ATAVRMC200

Hardware User Guide

"ATTENTION AND WARNING: The tools provided herein involve the use of high voltage and may result in electrocution if improperly used. Atmel advises you to read through the entire documentation in order to understand the application and development tools prior to use. Atmel assume no liability and no responsibility for any injury as a result of these development tools.

Section 1

Introduction

Congratulations on your purchase of the AVR® ATAVRMC200 evaluation kit. This document describes the board included in the ATAVRMC200 starter kit dedicated to AT90PWM3.

1.1 Overview

The ATAVRMC200 is an evaluation kit dedicated to AC induction motor control, The kit includes an evaluation board, and demonstration software. It allows users to quickly evaluate the capability of the AT90PWM3 AVR® microcontroller to control a three phase asynchronous induction motor.

The kit can also serve as a development platform. Low cost AVR development tools make debugging easier, and source code, written in C, can be easily re-used by developers for their own motor control applications.

Note: This evaluation kit does not contain the AC induction motor, the motor can be purchased separately.

Figure 1-1 . ATAVRMC200

1.2 ATAVRMC200 Features
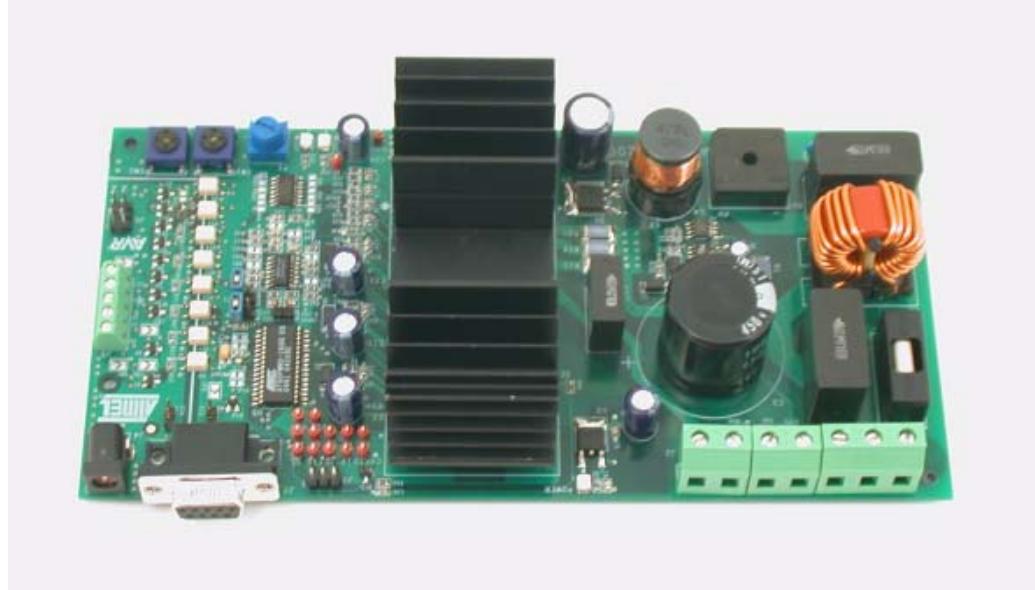
The ATAVRMC200 provides the following features:

- AT90PWM3-16SQ SO32 device (2.7 - 5.5V)
- Power bridge for AC induction Motors (Maximum Power 370W)
- Embedded AC/DC power supply
- Hardware temperature detection
- Hardware overcurrent detection
- On-board Voltage Regulator (5V)
- AVR Studio® Software Interface(1)
- Power-supply flagged by Green LED
- ISP connector for Debug Wire
- Opto-isolated ISP connector for on-chip In-System-Programming (Reserved for future used)
- Opto-isolated uart interface
- System Clock: Internal RC Oscillator Only
- Numerous access points for test
- Three opto-isolated input for sensors
- One trimmer, two push buttons and two leds for program interaction
- Recommended voltage operation from 110/230 V (50/60Hz) or 48 V DC
- Power supply EMC filtering embedded
- Operating Temperature Range from 0°C to 70°C
- Dimension: 200 mm x 100 mm

Notes: 1. The AT90PWM3 is supported by AVR Studio®, version 4.12 Service Pack 2 or higher. For up-to-date information on this and other AVR tool products, please consult our web site. The newest version of AVR Studio®, AVR tools and this User Guide can be found in the AVR section of the Atmel web site, http://www.atmel.com.

