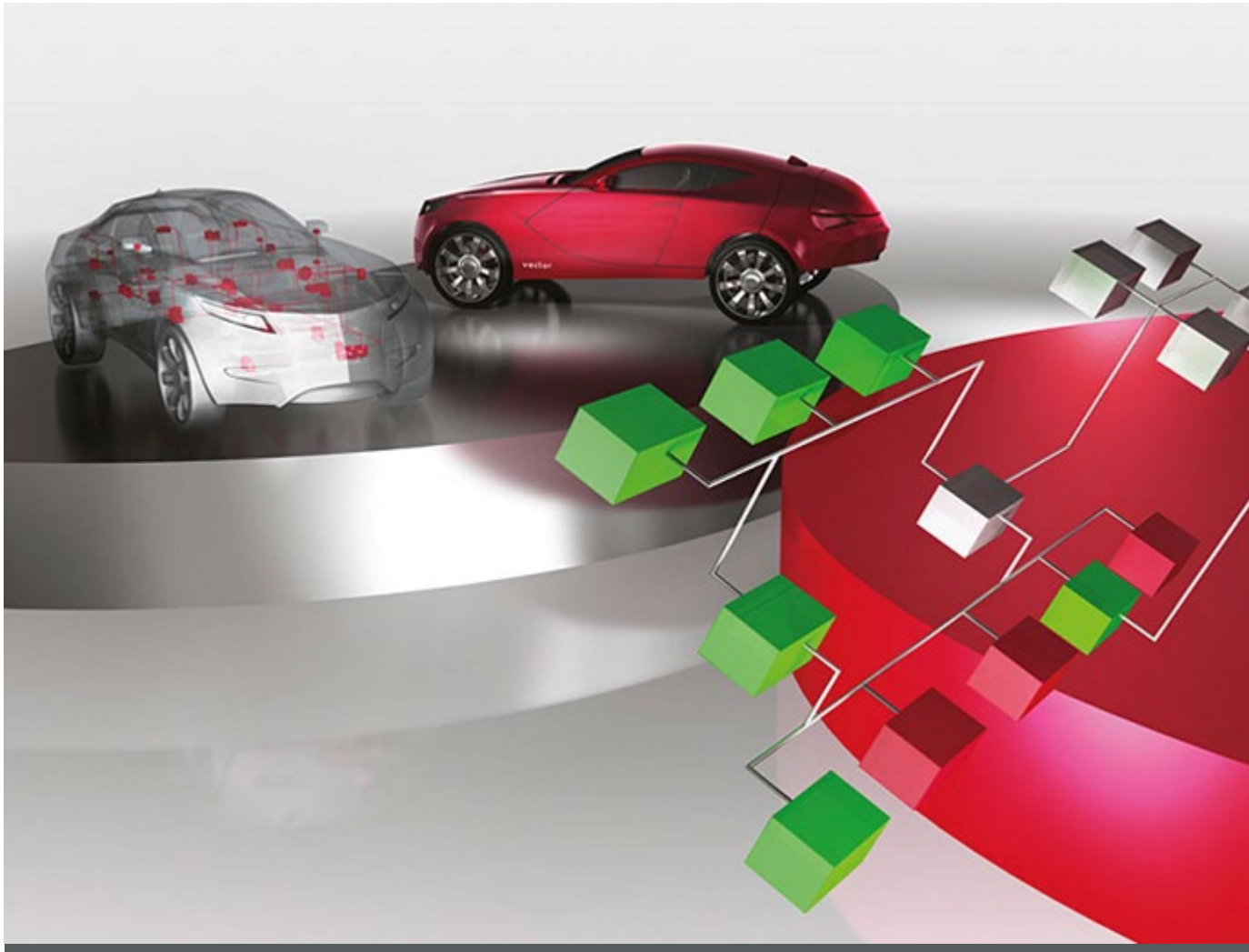
VECTOR



User Manual
VT System Application Boards
Design and Configuration of Application Boards

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English

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Table of Contents

1 Introduction

This chapter contains the following information:

1.1 Application Boards at a Glance

Application-specific hardware

The VT7900 extension module supports adding application-specific hardware to the VT system. The VT7900 is the base PCB, on which an application board can be mounted. To enable a simple and configuration-free interaction between CANoe and the custom-designed application board, a configuration is generated once at the time the module is created and stored in the application board. CANoe automatically reads the configuration and creates the appropriate system variables.

Note: Vector application boards use this model number convention: VT78xx.

Use of application boards

Three important steps are necessary to use an application-specific application board:

Step 1

Design of an application board

The first step is to design the application board. Because it will be mounted on a VT7900 module, please note the available interfaces when designing the board. This includes both the dimensions of the application board as well as the location of the drill holes and plugs. Furthermore, the application board must include an EEPROM, because this is where the board's configuration will be stored. Depending on the application, various ICs can also be fitted on the application board, which allow it to communicate with the environment.

The precise procedure for designing application boards is described in Chapter 2. The points introduced here are discussed in greater detail there.

Step 2

Creating the configuration

The second step is to create a configuration for the application board. This configuration also defines the ICs located on the board, which will allow CANoe to communicate with the ICs. This communication can be configured, for example, through the definition of scalings. Once complete, the configuration is stored directly in the application board's EEPROM.

Chapter 3 explains how to create this configuration using the Application Board Configurator.

Step 3

Integration in CANoe

Only a few steps are required to use an application board in CANoe.

First, the application board must be mounted on a VT7900 module that is then inserted into a VT rack. The VT rack must be connected to the computer and switched on. Now you can start CANoe and open the VT configuration dialog. At this point the application board should be detected automatically and the appropriate system variables created based on the configuration stored in the board. Communication with the application board is enabled by these system variables.

1.2 About this User Manual

To find information quickly

This user manual provides you with the following navigational aids:

- At the beginning of each chapter you will find a summary of the contents
- The header shows which chapter and paragraph you are located in
- The footer shows which version the user manual refers to
- The index, located at the end of the manual on page, helps you to find information quickly

Conventions

The following two charts show the spelling and symbol conventions used in this manual.

Style	Utilization
bold	Fields, interface elements, window and dialog names in the software. Accentuation of warnings and notes. **[OK]** Buttons are denoted by square brackets **File** | **Save** Notation for menus and menu commands
CANoe	Legally protected proper names and side notes.
`Source code`	File name and source code.
Hyperlink	Hyperlinks and references.
<Ctrl>+<S>	Notation for shortcuts.

Symbol	Utilization
	You can obtain supplemental information here.
	This symbol calls your attention to warnings.
	You can find additional information here.
	Here is an example that has been prepared for you.
	Step-by-step instructions provide assistance at these points.
	Instructions on editing files are found at these points.
	This symbol warns you not to edit the specified file.

1.2.1 Certification

Certified Quality Management System
Vector Informatik GmbH has ISO 9001:2008 certification. The ISO standard is a globally recognized quality standard.

CE Compliance
All VT System products comply with CE regulations.

1.2.2 Warranty

Limitation of warranty
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1.2.3 Support

Need support?
You can get through to our hotline by calling

+49 (711) 80670-200

or you can send a problem report to CANoe Support.

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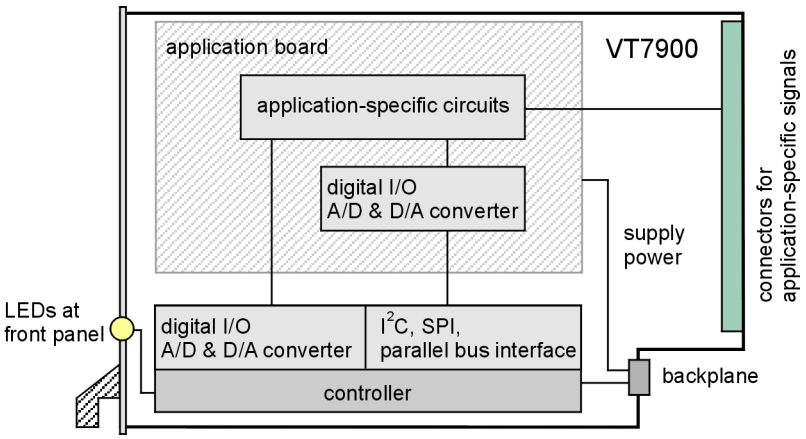
2 Design of Application Boards

This chapter contains the following information:

2.1 Overview

Electronics

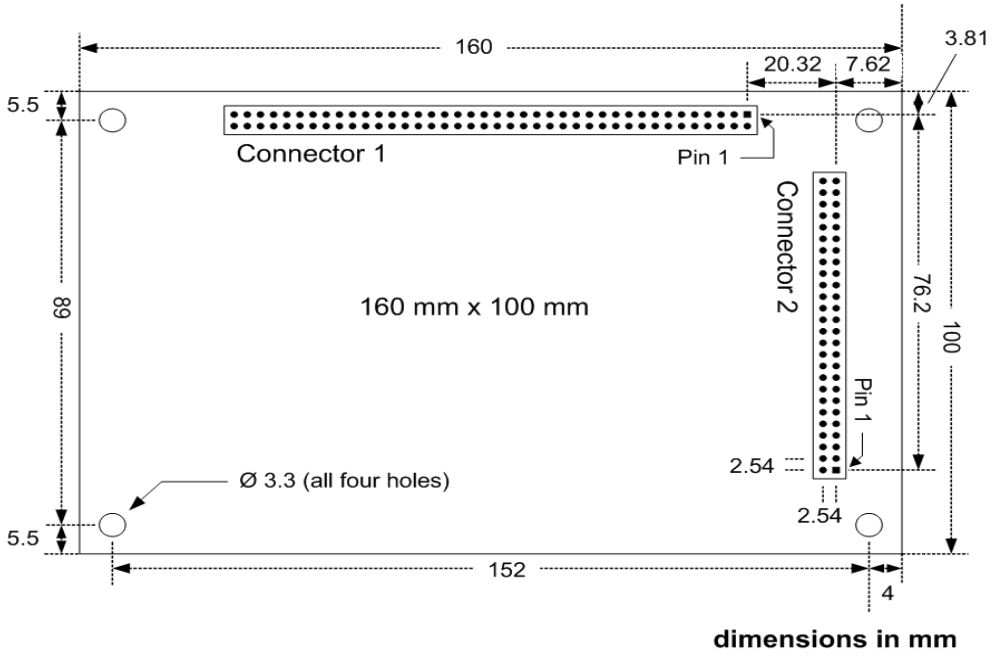
As described in chapter 1.1 the application board provides application-specific electronics. The VT7900 functions as the base board, it provides the supply power and some digital and analog I/O lines. Additionally there are 16 LEDs for status display located on the front panel of the VT7900. The structure of a VT7900 module with application board is displayed in the following figure.



2.2 Dimensions

Dimensions

The following image shows the dimensions as well as the location of the drill holes and the plugs.



dimensions in mm

A standard lead spacing of 2.54 mm (0.100”) is used. Most commercially available breadboards can be used to build a simple application board.

2.3 Supply Power for the Application Board

Two supply voltages

The application board provides two different supply voltages:

> 12 V directly from the backplane; from this voltage, further voltage supplies (e.g. 5 V) can be created on the application board as required.

> 3.3 V provided by the VT7900 for the supply of digital logic components.

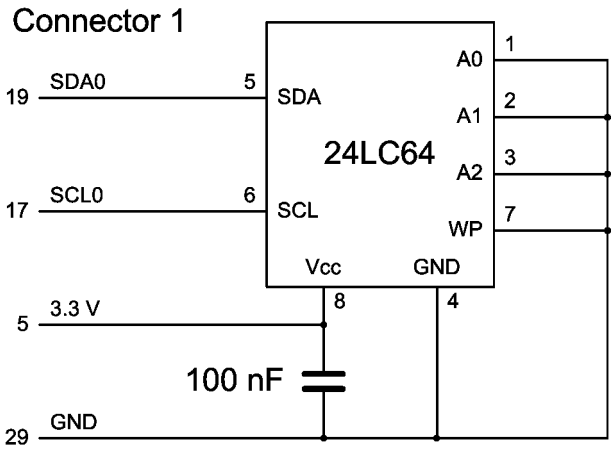
Caution: You must not overload these voltage supplies, as they are only secured by non-replaceable safety fuses on the VT7900. Moreover, disturbances in these voltages must be avoided as they will affect the rest of the VT System.

2.4 Configuration EEPROM on the Application Board

Circuit

The application board configuration is saved directly on the board. For this purpose, an I²C EEPROM has to be provided on every application board. A 64 Kbit EEPROM of type 24LC64 or a compatible EEPROM has to be used.

