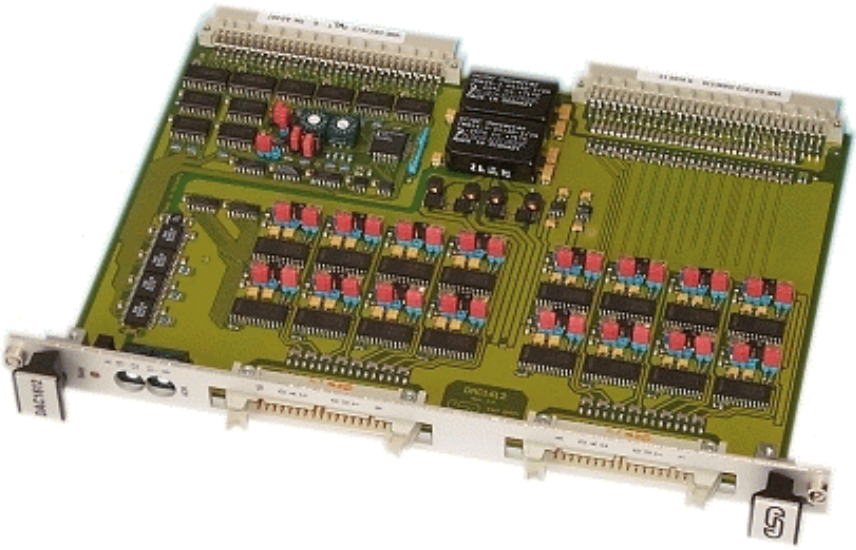
VME-DAC1612

16 Analog Outputs



Manual

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Changes in the chapters

The changes in the document listed below affect changes in the hardware as well as changes in the description of facts only.

Chapter	Changes versus previous version
4.1.2.1	Default value of base address corrected.
4.1.4	Jumper unipolar/bipolar: Meaning of setting corrected.

Technical details are subject to change without further notice.

N O T E

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Contents

1. Overview

1.1 Module Description

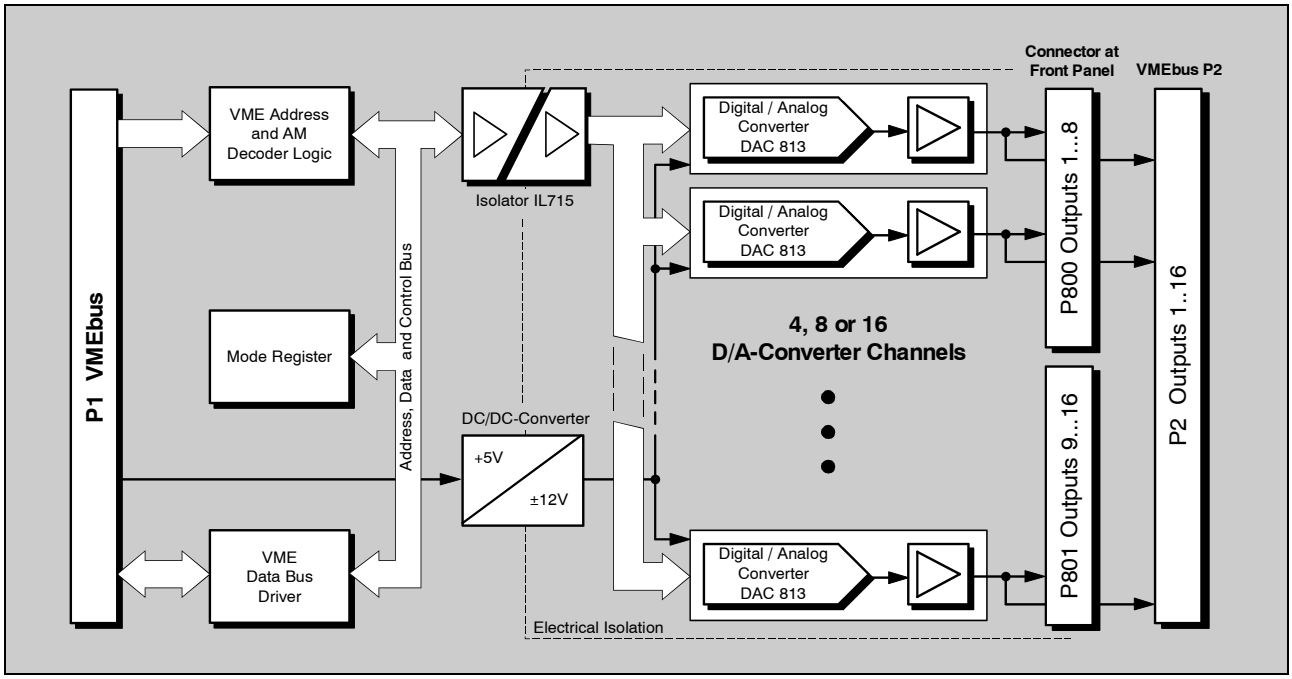


Fig. 1.1.1: Block-circuit diagram of the VME-DAC1612 module

The VME-DAC1612 has got up to 16 analog outputs. The output voltages can be selected as ±5 V, ±10 V or 0 ...+10 V, with a resolution of 12 bits.

A D/A-converter of DAC 813 type is used. The control and data signals between VMEbus and analog process are electrically insulated by means of fast digital couplers.

The power supply of the analog side (±15 V, +5 V) are generated by DC/DC-converters from the +5 VMEbus power supply.

The VME-DAC1612 is compatible to VMEbus Standard Rev. C. With a height of 4 TE it uses one slot on the VMEbus.

2. Summary of Technical Data

2.1 General Technical Data

VMEbus interface	IEEE 1014 / C.1
Data transfer mode	A16/D16, A24/D16
Interrupts	none
Temperature range	max. permissible ambient temperature: 0...70 ˚C
Humidity	max. 90%, non-condensing
Connectors	P1 - DIN 41612-C96 (VMEbus) P2 - DIN 41612-C64 (analog outputs 1-16) P800 - 34-pin post connector (analog outputs 1-8) P801 - 34-pin post connector (analog outputs 9-16) X140 - 8-pin socket strip (ISP-programming for testing)
Board dimensions	160 mm x 233 mm
VMEbus installation	6 HE high / 4 TE wide front panel with lever holds
Weight	ca. 320 g
Power supply	VMEbus P1: 5V ± 5% / 1.6 A (typical, at T = 20 ˚C, 16 channels)

Table 2.1.1: General module data

2.2 Technical Data of Analog Units

Number of D/A-channels	4, 8 or 16
Resolution	12 bits
D/A-converter	DAC813
Output voltage	configurable via jumpers: 0-10 V, ±5 V, ±10 V
Output capacity	$R_L \geq 2$ kΩ
Resolution	± 1 LSB in adjusted status, i.e. *) at 0-10 V: ≤ ± 2.5 mV at ±5 V: ≤ ± 2.5 mV at ±10 V: ≤ ± 5.0 mV
Settling time of D/A-converter	max. 6 µs / channel (at voltage swing 20 V, final value achieved to 0.01%)

Table 2.2.1: Technical data of analog units

***) Note:**
The board is default set and adjusted to bipolar operation (±10V).

If the board is set to unipolar operation (0...10 V) via jumpers without being coordinated via the gain potentiometer afterwards, you have to consider an additional deviation of about ½ LSB (referred to maximum value).

2.3 Order Information

Type	Features	Order no.
VME-DAC1612-04	4 analog outputs, 12 bits, adjusted for ±10V	V.1706.04
VME-DAC1612-08	8 analog outputs, 12 bits, adjusted for ±10V	V.1706.08
VME-DAC1612-16	16 analog outputs, 12 bits, adjusted for ±10V	V.1706.16
VME-DAC1612-ADAPT1	Adapter module with solderless lug connectors for connection to P2	V.1706.09
VME-DAC1612-ADAPT2	Adapter module with spring clip connectors for connection to P2	V.1706.10
DAC812-20mA-4	Adapter module for VME-DAC1612-04 to convert voltage outputs into current outputs 0(4)...20 mA for 4 channels	V.1702.24
DAC812-20mA-8	Adapter module for VME-DAC1612-08 to convert voltage outputs into current outputs 0(4)...20 mA for 8 channels	V.1702.28
VME-DAC1612-OS9	C-driver for OS-9 as source code	P.1706.50
VME-DAC1612-VxWorks	C-driver for VxWorks as source code	P.1706.56
VME-DAC1612-MD	German manual *)	V.1706.20
VME-DAC1612-ME	English manual *)	V.1706.21

*) If manual and VMEbus board are ordered together, the manual is included in the price of the board.

