>■ If you connect the remote pin to the plus pole of the car battery directly, MicroAutoBox will always be turned on, and the car battery will soon be exhausted if the engine is not running. Thus, a switch is highly recommended.<br>■ The voltage connected to the REMOTE pin should not exceed the supply voltage.<br>■ To wake up MicroAutoBox via CAN messages, the REMOTE pin must be left open when MicroAutoBox is powered down. This is due to the fact that there is an additional internal connection to the REMOTE pin. Nevertheless, you can always use a remote switch to supply voltage (e.g., VBAT) to start MicroAutoBox. |
| 5 | REMOTE_Pullup | You can use this output to connect a remote switch between REMOTE and this pin. REMOTE_Pullup is internally connected to VBAT via 39 kΩ pull-up resistor. |

**DS1513 ZIF I/O connector** The following table lists the pin description of the DS1513 I/O Boards ZIF I/O connector on the rear:

| Pins | Signal | Description / Function |
|---|---|---|
| A1, A4, B1, B4, C1, C6, D1, E1, F1, G1, H1, H6, J1, K1, L1, N4, P4, R2 ... R6, S1, T1, U1, V1, W1, X1, Y1, Z1, a1, b1, b4, c1, c4 | GND | Main power supply return and reference for all input and output signals. Use the nearest possible GND pin as reference for your signals in order to keep noise levels at minimum. The case of MicroAutoBox is also connected to GND. |
| a2 | SGND | Connected to GND internally.<br>Use the SGND signal pin as reference for ADC- and DAC-channels of the DS1513 I/O Board to get the optimum analog performance. |
| N1 | VDRIVE | This input supplies all digital input and output circuits located on the DS1513 I/O Board.<br>■ Connect this input to VSENS to set CMOS/TTL-compatible logic levels to your inputs/outputs.<br>■ Connect this input to VBATprot to set automotive-compatible logic levels to your inputs/outputs.<br>■ Do not connect this pin directly to VBAT, because the input and output circuits are not load-dump-protected or reverse-voltage-protected at this signal. |

| Pins | Signal | Description / Function |
|---|---|---|
| M1 | VSENS | Sensor supply output.<br>Use this output to supply your sensors and/or VDRIVE. If you need CMOS/TTL-compatible logic levels at the inputs/outputs connect VSENS to VDRIVE. |
| P1 | VBAT prot | Protected VBAT output.<br>Use this output to supply VDRIVE when automotive logic levels are needed. |
| R1 | REMOTE | ■ The remote voltage may be used for starting MicroAutoBox with a remote switch: KL15, for example (output of the ignition/driving switch).<br>■ If you connect the remote pin to the car battery directly, MicroAutoBox will always be turned on, and the car battery will soon be exhausted if the engine is not running. Thus, a switch is highly recommended.<br>■ The remote voltage should not exceed the supply voltage. |

**DS1514 ZIF I/O connector** For the pin description of the DS1514 I/O board's ZIF I/O connector if the DS1552 Multi-I/O Module is installed, refer to *Power Inputs and Outputs* on page 588.

**Tip**

To use the digital inputs and outputs, you have to connect the VDRIVE pin inside the ZIF I/O connector according to the logic level needed. *This pin is not preconfigured in the ZIF I/O connector delivered with each MicroAutoBox II.* You have to connect VDRIVE to VBATprot or VSENS+. If you use VSENS+, you have to connect VSENS- to ground.

**Characteristics**

The characteristics are specified for the following conditions:

- $V_{BAT}$=+12 V (unless otherwise noted)

  $T_{CASE}$=+25 °C (unless otherwise noted)

  All voltages are referenced to GND (unless otherwise noted).

| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Power** | | | | | | |
| Operating voltage | VBAT | For start-up with an input power consumption < 35 W | 6 | | 40 | V |
| | VBAT | Operating | 4.5 | | 40 | V |
| | VBAT | Reverse protection | | | -40 | V |
| | VBAT | Load dump protection | | | +100 | V |

| Signal[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Inputs** | | | | | | |
| Operating current | $I_{VBAT}$ | REMOTE ≥ $V_{iHRemote}$ | | 2 | | A |
| | $I_{VBAT}$ | REMOTE ≤ $V_{iLRemote}$ | | 5 | | mA |
| REMOTE voltage input | $V_{iHRemote}$ | Input high voltage | 4.7 | | | V |
| | $V_{iLRemote}$ | Input low voltage | | | 0.8 | V |
| | $V_{iHysRemote}$ | Input hysteresis voltage | 0.5 | 1 | | V |
| | $R_{inRemote}$ | Input impedance | 60 | | 185 | kΩ |
| Inrush current | $I_{VBAT\ inrush}$ | All inputs/outputs unconnected | see *Power supply* on page 40 | | | |
| Digital I/O voltage supply input on DS1513 ZIF I/O connector | VDRIVE | Supply for digital input/output circuits | | | 45 | V |
| | $I_{VDRIVE\ no\ load}$ | All inputs/outputs unconnected | | 20 | | mA |
| | $I_{VDRIVE\ maximum\ load}$ | All outputs shorted to GND | | 1 | | A |
| Digital I/O voltage supply input on DS1514 ZIF I/O connector | VDRIVE | Supply for digital input/output circuits | | | 45 | V |
| | $I_{VDRIVE\ no\ load}$ | All inputs/outputs unconnected | | 10 | | mA |
| | $I_{VDRIVE\ maximum\ load}$ | All outputs shorted to GND | | 500 | | mA |
| **Outputs** | | | | | | |
| Sensor supply output on DS1513 ZIF I/O connector | VSENS | Output voltage | 4.84 | 5.05 | 5.25 | V |
| | VSENS = f(T) | Temperature caused voltage drift $T_{CASE}$ = –40 °C ... +85 °C | –2 | | 2 | % |
| | $I_{VSENS,\ max}$ | Maximum output current | 750 | | | mA |
| Sensor supply output of DS1552 Multi-I/O Module on DS1514 ZIF I/O connector | VSENS+ | Output voltage, isolated and adjustable, controlled by a DAC (relative to VSENS-) | 2 | | 20 | V |
| | $P_{VSENS,\ max}$ | Maximum output power (if VSENS+ is in range 5..20V and VSENS- is connected to GND) | | 1 | | W |
| Sensor supply output of DS1554 Engine Control I/O Module on DS1514 ZIF I/O connector | VSENS+ | Fixed and isolated output voltage relative to VSENS- | 4.75 | 5 | 5.25 | V |
| | $P_{VSENS,\ max}$ | Maximum output power | | 2 | | W |
| Protected VBAT output | VBATprot | IL = 1A; VBAT = 12 V | 11.56 | 11.78 | 12 | V |
| | $I_{VBATprot,\ max}$ | Maximum output current | | | 1000 | mA |
| | $I_{ProtPeak}$ | Overload current limit (–40 °C ... 85 °C) | 4 | | 9 | A |
| | t(overload) | Time to shut off $I_{ProtPeak}$ | | | 5 | ms |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

# Digital Inputs

**Note on the cable harness**

**Note**

To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the DS1513 ZIF I/O connector and the DS1514 ZIF I/O connector. For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**Pin description**

The following table gives a description of the digital input pins on the DS1513 ZIF I/O connector:

| Pins | Port Number | Signal | Description / Function |
|---|---|---|---|
| M2, L2, K2, J2, H2, M3, L3, K3, J3, H3, M4, L4, K4, J4, H4, M5 | 1 | Channel 1 ... 16<br>DIO Type 4 | Standard discrete digital input with pull-up. |
| L5, K5, J5, H5, M6, L6, K6, J6 | 2 | Channel 1 ... 8<br>DIO Type 4 | |

**Characteristics**

The characteristics are specified for the following conditions:

- $V_{BAT}$=+12 V (unless otherwise noted)

  $T_{CASE}$=+25 °C (unless otherwise noted)

  All voltages are referenced to GND (unless otherwise noted).

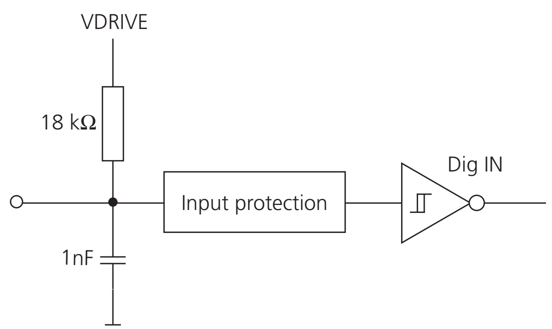
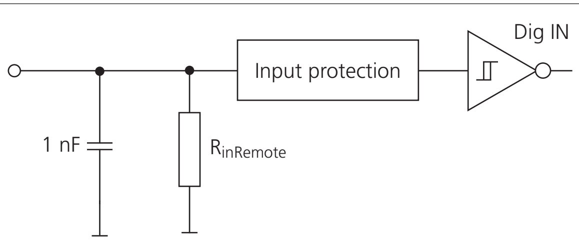
| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC characteristics** | | | | | | |
| Digital input channel 1 ... 24 | $V_{iH}$ | Input high voltage | 3.1 | | | V |
| | $V_{iL}$ | Input low voltage | | | 1.2 | V |
| | $V_{iHys}$ | Input hysteresis voltage | | 1 | | V |
| | $R_{DigIn}$ | Pull-up resistor to VDRIVE | 17 | 18 | 19 | kΩ |
| | $C_{DigIn}$ | Input capacitance | | 1 | | nF |
| REMOTE | $V_{iHRemote}$ | Input high voltage | 4.7 | | | V |
| | $V_{iLRemote}$ | Input low voltage | | | 0.8 | V |
| | $V_{iHysRemote}$ | Input hysteresis voltage | 0.5 | 1 | | V |
| | $R_{inRemote}$ | Input impedance | 60 | | 185 | kΩ |

| Signal[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **AC characteristics** | | | | | | |
| Inputs | $t_{LowMin}$ | Minimum pulse width low | | 250 | 500 | ns |
| | $t_{HighMin}$ | Minimum pulse width high | | 300 | 600 | ns |
| | $F_{max}$ | Duty cycle: 50 % | | 1.8 | | MHz |
| | | Duty cycle: 1 % or 99 % | | 33 | | kHz |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagrams**

The following table shows *simplified* diagrams of the I/O circuitry of the digital inputs:

| Signal | | I/O Circuit |
|---|---|---|
| Digital inputs | Channel 1 ... 24 |  For proper operation, VDRIVE must have a level above the maximum input voltage. |
| | Remote |  |

**Digital inputs on the DS1514 ZIF I/O connector**

Only I/O modules can provide digital inputs on the DS1514 ZIF I/O connector. For signal descriptions of the DS1552 Multi-I/O Module, refer to *Digital Inputs* on page 590.

**Related topics**

Basics

- *Bit I/O Unit (DIO Type 4)* (*MicroAutoBox Features*)

# Digital Outputs

**Note on the cable harness**

> **Note**
>
> To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the DS1513 ZIF I/O connector and the DS1514 ZIF I/O connector. For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**General behavior of digital signals**

All digital outputs are set to high impedance (tristate) until the application is started. Then the outputs follow the states defined in your application. Unused outputs remain in tristate mode.

**Pin description**

The following table gives a description of the digital output pins on the DS1513 ZIF I/O connector:

| Pins | Port Number | Signal | Description / Function |
|---|---|---|---|
| G2, F2, E2, D2, C2, G3, F3, E3, D3, C3, G4, F4, E4, D4, C4, G5 | 1 | Channel 1 ... 16<br>DIO Type 4 | Standard discrete digital output. |
| F5, E5, D5, C5, G6, F6, E6, D6 | 2 | Channel 1 ... 8<br>DIO Type 4 | |

**Characteristics**

The characteristics are specified for the following conditions:

- $V_{BAT}$=+12 V (unless otherwise noted)

  $T_{CASE}$=+25 °C (unless otherwise noted)

  All voltages are referenced to GND (unless otherwise noted).

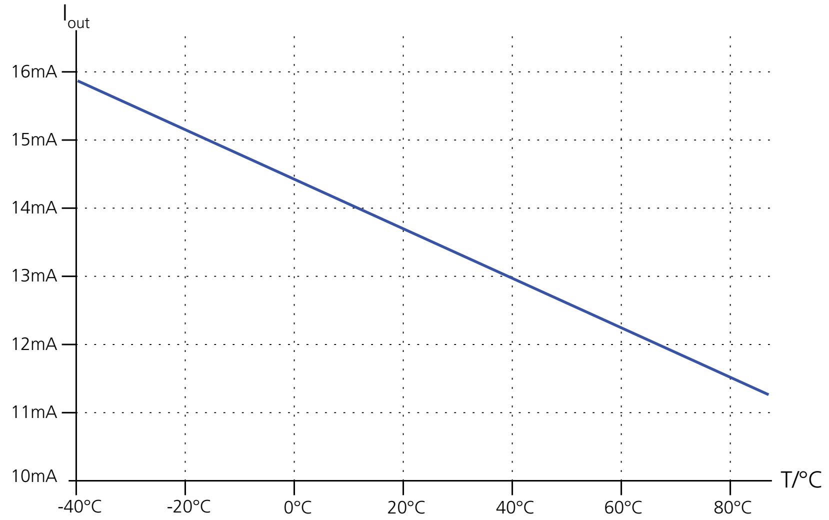
| Signal[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC Characteristics** | | | | | | |
| Digital output channel 1 ... 24 | $V_{oH}$ | IL = 0 mA; VDRIVE = 5 V | 4.4 | 4.6 | | V |
| | $V_{oL}$ | IL = 0 mA; VDRIVE = 5 V | | 0.1 | 0.3 | V |
| | $V_{oH}$ | IL = 5 mA; VDRIVE = 5 V | 3.2 | 3.4 | | V |
| | $V_{oL}$ | IL = –5 mA; VDRIVE = 5 V | | 0.7 | 0.9 | V |
| | $V_{oH}$ | IL = 0 mA; VDRIVE = 12 V | 11.3 | 11.6 | | V |
| | $V_{oL}$ | IL = 0 mA; VDRIVE = 12 V | | 0.1 | 0.3 | V |
| | $V_{oH}$ | IL = 5 mA; VDRIVE = 12 V | 10.3 | 10.5 | | V |
| | $V_{oL}$ | IL = –5 mA; VDRIVE = 12 V | | 0.7 | 0.9 | V |
| | $\lvert I_{OHmax} \rvert$ | Current limit high<br>$T_{CASE}$ = –40 °C ... +85 °C | 5 | 13 | 17 | mA |
| | $\lvert I_{OLmax} \rvert$ | Current limit low<br>$T_{CASE}$ = –40 °C ... +85 °C | 5 | 14 | 18 | mA |
| | $\lvert I_{OTLeak} \rvert$ | Leakage current tristate<br>$T_{CASE}$ = -40 °C ... +85 °C | | | 100 | µA |
| **AC Characteristics** | | | | | | |
| Outputs | $t_{minPulseHigh}$ | Minimum pulse width high,<br>VDRIVE = 5 V or 12 V, RL=1 kΩ | | 700 | 1400 | ns |
| | $t_{minPulseLow}$ | Minimum pulse width low,<br>VDRIVE = 5 V or 12 V, RL=1 kΩ | | 200 | 400 | ns |
| | $F_{max}$ | Duty cycle: 50 %<br>VDRIVE = 5 V or 12 V | | 0.7[2] | | MHz |
| | | Duty cycle: 1 % or 99 %<br>VDRIVE = 5 V or 12 V | | 14 | | kHz |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

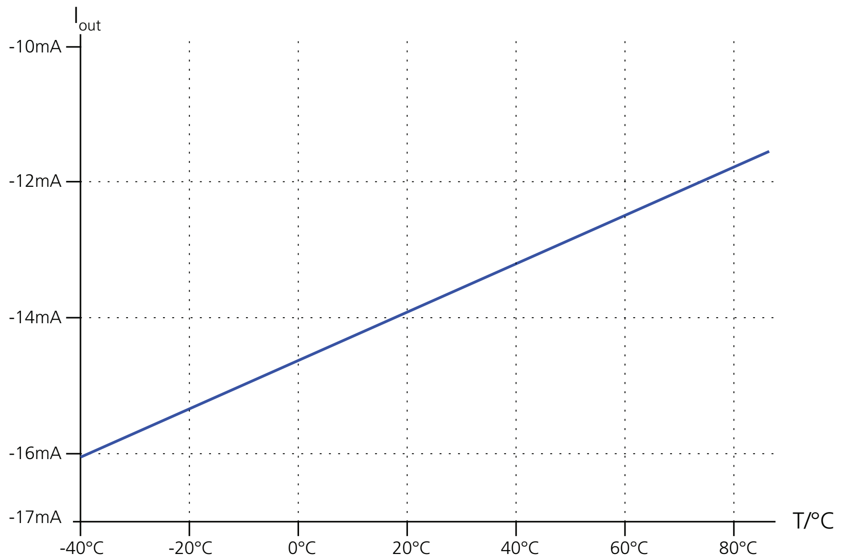
[2] Limited by software to 150 kHz

The following illustrations show the maximum output current of a digital output circuit as a function of ambient temperature (VDRIVE = 12 V; output is shorted to 6 V):

- Output high

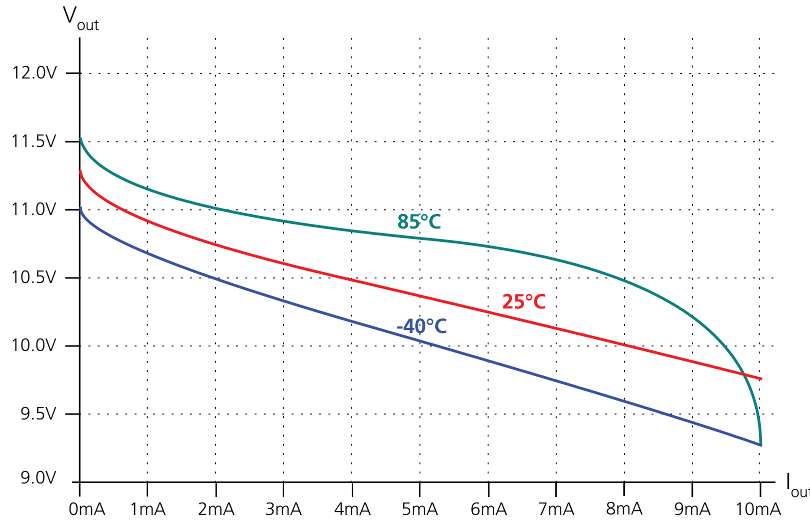



- Output low

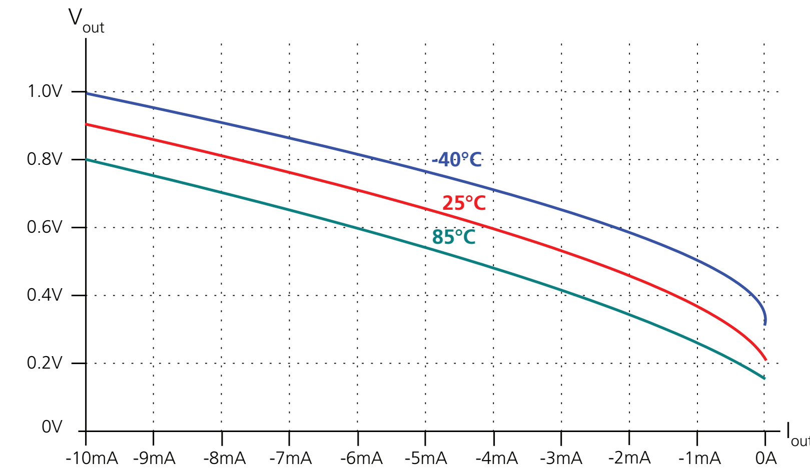


The following illustrations show the typical digital output voltage as a function of the output current (VDRIVE = 12 V):

- Output high

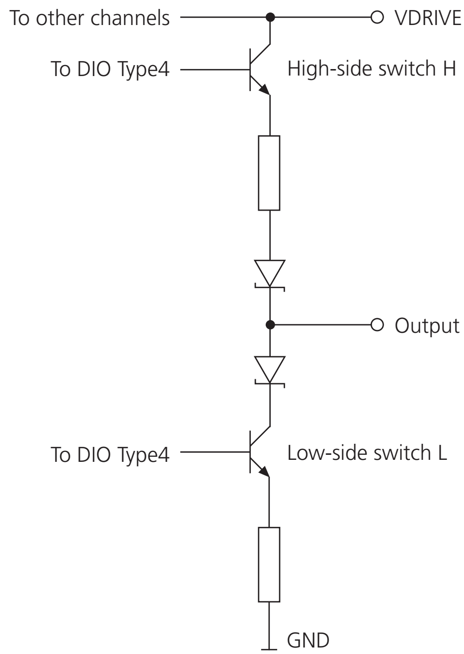



- Output low



**Circuit diagrams**

The following table shows a *simplified* diagram of the I/O circuitry of the digital outputs:

| Signal | I/O Circuit |
|---|---|
| Digital outputs |  |

**Digital outputs on the DS1514 ZIF I/O connector**

Only I/O modules provide digital outputs on the DS1514 ZIF I/O connector.

For signal descriptions, refer to the following topics:

- If you use a DS1552 Multi-I/O Module, refer to *Digital Outputs* on page 592.
- If you use a DS1554 Engine Control I/O Module, refer to *Digital Outputs* on page 618.

**Related topics**

Basics

- *Bit I/O Unit (DIO Type 4)* (📖 *MicroAutoBox Features*)

# Digital I/O (Bidirectional)

**Objective**

The information on the digital bidirectional I/O channels is relevant only if the DS1514 I/O Board is equipped with an I/O module.

For information on the digital bidirectional I/O channels, refer to the following topics:

- If you use a DS1552 Multi-I/O Module, refer to *Digital I/O (Bidirectional)* on page 595.
- If you use a DS1554 Engine Control I/O Module, refer to *Digital I/O (Bidirectional)* on page 622.

# Analog Inputs

**Note on the cable harness**

> **Note**
>
> To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the two ZIF I/O connectors (DS1513 and DS1514). For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**Pin description**

The following table gives a description of the analog input pins on the DS1513 ZIF I/O connector:

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| Z3, Y3, X3, W3, Z4, Y4, X4, W4, Z5, Y5, X5, W5, Z6, Y6, X6, W6 | ADC channel 1 ... 16 | ADC Unit Type 4 | -10 V ... +10 V |
| a3, a4, a5, a6 | External trigger 1 ... 4 | | For information on function of the trigger signals, refer to *ADC Unit Type 4* (*MicroAutoBox Features*). |
| V3, U3, T3, S3, V4, U4, T4, S4, V5, U5, T5, S5, V6, U6, T6, S6 | ADC channel 1 ... 16 | AIO Type 1 ADC Unit | -10 V ... +10 V |

**Characteristics**

The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25° C.

**ADC Unit Type 4** The following table shows the characteristics of the ADC Unit Type 4 channels. All voltages are referenced to SGND pin a2, unless otherwise noted.

| Signal[1)] | Parameter | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **General characteristics** | | | | | | |
| ADC (all 16 channels) | Number of independent input channels | | | 16 | | |
| | Resolution | | | 16 | | bit |
| | Sample rate | Burst mode with more than 1 sample | | | 1 | MSPS |
| | Input voltage range | | -10 | | 10 | V |
| | Conversion timer | Separate for each channel. | | | | |
| | | Width | 27 | | | bit |
| | | Resolution | 10 | | | ns |
| | | Interval | | | 1.342 | s |
| | Timer for time stamping | Common for all channels. Two channels are required to carry one 32 bit value. | | | | |
| | | Width | 32 | | | bit |
| | | Resolution | 10 | | | ns |
| | | Interval | | | 42.9 | s |
| | Buffer size | Software-configurable | 1 | | 8192 | Samples |
| | Buffers per channel | | 3 | | | |
| | Number of external trigger inputs | | 4 | | | |
| **DC characteristics** | | | | | | |
| ADC Type 4 (all 16 channels) | Initial offset error | Below 750 KSPs | -3 | | 3 | mV |
| | Initial gain error | Below 750 KSPs | -0.25 | | 0.25 | % |
| | Input impedance | | | 117 | | kΩ |
| | Offset drift | | | ±40 | | µV/K |
| | Gain drift | | | ±6 | | ppm/K |
| | Overvoltage protection | Continuous | -30 | | +30 | V |
| | | Short term | -50 | | 50 | V |
| External trigger | Input voltage | $V_{iH}$ | 2.3 | | | V |
| | | $V_{iL}$ | | | 0.4 | V |
| | Period | | | | 1 | MHz |
| | Overvoltage protection | Continuous | -48 | | 50 | V |

| Signal[1] | Parameter | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **AC Characteristics** | | | | | | |
| ADC Type 4 (all 16 channels) | No missing codes | | 15 | | | bit |
| | SNR | 12.4 kHz signal @ 200 KSPs | 80 | | | dB |
| | Input bandwidth | Full power bandwidth | 400 | | | kHz |
| | Channel crosstalk | 100 kHz | | | -96 | dB |
| | | 200 kHz | | | -92 | dB |
| | | 400 kHz | | | -90 | dB |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

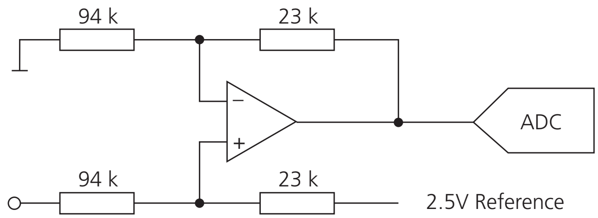
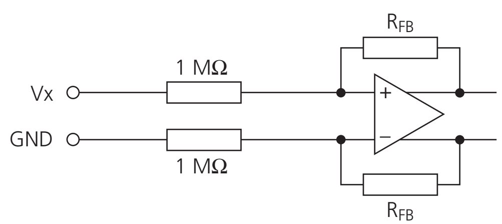
**AIO Type 1 ADC Unit** The following table shows the characteristics of the AIO Type 1 ADC Unit channels. All voltages are referenced to SGND pin a2, unless otherwise noted.

| Parameter[1] | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| **General characteristics** | | | | | |
| Number of independent input channels | | | 16 | | |
| Resolution | | | 16 | | bit |
| Sample rate | | | | 200 | kSPs |
| Input voltage range | | -10 | | 10 | V |
| Conversion time | inclusive transfer time | | 5 | | µs |
| **DC characteristics** | | | | | |
| Offset error | | -2 | | 2 | mV |
| Gain error | | -1 | | 1 | % of FSR |
| Input impedance | | | 1 | | MΩ |
| **AC Characteristics** | | | | | |
| Low pass filter | 3 dB frequency | | 23 | | kHz |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagrams**

The following table shows *simplified* diagrams of the I/O circuitry of the analog inputs:

| Signal | | I/O Circuit |
|---|---|---|
| Analog inputs | ADC Type 4 |  |
| | AIO Type 1 ADC Unit |  |

**Analog inputs on the DS1514 ZIF I/O connector**

Only I/O modules provide analog inputs on the DS1514 ZIF I/O connector.

For signal descriptions, refer to the following topics:

- If you use a DS1552 Multi-I/O Module, refer to *Analog Inputs* on page 597.
- If you use a DS1554 Engine Control I/O Module, refer to *Analog Inputs* on page 624.

**Related topics**

Basics

- *ADC Unit Type 4* (📖 *MicroAutoBox Features*)
- *AIO Unit Type 1 (ADC)* (📖 *MicroAutoBox Features*)

References

- *Analog Inputs* on page 624

# Analog Outputs

**Note on the cable harness**

> **Note**
>
> To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the two ZIF I/O connectors (DS1513 and DS1514). For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**Pin description**

The following table gives a description of the analog output pins on the DS1513 ZIF I/O connector:

| Pins (DS1513) | Signal | Module | Default State | Description / Function |
|---|---|---|---|---|
| Z2, Y2, X2, W2, V2, U2, T2, S2 | DAC1 … DAC8 | AIO Type 1 DAC Unit | 0 V | Standard analog outputs<br>16-bit digital values are converted to analog outputs by the DAC module. |

*Default state* means the state of the signal during reset.

**Characteristics**

The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25 °C; all voltages are referenced to SGND pin a2, unless otherwise noted.

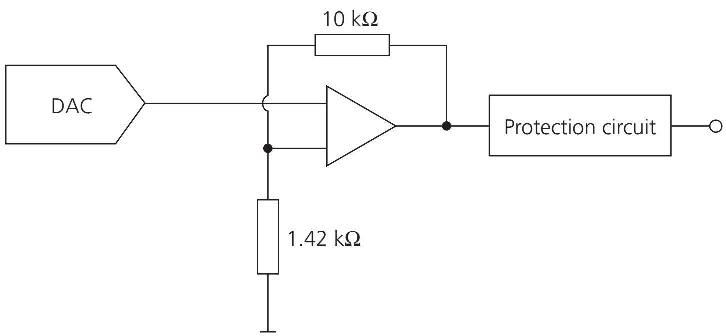
| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC characteristics** | | | | | | |
| DAC1 ... DAC8 | Output voltage range | | -10 | | +10 | V |
| | Resolution | | | 16 | | bit |
| | Offset error | | -4 | | 4 | mV |
| | Gain error | | -0.25 | | 0.25 | % |
| | $I_{DACout}$ | | -8 | | 8 | mA |
| | $C_{DACout}$ | Maximum load capacitance | | | 22 | nF |
| **AC characteristics** | | | | | | |
| DAC1 ... DAC8 | Settling time | Settling time of output (to 1 %) | | | 1 | µs |
| | $f_{gDAC}$ | Low-pass cutoff frequency of reconstruction filter (3 dB) | 500 | | | kHz |
| | $f_{out}$[2)] | Square, ±10 V, $C_{DACout}$ = 1 nF | | | 150 | kHz |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

2) Utilizable output frequency depends on voltage swing and capacitive load.

**Circuit diagrams**

The following table shows a *simplified* diagram of the I/O circuitry of the analog outputs:

| Signal | | I/O Circuit |
|---|---|---|
| Analog outputs | DAC1 … DAC8 (AIO Type 1) |  |

**Analog outputs on the DS1514 ZIF I/O connector**

Only I/O modules provide analog outputs on the DS1514 ZIF I/O connector. For signal descriptions of the DS1552 Multi-I/O Module, refer to *Analog Outputs* on page 602.

**Related topics**

Basics

- *AIO Unit Type 1 (DAC)* (📖 *MicroAutoBox Features*)

# Interfaces

**Pin description**

The following tables give a description of the interface pins provided by the two ZIF connectors.

> **Tip**
>
> The pinout of the ECU interface connectors, USB device connector, and Ethernet I/O connector is not documented. Use a suitable dSPACE connection cable.

**DS1513 ZIF I/O connector**

The DS1513 ZIF I/O connector provides the interface pins to connect CAN bus interfaces, LIN bus interfaces, or for serial communication.

| Pins | Signal | Module Type | Description / Function |
|---|---|---|---|
| c3 | CAN 1 low | CAN Type 1 | CAN controller:<br>■ CAN 1 high = CAN high of module number 1, channel number 1<br>■ CAN 2 high = CAN high of module number 1, channel number 2<br>■ CAN 3 high = CAN high of module number 2, channel number 1<br>■ CAN 4 high = CAN high of module number 2, channel number 2<br>■ CAN 5 high = CAN high of module number 3, channel number 1<br>■ CAN 6 high = CAN high of module number 3, channel number 2<br>■ ISO 11898 interface<br>■ The DS1513 provide a split termination. The CAN bus termination resistors are switchable by software. For further information, refer to *Setup Page (RTICANMM ControllerSetup)* (📖 *RTI CAN MultiMessage Blockset Reference*) or *Unit Page (RTICAN CONTROLLER SETUP)* (📖 *RTI CAN Reference*). |
| c2 | CAN 1 high | | |
| b3 | CAN 2 low | | |
| b2 | CAN 2 high | | |
| B3 | CAN 3 low | | |
| B2 | CAN 3 high | | |
| A3 | CAN 4 low | | |
| A2 | CAN 4 high | | |
| P3 | CAN 5 low | | |
| P2 | CAN 5 high | | |
| N3 | CAN 6 low | | |
| N2 | CAN 6 high | | |
| c6 | Serial 1 RXD[1)] | | RS232 interface |
| c5 | Serial 1 TXD[1)] | | |
| b5 | Serial 2 K / LIN[1)] | | |
| b6 | Serial 2 L[1)] | | |

| Pins | Signal | Module Type | Description / Function |
|---|---|---|---|
| B6 | Serial 3 RXD[1] | | LIN or ISO 9141 interface<br>The K line/LIN interface is bidirectional. The L line is input only. Both lines have no pull-up. For proper function of the K line connect an external pull-up resistor (4.7 kΩ) from this line to VBAT.<br>For information on configuring a LIN master, refer to *Connecting to a LIN Bus* on page 108. |
| B5 | Serial 3 TXD[1] | | |
| A5 | Serial 4 K / LIN[1] | | |
| A6 | Serial 4 L[1] | | |
| P6 | Serial 5 RXD[1] | | |
| P5 | Serial 5 TXD[1] | | |
| N5 | Serial 6 K / LIN[1] | | |
| N6 | Serial 6 L[1] | | |

[1] For a mapping of converter and channel numbers, as used in RTI and RTLib, refer to *Basics on Serial Interface* (*MicroAutoBox Features*).