The following image shows one possible wiring of the EEPROM.



2.5 Electrical Interface Characteristics

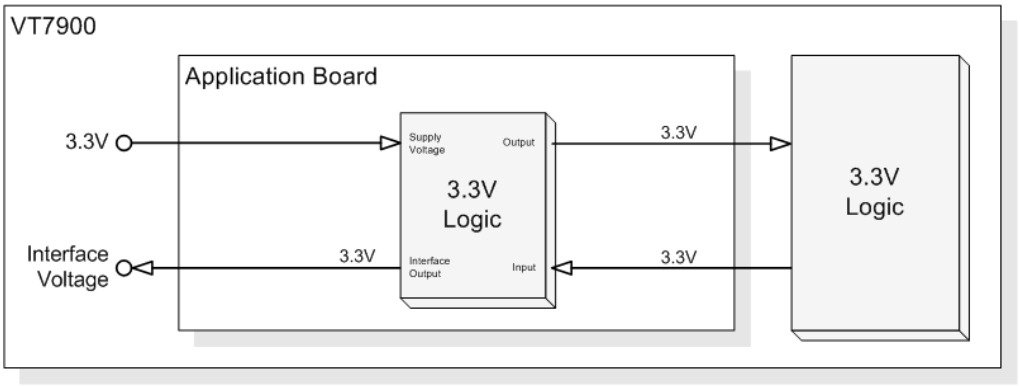
3.3 V / 5 V

For the interface between the VT7900 and the application board (SPI, parallel bus, digital input/output …) 3.3 V TTL levels are used. All input lines are 5 V tolerant. The I²C lines are switched between 3.3 V levels and 5 V levels explicitly by the VT7900. Thus it is possible to use 5 V logic circuits on the application board.

The interface voltage input of the VT7900 (pin 7 on connector 1 of the application board) has to be set to 3.3 V or to 5 V according to the used logic voltage on the application board. Please note that a supply power of 5 V has to be generated on the application board if required. The VT7900 only provides a supply voltage of 3.3 V.

2.5.1 Using 3.3V logic on the Application Board

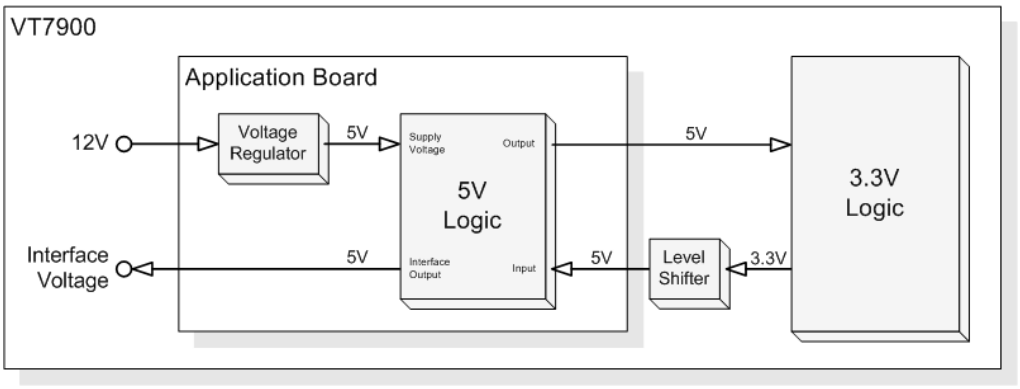
The following figure shows an example of how 3.3V logic can be used on the application board:



This allows the required supply voltage to be drawn directly from the VT7900. The voltage requires no adjustment for communication between the application board logic and the VT7900 logic as well. In this case, a supply voltage of 3.3 V must be applied to the interface voltage pin of the VT7900.

2.5.2 Using 5V logic on the Application Board

The following figure shows an example of how 5 V logic can be used on the application board:



To apply 5 V logic to the application board, the supply voltage must be adjusted from 12 V to 5 V. This voltage must then be applied to the interface voltage pin of the VT7900. No additional hardware is then required for communication with the 3.3 V logic of the VT7900. The VT7900 already has level shifters, which convert the 3.3 V outputs on the VT7900 to 5V for the inputs on the application board. These are activated when the 5V supply voltage is applied to the interface voltage pin. The application board's outputs can also be connected directly to the VT7900 because its inputs are 5V tolerant.

2.6 Using the I/O Lines of the VT7900 on the Application Board

Reference to AGND / GND

The VT7900 provides several I/O lines for direct control of the application electronics on the application board. The analog input and output signals relate to reference ground AGND. All other signals, including the digital input and output signals and the power supply, relate to ground GND.

2.6.1 Digital Input

The VT7900 provides the application board with four digital inputs (DIN0-3). GND is the reference potential here. CANoe can send digital signals to the application board via these inputs.

2.6.2 Digital Output

The application board is also provided with four digital outputs (DOUT0-3). These outputs are 5V tolerant, meaning they can be addressed by both 3.3V and 5V logic on the application board. These pins can then be evaluated in CANoe using the corresponding system variables. GND is also the reference potential here.

2.6.3 Analog Input

The VT7900 is also able to address four analog inputs on the application board (AIN0-3), which CANoe can use to transmit analog signals to the application board. AGND is the reference potential here.

All four input pins also have a sample and hold element, which the application board can use via the ASH0-3 pins.

2.6.4 Analog Output

The VT7900 also provides the application board with four analog outputs (AOUT0-3). All analog signals sent from CANoe to the application board can be transmitted via these outputs. AGND is also the reference potential here.

2.7 Using the I/O Interfaces of the VT7900 on the Application Board

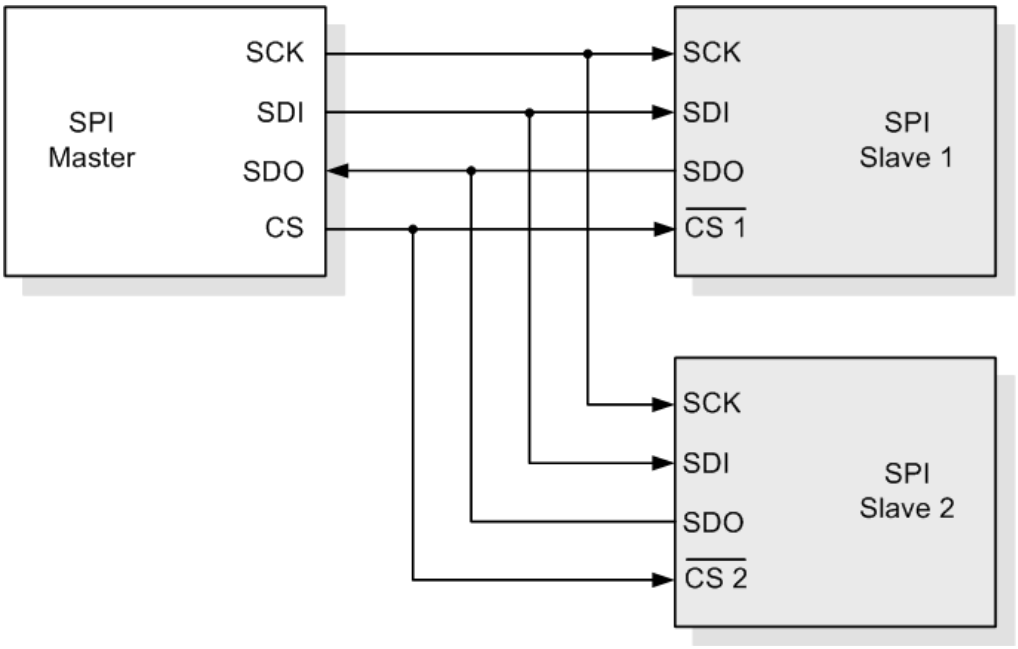
The VT7900 module can address I/O ICs (e.g. A/D converters), which can be connected using SPI, I2C or a 16-bit parallel bus.

2.7.1 SPI

The serial peripheral interface (SPI) is a synchronous serial data bus. SPIs can connect digital circuits based on the master/slave model. Four lines are needed to connect all subscribers.

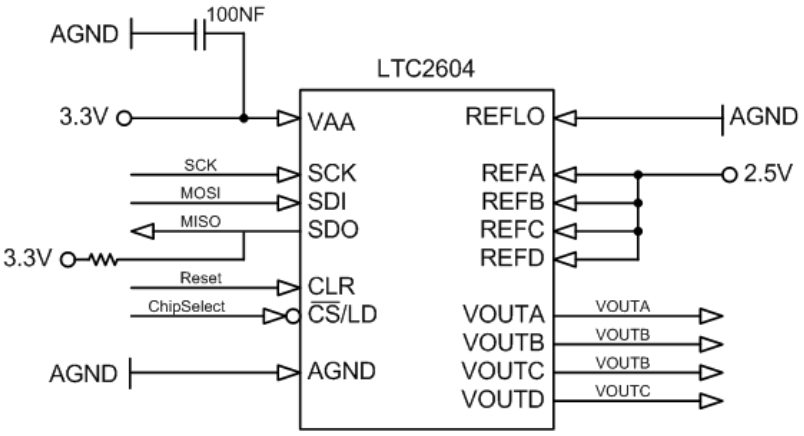
- SDO (Serial Data Out) and MISO (Master In - Slave Out)
- SDI (Serial Data In) and MOSI (Master Out – Slave In)
- SCK (Serial Clock) is output by the master
- CS (Chip Select) defines which slave the master wants to communicate with

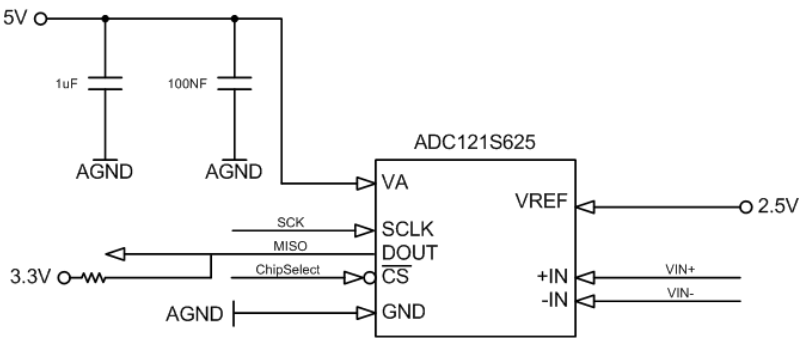
The following figure shows an example of a circuit with one master and two slave devices:

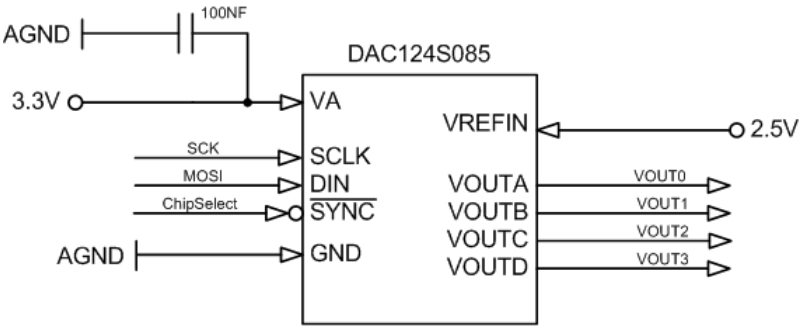


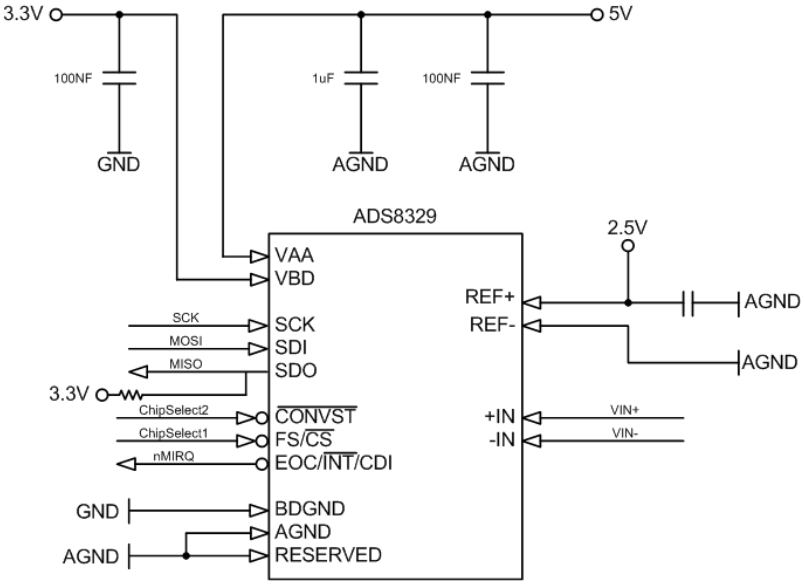
The VT7900 has a 4-bit chip select line. Four chips can be directly connected. Up to 15 slaves can be connected if an additional inverse multiplexer is used. The chip select signal is low active in this case.