Table 2.4.1: Order information

3. Address Assignment

The basis address of the board is configured via the coding switches SW120...SW124. The basis address can be set in steps of 32 bytes in the 16 Mbyte address range.

In addition to 'STANDARD' accesses (A24) there is the possibility to use the VME-addressing 'SHORT I/O' (jumper J120). In this addressing the address lines A16 to A23 are ignored and the basis address of the VME-DAC1612 board is set in the 'SHORT I/O' address range (64 KByte) of the VME-system.

The basis address of the VME-DAC1612 is default set to $xxE20000.

Each of the 16 D/A-converters of the VME-DAC1612 has got its own access address, which has to be addressed word-by-word. In addition a mode register can be read in which the setting of the operating mode and the number of equipped channels of the VME-DAC1612 is evaluated.

Unit	Offset address	Access mode
D/A-converter: DAC16 DAC15 DAC14 DAC13 DAC12 DAC11 DAC10 DAC9	 + $1E + $1C + $1A + $18 + $16 + $14 + $12 + $10	 word-by-word, only writing access
D/A-converter: DAC8 DAC7 DAC6 DAC5 DAC4 DAC3 DAC2 DAC1	 + $E + $C + $A + $8 + $6 + $4 + $2 + $0	 word-by-word, only writing access
Mode register	+ $0	word-by-word, only reading access

Table 3.1.1: Address assignment of VME-DAC1612

If jumper J130/pin 1-2 is not set, the D/A-converters are selected by means of the data bits D15...D12 (see page 21).

4. Jumpers and Coding Switches

4.1 PCB-View

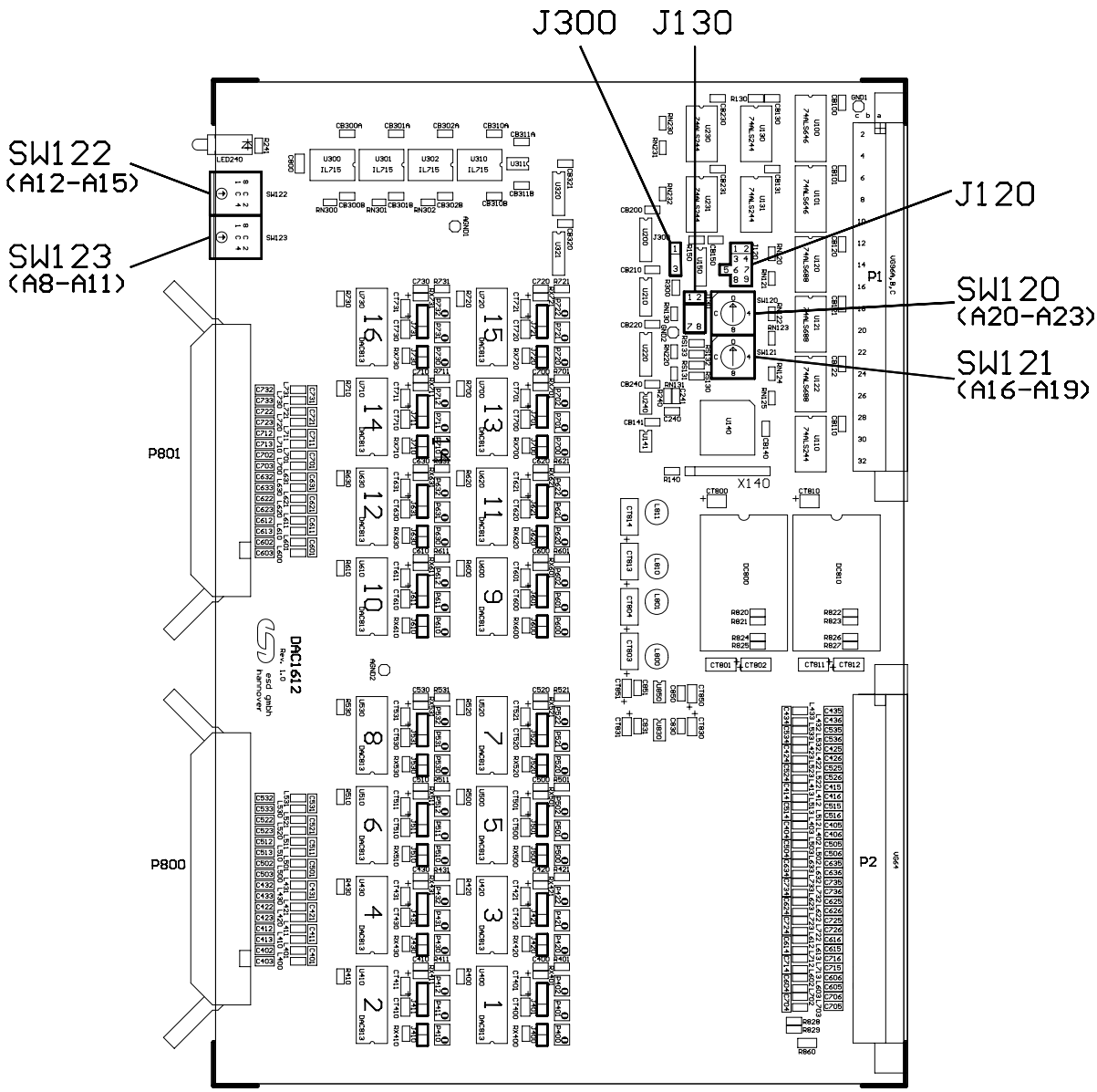


Fig 4.1.1: Position of coding switches and jumpers

4.1.1 Default Setting of Jumpers

The according default setting at board delivery is shown in the table below.
For the position of jumpers please refer to figure 4.1.1. The jumpers will be shown below as seen by users with the board in front of them and the VMEbus connectors on the right.

Default setting of jumpers:

Jumper	Function	Default setting at board delivery
SW120... SW123	basis address of board	VME-DAC1612: $E20000
J120	address modifier decoding	short/standard supervisory and non-privileged accesses permitted
J130	mode register	depending on model and the output voltage range selected
J300	output level after RESET (negation of data bit D11 for the D/A-converters)	D11 is inverted, i.e. a bipolar operation has been selected
J400, J410, J420, J430, J500, J510, J520, J530, J600, J610, J620, J630, J700, J710, J720, J730	voltage swing of the D/A-converter assigned	U = 20 V -▸ voltage range = ±10 V
J401, J411, J421, J431, J501, J511, J521, J531, J601, J611, J621, J631, J701, J711, J721, J731	bipolar/unipolar conversion of the D/A-converter assigned	bipolar : ±5V, ±10V

Table 4.1.1: Default setting of jumpers

4.1.2 Setting Basis Address and Address Modifier Decoding

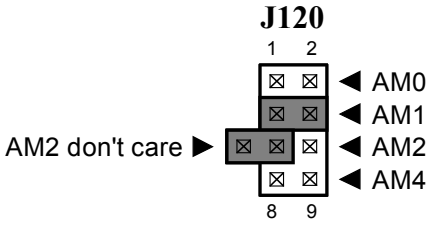
4.1.2.1 Basis Address (Coding Switch)

Address bits	Setting via coding switches	Default setting [Hex]	Position
A23...A20	SW120	E	on board next to VMEbus connector P1
A19...A16	SW121	2	
A15...A12	SW122	0	in front panel (above)
A11...A8	SW123	0	in front panel (below)

Table 4.1.2: Setting of basis address

4.1.2.2 Address Modifier (J120)

The address modifiers AM0 to AM5 are completely evaluated on board. The signals AM3 and AM5 are always decoded as '1'. The other signals can be configured via the jumper field J120. A set jumper sets the according bit to '0'.