Section 2

Getting Started

This chapter describes how to connect the AC motor on the MC200 board and run the embedded software.

The PWM3 part is already programmed with a firmware allowing to run a three phase AC motor.

Note: For 220V AC motor MC200 board must be powered with 220V AC, for 110V AC motor MC200 board must be powered with 110V AC.

Connect the motor Connect the motor to U, V,and W of J2 connector as describe below
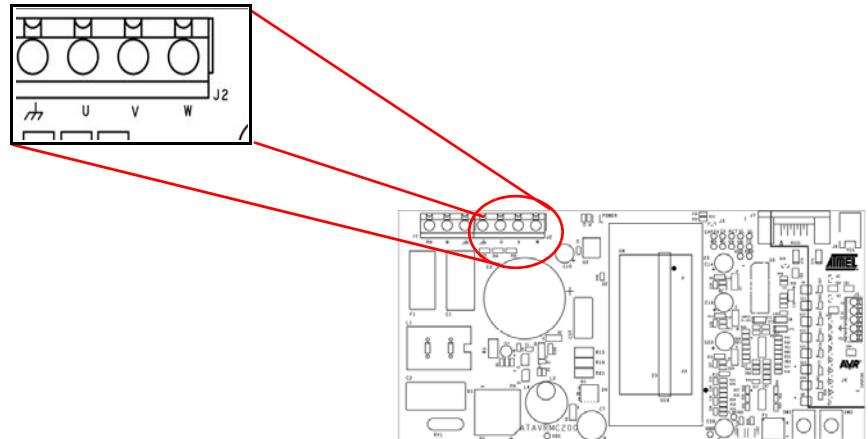
Connect the power as describe below. Phase line connected to pin 3 (PH) of J1, Neutral Line connected to pin 2 (N) of J1and Earth connected to Pin 1 of J1 (Ground).
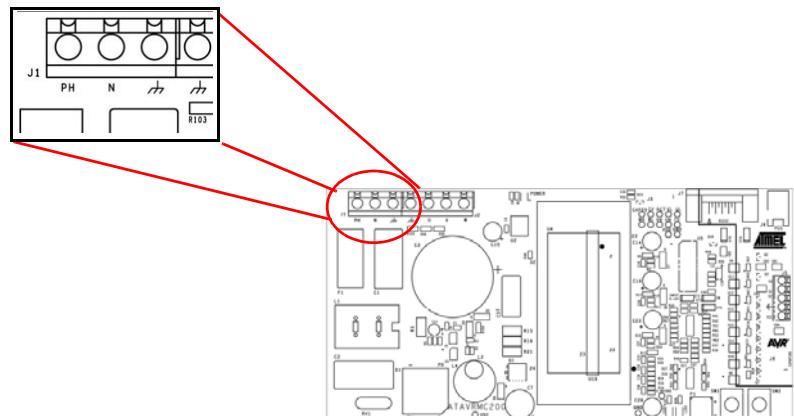
Switch power ON and enjoy the demo!