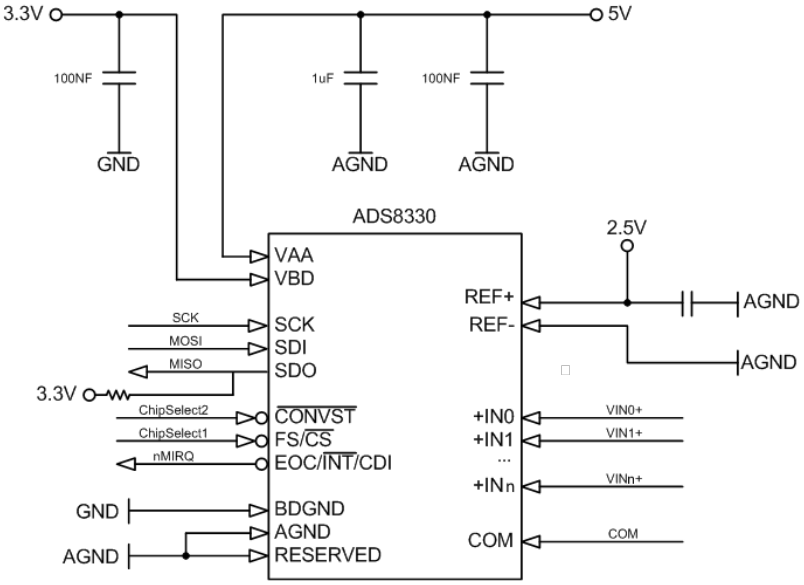
ICs supported on this bus:

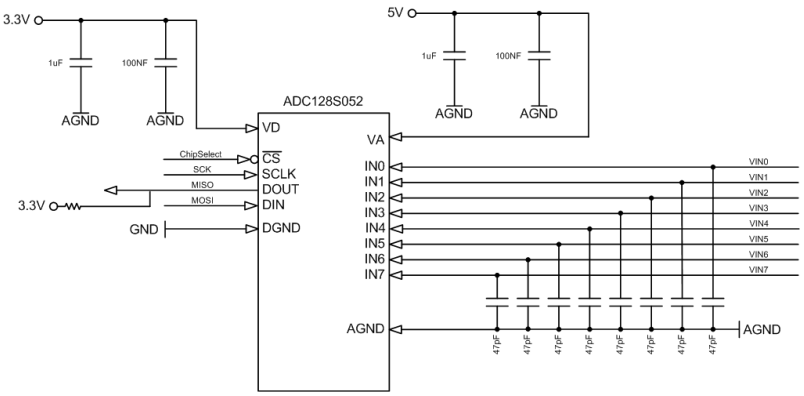
Name	Linear Technology LTC2604
Description	Digital/Analog converter
Interface	50 MHz, 4 channel, 16-bit resolution, SPI, 2.5 V – 5.5 V power supply range.
Example circuit	

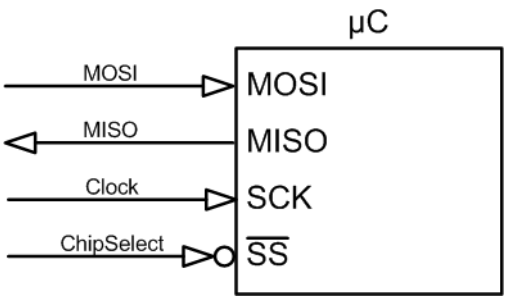
Name	National Semiconductor ADC121S625
Description	Analog/Digital converter
Interface	200 kSPS, 1 channel, 12-bit resolution, SPI, 5 V power supply
Example circuit	

Name	National Semiconductor DAC124S085
Description	Digital/Analog converter
Interface	30 MHz, 4 channel, 12-bit resolution, SPI, 2.7V – 5.5 V power supply range
Example circuit	

Name	Texas Instruments ADS8329
Description	Analog/Digital converter
Interface	1 MSPS, 1 channel, 16-bit resolution, SPI, 5 V power supply
Example circuit	

Name	Texas Instruments ADS8330, ADS8331 and ADS8332
Description	Analog/Digital converter
Interface	1 MSPS, 2/4/8 channel, 16-bit resolution, SPI, 5 V power supply
Example circuit	

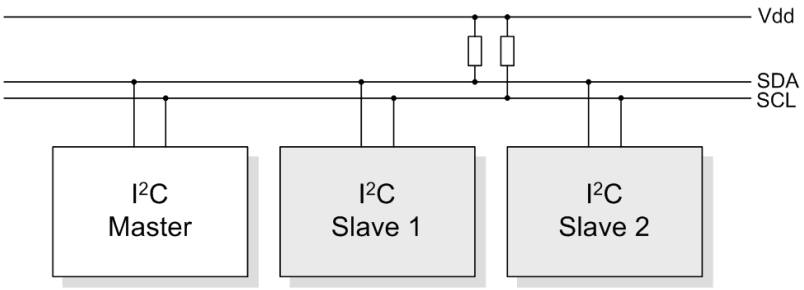
Name	National Semiconductor ADC128S052
Description	Analog/Digital converter
Interface	500 kSPS, 8 inputs (multiplexed), 12-bit resolution, SPI, 2.7V – 5.25V power supply range
Example circuit	

Name	Universal µC SPI Interface
Description	Universal SPI interface to a µC on the piggy board
Interface	SPI
Example circuit	

Note: If the pin MISO from a chip is used on the SPI bus, a pull-up resistor should be connected for this signal so that a defined level is applied to this signal when no chip is active. Otherwise, this may trigger a disturbance.

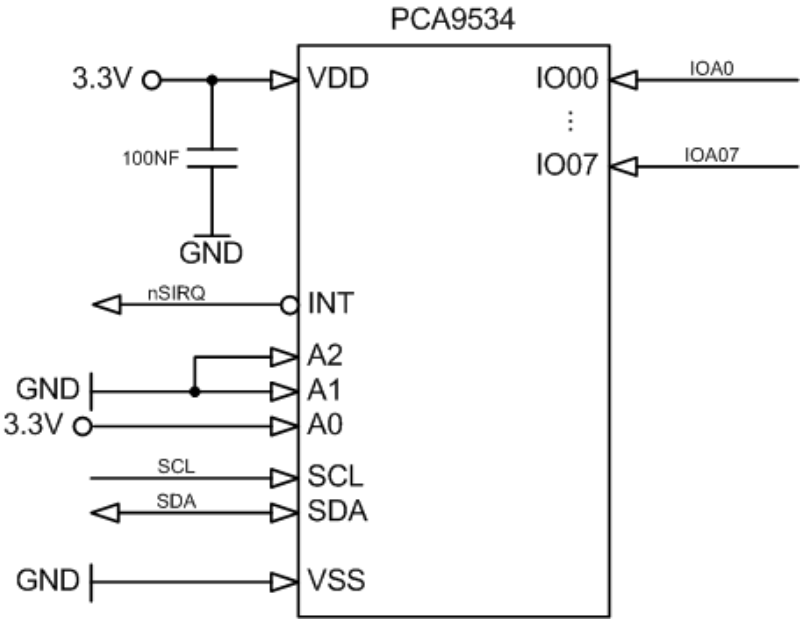
2.7.2 I²c

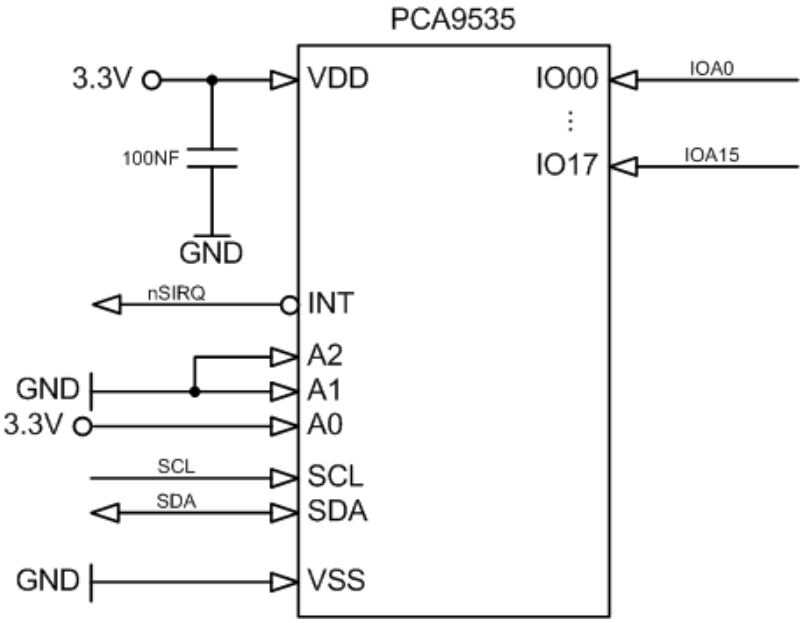
I2C is a serial data bus that requires two signal lines: the clock (SCL) and the data line (SDA). Both are in the supply voltage with a pull-up resistor. All slaves connected to it have open collector outputs. The following image shows an example connection:

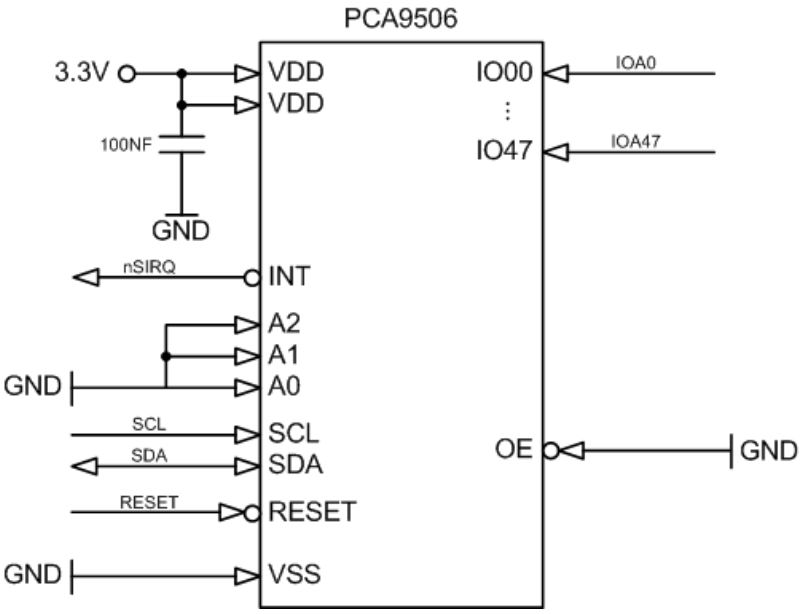


The VT7900 provides two I2C buses, one of which is reserved for operating the EEPROM. The following ICs can be operated on the second bus.

