

# Documentation ADDA12/4

**Doc Rev. 1.3 of 31.05.2009**  
**Hardware Rev. 1,0 of 11.11.1997**

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Rev.	Date	Aut hor.	Change
1.0	02.02.1998	Ha	Production
1.1	08.05.1998	La	Cap. 3,5 corrected
1.2	05.07.2000	Ko	no content change
1.3	31.05.2009	Ha	Sketchy english translation

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## **1 General references**

### **1.1 Handling**

1. Please read this documentation carefully before you unpack and use the hardware. This saves time and avoids problems.
2. Please consider EMI precautionary measures during handling of electrostatically endangered hardware.
3. If the hardware contains batteries, do not put it on electrically conductive surfaces. The batteries could be short circuit and cause damage.
4. Please make sure that the hardware is used only within its specified temperature range.

### **1.2 Installation**

1. Check whether all jumpers are set according to the application.
2. Before making a connection, switch off power supply and all external connections.
3. If you are safe the fact that all connections are correctly installed switches you on voltage supply.

### **1.3 Explanation**

We reserve ourselves the right to make changes to improve the circuit or the product without special notice. Despite careful supervision no liability can be taken for the correctness of the data, connection diagrams and programs given here and descriptions. The suitability of the product for a certain application is not assured.

### **1.4 Repairs**

If the product should be defective, please send it back to the vendor in suitable packing with the following description:

- Error description
- The error arose only under certain conditions
- What was attached
- As the attached signals looked
- Do you consider this warranty repair or not

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## **2 General information**

### **2.1 Installation**

The ADDA12/4 is intended for use in EMI safe housings. The wiring has to follow EMI guidelines and shall use shielded cables. Installation requires EMI trained personnel.

### **2.2 Operating conditions**

Ambient temperature (normal operation)	0-50 °C
Ambient temperature (storage)	-20-85 °C
rel. Humidity (powered on)	max. 95%, non-condensing
Altitude	-300m to +3000m

### **2.3 Mechanical dimensions**

Eurocard:	160 x 100 mm
Front plate:	4TE

### **2.4 Technical characteristics**

Supply voltage:	with option DCDC	5 V of DC $\pm 5\%$ , max. 0,9 A
	without option DCDC	5 V of DC $\pm 5\%$ , max. 0,3 A and $\pm 15$ V DC $\pm 5\%$ , max. 0,1 A
Bus connection	P-bus, VG64a+c, male	
Analogue inputs	8 differentially or 16 single ended, bipolar	
	Voltage sensitivity: configurable per channel, $\pm 10$ V, $\pm 1$ V, $\pm 0,1$ V	
	Current sensitivity: configurable per channel, $\pm 20$ mA, $\pm 2$ mA, burden : approx. 150 $\Omega$	
	Resolution: 12 bit, accuracy 11 bit	
Analogue outputs	4 voltage outputs $\pm 10$ V, 12 bit resolution	