Section 3

Hardware Description

3.1 Block Diagram

Figure 3-1. ATAVRMC200 Block Diagram
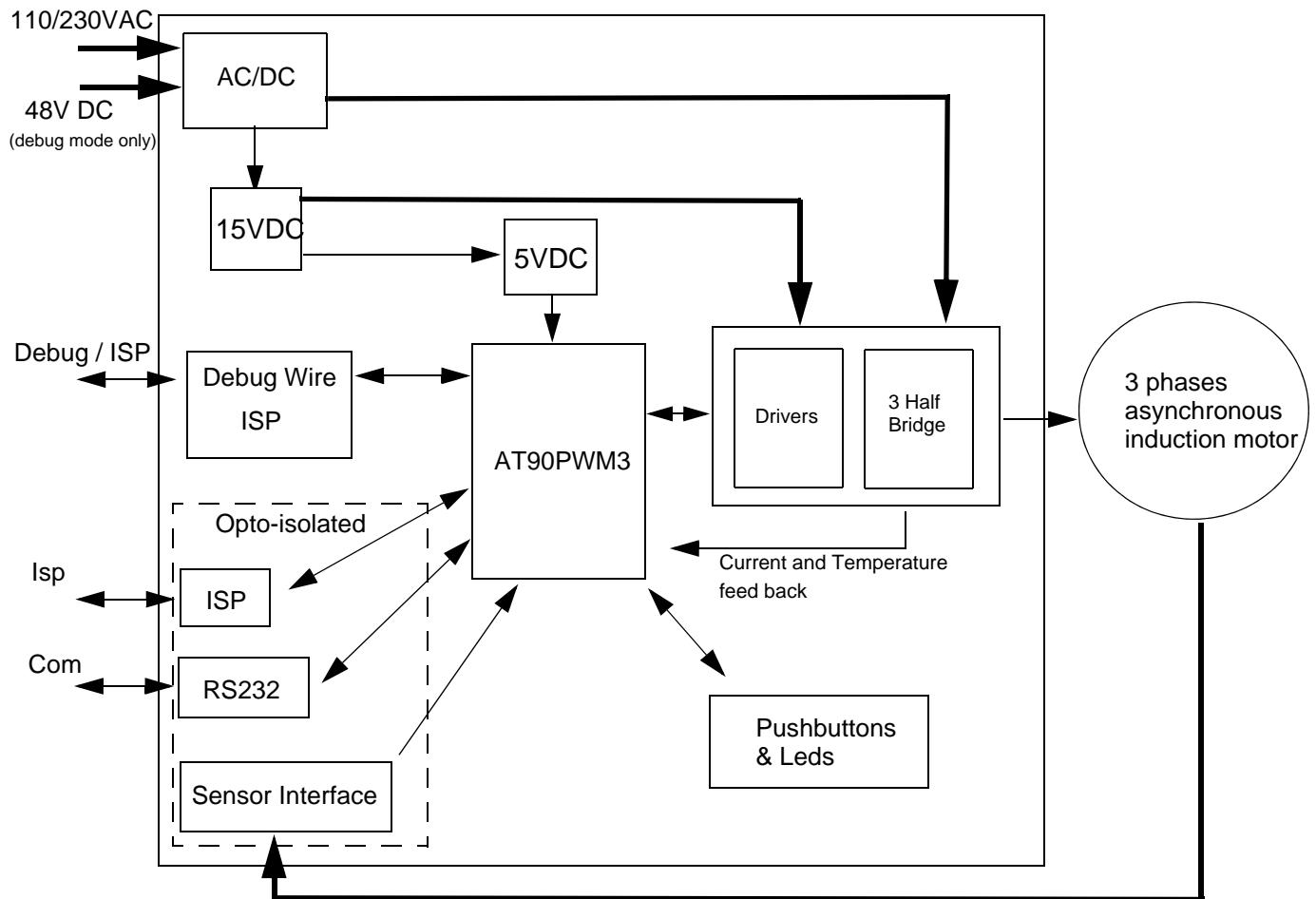
3.2 Power Supply

### 3.2.1 Power Supply

The power supply source must be 110V AC to 230V AC (50/60 Hz) on J1 connector.

Three differents voltages are generated from AC source to power the board.

- VDC = 325V DC (with 220V AC as input source) for motor phases
- VBridge = 15V DC for drivers control.
- and VDD = 5V DC for cpu power supply.

LED1 is always lit when VBridge power is applied to ATAVRMC200.

During microcode debugging phase, the user must power the board directly with VDC= 48V DC through J1 connector (PH and N connection), it will allow to check the signal on oscilloscope and use DebugWire interface (J3) to program and debug micro-code for AT90PWM3 part.

Warning: When using DebugWire or ISP interface through J3 connector for debugging or programming, board **must not** be powered with 110-220V AC source but only with 48V DC.

Figure 3-2 . Power supply Connector
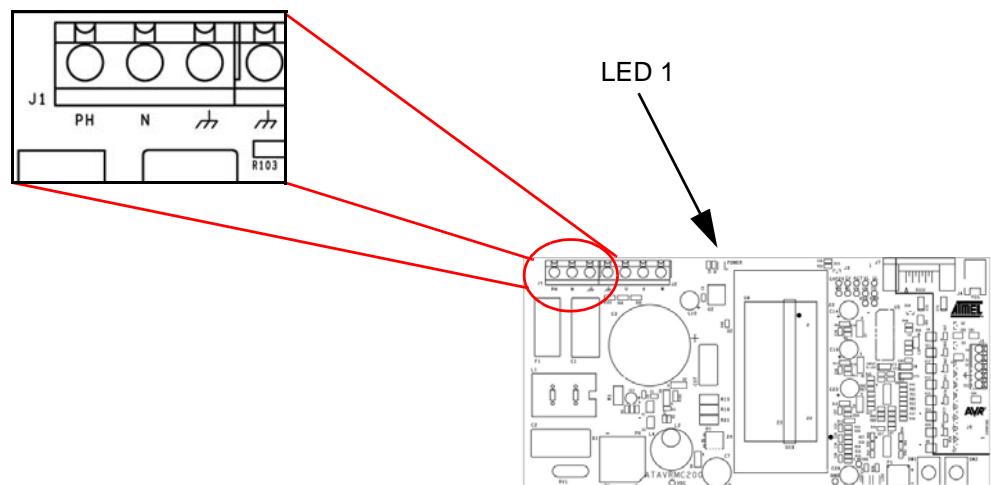
3.3   ISP / Debug wire Connector