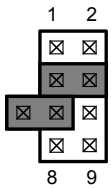
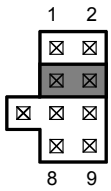
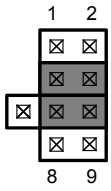
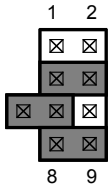
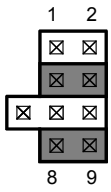
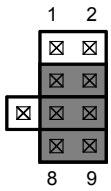


Example shown: standard setting of address modifiers:
standard supervisory data access and
standard nonprivileged data access and
short supervisory I/O access and
short nonprivileged I/O access permitted

The AM-configurations available to the VME-DAC1612 are listed in the table below. In addition to the AM-combinations listed, the bit AM2 can be ignored at decoding by setting jumper 'AM2 don't care'. Supervisor as well as nonprivileged accesses are permitted (see also example shown).

CODE	AM5	AM4	AM3	AM2	AM1	AM0	Function
$3E	1	1	1	1	1	0	standard supervisory program access
$3D	1	1	1	1	0	1	standard supervisory data access
$3A	1	1	1	0	1	0	standard nonprivileged program access
$39	1	1	1	0	0	1	standard nonprivileged data access
$2D	1	0	1	1	0	1	short supervisory I/O access
$29	1	0	1	0	0	1	short nonprivileged I/O access

Table 4.1.3: Selectable AM-combinations

Jumper field J120	permissible AM-codes							addressing
	AM5	AM4	AM3	AM2	AM1	AM0	HEX	
	1	1	1	0	0	1	39	standard nonprivileged data access or standard supervisory data access
	1	1	1	1	0	1	3D	
	1	1	1	1	0	1	3D	standard supervisory data access
	1	1	1	0	0	1	39	standard nonprivileged data access
	1	0	1	0	0	1	29	short nonprivileged access or short supervisory access
	1	0	1	1	0	1	2D	
	1	0	1	1	0	1	2D	short supervisory access
	1	0	1	0	0	1	29	short nonprivileged access

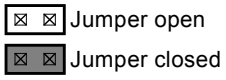


Table 4.1.4: Recommended useful AM-combinations

4.1.3 Configuration of Analog Units

34 jumper fields have been designed for the configuration of the board (number of channels, unipolar or bipolar operation).

Via jumper field J130 the number of equipped channels and a global flag for unipolar or bipolar operation is set in the mode register.

Via jumper field J300 the data bit D11 can be inverted for all D/A-converters together. This can be used, for example, to reset the D/A-converters to 0 V in bipolar operation after a RESET.

Jumpers J400 to J731 switch the respective D/A-converter outputs to unipolar or bipolar operation and the desired voltage swing.

4.1.4 Mode Register (J130)

The mode register is a 'read-only' register to configure the board via software. It is read as WORD under the local address '$00'. The LSB (D0-D7) is always read as $01. It is used to identify the board as VME-DAC1612 in the VMEbus system.

The MSB contains information about the number of D/A-converter channels equipped and the polarity of the output voltage. Depending on whether the output voltage is unipolar or bipolar, the D/A-data has to be specified in the format 'Unipolar Straight Binary' or 'Binary Two's Complement'.

Register bit	Assignment	
D15	Number of D/A-converter channels (set via the equipment of resistors)	
D14		
D13		
D12		
D11	Jumper J130, pin 7-8, available for user	
D10	Jumper J130, pin 5-6, switching between unipolar/bipolar	
D9	Jumper J130, pin 3-4, reserved	
D8	Jumper J130, pin 1-2, DAC-addresses D12-D15/A1-A4	
D7	0	These bits identify the board in the VMEbus system and cannot be changed.
D6	0	
D5	0	
D4	0	
D3	0	
D2	0	
D1	0	
D0	1	

Table 4.1.5: Jumper field J130 in mode register

A set jumper sets the according data bit to '0'.

D8: DAC-addresses
D12-D15/A1-A4...

The D/A-converters of the VME-DAC1612 are usually selected via the four least significant address bits (A1...A4). If the jumper J130/pin 1-2 has not been set, the D/A-converters are not selected via the addresses, but the most significant data bits (D11...D15). These bits are transmitted along with the 12-bit analog value.
On the standard version of the board this jumper is default-set.

D10: unipolar/bipolar...

D 10 specifies whether the D/A-converters on board have been configured for unipolar or bipolar operation. The format of the transmitted D/A-data depends on the polarity selected.

Jumper J130, pin 5-6	Bit D10	Polarity	Data format
open	0	unipolar	USB (Unipolar Straight Binary)
set	1	bipolar	BTC (Binary Two's Complement) **Default setting at delivery**

It is principly possible to select unipolar operation fo some channels and bipolar operation for others. However, this is not recommendable, because it does not only cause irregularities for this jumper, but also for jumper field J300. Especially the resetting of channels to 0 V after a RESET is not possible simultaneously for unipolar and bipolar operation.

D11: free for users...

This jumper can be freely set and evaluated by the user.

D12-D15: DAC-number...

By means of these four bits the number of equipped D/A-converter channels can be read. The bits encode the channel number as follows:

Bit 3 (D15)	Bit 2 (D14)	Bit 1 (D13)	Bit 0 (D12)	Number of equipped D/A-converter channels
0	0	0	1	1
0	0	0	0	2
0	0	1	1	3
0	0	1	0	4
0	1	0	1	5
0	1	0	0	6
0	1	1	1	7
0	1	1	0	8
1	0	0	1	9
1	0	0	0	10
1	0	1	1	11
1	0	1	0	12
1	1	0	1	13
1	1	0	0	14
1	1	1	1	15
0	0	0	0	16

Table 4.1.6: Encoding the number of equipped D/A-converter channels

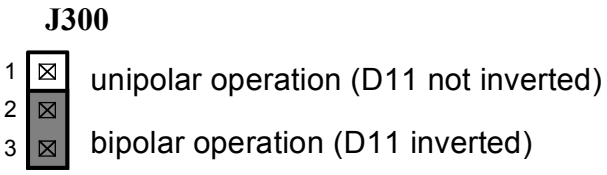
4.1.5 Negation of Data Bit D11 (J300)

Via jumper field J300 the data bit D11 can be inverted for all D/A-converters simultaneously. This is necessary, because depending on the mode of the output voltage, the D/A-converters expect the data in various formats:

In **unipolar** operation the data has to be transmitted in **USB (Unipolar Straight Binary)** format.

In **bipolar** operation the converter expects the data in **BTC (Binary Two's Complement)** format.

Attention:
The negation is especially important, because the analog outputs will only be set to 0 V after a RESET, if bit D11 has got the level required for the operating mode!



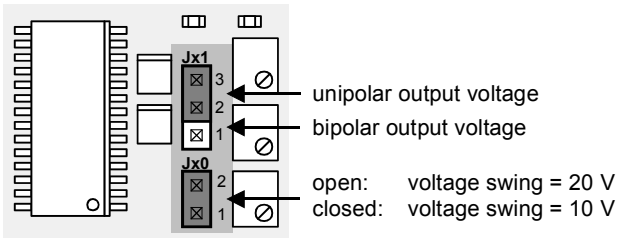
Example: D11 inverted for bipolar operation of D/A-converter outputs

4.1.6 Selecting the Output Voltage Range (J400-J731)

For each analog channel there are two jumper fields to configure the voltage range. As the jumpers are closely connected, they will be explained together.

