AVR470: MC310 Hardware User Guide

8-bit AVR® Microcontroller

Application Note

Features

- **Motor Control device board for Atmel ATmega32M1**
- **Modular system with 2,54mm pin header connectors for power board MC300**
- **Sensor & sensorless modes capabilities for DC motors**
- **Hall sensor header**
- **Potentiometer for motor control**
- **Networking interfaces : LIN, CAN**
- **Headers for Atmel DB101 Display module**
- **USB interface for PC connection**
- **Works with Atmel Motor Control Center software**
- **Electric specifications:**
  - **Supplied with Power board like MC300 from 3.3V up to 5V**

1. Introduction

The MC310 is the device board for ATmega32M1 AVR® microcontroller. Connected to the power stage board MC300, it enables to drive brushless DC, brushed DC and stepper motors.

The ATmega32M1 is the first AVR® microcontroller of a new family dedicated to advanced motor-control applications.

The MC310 board can be used to start development of applications which need to drive motors in sensor or sensorless mode with accurate control of speed and torque. These can be in the following automotive domain:

- Body Electronics:
  - sliding doors, Window lift with anti-pitch, Seat adjuster, Sun Roof, Power trunk, Ventilation/FAN control
- Chassis:
  - Steering wheel Assistance, Synchronized adjustable pedals
- Powertrain Control
  - Braking assistance, Throttle Valve actuator, Engine Cooling
- In-vehicle Networking
  - Local Interconnect network (LIN), Controller Area Network (CAN)

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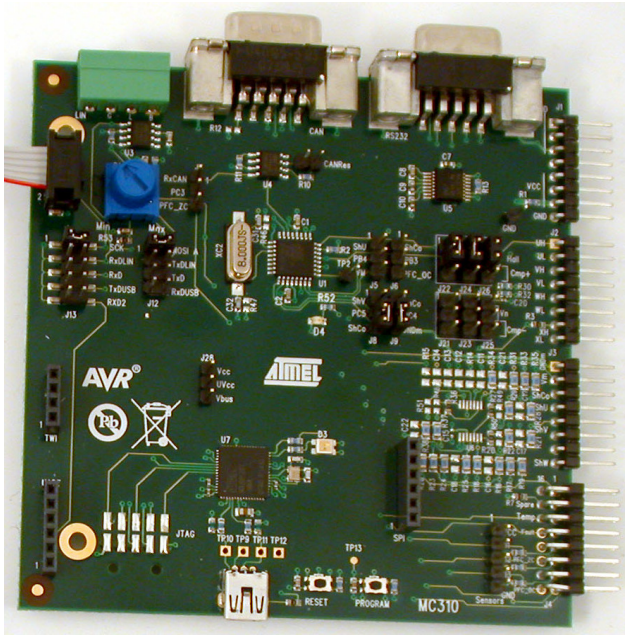
This board is also designed to be connected on any other driver board which could share the same interface. Power and all signals needed for a power stage board are available on the right side of the board. Interfaces like USB or Atmel DB101 Display module are also available for enhanced human interface.

Figure 1-1. MC310 Motor control ATmega32M1 processor board



2. Hardware overview

Please refer to schematics, layout and BOM available at http://www.atmel.com.

The MC310 motor control processor board is a ATmega32M1 AVR® microcontroller solution connected to a power stage board intended for driving DC motors (Brushless or brushed). All signals coming from the power stage board are connected to the microcontroller either directly or through jumpers for sensorless or sensor configuration. External comparators present on the board allow for the sensorless control mode with this particular ATmega32M1.

A potentiometer can control speed and rotation direction of the motor.

A UART to USB bridge is available to transfer motor control status & commands to a PC software interface: Atmel Motor Control Center.

Three 2,54mm headers are available to add the Atmel DB101 Display module in order to enhance visualization of motor control data & commands.

Three 8-pin & one 16-pin 2,54mm (100mil) horizontal male pin headers on the right side of the board form a system connector for the power boards like MC300.

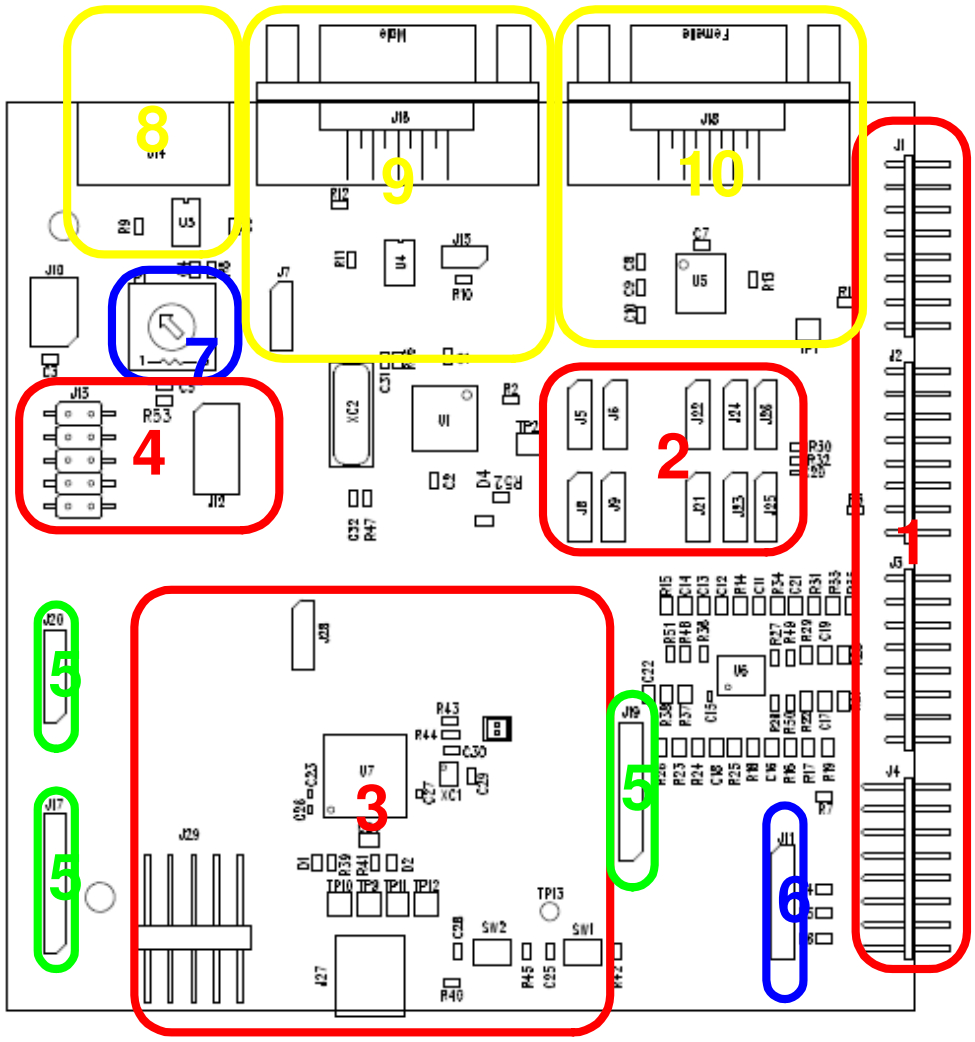
Both microcontrollers: ATmega32M1 & AT90USB1287 have their own debug/ISP interface for user's specific developments.