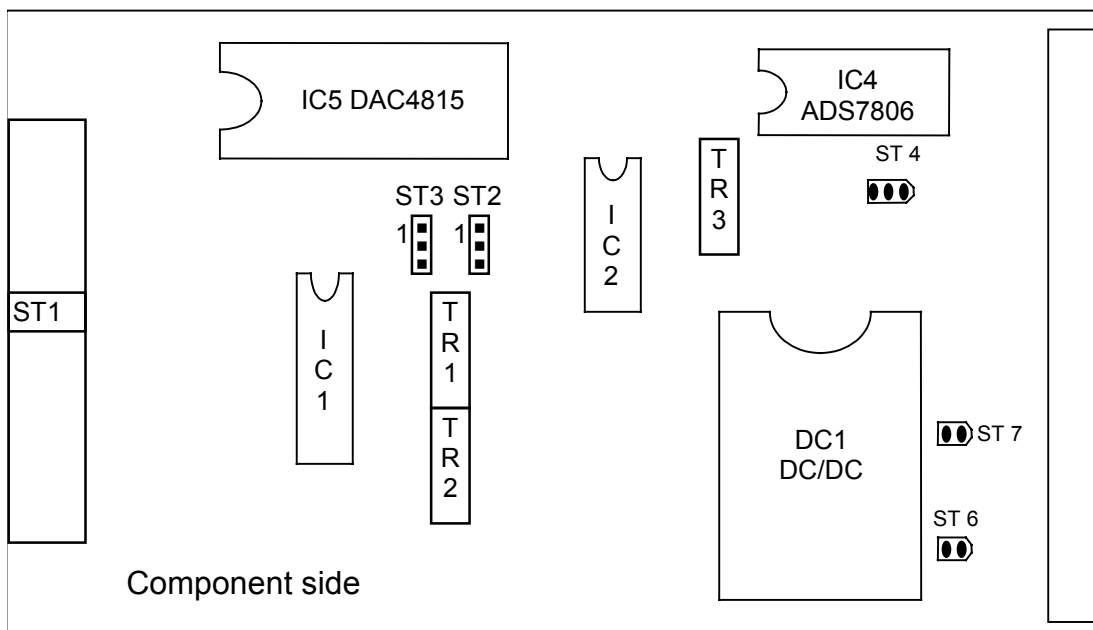
## 2.5 Configuration variants

The ADDA12/4 is available ex factory in the following configurations:

	diff. Inputs	single ended Inputs	Current inputs	Analogue outputs	Supply
ADDA12-D	8	0	no	0	5V, ±15V
ADDA12-D-DCDC	8	0	no	0	5V
ADDA12-S	0	16	no	0	5V, ±15V
ADDA12-S-DCDC	0	16	no	0	5V
ADDA12-I	8	0	yes	0	5V, ±15V
ADDA12-I-DCDC	8	0	yes	0	5V
ADDA12/4-D	8	0	no	4	5V, ±15V
ADDA12/4-D-DCDC	8	0	no	4	5V
ADDA12/4-S	0	16	no	4	5V, ±15V
ADDA12/4-S-DCDC	0	16	no	4	5V
ADDA12/4-I	8	0	yes	4	5V, ±15V
ADDA12-Î-DCDC	8	0	yes	4	5V

## 3 Start-up

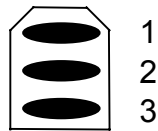
### 3.1 Placement of jumpers



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### 3.2 Description of jumpers

Solder jumper are counted as follows:



#### 3.2.1 ST2, ST3: Input configuration

**Only for factory setting or alignment!**

The Jumper ST2 and ST3 must be set according to the card's input configuration.

	IC1	ST2	ST3
<b>ADDA12/4-D</b>	MPC507	1-2	1-2
<b>ADDA12/4-S</b>	MPC506	2-3	1-2
<b>ADDA12/4-I</b>	MPC507	1-2	1-2
<b>Alignment</b>		2-3	2-3

Factory setting corresponds to card configuration.

#### 3.2.2 ST4: Codes of the A/D converter

ST4 specifies the output coding of the A/D converter.

	Input voltage	ST4, 1-2 set	ST4, 2-3 set
<b>+Full Scale</b>	9.99512 V	0xFFFF0	0x7FF0
<b>Zero V</b>	0 V	0x8000	0x0000
<b>1 bit below zero</b>	-0.00488 V	0x7FF0	0xFFFF0
<b>Full Scale</b>	-10 V	0x0000	0x8000

ST4, 1-2 set is factory setting (grey background).

