AVR469: MC301 Hardware User Guide

8-bit AVR® Microcontrollers

Application Note

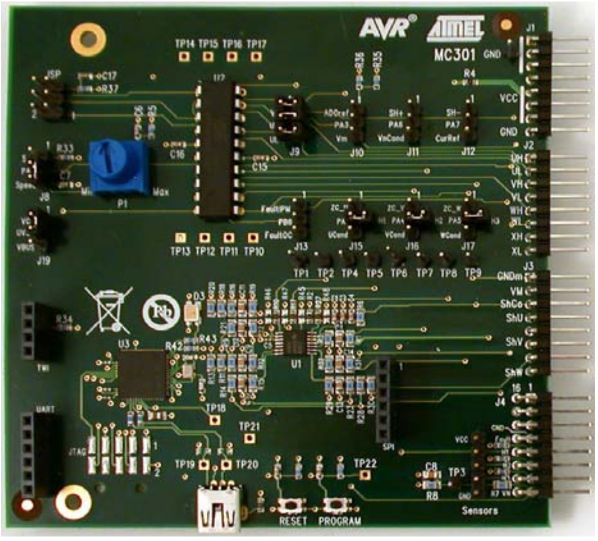
Features

- Motor Control device board for ATtiny861
- Modular system with 2.54mm pin header connector for power board MC300
- Sensor & sensorless modes capabilities
- Hall sensor header, Potentiometer for motor control
- Headers for Atmel® DB101 Display module
- USB interface for PC connection and usage of Atmel® Motor Control Center software
- ISP & debug interface for both ATtiny861 & USB device.
- Electric specifications:
  - Supplied with Power board like MC300 from 3.3V up to 5V
- Dimension: 100x100mm

1 Introduction

The MC301 is the device board for ATtiny861 AVR® microcontroller which can be connected to the general-purpose power stage board MC300 for driving brushless DC, brushed DC and stepper motors. 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. Jumpers allow demonstrating sensor or sensorless modes of motor control. Finally, interface like USB or Atmel DB101 Display module is also available.

Figure 1-1. MC301 Motor control ATtiny861 processor board.



Rev. 8195A-AVR-04/09

2 Hardware overview

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

The MC301 motor control processor board is a ATtiny861 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 sensorless control mode with this particular ATtiny861.

A potentiometer enables the user to control the motor: speed & direction in sensor mode and speed only in sensorless mode.

A Two Wire serial Interface (TWI) (compatible with Philips' I^2C protocol) 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.

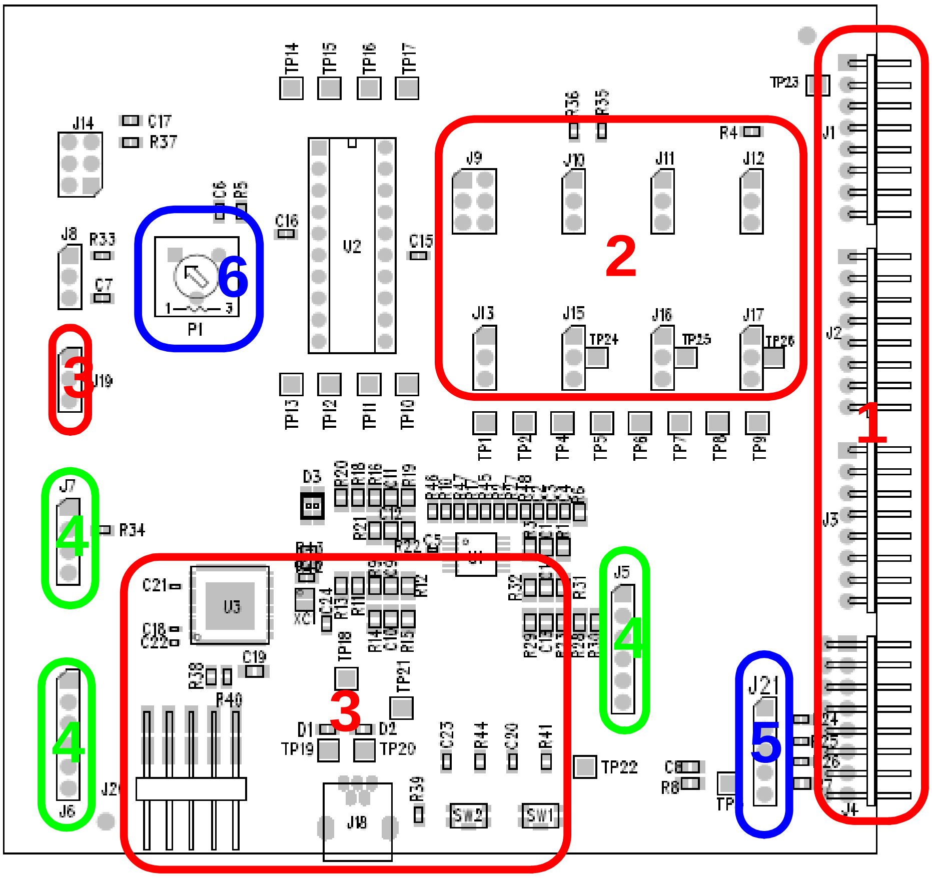
Both microcontrollers: ATtiny861 & AT90USB1287 have their own debug/ISP interface for user's specific developments.