Test points either mounted or not, are also available for instrumentation.

2.1 PCB Layout

The MC310 is organized as shown in 2-1. Most signals, important components and jumper information are written on the silk screen. For individual component placement refer to the component floorplan.

Figure 2-1. MC310 PCB layout



In 2-1 the following areas are marked:

1. Power board connector.
2. Sensor/sensorless mode configuration jumpers
3. USB bridge
4. Communication interface selection (ISP, LIN, UART, USB, Potentiometer)
5. Atmel DB101 Display module headers
6. Hall sensors header
7. Potentiometer for manual command
8. LIN interface and connection
9. CAN interface and connection
10. RS232 interface and connection

2.2 Specifications

MC310 maximum ratings with components as delivered:

Input:

- Vin: 10 – 20VDC coming from the Power board
- Vm: 0 – 40VDC, Im_{max} = 6A
- UVcc : 3.3v to 5V

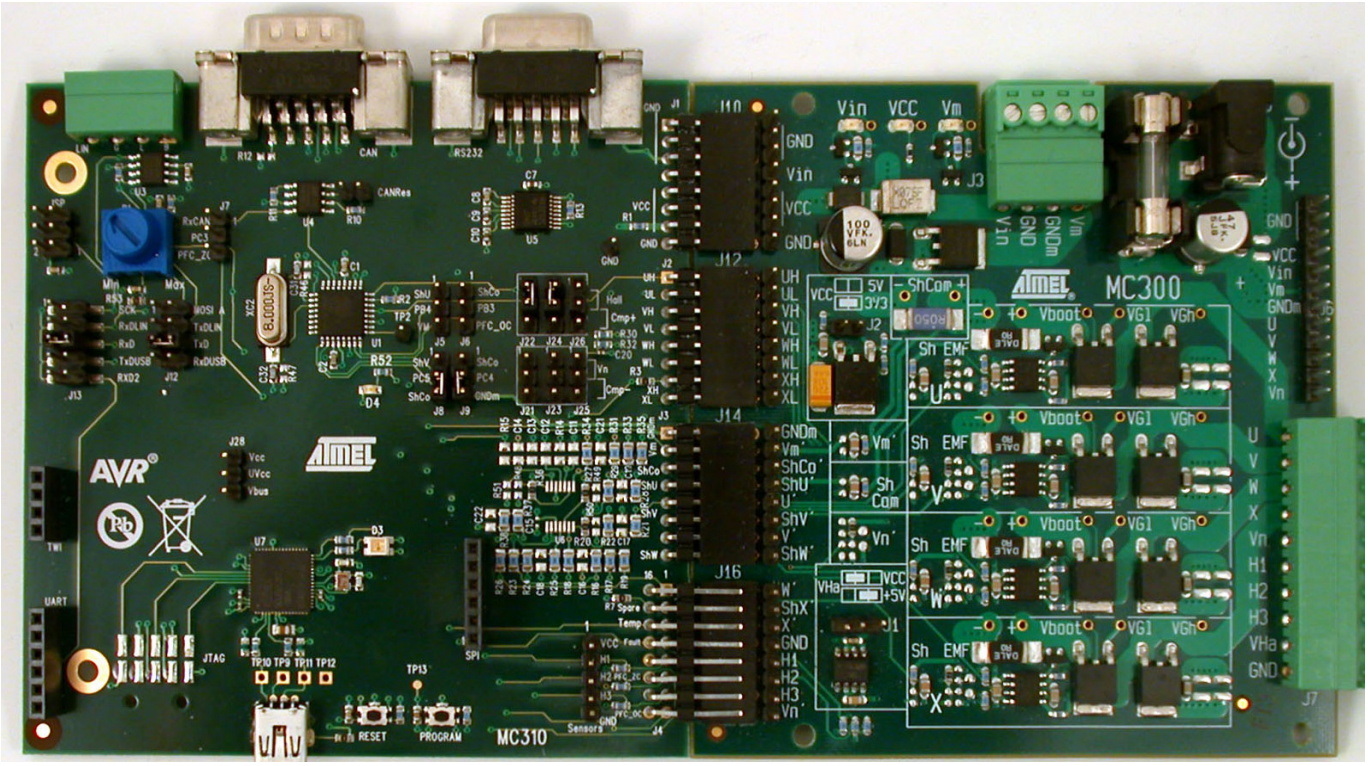
Output ratings:

- Vcc = 3.3/5V, I_{max} = 0.5A
- Vha = 5V, I_{max} = 0.1A

When working at Vcc 2.7V-3.3V, the user can keep USB functional by selecting power supply for USB coming from VBUS rather than from Vcc. The selection is made on the J28 jumper.

2.3 Connections

Figure 2-2. MC310 device board with power board MC300



2.3.1 Power board connector

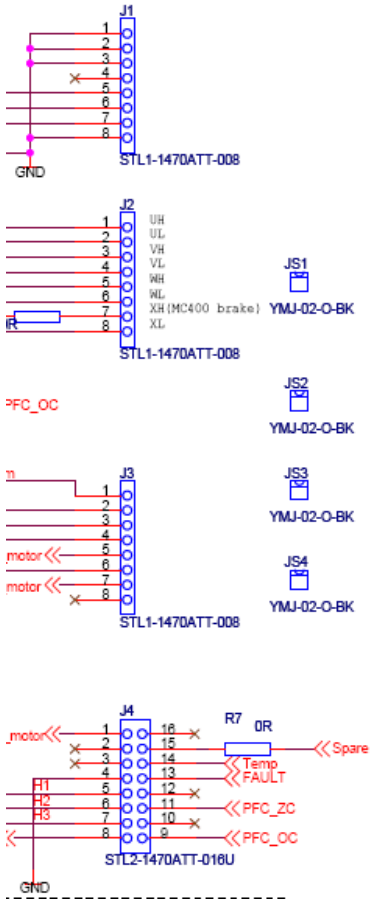
The MC310 processor board can connect directly to a driver board (typically the MC300 power board). This is accomplished by a horizontal male pin header connectors located on the right side of the board, shown in .

The device board interface on MC310 connector is split into four eight-pin connectors. Electric schematics and mechanical specifications are shown in and signal description in **Table 2-1**

Table 2-1. MC310 device board connector signal description.