### 3.2.3 ST6, ST7: Voltage supply

#### Caution!

#### Wrong jumper setting can damage the hardware!



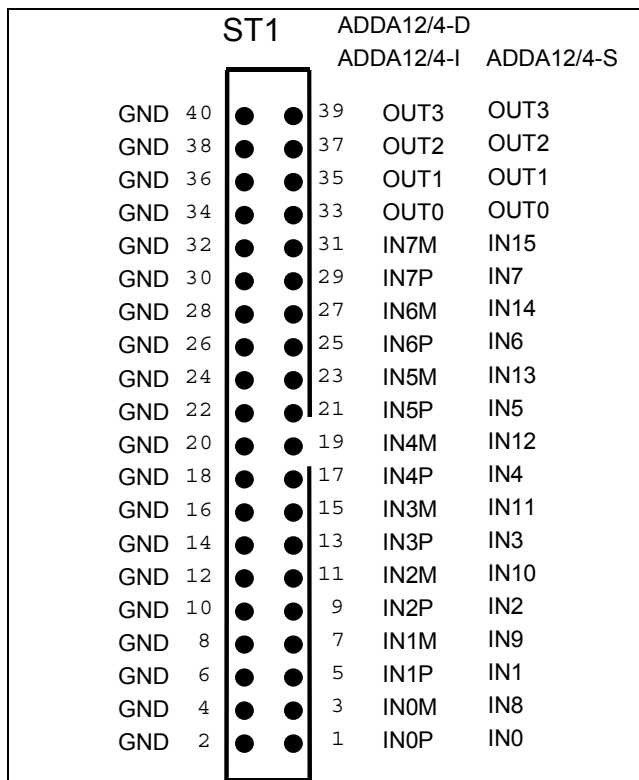
These jumper are to be set according to supply voltage and hardware configuration of the card.

	Supply	ST6	ST7
DC1 (option DC/DC) fitted	+5V	open	open
DC1 (option DC/DC) not fitted	+5V, ±15V	closed	closed

Factory setting corresponds to the card configuration.

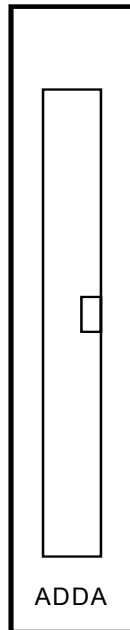
### 3.3 Plug pinning

The signal connection is made by a 40-pin post border with the following pinning (view on front plate):



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### **3.4 Front view**



### **3.5 P-bus**

The ADDA12/4 is operates on the P-bus. It does not use interrupts.

Depending upon card configuration only +5V or additionally  $\pm 15V$  are needed.

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## **4 Programming**

### **4.1 Address allocation**

The base address (0x10) the ADDA12/4 is decoded by a GAL and is not user configurable.

The ADDA12/4 uses maximally 0x10 addresses as follows:

	<b>Read</b>	<b>Write</b>
<b>Basis+0x00</b>	A/D data register0, MSB, D7-D0	Control register and conversion start
<b>Basis+0x01</b>	A/D data register1, LSB, D7-D4	
<b>Basis+0x02</b>	A/D status register, D7	Not used
<b>Basis+0x03</b>		
<b>Basis+0x04</b>	Not used	
<b>Basis+0x05</b>		
<b>Basis+0x06</b>		
<b>Basis+0x07</b>		
<b>Basis+0x08</b>	DA output strobe	D/A channel 0, LSB, D7-D0
<b>Basis+0x09</b>	DA output strobe	D/A channel 0, MSB, D3-D0
<b>Basis+0x0A</b>	DA output strobe	D/A channel 1, LSB, D7-D0
<b>Basis+0x0B</b>	DA output strobe	D/A channel 1, MSB, D3-D0
<b>Basis+0x0C</b>	DA output strobe	D/A channel 2, LSB, D7-D0
<b>Basis+0x0D</b>	DA output strobe	D/A channel 2, MSB, D3-D0
<b>Basis+0x0E</b>	DA output strobe	D/A channel 3, LSB, D7-D0
<b>Basis+0x0F</b>	DA output strobe	D/A channel 3, MSB, D3-D0

### **4.2 Description of A/D converter function**

A/D conversions are controlled by both data register as well as the control- and the status register.

The usual operational sequence for a conversion cycle is as follows:

1. Selection of the desired input port and input sensitivity by writing the control register (at the same time a conversion starts).

