M320 12-bit 8/16 Channel ADC M-module

Hardware Manual

Revision 2.0

Contents

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1. General Description

1.1. Validity of the Manual

Edition E2.0: This manual applies to the M320 R3.7 and up. Revision 3.7 means revision 3 PCB and revision 7 of the firmware implemented in pld's.

1.2. Using the Manual

This manual serves as instruction for the operation of the M320 12-bit 8/16 Channel M-module, the connection of peripheral devices and the integration with a M-module carrier. Furthermore it gives the user additional information for special applications and configurations of the assembly.

Detailed information concerning the individual assemblies (data sheets etc.) are not part of this manual. In the annex you will find a bibliography.

This manual describes the hardware of the assembly.

Notes concerning the nomenclature:

Hex numbers are marked with a leading "$"-sign: for example: $800000 or $BFFFFF.

Active-low signals are represented by a trailing asterisks (i.e. IACK*).

2. Introduction

The M320 12-bit 8/16 Channel ADC M-module is an analog input M-module featuring 8 differential or 16 single ended inputs unipolar, or bipolar depending on the module type.

The core of the M320 is a MAX122 12-bit sampling analog to digital converter with 2.6 μs conversion time. The 8 differential or 16 single ended channels are routed to the MAX122 by analog multiplexers with a switching time of 1.5 μs. Furthermore the M320 features a programmable gain amplifier which is capable of amplifying the input voltage with a factor 1, 2, 4, 8 or 16. Both the channel and the gain are software selectable.
The MAX122 has an input voltage range of 0..10V for unipolar modules and -5..+5V for bipolar modules. The M320 input range is the MAX122 input range divided by the gain.

2.1. Technical overview

- M-module interface
- Input range 0..10V for unipolar modules
- Input range -5..+5V for bipolar modules
- 8 channels on differential modules
- 16 channels on single ended modules
- Programmable channel selector
- Programmable gain (1,2,4,8,16)
- Connector detection
- Patch area for signal conditioning
- Identification EEPROM.

2.2. Module types

The M320 comes in four types wich are different with respect to the inputs (differential or single ended) and the polarity (unipolar or bipolar).

Differential modules have MAX329 multiplexers installed on sockets U14 and U15 and jumper JP1 open.

Single ended modules have MAX328 multiplexers installed on sockets U12 and U13 and jumper JP1 closed.

Unipolar modules have unlike bipolar modules a patch wire between pin 5 of U9 (MAX122) and pin 5 of U10 (AMP02).

The table below gives an overview of the M320 types:

Type	Description	Recognition
M320/SU	Single ended - unipolar	U12/U13: MAX328, JP1 closed, patch wire
M320/SB	Single ended - bipolar	U12/U13: MAX328, JP1 closed, no patch wire
M320/DU	Differential - unipolar	U14,U15: MAX329, JP1 open, patch wire
M320/DB	Differential - bipolar	U14/U15: MAX329, JP1 open, no patch wire

NOTE: The various M320 configurations are not user selectable because of differences in firmware (pld's).

3. Detailed Description

This chapter contains a block diagram of the M320 12-bit 8/16 channel ADC and describes the memory map. This chapter also describes the software configuration of the Module and gives a software example. Finaly the patch area and connector layout are described.