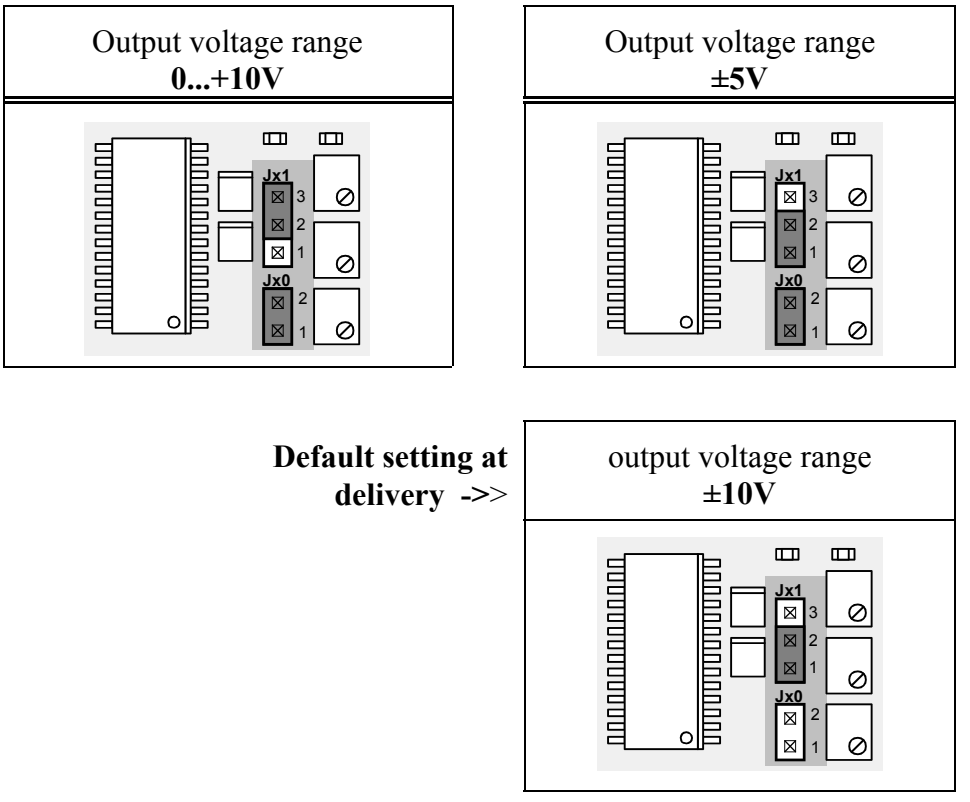
The voltage swing of the A/D-converters is set via jumpers J400...J730. Unipolar and bipolar operations are selected by means of the three-pin jumper fields J401...J731. For the assignment of jumpers to the sixteen channels, please refer to the PCB view on page 8. There the channel units are designated by numbers.

Alternatively, the voltage swing can also be determined by equipping resistors. In that case the jumpers are not equipped.



Example: Unipolar output voltage 0...+10V

Jumper settings for output voltage ranges



It is also important to make sure that the correct output

configuration has been set in mode register via BR1 and that the correct polarity has been assigned to data bit D11 via BR7!

Note:
Principally, unipolar and bipolar output configurations can be selected on a VME-DAC1612. However, this is not recommendable, because other settings (at J130) are made simultaneously for all channels of the board.

The jumpers are assigned to output channels as follows:

Jumper for voltage swing	Jumper for polarity	Output channel
J400	J401	1
J410	J411	2
J420	J421	3
J430	J431	4
J500	J501	5
J510	J511	6
J520	J521	7
J530	J531	8
J600	J601	9
J610	J611	10
J620	J621	11
J630	J631	12
J700	J701	13
J710	J711	14
J720	J721	15
J730	J731	16

Table 4.1.7: Assignment of jumpers BR8 to BR23 to output channels

Note:
For the assignment of jumpers to the sixteen channels, please refer to the PCB view on page 8. There the channel circuits are designated by numbers.

5. Analog Outputs

5.1 Output Circuit

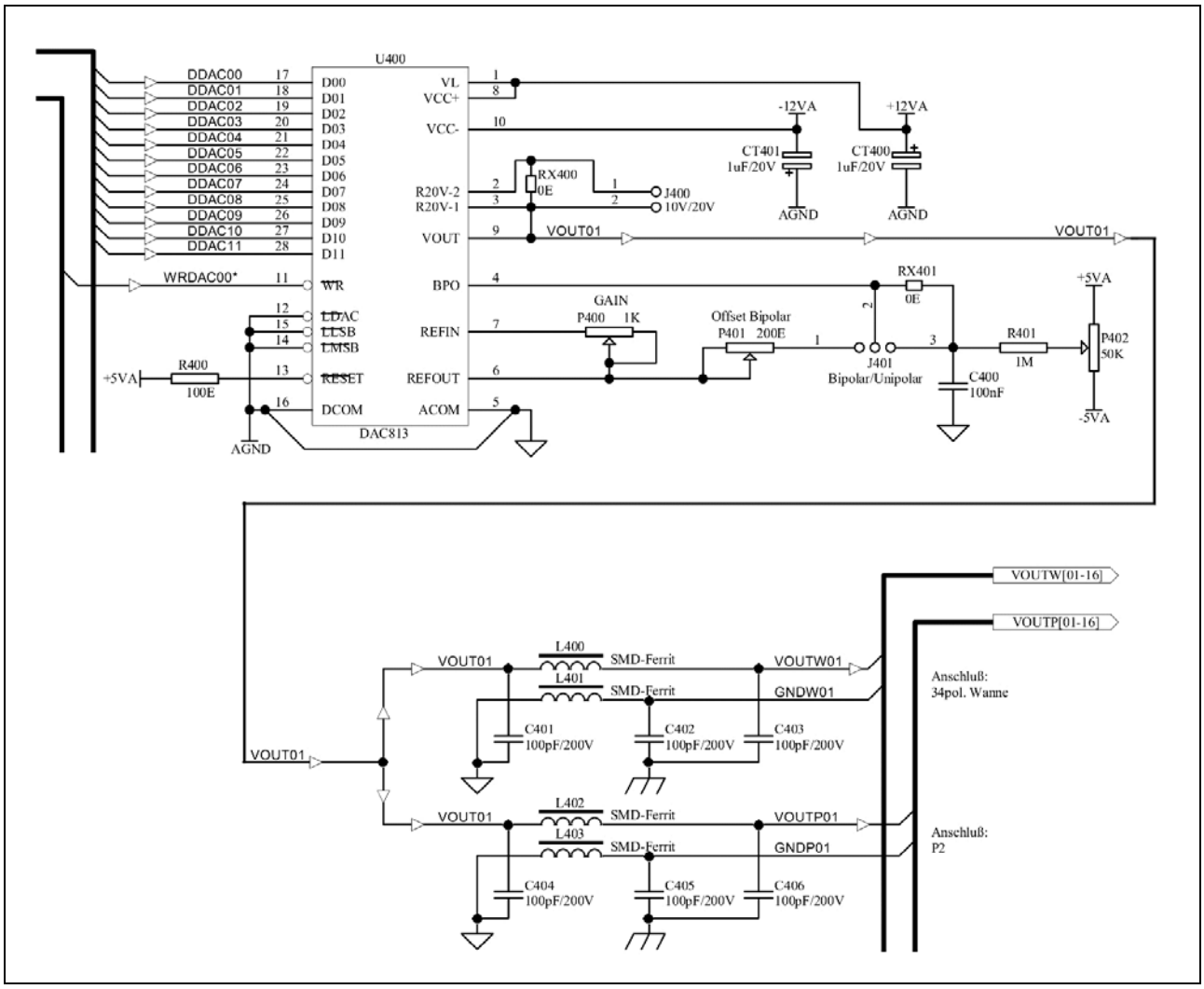


Fig. 5.1.1: Output circuit of the VME-DAC1612 (example: channel 1)

5.2 Operating Modes of the D/A-Converters

5.2.1 Data Transfer

Each of the 16 D/A-converters of the VME-DAC1612 has got its own access address. Writing the data at this address sets the D/A-converters und starts the conversion. The data has to be transferred word by word, because the conversion is started immediately when the WRITE signal is cancelled!

Additionally, a mode register can be read in which the setting of the output polarity and the number of equipped channels can be evaluated. The mode register has already been described in the chapter 'Mode Register (J130)' on page 14.

The D/A-converters evaluate the received data word as follows:

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
x	x	x	x	f MSB	f	f	f	f	f	f	f	f	f	f	f LSB

Meaning of bits:

D/A-converter data (f f f f .f f f f .f f f f)

Data bit D11 can be inverted for all D/A-converters simultaneously by means of jumper J300. This is necessary if the outputs are run in bipolar mode, because the D/A-converters expect the data in various formats, depending on the operating mode:

In **unipolar** operation the data have to be specified in
USB (Unipolar Straight Binary) format.
In **bipolar** operation the converter expects the data in
BTC (Binary Two's Complement) format.

Attention!
The negation is especially important, because the analog outputs will only be set to 0 V following a RESET, if bit D11 has got the level required for this operating mode!

In mixed operation of bipolar and unipolar channels on the VME-DAC1612 it is up to the user to decide which channels are to be set to 0 V after a RESET*.

In the following chapters the voltage values corresponding to the binary data words of the respective operating mode will be shown.