**Note**

Due to the limitations of the UART baud rate generator, not all baud rates can be programmed exactly to the desired baud rate without error (see Baud rate calculation of the serial interface).

**DS1514 ZIF I/O connector**

The following tables give a description of the interface pins provided by the DS1514 ZIF I/O connector.

You can install IP modules of various types to the DS1514:

- DS4340 FlexRay Interface Modules
- DS4342 CAN FD Interface Modules
- Third-party FlexRay IP modules
- Standard IP modules

**DS4340 FlexRay Interface Module** For a description of the interface pins of the DS4340 FlexRay Interface Module, refer to *Interfaces* on page 637.

**DS4342 CAN FD Interface Module** For a description of the interface pins of the DS4342 CAN FD Interface Module, refer to *Interfaces* on page 645.

**(FlexRay) IP Module 1 and DS4340 Module 1** The table describes the pins when a third-party FlexRay IP module is installed.

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| C6 | IP wakeup 1 | IP_Type1 | You do not need to connect this pin because wake-up functionality is not supported. |
| L3 | IP GND 1 | IP_Type1 | Connection to GND |
| M3 | IP bus high/A 1 | IP_Type1 | FlexRay 1 high in/out (FlexRay-H) |
| M4 | IP bus low/B 1 | IP_Type1 | FlexRay 1 low in/out (FlexRay-L) |
| J3 | IP GND 2 | IP_Type1 | Connection to GND |
| K3 | IP bus high/A 2 | IP_Type1 | FlexRay 2 high in/out (FlexRay-H) |
| K4 | IP bus low/B 2 | IP_Type1 | FlexRay 2 low in/out (FlexRay-L) |
| G5 | Reserved | - | Do not connect |
| H6 | Reserved | - | Do not connect |
| H5 | Reserved | - | Do not connect |
| J6 | Reserved | - | Do not connect |
| J5 | Reserved | - | Do not connect |
| K6 | Reserved | - | Do not connect |
| K5 | Reserved | - | Do not connect |

**(FlexRay) IP Module 2 and DS4340 Module 2** he table describes the pins when a third-party FlexRay IP module is installed.

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| S6 | IP wakeup 1 | IP_Type1 | You do not need to connect this pin because wake-up functionality is not supported. |
| a3 | IP GND 3 | IP_Type1 | Connection to GND |
| b3 | IP bus high/A 3 | IP_Type1 | FlexRay 1 high in/out (FlexRay-H) |
| b4 | IP bus low/B 3 | IP_Type1 | FlexRay 1 low in/out (FlexRay-L) |
| Y3 | IP GND 4 | IP_Type1 | Connection to GND |
| Z3 | IP bus high/A 4 | IP_Type1 | FlexRay 2 high in/out (FlexRay-H) |
| Z4 | IP bus low/B 4 | IP_Type1 | FlexRay 2 low in/out (FlexRay-L) |
| W5 | Reserved | - | Do not connect |
| X6 | Reserved | - | Do not connect |
| X5 | Reserved | - | Do not connect |
| Y6 | Reserved | - | Do not connect |
| Y5 | Reserved | - | Do not connect |
| Z6 | Reserved | - | Do not connect |
| Z5 | Reserved | - | Do not connect |

**Characteristics**

The interface characteristics are specified for the following conditions: $V_{BAT}$ = +12 V; $T_{CASE}$ = +25 °C; all voltages are referenced to GND pins of the ZIF connectors, unless otherwise noted.

| dSPACE Board | Interface | Parameter | Conditions / Comments | | Specification[1] |
|---|---|---|---|---|---|
| DS1401 | Host PC | Protocol | TCP/IP | | — |
| | | Bitrate | — | | ■ 10/1000[2]<br>■ 10/100[3] |
| | | Data throughput | — | | max. 2.6 MB/sec |
| | | Voltage levels | Ethernet standard | | — |
| | Ethernet I/O | Protocol | UDP/IP | | — |
| | | Bitrate | — | | typ. 1000 Mbit |
| | | Voltage levels | Ethernet standard | | — |
| | USB | USB 2.0 standard (USB Flight Recording) | | | |
| | | Data throughput | without connected host tool | | max. 1280 kB/sec |
| | | | with connected host tool | | max. 1024 kB/sec |
| | | | without data loss during cold start (dependend on the boot time of the host interface) | | max. 640 kB/sec |
| | | Current | — | | max. 1.3 A |
| | | Voltage | — | | max. 5 V |
| DS1513 | ECU | Bit rate | LVDS mode | | max. 250 Mbit |
| | | | LVDS2 mode | | max. 500 Mbit |
| | | Cable length | 2-paired twisted pair | | max. 5 m (16.4 ft.) |
| | | Cable type | | | CAT5 |
| | | Voltage levels | LVDS standard | | — |
| | | Full duplex data rate[4] | LVDS mode | Single transfer | max. 5 MWord/s |
| | | | LVDS2 mode | Single transfer | max. 11.2 MWord/s |
| | | | | Block transfer | max. 28 MWord/s |
| | | RAM size[4] | LVDS / LVDS2 mode | | 16 kWord |
| | | FIFO size[4] | LVDS / LVDS2 mode (Transmit buffer) | | 1 kWord |
| | CAN | Bit rate | ISO 11898 interface | | max. 1 MBaud |
| | Serial 1/3/5 RS232-Interface | Bit rate | — | | ■ min. 14 Baud<br>■ max. 115.2 kBaud |
| | | TX output voltage swing | 3 kΩ load | | ■ min. ±5 V<br>■ typ. ±9 V |
| | | $V_{RxinLow}$ | RX input threshold low | | ■ typ. 1.4 V<br>■ max. 0.8 V |
| | | $V_{RxinHigh}$ | RX input threshold high | | ■ min. 2.0 V<br>■ typ. 1.4 V |
| | | Word length | — | | ■ min. 5 bit<br>■ max. 8 bit |

| dSPACE Board | Interface | Parameter | Conditions / Comments | Specification[1] |
|---|---|---|---|---|
| | Serial 2/4/6 ISO9141-Interface | Bit rate | $R_{KO}$ = 510 Ω; $C_K$ ≤ 1.3 nF | ■ min. 14 Baud<br>■ max. 50 kBaud |
| | | Word length | — | ■ min. 5 bit<br>■ max. 8 bit |
| | Serial 2/4/6 LIN Interface | Bit rate | — | ■ min. 14 Baud<br>■ max. 20 kBaud |
| DS1514 | FlexRay | Bit rate | — | max. 2 x 10 MBaud |
| | | Frame length | — | max. 12 byte |
| | CAN FD | Bit rate | ISO 11898 interface | max. 2 x > 2 MBaud |
| | IP module carrier | Clocking | — | ■ min. 8 MHz<br>■ max. 32 MHz |
| | | Access type | — | byte / word |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.
2) Since board revision DS1401-23 (available since dSPACE Release 7.2).
3) Before board revision DS1401-23
4) Word is 16-bit wide

**Baud rate calculation of the serial interface**

**Note**

Due to the limitations of the UART baud rate generator, not all baud rates can be programmed exactly to the desired baud rate without error.

The UART baud rate generator provides several baud rates:

*To calculate the divisor T for a chosen baud rate*

$$T = \text{Round}\left(\frac{921600}{\text{BR (chosen)}}\right)$$

BR (chosen) = The baudrate to be generated
T = The baudrate generator divisor (8 ≤ T ≤ 65535)

*To calculate the real baud rate from a given divisor T*

$$\frac{\text{BR (real)}}{\text{Baud}} = \frac{921600}{T}$$

BR (real) = The baudrate you get
T = The baudrate generator divisor (8 ≤ T ≤ 65535)

*To calculate the resulting error*

$$\frac{\text{Error}_{BR}}{100\%} = \frac{\text{BR (real)} - \text{BR (chosen)}}{\text{BR (chosen)}}$$

**Note**

If $Error_{BR} \leq 2\%$, messages will be transferred and received correctly.

# Data Sheet DS1552 Multi-I/O Module

**Suitable MicroAutoBox variants**

You can use the DS1552 Multi-I/O Module with the following MicroAutoBox variants:

- MicroAutoBox II 1401/1511/1512
- MicroAutoBox II 1401/1511/1514
- MicroAutoBox II 1401/1512/1513
- MicroAutoBox II 1401/1513/1514

**Where to go from here**

Information in this section



Information in other sections

# General Information

## Absolute Maximum Levels

**Avoiding damage to the system**

> **NOTICE**
>
> Do not exceed the maximum levels since this might permanently damage the system.

**Levels**

The following table shows the maximum voltage levels of the DS1552 Multi-I/O Module. All voltages are referenced to GND (unless otherwise noted).

| Parameter | Specification[1)] | Description |
|---|---|---|
| VDRIVE | 0 V ... +45 V | |
| All digital output voltages | (VDRIVE – 45 V) ... +45 V | |
| All digital input voltages | (VDRIVE – 45 V) ... +45 V | |
| All analog input voltages | –40 V ... +40 V | |
| All analog output voltages | –30 V ... +40 V | |
| VSENS output | 0 V ... +40 V | VSENS is switched on and off with the REMOTE pin. |
| VBATprot output | 0 V ... +45 V | VBATprot follows VBAT within the specified range.<br>VBATprot is switched on and off with the REMOTE pin. |
| RS232, RS485/422 | –25 V ... +25 V | |
| All outputs short circuit to GND | continuous | |

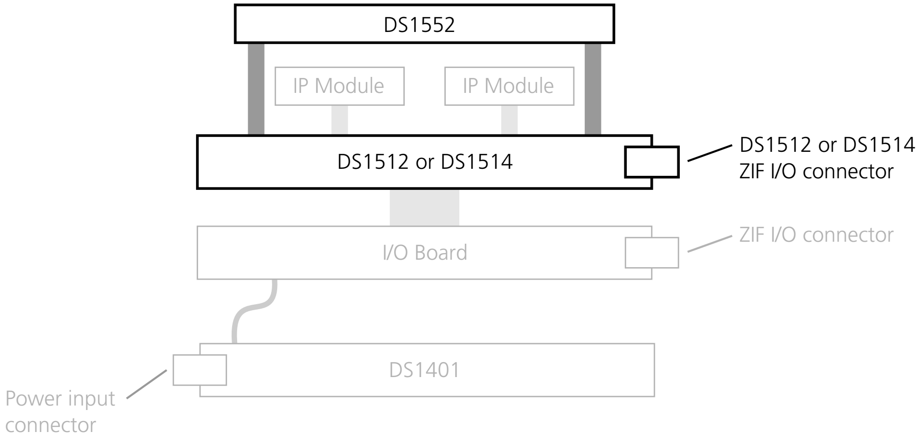
1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

# Connector Pinouts

## DS1512 and DS1514 ZIF I/O Connectors

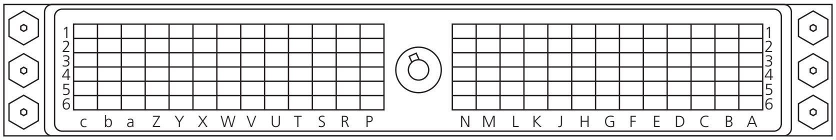
**Objective**

The DS1512 I/O connector and the DS1514 I/O connector are 156-pin zero insertion force (ZIF) connectors giving access to the I/O signals of the DS1552 Multi-I/O Module. The illustration below shows the internal assembly of MicroAutoBox with a DS1552 Multi-I/O Module installed.




**Pinout**

The DS1512 and DS1514 I/O boards have the same pinout. The following illustration shows the pin numbering of the I/O connector (front view of MicroAutoBox):




**Note**

There are pins identified by uppercase letters (A, B, C, etc.) and pins identified by lowercase letters (a, b, c).

The following table shows the signals of the I/O connector and the signal mapping to the IP connectors:

| 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GND | in | GND | in | CrankCam+ ch 3 | in | CrankCam– ch 3 | in | DigOut ch 15 | out | DigOut ch 16 | out | *A* |
| GND | in | DigOut ch 12 | out | CrankCam+ ch 2 | in | CrankCam– ch 2 | in | DigOut ch 13 | out | DigOut ch 14 | out | *B* |
| GND | in | DigOut ch 9 | out | DigOut ch 10 | out | GND | in | DigOut ch 11 | out | IP slot 1, pin 5 | i/o | *C* |
| GND | in | DigOut ch 4 | out | DigOut ch 5 | out | DigOut ch 6 | out | DigOut ch 7 | out | DigOut ch 8 | out | *D* |
| GND | in | AnalogIn ch 16[1] | in | AnalogIn+ ch 8[2] | in | AnalogIn- ch 8[2, 4] | in | DigOut ch 2 | out | DigOut ch 3 | out | *E* |
| GND | in | AnalogIn ch 15[1] | in | AnalogIn+ ch 7[2] | in | AnalogIn- ch 7[2, 4] | in | DigOut ch 1 | out | GND | in | *F* |
| GND | in | AnalogIn ch 14[1] | in | AnalogIn+ ch 6[2] | in | AnalogIn- ch 6[2, 4] | in | IP slot 1, pin 14 | i/o | GND | in | *G* |
| GND | in | AnalogIn ch 13[1] | in | AnalogIn+ ch 5[2] | in | AnalogIn- ch 5[2, 4] | in | IP slot 1, pin 16 | i/o | IP slot 1, pin 15 | i/o | *H* |
| GND | in | AnalogIn ch 12[1] | in | IP slot 1, pin 44 | i/o | GND | in | IP slot 1, pin 18 | i/o | IP slot 1, pin 17 | i/o | *J* |
| GND | in | AnalogIn ch 11[1] | in | IP slot 1, pin 46 | i/o | IP slot 1, pin 45 | i/o | IP slot 1, pin 20 | i/o | IP slot 1, pin 19 | i/o | *K* |
| GND | in | AnalogIn ch 10[1] | in | IP slot 1, pin 48 | i/o | DigIO ch 8 | i/o | GND | in | GND | in | *L* |
| VDRIVE | In | AnalogIn ch 9[1] | in | IP slot 1, pin 50 | i/o | IP slot 1, pin 49 | i/o | DigIO ch 6 | i/o | DigIO ch 7 | i/o | *M* |
| VDRIVE | In | DigIO ch 1 | i/o | DigIO ch 2 | i/o | DigIO ch 3 | i/o | DigIO ch 4 | i/o | DigIO ch 5 | i/o | *N* |
| VBAT prot | Out | GND | in | ZeroDetection+ | in | ZeroDetection– | in | DigIn ch 15 | in | DigIn ch 16 | in | *P* |
| VBAT prot | Out | DigIn ch 12 | in | CrankCam+ ch 1 | in | CrankCam– ch 1 | in | DigIn ch 13 | in | DigIn ch 14 | in | *R* |
| GND | in | DigIn ch 9 | in | DigIn ch 10 | in | GND | in | DigIn ch 11 | in | IP slot 2, pin 5 | i/o | *S* |
| GND | in | DigIn ch 4[3] | in | DigIn ch 5 | in | DigIn ch 6 | in | DigIn ch 7 | in | DigIn ch 8 | in | *T* |
| GND | in | AnalogIn ch 8[1] | in | AnalogIn+ ch 4[2] | in | AnalogIn- ch 4[2, 4] | in | DigIn ch 2[3] | in | DigIn ch 3[3] | in | *U* |
| GND | in | AnalogIn ch 7[1] | in | AnalogIn+ ch 3[2] | in | AnalogIn- ch 3[2, 4] | in | DigIn ch 1[3] | in | GND | in | *V* |
| GND | in | AnalogIn ch 6[1] | in | AnalogIn+ ch 2[2] | in | AnalogIn- ch 2[2, 4] | in | IP slot 2, pin 14 | i/o | GND | in | *W* |
| GND | in | AnalogIn ch 5[1] | in | AnalogIn+ ch 1[2] | in | AnalogIn- ch 1[2, 4] | in | IP slot 2, pin 16 | i/o | IP slot 2, pin 15 | i/o | *X* |

| 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GND | in | AnalogIn ch 4[1)] | in | IP slot 2, pin 44 | i/o | GND | in | IP slot 2, pin 18 | i/o | IP slot 2, pin 17 | i/o | *Y* |
| GND | in | AnalogIn ch 3[1)] | in | IP slot 2, pin 46[5)] | i/o | IP slot 2, pin 45[5)] | i/o | IP slot 2, pin 20[5)] | i/o | IP slot 2, pin 19[5)] | i/o | *Z* |
| GND | in | AnalogIn ch 2[1)] | in | IP slot 2, pin 48 | i/o | Serial 1 (DS1552)[6)] | i/o | Serial 1 (DS1552)[6)] | i/o | Serial 1 (DS1552)[6)] | i/o | *a* |
| GND | in | AnalogIn ch 1[1)] | in | IP slot 2, pin 50 | i/o | IP slot 2, pin 49 | i/o | Serial 1 (DS1552)[6)] | i/o | VSENS- | out | *b* |
| GND | in | AnalogOut ch 1 | out | AnalogOut ch 2 | out | AnalogOut ch 3 | out | AnalogOut ch 4 | out | VSENS+ | out | *c* |

1) ADC 1552 type 2
2) ADC 1552 type 1
3) The DigIn channels 1 ... 4 of the DIO 1552 Type 1 unit can be used whether as digital inputs or as external trigger inputs.
4) Negative input line of the ADC channel is connected to GND.
5) Serial 2 (DS1552): If you want to use the second serial interface channel the hardware must be modified by dSPACE. The ZIF pins Z3, Z4, Z5, Z6 are connected by default to the IP Slot 2.
6) For details on the RS232, full duplex RS485/422, or half duplex RS485/422 mode, refer to *Interfaces* on page 607.

**Signal descriptions**

For descriptions of the signals which are available on the DS1514 ZIF I/O connector, refer to:

- *Digital Inputs* on page 590
- *Digital Outputs* on page 592
- *Digital I/O (Bidirectional)* on page 595
- *Analog Inputs* on page 597
- *Analog Outputs* on page 602
- *Digital Crank/Cam Inputs* on page 603
- *Inductive Zero Voltage Detector* on page 605
- Serial: *Interfaces* on page 607

# Signal Descriptions

**Where to go from here**

Information in this section



## Power Inputs and Outputs

**Note on the cable harness**

**Note**

To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the two ZIF I/O connectors (DS1511/DS1513 and DS1512 or DS1514). For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**Pin description**

The following table gives a description of the power inputs and outputs on the DS1512 and DS1514 ZIF I/O connectors that are internally connected to the DS1552 Multi-I/O Module:

| Pins | Signal | Description / Function |
|---|---|---|
| M1, N1 | VDRIVE | This input supplies all digital input and output circuits located on the DS1552 Multi-I/O Module.<br>■ Connect this input to VSENS to set CMOS/TTL-compatible logic levels for your inputs/outputs.<br>■ Connect this input to VBATprot to set automotive-compatible logic levels for your inputs/outputs.<br>■ Do not connect this pin directly to VBAT, because the input and output circuits are not load-dump-protected or reverse-voltage-protected at this signal.<br>■ While MicroAutoBox is being powered down, the output stages may have pull-up behavior to VDRIVE. So the outputs may reach the level of VDRIVE. If this behavior is critical in your application, you have to power down your external devices or VDRIVE before powering down MicroAutoBox. You can also use the REMOTE signal (Kl.15) with the power control software functionality to first switch off VDRIVE via a relay. |
| c6 | VSENS+ | Sensor supply output.<br>Use this output to supply your sensors and/or VDRIVE. If you need CMOS/TTL-compatible logic levels at the inputs/outputs connect VSENS+ to VDRIVE and VSENS- to GND.<br>The sensor supply outputs are accessible via the RTI FPGA Programming Blockset. For further information, refer to *Parameters Page (FPGA_IO_WRITE_BL)* ( *RTI FPGA Programming Blockset - FPGA Interface Reference*). |
| b6 | VSENS- | |
| P1, R1 | VBAT prot | Protected VBAT output.<br>Use this output to supply VDRIVE when automotive logic levels are needed. |

Characteristics of the power inputs/outputs:

- For MicroAutoBox II 1401/1511/1512, refer to *Power Inputs and Outputs* on page 395.
- For MicroAutoBox II 1401/1511/1514, refer to *Power Inputs and Outputs* on page 440.
- For MicroAutoBox II 1401/1512/1513, refer to *Power Inputs and Outputs* on page 483.
- For MicroAutoBox II 1401/1513/1514, refer to *Power Inputs and Outputs* on page 560.

**Related topics**

Basics

- *ADC 1552 Type 1 Unit* (*MicroAutoBox Features*)
- *ADC 1552 Type 2 Unit* (*MicroAutoBox Features*)
- *Bit I/O Unit (DIO 1552 Type 1)* (*MicroAutoBox Features*)
- *DAC 1552 Type 1 Unit* (*MicroAutoBox Features*)

# Digital Inputs

**Note on the cable harness**

> **Note**
>
> To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the two ZIF I/O connectors (DS1511/DS1513 and DS1512 or DS1514). For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**Pin description**

The following table gives a description of the digital input pins on the DS1512 and DS1514 ZIF I/O connectors that are internally connected to the DS1552 Multi-I/O Module:

| Pins | Signal | Description / Function |
|---|---|---|
| V5, U5, U6, T2, T3, T4, T5, T6, S2, S3, S5, R2, R5, R6, P5, P6 | Channel 1 ... 16<br>DIO 1552 Type 1 | Standard discrete digital input with pull-up. |

**Characteristics**

The characteristics are specified for the following conditions:

- $V_{BAT}$=+12 V (unless otherwise noted)

  $T_{CASE}$=+25 °C (unless otherwise noted)

  All voltages are referenced to GND (unless otherwise noted).

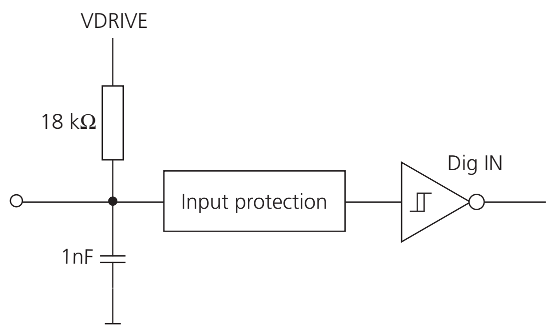
| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC characteristics** | | | | | | |
| Channel 1 ... 16<br>DIO 1552 Type 1 | $V_{iH}$ | Input high voltage | 3.1 | | | V |
| | $V_{iL}$ | Input low voltage | | | 1.2 | V |
| | $V_{iHys}$ | Input hysteresis voltage | | 1 | | V |
| | $R_{DigIn}$ | Pull-up resistor to VDRIVE | 17 | 18 | 19 | kΩ |
| | $C_{DigIn}$ | Input capacitance | | 1 | | nF |

| Signal[1)] | | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| **AC characteristics** | | | | | | | |
| DIO 1552 Type 1 | Inputs | $t_{LowMin}$ | Minimum pulse width low | | 250 | 500 | ns |
| | | $t_{HighMin}$ | Minimum pulse width high | | 300 | 600 | ns |
| | | $F_{max}$ | Duty cycle: 50 % | | 1.8 | | MHz |
| | | | Duty cycle: 1 % or 99 % | | 33 | | kHz |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagram**

The following table shows a *simplified* diagram of the I/O circuitry of the digital inputs:

<table>
<tr><th>Signal</th><th>I/O Circuit</th></tr>
<tr><td>DIO 1552 Type 1</td><td>


For proper operation, VDRIVE must have a level above the maximum input voltage.
</td></tr>
</table>

**Related topics**

Basics

- *ADC 1552 Type 1 Unit* (*MicroAutoBox Features*)
- *ADC 1552 Type 2 Unit* (*MicroAutoBox Features*)
- *Bit I/O Unit (DIO 1552 Type 1)* (*MicroAutoBox Features*)
- *DAC 1552 Type 1 Unit* (*MicroAutoBox Features*)

# Digital Outputs

**Note on the cable harness**

> **Note**
>
> To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the two ZIF I/O connectors (DS1511/DS1513 and DS1512 or DS1514). For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**General behavior of digital signals**

All digital outputs are set to high impedance (tristate) until the application is started. Then the outputs follow the states defined in your application. Unused outputs remain in tristate mode.

**Pin description**

The following table gives a description of the digital output pins on the DS1512 and DS1514 ZIF I/O connectors that are internally connected to the DS1552 Multi-I/O Module:

| Pins | Signal | Description / Function |
|---|---|---|
| F5, E5, E6, D2 ... D6, C2, C3, C5, B2, B5, B6, A5, A6 | Channel 1 ... 16<br>DIO 1552 Type 1 | Standard discrete digital output. |

**Characteristics**

The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25 °C; all voltages are referenced to GND, unless otherwise noted.

| Parameter[1)] | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| **General characteristics** | | | | | |
| Number of independent output channels | | | 16 | | |
| Supply voltage | The digital output circuits are supplied via the VDRIVE pin. | 4.5 | | 40 | V |
| Protected supply voltage | | | | 45 | V |
| Power-up default | | All outputs are in high-impedance state. | | | |
| **DC Characteristics** | | | | | |
| Output high voltage level without load | VDRIVE = 5 V | 4.1 | 4.3 | | V |
| | VDRIVE = 12 V | 11.0 | 11.2 | | V |
| Output high voltage level with 5 mA load | VDRIVE = 5 V | 3.2 | 3.4 | | V |
| | VDRIVE = 12 V | 10.1 | 10.3 | | V |

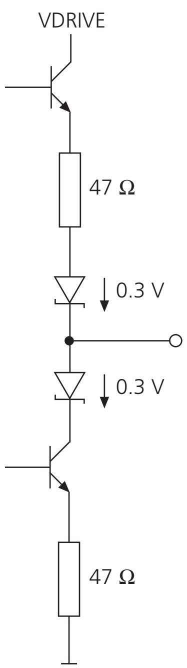
| Parameter[1] | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| Output low voltage level without load | VDRIVE = 5 V | | 0.1 | 0.3 | V |
| | VDRIVE = 12 V | | 0.1 | 0.3 | V |
| Output low voltage level with –5 mA load | VDRIVE = 5 V | | 0.7 | 0.9 | V |
| | VDRIVE = 12 V | | 0.7 | 0.9 | V |
| Current limit high level | $T_{CASE}$ = -40 °C ... +85 °C | 5 | 13 | | mA |
| Current limit low level | $T_{CASE}$ = -40 °C ... +85 °C | 5 | 14 | | mA |
| Leakage current tristate | $T_{CASE}$ = -40 °C ... +85 °C | | | 100 | µA |
| **AC Characteristics** | | | | | |
| Minimum pulse width high level with 1 kΩ load | VDRIVE = 5 V or 12 V | | 700 | | ns |
| Minimum pulse width low level with 1 kΩ load | VDRIVE = 5 V or 12 V | | 200 | | ns |
| Output Frequency at 50% duty cycle | VDRIVE = 5 V or 12 V | | 0.7 [2] | | MHz |
| Output frequency at 1% or 99% duty cycle | VDRIVE = 5 V or 12 V | | 14 | | kHz |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

2) RTI and RTI-MP limits the frequency to 150 kHz. Only the RTI FPGA Programming Blockset supports a higher frequency.

**Circuit diagram**

The following table shows a *simplified* diagram of the I/O circuitry of the digital outputs:

| Signal | I/O Circuit |
|---|---|
| DIO 1552 Type 1 |   |

**Related topics**

Basics

- *ADC 1552 Type 1 Unit* (📖 *MicroAutoBox Features*)
- *ADC 1552 Type 2 Unit* (📖 *MicroAutoBox Features*)
- *Bit I/O Unit (DIO 1552 Type 1)* (📖 *MicroAutoBox Features*)
- *DAC 1552 Type 1 Unit* (📖 *MicroAutoBox Features*)

# Digital I/O (Bidirectional)

**Note on the cable harness**

> **Note**
>
> To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the two ZIF I/O connectors (DS1511/DS1513 and DS1512 or DS1514). For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**Pin description**

The following table gives a description of the digital I/O pins on the DS1512 and DS1514 ZIF I/O connectors that are internally connected to the DS1552 Multi-I/O Module:

| Pins | Signal | Description / Function |
|---|---|---|
| N2, N3, N4, N5, N6, M5, M6, L4 | Channel 1 ... 8<br>DIO 1552 Type 2 | 8 digital bidirectional channels for:<br>■ Digital In (Type B)<br>■ Digital Out (Type B) |

> **Note**
>
> The digital bidirectional channels are available only via the RTI FPGA Programming Blockset. For details, refer to *RTI Block Settings for the FPGA1401Tp1 with Multi-I/O Module Frameworks* (📖 *RTI FPGA Programming Blockset - FPGA Interface Reference*).

**Characteristics**

The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25° C; all voltages are referenced to GND unless otherwise noted.

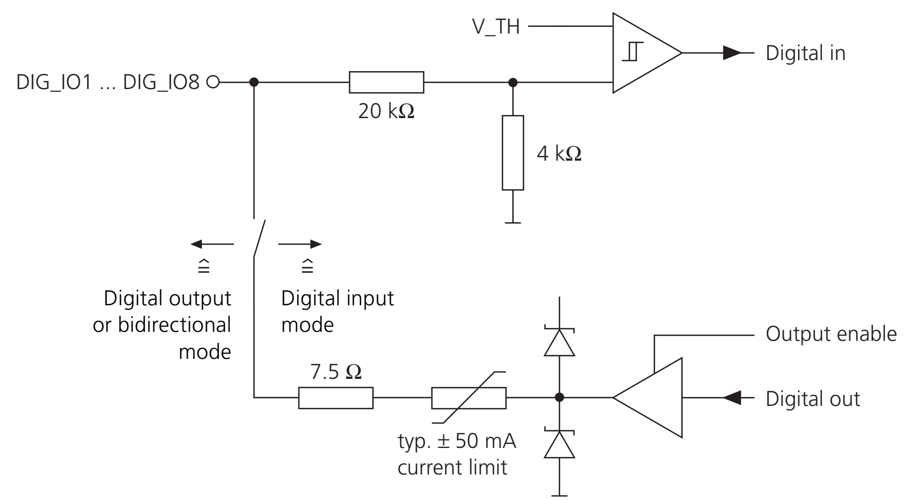
| Parameter[1)] | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| **General characteristics** | | | | | |
| Number of independent I/O channels | | | 8 | | |
| Power-up default | | All digital I/O lines are used as inputs. They are set to 5 V logic level and to a defined logical low level by built-in 24 kΩ pull-down resistors. | | | |

| Parameter[1] | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| **DC Characteristics** | | | | | |
| Input voltage | High | V_TH + 0.5 * V_Hyst | | 15 | V |
| | Low | 0 | | V_TH - 0.5 * V_Hyst | V |
| Overvoltage protection | | -50 | | +50 | V |
| Threshold voltage (V_TH) range [2] | | 1.0 | | 7.5 | V |
| Threshold voltage (V_TH) accuracy | | ± (5 % V_TH + 150 mV) | | | V |
| Hysteresis (V_Hyst) | Fixed voltage | | 0.7 | | V |
| Input impedance | | | 24 | | kΩ |
| Output voltage level with ±10 mA load | High level at 5 V logic level[2] | 4.6 | 5.0 | | V |
| | High level at 3.3 V logic level[2] | 2.8 | 3.2 | | V |
| | Low level | | 0.2 | | V |
| Output current during short circuit | | ±45 | | ±75 | mA |
| **AC Characteristics** | | | | | |
| Input frequency | 5 V logic level with 50% duty cycle and V_TH = 2.5 V | | | 10 | MHz |
| Input pulse width | 5 V logic level with 20% duty cycle and V_TH = 2.5 V | 20 | | | ns |
| Output frequency | Max. 100 pF capacitive load | | | 40 | MHz |
| Output pulse width | Max. 100 pF capacitive load | 12.5 | | | ns |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.
[2] Software-configurable.

**Circuit diagram**

The following table shows a *simplified* diagram of the I/O circuitry of the digital I/O channels:

| Signal | I/O Circuit |
|---|---|
| Channel 1 ... 8 DIO 1552 Type 2 [1)] |  |



1) Only available via the RTI FPGA Programming Blockset (see *RTI Block Settings for the FPGA1401Tp1 with Multi-I/O Module Frameworks* (*RTI FPGA Programming Blockset - FPGA Interface Reference*)).