3.1. Block Diagram

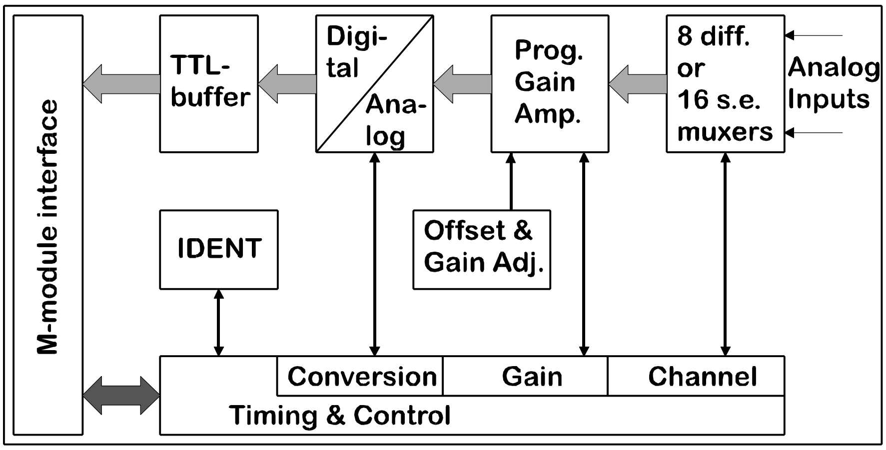

Figure 1 M320 Block Diagram

3.2. M-module Interface

The following sub paragraphs will describe the M-module interface and the various registers.

3.2.1. Address Map Overview

The following table will give an overview of the address map of the M320 Analog to Digital Converter. All addresses are relative to the base address of the module

Addr	Type	Read Operation	Write Operation
$00 $02	word word	Data Register SOC Register	Configuration Register Configuration Register
$ff	byte	Identification EEPROM	

Any read access to the Start Of Conversion (SOC) Register will start a conversion provided that the previous conversion has completed.

3.2.2. Configuration Register

There is only one 16-bit configuration Register mapped at address offset $00 and $02. The configuration register is defined as follows:

CONFIG Offset: $00 and $02

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved				Channel				Reserved					Gain		

Reset:

x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Write Only

- Gain Selection

The gain selection can be used to amplify the input voltage with a programmable factor. The table below shows the relation between the gain and bits D0..D2 of the configuration register:

D2	D1	D0	Gain
0	0	0	1
0	0	1	2
0	1	0	4
0	1	1	8
1	x	x	16

- Channel Selection

The channel selection programs the multiplexers to select one of eight differential channels (M320/DX) or one of sixteen single ended channels (M320/SX). Bits D8..D11 of the configuration register determine the input channel which will be measured.
The table below gives an overview of the relation between bits D8..D11 and the differential channel numbers, the single ended channel numbers and Physical input-pin names.

Channel selector				Single Ended		Differential	
D11	D10	D9	D8	Channel	Pin name	Channel	Pin names
0	0	0	0	0	DA0	0	DA0-DB0
0	0	0	1	1	DA1	1	DA1-DB1
0	0	1	0	2	DA2	2	DA2-DB2
0	0	1	1	3	DA3	3	DA3-DB3
0	1	0	0	4	DA4	-	-
0	1	0	1	5	DA5	-	-
0	1	1	0	6	DA6	-	-
0	1	1	1	7	DA7	-	-
1	0	0	0	8	DB0	4	DA4-DB4
1	0	0	1	9	DB1	5	DA5-DB5
1	0	1	0	10	DB2	6	DA6-DB 6
1	0	1	1	11	DB3	7	DA7-DB7
1	1	0	0	12	DB4	-	-
1	1	0	1	13	DB5	-	-
1	1	1	0	14	DB6	-	-
1	1	1	1	15	DB7	-	-

A conversion may not be started withing 1.5 μs after channel selection because of the switching time of the multiplexers.

3.2.3. Data Register

The data register can be accessed by a read operation to address offset $00. The data register is defined as follows:

DATAREG Offset: $00

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
12-bit Conversion Data												res.		POL	CON

Reset:

x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Read Only

- CON-bit

The CON-bit represents the inverted state of pin P9 of the M-module front connector and pin P17 of the P2 connector. It is a general purpose input line and can for instance be used to detect wether or not a connector is present.

- POL-bit

If the polling bit (POL-bit) is low a conversion (started by a read access to SOC) is still in progress and the conversion data is invalid. If the bit becomes high, the conversion is ready and the conversion data is valid. A new conversion can now be started by a read access to the SOC register: the polling bit becomes low again.