ATAVRMC200 has a six pin ISP connector (J3) allowing to reprogram the part with new code using standard AVR ISP tools. The same connector can be used as standard AVR debugWire connector

Figure 3-3 . J3 - ISP / DebugWire Connector Position
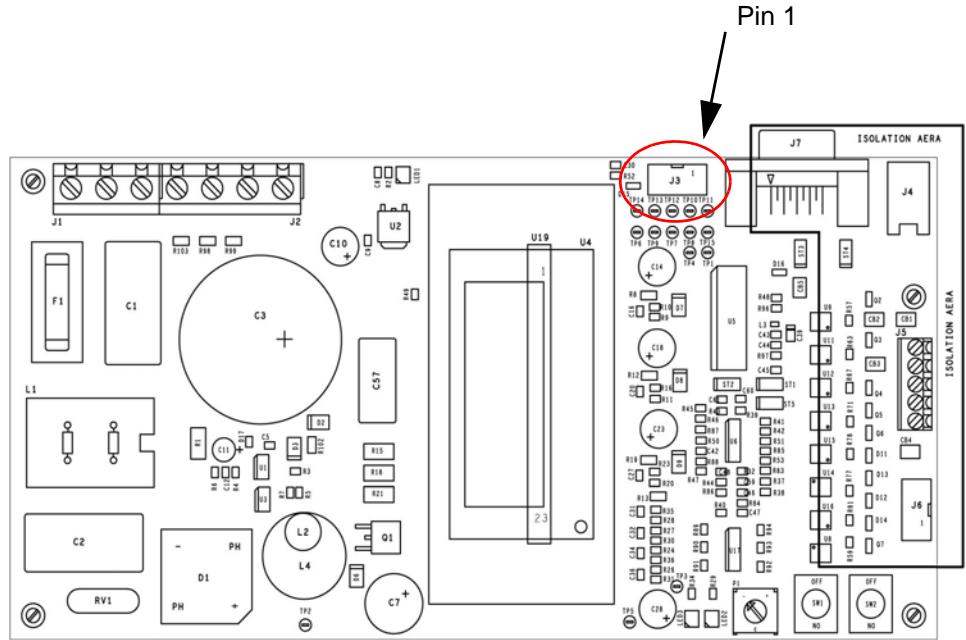
Table 3-1 . ISP / DebugWire connector Pin number vs Signal names

Pins number	Signals
1	MISO
2	VCC 5V
3	SCK
4	MOSI
5	/ Reset
6	Ground

For details informations about programming tools using ISP connector, refer to programming chapter.

Warning: When using DebugWire or ISP interface through J3 connector for debugging or programming, board **must not** be powered with 110-220V AC source but only with 48V DC.

3.4 Program Interaction

To help programmers, the ATAVRMC200 board has two push buttons, one potentiometer and two leds available for user interactions.