**Related topics**

Basics

- *ADC 1552 Type 1 Unit* (*MicroAutoBox Features*)
- *ADC 1552 Type 2 Unit* (*MicroAutoBox Features*)
- *Bit I/O Unit (DIO 1552 Type 1)* (*MicroAutoBox Features*)
- *DAC 1552 Type 1 Unit* (*MicroAutoBox Features*)

# Analog Inputs

**Note on the cable harness**

**Note**

To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the two ZIF I/O connectors (DS1511/DS1513 and DS1512 or DS1514). For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**Pin description**

The following table gives a description of the analog input pins on the DS1512 and DS1514 ZIF I/O connectors that are internally connected to the DS1552 Multi-I/O Module:

| Pins | Signal | Module | Description / Function |
|---|---|---|---|
| X4, X3, W4, W3, V4, V3, U4, U3, H4, H3, G4, G3, F4, F3, E4, E3 | ADC channel 1 ... 8 | ADC 1552 Type 1 | High sample rate analog to digital converter inputs.<br>■ DS1552: 0 V ... 5 V<br>■ DS1552B1: -10 V ... +10 V |
| V5, U5, U6, T2 | External trigger 1 ... 4[1)] | | For information on function of the ADC 1552 Type 1 module's trigger signals, refer to *ADC 1552 Type 1 Unit* (*MicroAutoBox Features*). |
| b2, a2, Z2, Y2, X2, W2, V2, U2, M2, L2, K2, J2, H2, G2, F2, E2 | ADC channel 1 ... 16 | ADC 1552 Type 2 | Low sample rate analog to digital converter inputs. |

1) DIO 1552 Type 1 unit

**Characteristics**

The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25 °C.

**ADC 1552 Type 1 module** The following table shows the characteristics of the ADC 1552 Type 1 module of the DS1552 Multi-I/O module. All voltages are referenced to X4...U4 and H4...E4, unless otherwise noted.

| Parameter[1)] | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| **General characteristics** | | | | | |
| Number of independent input channels | | | 8 | | |
| Resolution | | | 16 | | bit |
| Sample rate | Burst mode with more than 1 sample | | | 1 | MSPS |
| Input voltage range | DS1552 | 0 | | 5 | V |
| | DS1552B1 | -10 | | 10 | V |
| **DC characteristics - DS1552** | | | | | |
| Initial offset error | Below 750 KSPs | -0.5 | | 0.5 | mV |
| Initial gain error | Below 750 KSPs | -0.25 | | 0.25 | % |
| Input impedance | | | 192 | | kΩ |
| Offset drift | | | ±10 | | µV/K |
| Gain drift | | | ±6 | | ppm/K |
| Overvoltage protection | Continuous | -20 | | +30 | V |
| | Short term | -50 | | 50 | V |

| Parameter[1] | | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC characteristics - DS1552B1** | | | | | | |
| Initial offset error | | Below 750 KSPs | -3.0 | | +3.0 | mV |
| Initial gain error | | Below 750 KSPs | -0.25 | | 0.25 | % of FSR |
| Input impedance | | | | 117 | | kΩ |
| Offset drift | | | | ±40 | | µV/K |
| Gain drift | | | | ±6 | | ppm/K |
| Overvoltage protection | | Continuous | -30 | | +30 | V |
| | | Short term | -50 | | 50 | V |
| **AC Characteristics** | | | | | | |
| No missing codes | | | 15 | | | bit |
| SNR | | 12.4 kHz signal @ 200 KSPs | 80 | | | dB |
| Input bandwidth | | Full power bandwidth | 400 | | | kHz |
| Channel crosstalk | | 100 kHz | | | -96 | dB |
| | | 200 kHz | | | -92 | dB |
| | | 400 kHz | | | -90 | dB |
| **Characteristics if you use the *RTI DS1552 I/O Extension Blockset* (*MicroAutoBox RTI Reference*).** | | | | | | |
| Conversion timer | | Separate for each channel. | | | | |
| | | Width | 27 | | | bit |
| | | Resolution | 10 | | | ns |
| | | Interval | | | 1.342 | s |
| Timer for time stamping | | Common for all channels. Two channels are required to carry one 32 bit value. | | | | |
| | | Width | 32 | | | bit |
| | | Resolution | 10 | | | ns |
| | | Interval | | | 42.9 | s |
| Buffer size | | Software-configurable | 1 | | 8192 | Samples |
| Buffers per channel | | | 3 | | | |
| Number of external trigger inputs | | | 4 | | | |
| External trigger | Input voltage | $V_{iH}$ | 2.3 | | | V |
| | | $V_{iL}$ | | | 0.4 | V |
| | Period | | | | 1 | MHz |
| | Overvoltage protection | Continuous | -48 | | 50 | V |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

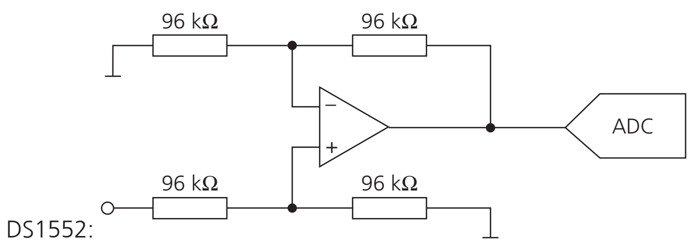
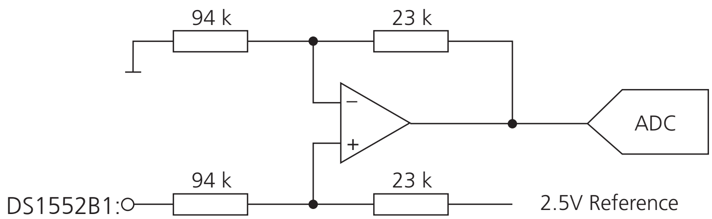
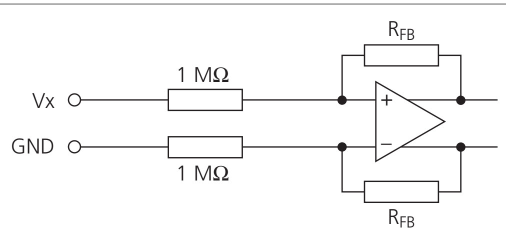
**ADC 1552 Type 2 module** The following table shows the characteristics of the ADC 1552 Type 2 module of the DS1552 Multi-I/O module. All voltages are referenced to GND, unless otherwise noted.

| Parameter[1)] | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| **General characteristics** | | | | | |
| Number of independent input channels | | | 16 | | |
| Resolution | | | 16 | | bit |
| Sample rate | | | | 200 | kSPs |
| Input voltage range | | -10 | | 10 | V |
| No damage voltage input range | | -45 | | 45 | |
| Conversion time | inclusive transfer time | | 5 | | µs |
| **DC characteristics** | | | | | |
| Offset error | | -2 | | 2 | mV |
| Gain error | | -1 | | 1 | % of FSR |
| Input impedance | | | 1 | | MΩ |
| **AC Characteristics** | | | | | |
| Low pass filter | 3 dB frequency | | 23 | | kHz |

[1)] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagrams**

The following table shows *simplified* diagrams of the I/O circuitry of the analog inputs:

| Signal | I/O Circuit |
|---|---|
| ADC 1552 Type 1 channel 1 … 8 |   |
| |   |
| ADC 1552 Type 2 channel 1 … 16 |   |

**Related topics**

Basics

- *ADC 1552 Type 1 Unit* (*MicroAutoBox Features*)
- *ADC 1552 Type 2 Unit* (*MicroAutoBox Features*)
- *Bit I/O Unit (DIO 1552 Type 1)* (*MicroAutoBox Features*)
- *DAC 1552 Type 1 Unit* (*MicroAutoBox Features*)

# Analog Outputs

**Note on the cable harness**

> **Note**
>
> To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the two ZIF I/O connectors (DS1511/DS1513 and DS1512 or DS1514). For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**Pin description**

The following table gives a description of the analog output pins on the DS1512 and DS1514 ZIF I/O connectors that are internally connected to the DS1552 Multi-I/O Module:

| Pins | Signal | Default State | Description / Function |
|---|---|---|---|
| c2, c3, c4, c5 | DAC1 … DAC4<br>DAC 1552 Type 1 | 0 V | Standard analog outputs<br>16-bit digital values are converted to analog outputs by the DAC module. |

*Default state* means the state of the signal during reset.

**Characteristics**

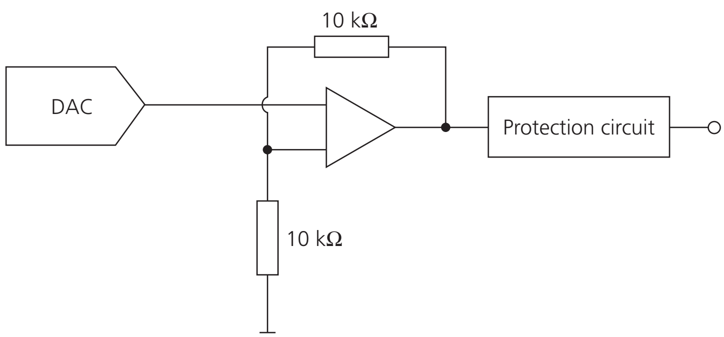
The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25 °C; all voltages are referenced to GND, unless otherwise noted.

| Signal[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC characteristics** | | | | | | |
| DAC 1552Type 1 | Output voltage range | | 0 | | 5 | V |
| | Resolution | | | 16 | | bit |
| | Offset error | | -2 | | 2 | mV |
| | Gain error | | -0.25 | | 0.25 | % |
| | $I_{DACout}$ | | -8 | | 8 | mA |
| | $C_{DACout}$ | Maximum load capacitance | | | 22 | nF |
| **AC characteristics** | | | | | | |
| DAC 1552Type 1 | Settling time | Settling time of output (to 1 %) | | | 1 | µs |
| | $f_{gDAC}$ | Low-pass cutoff frequency of reconstruction filter (3 dB) | 500 | | | kHz |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagram**

The following table shows a *simplified* diagram of the I/O circuitry of the analog outputs:

| Signal | I/O Circuit |
|---|---|
| DAC 1552 Type 1<br>DAC1 … DAC4 |  |

**Related topics**

Basics

- *ADC 1552 Type 1 Unit* (*MicroAutoBox Features*)
- *ADC 1552 Type 2 Unit* (*MicroAutoBox Features*)
- *Bit I/O Unit (DIO 1552 Type 1)* (*MicroAutoBox Features*)
- *DAC 1552 Type 1 Unit* (*MicroAutoBox Features*)

# Digital Crank/Cam Inputs

**Note on the cable harness**

> **Note**
>
> To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the two ZIF I/O connectors (DS1511/DS1513 and DS1512 or DS1514). For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**Pin description**

The following table gives a description of the digital crank/cam input pins on the DS1512 and DS1514 ZIF I/O connectors that are internally connected to the DS1552 Multi-I/O Module:

| Pins | Signal | Description / Function |
|---|---|---|
| A3, A4, B3, B4, R3, R4 | Digital Crank/Cam Sensor | Digital input with pull-up for crankshaft and camshaft sensors. |

**Note**

The digital channels for for crankshaft and camshaft sensors are available only via the RTI FPGA Programming Blockset. For details, refer to *RTI Block Settings for the FPGA1401Tp1 with Multi-I/O Module Frameworks* (*RTI FPGA Programming Blockset - FPGA Interface Reference*).

**Characteristics**

The characteristics are specified for the following conditions:

- $V_{BAT}$ = +12 V (unless otherwise noted)

  $T_{CASE}$ = +25 °C (unless otherwise noted)

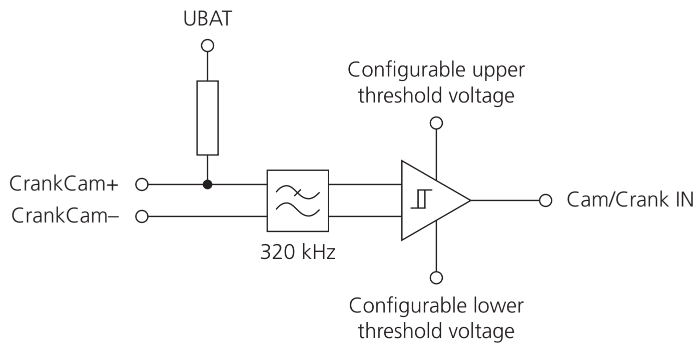
  All voltages are referenced to GND (unless otherwise noted).

| **Parameter**[1)] | **Conditions / Comments** | **Min.** | **Typ.** | **Max.** | **Unit** |
|---|---|---|---|---|---|
| **General characteristics** | | | | | |
| Number of independent input channels | | | 3 | | |
| Input voltage range | | -55 | | +55 | V |
| **DC characteristics** | | | | | |
| Threshold voltage range | Lower and upper thresholds software-configurable | -40 | | +40 | V |
| Threshold voltage accuracy | Accuracy depends on the configured threshold voltage levels $V_{Th}$ | -1% $V_{Th}$ - 100 mV | | +1% $V_{Th}$ + 100 mV | – |
| Input impedance | | | 170 | | kΩ |
| **AC Characteristics** | | | | | |
| Low pass filter | 3 dB frequency | | 320 | | kHz |

[1)] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagram**

The following diagram is a simplified I/O circuitry of the digital crank/cam inputs:




**Related topics**

References

- *Parameters Page (FPGA_IO_READ_BL)* (*RTI FPGA Programming Blockset - FPGA Interface Reference*)

# Inductive Zero Voltage Detector

**Note on the cable harness**

**Note**

To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the two ZIF I/O connectors (DS1511/DS1513 and DS1512 or DS1514). For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**Pin description**

The following table gives a description of the inductive zero voltage detector pins on the DS1512 and DS1514 ZIF I/O connectors that are internally connected to the DS1552 Multi-I/O Module:

| Pins | Signal | Description / Function |
|---|---|---|
| P3, P4 | Inductive zero voltage detector | Digital input to detect a zero crossing from positive to negative. |

**Note**

The inductive zero voltage detector is available only via the RTI FPGA Programming Blockset. For details, refer to *RTI Block Settings for the FPGA1401Tp1 with Multi-I/O Module Frameworks* (*RTI FPGA Programming Blockset - FPGA Interface Reference*).

**Characteristics**

The characteristics are specified for the following conditions:

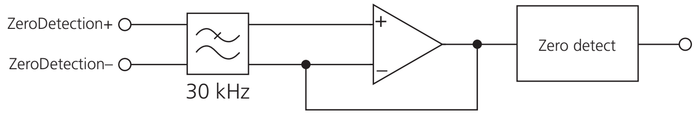
- $V_{BAT}$ = +12 V (unless otherwise noted)
  $T_{CASE}$ = +25 °C (unless otherwise noted)
  All voltages are referenced to GND (unless otherwise noted).

| Parameter[1] | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| **General characteristics** | | | | | |
| Number of independent input channels | | | 1 | | |
| **DC characteristics** | | | | | |
| Input voltage range | | -60 | | +60 | V |
| Input impedance | | | 67 | | kΩ |
| **AC Characteristics** | | | | | |
| Input voltage range | | -200 | | +200 | V |
| Low pass filter | 3 dB frequency | | 30 | | kHz |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagram**

The following diagram is a simplified I/O circuitry of the inductive zero voltage detector:




**Related topics**

References

- *Parameters Page (FPGA_IO_READ_BL)* (*RTI FPGA Programming Blockset - FPGA Interface Reference*)

# Interfaces

**Serial interface of the DS1552 Multi-I/O Module**

With the DS1552 Multi-I/O Module you can use up to two serial interface channels in different modes. For further information, refer to *RTI FPGA Programming Blockset - FPGA Interface Reference*.

**Note**

The ZIF pins Z3, Z4, Z5, Z6 are connected by default to the IP Slot 2. If you want to use the second serial interface channel the hardware must be modified by dSPACE.

The following table gives a description of the interface pins on the DS1512 and DS1514 ZIF I/O connectors that are internally connected to the DS1552 Multi-I/O Module:

| Serial Interface Mode | Pins | Signal | Description / Function |
|---|---|---|---|
| RS232 Mode | b5 | RX[1] | UART channel 1 receive input |
| | a4 | CTS[1] | UART channel 1 clear to send input |
| | a5 | TX[1] | UART channel 1 transmit input |
| | a6 | RTS[1] | UART channel 1 request to send input |
| | Z3 | RX[2] | UART channel 2 receive input |
| | Z4 | CTS[2] | UART channel 2 clear to send input |
| | Z5 | TX[2] | UART channel 2 transmit input |
| | Z6 | RTS[2] | UART channel 2 request to send input |
| Full Duplex RS485/422 Mode | b5 | RX–[1] | UART channel 1 inverting receiver input |
| | a4 | RX+[1] | UART channel 1 noninverting receiver input |
| | a5 | TX–[1] | UART channel 1 inverting transmit input |
| | a6 | TX+[1] | UART channel 1 noninverting transmit input |
| | Z3 | RX–[2] | UART channel 2 inverting receiver input |
| | Z4 | RX+[2] | UART channel 2 noninverting receiver input |
| | Z5 | TX–[2] | UART channel 2 inverting transmit input |
| | Z6 | TX+[2] | UART channel 2 noninverting transmit input |

| Serial Interface Mode | Pins | Signal | Description / Function |
|---|---|---|---|
| Half Duplex RS485/422 Mode | b5 | — | Do not connect |
| | a4 | — | Do not connect |
| | a5 | BM[1] | UART channel 1 inverting receive/transmit input/output (Bus Minus) |
| | a6 | BP[1] | UART channel 1 inverting receive/transmit input/output (Bus Plus) |
| | Z3 | — | Do not connect |
| | Z4 | — | Do not connect |
| | Z5 | BM[2] | UART channel 2 inverting receive/transmit input/output (Bus Minus) |
| | Z6 | BP[2] | UART channel 2 inverting receive/transmit input/output (Bus Plus) |

**Characteristics**

The interface characteristics are specified for the following conditions: $V_{BAT}$ = +12 V; $T_{CASE}$ = +25 °C; all voltages are referenced to GND pins of the ZIF connectors, unless otherwise noted.

| Interface | Parameter | Conditions / Comments | Specification[1)] |
|---|---|---|---|
| RS232 | Data rate | — | max. 1 Mbit/s |
| RS485/422 | Data rate | Configurable on-board termination for RS485 | max. 10 Mbit/s |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Baud rates of the DS1552's serial interface**

dSPACE provides a list of baud rates in a file (`FPGA1401Tp1_uart_parameters.mat`). That lets you select a matching baud rate.

Location of the file:
`<InstallationFolder>\RCPHIL\MATLAB\RTIFPGA\Frameworks\FPGA1401Tp1_<DS1552 Variant>_<FPGA Variant>\`

**Related topics**

Basics


- *ADC 1552 Type 1 Unit* (📖 *MicroAutoBox Features*)
- *ADC 1552 Type 2 Unit* (📖 *MicroAutoBox Features*)
- *Bit I/O Unit (DIO 1552 Type 1)* (📖 *MicroAutoBox Features*)
- *DAC 1552 Type 1 Unit* (📖 *MicroAutoBox Features*)

# Data Sheet DS1554 Engine Control I/O Module

| | |
|---|---|
| **Suitable MicroAutoBox variants** | You can use the DS1554 Engine Control I/O Module with the following MicroAutoBox variants:<br>■ MicroAutoBox II 1401/1511/1514<br>■ MicroAutoBox II 1401/1513/1514 |
| **Software support** | The DS1554 Engine Control I/O Module is supported only by the RTI FPGA Programming Blockset. Refer to 📖 *RTI FPGA Programming Blockset Guide*. |
| **Where to go from here** | Information in this section |



Information in other sections

# General Information

## Absolute Maximum Levels

**Avoiding damage to the system**

**NOTICE**

Do not exceed the maximum levels since this might permanently damage the system.

**Levels**

The following table shows the maximum voltage levels of the DS1554 Engine Control I/O Module. All voltages are referenced to GND (unless otherwise noted).

| Parameter | Specification[1)] | Description |
|---|---|---|
| VDRIVE | 0 V ... +45 V | |
| All digital output voltages | (VDRIVE – 45 V) ... +45 V | |
| All digital input voltages | (VDRIVE – 45 V) ... +45 V | |
| All analog input voltages | –40 V ... +40 V | |
| VSENS output | 0 V ... +40 V | VSENS is switched on and off with the REMOTE pin. |
| VBATprot output | 0 V ... +45 V | VBATprot follows VBAT within the specified range.<br>VBATprot is switched on and off with the REMOTE pin. |
| All outputs short circuit to GND | continuous | |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

# Connector Pinouts

**Where to go from here**

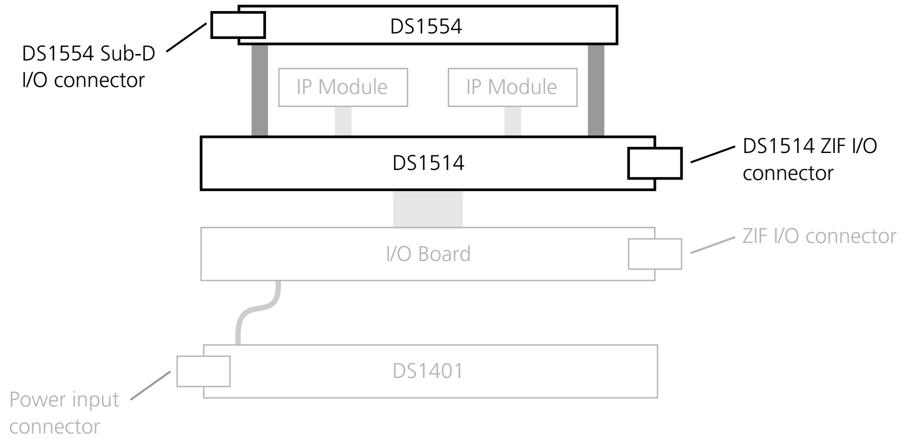
Information in this section



## DS1514 ZIF I/O Connector

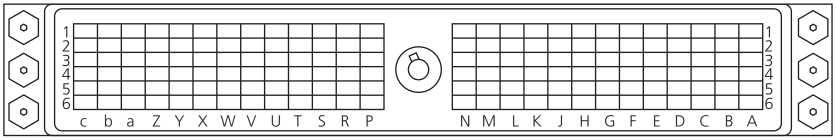
**Objective**

The DS1514 I/O connector is a 156-pin zero insertion force (ZIF) connector giving access to various I/O signals of the DS1554 Engine Control I/O Module. The following illustration shows the internal assembly of MicroAutoBox with a DS1554 Engine Control I/O Module installed.




**Pinout**

The following illustration shows the pin numbering of the I/O connector (front view of MicroAutoBox):



> **Note**
>
> There are pins identified by uppercase letters (A, B, C, etc.) and pins identified by lowercase letters (a, b, c).

The following table shows the signals of the I/O connector and the signal mapping to the IP connectors:

| 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GND | in | DigOut ch 30 | out | DigOut ch 27 | out | GND | in | DigOut ch 31 | out | DigOut ch 26 | out | *A* |
| GND | in | DigOut ch 32 | out | DigOut ch 19 | out | GND | in | DigOut ch 23 | out | DigOut ch 29 | out | *B* |
| GND | in | DigOut ch 22 | out | DigOut ch 11 | out | GND | in | DigOut ch 15 | out | IP slot 1, pin 5 | i/o | *C* |
| GND | in | DigOut ch 28 | out | DigOut ch 3 | out | GND | in | DigOut ch 7 | out | DigOut ch 25 | out | *D* |
| GND | in | DigOut ch 18 | out | DigOut ch 35 | out | GND | in | DigOut ch 36 | out | DigOut ch 21 | out | *E* |
| GND | in | DigOut ch 24 | out | DigOut ch 40 | out | GND | in | DigOut ch 33 | out | DigOut ch 17 | out | *F* |
| GND | in | DigOut ch 20 | out | DigOut ch 39 | out | GND | in | IP slot 1, pin 14 | i/o | DigOut ch 13 | out | *G* |
| GND | in | DigOut ch 14 | out | DigOut ch 37 | out | GND | in | IP slot 1, pin 16 | i/o | IP slot 1, pin 15 | i/o | *H* |
| GND | in | DigOut ch 16 | out | IP slot 1, pin 44 | i/o | GND | in | IP slot 1, pin 18 | i/o | IP slot 1, pin 17 | i/o | *J* |
| GND | in | DigOut ch 10 | out | IP slot 1, pin 46 | i/o | IP slot 1, pin 45 | i/o | IP slot 1, pin 20 | i/o | IP slot 1, pin 19 | i/o | *K* |
| GND | in | DigOut ch 12 | out | IP slot 1, pin 48 | i/o | GND | in | DigOut ch 1 | out | DigOut ch 9 | out | *L* |
| VDRIVE | In | DigOut ch 8 | out | IP slot 1, pin 50 | i/o | IP slot 1, pin 49 | i/o | DigOut ch 38 | out | DigOut ch 5 | out | *M* |
| VDRIVE | In | DigOut ch 2 | out | DigOut ch 6 | out | GND | in | DigOut ch 4 | out | DigOut ch 34 | out | *N* |
| | | | | | | | | | | | | |
| VBAT prot | Out | AnalogIn– ch 14 | in | AnalogIn+ ch 14 | in | GND | in | AnalogIn+ ch 13 | in | AnalogIn– ch 13 | in | *P* |
| VBAT prot | Out | AnalogIn– ch 3 | in | AnalogIn– ch 12 | in | GND | in | AnalogIn+ ch 11 | in | AnalogIn– ch 11 | in | *R* |
| GND | in | AnalogIn+ ch 3 | in | AnalogIn+ ch 12 | in | GND | in | AnalogIn+ ch 9 | in | IP slot 2, pin 5 | i/o | *S* |
| GND | in | AnalogIn+ ch 4 | in | AnalogIn+ ch 7 | in | GND | in | AnalogIn+ ch 10 | in | AnalogIn– ch 9 | in | *T* |
| GND | in | AnalogIn– ch 4 | in | AnalogIn– ch 7 | in | GND | in | AnalogIn+ ch 8 | in | AnalogIn– ch 10 | in | *U* |
| GND | in | AnalogIn– ch 1 | in | AnalogIn– ch 6 | in | GND | in | AnalogIn+ ch 5 | in | AnalogIn– ch 8 | in | *V* |
| GND | in | AnalogIn+ ch 1 | in | AnalogIn+ ch 6 | in | GND | in | IP slot 2, pin 14 | i/o | AnalogIn– ch 5 | in | *W* |

| 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GND | in | AnalogIn– ch 2 | in | GND | in | GND | in | IP slot 2, pin 16 | i/o | IP slot 2, pin 15 | i/o | *X* |
| GND | in | AnalogIn+ ch 2 | in | IP slot 2, pin 44 | i/o | GND | in | IP slot 2, pin 18 | i/o | IP slot 2, pin 17 | i/o | *Y* |
| GND | in | DigIO ch 8 | i/o | IP slot 2, pin 46 | i/o | IP slot 2, pin 45 | i/o | IP slot 2, pin 20 | i/o | IP slot 2, pin 19 | i/o | *Z* |
| GND | in | DigIO ch 7 | i/o | IP slot 2, pin 48 | i/o | GND | in | GND | in | GND | in | *a* |
| GND | in | DigIO ch 3 | i/o | IP slot 2, pin 50 | i/o | IP slot 2, pin 49 | i/o | DigIO ch 2 | i/o | VSENS+ | out | *b* |
| GND | in | DigIO ch 6 | i/o | DigIO ch 1 | i/o | DigIO ch 5 | i/o | DigIO ch 4 | i/o | VSENS- | out | *c* |

**Signal descriptions**

For descriptions of the signals available on the DS1514 ZIF I/O connector, refer to:

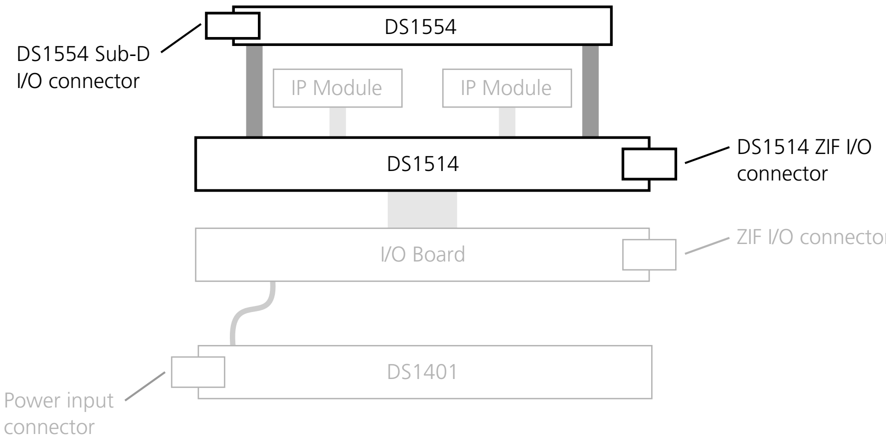
- *Power Inputs and Outputs* on page 616
- *Digital I/O (Bidirectional)* on page 622
- *Digital Outputs* on page 618
- *Analog Inputs* on page 624

# DS1554 Sub-D I/O Connector

**Objective**

The DS1554 Engine Control I/O Module provides a 37-pin, male Sub-D connector at the front of MicroAutoBox.

The illustration below shows the internal assembly of a MicroAutoBox with a DS1554 Engine Control I/O Module installed.

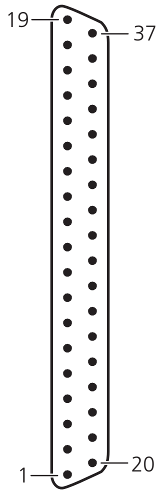



**Pinout**

Because the pin numbering used for Sub-D connectors is not standardized, the following figure shows the numbering scheme used (front view).

**Note**

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

| DS1554 Sub-D I/O Connector | Pin | Signal | Pin | Signal |
|---|---|---|---|---|
|   | 19 | KnockIn+ ch 4 | | |
| | 18 | KnockIn+ ch 3 | 37 | KnockIn– ch 4 |
| | 17 | KnockIn+ ch 2 | 36 | KnockIn– ch 3 |
| | 16 | KnockIn+ ch 1 | 35 | KnockIn– ch 2 |
| | 15 | CrankCam GND | 34 | KnockIn– ch 1 |
| | 14 | CrankCamIn ch 3 | 33 | CrankCamIn ch 4 |
| | 13 | CrankCamIn ch 1 | 32 | CrankCamIn ch 2 |
| | 12 | CrankCamIn ch 5 | 31 | Reserved |
| | 11 | CrankCam GND | 30 | Reserved |
| | 10 | ZeroDetection+ | 29 | ZeroDetection– |
| | 9 | Reserved | 28 | Reserved |
| | 8 | Reserved | 27 | Reserved |
| | 7 | Reserved | 26 | Reserved |
| | 6 | Reserved | 25 | Reserved |
| | 5 | Reserved | 24 | Reserved |
| | 4 | Reserved | 23 | Reserved |
| | 3 | Reserved | 22 | Reserved |
| | 2 | Reserved | 21 | Reserved |
| | 1 | Reserved | 20 | Reserved |

**Signal descriptions**

For descriptions of the signals available on the DS1554 Sub-D I/O connector, refer to:


- *Digital Crank/Cam Inputs* on page 626
- *Inductive Zero Voltage Detector* on page 628
- *Knock Sensor Input* on page 629

# Signal Descriptions

**Where to go from here**

Information in this section



## Power Inputs and Outputs

**Note on the cable harness**

**Note**

To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the two ZIF I/O connectors (DS1511/DS1513 and DS1514). For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**Pin description**

The following table gives a description of the power input and output on the DS1514 ZIF I/O connector that are connected to the DS1554 Engine Control I/O Module:

| Pins | Signal | Description / Function |
|---|---|---|
| M1, N1 | VDRIVE | This input supplies the digital output circuits located on the DS1554 Engine Control I/O Module.<br>■ Connect this input to VSENS to set CMOS/TTL-compatible logic levels for your inputs/outputs.<br>■ Connect this input to VBATprot to set automotive-compatible logic levels for your inputs/outputs.<br>■ Do not connect this pin directly to VBAT, because the input and output circuits are not load-dump-connected or reverse-voltage-protected at this signal.<br>■ While MicroAutoBox is being powered down, the output stages might have pull-up behavior to VDRIVE. This means the outputs can reach the level of VDRIVE. If this behavior is critical in your application, you have to power down your external devices or VDRIVE before powering down MicroAutoBox. You can also use the REMOTE signal (Kl.15) with the power control software functionality to first switch off VDRIVE via a relay. |
| b6 | VSENS+ | Sensor supply output.<br>Use this output to supply your sensors and/or VDRIVE. If you need CMOS/TTL-compatible logic levels at the inputs and outputs, connect VSENS+ to VDRIVE and VSENS- to GND. |
| c6 | VSENS- | |
| R1, P1 | VBAT prot | Protected VBAT output.<br>Use this output to supply VDRIVE when automotive logic levels are needed. |

Characteristics of the power inputs and outputs:

- For MicroAutoBox II 1401/1511/1514, refer to *Power Inputs and Outputs* on page 440.
- For MicroAutoBox II 1401/1513/1514, refer to *Power Inputs and Outputs* on page 560.