ICs supported on this bus:

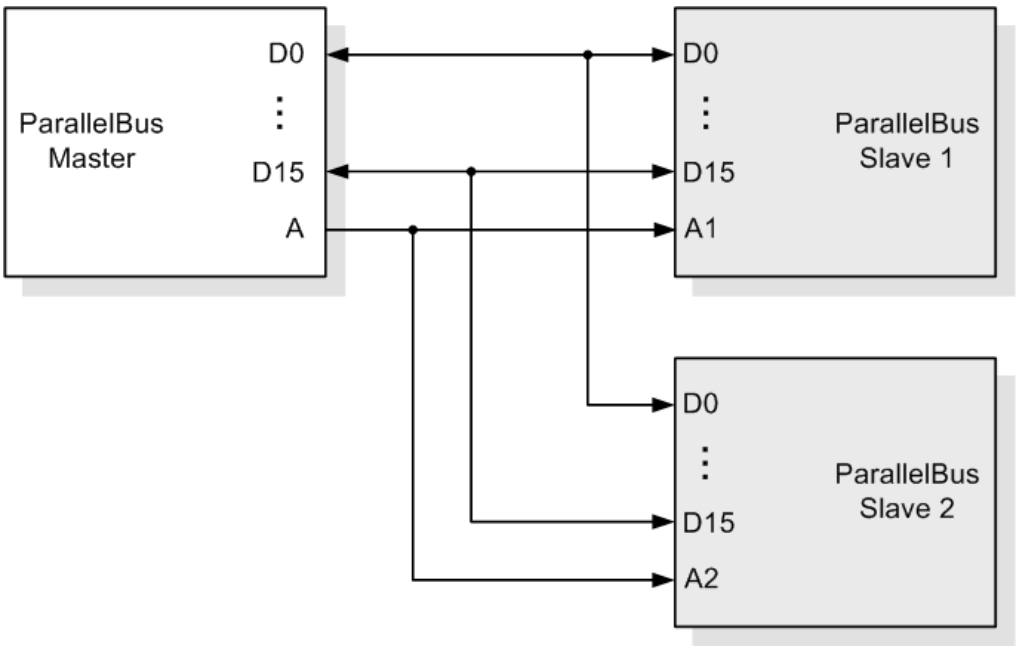
Name	NXP PCA9534
Description	I2C and SMB bus I/O port
Interface	8-bit, I2C bus, 2.3V – 5.5V power supply range
Example circuit	

Name	NXP PCA9535
Description	I2C and SMB bus I/O port
Interface	16-bit, I2C bus, 2.3V – 5.5V power supply range
Example circuit	

Name	NXP PCA9506
Description	I2C and SMB bus I/O port
Interface	40-bit, I2C bus, 2.3V – 5.5V power supply range
Example circuit	

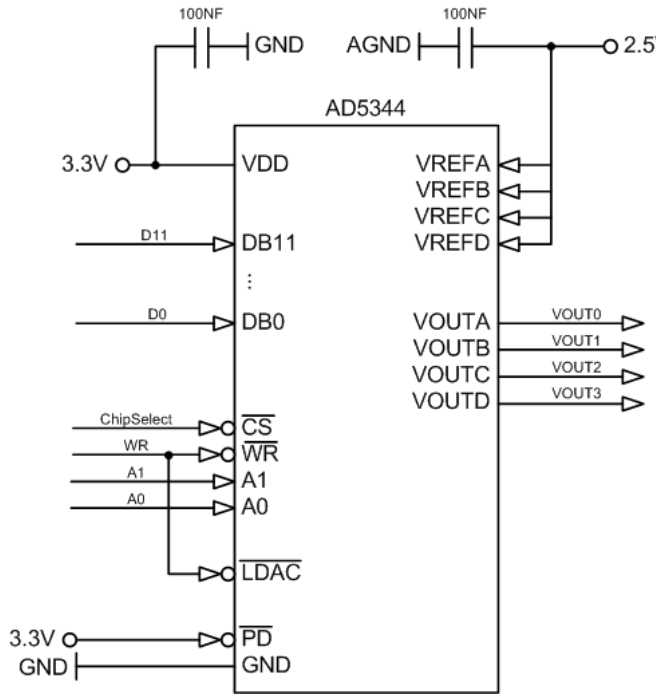
2.7.3 Parallel Bus

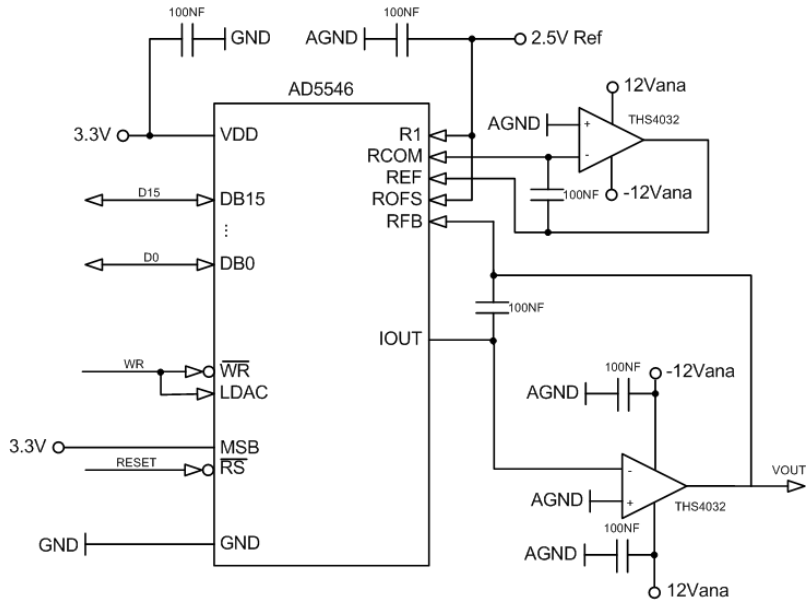
In addition to the serial buses, the VT7900 has a 16-bit parallel bus with a 5-bit address line. Up to 32 circuits can be address via this bus. An example of this is shown for one master and two slave circuits in the following figure.

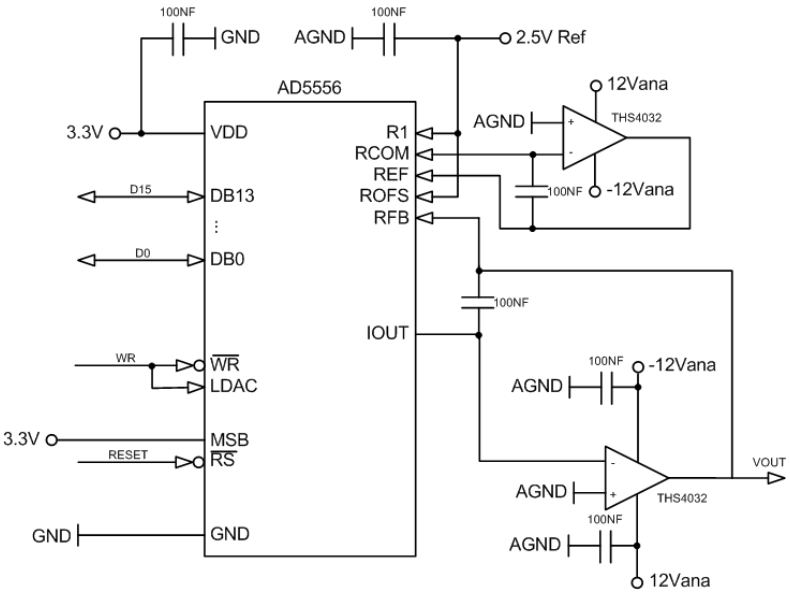


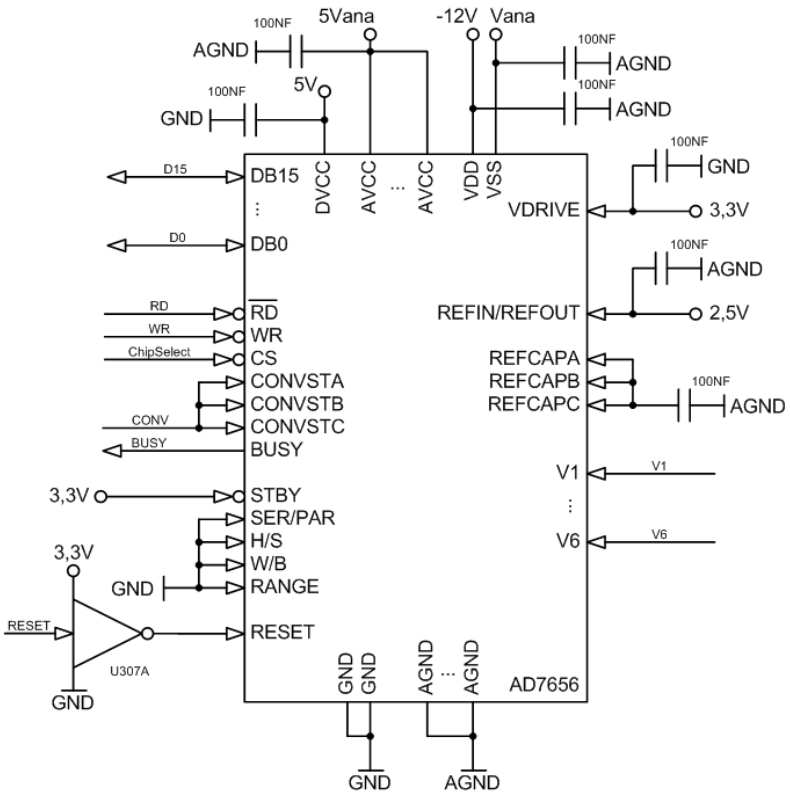
The parallel bus also provides lines such as reset, write enable, read enable, etc., which can be used to operate the circuits.

ICs supported on this bus:

Name	Analog Devices AD5344
Description	Digital/Analog converter
Interface	4 channel, 12-bit resolution, parallel bus, 2.5V – 5.5V power supply range
Example circuit	

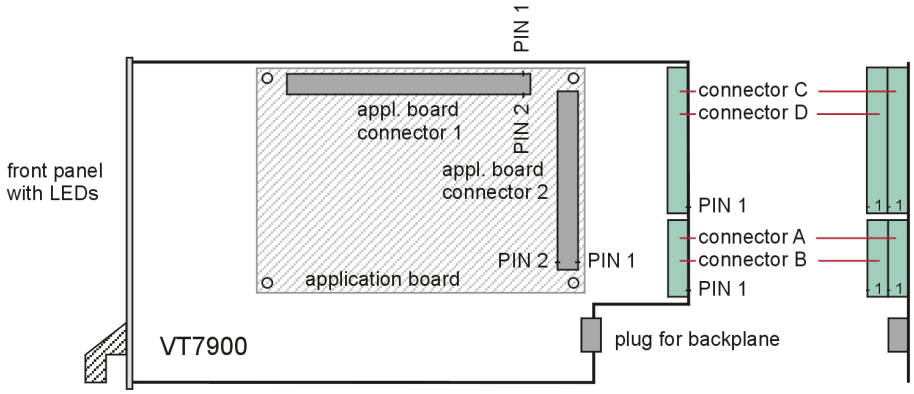
Name	Analog Devices AD5546
Description	Digital/Analog converter
Interface	1 channel, 16-bit resolution, parallel bus, 2.7V – 5.5V power supply range
Example circuit	

Name	Analog Devices AD5556
Description	Digital/Analog converter (current output)
Interface	1 channel, 14-bit resolution, parallel bus, 2.7V – 5.5V power supply range
Example circuit	

Name	Analog Devices AD7656
Description	Analog/Digital converter
Interface	250 kSPS, 6 channel, 16-bit resolution, parallel bus, 5V power supply
Example circuit	

2.8 Connectors

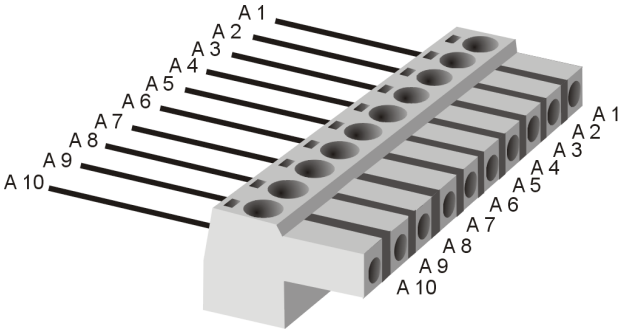
The following image shows designations for the connections (including pin numbers) on the VT7900 module and the application board.



The following sections will explain the specific pin assignments in each connection.

2.8.1 VT7900 Connectors

Connectors A, B, C and D on the back of the VT7900 base PCB can be used to connect additional hardware (e.g. test system) to the application board. All pins for these connectors are then available to the application board at connector 2 (see above image). A Phoenix Contact MC 1.5/16-ST-3.81 and/or MC 1.5/10-ST-3.81 plug connector is used for connectors A, B, C and D. The connector A pins are assigned as follows:



Pin	Description
10	Signal A10 from application board
9	Signal A9 from application board
8	Signal A8 from application board
7	Signal A7 from application board
6	Signal A6 from application board
5	Signal A5 from application board
4	Signal A4 from application board
3	Signal A3 from application board
2	Signal A2 from application board

Pin	Description
1	Signal A1 from application board

The pin assignments for connectors B, C and D are the same as for connector A. Connectors A and B have 10 pins; connectors C and D have 16 pins.

Connector on VT7900	Number of pins	Connector on application board
A	10	Connector 2, Pins 1, 3, 5, …, 19
B	10	Connector 2, Pins 2, 4, 6, …, 20
C	16	Connector 2, Pins 21, 23, 25, …, 51
D	16	Connector 2, Pins 22, 24, 26, …, 52

2.8.2 Application Board Connectors

On the application board, pin header, pitch 2.54 mm (0.100”), 2x40 plug connectors are to be used for connector 1 and 2x26 for connector 2.