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2. Waiting for the end of the actual conversion by polling the status register.  
The conversion result is rejected, as the desired input port was not changed.
  3. Selection of the next input port. Hereby, the conversion for the input port selected in step 1) is started.
  4. Waiting for the end of the conversion by polling the status register.
  5. Reading the conversion result
  6. Continuous conversions can be used by going over to step 3). Single conversions have to start again at step 1).

Operation of the A/D converter is overlapping. While a conversion is active, the converter's input circuitry (multiplexer and input amplifier) has time to settle to the next input value. With higher input sensitivities the settling time of the input circuitry has to be considered in software, for the conversion duration is smaller than the settling time.

#### 4.2.1 Control register

Writing to the control register does:

1. Start a conversion
2. Select the next input channel
3. Set the input sensitivity for the next conversion

The control register has the following fields:

	D7	D6	D5	D4	D3	D2	D1	D0
<b>ADDA12/4-D, ADDA 12/4-I</b>	x	x	V1	V0	x	K2	K1	K0
<b>ADDA12/4-S</b>	x	x	V1	V0	K3	K2	K1	K0

x: Bit is without function and can be set at will.

Input sensitivity is specified by bits V1 and V0:

V1	V0	Amplification (PGA204)	Input sensitivity ADDA12/4-D ADDA12/4-S	Input sensitivity ADDA12/4-I	Settling time (PGA204+MUX) 0,01%
0	0	1	±10V	illegally	23 μs + 3.5 μs
0	1	10	±1V	±20mA	28 μs + 3.5 μs
1	0	100	±0,1V	±2mA	140 μs + 3.5 μs
1	1	1000	Not specified	Not specified	1300 μs + 3.5 μs

The input channel is selected by bits K3-K0:

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K3	K2	K1	K0	ADDA12/4-D ADDA12/4-I	ADDA12/4-S
0	0	0	0	IN0P-IN0M	IN0
0	0	0	1	IN1P-IN1M	IN1
0	0	1	0	IN2P-IN2M	IN2
0	0	1	1	IN3P-IN3M	IN3
0	1	0	0	IN4P-IN4M	IN4
0	1	0	1	IN5P-IN5M	IN5
0	1	1	0	IN6P-IN6M	IN6
0	1	1	1	IN7P-IN7M	IN7
1	0	0	0	IN0P-IN0M	IN8
1	0	0	1	IN1P-IN1M	IN9
1	0	1	0	IN2P-IN2M	IN10
1	0	1	1	IN3P-IN3M	IN11
1	1	0	0	IN4P-IN4M	IN12
1	1	0	1	IN5P-IN5M	IN13
1	1	1	0	IN6P-IN6M	IN14
1	1	1	1	IN7P-IN7M	IN15

#### 4.2.2 Status register

The highest bit of the status register shows the status of a A/D conversion:

D7 low	conversion active
D7 high	conversion done

#### 4.2.3 Data register

The result of a conversion is read from the data registers pointers. The data registers can be read in arbitrary order.

Data register0 contains the 8 bits with high order the result.

Data register1 contains the low order 4 bits of the result. These bits are left justified in the result byte, the lower Nibble of this byte is filled with 0.

The result word has thus the structure 0x???0. The interpretation of the data depends on selected coding (see ST4).

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**Reading of the data registers is only allowed, when no conversion is in progress (see status register)!**

### **4.3 Description of function of the D/A converter**

The D/A converter provides 4 independent output channels, whose output values are stored in individual data registers. The data register can be written any time in arbitrary order. The data registers are write-only.

The values of all data registers are output synchronously by reading any single data register.

It applies the following output coding:

<b>Coding</b>	<b>Meaning</b>	<b>Output voltage</b>
0x0FFF	+Full Scale	9.99512 V
0x0800	Zero	0 V
0x07FF	A bit under mass	-0.00488 V
0x0000	Full Scale	-10 V

After RESET, all outputs are forced to 0 V, and all output registers are initialized to 0x0000 (corresponding to -10V). Therefore, if a single data register is read before initialising all data registers to meaningful values, the output voltage of all non-initialized channels jumps to -10V. **!**

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## **5 Calibration**

All cards are tested and calibrated on delivery and do not require no aregular new calibration.