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

2.1 PCB Layout

The MC301 is organized as shown in Figure 2-1. Most signals, important components and jumper information are written on the silk screen. Test points are also available for user instrumentation. For individual component placement refer to the component floor plan.

Figure 2-1. MC301 PCB layout.



In Figure 2-1 the following areas are marked:

1. Power board connector.
2. Sensor/sensorless mode configuration jumpers
3. USB bridge
4. Atmel DB101 Display module headers
5. Hall sensors header
6. Potentiometer for manual command

2.2 Specifications

MC301 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

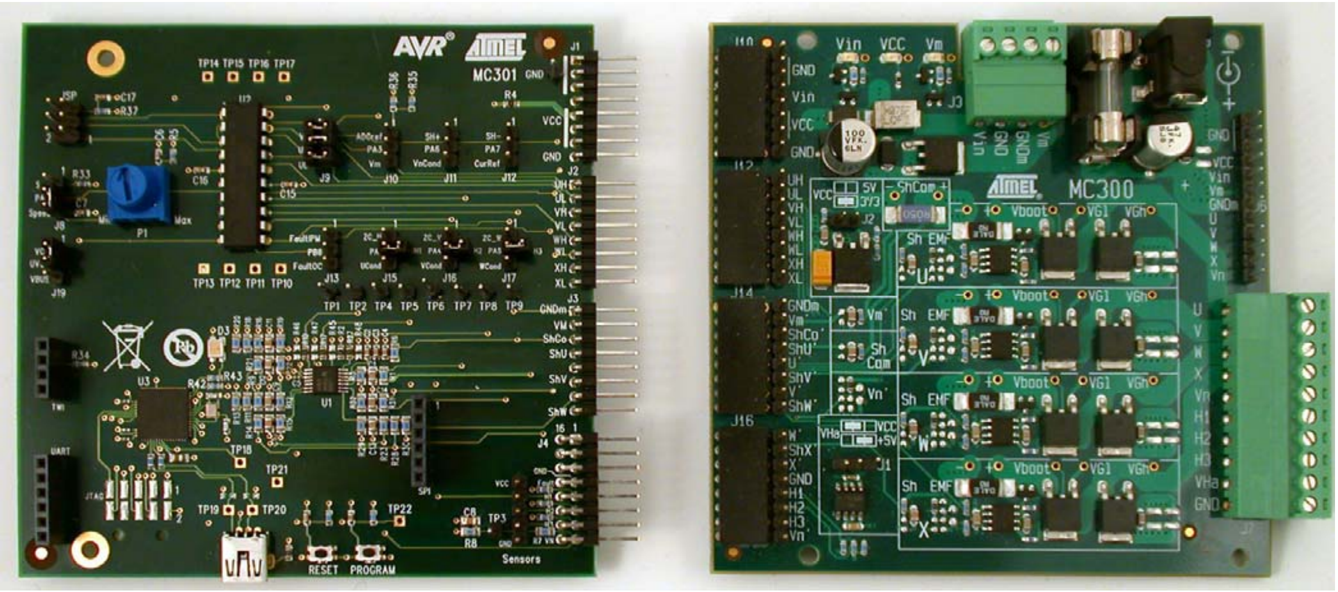
Output ratings:

- 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 J19 jumper.

2.3 Connections

Figure 2-2. MC301 device board with power board MC300.



2.3.1 Power board connector

The MC301 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 Figure 2-2.

The device board interface on MC301 connector is split into four eight-pin connectors. Electric schematics and mechanical specifications are shown in

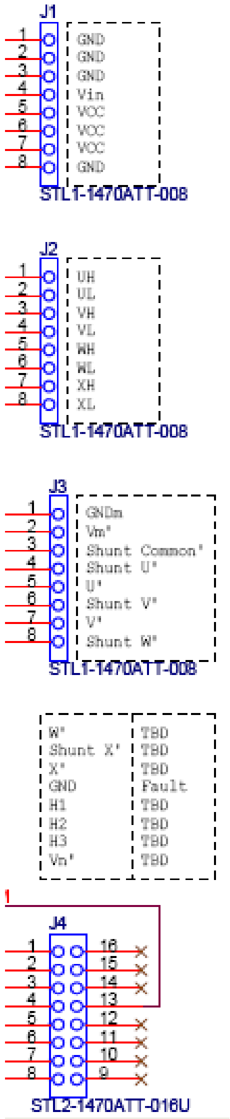
Figure **2-3** and signal description in Table 2-2