Alternative channel selection (xxxx)

These bits (D15...D12) are not evaluated, unless jumper J130/pin 1-2 is not set (‘1’). In this case the desired D/A-converter is selected via these bits:

Value of bits				D/A-converter (output channel)
D15	D14	D13	D12	
0	0	0	0	1
0	0	0	1	2
0	0	0	0	3
0	0	1	1	4
0	0	1	0	5
0	1	0	1	6
0	1	0	0	7
0	1	1	1	8
0	1	1	0	9
1	0	0	1	10
1	0	0	0	11
1	0	1	1	12
1	0	1	0	13
1	1	0	1	14
1	1	0	0	15
1	1	1	1	16

Table 5.2.1: Selection of D/A-converter

If jumper J130/pin 1-2 is set (‘0’), the D/A-converters are selected via addresses A1...A4, as described on page 7.

5.2.2 Unipolar Operation 0...10 V

Prerequisite for a unipolar operation with 0...10 V is the correct configuration of the board via the jumpers (J300 for all channels together and two of jumpers J400...J731 for the according channel)!

For the output voltage range 0...10V the converter components DAC813 require the data in format 'USB' (Unipolar Straight Binary). The following table shows the assignment of data to output voltages for this format by means of some basic data.

Input D11 D0 MSB LSB ▼ ▼	Output	
111111111111	+ maximum value	(+ 9.9976 V)
100000000000	+ ½ maximum value	(+ 5.0000 V)
011111111111	+ ½ maximum value-1 LSB	(+ 4.9976 V)
000000000000	null	(0.0000 V)

Table 5.2.2: Data format for output voltages of 0...10 V

5.2.3 Bipolar Operation ±5 V

Prerequisite for a bipolar operation with ±5 V is the correct configuration of the board via the jumpers (J300 for all channels together and two of jumpers J400...J731 for the according channel)!

For the output voltage range ±5 V the converter components DAC813 require the data in 'BTC' (Binary Two's Complement) format. The following table shows the assignment of data to output voltages for this format by means of some basic data.

Input D11 D0 MSB LSB ▼ ▼	Output
111111111111	- 1 LSB (- 0.0024 V)
100000000000	- maximum value (- 5.000 V)
011111111111	+ maximum value (+ 4.9975 V)
000000000000	null (0.0000 V)

Table 5.2.3: Data format for output voltages of ±5 V

5.2.4 Bipolar Operation ±10 V

Prerequisite for a bipolar operation with ±10 V is the correct configuration of the board via the jumpers (J300 for all channels together and two of jumpers J300...J731 for the according channel)!

For the output voltage range ±10 V the converter components DAC813 require the data in 'BTC' (Binary Two's Complement) format. The following table shows the assignment of data to output voltages for this format by means of some basic data.

Input D11 D0 MSB LSB ▼ ▼	Output	
111111111111	- 1 LSB	(- 0.0049 V)
100000000000	- maximum value	(- 10.0000 V)
011111111111	+ maximum value	(+ 9.9951 V)
000000000000	null	(0.0000 V)

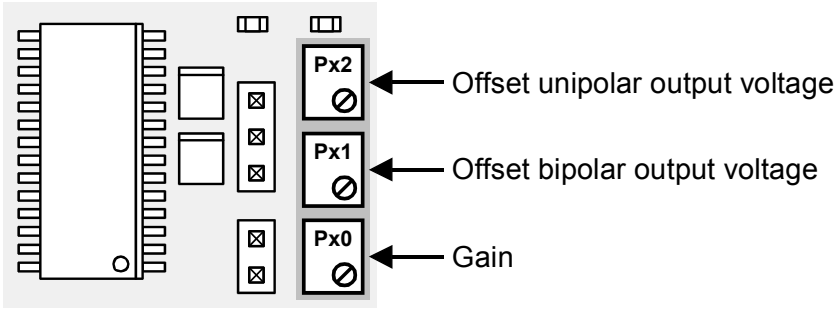
Table 5.2.4: Data format for output voltages of ±10 V

5.3 Adjusting the D/A-Converters

Offset and Gain have already been adjusted by the manufacturer. However, if another adjustment, for instance following a change in operating mode of a channel, was required, just follow the instructions given in the following chapters.

Note:
For the assignment of potentiometers to the sixteen channels please refer to the PCB view on page 8. There the channel circuits are designated by numbers.

For each channel three potentiometers are available for adjustment:



The following table shows the potentiometers for Offset (unipolar and bipolar) and Gain for each D/A-channel.

D/A-converter channel	Potentiometer		
	Gain	Offset bipolar	Offset unipolar
1	P400	P401	P402
2	P410	P411	P412
3	P420	P421	P422
4	P430	P431	P432
5	P500	P501	P502
6	P510	P511	P512
7	P520	P521	P522
8	P530	P531	P532
9	P600	P601	P602
10	P610	P611	P612
11	P620	P621	P622
12	P630	P631	P632
13	P700	P701	P702
14	P710	P711	P712
15	P720	P721	P722
16	P730	P731	P732

Table 5.3.1: Assignment of adjusting potentiometers to channels

5.3.1 Offset Setting

The offset voltage is adjusted by means of a potentiometer (see above). Via this adjustment the offset voltage of the D/A-converter and the following operation amplifier is set.

In unipolar operation the value $0000 is applied to the D/A-converter which is to generate an output voltage of 0.0 V at the output of the according channel of the VME-DAC1612.

$0000 -► 0.0 V

Via offset potentiometer ‘Px2’ the output of the respective channel is set to 0.0 V.

In bipolar operation (BTC) the value $0800 is applied to the D/A-converter which is to generate the maximum possible negative output voltage.

$0800 -► -5.0 V or -10.0 V

Via offset potentiometer ‘Px1’ the output of the respective channel is set to the maximum possible negative output voltage (-5.0 V or -10.0 V).

5.3.2 Gain

For unipolar as well as for bipolar operation a digital value is applied to the D/A-converter which generates the maximum possible positive output voltage:

	$0FFF = +9.9976 V	in unipolar operation
or	$07FF = +4.9976 V or +9.9951 V	in bipolar operation

Via gain potentiometer ‘Px0’ the output of the respective channel is set to the maximum possible positive output voltage.

Note:

The board is first configured and adjusted to the unipolar operation by the manufacturer. Then it is configured and adjusted to bipolar operation. The board is delivered with the bipolar setting (±10 V).

If the board is then changed to unipolar operation (0...10 V) via jumpers again and is then *not* adjusted via the gain potentiometer, you have to expect a further deviation of about ½ LSB (regarding to the maximum value) in unipolar operation.

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6. Software

6.1 Initialisation

The D/A-converter outputs generally do not have to be especially initialized after a RESET signal by the VMEbus, if the same operating mode was selected for all output channels. In this case a sequence control on board resets the output voltages to 0.0 V.

In mixed operation (unipolar and bipolar) the reset status for only one operating mode is met, however, so that the other channels should be reset by the user.

An output voltage at the D/A-converter channel can be generated by writing the data word word-by-word (depending on operating mode) at the corresponding address of the DAC channel.

The following page shows an example program for accesses to the VME-DAC1612 board in realtime-multitasking-standard language PEARL.

The MODE register can only be read (see chapter ‘Mode Register (J130)’, page 14), from which the user can take information about the configuration of the VME-DAC1612-board in the system.

6.2 PEARL-Example Program to Generate Lissajous-Figures on an Oscilloscope

```
MODULE DAC812;
SYSTEM;
    /* für 'xx' jeweils VMEbus Adresse einsetzen */
dac0   : BU(xxE20000,02)   ->; /* DA-Wandler Nr. 1 */
dac1   : BU(xxE20002,02)   ->; /* DA-Wandler Nr. 2 */
dac2   : BU(xxE20004,02)   ->; /* DA-Wandler Nr. 3 */
dac3   : BU(xxE20006,02)   ->; /* DA-Wandler Nr. 4 */
dac4   : BU(xxE20008,02)   ->; /* DA-Wandler Nr. 5 */
dac5   : BU(xxE2000A,02)   ->; /* DA-Wandler Nr. 6 */
dac6   : BU(xxE2000C,02)   ->; /* DA-Wandler Nr. 7 */
dac7   : BU(xxE2000E,02)   ->; /* DA-Wandler Nr. 8 */
dacmode: BU(xxE20000,02)  <- ; /* DAC-Revision, read only */
PROBLEM;
SPC (dac0,dac1,dac2,dac3,dac4,dac5,dac6,dac7)
            DATION OUT BASIC;
SPC dacmode DATION IN  BASIC;
SPC PI      FLOAT GLOBAL;
...
lissajous: TASK;
/* Lissajous-Figuren mit DAC_0=x und DAC_1=y auf einem
   Oszilloskope
   ! unipolar- oder bipolar-Mode beachten ! */;
 DCL (a, r, b)      FLOAT;
 DCL (sinus, cosin) FIXED;
 DCL speed          FIXED INIT(5);
 b=TOFIXED '0800'B4-0.5;
 REPEAT;
   r=PI/speed;
   FOR i FROM  -speed TO speed REPEAT;
    sinus=ROUND((SIN(i*r)+1.0)*b);
    cosin=ROUND((COS(i*r)+1.0)*b);
    SEND sinus  TO dac0;
    SEND cosin  TO dac1;
   END;
 END;
END;                          /* of Task "lissajous" */
...
MODEND;
```