Cards with the DC/DC- option do not require further alignment.

Cards without the DC/DC- option have to be calibrated in the target system.

Tools for calibration:

- digital voltmeter, accuracy better 2.4 mVs when input voltage is  $\pm 10V$
- adjustable precision voltage supply with ADDA12/4-D and ADDA12/4-S
- adjustable precision power source with ADDA12/4-I
- small screw driver for trimmer adjustment

### **5.1 A/D converter**

Ground reference is the signal AGND2 of the ADS7806 (pin 6). Alternatively, the AGND connection to the P-bus can be used (ST5, pin 29c)

To calibrate the A/D-converter, follow these steps:

1. Calibrate the input offset of the PGA204 by TR1
2. Calibrate the A/D converter offsets by TR2
3. Calibrate the A/D converter amplification by TR3

<b>Step</b>	<b>Precondition</b>	<b>Measuring point</b>	<b>Calibration criterium</b>	<b>Poti</b>
1	ST2 and ST3 on position 2-3	PGA204, pin 10	0.0000 V	TR2
2	PGA on max. amplification (control word 0x30)	PGA204, pin 11	0.0000 V	TR1
3	PGA on min. amplification (control word 0x00)	PGA204, pin 11	0.0000 V	TR2
4	Repeat steps 2 and 3 iterating			
5	ST2 and ST3 on operating position, set input to -9,99756 V	Converter values	-full scale, lowest bit toggles	TR2
6	Input +9.99268 V	Converter values	+ full scale, lowest bit toggles	TR3

### **5.2 D/A converter**

The D/A converter can not be calibrated.

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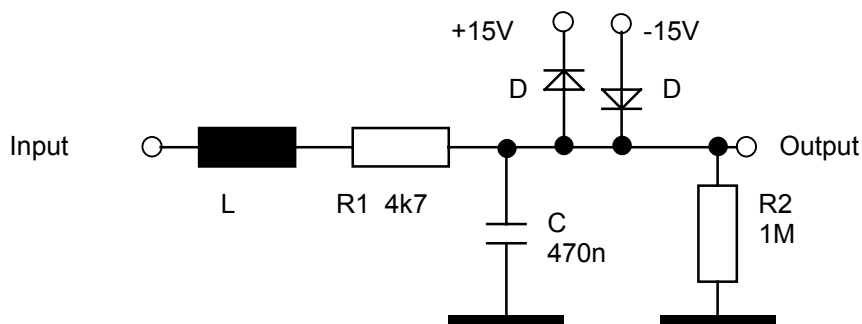
## **6 Input and output circuitry**

The inputs and outputs of the ADDA12/4 are fitted with protection and filter circuits, which ensure a perfect function of the card according to the EMI guidelines.

These wirings have influences on the signal transmission.

### **6.1 ADDA12/4-S**

The input wiring has the following structure:



C stores the charge necessary for reloading the input multiplexer

D are protection diodes, clamping overvoltage spikes to the supply voltage

R1 limits the maximum current flowing through the protection diodes D

L serves as high impedance input protection for transient disturbances

R2 define a reference potential for open inputs

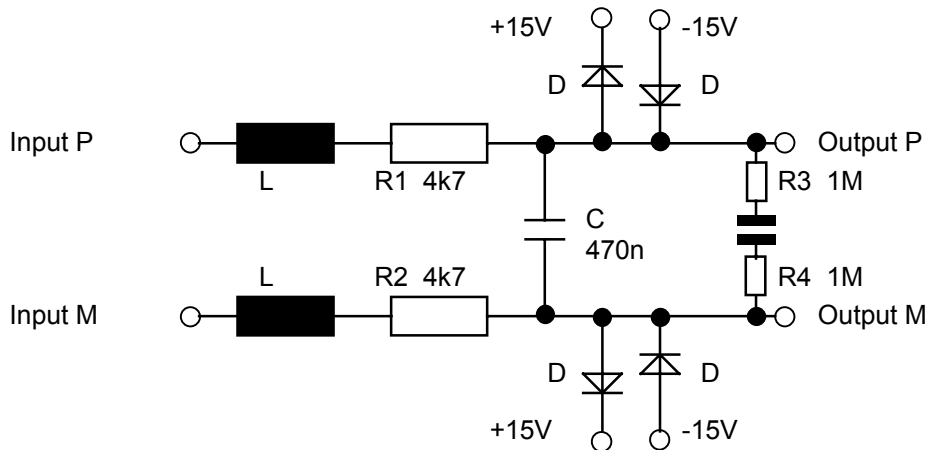
C and R1 work as low-pass filter and protect the input against high frequency disturbances.