Table 2-1. MC301 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	-	

Pin	Located	Name	Direction	Description
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

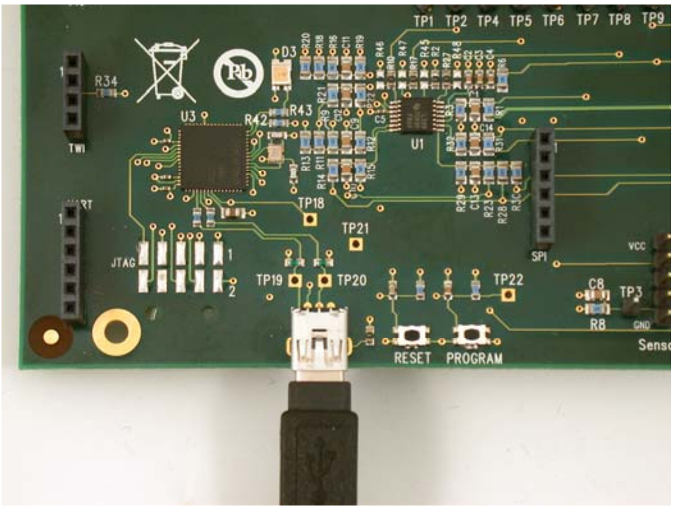
Figure 2-3. Device board connector: mechanical specification and schematics.



2.3.2 USB connector

The board has a USB mini B receptacle (J18) to interface with a PC using the USB cable included in the kit.

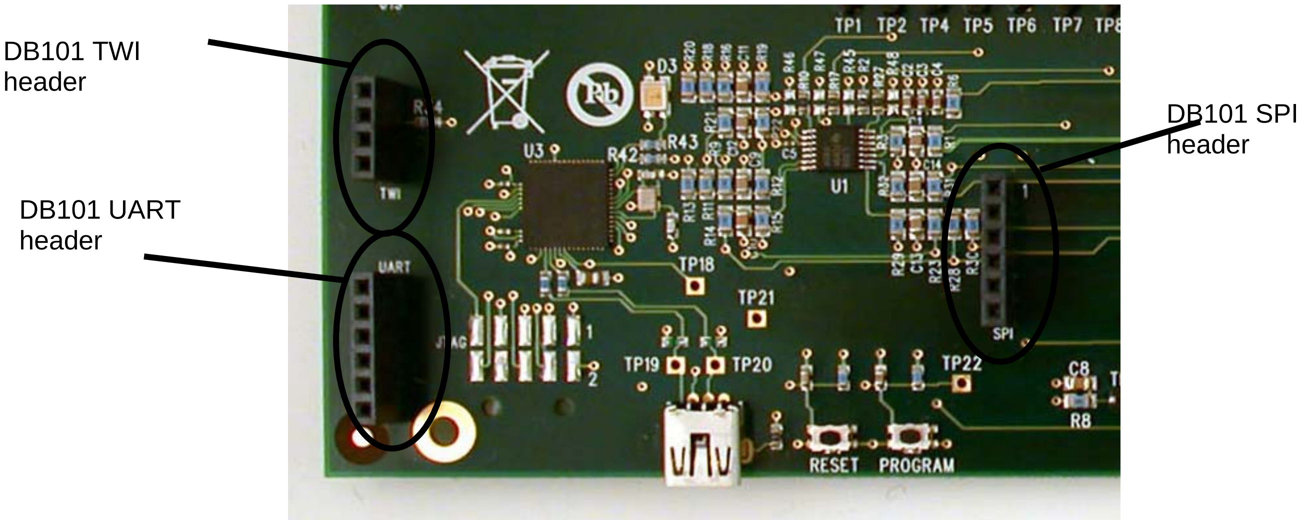
Figure 2-4. USB Connection.



2.3.3 DB101 Display module connectors

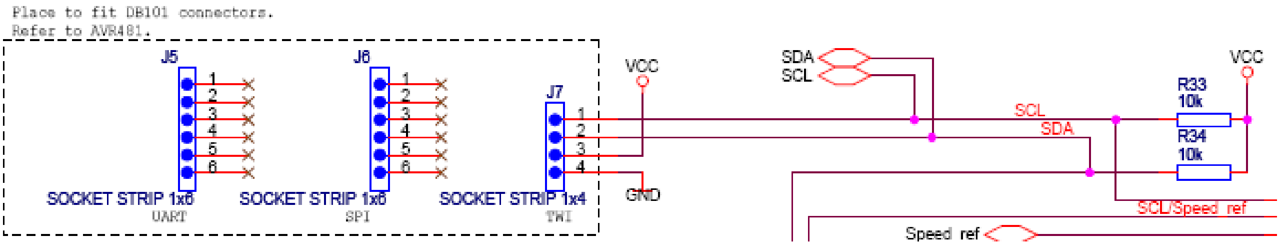
The board has three 2.54 mm header to mount the Atmel DB101 Display module: J5, J6 & J7 (respectively UART, SPI, and TWI). The MC301 uses the TWI.