**Related topics**

References

- *FPGA_IO_WRITE_BL (FPGA1401Tp1 with Engine Control I/O Module Settings)* (*RTI FPGA Programming Blockset - FPGA Interface Reference*)

# Digital Outputs

**Note on the cable harness**

> **Note**
>
> To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the two ZIF I/O connectors (DS1511/DS1513 and DS1514). For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**General behavior of digital signals**

All digital outputs are set to high impedance (tristate) until the application is started. Then the outputs follow the states defined in your application. Unused outputs remain in tristate mode.

**Pin description**

The following table gives a description of the digital output pins on the DS1514 ZIF I/O connector:

| Pins | Signal | Description / Function |
|---|---|---|
| L5, N2, D3, N5, M6, N3, D5, M2, L6, K2, C3, L2, G6, H2, C5, J2, F6, E2, B3, G2, E6, C2, B5, F2, D6, A6, A3, D2, B6, A2, A5, B2, F5, N6, E3, E5, H3, M5, G3, F3 | Channel 1 ... 40 Digital Out (Type A) | Standard discrete digital output. |

**Characteristics**

The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25 °C; all voltages are referenced to GND, unless otherwise noted.

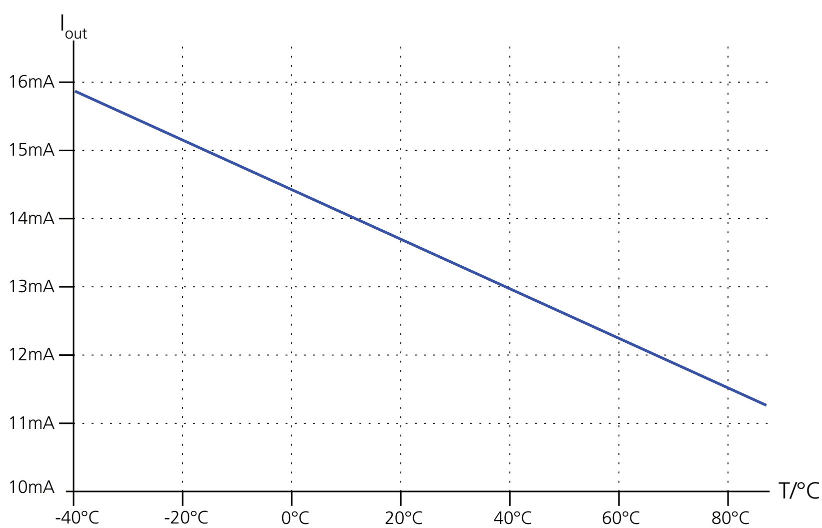
| Parameter[1)] | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| **General characteristics** | | | | | |
| Number of independent output channels | | | 40 | | |
| Supply voltage | The digital output circuits are supplied via the VDRIVE pin. | 4.5 | | 40 | V |
| Protected supply voltage | | | | 45 | V |
| Power-up default | | All outputs are in high-impedance state. | | | |
| **DC Characteristics** | | | | | |
| Output high voltage level without load | VDRIVE = 5 V | 4.1 | 4.3 | | V |
| | VDRIVE = 12 V | 11.0 | 11.2 | | V |
| Output high voltage level with 5 mA load | VDRIVE = 5 V | 3.2 | 3.4 | | V |
| | VDRIVE = 12 V | 10.1 | 10.3 | | V |

| Parameter[1] | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| Output low voltage level without load | VDRIVE = 5 V | | 0.1 | 0.3 | V |
| | VDRIVE = 12 V | | 0.1 | 0.3 | V |
| Output low voltage level with –5 mA load | VDRIVE = 5 V | | 0.7 | 0.9 | V |
| | VDRIVE = 12 V | | 0.7 | 0.9 | V |
| Current limit high level | $T_{CASE}$ = -40 °C ... +85 °C | 5 | 13 | | mA |
| Current limit low level | $T_{CASE}$ = -40 °C ... +85 °C | 5 | 14 | | mA |
| Leakage current tristate | $T_{CASE}$ = -40 °C ... +85 °C | | | 100 | µA |
| **AC Characteristics** | | | | | |
| Minimum pulse width high level with 1 kΩ load | VDRIVE = 5 V or 12 V | | 700 | | ns |
| Minimum pulse width low level with 1 kΩ load | VDRIVE = 5 V or 12 V | | 200 | | ns |
| Output Frequency at 50% duty cycle | VDRIVE = 5 V or 12 V | | 0.7 | | MHz |
| Output frequency at 1% or 99% duty cycle | VDRIVE = 5 V or 12 V | | 14 | | kHz |

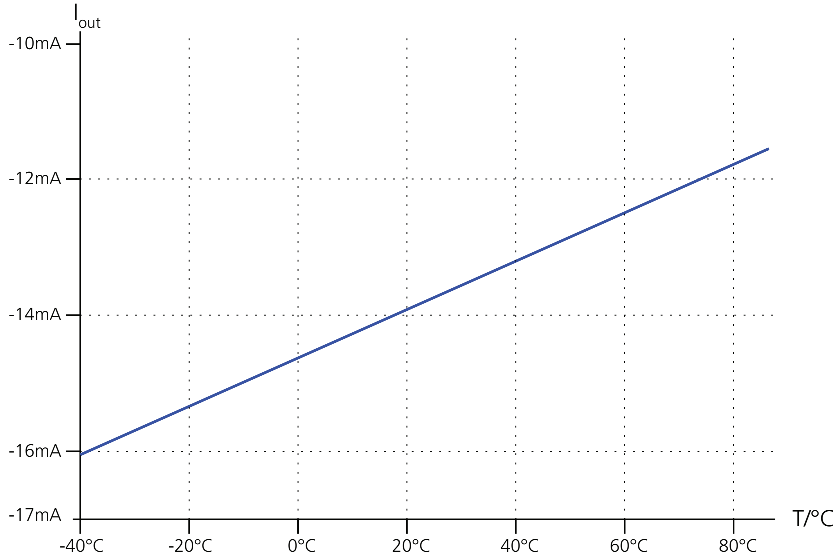
1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

The following illustrations show the maximum output current of a digital output circuit as a function of ambient temperature (VDRIVE = 12 V; output is shorted to 6 V):

- Output high

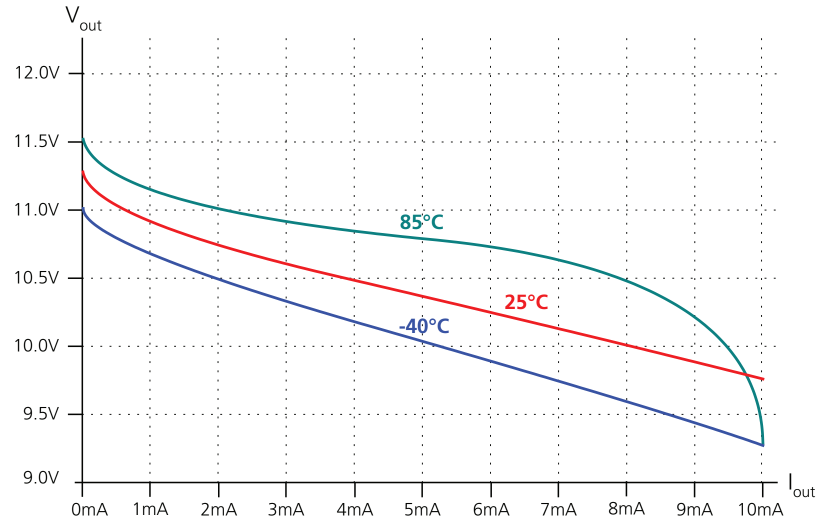


- Output low

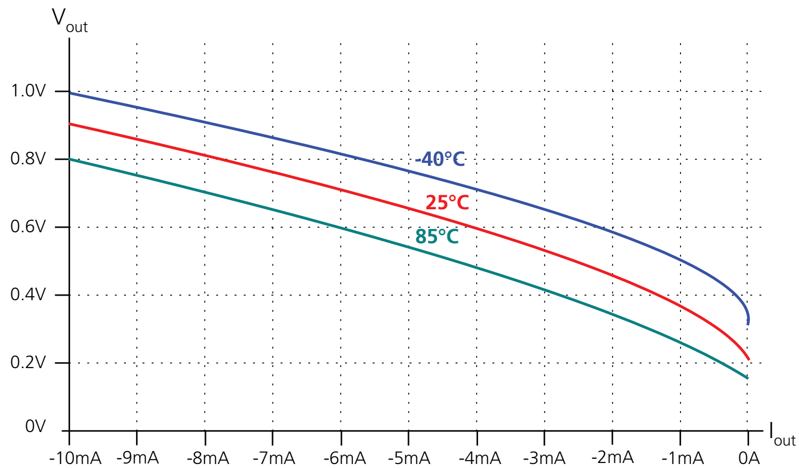



The following illustrations show the typical digital output voltage as a function of the output current (VDRIVE = 12 V):

- Output high

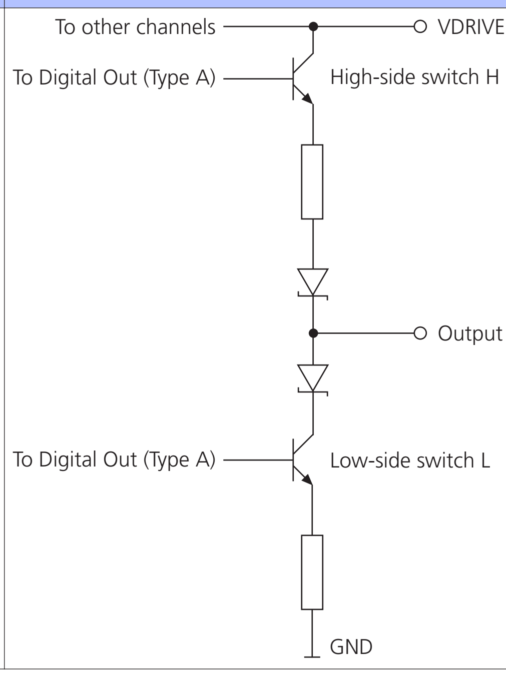


■ Output low




**Circuit diagrams**

The following table shows a *simplified* diagram of the I/O circuitry of the digital outputs:

| Signal | I/O Circuit |
|---|---|
| Digital Out (Type A) |  |

**Related topics**

References

- *FPGA_IO_WRITE_BL (FPGA1401Tp1 with Engine Control I/O Module Settings)* (*RTI FPGA Programming Blockset - FPGA Interface Reference*)

## Digital I/O (Bidirectional)

**Note on the cable harness**

**Note**

To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the two ZIF I/O connectors (DS1511/DS1513 and DS1514). For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**General behavior of digital signals**

All digital outputs are set to high impedance (tristate) until the application is started. Then the outputs follow the states defined in your application. Unused outputs remain in tristate mode.

**Pin description**

The following table gives a description of the digital I/O pins on the DS1514 ZIF I/O connector:

| Pins | Signal | Description / Function |
|---|---|---|
| c3, b5, b2, c5, c4, c2, a2, Z2 | Channel 1 ... 8<br>Digital In (Type B) and Digital Out (Type B) | Digital bidirectional channels |

**Characteristics**

The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25 °C; all voltages are referenced to GND, unless otherwise noted.

| Parameter[1)] | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| **General characteristics** | | | | | |
| Number of independent I/O channels | | | 8 | | |
| Power-up default | | All digital I/O lines are used as inputs. They are set to 5 V logic level and to a defined logical low level by built-in 120 kΩ pull-down resistors. | | | |

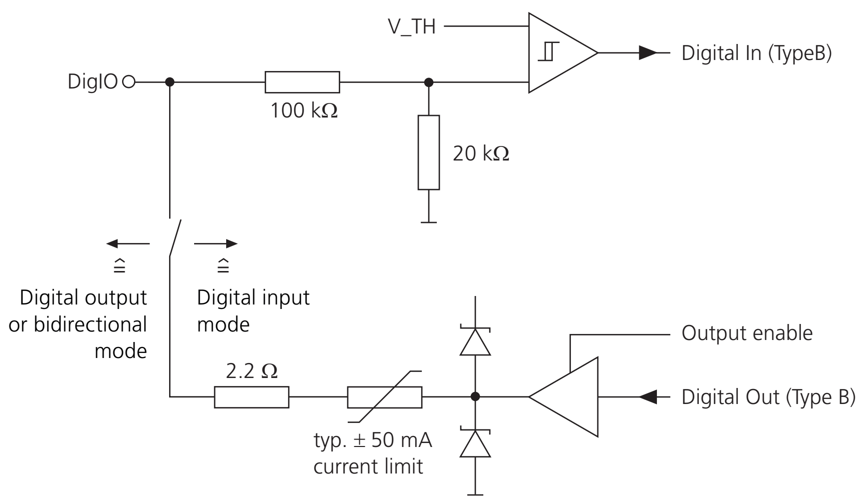
| Parameter[1] | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| **DC Characteristics** | | | | | |
| Input voltage | High | V_TH + 0.5 * V_Hyst | | 15 | V |
| | Low | 0 | | V_TH - 0.5 * V_Hyst | V |
| Overvoltage protection | | -50 | | +50 | V |
| Threshold voltage (V_TH) range [2] | | 1.0 | | 7.5 | V |
| Threshold voltage (V_TH) accuracy | | ± (5 % V_TH + 150 mV) | | | V |
| Hysteresis (V_Hyst) | Fixed voltage | | 0.7 | | V |
| Input impedance | | | 100 | | kΩ |
| Output voltage level with ±10 mA load | High level at 5 V logic level[2] | 4.6 | 5.0 | | V |
| | High level at 3.3 V logic level[2] | 2.8 | 3.2 | | V |
| | Low level | | 0.2 | | V |
| Output current during short circuit | | ±45 | | ±75 | mA |
| **AC Characteristics** | | | | | |
| Input frequency | 5 V logic level with 50% duty cycle and V_TH = 2.5 V | | | 10 | MHz |
| Input pulse width | 5 V logic level with 20% duty cycle and V_TH = 2.5 V | 20 | | | ns |
| Output frequency | Max. 100 pF capacitive load | | | 40 | MHz |
| Output pulse width | Max. 100 pF capacitive load | 12.5 | | | ns |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

[2] Software-configurable.

**Circuit diagram**

The following table shows a *simplified* diagram of the I/O circuitry of the digital I/O channels:

| Signal | I/O Circuit |
|---|---|
| Digital In (Type B) and Digital Out (Type B) |  |



**Related topics**

References

- *FPGA_IO_READ_BL (FPGA1401Tp1 with Engine Control I/O Module Settings)* (📖 *RTI FPGA Programming Blockset - FPGA Interface Reference*)
- *FPGA_IO_WRITE_BL (FPGA1401Tp1 with Engine Control I/O Module Settings)* (📖 *RTI FPGA Programming Blockset - FPGA Interface Reference*)

# Analog Inputs

**Note on the cable harness**

**Note**

To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the two ZIF I/O connectors (DS1511/DS1513 and DS1514). For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**Pin description**

The following table gives a description of the analog input pins on the DS1514 ZIF I/O connector:

| Pins | Signal | Description / Function |
|---|---|---|
| (W2;V2),(Y2;X2), (S2;R2), (T2;U2), (V5;W6), (W3;V3), (T3;U3), (U5;V6), (S5;T6), (T5;U6), (R5;R6), (S3;R3), (P5;P6), (P3;P2) | ADC channel 1 ... 14<br>ADC (Type A) | Differential analog inputs |

**Characteristics**

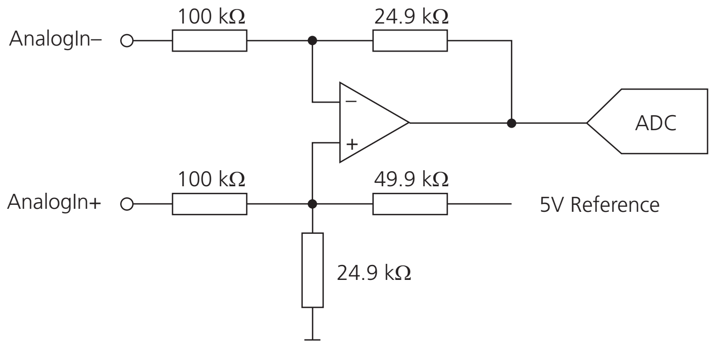
The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25 °C; all voltages are referenced to GND, unless otherwise noted.

| Parameter[1] | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| **General characteristics** | | | | | |
| Number of independent input channels | | | 14 | | – |
| Resolution | | | 16 | | bit |
| Sample rate | Burst mode with more than 1 sample | | | 1 | MSPS |
| Input voltage range | Voltage difference between the non-inverted and inverted input | -10 | | +10 | V |
| Working input voltage range | Voltage difference between GND and each input | -11 | | +11 | V |
| **DC characteristics** | | | | | |
| Initial offset error | Below 750 KSPs | -3.0 | | +3.0 | mV |
| Initial gain error | Below 750 KSPs | -0.25 | | +0.25 | % |
| Input impedance | | | 117 | | kΩ |
| Offset drift | | | ±40 | | µV/K |
| Gain drift | | | ±6 | | ppm/K |
| Overvoltage protection | Continuous | -30 | | +30 | V |
| | Short-term | -50 | | +50 | V |
| **AC Characteristics** | | | | | |
| No missing codes | | 15 | | | bit |
| SNR | 12.4 kHz signal at 200 KSPs | 80 | | | dB |
| Input bandwidth | Full-power bandwidth | 400 | | | kHz |
| Channel crosstalk | 100 kHz | | | -96 | dB |
| | 200 kHz | | | -92 | dB |
| | 400 kHz | | | -90 | dB |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagrams**

The following table shows a simplified diagram of the I/O circuitry of the analog input:

| Signal | I/O Circuit |
|---|---|
| ADC (Type A) |  |

**Related topics**

References

- *FPGA_IO_READ_BL (FPGA1401Tp1 with Engine Control I/O Module Settings)* (RTI FPGA Programming Blockset - FPGA Interface Reference)

# Digital Crank/Cam Inputs

**Note on the cable harness**

**Note**

To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the two ZIF I/O connectors (DS1511/DS1513 and DS1514). For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**Pin description**

The following table gives a description of the digital camshaft input pins on the DS1554 Sub-D I/O connector:

| Pins | Signal | Description / Function |
|---|---|---|
| 13, 32, 14, 33, 12 | Channel 1 ... 5<br>Digital Crank/Cam Sensor | Digital inputs for crankshaft and camshaft sensors. |

**Characteristics**

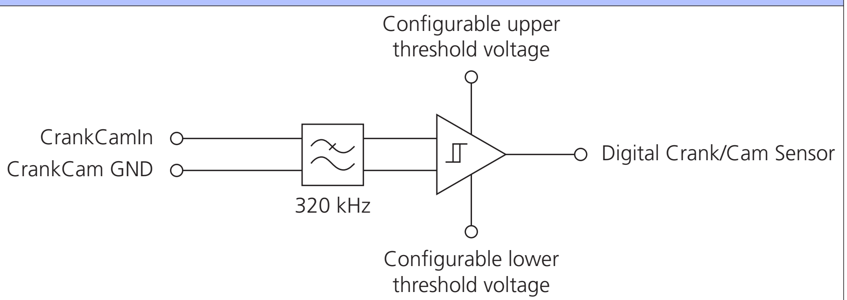
The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25 °C; all voltages are referenced to GND, unless otherwise noted.

| Parameter[1)] | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| **General characteristics** | | | | | |
| Number of independent input channels | | | 5 | | – |
| Input voltage range | | -40 | | +60 | V |
| Overvoltage protection | | -70 | | +70 | V |
| **DC characteristics** | | | | | |
| Threshold voltage range | Lower and upper thresholds software-configurable in 100 mV steps. | -40 | | +40 | V |
| Threshold voltage accuracy | Accuracy depends on the configured threshold voltage levels $V_{Th}$. | ± [1% $V_{Th}$ + 100 mV] | | | |
| Input impedance | | | 170 | | kΩ |
| **AC Characteristics** | | | | | |
| Low-pass filter | 3 dB frequency | | 320 | | kHz |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagram**

The following diagram is a simplified I/O circuitry of the digital crankshaft/camshaft sensor inputs:

| Signal | I/O Circuit |
|---|---|
| Digital Crank/Cam Sensor |  |

**Related topics**

References

- *FPGA_IO_READ_BL (FPGA1401Tp1 with Engine Control I/O Module Settings)* (*RTI FPGA Programming Blockset - FPGA Interface Reference*)

# Inductive Zero Voltage Detector

**Note on the cable harness**

**Note**

To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the two ZIF I/O connectors (DS1511/DS1513 and DS1514). For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**Pin description**

The following table gives a description of the crankshaft input pins on the DS1554 Sub-D I/O connector:

| Pins | Signal | Description / Function |
|---|---|---|
| 10, 29 | Channel 1<br>Inductive Zero Voltage Detector | Inductive zero voltage detector for crankshaft sensors to detect a zero crossing from positive to negative. |

**Characteristics**

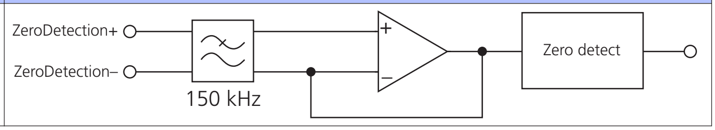
The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25 °C; all voltages are referenced to GND, unless otherwise noted.

| Parameter[1)] | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| **General characteristics** | | | | | |
| Number of independent input channels | | | 1 | | |
| **DC characteristics** | | | | | |
| Input voltage range | | -60 | | +60 | V |
| Input impedance | | | 67 | | kΩ |
| **AC Characteristics** | | | | | |
| Input voltage range | | -200 | | +200 | V |
| Low-pass filter | 3 dB frequency | | 150 | | kHz |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagram**

The following diagram is a simplified I/O circuitry of the inductive zero voltage detector input:

| Signal | I/O Circuit |
|---|---|
| Inductive Zero Voltage Detector |   |

**Related topics**

References

- *FPGA_IO_READ_BL (FPGA1401Tp1 with Engine Control I/O Module Settings)* (*RTI FPGA Programming Blockset - FPGA Interface Reference*)

# Knock Sensor Input

**Note on the cable harness**

> **Note**
>
> To avoid malfunction and/or poor signal quality, it is recommended to distinguish between the signals of the two ZIF I/O connectors (DS1511/DS1513 and DS1514). For example, do not use a signal pin of one ZIF I/O connector and a GND pin of the other ZIF I/O connector together.

**Pin description**

The following table gives a description of the knock sensor input pins on the DS1554 Sub-D I/O connector:

| Pins | Signal | Description / Function |
|---|---|---|
| (16;34), (17;35), (18;36), (19;37) | Channel 1 ... 4 Knock Sensor | Differential analog inputs to connect knock sensors. |

**Characteristics**

The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25 °C; all voltages are referenced to GND, unless otherwise noted.

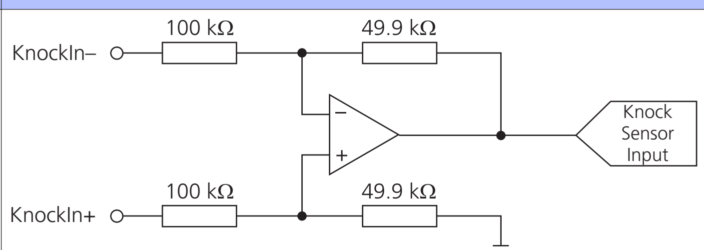
| Parameter[1)] | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| **General characteristics** | | | | | |
| Number of independent input channels | | | 4 | | |
| Resolution | | | 16 | | bit |

| Parameter[1] | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| Sample rate | | | | 1 | MSPS |
| Input voltage range | Voltage difference between the noninverted and inverted input | -5 | | +5 | V |
| Working input voltage range | Voltage difference between GND and each input | -11 | | +11 | V |
| **DC characteristics** | | | | | |
| Initial offset error | Below 750 KSPs | -1.5 | | +1.5 | mV |
| Initial gain error | Below 750 KSPs | -0.25 | | +0.25 | % |
| Input impedance | | | 117 | | kΩ |
| Offset drift | | | ±20 | | µV/K |
| Gain drift | | | ±6 | | ppm/K |
| **AC characteristics** | | | | | |
| No missing codes | | 15 | | | bit |
| SNR | 12.4 kHz signal at 200 KSPs | 80 | | | dB |
| Input bandwidth | Full-power bandwidth | 400 | | | kHz |
| Channel crosstalk | 100 kHz | | | -96 | dB |
| | 200 kHz | | | -92 | dB |
| | 400 kHz | | | -90 | dB |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Circuit diagram**

The following diagram is a simplified I/O circuitry of the knock sensor input:

| Signal | I/O Circuit |
|---|---|
| Knock Sensor |  |



**Related topics**

References

- *FPGA_IO_READ_BL (FPGA1401Tp1 with Engine Control I/O Module Settings)* (📖 *RTI FPGA Programming Blockset - FPGA Interface Reference*)

# Data Sheet DS4340 FlexRay Interface Module

**Suitable MicroAutoBox variants**

You can use the DS4340 Flexray Interface Module inside the following MicroAutoBox variants:

- MicroAutoBox II 1401/1505/1507
- MicroAutoBox II 1401/1507
- MicroAutoBox II 1401/1511/1512
- MicroAutoBox II 1401/1511/1514
- MicroAutoBox II 1401/1512/1513
- MicroAutoBox II 1401/1513/1514

**Where to go from here**

Information in this section

# General Information

## Absolute Maximum Levels

**Avoiding damage to the system**

**NOTICE**

Do not exceed the maximum levels since this might permanently damage the system.

**Levels**

The following table shows the maximum voltage levels of the DS4340 FlexRay Interface Module. All voltages are referenced to GND (unless otherwise noted).

| Parameter | Specification[1)] | Description |
|---|---|---|
| $V_{BAT}$ | –0.2 V ... +60 V | Voltage level on UBAT pin |
| $V_{INH}$, $V_{WAKE}$ | –0.2 V ... +$V_{BAT}$ | Voltage level on INH1, INH2, and Wake-up pins |
| $V_{BP}$, $V_{BM}$ | –58 V ... +58 V | Voltage level on BP and BM pins. |
| $V_{Diff\ (BP\ -\ BM)}$ | –5 V ... +5 V | Voltage difference between BP and BM pins (due to termination resistors). |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

# Connector Pinouts

**Where to go from here**

Information in this section



## DS1507 Sub-D I/O Connector

**Objective**

MicroAutoBox II 1401/1505/1507 and MicroAutoBox II 1401/1507 provide the signals of installed IP modules at the DS1507 Sub-D I/O connector.

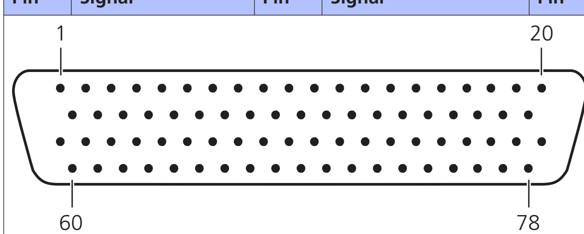
**Pinout**

The DS1507 Sub-D I/O connector is a 78-pin, male Sub-D connector giving access to the I/O signals provided by the DS4340 FlexRay Interface Modules. The pin numbering used for Sub-D connectors is not standardized. The following illustration shows the numbering used (front view).

**Note**

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

The following table shows the signals of two DS4340 FlexRay Interface Module installed to the IP slots:

| Pin | Signal | Pin | Signal | Pin | Signal | Pin | Signal |
|---|---|---|---|---|---|---|---|
|  | | | | | | | |
| 1 | | | | 40 | | | |
| 2 | | 21 | | 41 | | 60 | |
| 3 | | 22 | | 42 | | 61 | |

| Pin | Signal | Pin | Signal | Pin | Signal | Pin | Signal |
|---|---|---|---|---|---|---|---|
| 4 | | 23 | | 43 | | 62 | |
| 5 | | 24 | Reserved | 44 | | 63 | Reserved |
| 6 | | 25 | | 45 | | 64 | |
| 7 | | 26 | | 46 | | 65 | |
| 8 | | 27 | | 47 | | 66 | |
| 9 | | 28 | | 48 | | 67 | |
| 10 | | 29 | | 49 | | 68 | |
| 11 | | 30 | | 50 | | 69 | |
| 12 | | 31 | | 51 | | 70 | |
| *13* | | 32 | | *52* | | 71 | |
| *14* | | *33* | *INH1_1* | *53* | | *72* | *INH1_2* |
| *15* | *GND_ChA_1* | *34* | *INH2_1* | *54* | *GND_ChA_2* | *73* | *INH2_2* |
| *16* | *BP_ChA_1* | *35* | *UBAT_1* | *55* | *BP_ChA_2* | *74* | *UBAT_2* |
| *17* | *BM_ChA_1* | *36* | *BP_FT_ChB_1* | *56* | *BM_ChA_2* | *75* | *BP_FT_ChB_2* |
| *18* | *GND_ChB_1* | *37* | *BM_FT_ChB_1* | *57* | *GND_ChB_2* | *76* | *BM_FT_ChB_2* |
| *19* | *BP_ChB_1* | *38* | *BP_FT_ChA_1* | *58* | *BP_ChB_2* | *77* | *BP_FT_ChA_2* |
| *20* | *BM_ChB_1* | *39* | *BM_FT_ChA_1* | *59* | *BM_ChB_2* | *78* | *BM_FT_ChA_2* |

**Signal names** The signal names of the FlexRay bus lines consist of up to four parts separated by an underscore:

- Bus line plus (BP) or bus line minus (BM)
- Normal bus line ("  ") or feed-through line (FT)
- FlexRay channel (ChA or ChB)
- Module slot (1 or 2)

For example, BP_FT_ChB_2 means: bus line plus, feed-through line, channel B, 2nd module slot.

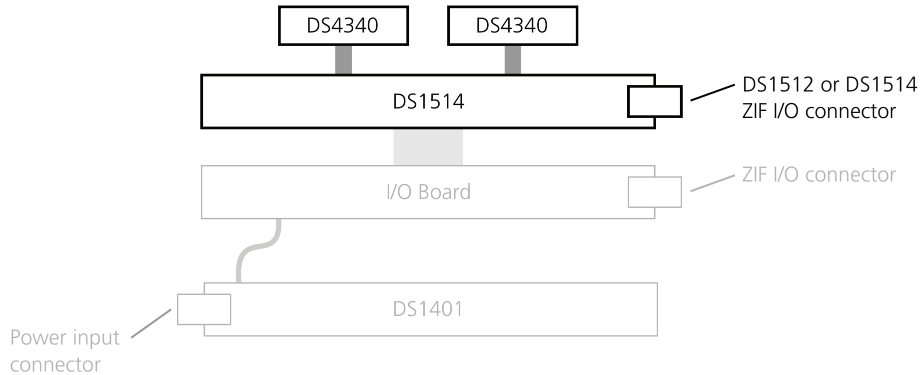
For pin descriptions, refer to *Interfaces* on page 637.

# DS1512 and DS1514 ZIF I/O Connectors

**Objective**

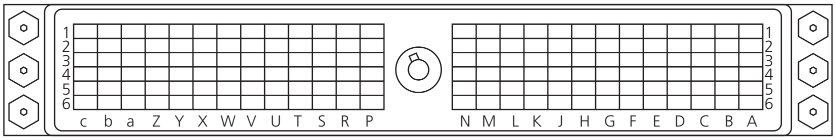
The DS1512 I/O connector and the DS1514 I/O connector are 156-pin zero insertion force (ZIF) connectors giving access to the I/O signals of the DS4340 FlexRay Interface Modules.

The illustration below shows the internal assembly of MicroAutoBox with two DS4340 FlexRay Interface Modules installed.




**Pinout**

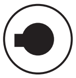
The following illustration shows the pin numbering of the I/O connector (front view of MicroAutoBox):




**Note**

There are pins identified by uppercase letters (A, B, C, etc.) and pins identified by lowercase letters (a, b, c).