Connector 1 is assigned as follows:

Pin	Description
1	12 V supply power
2	12 V supply power
3	3.3 V supply power
4	DPDATA – display port data – reserved, not used
5	3.3 V supply power
6	DPCLK – display port clock – reserved, not used
7	Interface voltage (3.3 V or 5.0 V)
8	DPSTRB – display port strobe – reserved, not used
9	DIN0 – digital input
10	DOUT0 – digital output
11	DIN1 – digital input
12	DOUT1 – digital output
13	DIN2 – digital input
14	DOUT2 – digital output
15	DIN3 – digital input
16	DOUT3 – digital output
17	SCL0 – I²C for configuration EEPROM (clock)
18	SCL1 – I²C for extra peripherals (clock)
19	SDA0 – I²C data for configuration EEPROM (data)
20	SDA1 – I²C for extra peripherals (data)

Pin	Description
21	MISO – SPI for extra peripherals (data input)
22	MOSI – SPI for extra peripherals (data output)
23	SPCK – SPI for extra peripherals (clock)
24	/MIRQ – SPI for extra peripherals (interrupt)
25	/MCS0 – SPI for extra peripherals (chip select 0)
26	/MCS1 – SPI for extra peripherals (chip select 1)
27	/MCS2 – SPI for extra peripherals (chip select 2)
28	/MCS3 – SPI for extra peripherals (chip select 3)
29	GND – ground
30	GND – ground
31	D0 – parallel bus for extra peripherals (data)
32	D1 – parallel bus for extra peripherals (data)
33	D2 – parallel bus for extra peripherals (data)
34	D3 – parallel bus for extra peripherals (data)
35	D4 – parallel bus for extra peripherals (data)
36	D5 – parallel bus for extra peripherals (data)
37	D6 – parallel bus for extra peripherals (data)
38	D7 – parallel bus for extra peripherals (data)
39	D8 – parallel bus for extra peripherals (data)
40	D9 – parallel bus for extra peripherals (data)
41	D10 – parallel bus for extra peripherals (data)
42	D11 – parallel bus for extra peripherals (data)
43	D12 – parallel bus for extra peripherals (data)
44	D13 – parallel bus for extra peripherals (data)
45	D14 – parallel bus for extra peripherals (data)
46	D15 – parallel bus for extra peripherals (data)
47	A1 – parallel bus for extra peripherals (address)
48	A2 – parallel bus for extra peripherals (address)
49	A3 – parallel bus for extra peripherals (address)
50	A4 – parallel bus for extra peripherals (address)
51	A5 – parallel bus for extra peripherals (address)
52	/RESET – parallel bus for extra peripherals
53	/WR – parallel bus for extra peripherals (write enable)
54	/RD – parallel bus for extra peripherals (read enable)
55	/BHE – parallel bus for extra peripherals – reserved, not used
56	/PCLK – parallel bus for extra peripherals (clock)
57	/CONV – parallel bus for extra peripherals (start of conversation)
58	/IRQ0 – parallel bus for extra peripherals (interrupt)
59	/WAIT – parallel bus for extra peripherals (wait)
60	/IRQ1 – parallel bus for extra peripherals (interrupt)
61	/BUSY – parallel bus for extra peripherals (busy)

Pin	Description
62	/SIRQ – additional interrupt input
63	GND – ground
64	GND – ground
65	AGND – analog ground (connected to backplane)
66	AGND – analog ground (connected to backplane)
67	AOUT0 – analog output
68	AOUT1 – analog output
69	AOUT2 – analog output
70	AOUT3 – analog output
71	AIN0 – analog input
72	AIN1 – analog input
73	AIN2 – analog input
74	AIN3 – analog input
75	ASH0 – sample&hold signal for analog input
76	ASH1 – sample&hold signal for analog input
77	ASH2 – sample&hold signal for analog input
78	ASH3 – sample&hold signal for analog input
79	AGND – analog ground (connected to backplane)
80	AGND – analog ground (connected to backplane)

Connector 2 is assigned as follows:

Pin	Description
1	Signal A1
2	Signal B1
3	Signal A2
4	Signal B2
5	Signal A3
6	Signal B3
7	Signal A4
8	Signal B4
9	Signal A5
10	Signal B5
11	Signal A6
12	Signal B6
13	Signal A7
14	Signal B7
15	Signal A8
16	Signal B8
17	Signal A9
18	Signal B9

Pin	Description
19	Signal A10
20	Signal B10
21	Signal C1
22	Signal D1
23	Signal C2
24	Signal D2
25	Signal C3
26	Signal D3
27	Signal C4
28	Signal D4
29	Signal C5
30	Signal D5
31	Signal C6
32	Signal D6
33	Signal C7
34	Signal D7
35	Signal C8
36	Signal D8
37	Signal C9
38	Signal D9
39	Signal C10
40	Signal D10
41	Signal C11
42	Signal D11
43	Signal C12
44	Signal D12
45	Signal C13
46	Signal D13
47	Signal C14
48	Signal D14
49	Signal C15
50	Signal D15
51	Signal C16
52	Signal D16

2.9 Technical Data

2.9.1 Application Board

Parameter	Min.	Typ.	Max.	Unit
Dimensions (length × width)	160 × 100			mm
Overall height of board incl. circuits			26	mm
Supply Power 12 V > voltage > current	10.8	12	13.2 1.8	V A
Supply Power 3.3 V > voltage > current	3.15	3.3	3.45 1.0	V A
Overall power consumption			25	W

2.9.2 Connectors for Application-Specific Signals

Parameter	Min.	Typ.	Max.	Unit
Voltage	-60		+60	V
Current			2	A

2.9.3 Analog Inputs AIN0 … AIN3

Parameter	Min.	Typ.	Max.	Unit
Input voltage	0		3.3	V
Measurement range	0		3.3	V
Resolution	8			bit
Tolerance			0.5	%
Sampling rate		10		kSamples/s

2.9.4 Analog Outputs AOUT0 … AOUT3

Parameter	Min.	Typ.	Max.	Unit
Output voltage	0		3.3	V
Tolerance			0.004	V
Output resistance			100	kΩ

3 Application Board Configurator

This chapter contains the following information:

3.1 Overview

The Application Board Configurator is intended to simplify the process of creating and adapting application board configurations. The configurator contains information about the hardware used on the application board.

If the application board is used in CANoe, for example, the system loads the configuration automatically and creates the appropriate system variables. As a result, the application board can be used on a number of different PCs without the need for reconfiguration.

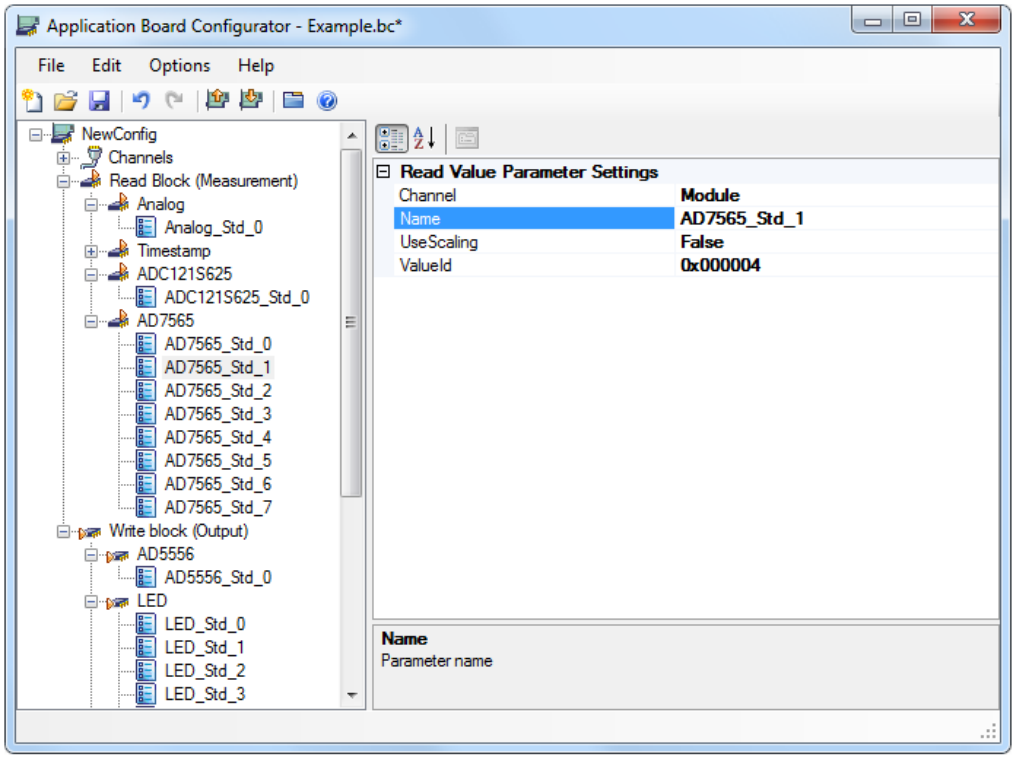
Main window

The main window essentially has two areas:

The configuration tree is located on the left side. Here you will find a hierarchical display of all the elements contained in the current configuration.

The properties window is located on the right side. Here you will find all the important properties of the element currently selected in the configuration tree.

The following image shows both areas with the help of a simple sample configuration.



There are three ways to display/hide the sub-elements of an entry in the configuration tree:

- Click on the + or – symbol left of the entry
- Double-click on the element
- Press the spacebar

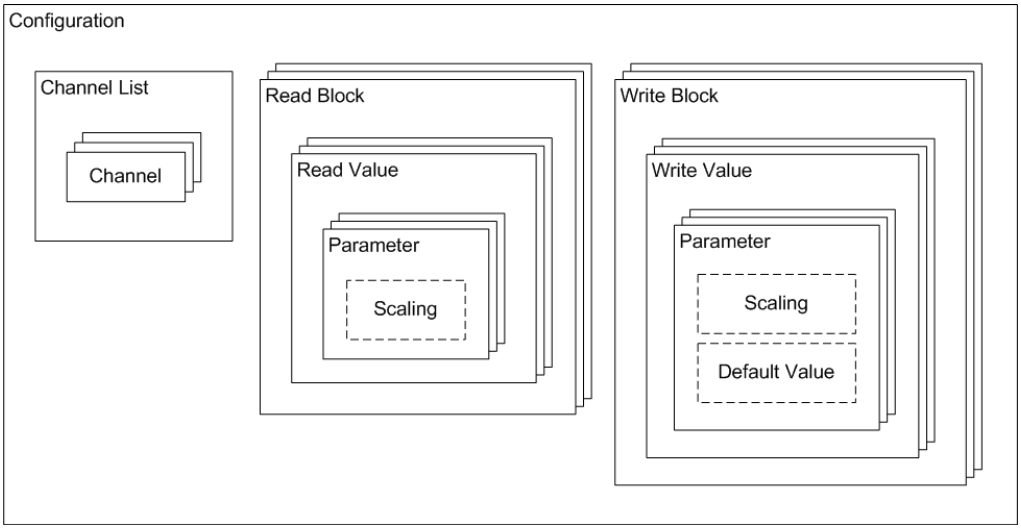
Elements

The following table lists all possible configuration elements. The table also includes the corresponding symbols that identify the elements in the configurator.

Element name	Symbol
Root of the configuration tree	
Channel	
Read block	
Read value in a read block	
Write block	
Write value in a write block	
Parameters of a read or write value	
Scaling of a parameter	

3.2 Configuration Structure

This section explains the basic structure of a configuration. First, the hierarchical structure of a configuration is illustrated and then the individual elements are explained in a greater detail.



3.2.1 Elements of a Configuration Hierarchy

3.2.1.1 Root of the Configuration Tree

The root of the configuration tree contains all the elements of the configuration. The following properties can also be defined here:

Configuration properties:

Is clock active	Activates/deactivates the 64 MHz clock for the application board on pin 56 (PCLK). Only active when absolutely necessary.
Name	Configuration name; part of the default name in CANoe.
Piggy board display control active	When activated, the front panel LEDs can be operated through the application board. To do this, pins 4, 6 and 8 (DPDATA, DPCLK, DPSTRB) must be operated.
Read value update time in ms	Global cycle time in which all read values in the read blocks are updated. You can slow the cycle time of individual read blocks using the CycleTimePrescaler.