The remaining elements do not have considerable influence on the signal transmission.

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## 6.2 ADDA12/4-D

The input wiring has the following structure:



C stores the charge necessary for reloading the input multiplexer

D are protection diodes, clamping overvoltage spikes to the supply voltage

R1, R2 limit the maximum current flowing through the protection diodes D

L serves as high impedance input protection for transient disturbances

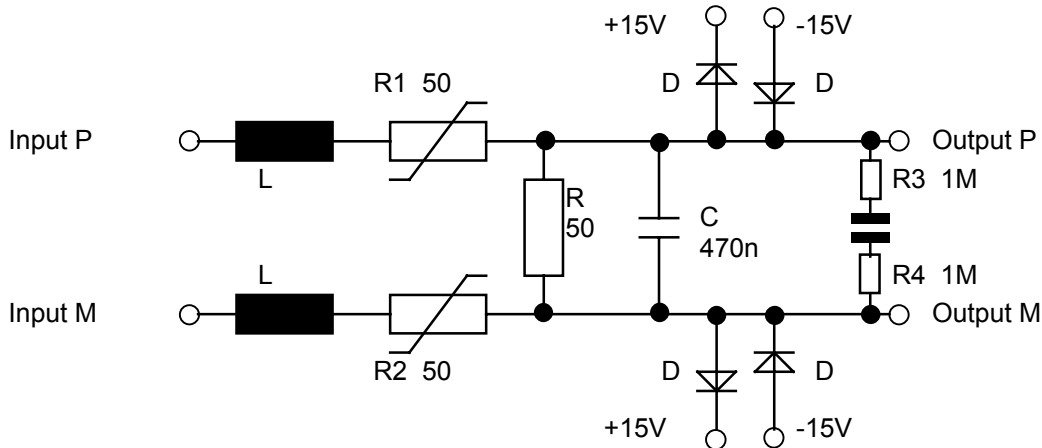
R3, R4 define a reference potential for open inputs

C and R1+R2 work as low-pass filter and protect the input against high frequency disturbances.

The remaining elements do not have considerable influence on the signal transmission.

### 6.3 ADDA12/4-I

The input wiring has the following structure:



C stores the charge necessary for reloading the input multiplexer

D are protection diodes, clamping overvoltage spikes to the supply voltage

R is the burden resistor, over which the input current is converted to an input voltage .

R1, R2 (PTC) limit the maximum input current

L serves as high impedance input protection for transient disturbances

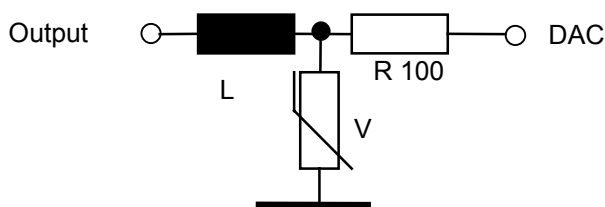
R3, R4 define a reference potential for open inputs

C||R and R1+R2 work as low-pass filter and protect the input against high frequency disturbances.

The remaining elements do not have considerable influence on the signal transmission.

### 6.4 Analogue outputs

The output wiring has the following structure:



L serves as high impedance input protection for transient disturbances

R limits the reaction to input disturbances

V (varistor) clamps input overvoltages

R sets the minimum load resistance, which can be driven with voltages in the specified accuracy to 400 k $\Omega$ .