- Conversion Result

Bits D4..D15 contain the conversion result in two's complement representation. The conversion result is valid when the POL-bit is high. The table below shows the relation between the conversion data and the input voltage with a gain of '1' for both an unipolar as a bipolar module:

Conversion Data (D15..D4)	Bipolar (-5V..+5V)	Unipolar (0V..+10V)
$1000 0000 0000	- 5.00000 V	0.00000 V
$1000 0000 0001	- 4.99756 V	0.00244 V
|	|	|
$1111 1111 1111	- 0.00244 V	4.99756 V
$0000 0000 0000	0.00000 V	5.00000 V
$0000 0000 0001	+ 0.00244 V	5.00244 V
|	|	|
$0111 1111 1111	+ 4.99756 V	9.99756 V

3.2.4. SOC register

A conversion can be started by any read access to the SOC register at address offset $02. A conversion will only be started if a previous conversion has completed. The result of the read operation must be discarded.

SOC Offset: $02

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
undefined data															

Reset:

x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Read Only

3.3. Software Example

This section contains a software example coded in ANSI-C which shows a correct method to sample and store data from all 16 channels with a total of 1000 samples, from a single ended M320.

```
#include <types.h>

#define MBASE   0x00500000  /* M320 base address */
#define SAMP    1000        /* number of samples to take */

main()
{
    volatile unsigned short *base, value;
    unsigned short *buffer, *ptr;
    int ch, i, num;
    volatile int delayc;

    base = (unsigned short *)MBASE;
    num = SAMP;

    /* allocate memory for sample storage, 2 bytes per sample */
    buffer = (unsigned short *) malloc (2 * num);
    ptr = buffer;

    for (i = 0; i < num; i++)
    {
        ch = i % 16; calculate channel number */

        /* select channel and set gain to 1 */
        *base = (ch << 8) & 0x0f00;

        /* there must be a delay of at least 1.5 us between channel
         * selection and start of conversion.
         * most platforms will require a small software delay.
         *
         */
        for (delayc = 0; delayc < 10; delayc++);

        value = *(base+1);  /* start conversion by reading SOC ($02) */
        do
            value = *base;           /* read conversion status */
        while (!(value & 0x0002));  /* repeat until conversion ready */

        /* store conversion result as follows:
         *    $xxxy
         *    where: xxx is the 12 bit conversion data
         *           y is the channel number
         */
        *ptr++ = (value & 0xfff0) | ch;
    }
}
```

3.4. Identification Control

The identification of the M320 M-module is implemented with a serial EEPROM with a 16*16 word organisation. An industry-standard component 93C06 is used in order to make the identification compatible throughout the complete range of available modules. Access to the identification EEPROM takes place through the following register:

EEPROM Offset: $FF

3	2	1	0
unused	CS	CLK	DI/O
reset:			
x	0	0	x

Read/Write

CS Chip-Select
This bit corresponds to the chip select input of the EEPROM.

CLK Clock
This bit corresponds to the clock input of the EEPROM.

DI/O Data input/output
This bit corresponds to the data input of the EEPROM when writing, and data output of the EEPROM when reading.

The identification EEPROM contains the following information:

Word 0:	identification
Word 1:	module code
Word 2:	revision code
Word 3:	characteristics
Word 4:	no intermodule port
Word 5..7:	reserved
Word 8..15:	reserved

3.5. Patch Area

On the M320, a patch area is available for mounting optional input circuitry such as low/high pass filters and voltage dividers for each channel individually. The figure below shows the patch area.

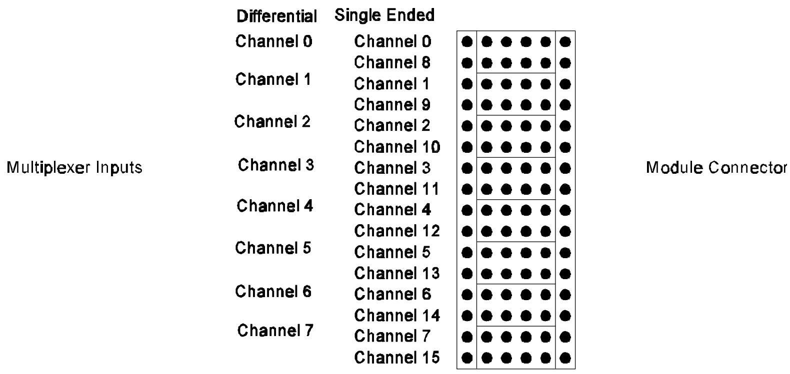

Figure 2 M320 patch area

As illustrated in figure 2, input circuitry can be mounted for each individual channel. If the module is configured for single-ended acquisition, 16 'single-channel' patch areas are available, and if the module is configured for differential acquisition, 8 'dual-channel' patch areas are available.