3.2.1.2 Channels

Channels in a configuration are managed in the channel list. The channel list defines which channels CANoe can use to access the different parameters. The first channel in all configurations is the module channel. This channel can be assigned to a parameter, if the parameter shall not be addressed by CANoe with a dedicated channel. The module channel may not be renamed or deleted in contrast to other channels.

Channel properties:

Name	The name of the channel; a unique name is required.

3.2.1.3 Blocks

A configuration can contain a total of 4 read and write blocks. Each of these blocks can contain any number of read and write values.

Read block properties:

Cycle time prescaler	You can use this to slow the cycle time in which the values for this block are read. The value cycle time of a read block is calculated as follows: Cycle time = CycleTimePrescaler * ReadValueUpdateTimeMs

3.2.1.4 Values

Each read and write block can have any number of read and write values assigned to it. The values should be selected based on the hardware available on the application board.

Read values

The following read values are available:

Name	AD7656
Type	Analog
Description	Analog/Digital converter 250 kSPS, 6 channel, 16-bt resolution SPI connection

Name	Analog
Type	Analog
Description	Simple 8-bit accuracy A/D converter. A total of 4 A/D converters come on the VT7900 base PCB that can each be used individually. For more technical details, see Chapter 2.9.3.

Name	PCA9534
Type	Digital
Description	8-bit digital I/O port on I²C bus. All the I/O pins on the chip are configured as inputs.

Name	PCA9535
Type	Digital
Description	16-bit digital I/O port on I²C bus. All the I/O pins on the chip are configured as inputs.

Name	PCA9506
Type	Digital
Description	40-bit digital I/O port on I²C bus. All the I/O pins on the chip are configured as inputs.

Name	Parallel Port
Type	Digital
Description	4-bit parallel input port. Only one parallel input port comes on the VT7900 base PCB.

Name	ADC121S625
Type	Analog

Description	Analog/Digital converter 200 kSPS, 1 channel, 12-bit resolution SPI connection

Name	ADC128S052
Type	Analog
Description	Analog/Digital converter 500 kSPS, 1 channel, 12-bit resolution SPI connection

Name	ADS8329
Type	Analog
Description	Analog/Digital converter 1 MSPS, 1 channel, 16-bit resolution SPI connection

Name	ADS8330
Type	Analog
Description	Analog/Digital converter 1 MSPS, 2 channel, 16-bit resolution SPI connection

Name	ADS8331
Type	Analog
Description	Analog/Digital converter 1 MSPS, 4 channel, 16-bit resolution SPI connection

Name	ADS8332
Type	Analog
Description	Analog/Digital converter 1 MSPS, 8 channel, 16-bit resolution SPI connection

Name	Digital Data Bus
Type	Digital
Description	Used to read simple components on the parallel bus (e.g. switches or a simply digital input logic).

Name	Timestamp
Type	-
Description	Time stamp for all subsequent values in this block.

Name	Wait
Type	-
Description	Wait time (busy), after which the next value in the block is read.

Name	SPI Processor
Type	SPI µC Interface
Description	Universal SPI interface to a µC on the piggy board for read values.

Write values

The following write values are available:

Name	AD5344
Type	Analog
Description	Digital/Analog converter 4 channel, 12-bit resolution Parallel bus connection The value must be entered four times with the different corresponding bus addresses in order to use all four channels.

Name	AD5546
Type	Analog
Description	Digital/Analog converter 1 channel, 16-bit resolution Parallel bus connection

Name	AD5556
Type	Analog
Description	Digital/Analog converter 1 channel, 14-bit resolution Parallel bus connection

Name	Analog
Type	Analog
Description	Simple 8-bit accuracy D/A converter. A total of 4 D/A converters come on the VT7900 base PCB that can each be used individually. For more technical details, see Chapter 2.9.4.

Name	Digital Data Bus
Type	Digital
Description	Used to operate simple components on the parallel bus (e.g. LEDs or simple digital output logic).

Name	LED
Type	Digital
Description	The 16 front LEDs in the VT7900 module.

Name	Parallel Port
Type	Digital
Description	4-bit parallel output port. Only one parallel output port comes on the VT7900 base PCB.

Name	PCA9534
Type	Digital
Description	8-bit digital I/O port on I²C bus. All the I/O pins on the chip are configured as outputs.

Name	PCA9535
Type	Digital
Description	16-bit digital I/O port on I²C bus. All the I/O pins on the chip are configured as outputs.

Name	PCA9506
Type	Digital
Description	40-bit digital I/O port on I²C bus. All the I/O pins on the chip are configured as outputs.

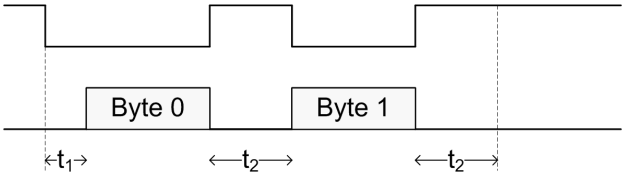
Name	DAC124S085
Type	Analog
Description	Digital/Analog converter 30 MHz, 4 channel, 12-bit resolution SPI connection

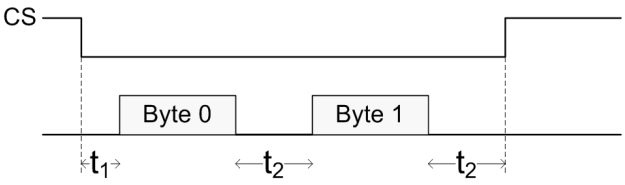
Name	LTC2604
Type	Analog
Description	Digital/Analog converter 50 MHz, 4 channel, 16-bit resolution SPI connection

Name	SPI Processor
Type	SPI µC Interface
Description	Universal SPI interface to a µC on the piggy board for write values.

Read & write values

The following read and write values are available:

AD converter index	Index of A/D converters to be used on the VT7900 base PCB.
Bus address	Bus addresses on the parallel bus for this value when the corresponding chip is addressed.
Byte length	Total length of the value in bytes.
Chip select line	Chip select lines on the SPI bus for this value when the corresponding chip is addressed.
Clock freq. in kHz	Clock frequency in kHz for this chip.
Clock freq. in MHz	Clock frequency in MHz for this chip.
CONVST chip select line	Necessary when manual mode is activated for this chip. Use this to operate the CONVST signal of the chip via the chip select line on the SPI bus. Contains the status of the chip select lines when if the CONVST signal is activated.
DA converter index	Index of D/A converters to be used on the VT7900 base PCB.
Data access time in ns	Time after which the data on the parallel bus are valid.
Data hold time in ns	Hold time for the data on the parallel bus.
Number of parameters	The number of parameters inside the value.
Release CS lines	Determines if the CS lines are released after each byte (see illustration below). 
SPI mode CPHA	Determines if data is captured on the clocks falling or rising edge.
SPI mode CPOL	Determines if the clock is idle low (false) or idle high (true).
Use 100kHz clock	When enabled, a 100kHz (Standard Mode) clock frequency is used instead of a 400kHz (Fast Mode) clock frequency.
Use single LEDs	Defines whether the front panel LEDs are addressed individually (16x1 bit) or simultaneously (1x16 bit).
Use single lines	For digital values, defines whether an individual parameter should be created for each pin. When active, a separate system variable is generated for each bit.
Use manual mode	Activates manual mode for this chip. When active, the property CONVSTChipSelectLine must be adapted accordingly.

Wait time after CS in us	Wait time between chip select and the first byte in microseconds (see t_1 in the illustration below).
Wait time after each byte in us	Wait time after each byte in microseconds (see t_2 in the illustration below). 
Wait time in us	Wait time in nanoseconds.
Write value link	Index of the write value that is linked to this value (0: no link).

3.2.1.5 Parameters

Each read and write value has one or more parameters. These values are available in CANoe as measurement and output values in the form of system variables. To prevent conflicting names, ensure that the channel name and parameter name combination is always unique.

Properties

Parameter properties:

Bit length	The length of the parameter in bits. Only values of 1, 8, 16 and 32 are allowed.
Bit offset	This property sets the parameter's offset in bits, relative to the ByteOffset. This property can only be set when BitLength = 1.
Byte offset	The starting offset of this parameter in the value, measured in bytes.
Default value	Parameter default value.
Is floating point	This flag indicates if the parameter's values shall be interpreted as floating point or integer values.
Is unsigned	This flag indicates if the parameter's values shall be interpreted as unsigned or signed values.
Line	Defines which channel this parameter is assigned to.
Name	Parameter name; each channel must have a unique name.
Scaling type	This property determines if a digital or a standard scaling is used for this parameter. This property only takes effect if the scaling is enabled.
Use default value	Defines whether a default value should be used for this parameter.
Use scaling	If this value is set to TRUE, scaling is used with this parameter. The type of scaling (analog or digital) depends on the type of read and write value.
Value ID	Unique parameter identification.

3.2.1.6 Scalings

Scalings enable raw measurement values from the module to be scaled for display in CANoe. The following two types of scaling are available depending on the type of parameter:

Analog scaling

Analog scaling allows you to enter a scaling value, an offset value and a minimum and maximum value. One of the following scalings are performed depending on the read or write value:

Scaling of a read values (measurement):

Formula	Out = In*Scaling + Offset
In	Raw measurement value from module (measurement value from A/D converter)
Out	Output value in CANoe (system variable value)
Comment	Min and max are only for correctly displaying the system variables values in CANoe.

Scaling of a write values (output):

Formula	In = max(In, min) In = min(In, max) Out = (In – Offset)/Scaling
In	Input value in CANoe (system variable value)
Out	Output value to module (value for D/A converter)
Comment	Each of the four values can be individually activated or deactivated using a flag.

Properties of an analog scaling:

Max	Maximum allowable input value in CANoe.
Use max value	Defines whether this value will be used.
Min	Minimum allowable input value in CANoe.
Use min value	Defines whether this value will be used.
Offset	Offset of the input value in CANoe.
Use offset value	Defines whether this value will be used.
Scale	Scaling of the input value in CANoe.
Use scale value	Defines whether this value will be used.

Digital scaling

Digital scaling has a flag which allows the pins in use to be inverted.

Properties of a digital scaling:

Inverted pins	Inverts the input and output of a value; “high” becomes “low”.

3.2.1.7 Default Values

Default values can be entered for the write value parameters, which are set after the module is switched on or after measurement begins. The value range is from 1 to 16 bit and depends on the type of parameter. You also have the account for the scaling in this case, which means the value may not exceed the defined min and max levels (if activated).

3.3 Create a Configuration

Select **File|New Configuration…** to create a new configuration.

You can also use the key combination <Ctrl>+<N> or select in the toolbar.

If a configuration is open, it will be closed before creation of the new configuration.

3.4 Edit a Configuration

You can edit the current configuration in the main window of the Application Board Configurator. The components of this window are explained below.

3.4.1 Add and Delete Elements

Use the shortcut menu to add and delete elements in the configuration tree. Simply right-click on an element in the configuration tree to open the shortcut menu. A number of options are available depending on the element.

Element	Symbol	Options
Root of the configuration tree		> Add read block > Add write block > Delete all configuration elements
Channel		> Add channel > Delete channel
Read block		> Add several read values > Delete read block
Read value of a read block		> Delete read values
Write block		> Add several write values > Delete write block
Write value of a write block		> Delete write value
Parameter		> Add/delete scaling

You can also delete an element from the configuration tree by first selecting it and then pressing the delete key.

3.4.2 Edit Properties

To edit the properties of an element, you must first select the element in the configuration tree. Once selected, the element's important properties are displayed in the properties window on the right. Any “read-only” properties (which cannot be edited), are displayed separately and inactive.

Click on the property you wish to edit. Once selected, you may enter new values using your keyboard.

If the entered value is invalid (e.g. restrictions based on data type), you will receive an error message and the property will be reset to its original value.

3.4.3 User FPGA Configuration

Requirements

To use this feature you need a VT7900A module equipped with a user programmable FPGA.

Configuration

Select the root node of your configuration tree.

On the right hand side choose **Edit...** on the setting **User FPGA configuration**.

This will open up the User FPGA configuration dialog. Here you can choose between three modes:

- **Disabled**: the User FPGA will not be used (this is the default setting).
- **Mode 1**: Pins 23 to 38 will be used as SPI, digital outputs and digital inputs. Thus the following interfaces can be used by the User FPGA: I2C, databus, SPI, digital outputs and digital inputs.
- **Mode 2**: Pins 23 to 38 will be used for the databus interface. Thus only the following interfaces can be used by the User FPGA: I2C and databus.