Pin	Located	Name	Direction	Description
1	J1p1	GND	-	
2	J1p2	GND	-	System ground (Vin/VCC)
3	J1p3	GND	-	
4	J1p4	Vin	Input	Input power Vin (10-20V)
5	J1p5	VCC	Input	
6	J1p6	VCC	Input	Regulated power Vcc (3.3V/5V)
7	J1p7	VCC	Input	
8	J1p8	GND	-	System ground (Vin/VCC)
9	J2p1	UH	Output	Phase U Highside control output
10	J2p2	UL	Output	Phase U Lowside control output
11	J2p3	VH	Output	Phase V Highside control output
12	J2p4	VL	Output	Phase V Lowside control output
13	J2p5	WH	Output	Phase W Highside control output
14	J2p6	WL	Output	Phase W Lowside control output
15	J2p7	XH	Output	Phase X Highside control output
16	J2p8	XL	Output	Phase X Lowside control output
17	J3p1	GNDm	-	Motor ground (Vmotor)
18	J3p2	Vmotor’	Input	Vmotor filtered/divided
19	J3p3	ShCom’	Input	Voltage over ShCom filtered/divided
20	J3p4	ShU’	Input	Voltage over ShU filtered/divided
21	J3p5	U’	Input	BackEMF phase U filtered/divided
22	J3p6	ShV’	Input	Voltage over ShV filtered/divided
23	J3p7	V’	Input	BackEMF phase V filtered/divided
24	J3p8	ShW’	Input	Voltage over ShW filtered/divided
25	J4p1	W’	Input	BackEMF phase W filtered/divided
26	J4p2	ShX’	Input	Voltage over ShX filtered/divided
27	J4p3	X’	Input	BackEMF phase X filtered/divided
28	J4p4	GND	-	System ground (Vin/VCC)
29	J4p5	H1	Input	Hall sensor 1 signal
30	J4p6	H2	Input	Hall sensor 2 signal
31	J4p7	H3	Input	Hall sensor 3 signal
32	J4p8	Vn’	Input	Vn (neutral point) filtered/divided
25	J4p9	PFC_OC	Input	Power Factor Corrector Over Current signal
26	J4p10	nc	-	
27	J4p11	PFC_ZC	Input	Power Factor Corrector Zero Crossing signal
28	J4p12	nc	-	
29	J4p13	FAULT	Input	Fault signal from Power board
30	J4p14	Temp	Input	Tempeture sensor input
31	J4p15	nc	-	
32	J4p16	Spare	Output/ Input	Reserved

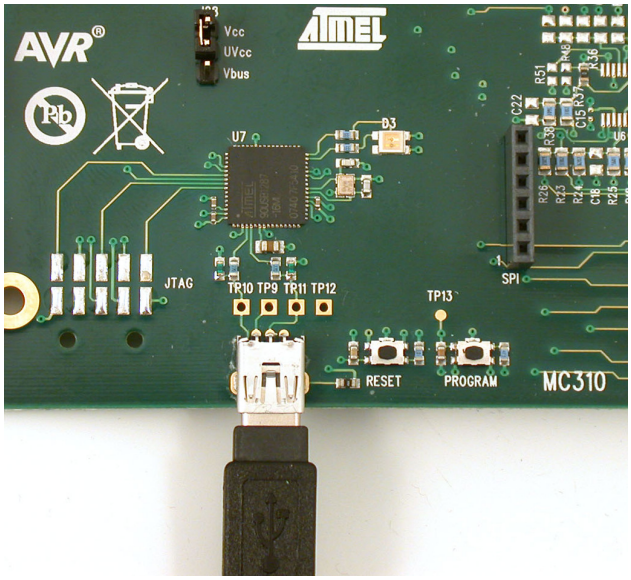
Figure 2-3. Device board connector*: mechanical specification and schematics*



2.3.2 USB connector

The board has a USB mini B receptacle (J27) to interface with a PC using the USB cable included in the kit.

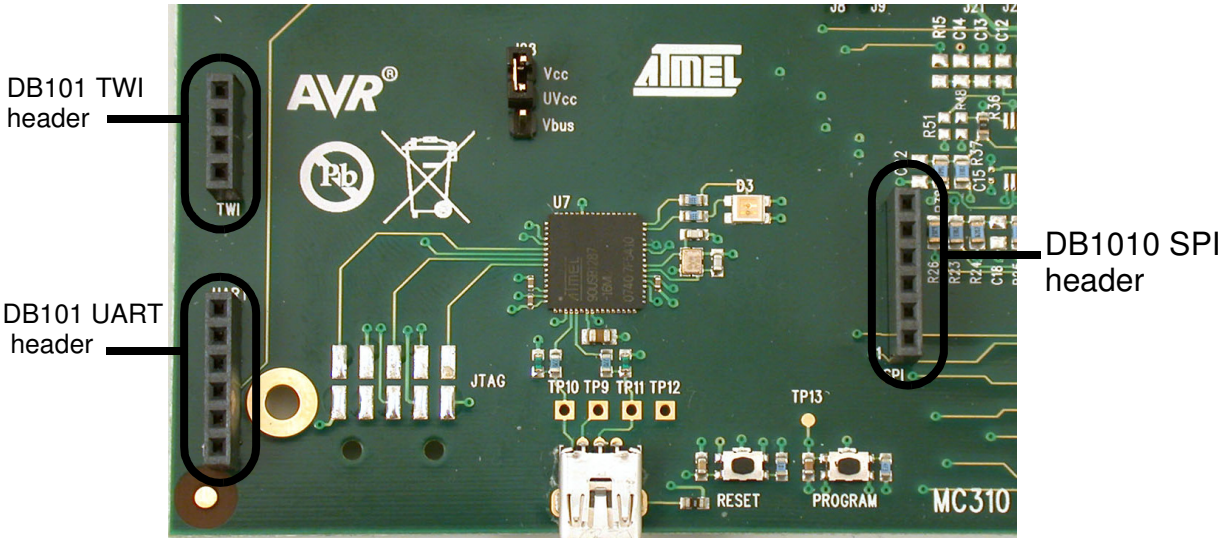
Figure 2-4. USB connector for PC interface



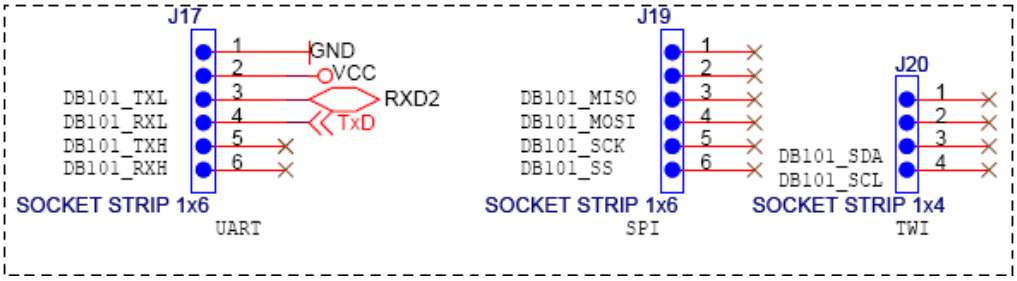
2.3.3 DB101 Display module connectors

The board has three 2.54 mm header to mount the Atmel DB101 Display module: J17, J19 & J20 (respectively UART, SPI, TWI). The MC310 uses the UART.

Figure 2-5. DB101 headers



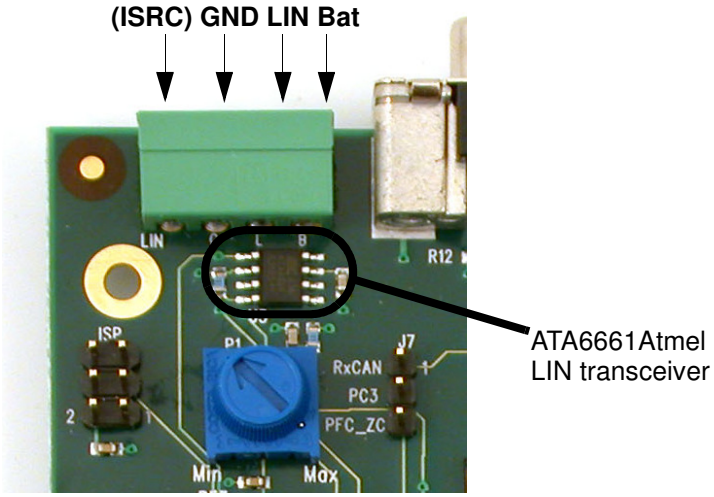
See the following description for the DB101 headers:



2.3.4 LIN connector

The MC310 processor board can be connected to a LIN network and will behave as a LIN slave. The connection is made using the LIN connector J14.