In figure 3, two 'single ended channels' patch areas (S1 and S2) are visualized. This figure is also valid for one ‘differential channel’ patch area (D1). Each pad is marked with a number. These numbers refer to the node-numbers of the circuit in figure 4.

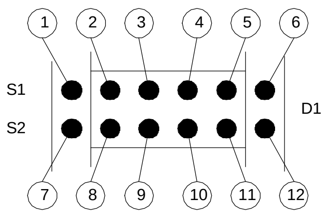

Figure 3 Single patch area

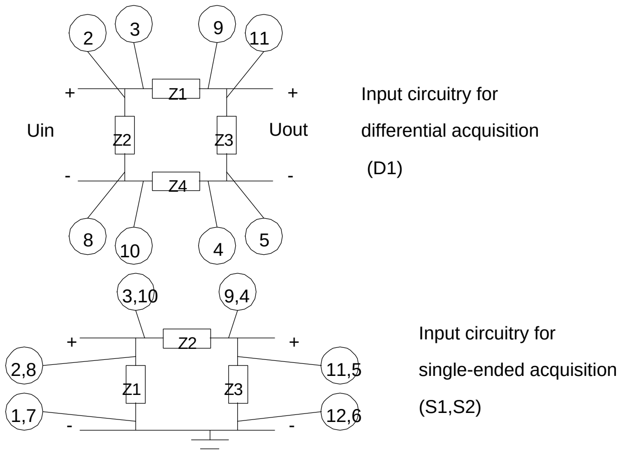

Figure 4 Patch area, circuit representation

The components in figure 4 can be replaced by resistors, capacitors and/or inductors in any wanted configuration. If, for example, a low pass filter is required on single-ended channel S1 and S2, the following should be done:

- do not mount device Z1,
- mount a resistor as Z2,
- mount a capacitor as Z3.

The frequency of the -3dB point can be calculated in the following way:

$$f_{-3dB} = (2 * \pi * R * C)^{-1};$$

3.6. Connector Layout

The M320 analog input channels are available at the 25-pole sub-D connector and at the M-module P2 connector.

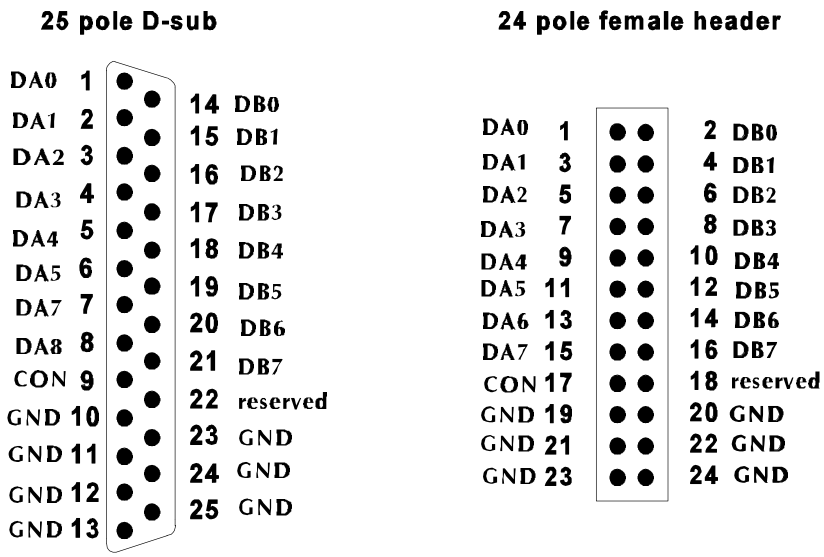

Figure 5 M310 Connector layout

4. Installation and Setup

4.1. Unpacking the module

The M320 M-module is shipped in an ESD protective container. Before unpacking the M320 M-module, make sure that this takes place in an environment with controlled static electricity. The following recommendations should be followed:

- Make sure your body is discharged to the static voltage level on the floor, table and system chassis by wearing a conductive wrist-chain connected to a common reference point.