7. Appendix

7.1 Connector Assignment

7.1.1 VMEbus Connector P1

Pin	Row a	Row b	Row c
1	D00	-	D08
2	D01	-	D09
3	D02	-	D10
4	D02	BG0IN* ⌉	D11
5	D04	BG0OUT* ⌋	D12
6	D05	BG1IN* ⌉	D13
7	D06	BG1OUT* ⌋	D14
8	D07	BG2IN* ⌉	D15
9	GND	BG2OUT* ⌋	GND
10	-	BG3IN* ⌉	-
11	GND	BG3OUT* ⌋	-
12	DS1*	-	SYSRESET*
13	DS0*	-	LWORD*
14	WRITE*	-	AM5
15	GND	-	A23
16	DTACK*	AM0	A22
17	GND	AM1	A21
18	AS*	AM2	A20
19	GND	AM3	A19
20	IACK*	GND	A18
21	IACKIN* ⌉	-	A17
22	IACKOUT* ⌋	-	A16
23	AM4	GND	A15
24	-	-	A14
25	-	-	A13
26	-	-	A12
27	A04	-	A11
28	A03	-	A10
29	A02	-	A09
30	A01	-	A08
31	-	-	-
32	+5V	+5V	+5V

Spring contact strip according to DIN41612 design C96/a+b+c
I_{max} per pin : 1.0 A

⌉⌋ ... signals on board bridged
- ... signal not connected

7.1.2 I/O-Connector P2 and Transition Module

Assignment of a 64-pin transition module					
	Assignment of I/O-connector P2				
Pin	Row a	Signal		Row c	Pin
2	1	-	-	1	1
4	2	-	-	2	3
6	3	DAC4-GND	DAC4-OUT	3	5
8	4	-	-	4	7
10	5	DAC8-GND	DAC8-OUT	5	9
12	6	-	-	6	11
14	7	DAC3-GND	DAC3-OUT	7	13
16	8	-	-	8	15
18	9	DAC7-GND	DAC7-OUT	9	17
20	10	-	-	10	19
22	11	DAC2-GND	DAC2-OUT	11	21
24	12	-	-	12	23
26	13	DAC6-GND	DAC6-OUT	13	25
28	14	-	-	14	27
30	15	DAC1-GND	DAC1-OUT	15	29
32	16	-	-	16	31
34	17	DAC5-GND	DAC5-OUT	17	33
36	18	-	-	18	35
38	19	DAC12-GND	DAC12-OUT	19	37
40	20	DAC16-GND	DAC16-OUT	20	39
42	21	DAC11-GND	DAC11-OUT	21	41
44	22	DAC15-GND	DAC15-OUT	22	43
46	23	DAC10-GND	DAC10-OUT	23	45
48	24	DAC14-GND	DAC14-OUT	24	47
50	25	DAC09-GND	DAC9-OUT	25	49
52	26	DAC13-GND	DAC13-OUT	26	51
54	27	-	-	27	53
56	28	(+5 V_{analog})	(+5 V_{analog})	28	55
58	29	(-15 V_{analog})	(-15 V_{analog})	29	57
60	30	(+15 V_{analog})	(+15 V_{analog})	30	59
62	31	GND_{analog}	GND_{analog}	31	61
64	32	-	-	32	63

I/O-connector: spring contact strip according to DIN41612 design C64/a+c
I_{max} per pin : 1.0 A

See the following page for the description of signals.

Signal descriptions for `I/O-connector P2 and transition module':

-	...	These connector pins are not connected on board.
DACx-OUT	...	Output of A/D-converter channel 'x' (x = 1, 2, ...16)
DACx-GND	...	reference potential of A/D-converter output 'x'
($+5V_{analog}$), ($+15V_{analog}$), ($-15V_{analog}$)		**Attention!** In the standard version of the board the analog supply voltages are generated via DC/DC-converters from the +5V-power supply of the VMEbus. The supply voltages ($+5V_{analog}$), ($+15V_{analog}$) and ($-15V_{analog}$) **are not** connected, therefore!
GND_{analog}	...	The reference potential of the analog supply voltages is only required at P2, if the DAC812 adapter is used for the conversion of voltage outputs to current outputs. The reference potential of the analog supply voltages is connected to the reference potentials of the analog outputs only on the VME-DAC1612 board and not on the adapter. Therefore the reference potential of the supply voltages of the VME-DAC1612 and the reference potential of the supply voltages of the adapter board (GND_{analog}) are connected via P2.

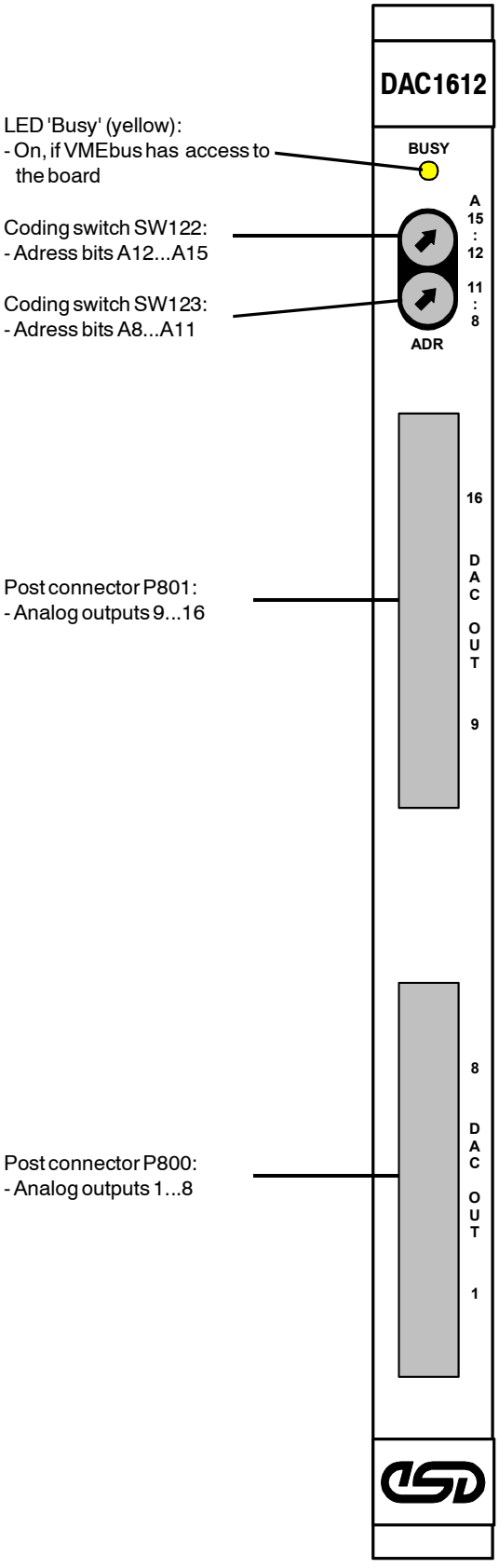
7.1.3 Post Connectors P800 and P801

Signal	Pin **P801**		Signal
DAC9-GND	1	2	DAC9-OUT
DAC9-GND	3	4	-
DAC10-GND	5	6	DAC10-OUT
DAC10-GND	7	8	-
DAC11-GND	9	10	DAC11-OUT
DAC11-GND	11	12	-
DAC12-GND	13	14	DAC12-OUT
DAC12-GND	15	16	-
DAC13-GND	17	18	DAC13-OUT
DAC13-GND	19	20	-
DAC14-GND	21	22	DAC14-OUT
DAC14-GND	23	24	-
DAC15-GND	25	26	DAC15-OUT
DAC15-GND	27	28	-
DAC16-GND	29	30	DAC16-OUT
DAC16-GND	31	32	-
Shield	33	34	Shield

Signal	Pin **P800**		Signal
DAC1-GND	1	2	DAC1-OUT
DAC1-GND	3	4	-
DAC2-GND	5	6	DAC2-OUT
DAC2-GND	7	8	-
DAC3-GND	9	10	DAC3-OUT
DAC3-GND	11	12	-
DAC4-GND	13	14	DAC4-OUT
DAC4-GND	15	16	-
DAC5-GND	17	18	DAC5-OUT
DAC5-GND	19	20	-
DAC6-GND	21	22	DAC6-OUT
DAC6-GND	23	24	-
DAC7-GND	25	26	DAC7-OUT
DAC7-GND	27	28	-
DAC8-GND	29	30	DAC8-OUT
DAC8-GND	31	32	-
Shield	33	34	Shield

34-pin post connector in front panel with locking.
Please refer to previous page for a description of signals.