The following table shows the signals of two DS4340 FlexRay Interface Module installed to the IP slots:

| **1** | **2** | **3** | **4** | **5** | **6** | |
|---|---|---|---|---|---|---|
| | | | | | | *A* |
| | | | | | | *B* |
| | | | | | Wake-up_1 | *C* |
| | | | | | | *D* |
| | | | | | | *E* |
| | | | | | | *F* |
| | | | | INH1_1 | | *G* |
| | | | | UBAT_1 | INH2_1 | *H* |
| | | GND_ChB_1 | | BM_FT_ChB_1 | BP_FT_ChB_1 | *J* |
| | | BP_ChB_1 | BM_ChB_1 | BM_FT_ChA_1 | BP_FT_ChA_1 | *K* |
| | | GND_ChA_1 | | | | *L* |
| | | BP_ChA_1 | BM_ChA_1 | | | *M* |
| | | | | | | *N* |
| | | |  | | | |
| | | | | | | *P* |
| | | | | | | *R* |
| | | | | | Wake-up_2 | *S* |
| | | | | | | *T* |
| | | | | | | *U* |
| | | | | | | *V* |
| | | | | INH1_2 | | *W* |
| | | | | UBAT_2 | INH2_2 | *X* |
| | | GND_ChB_2 | | BM_FT_ChB_2 | BP_FT_ChB_2 | *Y* |
| | | BP_ChB_2 | BM_ChB_2 | BM_FT_ChA_2 | BP_FT_ChA_2 | *Z* |
| | | GND_ChA_2 | | | | *a* |
| | | BP_ChA_2 | BM_ChA_2 | | | *b* |
| | | | | | | *c* |

**Signal descriptions**

For signal descriptions, refer to *Interfaces* on page 637.

# Signal Descriptions

## Interfaces

**Pin and signal description**

The following tables give a description of the interface pins and signals provided by the DS4340 FlexRay Interface Module.

**DS4340 installed to IP slot 1**

| Pins | | Signal | Description / Function |
|---|---|---|---|
| DS1507 Sub-D I/O Connector | DS1512 and DS1514 ZIF I/O Connector | | |
| 13 | C6 | Wake-up_1 | Connection to an external wake-up signal for module 1<br>The WakeUp pin is connected to the WAKE input of TJA1080 devices. This pin has no pull-up resistor. To set the wake flag on the TJA1080, a falling edge is needed. See the TJA1080 manual for the functionality of the WAKE pin. |
| 15 | L3 | GND_ChA_1 | Ground for FlexRay channel A, module 1 |
| 16 | M3 | BP_ChA_1 | FlexRay channel A, bus line plus, module 1 |
| 17 | M4 | BM_ChA_1 | FlexRay channel A, bus line minus, module 1 |
| 18 | J3 | GND_ChB_1 | Ground for FlexRay channel B, module 1 |
| 19 | K3 | BP_ChB_1 | FlexRay channel B, bus line plus, module 1 |
| 20 | K4 | BM_ChB_1 | FlexRay channel B, bus line minus, module 1 |
| 33 | G5 | INH1_1 | Inhibit outputs from TJA1080 to switch external voltage regulator of module 1. They can be used to wake up MicroAutoBox. The outputs are on the voltage level of UBAT and can be connected directly to the KL15IN (Remote) pin of MicroAutoBox.<br>The pins are not connected by default. If you want to use the pins, the hardware of your MicroAutoBox must be adapted, see *How to Wake Up MicroAutoBox by Activity on the FlexRay Bus* on page 99. |
| 34 | H6 | INH2_1 | |
| 35 | H5 | UBAT_1 | To power the TJA1080 transceivers of module 1. |
| 36 | J6 | BP_FT_ChB_1 | FlexRay channel B, feed-through bus line plus, module 1.<br>Feed-through lines are useful to keep the stub length in a linear passive bus as short as possible, see *DS4340 Connections in Different Topologies* on page 87. |
| 37 | J5 | BM_FT_ChB_1 | FlexRay channel B, feed-through bus line minus, module 1 |
| 38 | K6 | BP_FT_ChA_1 | FlexRay channel A, feed-through bus line plus, module 1 |
| 39 | K5 | BM_FT_ChA_1 | FlexRay channel A, feed-through bus line minus, module 1 |

**DS4340 installed to IP slot 2**

| Pins<br>DS1507 Sub-D I/O connector | <br>DS1512 and DS1514 ZIF I/O connector | Signal | Description / Function |
|---|---|---|---|
| 52 | S6 | Wake-up_2 | Connection to an external wake-up signal for module 2<br>The WakeUp pin is connected to the WAKE input of TJA1080 devices. This pin has no pull-up resistor. To set the wake flag on the TJA1080, a falling edge is needed. See the TJA1080 manual for the functionality of the WAKE pin. |
| 54 | a3 | GND_ChA_2 | Ground for FlexRay channel A, module 2 |
| 55 | b3 | BP_ChA_2 | FlexRay channel A, bus line plus, module 2 |
| 56 | b4 | BM_ChA_2 | FlexRay channel A, bus line minus, module 2 |
| 57 | Y3 | GND_ChB_2 | Ground for FlexRay channel B, module 2 |
| 58 | Z3 | BP_ChB_2 | FlexRay channel B, bus line plus, module 2 |
| 59 | Z4 | BM_ChB_2 | FlexRay channel B, bus line minus, module 2 |
| 72 | W5 | INH1_2 | Inhibit outputs from TJA1080 to switch external voltage regulator of module 2.<br>They can be used to wake up MicroAutoBox. The outputs are on the voltage level of UBAT and can be connected directly to the KL15IN (Remote) pin of MicroAutoBox.<br>The pins are not connected by default. If you want to use the pins, the hardware of your MicroAutoBox must be adapted, see *How to Wake Up MicroAutoBox by Activity on the FlexRay Bus* on page 99. |
| 73 | X6 | INH2_2 | |
| 74 | X5 | UBAT_2 | To power the TJA1080 transceivers of module 2. |
| 75 | Y6 | BP_FT_ChB_2 | FlexRay channel B, feed-through bus line plus, module 2.<br>Feed-through lines are useful to keep the stub length in a linear passive bus as short as possible, see *DS4340 Connections in Different Topologies* on page 87. |
| 76 | Y5 | BM_FT_ChB_2 | FlexRay channel B, feed-through bus line minus, module 2 |
| 77 | Z6 | BP_FT_ChA_2 | FlexRay channel A, feed-through bus line plus, module 2 |
| 78 | Z5 | BM_FT_ChA_2 | FlexRay channel A, feed-through bus line minus, module 2 |

**Characteristics**

The interface characteristics are specified for the following conditions: $V_{BAT}$ = +12 V; $T_{CASE}$ = +25 °C; all voltages are referenced to GND pins of the ZIF connectors, unless otherwise noted.

| Interface | Parameter | Conditions / Comments | Specification[1)] |
|---|---|---|---|
| FlexRay | Bit rate | — | max. 2 x 10 MBaud |
| | Frame length | — | max. 12 byte |
| IP module carrier | Clocking | — | ■ min. 8 MHz<br>■ max. 32 MHz |
| | Access type | — | byte / word |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

# Data Sheet DS4342 CAN FD Interface Module

**Suitable MicroAutoBox variants**

You can use the DS4342 CAN FD Interface Module inside the following MicroAutoBox variants:

- MicroAutoBox II 1401/1505/1507
- MicroAutoBox II 1401/1507
- MicroAutoBox II 1401/1511/1512
- MicroAutoBox II 1401/1511/1514
- MicroAutoBox II 1401/1512/1513
- MicroAutoBox II 1401/1513/1514

**Where to go from here**

Information in this section

# General Information

## Absolute Maximum Levels

**Avoiding damage to the system**

**NOTICE**

Do not exceed the maximum levels since this might permanently damage the system.

**Levels**

The following table shows the maximum voltage levels of the DS4342 CAN FD Interface Module. All voltages are referenced to GND (unless otherwise noted).

| Parameter | Specification[1] | Description |
|---|---|---|
| $V_{BAT}$ | –0.2 V ... +40 V | Voltage level on VBAT pin |
| $V_{INH}$ | –0.2 V ... +40 V | Voltage level on INH1 and INH2 pins |
| $V_{CAN\ high}$, $V_{CAN\ low}$ | –58 V ... +58 V | Voltage level on CAN high and CAN low pins. |
| $V_{Diff\ (CAN\ high\ -\ CAN\ low)}$ | –5 V ... +5 V | Voltage difference between CAN high and CAN low pins (due to termination resistors). |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

# Connector Pinouts

**Where to go from here**

Information in this section



## DS1507 Sub-D I/O Connector

**Objective**

MicroAutoBox II 1401/1505/1507 and MicroAutoBox II 1401/1507 provide the signals of installed IP modules at the DS1507 Sub-D I/O connector.

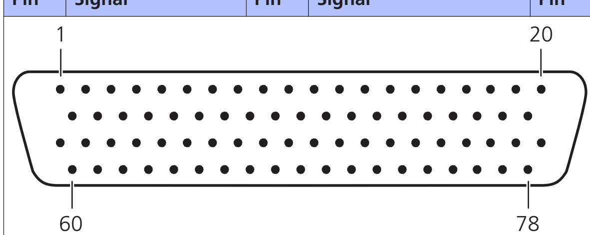
**Pinout**

The DS1507 Sub-D I/O connector is a 78-pin, male Sub-D connector giving access to the I/O signals provided by the DS4342 CAN FD Interface Modules. The pin numbering used for Sub-D connectors is not standardized. The following illustration shows the numbering used (front view).

**Note**

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

The following table shows the signals of two DS4342 CAN FD Interface Modules installed to the IP slots:

| Pin | Signal | Pin | Signal | Pin | Signal | Pin | Signal |
|---|---|---|---|---|---|---|---|
|   | | | | | | | |
| 1 | | | | 40 | | | |
| 2 | | 21 | | 41 | | 60 | |
| 3 | | 22 | | 42 | | 61 | |

| Pin | Signal | Pin | Signal | Pin | Signal | Pin | Signal |
|---|---|---|---|---|---|---|---|
| 4 | | 23 | | 43 | | 62 | |
| 5 | | 24 | Reserved | 44 | | 63 | Reserved |
| 6 | | 25 | | 45 | | 64 | |
| 7 | | 26 | | 46 | | 65 | |
| 8 | | 27 | | 47 | | 66 | |
| 9 | | 28 | | 48 | | 67 | |
| 10 | | 29 | | 49 | | 68 | |
| 11 | | 30 | | 50 | | 69 | |
| 12 | | 31 | | 51 | | 70 | |
| 13 | | 32 | | 52 | | 71 | |
| 14 | | 33 | *INH1_1* | 53 | | 72 | *INH1_2* |
| 15 | *GND_Ch1_1* | 34 | *INH2_1* | 54 | *GND_Ch1_2* | 73 | *INH2_2* |
| 16 | *CANH_Ch1_1* | 35 | *VBAT_1* | 55 | *CANH_Ch1_2* | 74 | *VBAT_2* |
| 17 | *CANL_Ch1_1* | 36 | *CANH_FT_Ch2_1* | 56 | *CANL_Ch1_2* | 75 | *CANH_FT_Ch2_2* |
| 18 | *GND_Ch2_1* | 37 | *CANL_FT_Ch2_1* | 57 | *GND_Ch2_2* | 76 | *CANL_FT_Ch2_2* |
| 19 | *CANH_Ch2_1* | 38 | CANH_FT_Ch1_1 | 58 | *CANH_Ch2_2* | 77 | *CANH_FT_Ch2_2* |
| 20 | *CANL_Ch2_1* | 39 | CANL_FT_Ch1_1 | 59 | *CANL_Ch2_2* | 78 | *CANL_FT_Ch2_2* |

**Signal names** The signal names of the CAN bus lines consist of up to four parts separated by an underscore:

- CAN high (CANH) or CAN low (CANL)
- Normal bus line (" ") or feed-through line (FT)
- CAN channel (Ch1 or Ch2)
- Inhibit signal (INH1 or INH2)
- Signal ground (GND)
- Module slot (1 or 2)

For example, CANH_FT_Ch2_2 means: CAN high, feed-through line, channel 2, 2nd module position.

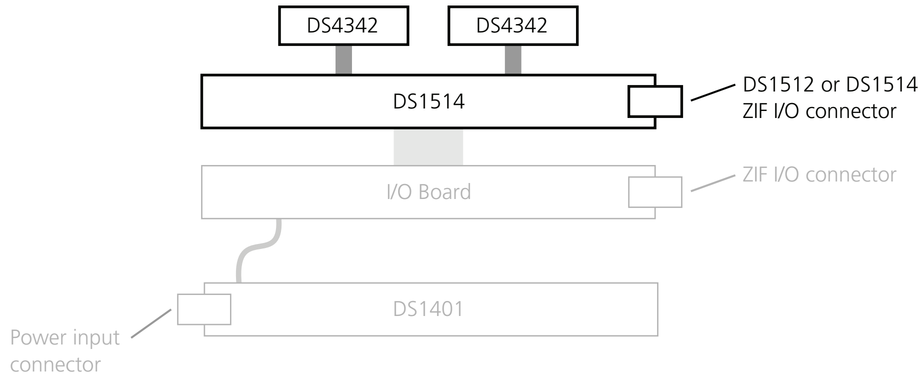
For pin descriptions, refer to *Interfaces* on page 645.

# DS1512 and DS1514 ZIF I/O Connectors

**Objective**

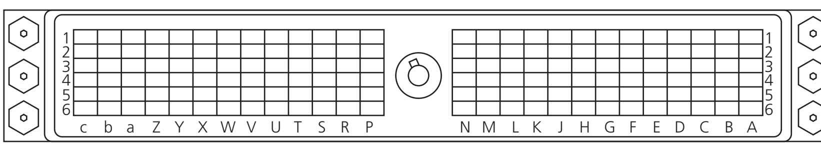
The DS1512 I/O connector and the DS1514 I/O connector are 156-pin zero insertion force (ZIF) connectors giving access to the I/O signals of the DS4342 CAN FD Interface Modules.

The illustration below shows the internal assembly of MicroAutoBox with two DS4342 CAN FD Interface Modules installed.




**Pinout**

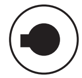
The following illustration shows the pin numbering of the I/O connector (front view of MicroAutoBox):




> **Note**
>
> There are pins identified by uppercase letters (A, B, C, etc.) and pins identified by lowercase letters (a, b, c).

The following table shows the signals of two DS4342 CAN FD Interface Modules installed to the IP slots:

| 1 | 2 | 3 | 4 | 5 | 6 | |
|---|---|---|---|---|---|---|
| | | | | | | *A* |
| | | | | | | *B* |
| | | | | | Reserved | *C* |
| | | | | | | *D* |
| | | | | | | *E* |
| | | | | | | *F* |
| | | | | INH1_1 | | *G* |
| | | | | VBAT_1 | INH2_1 | *H* |
| | | GND_Ch2_1 | | CANL_FT_Ch2_1 | CANH_FT_Ch2_1 | *J* |
| | | CANH_Ch2_1 | CANL_Ch2_1 | CANL_FT_Ch1_1 | CANH_FT_Ch1_1 | *K* |
| | | GND_Ch1_1 | | | | *L* |
| | | CANH_Ch1_1 | CANL_Ch1_1 | | | *M* |

| 1 | 2 | 3 | 4 | 5 | 6 | |
|---|---|---|---|---|---|---|
| | | | | | | *N* |
| | | |  | | | |
| | | | | | | *P* |
| | | | | | | *R* |
| | | | | | Reserved | *S* |
| | | | | | | *T* |
| | | | | | | *U* |
| | | | | | | *V* |
| | | | | INH1_2 | | *W* |
| | | | | VBAT_2 | INH2_2 | *X* |
| | | GND_Ch2_2 | | CANL_FT_Ch2_2 | CANH_FT_Ch2_2 | *Y* |
| | | CANH_Ch2_2 | CANL_Ch2_2 | CANL_FT_Ch1_2 | CANH_FT_Ch1_2 | *Z* |
| | | GND_Ch1_2 | | | | *a* |
| | | CANH_Ch1_2 | CANL_Ch1_2 | | | *b* |
| | | | | | | *c* |

**Signal names** The signal names of the CAN bus lines consist of up to four parts separated by an underscore:

- CAN high (CANH) or CAN low (CANL)
- Normal bus line (" ") or feed-through line (FT)
- CAN channel (Ch1 or Ch2)
- Inhibit signal (INH1 or INH2)
- Signal ground (GND)
- Module slot (1 or 2)

For example, CANH_FT_Ch2_2 means: CAN high, feed-through line, channel 2, 2nd module position.

**Signal descriptions**

For signal descriptions, refer to *Interfaces* on page 645.

# Signal Descriptions

## Interfaces

**Pin and signal descriptions**

The following tables gives a description of the interface pins and signals provided by the DS4342 CAN FD Interface Module.

**DS4342 installed to IP slot 1**

| Pins | | Signal | Description / Function |
|---|---|---|---|
| DS1507 Sub-D I/O Connector | DS1512 and DS1514 ZIF I/O Connector | | |
| 15 | L3 | GND_Ch1_1 | Ground for CAN FD channel 1, module 1 |
| 16 | M3 | CANH_Ch1_1 | CAN FD high channel 1, module 1 |
| 17 | M4 | CANL_Ch1_1 | CAN FD low channel 1, module 1 |
| 18 | J3 | GND_Ch2_1 | Ground for CAN FD channel 2, module 1 |
| 19 | K3 | CANH_Ch2_1 | CAN FD high channel 2, module 1 |
| 20 | K4 | CANL_Ch2_1 | CAN FD low channel 2, module 1 |
| 33 | G5 | INH1_1 | Inhibit outputs from the TJA1145T/FD transceiver of module 1. They can be used to wake up MicroAutoBox. The outputs are on the voltage level of VBAT and can be connected directly to the KL15IN (REMOTE) pin of MicroAutoBox.<br>If you want to use these pins, the hardware of your MicroAutoBox must be adapted. Refer to *How to Configure MicroAutoBox and a DS4342 for CAN Partial Networking* on page 141. |
| 34 | H6 | INH2_1 | |
| 35 | H5 | VBAT_1 | To power the TJA1145T/FD transceivers of module 1. |
| 36 | J6 | CANH_FT_Ch2_1 | CAN FD high channel 2, feed-through bus line, module 1.<br>Feed-through lines are useful to keep the stub length in a linear passive bus as short as possible, see *DS4342 Connections in Different Topologies* on page 136. |
| 37 | J5 | CANL_FT_Ch2_1 | CAN FD low channel 2, feed-through bus line, module 1 |
| 38 | K6 | CANH_FT_Ch1_1 | CAN FD high channel 1, feed-through bus line, module 1 |
| 39 | K5 | CANL_FT_Ch1_1 | CAN FD low channel 1, feed-through bus line, module 1 |

**DS4342 installed to IP slot 2**

| Pin<br>DS1507 Sub-D I/O connector | <br>DS1512 and DS1514 ZIF I/O connector | Signal | Description / Function |
|---|---|---|---|
| 54 | a3 | GND_Ch1_2 | Ground for CAN FD channel 1, module 2 |
| 55 | b3 | CANH_Ch1_2 | CAN FD high channel 1, module 2 |
| 56 | b4 | CANL_Ch1_2 | CAN FD low channel 1, module 2 |
| 57 | Y3 | GND_Ch2_2 | Ground for CAN FD channel 2, module 2 |
| 58 | Z3 | CANH_Ch2_2 | CAN FD high channel 2, module 2 |
| 59 | Z4 | CANL_Ch2_2 | CAN FD low channel 2, module 2 |
| 72 | W5 | INH1_2 | Inhibit outputs from the TJA1145T/FD transceiver of module 2. They can be used to wake up MicroAutoBox. The outputs are on the voltage level of VBAT and can be connected directly to the KL15IN (Remote) pin of MicroAutoBox.<br>If you want to use these pins, the hardware of your MicroAutoBox must be adapted. Refer to *How to Configure MicroAutoBox and a DS4342 for CAN Partial Networking* on page 141. |
| 73 | X6 | INH2_2 | |
| 74 | X5 | VBAT_2 | To power the TJA1145T/FD transceivers of module 2. |
| 75 | Y6 | CANH_FT_Ch2_2 | CAN FD high channel 2, module 2<br>Feed-through lines are useful to keep the stub length in a linear passive bus as short as possible, see *DS4342 Connections in Different Topologies* on page 136. |
| 76 | Y5 | CANL_FT_Ch2_2 | CAN FD low channel 2, feed-through bus line, module 2 |
| 77 | Z6 | CANH_FT_Ch1_2 | CAN FD high channel 1, feed-through bus line, module 2 |
| 78 | Z5 | CANL_FT_Ch1_2 | CAN FD low channel 1, feed-through bus line, module 2 |

**Characteristics**

The interface characteristics are specified for the following conditions: $V_{BAT}$ = +12 V; $T_{CASE}$ = +25 °C; all voltages are referenced to GND pins of the ZIF connectors, unless otherwise noted.

| Interface | Parameter | Conditions / Comments | Specification[1)] |
|---|---|---|---|
| CAN FD | Bit rate | ISO 11898 interface | max. 2 x > 2 MBaud |
| IP module carrier | Clocking | — | ■ min. 8 MHz<br>■ max. 32 MHz |
| | Access type | — | byte / word |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

# Data Sheet for MicroAutoBox Embedded PC

**Where to go from here**

Information in this section

# Overview and General Information

**Where to go from here**

Information in this section



## Housing Components

**Variants**

The MicroAutoBox Embedded PC is available with different CPUs:

- Intel® Atom™ Processor N270
- Intel® Core™ i7-3517UE Processor

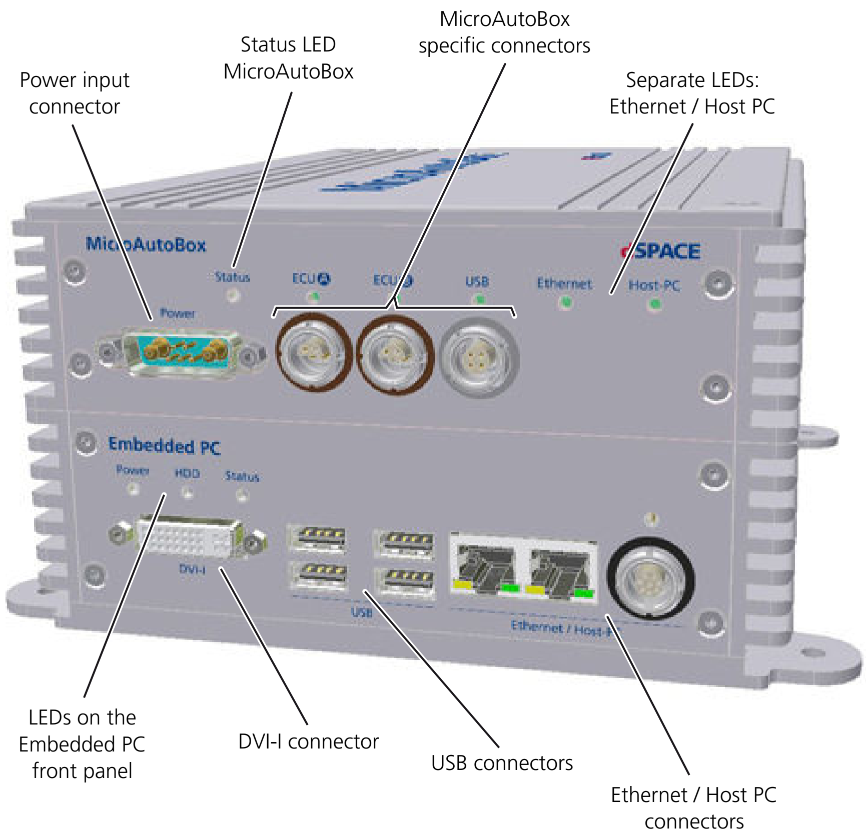
Furthermore the variants differ in some technical details (USB, CFast slot, fan, etc.).

**Information in this topic**

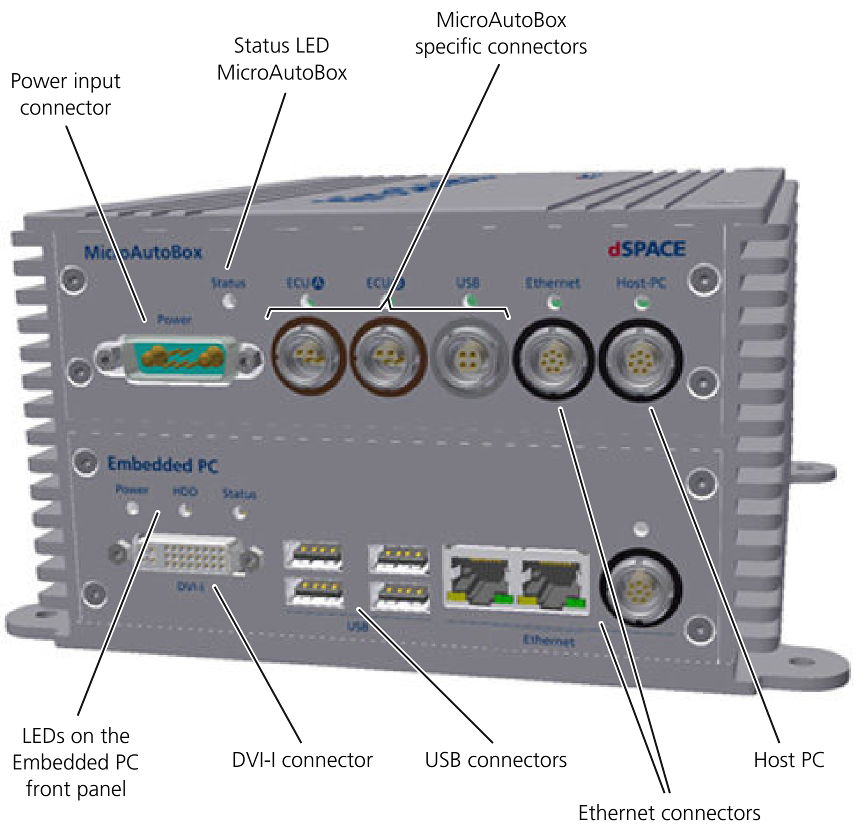
**MicroAutoBox Embedded PC with Intel® Atom™ Processor N270**

**Housing** The illustrations show the locations of connectors and status LEDs on the MicroAutoBox Embedded PC and the used MicroAutoBox variant.

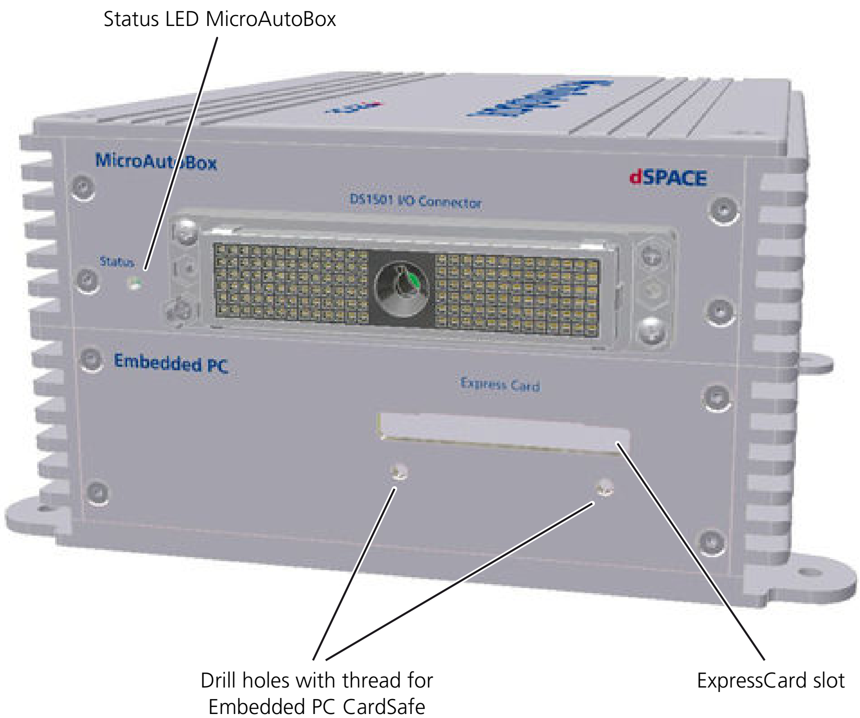
Front view (board revision DS1401 - 24 and earlier)



Front view (board revision DS1401 - 25ff.)



**Rear view**




MicroAutoBox Embedded PC and the MicroAutoBox variant contain the following connectors and LEDs:

**Power input connector** Supplies the required power to MicroAutoBox and MicroAutoBox Embedded PC. It is a 7-pin, male Sub-D connector with two high-current pins.

> **Note**
>
> In contrast to MicroAutoBox variants without MicroAutoBox Embedded PC, the power input connector provides two additional remote inputs. These remote inputs control the power on/off behavior of MicroAutoBox Embedded PC and MicroAutoBox. For further information, refer to *Power On/Off Behavior of MicroAutoBox Embedded PC and MicroAutoBox* on page 166.

For the pinout, refer to *Power Input Connector* on page 668.

**Status LED MicroAutoBox** Shows you different states and potential malfunctions.

If battery power is switched on and the REMOTE signal/KL15 is activated (see *Basics on Connecting to Power Supply* on page 44), the status LED (= dual LED) shows different states indicated by the LED color:

- LED is red: Reset state and no application is downloaded to the real-time processor.
- LED is green: Application is running.
- LED is flashing red: MicroAutoBox is in secured mode. For further instructions, refer to *Checking MicroAutoBox* on page 672.

The status LED on the front panel has the same functionality as the status LED on the rear panel of MicroAutoBox.

**LEDs on the Embedded PC front panel** The MicroAutoBox Embedded PC provides three LEDs above the DVI-I connector on its front panel.

- Power LED - is lit green if power is available
- HDD LED - is flashing green: indicates access to the internal hard disk.
- Status LED - User programmable LED

**DVI-I connector** The DVI-I connector is a standard PC connector for connecting graphical devices, such as a TFT monitor.

**USB connectors** The four USB connectors (4 x USB 2.0, type A) let you connect devices such as a mouse, keyboard, external storage device, or touchpad feedback connector.

**Note**

The USB type A connectors are not internally connected to DS1401 Base Board and do not provide the USB Flight Recorder feature of MicroAutoBox. Use the USB device connector (see below) for this.

**Ethernet / Host PC connectors** The MicroAutoBox Embedded PC provides three Ethernet connectors on its front panel. There are two RJ45, and one 8-pin LEMO connector which provide communication to external devices, such as the host PC, LAN connection, or ECUs based on the UDP/IP Ethernet protocol, for example, in bypassing scenarios. All three connectors have equal rights and are connected to an internal gigabit Ethernet switch.

- Each RJ45 connector provides two LEDs. The right, green LED is flashing for data traffic. The left, yellow LED is lit if power is available at both ends of the link and the relevant connection is serviceable.

  You can use standard Ethernet cables to connect devices.

- The LEMO connector provides a corresponding LED. It is lit green if power is available at both ends of the link and the relevant connection is serviceable. The LED is flashing green for data traffic.

**Separate LEDs: Ethernet / Host PC** There are two separate LEDs for Ethernet and host PC on the MicroAutoBox front panel.

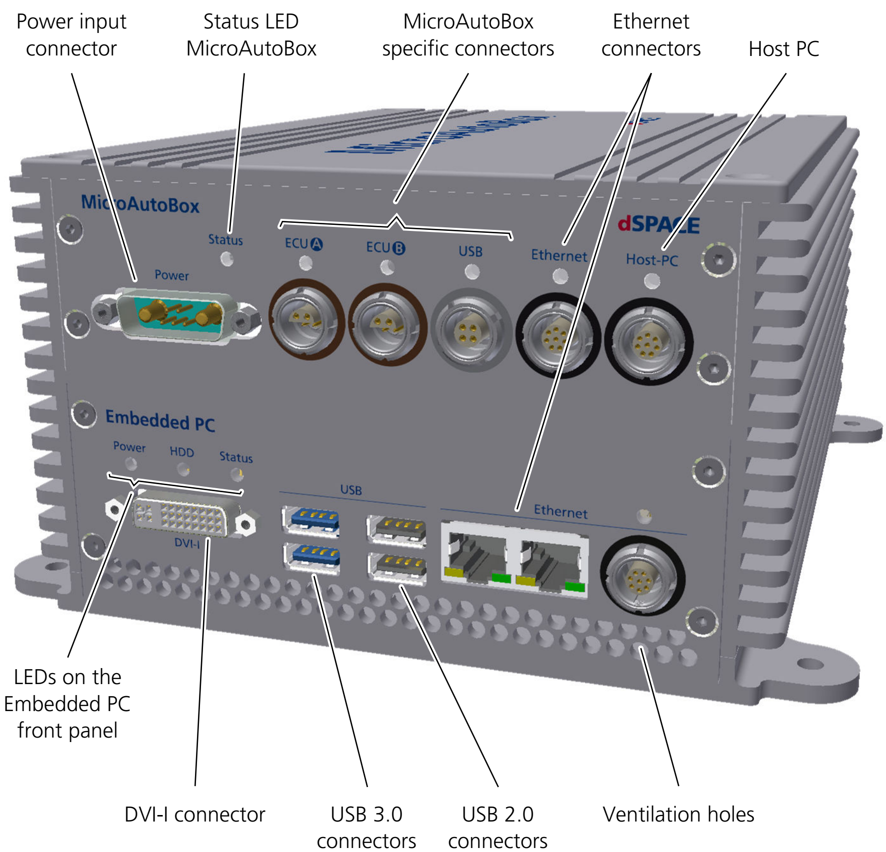
- Ethernet LED - is flashing green for data traffic on the bypass Ethernet I/O
- Host PC LED - is lit green if power is on. The LED is flashing green when data is being sent or received to/from the host PC interface.