Figure 2-5. DB101 Display module.



See the following description for the DB101 headers:

Figure 2-6. DB101 Header.



2.3.4 ISP/Debug connectors

The board has two ISP/Debug connector, one populated for interfacing the ATtiny861 (J14), one not populated for the AT90USB1287 (USB bridge) (J20).

Figure 2-7. ATtiny861 ISP/ debugWire header

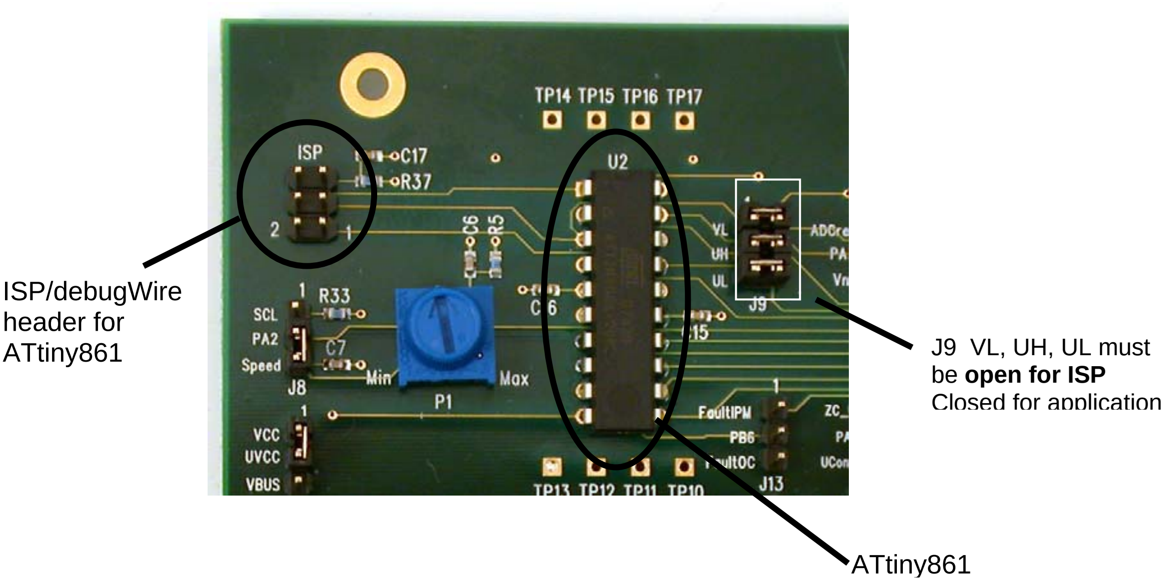
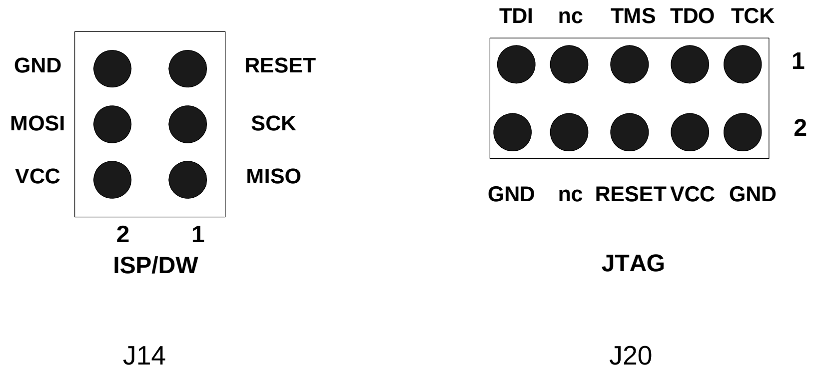
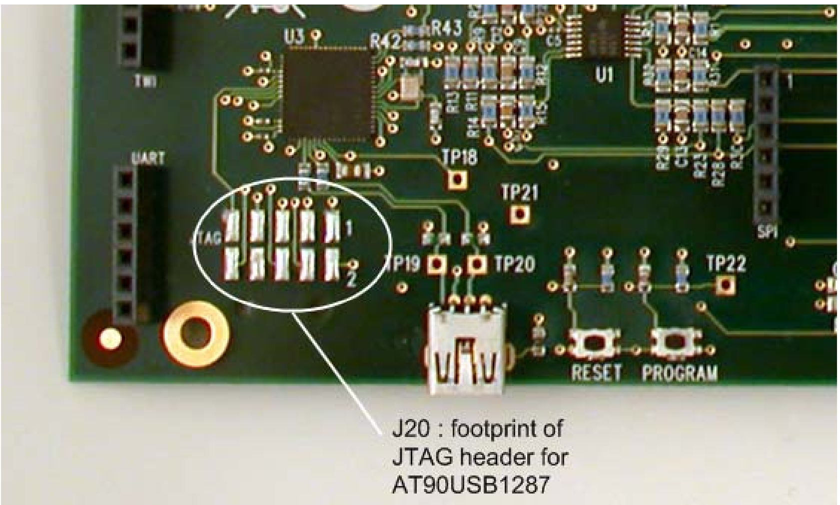


Figure 2-8. J14- ISP/DebugWire connector for ATtiny861 & J20- JTAG connector for AT90USB1287



Note that J20 for AT90USB1287 is not mounted

Figure 2-9. AT90USB1287 J20 JTAG header.