In modes 1 and 2 you can enable or disable any interface for the User FPGA by checking / unchecking the corresponding check box in the column **Enabled**.

Creating a User FPGA program

Once you have finished your application board configuration, you can create a User FPGA project for your board. The VT System FPGA Manager (also shipped with CANoe) will help you do so.

The general steps are as follows:

- Save your application board configuration as a.bc or .bcs file in the VT System Application Board Configurator.
- Start the VT System FPGA Manager and create a new VT7900A project.
- Choose your previously saved .bc or .bcs file to allow the VT System FPGA Manager to create a code or model template for you.
- Enhance the template by adding your own custom functionality.
- Compile and write your project to a connected VT7900A board.
- Use your application board in CANoe.

Please see the VT System FPGA Manager help for more details on how to create a User FPGA project.

3.5 Save and Load Configurations

Save configuration

Select **File|Save** in the menu to save the current configuration.

You can also use the key combination <Ctrl>+<S> or select  in the toolbar.

Select **File|Save As…** to save a configuration under a new name.

Load configuration

Select **File|Open Configuration…** to load a new configuration.

You can also use the key combination <Ctrl>+<O> or select  in the toolbar.

3.6 File Formats

You have the option to save your configuration in two different file formats.

BC (Board Config) file format

The BC file format is an XML-based file. The configuration is saved in plain text and can be opened without the Application Board Configurator. This file format is less error-prone – a damaged BC file is easy to repair. We therefore recommend that you save your configurations by default using the BC file format.

BCS (Board Config Structure) file format

The BCS file format saves the configuration in a binary format, which allows much smaller file sizes. The BCS format is therefore used to store a configuration in the VT module. However, we still recommend that you save your configurations on your computer using the BC file format.

3.7 Read a Configuration from a VT Module

The Application Board Configurator allows you to import an existing configuration from a connected VT module. To do so, proceed as follows:

Step 1

Connect the VT module to the computer

To read a configuration, you must first connect the VT module to your computer. Insert the module into a VT rack and connect it to the computer‘s network card. Then ensure you provide the VT rack with power.

Step 2

Using the read dialog

Once you have connected the VT module to your computer as described above, you can now open the read dialog in the Application Board Configurator by either selecting **Edit|Read BSC from VT Module…** in the menu or in the toolbar.

In the read dialog, select the **network adapter** connected to the VT rack. All available VT7900 modules are displayed in the **VT module** list.

Note: If no VT modules are displayed in the list, check the following:

> Is the correct network card selected?

> Is the VT rack connected to this card and provided with power?

> Is a VT7900 module inserted into the rack?

All other programs that use the network card for EtherCAT communication (e.g. CANoe) must be closed.

Once you have selected the module, you can start the read process by selecting the **[Start Reading]** button. At this point the imported configuration can be viewed in the Application Board Configurator.

3.8 Write a Configuration to a VT Module

Using the Application Board Configurator, you can write the current configuration to one or more VT modules. To do so, proceed as follows:

Step 1

Connect the VT module(s) to the computer

To write a configuration, you must first connect at least one VT module to your computer. Insert the module(s) into a VT rack and connect it(them) to your computer's network card. Then ensure the VT rack is supplied with electricity.

Step 2

Using the write dialog

Once you have connected the VT module(s) to your computer as described above, you can now start the download dialog in the Application Board Configurator by either selecting **Edit|Write BCS to VT Modules…** in the menu or in the toolbar.

In the write dialog, now select the **network adapter** connected to the VT rack. All available VT7900 modules are displayed in then in the **Available VT7900 Modules** list.

The **Selected for writing to** list shows all modules to which the current configuration will be written. Use the **[>>]** and **[<<]** buttons to add other modules to the list or remove modules from the list.

Note: If no VT modules are displayed in the **Available VT7900 modules** list, check the following:

> Is the correct network card selected?

> Is the VT rack connected to this card and provided with power?

> Is a VT7900 module inserted into the rack?

All other programs that use the network card for EtherCAT communication (e.g. CANoe) must be closed.

Once you have selected the module(s), you can start the write process by selecting the **[Start Writing]** button.

3.9 Adapt the Application Board Configurator

Open the configuration dialog by selecting **Options|Configuration…** in the menu or  in the toolbar.

You can change the following Application Board Configurator settings in this dialog.

Default file format

Here you can select the default file format. This format will be the default setting when you create and save a configuration. We recommend selecting the xml-based format (**.bc**).

On application start-up

Use this option to define what the Application Board Configurator performs at start-up. You can select whether the previously edited configuration should be loaded or if a new configuration should be created.

Use the option **Expand tree** to define whether the configuration tree should be open or closed by default.

4 Application Board Templates

This chapter contains the following information:

4.1 EAGLE

4.1.1 Overview

Design Tool

This chapter includes a guideline how to use the provided EAGLE templates to design an application board for the VT7900. This tool is easy to use and so very common. To work with these templates you have to use a version of EAGLE which supports a routing area of 160mm x 100mm or larger.

Templates

The templates include a schematic and layout of application boards with two or four layers. The templates are based on the supported PCB size 160mm x 100mm. The required connectors, the mounting holes and the mandatory EEPROM are already integrated in the templates. So you can immediately start to design your circuit.

Additional a library with all supported devices for the application board and other helpful parts is provided with these templates.

The templates can be found in the same folder as the CANoe sample configurations. The path to this sample configuration folder will be set during installation of CANoe. The subfolder for the templates is "…\VTSystem_Templates\VT7900_AppBoard_Template".

The sample configuration folder can also be reached via the task bar of CANoe: **Configuration|Options|General|File Locations|Location** of user data.

4.1.2 Setting up a Project

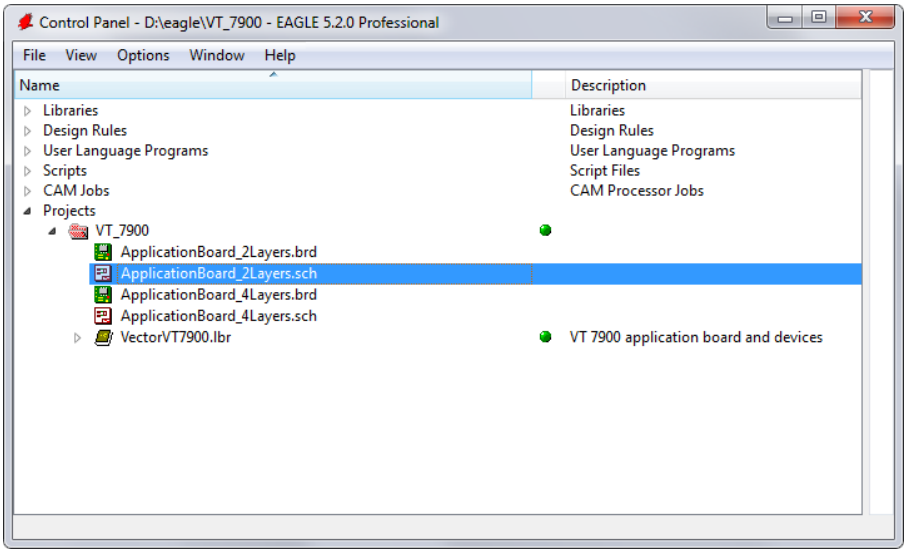
Project Directory

First you have to copy the complete folder including the EAGLE template files into the EAGLE project directory. If the EAGLE project directory does not already exist, it has to be created first. The path to the EAGLE project directory can be set by choosing **Options|Directories….**

Now EAGLE displays the project folder with the template files in the tree view. Right click the project folder and choose **Open Project**. After that right click on VectorVT7900.lbr and select **Use**.

You can also rename your EAGLE project and the single file names now.

If the project is set up properly, the EAGLE control panel should look like in the following figure:

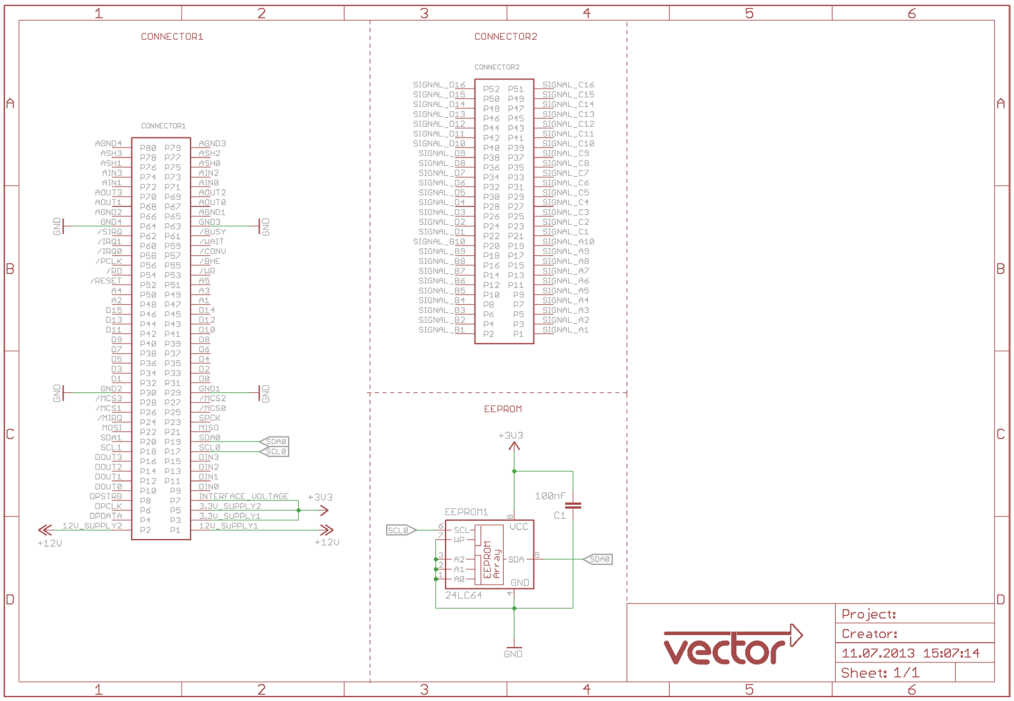


4.1.3 Templates

There are two different templates available. Each template consists of a schematic and a layout file. The schematic (.sch) is connected automatically to the board layout (.brd) with the same name. So make sure that both files are opened when you work with it. Otherwise the changes in the schematic are not applied to the board layout.

Schematic

The schematics of the two templates are the same. They include Connector 1 and Connector 2 to the main module VT7900 and the mandatory EEPROM which stores the configuration of the application board. All GND and VCC supply pins are already attributed to the supply nets.



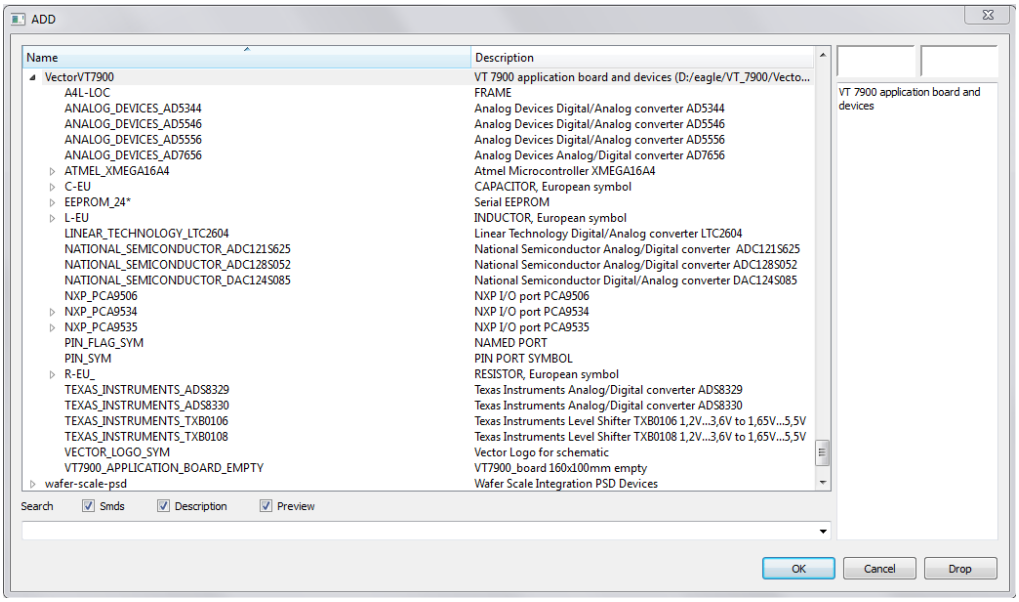
Layout

There are two different layout templates. One layout supports two layers, the other layout supports four layers. The four layer version provides two signal layers, a supply layer and a ground layer. The layer assignment of the two layer version is mixed. The two connectors and the four drill holes are already placed on the right position. The EEPROM is also already placed. The connections of the nets in the schematic appear as air wires in the layout. By typing in the command `route` in the EAGLE command line, the PCB tracks can be routed.