**ExpressCard slot** The rear panel of the MicroAutoBox Embedded PC provides an ExpressCard slot for ExpressCards/34 or ExpressCards/54. In this way you can enhance the system with, for example, WLAN.

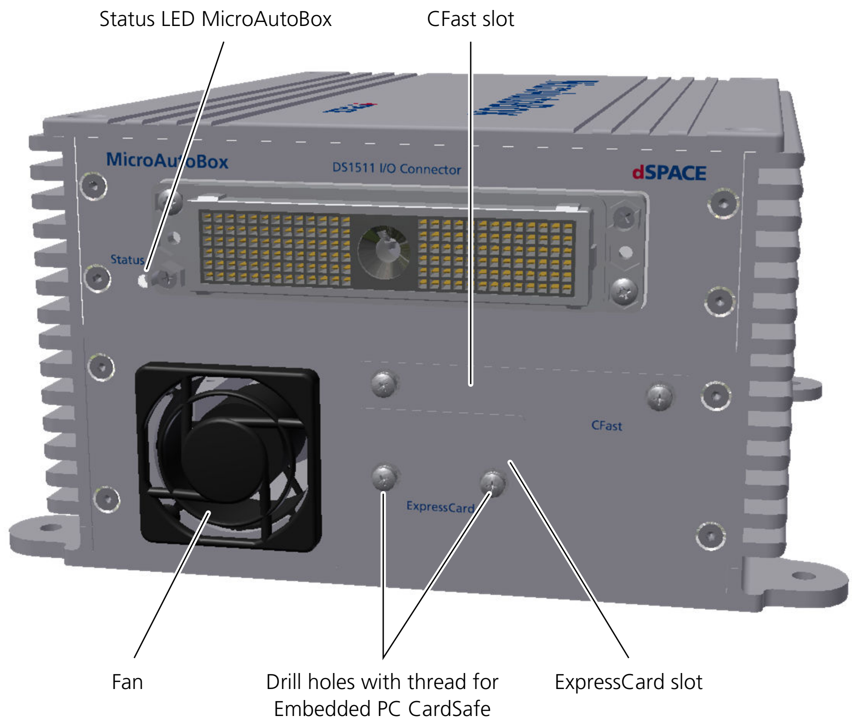
**MicroAutoBox Embedded PC with Intel® Core™ i7-3517UE Processor**

**Housing** The illustrations show the locations of connectors and status LEDs on the MicroAutoBox Embedded PC and the used MicroAutoBox variant.

Front view



Rear view




MicroAutoBox Embedded PC and the MicroAutoBox variant contain the following connectors and LEDs:

**Power input connector** Supplies the required power to MicroAutoBox and MicroAutoBox Embedded PC. It is a 7-pin, male Sub-D connector with two high-current pins.

> **Note**
>
> In contrast to MicroAutoBox variants without MicroAutoBox Embedded PC, the power input connector provides two additional remote inputs. These remote inputs control the power on/off behavior of MicroAutoBox Embedded PC and MicroAutoBox. For further information, refer to *Power On/Off Behavior of MicroAutoBox Embedded PC and MicroAutoBox* on page 166.

For the pinout, refer to *Power Input Connector* on page 668.

**Status LED MicroAutoBox** Shows you different states and potential malfunctions.

If battery power is switched on and the REMOTE signal/KL15 is activated (see *Basics on Connecting to Power Supply* on page 44), the status LED (= dual LED) shows different states indicated by the LED color:

- LED is red: Reset state and no application is downloaded to the real-time processor.
- LED is green: Application is running.
- LED is flashing red: MicroAutoBox is in secured mode. For further instructions, refer to *Checking MicroAutoBox* on page 672.

The status LED on the front panel has the same functionality as the status LED on the rear panel of MicroAutoBox.

**LEDs on the Embedded PC front panel** The MicroAutoBox Embedded PC provides three LEDs above the DVI-I connector on its front panel.

- Power LED - is lit green if power is available
- HDD LED - is flashing green: indicates access to the internal hard disk.
- Status LED - User programmable LED

**DVI-I connector** The DVI-I connector is a standard PC connector for connecting graphical devices, such as a TFT monitor.

**USB connectors** The four USB connectors let you connect devices such as a mouse, keyboard, external storage device, or touchpad feedback connector. There are 2 x USB 3.0 type A connectors left and 2 x USB 2.0 type A connectors right.

> **Note**
>
> The USB type A connectors are not internally connected to DS1401 Base Board and do not provide the USB Flight Recorder feature of MicroAutoBox. Use the USB device connector (see below) for this.

**Ethernet / Host PC connectors** The MicroAutoBox Embedded PC provides three Ethernet connectors on its front panel. There are two RJ45, and one 8-pin LEMO connector which provide communication to external devices, such as the host PC, LAN connection, or ECUs based on the UDP/IP Ethernet protocol, for example, in bypassing scenarios. All three connectors have equal rights and are connected to an internal gigabit Ethernet switch.

- Each RJ45 connector provides two LEDs. The right, green LED is flashing for data traffic. The left, yellow LED is lit if power is available at both ends of the link and the relevant connection is serviceable.

  You can use standard Ethernet cables to connect devices.
- The LEMO connector provides a corresponding LED. It is lit green if power is available at both ends of the link and the relevant connection is serviceable. The LED is flashing green for data traffic.

**Separate LEDs: Ethernet / Host PC** There are two separate LEDs for Ethernet and host PC on the MicroAutoBox front panel.

- Ethernet LED - is flashing green for data traffic on the bypass Ethernet I/O
- Host PC LED - is lit green if power is on. The LED is flashing green when data is being sent or received to/from the host PC interface.

**CFast card slot** The rear panel of the MicroAutoBox Embedded PC Intel® Core™ i7-3517UE Processor provides an CFast card slot. In this way you can enlarge the flash memory of the system.

**ExpressCard slot** The rear panel of the MicroAutoBox Embedded PC provides an ExpressCard/34 slot. In this way you can enhance the system with, for example, WLAN.

**MicroAutoBox - specific connectors**

On the front and the rear of the unit, there are MicroAutoBox connectors which depend on the specific variant (for example, DS1401/1507 or DS1401/1511/1512) that is mounted on the MicroAutoBox Embedded PC:

- USB device connector

  **Note**

  The USB device connector is not connected to MicroAutoBox Embedded PC. Do not connect a mouse, keyboard, etc., as it does not work. The connector can be used only to provide the USB Flight Recorder feature of MicroAutoBox.
- ECU interface connectors and corresponding LED
- ZIF I/O connector(s)
- Sub-D I/O connector

For further information on these connectors, refer to:


- MicroAutoBox II 1401/1501 - *Housing Components* on page 216
- MicroAutoBox II 1401/1504 - *Housing Components* on page 250
- MicroAutoBox II 1401/1505/1507 - *Housing Components* on page 283
- MicroAutoBox II 1401/1507 - *Housing Components* on page 324
- MicroAutoBox II 1401/1511 - *Housing Components* on page 346
- MicroAutoBox II 1401/1511/1512 - *Housing Components* on page 377
- MicroAutoBox II 1401/1511/1514 - *Housing Components* on page 419
- MicroAutoBox II 1401/1512/1513 - *Housing Components* on page 465
- MicroAutoBox II 1401/1513 - *Housing Components* on page 506
- MicroAutoBox II 1401/1513/1514 - *Housing Components* on page 539


## General Data

**MicroAutoBox Embedded PC with Intel® Atom™ Processor N270**

The following table shows some general characteristics of MicroAutoBox Embedded PC with Intel® Atom™ Processor N270:

| Parameter | | Specification[1)] |
|---|---|---|
| Base board | Processor | ■ Intel® Atom™ N270 (passive cooling, no fan)<br>■ 1.6 GHz<br>■ 512 kB cache<br>■ 533 MHz FSB |
| | Memory | ■ 2 GB RAM, DDR2 RAM, 533 MHz<br>■ Storage medium: solid-state drive, 64 GB[2)] |

<table>
<tr><th colspan="3">Parameter</th><th>Specification[1]</th></tr>
<tr><td colspan="3">Interfaces</td><td>■ Ethernet (100/1000 Mbit/s)(Wake on LAN capable):<br>  ■ 2 x RJ45 connectors<br>  ■ 1 x LEMO connector<br>■ 4 x USB 2.0 connectors (type A)<br>■ 1 x DVI-I connector<br>■ 1 x slot for ExpressCard/34 or ExpressCard/54<br>■ 1 x internal Mini PCI Express slot (for PCI Mini Card Electromechanical Specification 1.1)</td></tr>
<tr><td colspan="3">Operating system</td><td>■ Microsoft Windows 7 Ultimate (32 bit)<br>■ Ubuntu 10.4.2 LTS (Linux distribution)</td></tr>
<tr><td rowspan="3">Chassis dimensions</td><td colspan="2">Case width</td><td>202 mm (7.95 in.)</td></tr>
<tr><td rowspan="2">Case height</td><td>MicroAutoBox Embedded PC with:<br>■ MicroAutoBox II DS1401/1501<br>■ MicroAutoBox II DS1401/1504<br>■ MicroAutoBox II DS1401/1507<br>■ MicroAutoBox II DS1401/1511<br>■ MicroAutoBox II DS1401/1513</td><td>100 mm (3.94 in.)</td></tr>
<tr><td>MicroAutoBox Embedded PC with:<br>■ MicroAutoBox II DS1401/1505/1507<br>■ MicroAutoBox II DS1401/1511/1512<br>■ MicroAutoBox II DS1401/1511/1514<br>■ MicroAutoBox II DS1401/1512/1513<br>■ MicroAutoBox II DS1401/1513/1514</td><td>146 mm (5.51 in.)</td></tr>
</table>

| Parameter | | Specification[1] |
|---|---|---|
| | Case depth | 222 mm (8.74 in.) |
| Weight (without external cable) | ■ MicroAutoBox II DS1401/1501<br>■ MicroAutoBox II DS1401/1504<br>■ MicroAutoBox II DS1401/1507<br>■ MicroAutoBox II DS1401/1511<br>■ MicroAutoBox II DS1401/1513 | About 4.15 kg (8.82 lb.) |
| | MicroAutoBox Embedded PC with:<br>■ MicroAutoBox II DS1401/1505/1507<br>■ MicroAutoBox II DS1401/1511/1512<br>■ MicroAutoBox II DS1401/1511/1514<br>■ MicroAutoBox II DS1401/1512/1513<br>■ MicroAutoBox II DS1401/1513/1514 | About 5.25 kg (11.02 lb.) |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.
[2] dSPACE may change the hard disk without notice.

**MicroAutoBox Embedded PC with Intel® Core™ i7-3517UE Processor**

The following table shows some general characteristics of MicroAutoBox Embedded PC with Intel® Core™ i7-3517UE Processor:

| Parameter | | Specification[1] |
|---|---|---|
| Base board | Processor | ■ Intel® Core™ i7-3517UE Processor<br>■ 2 x 1.7 / 2.8 GHz, 4 MB |
| | Memory | ■ 8 GB RAM, DDR3 RAM, 1.6 GHz<br>■ Storage medium [2]:<br>  ■ internal MSATA, 64 GB<br>  ■ CFast card, 64 GB (in the CFast card slot) |

| Parameter | | | Specification[1] |
|---|---|---|---|
| Interfaces | | | ■ Ethernet (100/1000 Mbit/s)(Wake on LAN capable):<br>  ■ 2 x RJ45 connectors<br>  ■ 1 x LEMO connector<br>■ USB connectors (type A)<br>  ■ 2 x USB 3.0<br>  ■ 2 x USB 2.0<br>■ 1 x DVI-I connector<br>■ CFast card slot<br>■ 1 x slot for ExpressCard/34<br>■ 1 x internal Mini PCI Express slot (for PCI Mini Card Electromechanical Specification 1.1) |
| Operating system | | | ■ Microsoft Windows 7 Ultimate (64 bit, Service Pack1)<br>■ Ubuntu 14.04 LTS (Linux distribution) as image file on USB recovery stick |
| Chassis dimensions | Case width | | 202 mm (7.95 in.) |
| | Case height | ■ MicroAutoBox II DS1401/1501<br>■ MicroAutoBox II DS1401/1504<br>■ MicroAutoBox II DS1401/1507<br>■ MicroAutoBox II DS1401/1511<br>■ MicroAutoBox II DS1401/1513 | 105 mm (4.13 in.) |

| Parameter | | | Specification[1] |
|---|---|---|---|
| | | MicroAutoBox Embedded PC with:<br>■ MicroAutoBox II DS1401/1505/1507<br>■ MicroAutoBox II DS1401/1511/1512<br>■ MicroAutoBox II DS1401/1511/1514<br>■ MicroAutoBox II DS1401/1512/1513<br>■ MicroAutoBox II DS1401/1513/1514 | 151 mm (5.94 in.) |
| | Case depth | | 222 mm (8.74 in.) |
| Weight (without external cable) | ■ MicroAutoBox II DS1401/1501<br>■ MicroAutoBox II DS1401/1504<br>■ MicroAutoBox II DS1401/1507<br>■ MicroAutoBox II DS1401/1511<br>■ MicroAutoBox II DS1401/1513 | | About 4.15 kg (8.82 lb.) |
| | MicroAutoBox Embedded PC with:<br>■ MicroAutoBox II DS1401/1505/1507<br>■ MicroAutoBox II DS1401/1511/1512<br>■ MicroAutoBox II DS1401/1511/1514<br>■ MicroAutoBox II DS1401/1512/1513<br>■ MicroAutoBox II DS1401/1513/1514 | | About 5.25 kg (11.02 lb.) |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

[2] dSPACE may change the hard disk without notice.

# Absolute Maximum Levels

**Avoiding damage to the system**

**NOTICE**

- Do not exceed the maximum levels since this may permanently damage the system.
- The operating temperature of the MicroAutoBox Embedded PC limits the operating temperatures listed for the MicroAutoBox variants.

**MicroAutoBox Embedded PC with Intel® Atom™ Processor N270**

The following table shows the levels (for example, voltage, temperature) of the MicroAutoBox Embedded PC with Intel® Atom™ Processor N270:

| Parameter | Specification[1)] |
|---|---|
| Continuous power dissipation ($T_{ambient}$ = +60 °C) | ■ max. 50 W for MicroAutoBox Embedded PC (Intel® Atom™ Processor N270) with:<br>■ MicroAutoBox II 1401/1501<br>■ MicroAutoBox II 1401/1504<br>■ MicroAutoBox II 1401/1505/1507<br>■ MicroAutoBox II 1401/1507<br>■ MicroAutoBox II 1401/1511<br>■ MicroAutoBox II 1401/1513<br>■ max. 60 W for MicroAutoBox Embedded PC (Intel® Atom™ Processor N270) with:<br>■ MicroAutoBox II 1401/1511/1512<br>■ MicroAutoBox II 1401/1511/1514<br>■ MicroAutoBox II 1401/1512/1513<br>■ MicroAutoBox II 1401/1513/1514 |
| Operating temperature | 0 °C ... +60 °C |
| Storage temperature | –55 °C ... +125 °C |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**MicroAutoBox Embedded PC with Intel® Core™ i7-3517UE Processor**

The following table shows the levels (for example, voltage, temperature) of the MicroAutoBox Embedded PC with Intel® Core™ i7-3517UE Processor:

| Parameter | Specification[1] |
|---|---|
| Continuous power dissipation ($T_{ambient}$ = +60 °C) | ▪ max. 60 W for MicroAutoBox Embedded PC (Intel® Core™ i7-3517UE Processor) with:<br>▪ MicroAutoBox II 1401/1501<br>▪ MicroAutoBox II 1401/1504<br>▪ MicroAutoBox II 1401/1505/1507<br>▪ MicroAutoBox II 1401/1507<br>▪ MicroAutoBox II 1401/1511<br>▪ MicroAutoBox II 1401/1513<br>▪ max. 80 W for MicroAutoBox Embedded PC (Intel® Core™ i7-3517UE Processor) with:<br>▪ MicroAutoBox II 1401/1511/1512<br>▪ MicroAutoBox II 1401/1511/1514<br>▪ MicroAutoBox II 1401/1512/1513<br>▪ MicroAutoBox II 1401/1513/1514 |
| Operating temperature | 0 °C ... +60 °C |
| Storage temperature | –55 °C ... +125 °C |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

## Certifications

**CE compliance**

MicroAutoBox Embedded PC meets the requirements of the European directive 2014/30/EU (Electromagnetic Compatibility Directive) for CE marking.

**Vibration and shock tests**

To verify the reliability of MicroAutoBox Embedded PC under realistic operating conditions, it was exposed to vibration and shock tests. During the tests, MicroAutoBox Embedded PC executed a program without any failures.

**Applied standards**

The characteristics of MicroAutoBox Embedded PC were tested according to the standards shown in the following table:

**MicroAutoBox Embedded PC with Intel® Atom™ Processor N270**

| Tested Characteristics | Applied Standard | Description |
|---|---|---|
| Electromagnetic compatibility (EMC) | EN 55024:2010 | Information technology equipment - Immunity characteristics |
| | EN 61326-1:2006 | Electrical equipment for measurement, control and laboratory use - immunity according table 2 (industrial environment) |
| | EN 55022:2010 | Information technology equipment - Radio disturbance (class A) |
| | EN 61326-1:2006 | Electrical equipment for measurement, control and laboratory use Radio disturbance (class A) |
| | FCC 47 CFR Part 15 | Radio disturbance |
| Vibration | ISO 16750-3:2007 / 4.1.2.4 Test IV | Test conditions: Broad band noise, 2h per axis, RMS-acceleration 27,8 m/s$^2$ |
| | DO-160F.8 / B1 Test Conditions | Test conditions: Broad band noise, 2h per axis, based on DO160F Section 8, Category B1 |
| | EN 60068-2-6 | Test conditions:<br>■ Swept sine, 1 octave per minute, 3-axis test<br>■ 5 ... 2000 Hz, up to 5 g, 2 sweeps per axis<br>■ Operating |
| Shock | ISO 16750-3:2007 / 4.2.2. | Test conditions:<br>■ Linear shock (1/2 sine pulse), 6-axis<br>■ 500 m/s$^2$, 6 ms, 10 pulses per axis<br>■ Operating |
| | RTCA / DO-160F Section 7 Test 7.2 Category A Test type R | Operational shocks test (standard):<br>■ Saw-tooth wave, 6-axis<br>■ 200 m/s$^2$, 11 ms, 10 pulses per axis<br>■ Operating |
| | RTCA / DO-160F Section 7 Test 7.2 Category D Test type R | Operational shocks test (low frequency):<br>■ Saw-tooth wave, 6-axis<br>■ 200 m/s$^2$, 20 ms, 10 pulses per axis<br>■ Operating |

**MicroAutoBox Embedded PC with Intel® Core™ i7-3517UE Processor**

| Tested Characteristics | Applied Standard | Description |
|---|---|---|
| Electromagnetic compatibility (EMC) | EN 55024:2010 | Information technology equipment - Immunity characteristics |
| | EN 61326-1:2013 | Electrical equipment for measurement, control and laboratory use - immunity according table 2 (industrial environment) |
| | EN 55022:2010 | Information technology equipment - Radio disturbance (class A) |
| | EN 61326-1:2013 | Electrical equipment for measurement, control and laboratory use Radio disturbance (class A) |
| | FCC 47 CFR Part 15 | Radio disturbance |
| Vibration | ISO 16750-3:2012 / 4.1.2.4 Test IV | Test conditions: Broad band noise, 3h per axis, RMS-acceleration 27,8 m/s$^2$ |
| | DO-160F.8 / B1 Test Conditions | Test conditions: Broad band noise, 2h per axis, based on DO160F Section 8, Category B1 |
| | EN 60068-2-6 | Test conditions:<br>■ Swept sine, 1 octave per minute, 3-axis test<br>■ 5 ... 2000 Hz, up to 3 g, 2 sweeps per axis<br>■ Operating |
| Shock | ISO 16750-3:2012 / 4.2.2. | Test conditions:<br>■ Linear shock (1/2 sine pulse), 6-axis<br>■ 500 m/s$^2$, 6 ms, 10 pulses per axis<br>■ Operating |
| | RTCA / DO-160F Section 7 Test 7.2 Category A Test type R | Operational shocks test (standard):<br>■ Saw-tooth wave, 6-axis<br>■ 200 m/s$^2$, 11 ms, 10 pulses per axis<br>■ Operating |
| | RTCA / DO-160F Section 7 Test 7.2 Category D Test type R | Operational shocks test (low frequency):<br>■ Saw-tooth wave, 6-axis<br>■ 200 m/s$^2$, 20 ms, 10 pulses per axis<br>■ Operating |

# Connector Pinouts

## Power Input Connector

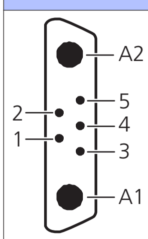
**Objective**

MicroAutoBox provides a power input connector on its front panel. It is a 7-pin, male connector with two high-current pins. It is a special variant of a 15-pin Sub-D connector (mixed-layout 7W2 Sub-D).

> **Note**
>
> The pinout of the power input connector features two additional signals when a MicroAutoBox Embedded PC is part of the system.

**Pinout**

The following illustration shows the pinout (front view of MicroAutoBox).

| Connector | Pin | Signal | Pin | Signal |
|---|---|---|---|---|
|  | A2[1] | VBAT (8 V … 32 V DC) | | |
| | | | 5 | REMOTE_PULLUP |
| | 2 | REMOTE$_{IN2}$[2] | 4 | REMOTE[2, 3] |
| | 1 | Do not connect | 3 | REMOTE$_{IN1}$[2] |
| | A1 | GND | | |

[1] NOTE: It is highly recommended to insert a fuse into the main power supply input wire (close to battery). Choose the value of the fuse according to the maximum current. A 10 A fuse is recommended.

[2] The remote inputs (REMOTE, REMOTE$_{IN1}$, REMOTE$_{IN2}$) control the power on/off behavior of MicroAutoBox Embedded PC and MicroAutoBox. For further information, refer to *Power On/Off Behavior of MicroAutoBox Embedded PC and MicroAutoBox* on page 166

[3] If you use the matching cable supplied by dSPACE, REMOTE is connected to VBAT within the connector shell. This cable is intended for use with a lab power supply only.

**NOTICE**

**Risk of material damage**

**Do not power MicroAutoBox II 1401/1501, 1401/1504, and 1401/1505/1507 via ZIF I/O connector. The applied voltages are also available at the pins of the power input connector.**

You have to use the power input connector to supply the MicroAutoBox and the MicroAutoBox Embedded PC. Only the power input connector provides connector pins (A1 and A2) that are designed for the power consumption of both units. In addition, the remote inputs ($REMOTE_{IN1}$ and $REMOTE_{IN2}$) are only available on the power input connector and enable the power on/off behavior (see *Power On/Off Behavior of MicroAutoBox Embedded PC and MicroAutoBox* on page 166).

**NOTICE**

**Risk of material damage**

**Do not switch off MicroAutoBox and the MicroAutoBox Embedded PC by disconnecting the VBAT and/or GND connection or by pulling the power input connector when the operating system of the MicroAutoBox Embedded PC is running.**

You are strongly recommended to shut down the operating system of the MicroAutoBox Embedded PC via the remote inputs before the system is switched off.

**Characteristics**

The characteristics are specified for the following conditions: $V_{BAT}$=+12 V; $T_{CASE}$=+25° C; all voltages are referenced to GND.

| Signal[1)] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Power** | | | | | | |
| Operating voltage | VBAT | For start-up | 8 | | 32 | V |
| | VBAT | Operating | 8 [2)] | | 32 | V |
| | VBAT | Reverse protection | | | -40 | V |
| | VBAT | Temporary overvoltage protection for max. 400 ms (load dump protection) | | | +80 | V |
| **Inputs** | | | | | | |
| Operating current | $I_{VBAT}$ | REMOTE ≤ $V_{iLRemote}$ | | 5 | | mA |

| Signal[1] | Symbol | Conditions / Comments | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| REMOTE voltage input | $V_{iHRemote}$ | Input high voltage | 4.7 | | | V |
| | $V_{iLRemote}$ | Input low voltage | | | 0.8 | V |
| | $V_{iHysRemote}$ | Input hysteresis voltage | 0.5 | 1 | | V |
| | $R_{inRemote}$ | Input impedance | 60 | | 185 | kΩ |
| $REMOTE_{IN1}$ and $REMOTE_{IN2}$voltage input | $V_{iHRemoteINx}$ | Input high voltage | 4.7 | | | V |
| | $V_{iLRemoteINx}$ | Input low voltage | | | 0.8 | V |
| | $R_{inRemoteINx}$ | Input impedance | | 66 | | kΩ |
| Inrush current | $I_{VBAT\ inrush}$ | All inputs/outputs unconnected | see *Power supply* on page 40 | | | |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

[2] Valid for MicroAutoBox Embedded PC with Intel® Core™ i7-3517UE Processor: 8 ... 10 V for a maximum of 1 minute

**Matching cable**

A preconfigured cable for the supply voltage is provided by dSPACE. This cable is for running MicroAutoBox and the MicroAutoBox Embedded PC with a laboratory power supply during development. Therefore, REMOTE (pin 4) is shorted to VBAT (pin A2) inside the connector in order to save a separate switch. The $REMOTE_{IN1}$ and $REMOTE_{IN2}$ inputs are not connected, but both with internal pull-down resistors. The DS1401 base board and the MicroAutoBox Embedded PC are started and stopped together in this configuration.

Do not use this cable in the vehicle. Otherwise, the units will always be turned on.

The VBAT wire (red) contains a melting fuse. Each wire has a cross-section of 1.5 mm².

Fuse specification:

- Cable delivered through dSPACE Release 2013-B: 7.5 A, time lag
- Cable delivered as of dSPACE Release 2014-A: 10 A, time lag

# Troubleshooting

| | |
|---|---|
| **Objective** | If any problem related to the installation and configuration of your MicroAutoBox comes up, refer to the information given in this section. |
| **Getting further support** | If the information in this section does not help you solve the problem, you should check the Support Knowledge Base on our website. See http://www.dspace.com/go/kb.<br>If self-help does not solve the problem, contact dSPACE Support and give them information about your dSPACE environment and the problems you have. The best way to do this is with the support request form provided on the website at http://www.dspace.com/go/supportrequest, but you can also send an e-mail or phone us. For details, refer to *Contacting dSPACE Support* (📖 *Software Installation and Management Guide*). |
| **Where to go from here** | Information in this section |

# Hardware Problems

**Where to go from here**

Information in this section



## Checking MicroAutoBox

**Check list**

Perform the following checks if MicroAutoBox does not operate correctly:

- Check the power supply of the system (see *Basics on Connecting to Power Supply* on page 44).
- Check the connection cable to the power supply (refer to *Basics on Connecting to Power Supply* on page 44).
- Check the connection from the host PC to MicroAutoBox.
- Use ControlDesk to check the board properties (see *Board Details Properties* (📖 *ControlDesk Platform Management*) (ControlDesk)).

**Status LED**

The status LED of MicroAutoBox indicates the following malfunctions :

| Behavior | Cause | Remedy |
|---|---|---|
| LED is not lit | The power supply is not connected correctly. | Check the power supply of the system (see *Basics on Connecting to Power Supply* on page 44). |
| LED is flashing red | MicroAutoBox is in secured mode. The default factory code has been loaded. | Update the firmware (System PLD firmware and I/O module firmware). For instructions, refer to 📖 *Firmware Manager Document*. |

**Host PC LED**

The host PC LED of MicroAutoBox indicates the following malfunctions:

| Behavior | Cause | Remedy |
|---|---|---|
| LED is flashing red | MicroAutoBox is in secured mode. The default factory code has been loaded. | ■ Update the firmware (Host IF firmware and Host IF PLD firmware). For instructions, refer to 🕮 *Firmware Manager Document*.<br>■ Use a lab power supply with a higher output power capability or connect a 1000 µF capacitor to the outputs of the lab power supply. |

**Status LED FPGA**

The status LED FPGA indicates the following malfunctions of the MicroAutoBox II 1401/1511/1514 and 1401/1513/1514:

| Behavior | Cause | Remedy |
|---|---|---|
| LED lights blue | The FPGA die temperature is too hot for operating. | ■ Reduce the ambient temperature or increase the air flow.<br>■ You can decrease the temperature if your FPGA application reduces the FPGA's toggle rate (e.g., by using clock enable) or by reducing the utilization of the FPGA resources. |

## Problems Related to the Firmware

**Corrupt firmware**

**Note**

You should not switch off MicroAutoBox's power supply or disconnect MicroAutoBox from the host PC while loading an application to the box. This might be the reason for a corrupted firmware.

**Error messages**

One of the following error messages may come up when you try to download an application to MicroAutoBox. The application is not executed.

- *<board_name>: Startup code has not been executed correctly after loading <application>.*
- *<board_name>: No firmware (bootstrap code) found. Please load the firmware again.*

If the error messages are caused by a corrupted bootstrap loader which is included in the firmware, you have to re-program the firmware.

**Remedy**

1. Clear the flash memory, refer to *How to Clear an Application from the Flash Memory* (📖 *First Work Steps with a dSPACE System*).
2. Update the boot firmware as described in 📖 *Firmware Manager Document*.

   If there are problems updating the firmware, contact dSPACE support.
3. To verify if the firmware problem is solved, download the demo application you find in `<InstallationFolder>\Demos\1401\Check`.
   - Load the demo application to the RAM, refer to *Real-Time Application - Load* (📖 *ControlDesk Platform Management*).
   - Load the demo application to the flash memory, refer to *Real-Time Application - Load to Flash (DS1005/DS1006/DS1104/MicroAutoBox)* (📖 *ControlDesk Platform Management*).

     Check the logfile for error messages.
4. Load your own real-time application to the RAM or FLASH.

   If there are problems, contact dSPACE support.

# How to Start MicroAutoBox to Secured Mode

**Objective**

If MicroAutoBox does not operate correctly and is not shown in the Platform Navigator (ControlDesk) or the Platform/Device Manager (ControlDesk), the firmware may be corrupt.

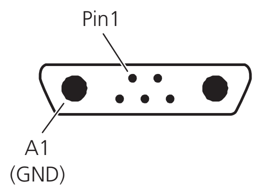
You have to start MicroAutoBox to the secured mode to load valid firmware.

**Method**

**To start MicroAutoBox to secured mode**

1 Switch off MicroAutoBox.

2 Establish a connection between pin 1 and A1 (GND). The power input connector of MicroAutoBox and its pinout are shown in the illustration below.




**NOTICE**

Ensure that you connect the correct pins to avoid damage.

3 Switch on MicroAutoBox. The status LED flashes red.
MicroAutoBox is in secured mode.

4 Update the firmware corresponding to your ControlDesk variant.

5 Switch off MicroAutoBox.

6 Remove the connection between pin 1 and A1.

**Result**

MicroAutoBox provides valid firmware.

**Updating the firmware**

For information on updating the firmware with ControlDesk, refer to *How to Update Firmware* (📖 *ControlDesk Platform Management*).

For general information on updating the firmware, refer to 📖 *Firmware Manager Document*.

# Problems with the Ethernet Connection

**Where to go from here**

Information in this section



## General Errors Using Ethernet Connection

**Objective**

The following general errors may occur when you work with MicroAutoBox due to Ethernet problems.

**IP address lost**

If you do not know the current IP address of your MicroAutoBox, you can use it's MAC address and serial number to set the IP address to the required one. The MAC address and serial number are printed on a type plate on the bottom of your MicroAutoBox.