2.4 Jumpers

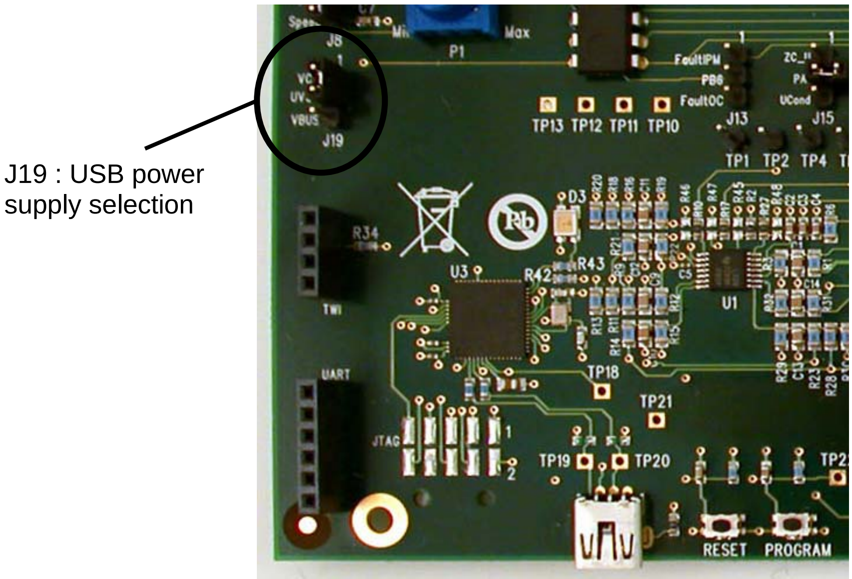
Refer to component floorplan for the location of the jumpers.

Table 2-2. Jumpers and their function.

Designator	Function and settings
J8	Selects Speed reference or SCL signal to either measure motor speed or interface with DB101 J8 pin 1 & 2 connected – PA2 (SCL) is connected to DB101 TWI interface thru J7. J8 pin 2 & 3 connected – PA2 (ADC2) is connected to Speed reference coming from potentiometer P1 for speed control (default configuration)
J9	Selects half bridge signal from power board or ISP signals for ATtiny861 device J9 pin 1 & 2 connected – PB2 is used to get VL signal from J2.4 from power board. (default configuration) J9 pin 1 & 2 open – PB2 is used as SCK signal in ISP mode. J9 pin 3 & 4 connected – PB1 is used to get UH signal from J2.1 from power board. (default configuration) J9 pin 3 & 4 open – PB1 is used as MISO signal in ISP mode. J9 pin 5 & 6 connected – PB0 is used to get UL signal from J2.2 from power board. (default configuration) J9 pin 5 & 6 open – PB0 is used as MOSI signal in ISP mode.
J10	Selects a voltage reference signal or Vm signal (Vmotor filtered) J10 open – None of Vm or voltage reference connected to PA3 (default configuration) J10 pin 1 & 2 connected – PA3 (AREF) is connected to a voltage reference made of R35/R36 voltage bridge. J10 pin 2 & 3 connected – PA3 is connected to Vm' (Vmotor filtered) coming from J3.2 from the power board. In this case, no divisor is applied on Vm' so Vm'=Vm coming from MC300. User must be careful as this voltage will be defined as voltage reference of the ADC
J11	Selects the positive shunt signal from power board or V neutral in sensorless mode J11 pin 1 & 2 connected – PA6 (ADC5) is connected to the positive shunt signal coming from J3.3 from the board. (default configuration) J11 pin 2 & 3 connected – PA6 is connected to Vn conditioned (Vneutral point in sensorless mode)
J12	Selects the negative shunt signal from the power board or the current reference signal in sensorless mode J12 pin 1 & 2 connected – PA7 (ADC6) is connected to the negative shunt signal coming from J3.1 from the board. (default configuration) J12 pin 2 & 3 connected – PA7 is connected to the current reference signal in sensorless mode