7.2 Front Panel



7.3 DAC812-Adapter (DAC812-20mA)

7.3.1 Overview

The optional adapter DAC812-20mA is connected to I/O-connector P2. The adapter converts the output voltage of 0...10 V to a current of 0(4)...20 mA. You can select between 0...20 mA and 4...20 mA via a jumper. When using a precision load resistor at the current output, the voltage drop caused by the connected line can be compensated: if, for instance, a resistor of 500 Ω is connected to the output configured for 0...20 mA, the voltage drop over the resistor is always 0...10 V.

The conversion from voltage/current is made via converter component XTR110 by means of a transistor (BSS110), connected in series. Potentiometers for adjusting offset and gain are available for each of the at most 8 channels. The channels have already been adjusted by the manufacturer.

Each of the voltage/current converters has got three jumpers, by which the three different operating modes can be selected:

1. Voltage output (the output voltage of the VME-DAC1612 is directly fed to the terminals of the adapter. All voltage ranges of the VME-DAC1612 are permissible)
2. Current output 0...20 mA
3. Current output 4...20 mA (line break recognition)

7.3.2 PCB View with Jumpers

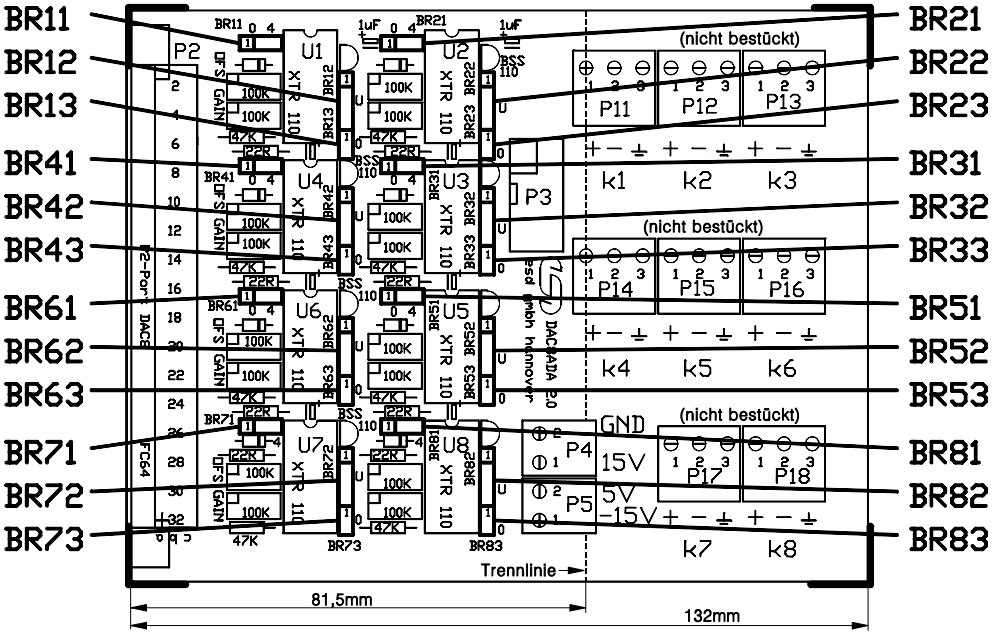


Fig. 7.3.1: Position of jumpers on the DAC812-adapter

7.3.3 Default Settings of Jumpers

The respective default setting at the time of delivery of the board can be found in the table below.

The position of jumpers can be found in figure 7.3.1. The jumpers are shown below as seen by users with the board in front of them, transition connector P2 pointing to the left.

Jumper	Function	Default setting at the time of delivery
BR11, BR21,... ...BR81	Selection between 0...20 mA and 4...20 mA	all channels set to 0...20 mA
BR12, BR22,... ...BR82	Selection between current and voltage output	all channels set to current output
BR13, BR23,... ...BR83	Determining the reference input of the voltage/current converters for 0...20 mA or 4...20 mA	set to 0...20 mA for all channels

Table 7.3.1: Default setting of jumpers

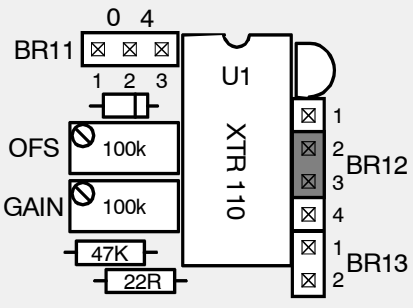
7.3.4 Description of Jumpers

Each channel of the DAC812-adapter has got three jumper fields. By means of bridges Brx1 and Brx3 (x= 1, 2,..., 8 for the channel number) 0...20 mA and 4...20 mA current outputs are distinguished. Jumper Brx2 distinguishes between voltage and current output.

Channel No.	Current or voltage output	0...20 mA or 4...20 mA output
1	BR12	BR11 and BR13
2	BR22	BR21 and BR23
3	BR32	BR31 and BR33
4	BR42	BR41 and BR43
5	BR52	BR51 and BR53
6	BR62	BR61 and BR63
7	BR72	BR71 and BR73
8	BR82	BR81 and BR83

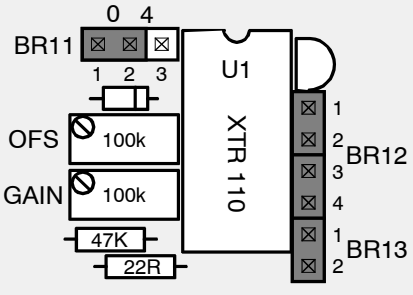
Table 7.3.2: Assignment of jumpers to channels

There are three combinations of jumper positions. They are shown in the following figures. The example in the diagrams always shows the first channel in the possible configurations. The position of the jumpers of the individual channels can be taken from the figure 'Position of jumpers of the DAC812-adapter' above.



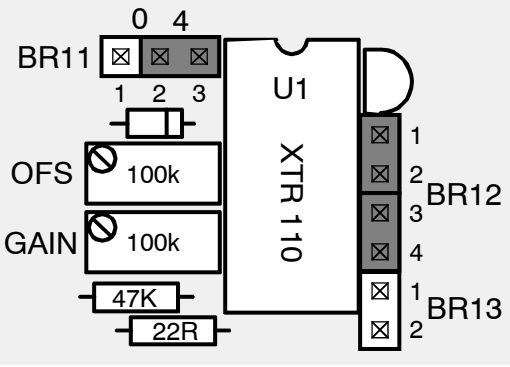
Voltage outputs
If the output voltage of the VME-DAC1612 is to fed through for a channel, a jumper has to bridge pins 2-3 in jumper field Brx2. Jumper fields Brx1 and Brx2 are insignificant in this case.
(x = 1, 2,...,8 for the channel number).

Fig. 7.3.2: Jumper position for voltage outputs



0...20 mA current outputs
For current outputs pins 1-2 and 3-4 of jumper field BRx2 have to be bridged. For operation with 0...20 mA a jumper has to be set on pins 1-2 of jumper field Brx1 and jumper Brx3 has to be set additionally.
(x = 1, 2,...,8 for the channel number).

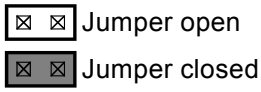
Fig. 7.3.3: Jumper position for 0...20 mA current outputs.