Figure 2-6. LIN connector



Configure TxDLIN & RxDLIN on J12, J13 (3-4 connected only)

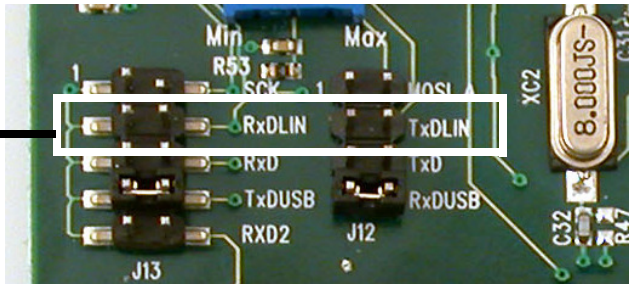
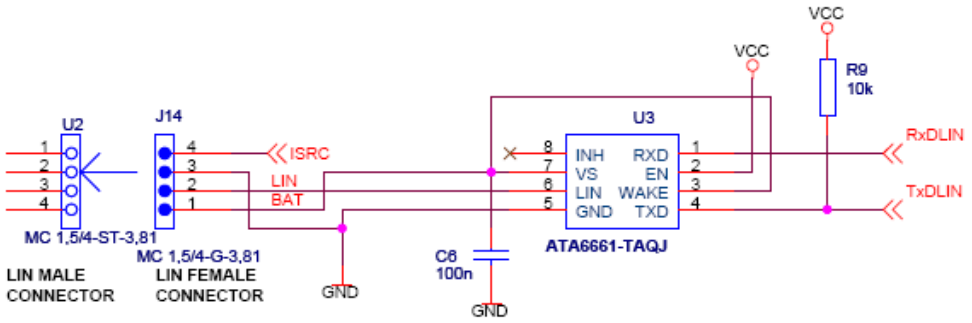


Figure 2-7. LIN configuration

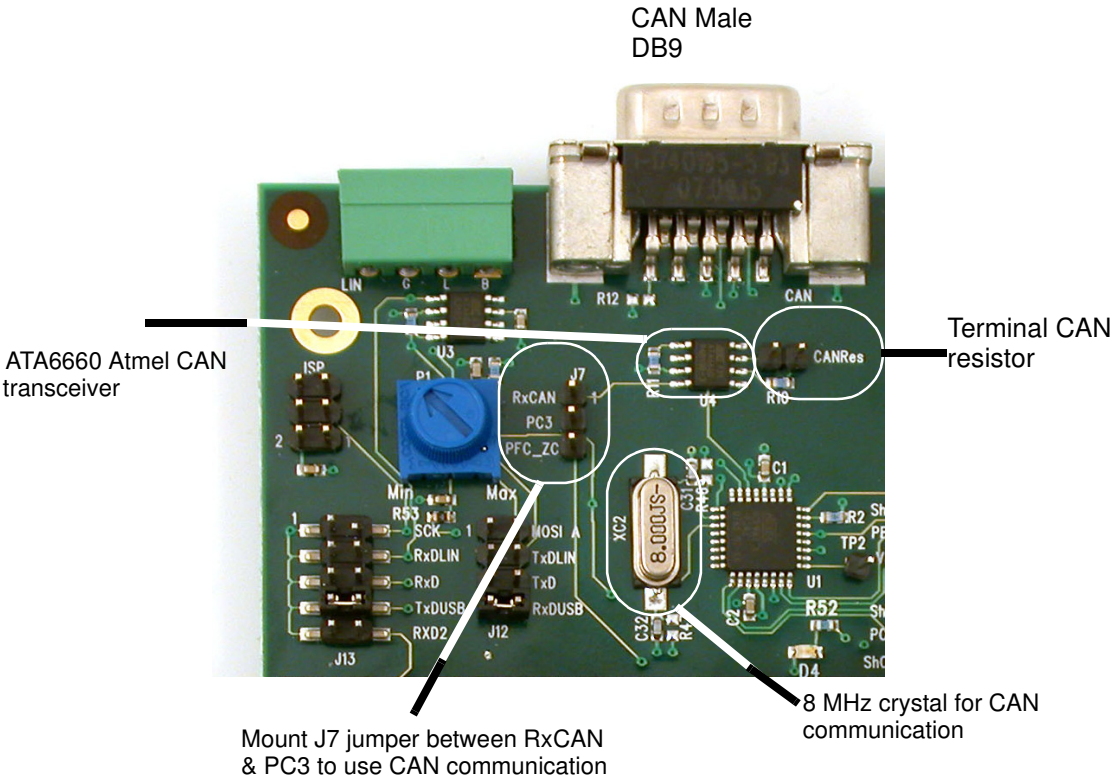
See the following description for the LIN signals:



2.3.5 CAN connector

The MC310 processor board can be connected to a CAN network. The connection is made using the CAN DB9 connector J16.

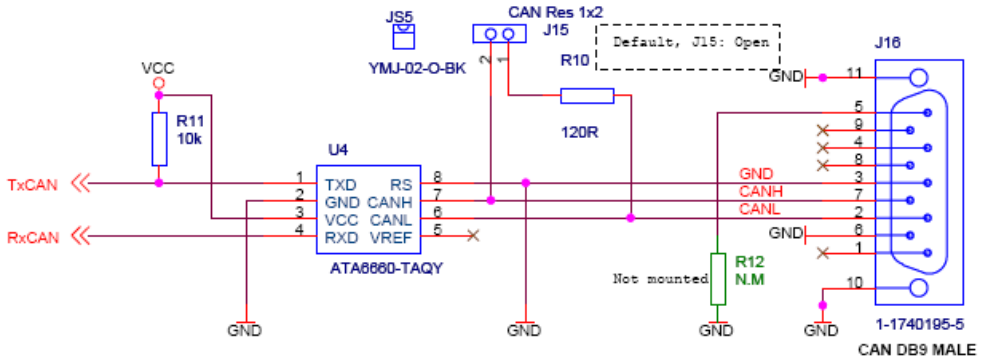
Figure 2-8. CAN connector



J7 must be closed between RxCAN & PC3 and a terminal resistor can be added by closing the CAN Res jumper (J15).

An external 8 MHz crystal is mounted between XTAL1 & XTAL2 of ATmega32M1 to achieve proper CAN baudrates.