Designator	Function and settings
J13	Selects the overcurrent source signal from the power board or from the sensorless mode J13 pin 1 & 2 connected – PB6 (ADC9) is connected to the overcurrent fault signal coming from J4.13 from the board. (default configuration) J13 pin 2 & 3 connected – PB6 (ADC9) is connected to the overcurrent fault signal in sensorless mode
J15-TP24	Selects for U' (PA1/ADC1) J15 pin 1 & 2 connected – PA1 (ADC1) is connected to the zero crossing U signal in sensorless mode. J15 pin 2 & 3 connected – PA1 (ADC1) is connected to the U conditioned signal in sensorless mode J15 pin 2 & TP24 connected – PA1 (ADC1) is connected to the hall sensor output 1 in sensor mode (default configuration)
J16-TP25	Selects for U' (PA4/ADC3) J16 pin 1 & 2 connected – PA4 (ADC3) is connected to the zero crossing V signal in sensorless mode. J16 pin 2 & 3 connected – PA4 (ADC3) is connected to the V conditioned signal in sensorless mode J16 pin 2 & TP25 connected – PA4 (ADC3) is connected to the hall sensor output 2 in sensor mode (default configuration)
J17-TP26	Selects for U' (PA5/ADC4) J17 pin 1 & 2 connected – PA5 (ADC4) is connected to the zero crossing W signal in sensorless mode. J17 pin 2 & 3 connected – PA5 (ADC4) is connected to the W conditioned signal in sensorless mode J17 pin 2 & TP26 connected – PA5 (ADC4) is connected to the hall sensor output 3 in sensor mode (default configuration)
J19	Selects voltage source UVCC (Power supply for USB stage) 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. J19 open – UVCC not connected, USB bridge not usable J19 pin 1 & 2 connected – UVCC connected to Vcc coming from Power board (default configuration) J19 pin 2 & 3 connected – UVCC connected to Vbus coming from USB line (See picture below)

Figure 2-10. J19: USB Power supply selection



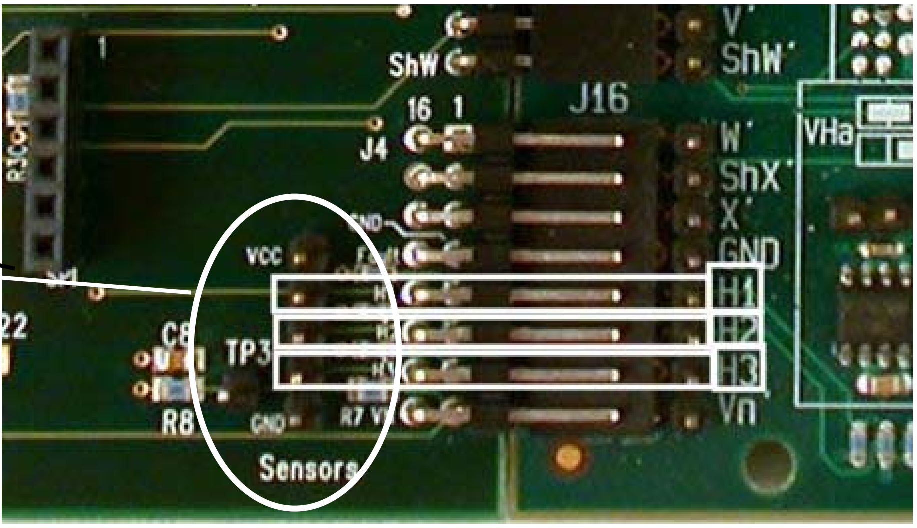
2.5 Headers

Table 2-3. MC301 device board J21 Hall sensors header description.

Pin	Located	Name	Direction	Description
1	J21p1	VCC	-	Regulated power Vcc (3.3V/5V) coming from power board
2	J21p2	H1		Hall sensor output 1
3	J21p3	H2		Hall sensor output 2
4	J21p4	H3		Hall sensor output 3
5	J21p5	H4		Hall sensor output 4
6	J21p6	GND	-	System ground (Vin/VCC)

Figure 2-11. J21: HALL sensors header

J21: HALL sensor header



2.6 Schematics, component floorplan and bill of materials

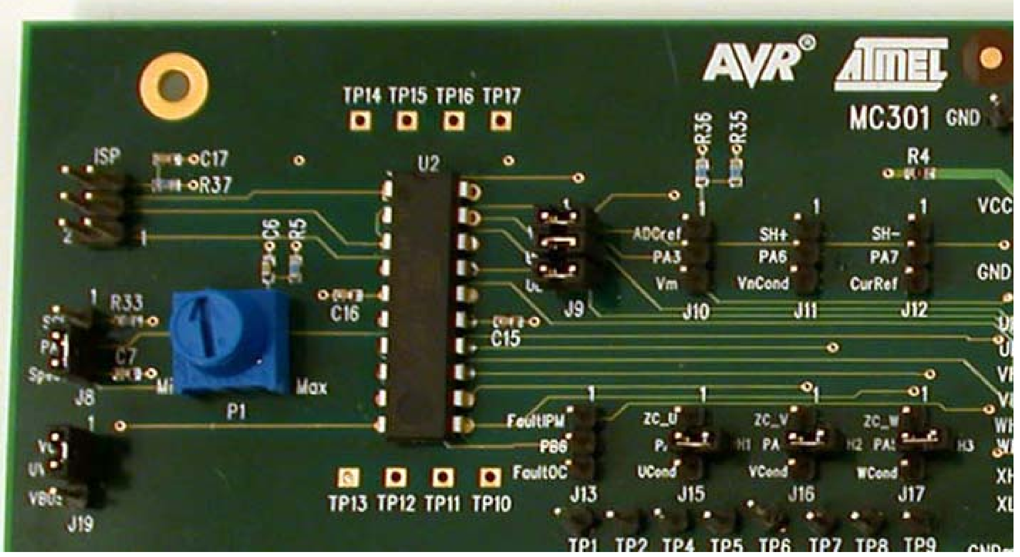
The schematics, component floorplan and bill of materials (BOM) for MC301 are found as separate PDF files distributed with this application note. They can be downloaded from http://www.atmel.com.