For further instructions and an example, refer to *How to Change the IP Address of MicroAutoBox* on page 68.

**Wrong IP address**

The IP addresses of MicroAutoBox and network, or MicroAutoBox and host PC (for peer-to-peer connection) must adhere to the following rules:

- The network part of the IP address must be identical on both systems. Only the workstation part may differ. For details, refer to a definition of IP address classes.
- The IP address of each node must be unique within the network.
- The IP address must not be one of the reserved loopback addresses from 127.0.0.0 to 127.255.255.255 .

**Changing connected MicroAutoBox with an identical IP address**

If you change a connected MicroAutoBox to a MicroAutoBox with an identical IP address it may take a few minutes to connect the host PC to this MicroAutoBox. This is caused by invalid Ethernet address cache entries on your host PC.

**Error message**

Pinging 192.168.140.1 with 32 bytes of data:

Request timed out

MicroAutoBox uses 192.168.140.1 as the default IP address.

This error message can appear, when you set up a peer-to-peer connection.

Perform the following checks to solve the problem:

- Check whether the network adapter of the host PC has been installed and configured correctly.
- Check the IP address of the host PC.
- Check whether MicroAutoBox is configured to a wrong IP address: see *How to Change the IP Address of MicroAutoBox* on page 68.

**No connection to the host PC due to Ethernet hardware**

Ethernet hardware (such as cables or switches) that does not support the Gigabit transfer rate of 1 Gbit/s might cause this problem. In exceptional cases, auto-negotiation does not lead to a stable Ethernet connection.

**Solution** Manually reduce the transfer rate of one Ethernet device (e.g., the host PC) to an Ethernet transfer rate of 100 Mbit/s.

# Problems When Setting Up the TCP/IP Protocol

**Troubleshooting**

When you check the installation of the TCP/IP protocol with the ping command, the following error messages may occur.

| Error message | Cause | Remedy |
|---|---|---|
| Bad command or file name | The TCP/IP protocol has not been installed properly. | Install the TCP/IP protocol again. |
| The name specified is not recognized as an internal or external command, operable program or batch file | The TCP/IP protocol has not been installed properly. | Install the TCP/IP protocol again. |
| Unable to contact IP driver, error code x found. | The TCP/IP protocol has not been installed properly. | Install the TCP/IP protocol again. |

| Error message | Cause | Remedy |
|---|---|---|
| Pinging 127.0.0.1 with x bytes of data: Request timed out | The TCP/IP protocol has not been configured properly. | Check the configuration of the TCP/IP protocol. If you are uncertain, ask your system administrator. |

# Problems Due to Specific Use Cases

## Problems with the Flight Recorder

**Troubleshooting**

One of the following error messages may come up when you use the flight recorder.

| Error Message | Cause | Remedy |
|---|---|---|
| The flight recorder has saved no data | You did not use the flight recorder. | – |
| The file '<filename>' contains no flight recorder data | You tried to convert a file that contains no flight recorder data. | Select a BIN file with flight recorder data. |
| Overrun during flight recording detected (data incomplete) | During data saving, the bit rate was so high that some data could not be recorded. Reasons:<br>■ Too many variables are saved in too short a period, or<br>■ Data is written to the flash too fast. The flash of MicroAutoBox has a bit rate of approx. 700 KByte/s. If this bit rate overruns, data is lost. | Reduce the variables or the cycle time of the model/program, so that the flash has a longer period to save the data. |
| Detected incomplete or faulty flight recorder data | During data saving or conversion, failures in the data structure occurred. The BIN file or the data in the flash memory is corrupt. | Contact dSPACE support for further measures. |

# Accessories

**Where to go from here**

Information in this section

# MicroAutoBox Break-Out Boxes

**Objective**

The MicroAutoBox Break-Out Boxes provide easy access to all the signals of the connectors of a MicroAutoBox. For example, you can:

- Check and/or reconnect signals without changing the already existing cable harness
- Connect sensors and/or actuators
- Connect measurement devices

**Where to go from here**

Information in this section



# Data Sheet MicroAutoBox Break-Out Box DS1541

**Objective**

The MicroAutoBox Break-Out Box DS1541 provides easy access to signals on the I/O connectors of all MicroAutoBox II variants.

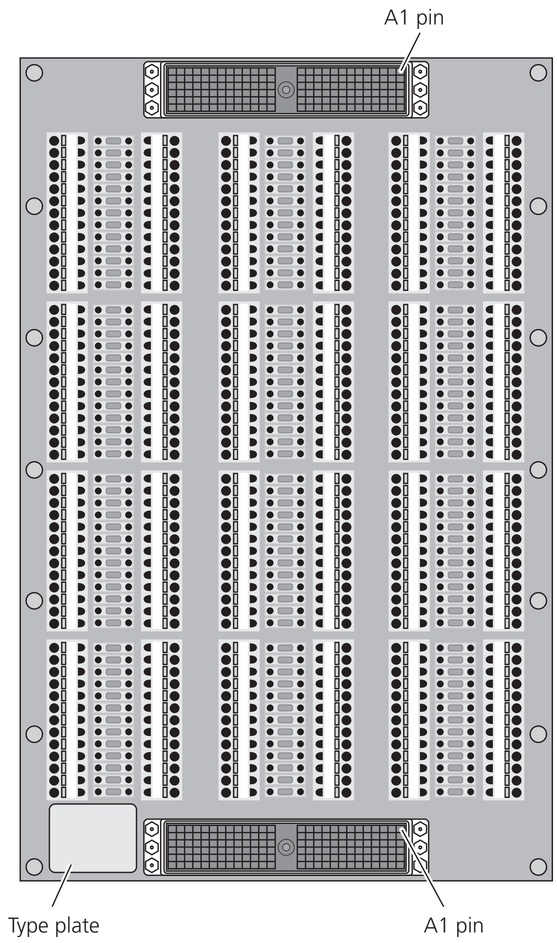
**Where to go from here**

Information in this section

# Components and Their Functionality - MicroAutoBox Break-Out Box DS1541

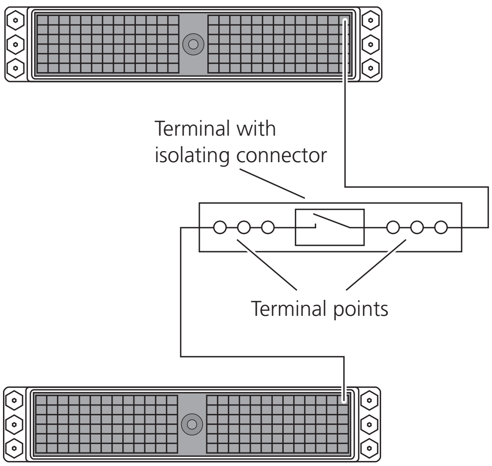
**Schematic**

Components of the MicroAutoBox Break-Out Box DS1541:



**Block diagram**

The block diagram shows the functional units, their functionality, and the signal paths in a simplified form.




The signals at the I/O connector pins on one side are routed to the same pins on the other side. This means that the Break-Out Box itself does not affect the cable harness. In addition to the same pinout, the ZIF I/O connectors also have the same orientation on the board.

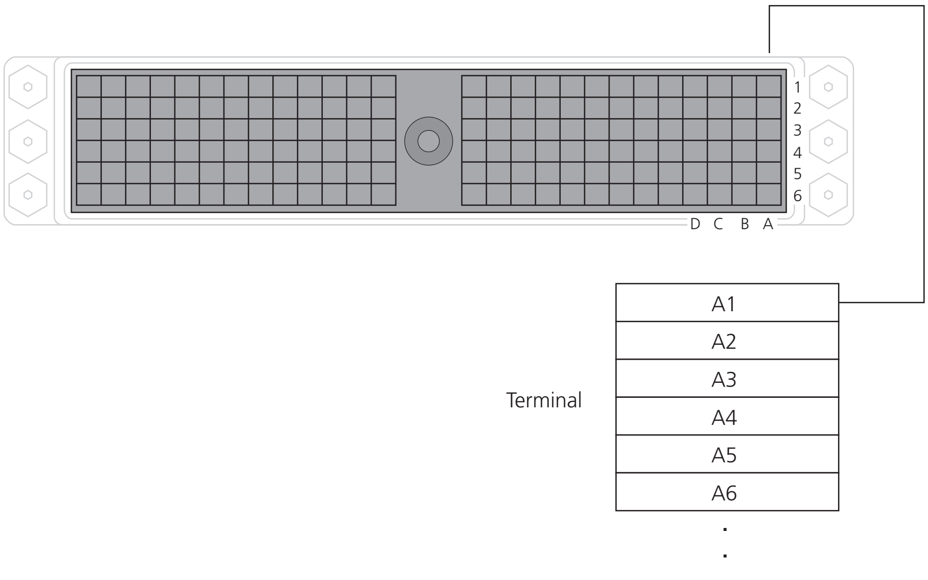
**Terminals**

The terminals are labeled according to the ZIF I/O connector pin numbering.

**Terminal points** You can connect stripped wires and test plugs to the signal path via terminal points.

**Isolating connectors** Each signal terminal provides a switch, called a isolating connector. This is to interrupt the signal between the cable harness and MicroAutoBox.

**Terminal grouping** The terminals are grouped according to ZIF connector. The illustration below shows the grouping scheme.

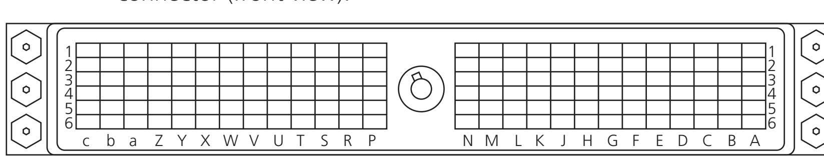



## Zero Insertion Force Connector

**Pin numbering**

The main I/O connectors are 156-pin zero insertion force (ZIF) connectors, the same like the ZIF I/O connector of MicroAutoBox. Both ZIF connectors have the same pin numbering and orientation on the board.

The following illustration shows the pin numbering of the female ZIF connector (front view):




> **Note**
>
> There are pins identified by uppercase letters (A, B, C, etc.) and pins identified by lowercase letters (a, b, c).

The terminals are grouped according to ZIF connector. For details, refer to *Components and Their Functionality - MicroAutoBox Break-Out Box DS1541* on page 683.

| | |
|---|---|
| **Matching cable** | Depending on your order, the break-out box is delivered with one standard cable (CB1541). For further information, refer to *CB1541 Break-Out Box Connection Cable for MicroAutoBox II* on page 709. |

**Pinout**

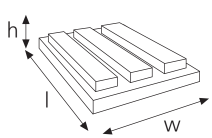
The signals available at the different pins depend on the MicroAutoBox variant. For the pinout of the

- MicroAutoBox II 1401/1501, refer to *ZIF I/O Connector* on page 224.
- MicroAutoBox II 1401/1504, refer to *ZIF I/O Connector* on page 258.
- MicroAutoBox II 1401/1505/1507, refer to *ZIF I/O Connector* on page 291.
- MicroAutoBox II 1401/1511, refer to *ZIF I/O Connector* on page 354.
- MicroAutoBox II 1401/1511/1512, refer to *DS1511 ZIF I/O Connector* on page 387 and *DS1512 ZIF I/O Connector* on page 389.
- MicroAutoBox II 1401/1511/1514, refer to *DS1511 ZIF I/O Connector* on page 431 and *DS1514 ZIF I/O Connector* on page 433.
- MicroAutoBox II 1401/1512/1513, refer to *DS1512 ZIF I/O Connector* on page 475 and *DS1513 ZIF I/O Connector* on page 476.
- MicroAutoBox II 1401/1513, refer to *ZIF I/O Connector* on page 514.
- MicroAutoBox II 1401/1513/1514, refer to *DS1513 ZIF I/O Connector* on page 551 and *DS1514 ZIF I/O Connector* on page 553.

# Data Overview - Break-Out Box DS1541

**Characteristics**

The following table shows the technical characteristics of the MicroAutoBox Break-Out Box DS1541.

| Parameter | | Specification [1] |
|---|---|---|
| Identification | | dSPACE number: DS1541 |
| I/O connectors | | 2 zero insertion force (ZIF) connectors to insert the Break-Out Box in an existing cable harness. |
| Terminals | | One terminal for each signal of the ZIF I/O connector:<br>■ 6 terminal points for each signal, 3 on each side of the isolating connector<br>■ Isolating connectors to interrupt the signal path |
| Connection cables | | Depending on your order, the break-out box is delivered with one standard cable (CB1541). |
| Mechanical characteristics | Physical size   | ■ l: 341 mm (13.43 in.)<br>■ w: 224 mm (8.82 in.)<br>■ h: 61 mm (2.40 in.) |
| | Weight | Approx. 2.5 kg (5.5 lb.) |
| Environmental conditions | Operating temperature | 0 … +70 °C (+32 … +158 °F) |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

# Data Sheet MicroAutoBox Break-Out Box DS5374

**Objective**

The MicroAutoBox Break-Out Box DS5374 provides easy access to signals on the I/O connectors only of the following MicroAutoBox variants:

- MicroAutoBox II 1401/1501
- MicroAutoBox II 1401/1504

- MicroAutoBox II 1401/1505/1507
- MicroAutoBox II 1401/1507

**⚠ WARNING**

**Risk of injury and material damage**

Do not connect any of the following MicroAutoBox variants to a MicroAutoBox Break-Out Box DS5374:

- MicroAutoBox II 1401/1511
- MicroAutoBox II 1401/1511/1512
- MicroAutoBox II 1401/1511/1514
- MicroAutoBox II 1401/1512/1513
- MicroAutoBox II 1401/1513
- MicroAutoBox II 1401/1513/1514

These variants have deviating ZIF connector pinouts.

**Where to go from here**

Information in this section

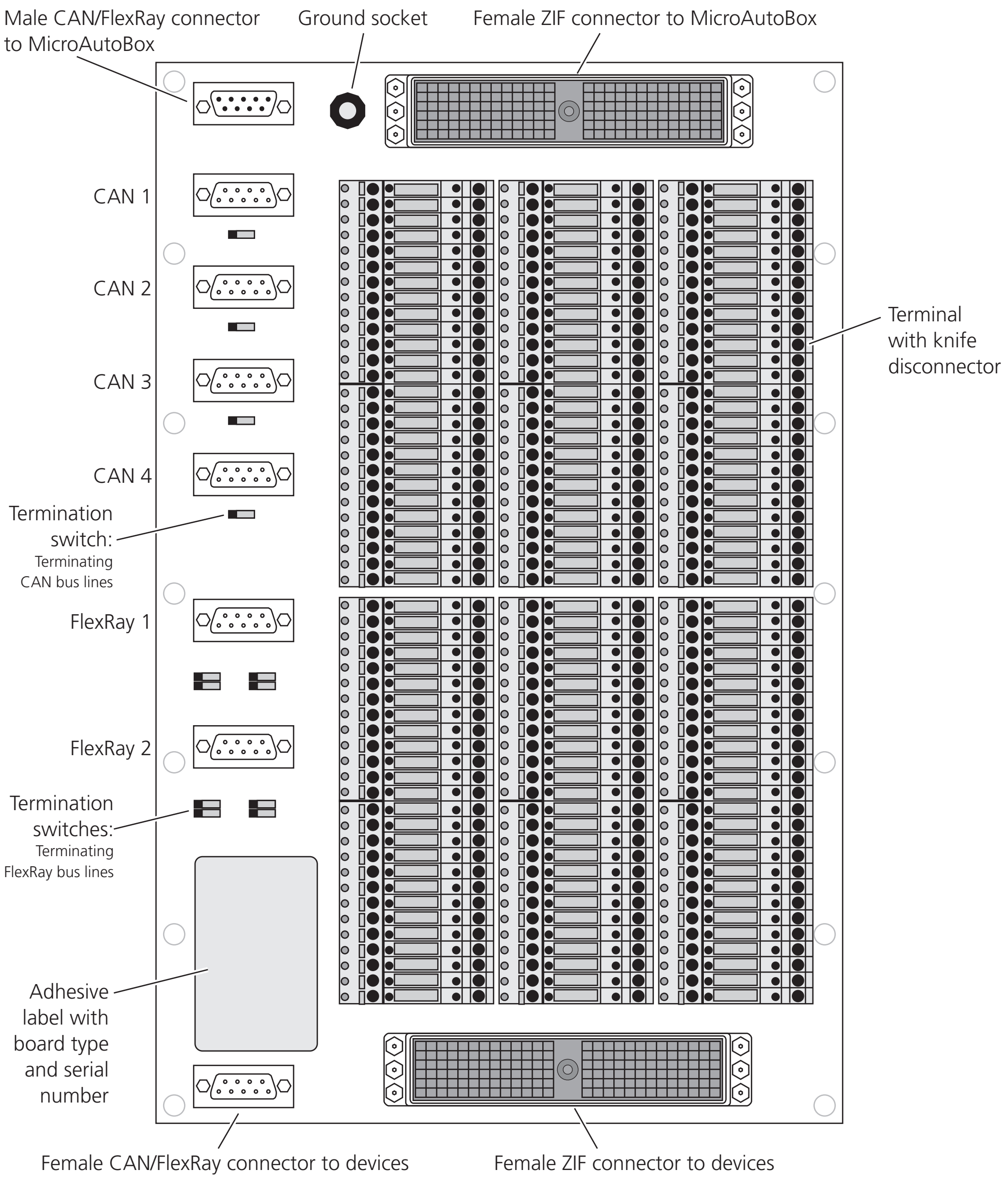


Information in other sections

# Components and Their Functionality - MicroAutoBox Break-Out Box DS5374

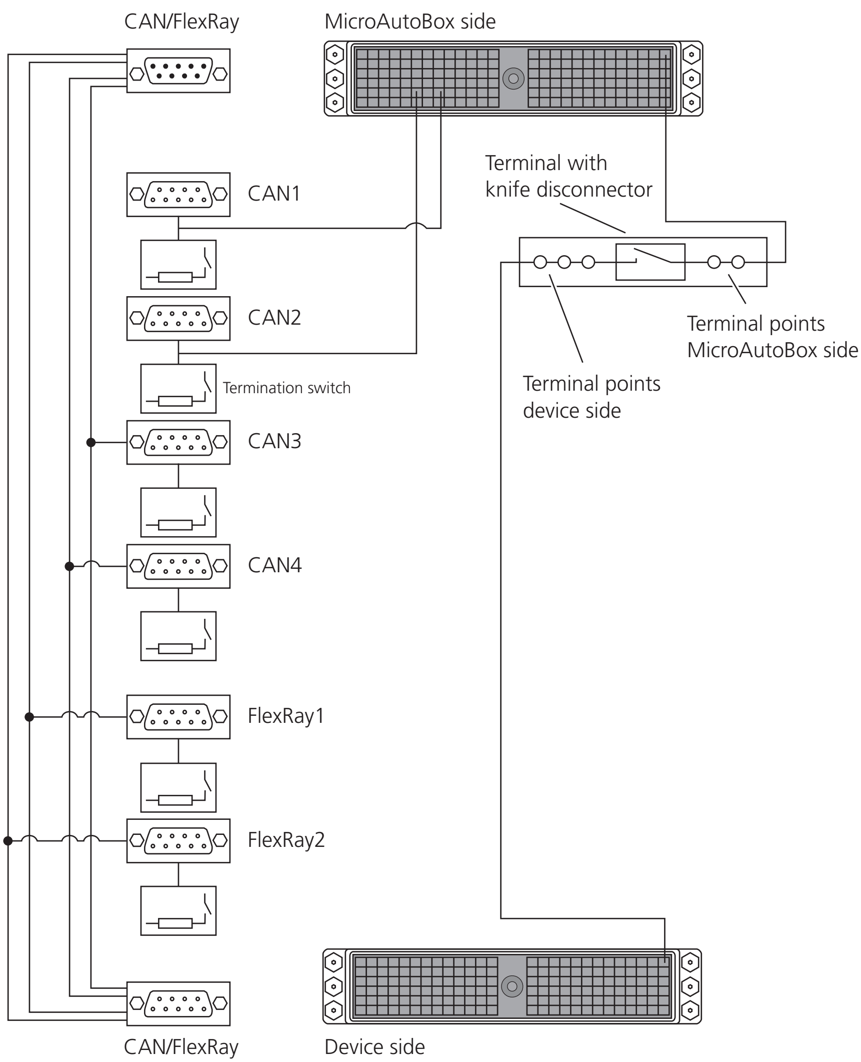
**Schematic**

Components of the MicroAutoBox Break-Out Box:



**Block diagram**

The block diagram shows the functional units, their functionality, and the signal paths in a simplified form.




The signals at the I/O connector pins on the MicroAutoBox side are routed to the same pins on the device side. This means that the Break-Out Box itself does not affect the cable harness. In addition to the same pinout, the ZIF I/O connectors also have the same orientation on the board.

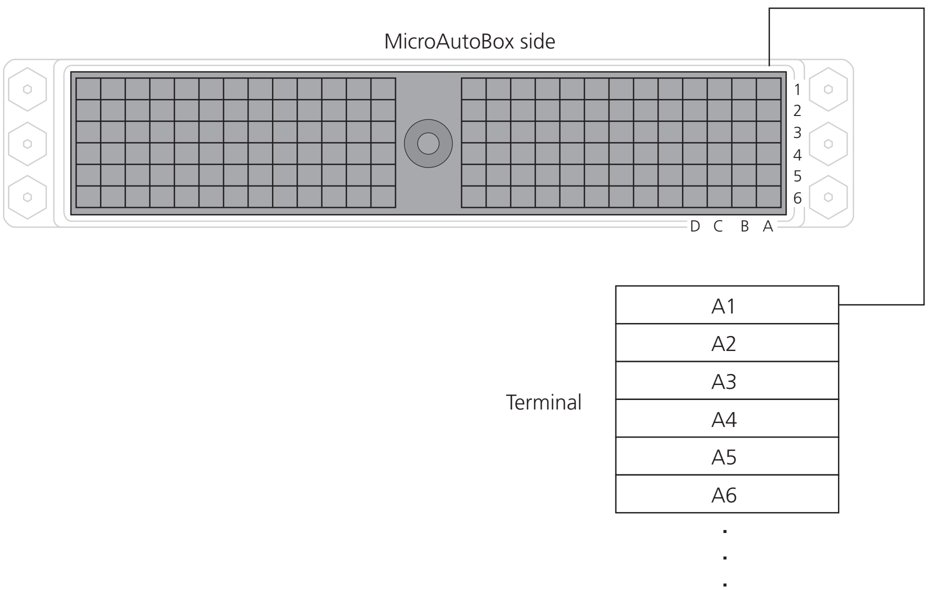
**Terminals**

The terminals are labeled according to the ZIF I/O connector pin numbering.

**Terminal points** You can connect stripped wires and test plugs to the signal path via terminal points.

**Knife disconnector** Each signal terminal provides a switch, called a knife disconnector. This is to interrupt the signal between the cable harness and MicroAutoBox.

**Terminal grouping** The terminals are grouped according to ZIF connector. The illustration below shows the grouping scheme.




**I/O connectors**

I/O connectors make it easy to insert the Break-Out Box in the existing cable harness and to add additional devices and measurement tools.

**Zero insertion force (ZIF) connector** The main I/O connectors are 156-pin ZIF connectors, the same like the ZIF I/O connector of MicroAutoBox. Both ZIF connectors have the same pinout and orientation on the board. For details, refer to *ZIF I/O Connector* on page 692.

**Sub-D I/O connectors for CAN and FlexRay buses** The 9-pin Sub-D I/O connectors make it easy to connect CAN/FlexRay devices and/or measurement tools. The table below gives you an overview how they are used and the MicroAutoBox variant they are intended for.

| Connector | MicroAutoBox Variant | Usage |
|---|---|---|
| CAN 1, CAN 2 | All variants that are supported by DS5374. | CAN bus I/O connectors for additional devices/measurement tools |
| CAN 3, CAN 4 | Intended for:<br>■ 1401/1507<br>■ 1401/1505/1507 | CAN bus I/O connectors for additional devices/measurement tools |
| FlexRay 1, FlexRay 2 | Intended for:<br>■ 1401/1507 (FlexRay 2 only)<br>■ 1401/1505/1507 | FlexRay bus I/O connectors for additional devices/measurement tools |
| CAN/FlexRay MicroAutoBox side | Intended for:<br>■ 1401/1507<br>■ 1401/1505/1507 | I/O connector to connect the Break-Out Box with the 78-pin Sub-D connector of MicroAutoBox I/O connector.[1)] |
| CAN/FlexRay device side | Intended for:<br>■ 1401/1507<br>■ 1401/1505/1507 | I/O connector to connect the Break-Out Box with devices. |

[1)] To connect the Break-Out Box with MicroAutoBox, you have to build an adapter cable according to the configuration and the pinout of MicroAutoBox.

For details, refer to *CAN/FlexRay Signal Mapping* on page 696.

**Ground socket** The ground socket provides a common ground. Test plugs (banana plugs) with 4.0 mm (0.16 in.) diameter fit in the ground socket.

**Termination switches**

Termination switches enable you to terminate all CAN and FlexRay buses. For details, refer to *Terminating CAN Bus Lines - MicroAutoBox Break-Out Box DS5374* on page 187 and *Terminating FlexRay Bus Lines - MicroAutoBox Break-Out Box DS5374* on page 189.

**Related topics**

Basics

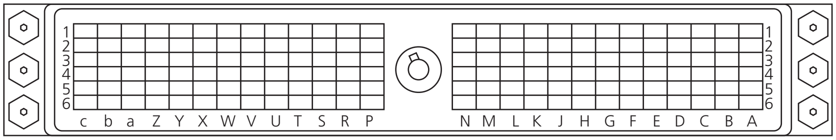
- *Working Principles - MicroAutoBox Break-Out Box DS5374* on page 183

# ZIF I/O Connector

**Pin numbering**

The main I/O connectors are 156-pin zero insertion force (ZIF) connectors, the same like the ZIF I/O connector of MicroAutoBox. Both ZIF connectors have the same pin numbering and orientation on the board.

The following illustration shows the pin numbering of the female ZIF connector (front view):




**Note**

There are pins identified by uppercase letters (A, B, C, etc.) and pins identified by lowercase letters (a, b, c).

The terminals are grouped according to ZIF connector. For details, refer to *Components and Their Functionality - MicroAutoBox Break-Out Box DS5374* on page 689.

**Matching cable**

Depending on your order, the break-out box is delivered with one of the following ready-to-use cables for connecting the ZIF I/O connector on MicroAutoBox to the ZIF I/O connector on Break-Out Boxes:

- Standard cable (CB5374): This cable does not provide a connection for the ECU interface that is accessible via ZIF I/O connector (on MicroAutoBox). The corresponding ECU interface signals (available at pins b5, a5, Z5, Y5) and the G5 ground pin are therefore left unconnected. For further information, refer to *CB5374 Break-Out Box Connection Cable for MicroAutoBox* on page 709.
- Special LVDS cable (CB5374LV): If you want to connect a Break-Out Box and also use the ECU interface that is accessible via ZIF I/O connector (on MicroAutoBox), you have to use this special cable. The corresponding ECU interface signals (available at pins b5, a5, Z5, Y5 and G5) are connected to wires which are bundled to a separate LVDS cable. For further information, refer to *CB5374LV Break-Out Box Connection Cable for MicroAutoBox* on page 710.

**Pinout**

The signals available at the different pins depend on the MicroAutoBox variant. For the pinout of the

- MicroAutoBox II 1401/1501, refer to *ZIF I/O Connector* on page 224.
- MicroAutoBox II 1401/1504, refer to *ZIF I/O Connector* on page 258.
- MicroAutoBox II 1401/1505/1507, refer to *ZIF I/O Connector* on page 291.

# CAN/FlexRay Sub-D I/O Connectors

**Objective**

The CAN/FlexRay I/O connectors are used with MicroAutoBox variants 1401/1507, and 1401/1505/1507.

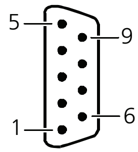
You have to build an adapter to connect the Break-Out Box with the 78-pin Sub-D connector of MicroAutoBox. Note that the pinout of the MicroAutoBox Sub-D connector differs depending on the FlexRay IP module used.

The Break-Out Box provides two 9-pin Sub-D CAN/FlexRay I/O connectors:

- One male connector on the MicroAutoBox (MABX) side to connect the Break-Out Box with MicroAutoBox.
- One female connector on the device side to connect the Break-Out Box with devices.

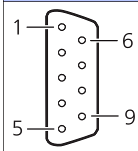
**Pinout of the male connector (MicroAutoBox side)**

The pin numbering used for Sub-D connectors is not standardized. The following illustration shows the numbering used (front view).

| CAN/FlexRay Connector | Pin | Signal | Pin | Signal |
|---|---|---|---|---|
|  | 5 | Ground | | |
| | 4 | FlexRay2 Low | 9 | FlexRay2 High |
| | 3 | FlexRay1 Low | 8 | FlexRay1 High |
| | 2 | CAN3 Low | 7 | CAN3 High |
| | 1 | CAN4 Low | 6 | CAN4 High |

**Pinout of the female connector (device side)**

The pin numbering used for Sub-D connectors is not standardized. The following illustration shows the numbering used (front view).

| CAN/FlexRay Connector | Pin | Signal | Pin | Signal |
|---|---|---|---|---|
|  | 1 | CAN4 Low | | |
| | 2 | CAN3 Low | 6 | CAN4 High |
| | 3 | FlexRay1 Low | 7 | CAN3 High |
| | 4 | FlexRay2 Low | 8 | FlexRay1 High |
| | 5 | Ground | 9 | FlexRay2 High |

**Related topics**

References

- *CAN/FlexRay Signal Mapping* on page 696

# CAN Sub-D I/O Connector (CAN 1 ... CAN 4)

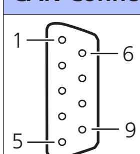
**Objective**

The female 9-pin Sub-D I/O connectors make it easy to connect CAN devices and/or measurement tools to the CAN bus lines of CAN 1 ... CAN 4.

CAN 3 and CAN 4 are only used with MicroAutoBox variants 1401/1507 1401/1505/1507.

**Pinout**

The pin numbering used for Sub-D connectors is not standardized. The following illustration shows the numbering used (front view).

| CAN Connector | Pin | Signal | Pin | Signal |
|---|---|---|---|---|
|  | 1 | NC[1)] | | |
| | 2 | CAN(x)[2)] Low | 6 | NC |
| | 3 | Ground | 7 | CAN(x)[2)] High |
| | 4 | NC | 8 | NC |
| | 5 | NC | 9 | NC |

1) Not connected
2) (x) refers to the CAN channel number and is in the range 1 ... 4

# FlexRay Sub-D I/O Connector (FlexRay 1 and FlexRay 2)

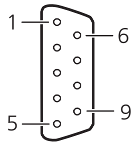
**Objective**

The female 9-pin Sub-D I/O connectors make it easy to connect FlexRay devices and/or measurement tools to the FlexRay bus lines of FlexRay 1 and FlexRay 2.

FlexRay bus lines are only used with MicroAutoBox variants 1401/1507 and 1401/1505/1507.

**Pinout**

The pin numbering used for Sub-D connectors is not standardized. The following illustration shows the numbering used (front view).

| FlexRay Connector | Pin | Signal | Pin | Signal |
|---|---|---|---|---|
|  | 1 | NC[1] | | |
| | 2 | FlexRay(x)[2] Low | 6 | NC |
| | 3 | Ground | 7 | FlexRay(x)[2] High |
| | 4 | NC | 8 | NC |
| | 5 | NC | 9 | NC |

1) Not connected
2) (x) refers to the FlexRay channel number and is 1 or 2.

# CAN/FlexRay Signal Mapping

**Signal mapping of the CAN/FlexRay buses**

All the CAN and FlexRay bus lines of MicroAutoBox are mapped to 9-pin Sub-D connectors. This makes it easy to connect CAN/FlexRay devices and/or measurement tools.

MicroAutoBox variants 1401/1507 and 1401/1505/1507 have additional CAN and FlexRay buses: CAN 3, CAN 4, FlexRay 1 (not 1401/1507), and FlexRay 2. These buses are only available at a 78-pin Sub-D I/O connector on the MicroAutoBox and are not available at a terminal of the MicroAutoBox Break-Out Box.

The MicroAutoBox Break-Out Box has Sub-D CAN/FlexRay connectors for inserting it between the Sub-D connector of MicroAutoBox and the connected devices.