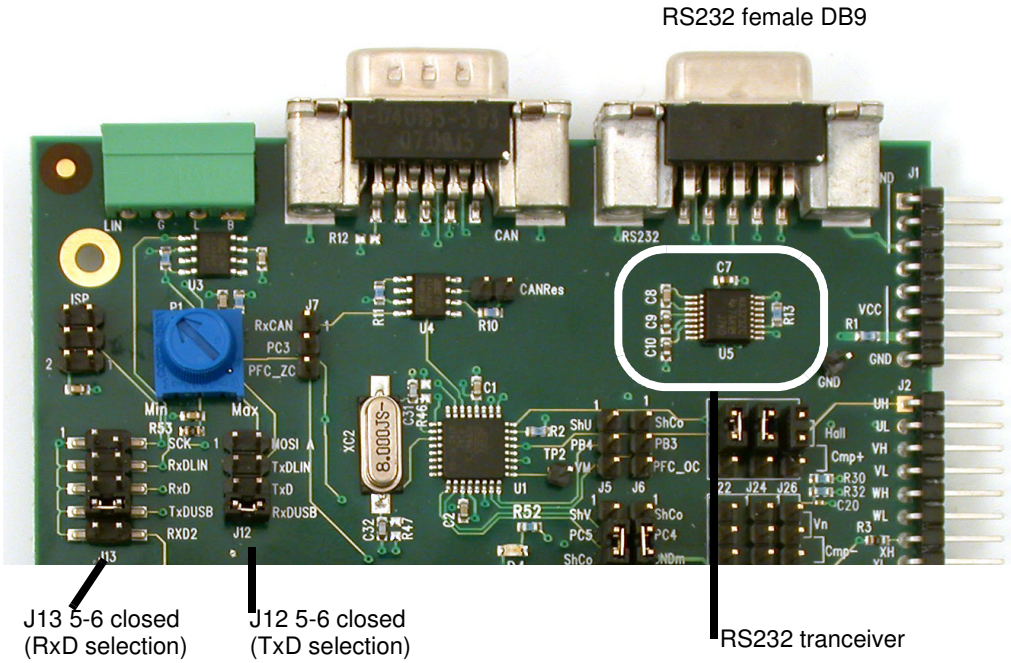
See the following description for the CAN signals:



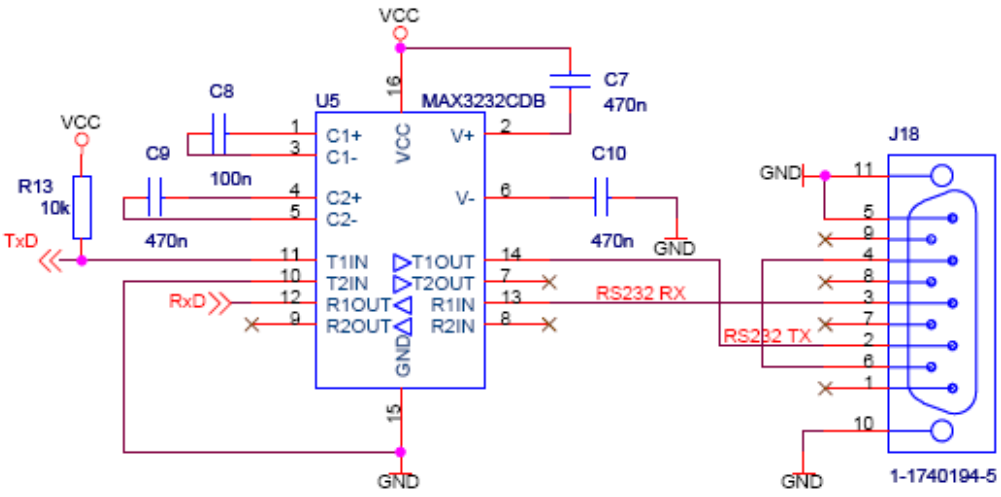
2.3.6 RS232 connector

The MC310 processor board can be connected to a PC through a DB9 RS232 connector. The connection is made using the RS232 connector J18.

Figure 2-9. RS232 connector & configuration



See the following description for the RS232 signals:



2.3.7 ISP/Debug connectors

The board has two ISP/Debug connectors, one populated for interfacing the ATmega32M1 (J10), one not populated for the AT90USB1287 (USB bridge) (J29).

Figure 2-10. ATmega32M1 ISP/debugWire header

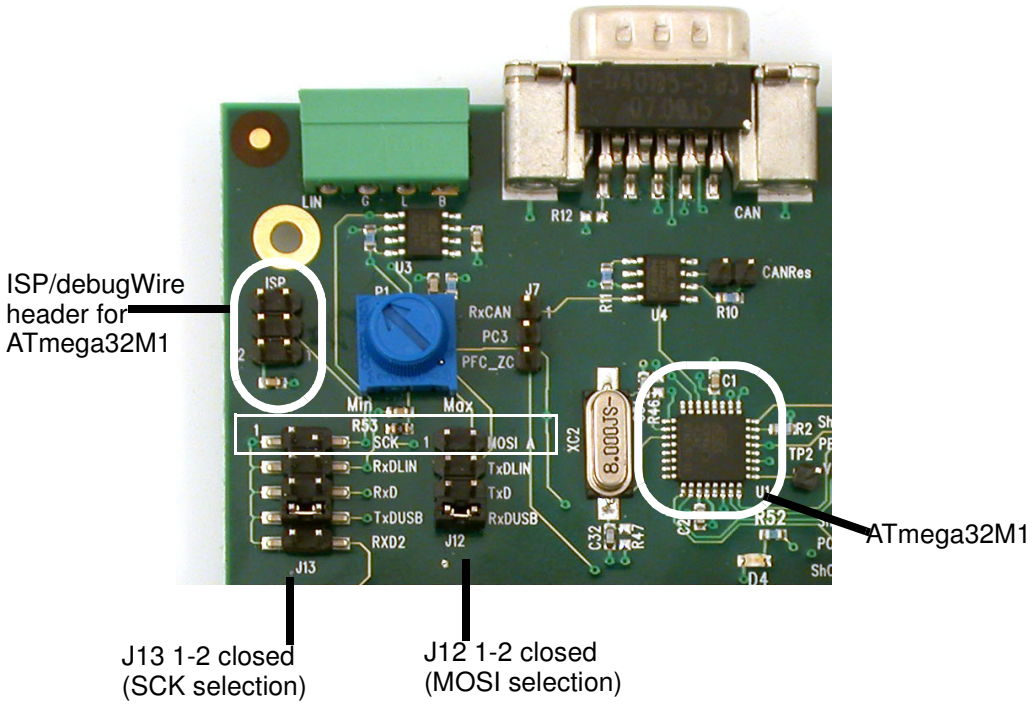
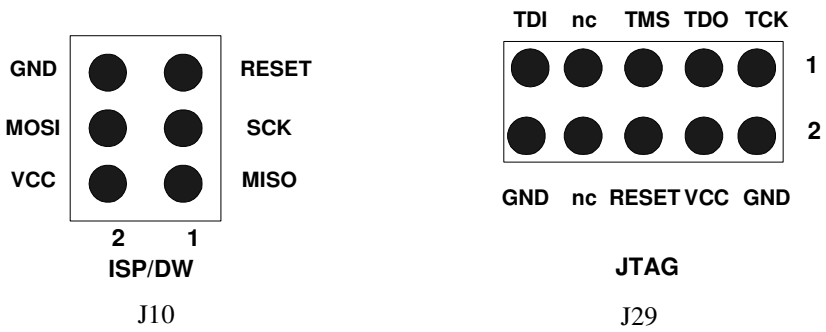
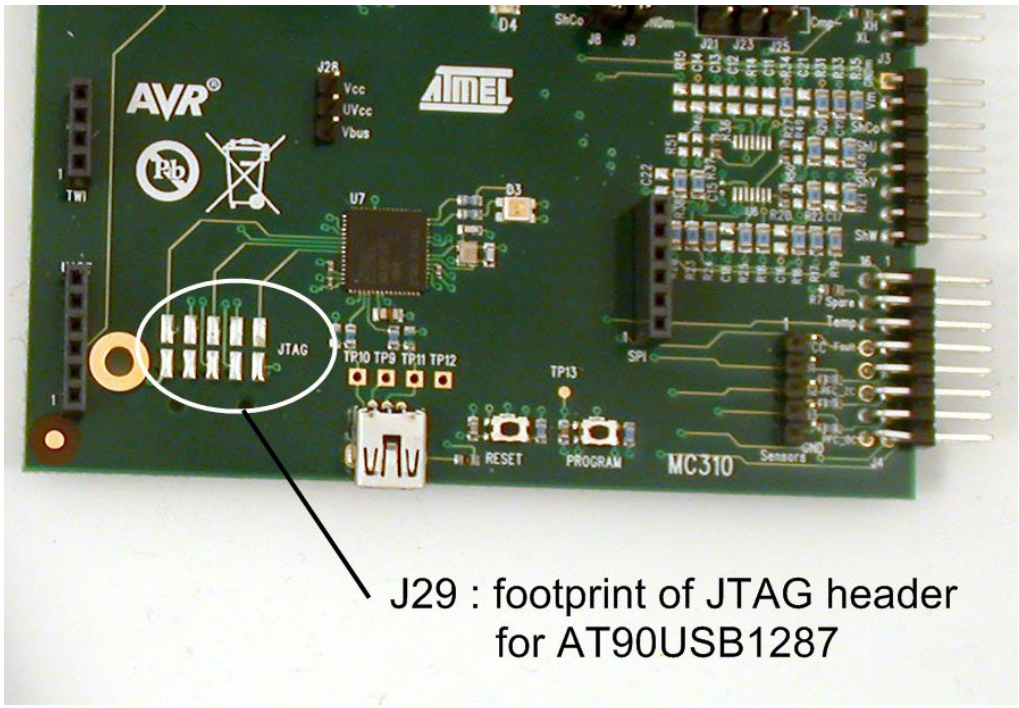