3 Detailed description

3.1 Sensor mode

The MC301 can be configured in sensor mode using the Hall sensors of the motor through the Power board interface (J4).

Figure 3-1. Sensor Mode Configuration.



J9 VL, UH, UL connected (1-2, 3-4, 5-6)

J15, J16 & J17 connected horizontally with H1, H2 & H3

J8 2-3 connected to use the potentiometer

All J9, J10, J11, J12, J13 left open.

3.2 Sensorless modes

The MC301 can be configured in sensorless mode thanks to the comparator circuitry populated on the MC301 board.

When using the zero crossing signals output from comparators, short 1-2 on J15, J16, J17 jumpers. This will connect respectively ZC_U, ZC_V & ZC_W to PA1, PA4 & PA5 of the ATtiny861.

When using the filtered U, V, W signals coming from the MC300 power board, short 2-3 on J15, J16, J17 jumpers. This will connect respectively U_Conditioned, V_ Conditioned & W_ Conditioned to PA1, PA4 & PA5 of the ATtiny861.

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

3.3 Interfacing MC301 with PC through USB

Commands & status can be transferred to a PC thru a USB link thanks to the USB bridge on the MC301.

3.3.1 Connection

Connect the USB mini B cable to the MC301 board and to a PC. Make sure J19 (power supply of USB bridge) is properly configured.

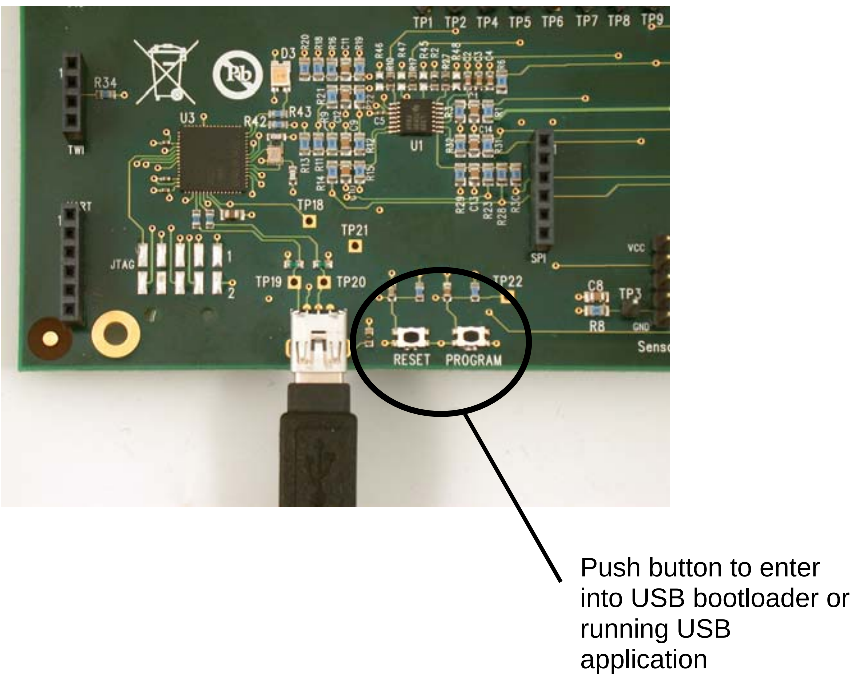
3.3.2 Communication

MC301 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. MC301 is delivered with a native USB CDC firmware in the AT90USB1287.