The table below shows CAN/FlexRay signals and the connectors and pins they are mapped to.

| Signal | MicroAutoBox | | MicroAutoBox Break-Out Box | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Pin Number | | Sub-D Connector Pin Number[1] | | | | | | |
| | ZIF Connector | Sub-D Connector | CAN/FlexRay | CAN 1 | CAN 2 | CAN 3 | CAN 4 | FlexRay 1 | FlexRay 2 |
| CAN1 High | V6 | 1 | – | 7 | – | – | – | – | – |
| CAN1 Low | V5 | 2 | – | 2 | – | – | – | – | – |
| CAN2 High | X6 | 4 | – | – | 7 | – | – | – | – |
| CAN2 Low | X5 | 5 | – | – | 2 | – | – | – | – |
| CAN3 High[2] | – | 40 | 7 | – | – | 7 | – | – | – |
| CAN3 Low[2] | – | 41 | 2 | – | – | 2 | – | – | – |
| CAN4 High[2] | – | 43 | 6 | – | – | – | 7 | – | – |
| CAN4 Low[2] | – | 44 | 1 | – | – | – | 2 | – | – |
| FlexRay1 High | – | 16 or 55[3] | 8 | – | – | – | – | 7 | – |
| FlexRay1 Low | – | 17 or 56[3] | 3 | – | – | – | – | 2 | – |
| FlexRay2 High[2] | – | 19 or 58[3] | 9 | – | – | – | – | – | 7 |
| FlexRay2 Low[2] | – | 20 or 59[3] | 4 | – | – | – | – | – | 2 |

[1] The pin numbering used for Sub-D connectors is not standardized. Do not rely on the numbers written on Sub-D connectors.
[2] Available only with MicroAutoBox variants 1401/1507 and 1401/1505/1507.
[3] Pin number depends on the FlexRay IP module used.

**Related topics**

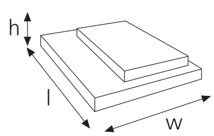
References

- *CAN Sub-D I/O Connector (CAN 1 ... CAN 4)* on page 695
- *CAN/FlexRay Sub-D I/O Connectors* on page 694
- *FlexRay Sub-D I/O Connector (FlexRay 1 and FlexRay 2)* on page 696
- *ZIF I/O Connector* on page 692

# Data Overview

**Characteristics** The following table shows the technical characteristics of the MicroAutoBox Break-Out Box.

| Parameter | Specification [1] |
|---|---|
| Identification | dSPACE number: DS5374 |
| I/O connectors | ■ 2 zero insertion force (ZIF) connectors to insert the Break-Out Box in an existing cable harness.<br>■ 8 Sub-D connectors<br>  ■ 2 CAN/FlexRay[2] connectors to insert the Break-Out Box in a cable harness of CAN 3, CAN 4, FlexRay 1 , and FlexRay 2.<br>  ■ 4 CAN connectors to connect CAN devices and/or measurement tools to the CAN bus lines of CAN 1 ... CAN 4[3].<br>  ■ 2 FlexRay[2] connectors to connect FlexRay devices and/or measurement tools to the FlexRay bus lines of FlexRay 1 and FlexRay 2.<br>■ One ground socket for test plugs (banana plugs) with 4 mm (0.16 inch.) diameter. |
| Terminals | ■ One terminal for each signal of the ZIF I/O connector:<br>  ■ 5 terminal points for each signal<br>    ■ 2 on the MicroAutoBox side<br>    ■ 3 on the device side<br>  ■ Knife disconnectors to interrupt the signal path.<br>  The ground potential cannot be interrupted. |
| Termination switches | 12 termination switches to terminate each CAN and FlexRay bus line.<br>■ 1 termination switch for each CAN bus (CAN 1 ... CAN 4) to terminate the bus lines with 120 Ω.<br>■ 4 termination switches for each FlexRay bus (FlexRay 1 and FlexRay 2) to terminate the bus lines either with 94 Ω or 47 Ω (47 Ω for test purposes). |

| Parameter | | Specification [1] |
|---|---|---|
| Connection cables | | One of two available ready-to-use cables to connect to the ZIF I/O connector of MicroAutoBox is included (depending on your order):<br>■ Standard cable (CB5374): You cannot use the ECU interface that is accessible via ZIF I/O connector (on MicroAutoBox) with this cable, because the corresponding signals are left unconnected.<br>■ Special LVDS cable (CB5374LV) for using the ECU interface that is accessible on the ZIF I/O connector (on MicroAutoBox). The corresponding signals are provided via a separate LVDS cable. |
| Mechanical characteristics | Physical size<br><br> | ■ l: 341 mm (13.43 in.)<br>■ w: 224 mm (8.82 in.)<br>■ h: 61 mm (2.40 in.) |
| | Weight | Approx. 2.6 kg (5.7 lb.) |
| Environmental conditions | Operating temperature | 0 … +70 °C (+32 … +158 °F) |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.
[2] Only used with MicroAutoBox variants 1401/1507 and 1401/1505/1507.
[3] CAN 3 and CAN 4 only used with MicroAutoBox variants 1401/1507 and 1401/1505/1507.

# Connection Cables

| | |
|---|---|
| **Cable design** | All the cables are designed to avoid false connections and polarity inversions. Some of them use LEMO connectors with different keyways which are color-coded for quick and convenient handling. |
| **Where to go from here** | Information in this section |



# USB Connection Cable

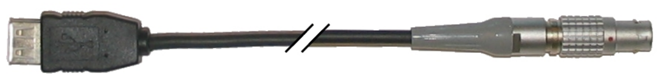
**Where to go from here**

Information in this section

# USB_CAB13 Interface Cable to Use the Flight Recorder Feature

**Technical data**

The following table shows the technical specifications of the USB_CAB13 interface cable:

| Parameter | Specification[1)] | | |
|---|---|---|---|
| Purpose | To connect standard USB devices to the MicroAutoBox's LEMO connector to use the flight recorder feature. | | |
| Illustration |  | | |
| Connector | USB jack, 4 pins | | LEMO-1B, male, 4 pins (grey) |
| Label on the cable | USB_CAB13 | | |
| Length | 1.8 m (70.8 in) | | |
| Operating temperature | –20 … +80 °C (–4 … +176°F) | | |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Note**

Do not extend the USB_CAB13 Interface Cable with a standard USB cable to avoid malfunction of the connected USB devices.

# LVDS Link Cables

**Where to go from here**

Information in this section

# LVDS_CAB1 LVDS Link Cable

**Technical data**

The following table shows the technical specifications of the LVDS_CAB1 LVDS link cable:

| Parameter | Specification[1] | | |
|---|---|---|---|
| Purpose | To connect a DCI-GSI1, a DPMEM POD, or a RapidPro system used as intelligent I/O subsystem to MicroAutoBox's ZIF connector via LVDS. | | |
| Illustration |  | | |
| Connector | LEMO-1S, 4 pins (2 male, 2 female) | – | 4 crimped contacts for ZIF connector |
| Label on the cable | LVDS_CAB1 | | |
| Length | 5.0 m (197 in.) | | |
| Operating temperature | –20 … +60 °C (–4 … +140 °F) | | |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

Valid for MicroAutoBox variants which provide ECU channels on the ZIF I/O connector.

The following table shows the pins of the ZIF I/O connector required for the LVDS connection:

| LVDS_CAB1 Color of Wire | MicroAutoBox ZIF I/O Connector | |
|---|---|---|
| | **Pin** | **Signal** |
| White<br>Orange | a5<br>b5 | ECU / IF1 TX–<br>ECU / IF1 TX+ |
| Blue | Y5 | ECU / IF1 RX+ |

| LVDS_CAB1 Color of Wire | MicroAutoBox ZIF I/O Connector | |
|---|---|---|
| | Pin | Signal |
| White | Z5 | ECU / IF1 RX– |
| Black | GND | GND |

For information on the COM connector of the RapidPro Control Unit, refer to *COM Connector* (📖 *RapidPro System Hardware Reference*).

**Note**

The link cables LVDS_CAB1 and LVDS_CAB9 are identical except for length.

# LVDS_CAB2 LVDS Link Cable

**Technical data**

The following table shows the technical specifications of the LVDS_CAB2 LVDS link cable:

<table>
<tr><th>Parameter</th><th colspan="3">Specification[1)]</th></tr>
<tr><td>Purpose</td><td colspan="3">To connect two devices with LEMO-1S connectors via LVDS.</td></tr>
<tr><td>Illustration</td><td colspan="3"></td></tr>
<tr><td>Connector</td><td>LEMO-1S, 4 pins (2 male, 2 female)</td><td>–</td><td>LEMO-1S, 4 pins (2 male, 2 female)</td></tr>
<tr><td>Label on the cable</td><td colspan="3">LVDS_CAB2</td></tr>
<tr><td>Length</td><td colspan="3">5.0 m (197 in.)</td></tr>
<tr><td>Operating temperature</td><td colspan="3">–20 … +60 °C (–4 … +140 °F)</td></tr>
</table>

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

# LVDS_CAB3 LVDS Link Cable

**Technical data**

The following table shows the technical specifications of the LVDS_CAB3 LVDS link cable:

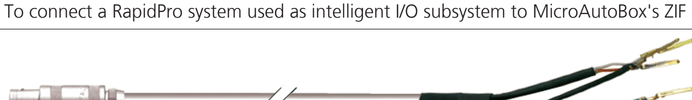
| Parameter | Specification[1] | | |
|---|---|---|---|
| Purpose | To connect two devices with LEMO-1S connectors via LVDS. | | |
| Illustration |  | | |
| Connector | LEMO-1S, 4 pins (2 male, 2 female) | – | LEMO-1S, 4 pins (2 male, 2 female) |
| Label on the cable | LVDS_CAB3 | | |
| Length | 5.0 m (197 in.) | | |
| Operating temperature | –40 ... +150 °C (–40 ... +302 °F) | | |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

# LVDS_CAB9 LVDS Link Cable

**Technical data**

The following table shows the technical specifications of the LVDS_CAB9 LVDS link cable:

| Parameter | Specification[1] | | |
|---|---|---|---|
| Purpose | To connect a RapidPro system used as intelligent I/O subsystem to MicroAutoBox's ZIF connector via LVDS. | | |
| Illustration |  | | |
| Connector | LEMO-1S, 4 pins (2 male, 2 female) | – | 4 crimped contacts for ZIF connector |
| Label on the cable | LVDS_CAB9 | | |
| Length | 1.0 m (39.3 in.) | | |
| Operating temperature | –20 ... +60 °C (–4 ... +140 °F) | | |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

Valid for MicroAutoBox variants which provide ECU channels on the ZIF I/O connector.

The following table shows the pins of the ZIF I/O connector required for the LVDS connection:

| LVDS_CAB9 Color of Wire | MicroAutoBox ZIF I/O Connector | |
|---|---|---|
| | Pin | Signal |
| White | a5 | ECU / IF1 TX– |
| Orange | b5 | ECU / IF1 TX+ |
| Blue | Y5 | ECU / IF1 RX+ |
| White | Z5 | ECU / IF1 RX– |
| Black | GND | GND |

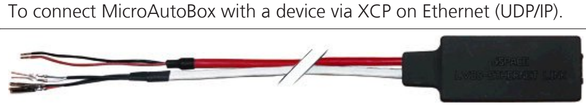
For information on the COM connector of the RapidPro Control Unit, refer to *COM Connector* (📖 *RapidPro System Hardware Reference*).

**Note**

The link cables LVDS_CAB1 and LVDS_CAB9 are identical except for length.

## LVDS_CAB13 LVDS-Ethernet Link Cable

The following table shows the technical specifications of the LVDS_CAB13 LVDS-Ethernet link cable:

| Parameter | Specification[1)] | | |
|---|---|---|---|
| Purpose | To connect MicroAutoBox with a device via XCP on Ethernet (UDP/IP). | | |
| Illustration |  | | |
| Connector | ■ 2 open, soldered leads (power cable)<br>■ 4 crimped contacts for ZIF connector (LVDS connection) | | RJ45 connector |
| Input voltage range | 6 V ... 48 V | | |
| Label on the cable | LVDS_CAB13 | | |

| Parameter | Specification[1] |
|---|---|
| Length | ■ 1 m (39 in) (power cable)<br>■ 0.3 m (12 in) (LVDS connection) |
| Operating temperature | –20 … +60 °C (–4 … +140 °F) |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

Valid for MicroAutoBox variants which provide ECU channels on the ZIF I/O connector.

The following table shows the pins of the ZIF I/O connector required for the LVDS connection:

| LVDS_CAB13 (ZIF Contacts) Color of Wire | MicroAutoBox ZIF I/O Connector | |
|---|---|---|
| | Pin | Signal |
| White<br>Orange | a5<br>b5 | ECU / IF1 TX–<br>ECU / IF1 TX+ |
| Blue<br>White | Y5<br>Z5 | ECU / IF1 RX+<br>ECU / IF1 RX– |
| Black | GND | GND |

For information on the COM connector of the RapidPro Control Unit, refer to *COM Connector* (📖 *RapidPro System Hardware Reference*).

The following table shows the pin assignment of the power cable:

| Color of Wire | Signal |
|---|---|
| Black | GND |
| Red | + |

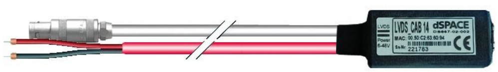
**Related topics**

HowTos

- *How to Connect MicroAutoBox to the ECU via UDP/IP* (📖 *ECU Interfaces Hardware Installation and Configuration*)

# LVDS_CAB14 LVDS-Ethernet Link Cable

The following table shows the technical specifications of the LVDS_CAB14 LVDS-Ethernet link cable:

| **Parameter** | **Specification**[1)] | | |
|---|---|---|---|
| Purpose | To connect a DS4121 ECU Interface Board with a device via XCP on Ethernet (UDP/IP). | | |
| Illustration |  | | |
| Connector | ■ LEMO-1S (LVDS connection)<br>■ 2 open, soldered leads (power cable) | | RJ45 connector |
| Input voltage range | 6 V ... 48 V | | |
| Label on the cable | LVDS_CAB14 | | |
| Length | ■ 0.3 m (12 in) (LVDS connection)<br>■ 1 m (39 in) (power cable) | | |
| Operating temperature | –20 … +60 °C (–4 … +140 °F) | | |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

The following table shows the pin assignment of the power cable:

| Color of wire | Signal |
|---|---|
| Black | GND |
| Red | + |

**Related topics**

HowTos

- *How to Connect MicroAutoBox to the ECU via DCI-GSI2* (📖 *ECU Interfaces Hardware Installation and Configuration*)
- *How to Connect MicroAutoBox to the ECU via UDP/IP* (📖 *ECU Interfaces Hardware Installation and Configuration*)
- *How to Connect the DS4121 to the ECU via DCI-GSI2* (📖 *ECU Interfaces Hardware Installation and Configuration*)
- *How to Connect the DS4121 to the ECU via UDP/IP* (📖 *ECU Interfaces Hardware Installation and Configuration*)

## LVDS_CAB15 LVDS Link Cable

**Technical data**

The following table shows the technical specifications of the LVDS_CAB15 LVDS link cable:

| Parameter | Specification[1)] | | |
|---|---|---|---|
| Purpose | To connect two devices with LEMO-1S connectors via LVDS. | | |
| Illustration |  | | |
| Connector | LEMO-1S, 4 pins (2 male, 2 female) | – | LEMO-1S, 4 pins (2 male, 2 female) |
| Label on the cable | LVDS_CAB15 | | |
| Length | 5.0 m (197 in.) | | |
| Operating temperature | –40 … +85 °C (–40 … +185 °F) | | |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

# MicroAutoBox Break-Out Box Connection Cables

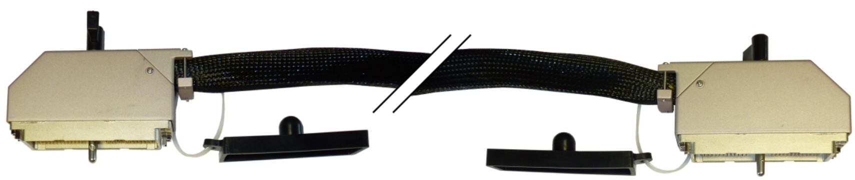
**Where to go from here**

Information in this section

# CB1541 Break-Out Box Connection Cable for MicroAutoBox II

**Technical data**

The following table shows the technical specifications of the CB1541 Break-Out Box connection cable:

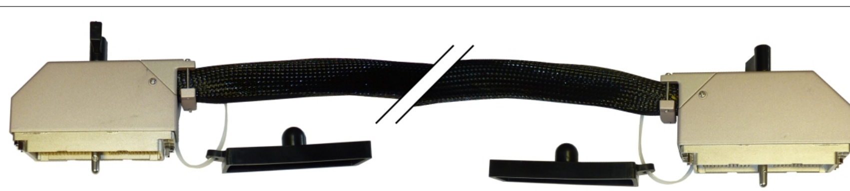
| Parameter | Specification[1] | | |
|---|---|---|---|
| Purpose | To connect the Break-Out Box DS1541 to the MicroAutoBox II. | | |
| Illustration |  | | |
| Connector | Male zero insertion force connector with 156 signal pins | – | Male zero insertion force connector with 156 signal pins |
| Length | 0.6 m (23.6 in.) | | |
| Operating temperature | 0 … +70 °C (+32 … +158 °F) | | |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

# CB5374 Break-Out Box Connection Cable for MicroAutoBox

**Technical data**

The following table shows the technical specifications of the CB5374 Break-Out Box connection cable:

| Parameter | Specification[1] | | |
|---|---|---|---|
| Purpose | To connect the Break-Out Box DS5374 to the MicroAutoBox or MicroAutoBox II.<br>This cable does not provide a connection for the ECU interface that is accessible via ZIF I/O connector (on MicroAutoBox). The corresponding ECU interface signals (available at pins b5, a5, Z5, Y5) and the G5 ground pin are therefore left unconnected. | | |
| Illustration |  | | |
| Connector | Male zero insertion force connector with 151 signal pins | – | Male zero insertion force connector with 151 signal pins |

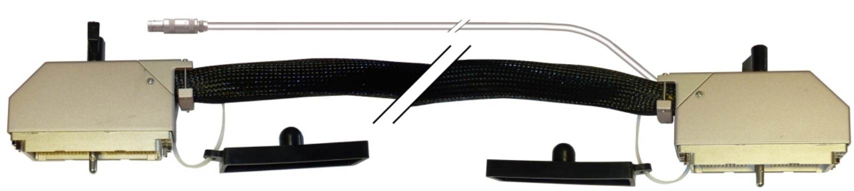
| Parameter | Specification[1] |
|---|---|
| Length | 1 m (39.4 in.) |
| Operating temperature | 0 … +70 °C (+32 … +158 °F) |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

# CB5374LV Break-Out Box Connection Cable for MicroAutoBox

**Technical data**

The following table shows the technical specifications of the CB5374LV Break-Out Box connection cable:

<table>
<tr><th>Parameter</th><th colspan="3">Specification[1]</th></tr>
<tr><td>Purpose</td><td colspan="3">To connect the Break-Out Box DS5374 to the MicroAutoBox or MicroAutoBox II including a separate LVDS connection.<br>If you want to connect a Break-Out Box and also use the ECU interface that is accessible via ZIF I/O connector (on MicroAutoBox), you have to use this special cable. The corresponding ECU interface signals (available at pins b5, a5, Z5, Y5 and G5) are connected to wires which are bundled to a separate LVDS cable.</td></tr>
<tr><td>Illustration</td><td colspan="3"></td></tr>
<tr><td>Connector</td><td>■ LEMO-1S, 4 pins (2 male, 2 female)<br>■ Male zero insertion force connector with 151 signal pins</td><td>–</td><td>Male zero insertion force connector with 156 signal pins</td></tr>
<tr><td>Length</td><td colspan="3">■ LEMO to ZIF: 5.0 m (197 in.)<br>■ ZIF to ZIF: 1 m (39.4 in.)</td></tr>
<tr><td>Operating temperature</td><td colspan="3">0 … +70 °C (+32 … +158 °F)</td></tr>
</table>

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

# FlexRay Connection Cables

**Where to go from here**

Information in this section



## FR_CAB1 FlexRay Interface Cable for MicroAutoBox

**Technical data**

The following table shows the technical specifications of the FR_CAB1 FlexRay interface cable:

| Parameter | Specification[1] | | |
|---|---|---|---|
| Purpose | The FR_CAB1 FlexRay Interface Cable can be used to connect FlexRay bus lines to the following MicroAutoBox variants if they have DS4340 modules:<br>■ MicroAutoBox II 1401/1507<br>■ MicroAutoBox II 1401/1505/1507<br>To connect FlexRay bus lines to the DS4505 Interface Board, use the FR_CAB2 FlexRay Interface Cable for DS4505 with crimped male contacts. | | |
| Illustration |  | | |
| Connector | 5 crimped female contacts for Sub-D connector | – | Two 9-pin Sub-D connectors, one male, one female |
| Label on the cable | FR_CAB1 | | |
| Length | 1 m (39.4 in.) | | |
| Operating temperature | 0 … +70 °C (+32 … +158 °F) | | |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

The following table shows the assignments of the signals to the connectors of the FlexRay Interface Cable.

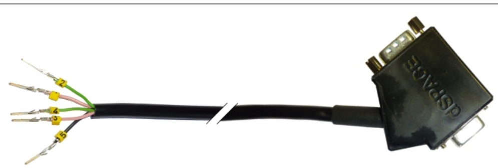
| Label on the Identification Ring | Color | Signal | Female 9-pin Sub-D Connector | Male 9-pin Sub-D Connector |
|---|---|---|---|---|
| 1 | Pink | BP[1)] | 7 | - |
| 2 | Green | BM[1)] | 2 | - |
| 3 | Pink | BP_FT[2)] | - | 7 |
| 4 | Green | BM_FT[2)] | - | 2 |
| 5 | Black | GND | 3 | 3 |

1) The wires of BP and BM signals are twisted.
2) The wires of BP_FT and BM_FT signals are twisted.

# FR_CAB3 FlexRay Interface Cable for MicroAutoBox

**Technical data**

The following table shows the technical specifications of the FR_CAB3 FlexRay interface cable:

| Parameter | Specification [1)] | | |
|---|---|---|---|
| Purpose | The FR_CAB3 FlexRay Interface Cable can be used to connect FlexRay bus lines to the following MicroAutoBox variants if they have DS4340 modules:<br>■ MicroAutoBox II 1401/1511/1512<br>■ MicroAutoBox II 1401/1511/1514<br>■ MicroAutoBox II 1401/1512/1513<br>■ MicroAutoBox II 1401/1513/1514 | | |
| Illustration |  | | |
| Connector | 5 crimped contacts for ZIF connector | – | Two 9-pin Sub-D connectors, one male, one female |
| Label on the cable | FR_CAB3 | | |
| Length | 1 m (39.4 in.) | | |
| Operating temperature | 0 … +70 °C (+32 … +158 °F) | | |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

The following table shows the assignments of the signals to the connectors of the FlexRay Interface Cable.

| Label on the Identification Ring | Color | Signal | Female 9-pin Sub-D Connector | Male 9-pin Sub-D Connector |
|---|---|---|---|---|
| 1 | Pink | BP[1)] | 7 | - |
| 2 | Green | BM[1)] | 2 | - |
| 3 | Pink | BP_FT[2)] | - | 7 |
| 4 | Green | BM_FT[2)] | - | 2 |
| 5 | Black | GND | 3 | 3 |

[1)] The wires of BP and BM signals are twisted.
[2)] The wires of BP_FT and BM_FT signals are twisted.

# Ethernet Connection Cables

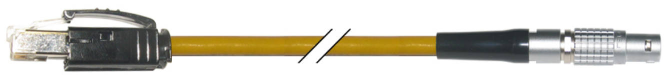
**Where to go from here**

Information in this section

# ETH_CAB1 Ethernet Connection Cable

**Technical data**

The following table shows the technical specifications of the cable:

| Parameter | Specification[1] | | |
|---|---|---|---|
| Purpose | To connect, for example, the host PC, an Ethernet switch, or an LVDS-Ethernet link cable to MicroAutoBox or to the DCI-GSI2. | | |
| Illustration |  | | |
| Connector | RJ45 jack | | LEMO-1B, 8 pins |
| Label on the cable | ETH_CAB1 | | |
| Length | 5 m (197 in.) | | |
| Operating temperature | –40 … +85 °C (–40 … +185 °F) | | |
| Max. transfer rate | 1 GBit/s | | |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Note**

The ETH_CAB1 connection cable can also be used to connect a MicroAutoBox to an ECU via Ethernet (see *How to Connect MicroAutoBox to the ECU via UDP/IP* (*ECU Interfaces Hardware Installation and Configuration*)).

**Related topics**

HowTos

- *How to Connect an ECU with DCI-GSI2 to the Host PC Directly* (*ECU Interfaces Hardware Installation and Configuration*)
- *How to Connect MicroAutoBox to the ECU via DCI-GSI2* (*ECU Interfaces Hardware Installation and Configuration*)
- *How to Connect the DS4121 to the ECU via DCI-GSI2* (*ECU Interfaces Hardware Installation and Configuration*)

# ETH_CAB2 Ethernet Connection Cable

**Technical data**

**Up to revision CB1401C-02-xxx** The revision number is written on the cable's label. The following table shows the technical specifications of the galvanically isolated connection cable:

| Parameter | Specification[1)] | | |
|---|---|---|---|
| Purpose | To connect, for example, the host PC, an Ethernet switch, or an LVDS-Ethernet link cable to MicroAutoBox or to the DCI-GSI2 electrically safe up to 300 V DC/$AC_{RMS}$ and 600 $V_{peak}$. | | |
| Illustration |  | | |
| Connector | RJ45 jack | Galvanic isolation | LEMO-1B, 8 pins |
| Label on the cable | ETH_CAB2 | | |
| Length | 4.5 m (177.2 in.) | | |
| Electrical characteristics | Electrically safe up to 300 V DC/$AC_{RMS}$ and 600 $V_{peak}$[2)] | | |
| Operating temperature | –40 … +85 °C (–40 … +185 °F) | | |
| Max. transfer rate | 100 MBit/s [3)] | | |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.
2) The voltage levels relate to secondary circuits without direct electrical connection to the AC mains.
3) In exceptional cases, auto-negotiation of connected Gigabit devices (e.g., the host PC) does not lead to a stable Ethernet connection. To solve the problem, manually reduce the Ethernet transfer rate of the host PC to 100 MBit/s.

**As of revision CB1401C-03-xxx** The revision number is written on the cable's label. The following table shows the technical specifications of the galvanically isolated connection cable:

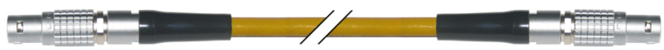
| Parameter | Specification[1)] | | |
|---|---|---|---|
| Purpose | To connect, for example, the host PC, an Ethernet switch, or an LVDS-Ethernet link cable to MicroAutoBox or to the DCI-GSI2 electrically safe up to 300 V DC/$AC_{RMS}$ and 600 $V_{peak}$. | | |
| Illustration |  | | |
| Connector | RJ45 jack | Galvanic isolation | LEMO-1B, 8 pins |
| Label on the cable | ETH_CAB2 | | |
| Length | 4.5 m (177.2 in.) | | |
| Electrical characteristics | Electrically safe up to 300 V DC/$AC_{RMS}$ and 600 $V_{peak}$[2)] | | |
| Operating temperature | –40 … +85 °C (–40 … +185 °F) | | |
| Max. transfer rate | 1 GBit/s | | |

1) Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.
2) The voltage levels relate to secondary circuits without direct electrical connection to the AC mains.

# ETH_CAB3 Ethernet Connection Cable

**Technical data**

The following table shows the technical specifications of the cable:

| Parameter | Specification[1] | | |
|---|---|---|---|
| Purpose | To connect, for example, a DCI-GSI2 to a MicroAutoBox. | | |
| Illustration |  | | |
| Connector | LEMO-1B, 8 pins | | LEMO-1B, 8 pins |
| Label on the cable | ETH_CAB3 | | |
| Length | 5 m (197 in.) | | |
| Operating temperature | –40 … +85 °C (–40 … +185 °F) | | |
| Max. transfer rate | 1 GBit/s | | |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Related topics**

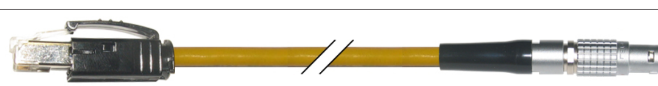
HowTos

- *How to Connect MicroAutoBox to the ECU via DCI-GSI2* (*ECU Interfaces Hardware Installation and Configuration*)

# ETH_CAB4 Ethernet Connection Cable

**Technical data**

The following table shows the technical specifications of the cable:

| Parameter | Specification[1] | | |
|---|---|---|---|
| Purpose | To connect, for example, the host PC, an Ethernet switch, or an LVDS-Ethernet link cable to MicroAutoBox or to the DCI-GSI2. | | |
| Illustration |  | | |
| Connector | RJ45 jack | | LEMO-1B, 8 pins |
| Label on the cable | ETH_CAB4 | | |
| Length | 10 m (394 in.) | | |
| Operating temperature | –40 … +85 °C (–40 … +185 °F) | | |
| Max. transfer rate | 1 GBit/s | | |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Note**

The ETH_CAB4 connection cable can also be used to connect a MicroAutoBox to an ECU via Ethernet (see *How to Connect MicroAutoBox to the ECU via UDP/IP* ( *ECU Interfaces Hardware Installation and Configuration*)).

**Related topics**

HowTos

- *How to Connect an ECU with DCI-GSI2 to the Host PC Directly* ( *ECU Interfaces Hardware Installation and Configuration*)
- *How to Connect MicroAutoBox to the ECU via DCI-GSI2* ( *ECU Interfaces Hardware Installation and Configuration*)
- *How to Connect the DS4121 to the ECU via DCI-GSI2* ( *ECU Interfaces Hardware Installation and Configuration*)

# ETH_CAB5 Ethernet Connection Cable

**Technical data**

The following table shows the technical specifications of the cable:

| Parameter | Specification[1] | | |
|---|---|---|---|
| Purpose | To connect, for example, the host PC, an Ethernet switch, or an LVDS-Ethernet link cable to MicroAutoBox or to the DCI-GSI2. | | |
| Illustration |  | | |
| Connector | RJ45 jack | | LEMO-1B, 8 pins |
| Label on the cable | ETH_CAB5 | | |
| Length | 5 m (197 in.) | | |
| Operating temperature | –40 … +150 °C (–40 … +302 °F) | | |
| Max. transfer rate | 1 GBit/s | | |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Note**

The ETH_CAB5 connection cable can also be used to connect a MicroAutoBox to an ECU via Ethernet (see *How to Connect MicroAutoBox to the ECU via UDP/IP* ( *ECU Interfaces Hardware Installation and Configuration*)).

**Related topics**

HowTos

- *How to Connect an ECU with DCI-GSI2 to the Host PC Directly* ( *ECU Interfaces Hardware Installation and Configuration*)
- *How to Connect MicroAutoBox to the ECU via DCI-GSI2* ( *ECU Interfaces Hardware Installation and Configuration*)
- *How to Connect the DS4121 to the ECU via DCI-GSI2* ( *ECU Interfaces Hardware Installation and Configuration*)

# ETH_CAB6 Ethernet Connection Cable

**Technical data**

The following table shows the technical specifications of the cable:

| Parameter | Specification[1] | | |
|---|---|---|---|
| Purpose | To connect, for example, a DCI-GSI2 to a MicroAutoBox. | | |
| Illustration |  | | |
| Connector | LEMO-1B, 8 pins | | LEMO-1B, 8 pins |
| Label on the cable | ETH_CAB6 | | |
| Length | 5 m (197 in.) | | |
| Operating temperature | –40 … +150 °C (–40 … +302 °F) | | |
| Max. transfer rate | 1 GBit/s | | |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Related topics**

HowTos

- *How to Connect MicroAutoBox to the ECU via DCI-GSI2* ( *ECU Interfaces Hardware Installation and Configuration*)

# ETH_CAB7 Ethernet Connection Cable

**Technical data**

The following table shows the technical specifications of the cable:

| Parameter | Specification[1] | | |
|---|---|---|---|
| Purpose | To connect, for example, a DCI-GSI2 to a MicroAutoBox. | | |
| Illustration |  | | |
| Connector | LEMO-1B, 8 pins | | LEMO-1B, 8 pins |
| Label on the cable | ETH_CAB7 | | |
| Length | 10 m (394 in.) | | |
| Operating temperature | –40 … +150 °C (–40 … +302 °F) | | |
| Max. transfer rate | 1 GBit/s | | |

[1] Unless otherwise stated, the specifications are valid only if the dSPACE hardware is correctly powered, switched on, and ready for operation.

**Related topics**

HowTos

- *How to Connect MicroAutoBox to the ECU via DCI-GSI2* ( *ECU Interfaces Hardware Installation and Configuration*)

## A



## B



## C



## D