Figure 2-11. J10- ISP/DebugWire connector for ATmega32M1 & J29- JTAG connector for AT90USB1287:



Note that J29 for AT90USB1287 is not mounted

Figure 2-12. Figure 2-10. Connecting AVRISP mkII to the ISP J10 connector:



2.4 Jumpers

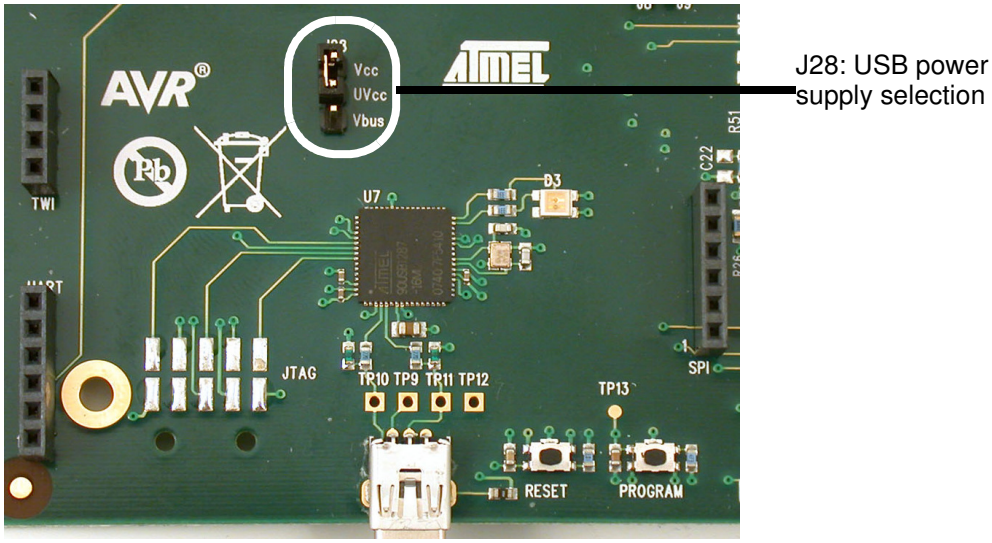
Refer to component floorplan for the location of jumpers. In brackets the application targeted on each configuration.

Table 2-2. Jumpers and their function.

Designator	Function and settings
J5	Selects a voltage reference signal or Vm' signal (Vmotor filtered) J5 pin 1 & 2 connected – PB4 is connected to Shunt U ShU voltage coming from J3.4 from the power board **(Field Oriented Control mode)** J5 pin 2 & 3 connected – PB4 is connected to Vm' (Vmotor filtered) coming from J3.2 from the power board, **(sensor mode)**
J6	Selects the overcurrent source signal J6 pin 1 & 2 connected – PB3 is connected to common shunt ShCo voltage coming from J3.3 from the power board **(Field Oriented Control mode)** J6 pin 2 & 3 connected – PB3 is connected to the power factor corrector overcurrent signal in sensorless mode coming from J4.9 from the power board. A **(Sensorless mode)**
J7	Selects CAN receive line or PFC zero crossing detection signal J8 pin 1 & 2 connected – PC3 is connected to RxCAN signal from the CAN interface J8 pin 2 & 3 connected – PC3 is connected to Power Factor corrector Zero crossing signal, output on J4.11 of the power board. **(Sensorless mode)**
J8	Selects a voltage reference signal or Vm' signal (Vmotor filtered) J8 pin 1 & 2 connected – PC5 is connected to Shunt V ShV voltage coming from J3.6 from the power board **(Field Oriented Control mode)** J8 pin 2 & 3 connected – PC5 is connected to common shunt ShCo voltage coming from J3.3 from the power board, **(Sensor mode)**
J9	Selects the common shunt signal or ground reference for motor J9 pin 1 & 2 connected – PC4 is connected to common shunt ShCo voltage coming from J3.3 from the power board **(Field Oriented Control mode)** J9 pin 2 & 3 connected – PC4 is connected to GNDm signal coming from J3.1 from the power board, **(Sensor mode)**
J12	Selects the communication interface for motor control commands & status for PD3 signal J12 pin 1 & 2 connected – PD3 configured as MOSI_A for ISP J12 pin 3 & 4 connected – PD3 configured as TxDLIN J12 pin 5 & 6 connected – PD3 connected to TxD for RS232 & DB101 interface J12 pin 7 & 8 connected – PD3 connected to RxD1 (or RxDUSB on silk screen) for USB interface
J13	Selects the communication interface for motor control commands & status for PD4 signal J13 pin 1 & 2 connected – PD4 configured as SCK for ISP J13 pin 3 & 4 connected – PD4 configured as RxDLIN J13 pin 5 & 6 connected – PD4 connected to RxD for RS232 interface J13 pin 7 & 8 connected – PD4 connected to TxD1 (or TxDUSB on silk screen) for USB interface J13 pin 9 & 10 connected – PD4 connected to RxD2 for DB101 interface
J15	Add a termination resistor to the CAN network when set
J21	Selects for PB2 (Analog Comparator Negative Input 0) **(Sensorless mode)** J21 pin 1 & 2 connected – PB2 (ACMN0) is connected to the Vneutral point in sensorless mode : filtered Vn_motor signal. J21 pin 2 & 3 connected – PB2 (ACMN0) is connected to the filtered U_motor signal in sensorless mode.