4...20 mA current outputs
For current outputs pins 1-2 and 3-4 of jumper field BRx2 have to be bridged. For operation with 4...20 mA you also have to bridge pins 2-3 of jumper field Brx1. Jumper Brx3 remains open.
(x = 1, 2,...,8 for the channel number).

Fig. 7.3.4: Jumper position for 4...20 mA current outputs

Description of jumper symbol:



7.3.5 Conversion of Voltages to Currents

The conversion of output voltage to current outputs is shown in the table below:

VME-DA1612-output voltage [V]	Output current of the DAC812-20mA adapter [mA]
+ 0.0 + 0.0 (4 mA option) + 9.9975	+ 0.0 + 4.0 + 20.0

Table 7.3.3: Voltage/current assignment

7.3.6 Adjusting the Channels

Offset and Gain have already been adjusted by the manufacturer. If you require another adjustment, for instance following a change in the operating mode of a channel, please refer to the previous chapter 'Adjusting the D/A-Converters'. Instead of the voltage values cited there, you set the equivalent current values.

If you only feed through the output voltage of the VME-DAC1612, you do not have to adjust offset and gain.

7.3.7 Assignment of Connectors of the DAC812-Adapter

In addition to the 64-pin socket strip P2 the adapter has got a 10-pin post connector (P3) to connect the analog outputs via flat ribbon cable and it has got screw terminals to connect the analog supply voltages (P4, P5).

The analog outputs can also be connected via screw-type terminals (such as *PHOENIX* SMKDS1.2-3) (P11-P18). These connectors are not available in the standard version of the adapter. If required, they can be equipped afterwards by the user or the manufacturer, if desired.

If connectors P11 to P18 are not required, the adapter board can be sawn-off at the line especially marked. This is useful, if the space in the VMEbus system is limited. The length of the board is reduced from 132 mm to 81.5 mm. Please refer to figure 'Position of jumpers of the DAC812-adapter' above for the position of the line.

7.3.7.1 Transition Connector P2

Assignment of I/O-connector P2			
Row a	Signal		Row c
1	Signal-GND	-	1
2	.	-	2
3	.	DAC4-IN	3
4	.	-	4
5	.	DAC8-IN	5
6	.	-	6
7	.	DAC3-IN	7
8	.	-	8
9	.	DAC7-IN	9
10	.	-	10
11	.	DAC2-IN	11
12	.	-	12
13	.	DAC6-IN	13
14	.	-	14
15	.	DAC1-IN	15
16	.	-	16
17	Signal-GND	DAC5-IN	17
18	-	-	18
19	-	-	19
20	-	-	20
21	-	-	21
22	-	-	22
23	-	-	23
24	-	-	24
25	-	-	25
26	-	-	26
27	-	-	27
28	+5 V_{analog}	+5 V_{analog}	28
29	-15 V_{analog}	-15 V_{analog}	29
30	+15 V_{analog}	+15 V_{analog}	30
31	GND_{analog}	GND_{analog}	31
32	-	-	32

I/O-connector: Spring contact strip in accordance with DIN41612 design C64/a+c
I_{max} per pin : 1.0 A

For signal description turn to the following page.

Signal descriptions to `Transition Connector P2`:

-	...	these connector pins are not connected on board
DACx-IN	...	analog input signal of the DAC812-adapter board (= output of VME-DAC1612 with x = 1...8)
Signal-GND	...	reference potential of analog inputs of the adapter board
$+5\ V_{analog}$, $+15\ V_{analog}$, $-15\ V_{analog}$, GND_{analog}	...	power supply of analog units

Note:
The analog supply voltages of the VME-DAC1612 are generated via DC/DC-converters from the +5 V supply voltage of the VMEbus. The DAC812-adapter requires its own analog power supply of 5 V and ±15 V, however!

Note:
The potentials 'Signal-GND' and 'GND_{analog}' are connected to each other on the VME-DAC1612-board. On the adapter board these signals are not connected.

7.3.7.2 Analog Outputs at P3

Signal	Pin		Signal
OUT 1	1	2	OUT 2
OUT 3	3	4	OUT 4
OUT 5	5	6	OUT 6
OUT 7	7	8	OUT 8
GND_{analog}	9	10	Signal-GND

10-pin post connector

OUT x ... analog output signal of the DAC812-adapter:
voltage output of the VME-DAC1612 or
current output 0...20 mA or
current output 4...20 mA

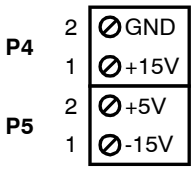
Signal-GND ... reference potential of analog outputs

GND_{analog} ... reference potential of the power supply of analog units
(used as shield)

Note:
The potentials 'Signal-GND' and 'GND_{analog}' are connected to each other on the VME-DAC1612-board. On the adapter board these signals are not connected.

7.3.7.3 Supplying the Analog Units via Screw Terminals (P4, P5)

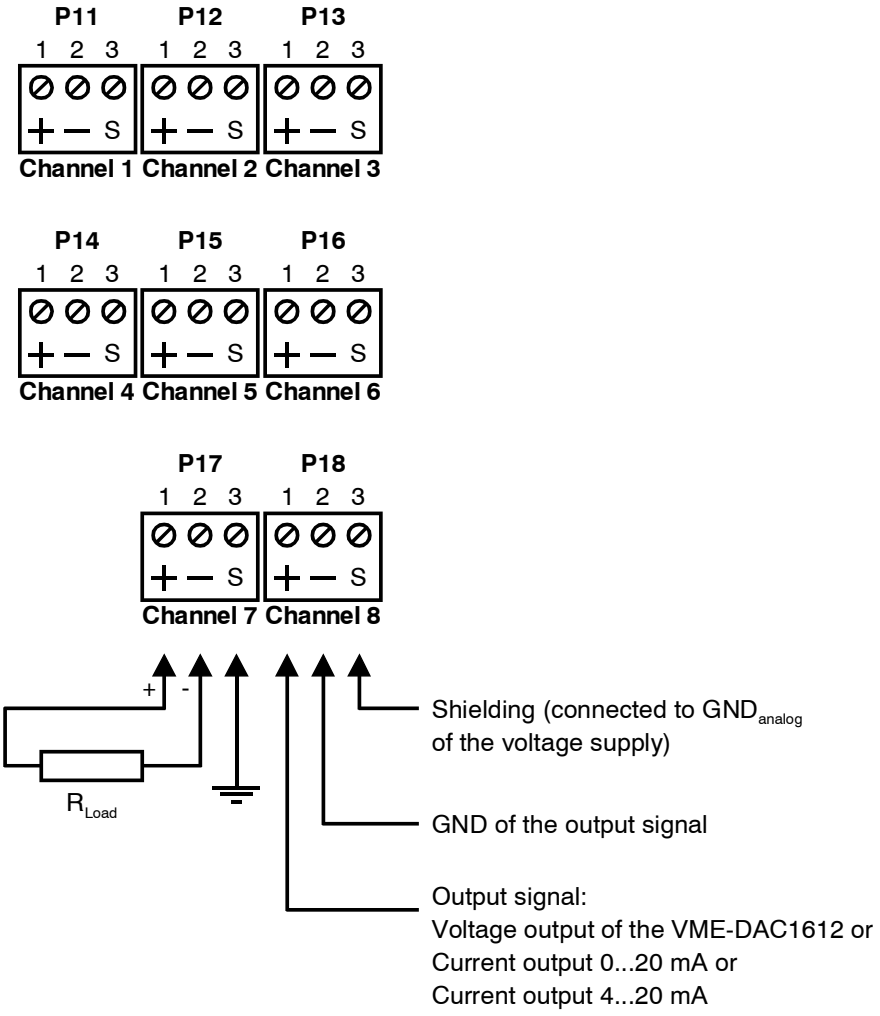
If the DAC812-adapter is not only to be used to feed through the output voltages of the VME-DAC1612, the power supply of the analog units of the adapter has to be supplied via P4 and P5.



P4 and P5 are 'SMKDS1.2' screw terminals and can be connected to lines with a cross-section of up to 1.5 mm^2.

7.3.7.4 Analog Outputs via Screw Terminals (P11-P18)

Screw terminals P11 to P18 can be equipped later, if required. They are not available on the standard board of the DAC812-adapter.



7.4 Circuit Diagrams of the VME-DAC1612 and DAC812-Adapter

The circuit diagrams are not available in PDF-format. They will be sent to you on request.