4.1.4 Using the Library

Dedicated Library

To add devices to the schematic type in `add` in the EAGLE command line. After that a window appears where all available libraries are listed. There is also access to the special VT7900 library where you can find all devices which are supported for the application board.



You can choose the required device and add it to the schematic. All devices added in the schematic automatically appear in the layout with the selected package.

The connections can be made using the `net` command. Make sure that all pins which should be connected to the same net have the same name. The net name can be set with the `name` command.

Especially in the schematic with the four layer layout all GND and +3V3 supply pins have to be connected to the net GND or +3V3, otherwise the pads are not connected to the VCC or ground layer.

4.1.5 Additional Hints

If the template for the four layer board is used, all Pads connected to GND or +3V3 nets are automatically connected to the supply layers, they don't have to be routed. Signals can be routed on top and bottom layer.

If you want to set a via (for example to connect a SMD pad to GND or +3V3 layer) use the `route` command and place it with shift - left click. This via automatically has the same name like your routed wire. To connect a via to a special copper plane, it is necessary that both of them have the same signal name, which is set by using the `name` command.

The supply layers are executed as polygon planes. With the command `ratsnest` you can display these planes, with `ripup @;` you can fade them out again. You can use this commands for all polygon planes.

At the end use the design rule check (DRC). The most PCB manufacturers provide their DRC specifications in a special .dru file. Download these file and apply it in the layout editor with the command `drc`.

A lot of PCB manufacturers (e.g. PCB Pool) directly accept the EAGLE layout file .brd as input. So you don't need to export Gerber files.

4.2 KiCAD

4.2.1 Overview

Design Tool

This chapter includes a guideline how to use the provided KiCAD templates to design an application board for the VT7900. This tool is open source and licensed under GNU GPL v3. Therefore it can be used without any invest and is an easy start to testing the VT7900.

Templates

The template includes a schematic and layout of an application board with four layers. If you only need two layers the additional layers can easily be removed in KiCAD. The template is based on the supported PCB size 160mm x 100mm. The required connectors, the mounting holes and the mandatory EEPROM are already integrated in the templates. So you can immediately start to design your circuit.

Additionally a library with all supported devices for the application board is provided within this template.

The templates can be found in the same folder as the CANoe sample configurations. The path to this sample configuration folder will be set during installation of CANoe. The subfolder for the templates is "…\VTSystem_Templates\VT7900_AppBoard_Template".

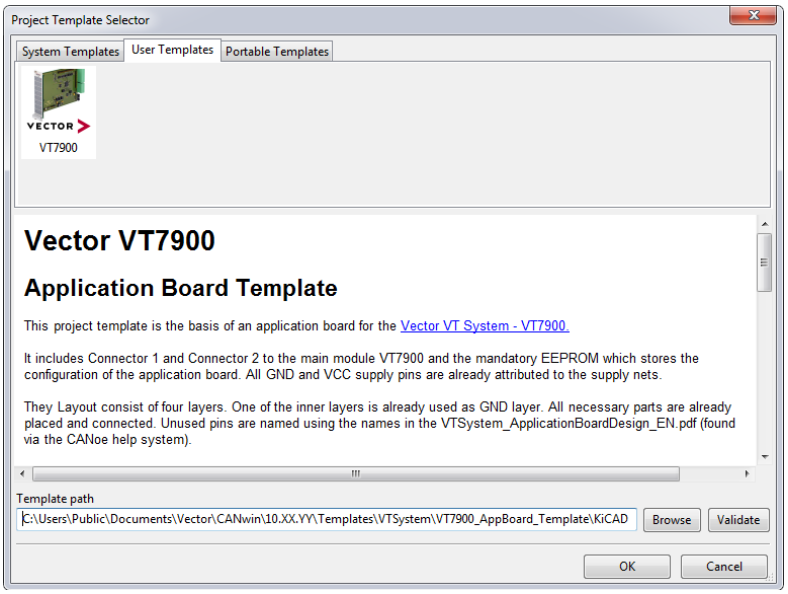
The sample configuration folder can also be reached via the CANoe options: **Options|General|File Locations|Location** of user data.

4.2.2 Setting up a Project

User Templates

To open the template you need to start KiCAD and click on "create new project from template". Select a folder where you want to create your new design. Then the template dialogue opens and you have to select the tab "User Templates". There you can enter the path to the template folder.

Now KiCAD shows the VT7900 template with a short description and by clicking on ok you can use the template. All files needed are automatically integrated into your new project folder.

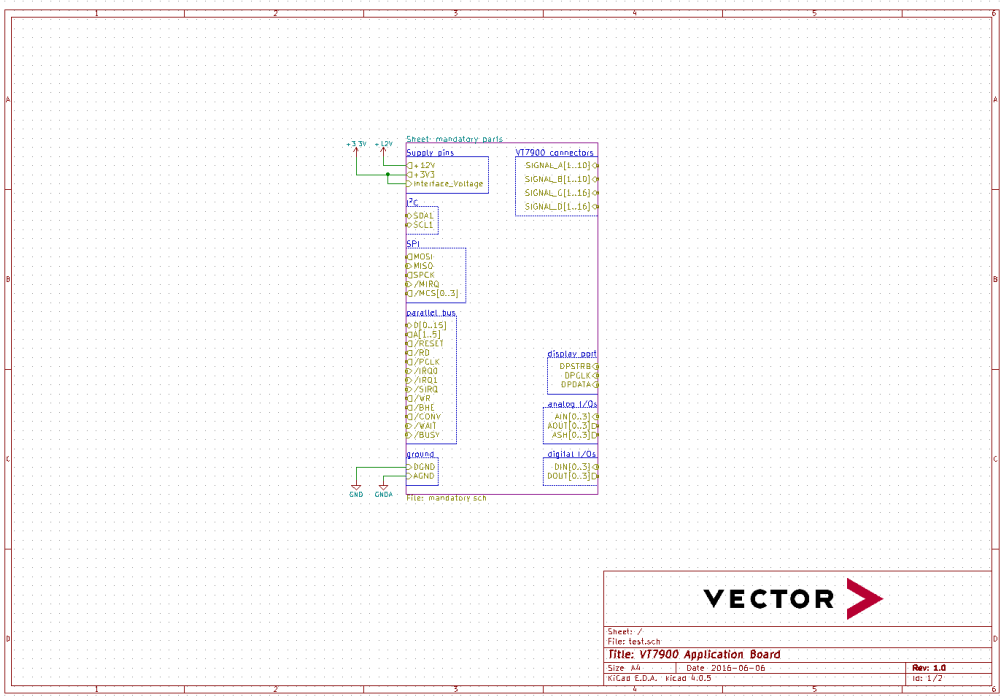


4.2.3 Template

For KiCAD only one template is integrated. Additional layers can easily be added or removed via “Design Rules/Layer Setup” in Pcbnew.

Schematic

The schematic includes Connector 1 and Connector 2 to the main module VT7900 and the mandatory EEPROM which stores the configuration of the application board. All GND and VCC supply pins are already attributed to the supply nets. Those mandatory parts are integrated into a hierarchical block. In most cases you don’t need to open this block and can just use it as is and connect your signals to it.



Layout

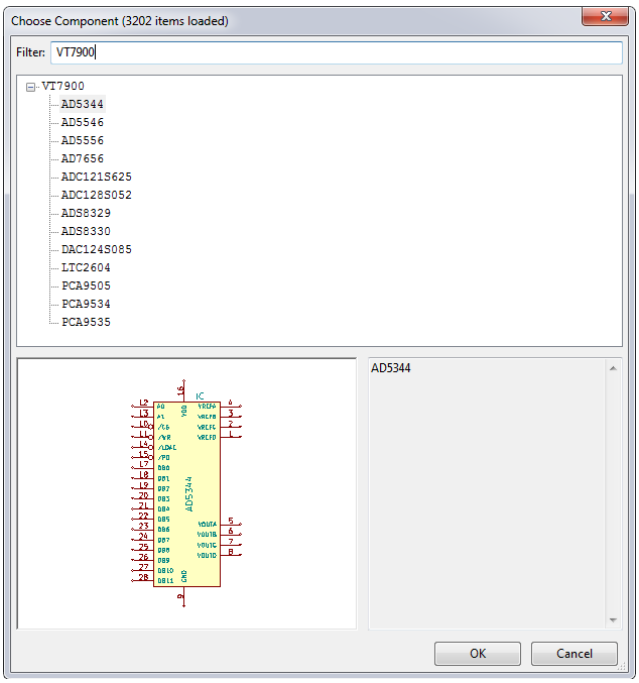
The layout contains four layers by default. The inner layer 1, directly underneath the top layer, is used as ground plane. If you need a changed layer structure you can simply click on “Design Rules/Layer Setup” in Pcbnew. The two connectors and the four drill holes are already placed on the right positions. The EEPROM is also already placed too.

4.2.4 Using the Library

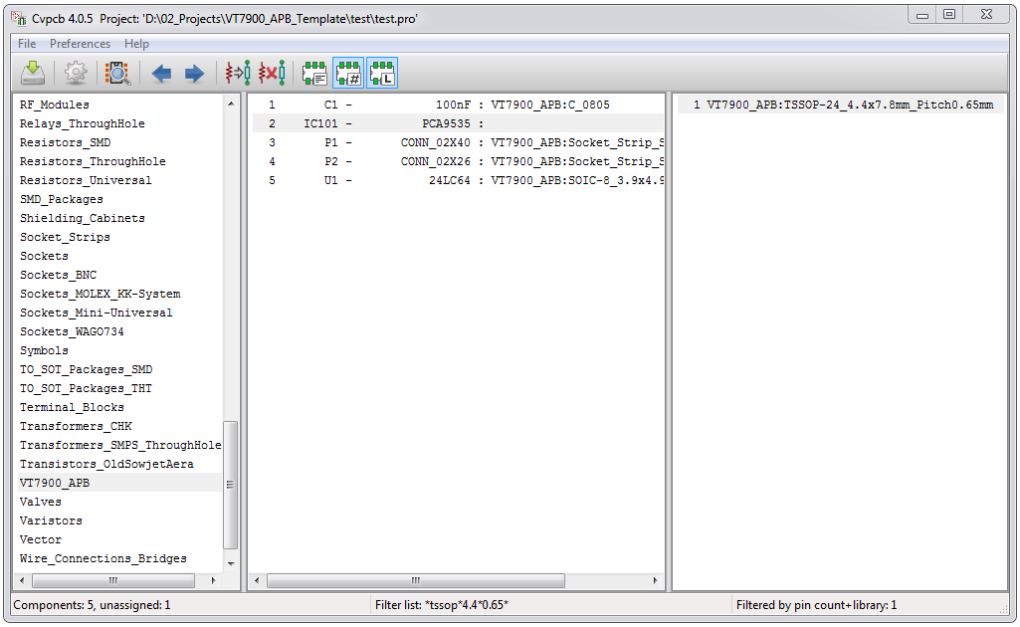
Dedicated Library

To add the supported parts library you have to open the schematic of your design and click on “Preferences/Component Library”. There you can click on “Add” and navigate to the “VT7900.lib” already included in your new project folder.

If you now add new components to your design via the “Place component” button there will be a new library called “VT7900” containing all the supported ICs.



After you finished adding parts and routing them you have to run “CvPcb” to connect the right footprints to the components. In the “CvPcb” dialog you’ll find the “VT7900_APB” library which contains all the footprints needed for the parts of the VT7900 component library.



4.2.5 Additional Hints

The GND layer is executed as zone. With the command `“Fill Zone”` you can make the zone visible. You can also use the hotkey “b”.

At the end use the design rule check (DRC). The most PCB manufacturers provide their DRC specifications in a special .dru file. Download these file and apply it in the layout editor.

If you activate all the filters in the “CvPcb” dialog and select the VT7900_APB library you will only get the correct footprint for the parts of the supported parts of the VT7900. The filters are activated with the first three buttons from the right in the CvPcb dialog.

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