Designator	Function and settings
J22	Selects PD7 (Analog Comparator Positive Input 0) J22 pin 1 & 2 connected – PD7 (ACMP0) is connected to the hall sensor output 1. (default configuration) **(Sensor mode)** J22 pin 2 & 3 connected – PD7 (ACMP0) is connected to the filtered U_motor signal. **(Sensorless mode)**
J23	Selects PB5 (Analog Comparator Negative Input 1)) **(Sensorless mode)** J23 pin 1 & 2 connected – PB5 (ACMN1) is connected to the Vneutral point in sensorless mode : filtered Vn_motor signal. J23 pin 2 & 3 connected – PB5 (ACMN1) is connected to the filtered V_motor signal in sensorless mode.
J24	Selects PC6 (Analog Comparator Positive Input 1) J24 pin 1 & 2 connected – PD7 (ACMP1) is connected to the hall sensor output 2. (default configuration) **(Sensor mode)** J24 pin 2 & 3 connected – PD7 (ACMP1) is connected to the filtered V_motor signal. **(Sensorless mode)**
J25	Selects PD6 (Analog Comparator Negative Input 2) J25 pin 1 & 2 connected – PD6 (ACMN2) is connected to the Vneutral point: filtered Vn_motor signal. **(Field Oriented Control mode)** J25 pin 2 & 3 connected – PD6 (ACMN2) is connected to the filtered W_motor signal. **(Sensorless mode)**
J26	Selects PD5 (Analog Comparator Positive Input 2) J26 pin 1 & 2 connected – PD5 (ACMP2) is connected to the hall sensor output 3 (default configuration) **(Sensor mode)** J26 pin 2 & 3 connected – PD5 (ACMP2) is connected to the filtered W_motor signal. **(Sensorless mode)**
J28	Selects voltage source UVCC (Power supply for USB stage) When working at Vcc 2.7V-3.3V, the user can keep the USB functional by selecting power supply for USB coming from VBUS rather than from Vcc. J28 open – UVCC not connected, USB bridge not usable J28 pin 1 & 2 connected – UVCC connected to Vcc coming from Power board (Default configuration) J28 pin 2 & 3 connected – UVCC connected to Vbus coming from USB line

Figure 2-13. J28: USB Power supply selection:

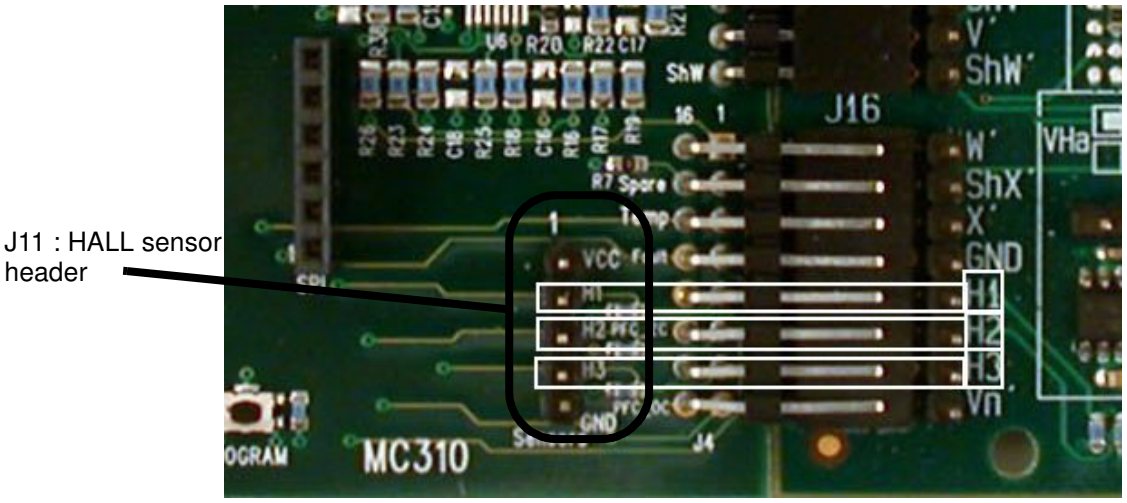


2.5 Headers

Table 2-3. MC310 device board J11 Hall sensors header description

Pin	Located	Name	Direction	Description
1	J11p1	VCC	-	Regulated power Vcc (3.3V/5V) coming from power board
2	J11p2	H1		Hall sensor output 1
3	J11p3	H2		Hall sensor output 2
4	J11p4	H3		Hall sensor output 3
5	J11p5	H4		Hall sensor output 4
6	J11p6	GND	-	System ground (Vin/VCC)

Figure 2-14. J11: HALL sensors header:



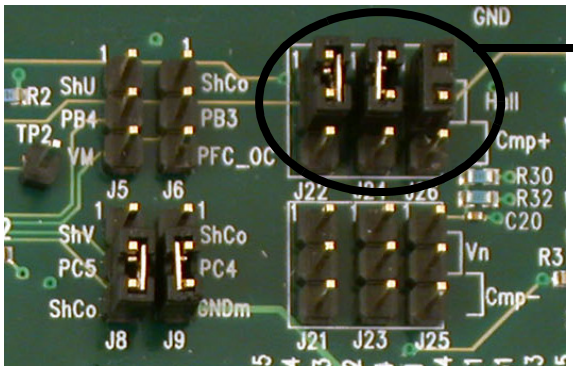
2.6 Schematics, component floorplan and bill of materials

The schematics, component floorplan and bill of materials (BOM) for MC310 are found as separate PDF files distributed with this application note. They can be downloaded from http://www.atmel.com.

3. Detailed description

3.1 Sensor mode

The MC310 can be configured in sensor mode using the Hall sensors of the motor through the Power board interface (J4).



J22-J24-J26:
1-2 connected, Hall selection

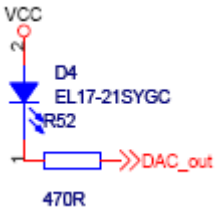
3.2 Sensorless modes

The MC310 can be configured in sensorless mode thanks to the comparator circuitry of the ATmega32M1 device.

Depending of the Sensorless control modes, refer to the appropriate application notes & see specific jumper configuration listed in Chapter 2.3 Jumpers

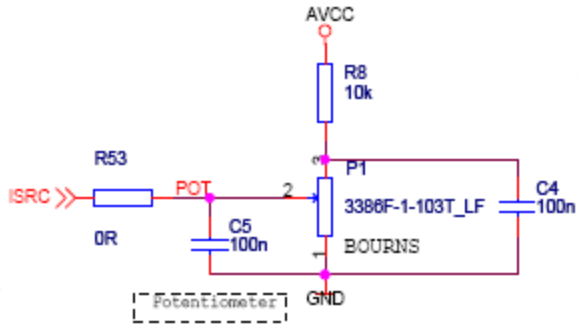
3.3 Application LED

A green color LED D4 is available for general purpose on ATmega32M1 PC7 (DAC_out signal).



3.4 Using the potentiometer

Potentiometer P1 is connected to the AREF (ISRC) signal of ATmega32M1 to control the speed of the motor.



3.5 Interfacing MC310 with PC through USB

Commands & status can be transferred to a PC using a USB link thanks to the USB bridge on the MC310.