3.3.3 USB bridge update

MC301 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 enumerate 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

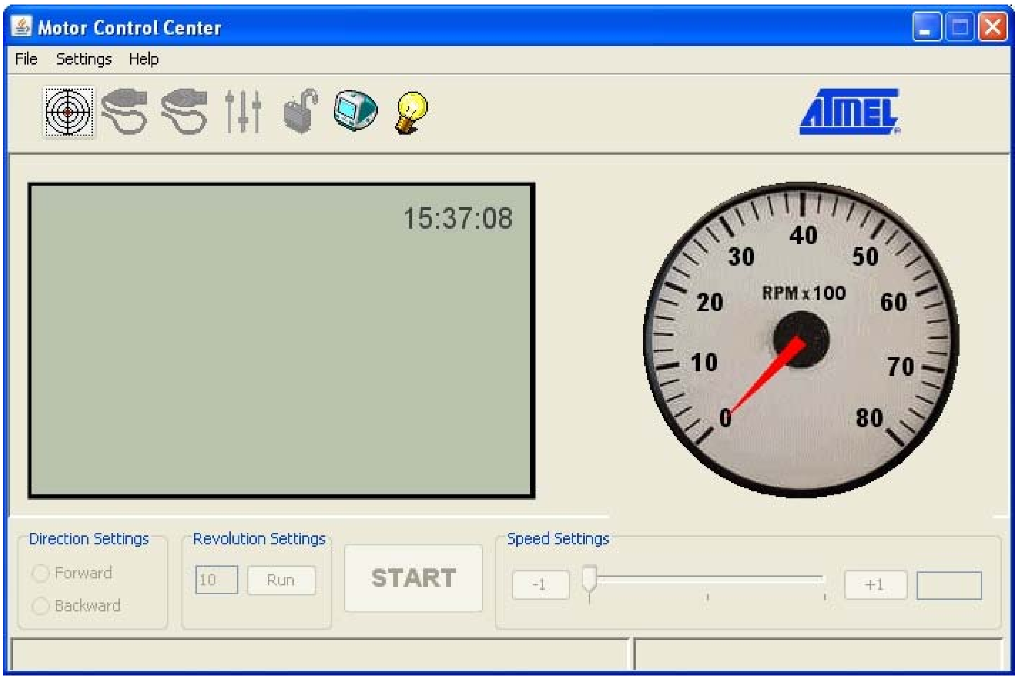
Figure 3-2. Entering in bootloader or start the application.



3.3.4 Atmel Motor Control Center

The Atmel Motor Control Center used with the MC301 is available on the Atmel website: www.atmel.com.

Figure 3-3. Motor Control Center User Interface.



See Atmel Motor control center user's guide & the application notes using MC301+MC300 & Atmel Motor Control center for further explanation on this PC software usage.

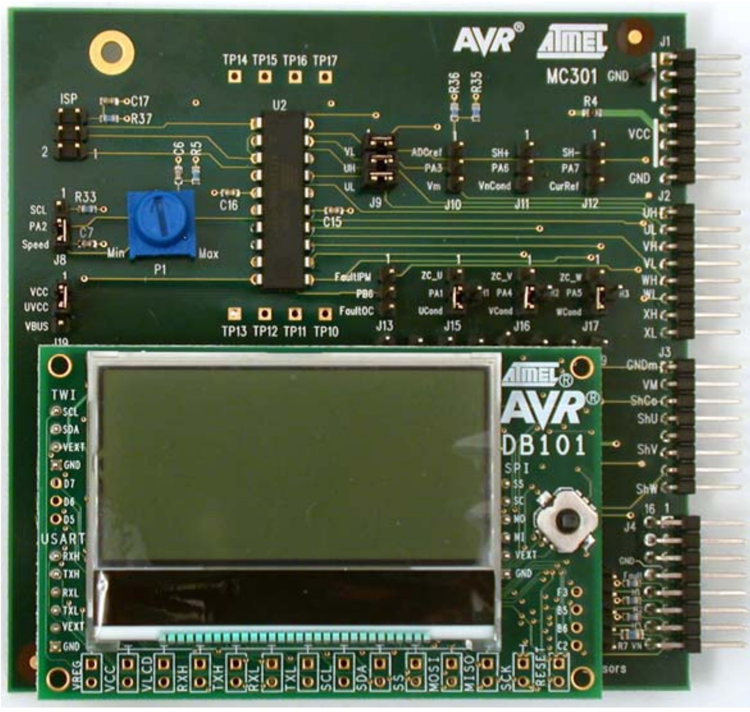
3.4 Interfacing MC301 with Atmel DB101 Display module

The DB101 display module can be added to the MC301 (See application notes 481, 482, and 483 on www.atmel.com).

3.4.1 Connection

DB101 connects using 3 headers J5, J6 & J7 (respectively UART, SPI, and TWI). See Figure 3-4. **MC301 PCB layout**

Figure 3-5. DB101 Display Module.



3.4.2 Communication

DB101 uses the TWI with ATtiny861 thru J7 header

1-2 of J8 must be connected to use the DB101; in this case the potentiometer is no longer usable.

3.5 Upgrading the MC301 Motor control firmware

Firmware on the MC301 can be updated through AVR Studio® using Atmel AVRISP mkII or JTAGICE mkII connected to J14 ISP/DW connector and by removing jumpers on J9.

Select the ATtiny861 device in the device list.

Figure 3-6. Firmware Upgrade Procedure.

CAUTION:

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

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