- If a conductive wrist-chain is not available, touch the surface where the board is to be put (like table, chassis etc.) before unpacking the board.

- Leave the board only on surfaces with controlled static characteristics, i.e. specially designed anti static table covers.

- If handling the board over to another person, touch this persons hand, wrist etc. to discharge any static potential.

IMPORTANT: Never put the board on top of the conductive plastic bag in which the board is shipped. The external surface of this bag is highly conductive and may cause rapid static discharge causing damage. (The internal surface of the bag is isolating.)

Inspect the board to verify that no mechanical damage appears to have occurred. Please report any discrepancies or damage to your distributor or to AcQuisition Technology immediately and do not install the M-module.

5. Annex

5.1. Bibliography

Specification for M-module interface and physical dimensions:
M-module specification manual, revision 2.2, MUMM.

MAX122, A/D Converter:
Data sheet by Maxim

AD526, Software Programmable Gain Amplifier
Amplifier Reference Manual by Analog Devices

MAX328/329 Analog Multiplexer:
1992 New Releases Data Book by Maxim

5.2. Difference compared to previous versions

Revision 2.0 is valid for the M320 with revision 3.7. Which means revision 3 PCB and revision 7 firmware.
The revision 7 firmware has the following differences with respect to previous versions:

- Improved behavior on ‘fast’ carrier boards (e.g. i6060 or i5332).
- Auto address increment feature is no longer supported *.
- External triggering and interrupts are not supported *.
- A conversion can only be started with a **read access** to address offset $02.

* These differences might require a software modification.

5.3. Component image

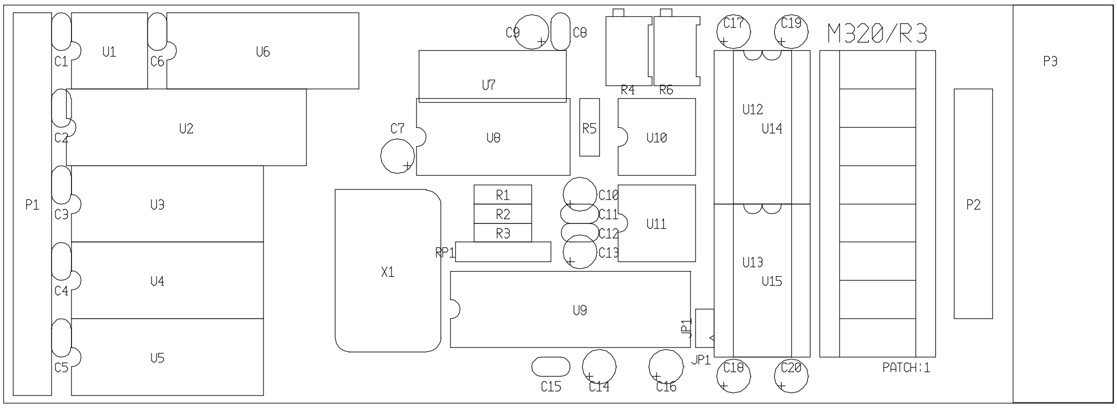

Figure 6 M320 R3.X component image

5.4. Technical data

Slots on the base-board:
Requires one 8-bit or 16-bit slot.

Interrupt:
none.

Connection:
To base-board via 40 pole M-module interface.
To peripheral on the front via 25 pole D-sub connector, or via M-module P2 connector

Input data:

Resolution:	12 bit
Accuracy:	± 3 LSB
Conversion time:	2.6 µs
Multiplexer switch time:	1.5 µs
Acquisition time:	< 4 µs
Input range:	-5V..+5V, 0..10V
Input resistance:	≥ 50 MΩ
Input capacitance:	5 pF (typ) with no input circuitry

Power supply:
+5 V DC ±5%, typical 150 mA
±12 V DC ±5%, typical 40 mA

Temperature range:
Operating: 0..+60 °C
Storage: -25..+85 °C

Humidity:
Class F, non-condensing.