3.5.1 Connection

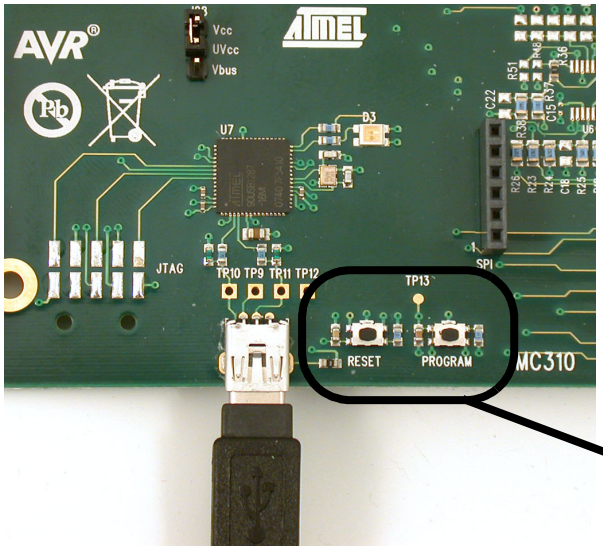
Connect the USB mini B cable to the MC310 board and to a PC. Make sure J28 (power supply of USB bridge) is properly configured.

3.5.2 Communication

MC310 USB interface uses USB CDC class for communication. As the Atmel Motor Control Center software uses the RS232 interface, CDC class fits perfectly with the needs of this software. MC310 is delivered with a native USB CDC firmware in the AT90USB1287.

3.5.3 USB bridge update

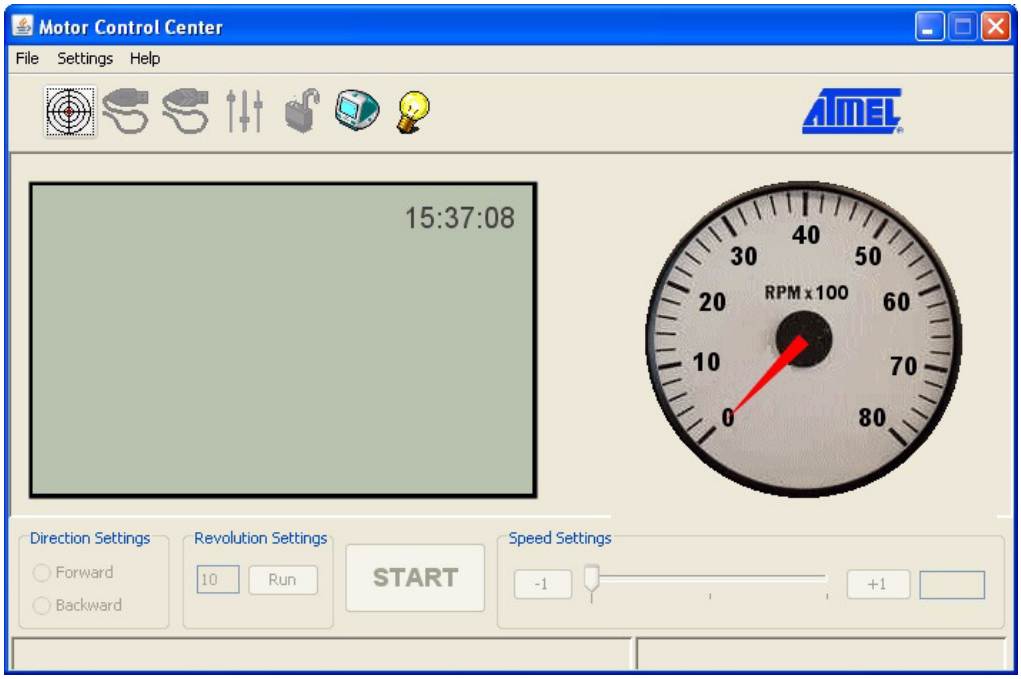
MC310 USB bridge can be updated thanks to the Atmel Bootloader in the AT90USB1287. Press Program Push button then Reset the USB device by pressing the Reset Push button. AT90USB1278 will then enumerates in DFU class (Device Firmware Upgrade class). See Atmel FLIP user's guide for upgrading the AT90USB1287 device on Atmel web site : www.atmel.com



Push button to enter into USB bootloader or running USB application

3.5.4 Atmel Motor Control Center

The Atmel Motor Control Center used with the MC310 is available on the Atmel website: www.atmel.com.



See Atmel Motor control center user's guide & the application notes using MC310+MC300 & Atmel Motor Control center for further explanation on this PC software usage..

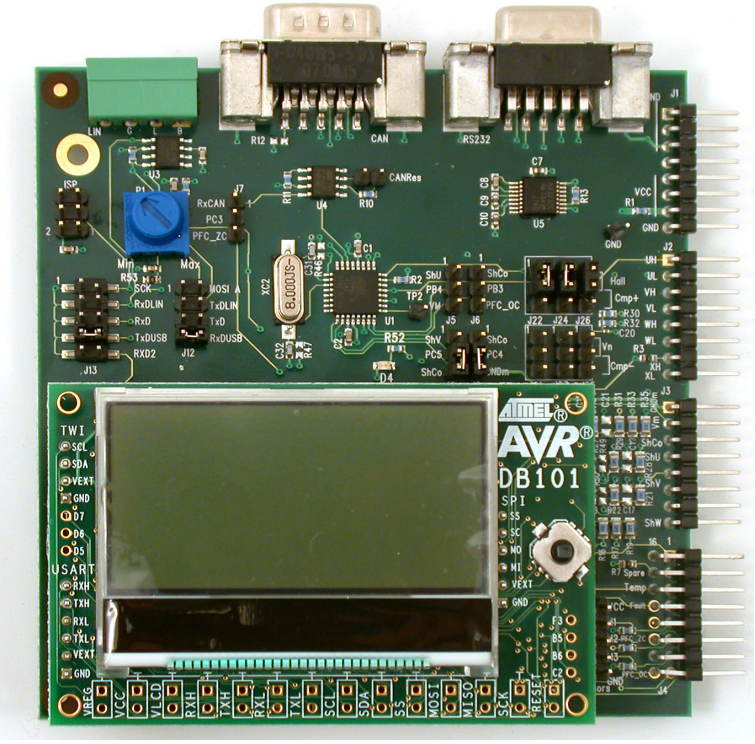
3.6 Interfacing MC310 with Atmel DB101 Display module

The DB101 display module can be added to the MC310 (See application notes 481, 482, 483 on www.atmel.com).

3.6.1 Connection

DB101 connects using 3 headers J17, J19 & J20 (respectively UART, SPI, TWI). See Figure 3-1.

Figure 3-1. MC310 PCB layout



3.6.2 Communication

DB101 uses the UART with ATmega32M1 thru J17 header. See DB101 Display module connectors.

5-6 of J12 & 9-10 of J13 must be connected to use the DB101. In this case, the USB, UART, LIN interfaces are no longer usable.

3.7 Upgrading the MC310 Motor control firmware

Firmware on the MC310 can be updated through AVR Studio using Atmel AVRISP mkII or JTAGICE mkII connected to J10 ISP/DW connector and by removing jumpers on J9.

Select the ATmega32M1 device in the device list in AVR Studio.

CAUTION:

While updating the firmware, it is recommended to disconnect the motor on the MC300 power board.

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