Figure 3-4 . Position of Available Interaction Features

leds   Potentiometer   Push Buttons
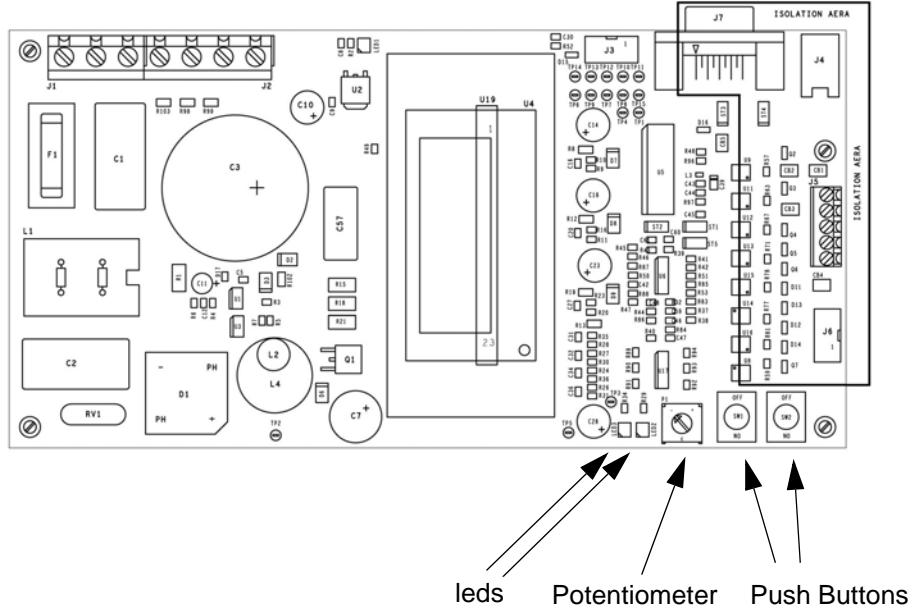
Table 3-2 . AT90PWM3 Pin number of Available Interaction Features

Pins number	Signal name	Stuff
7	PC1	Switch SW1
10	PC2	Switch SW2
11	PC3	Led LED 2
14	PE1	Led LED 3
26	PC6	Potentiometer P1

3.5 Hardware Overheating Detection

The Mosfet Driver circuit has an embedded thermal resistor, this dedicated output is connected to ADC input of AT90PWM3, it prevents overheating.

3.6 Hardware Overcurrent Detection

The current into each phase of the motor is controlled by hardware using analog to digital converter, it allows to turn off all Mosfets when overcurrent occurs. A reference voltage is generated throught digital to analog converter of the AT90PWM3, This signal is used as current reference, and adapts the reference for events such as inrush current when the motor starts rotating.

3.7 Opto isolated Area

The ATAVRMC200 board has an opto isolated area (in grey below) allowing to connect the board to external link when the board is powered by 110/220V AC.

3.7.1 UART Opto Isolated

The opto isolated uart (connector J7) is connected to Rxd and Txd pin of AT90PWM3, it allows full duplex communication. Users may use a nine wire to wire cable to connect ATAVRMC200 to PC or terminal. The maximum baud rates is 38400 bauds.

Uart is self powered by PC using RTS and CTS pins, for that reason, uart must be used with no flux control.

Figure 3-5 . Position of opto isolated area and uart connector
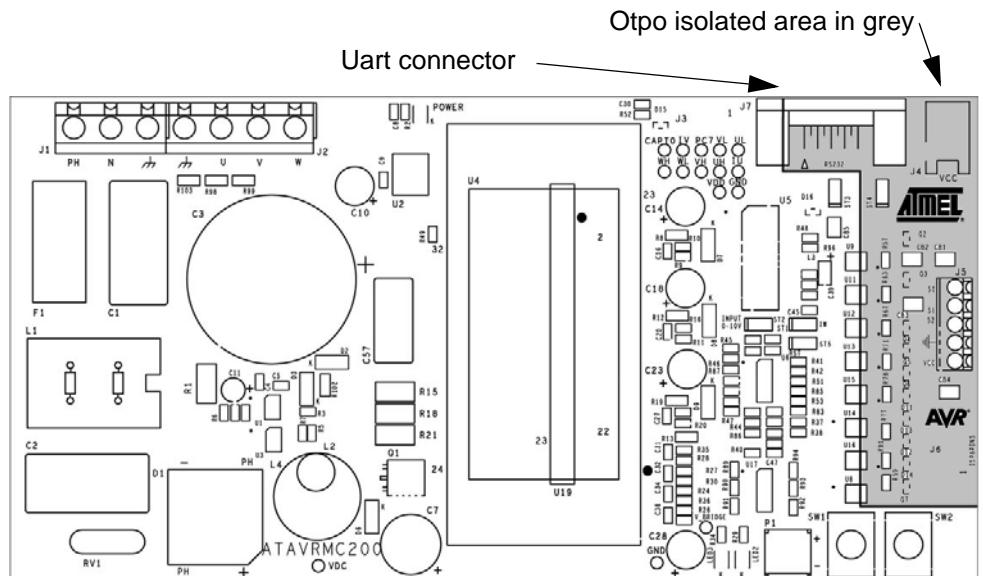
Table 3-3 . Uart Connector pin used vs signal

DB9 pin number	connected to
1	NC
2	TXD of PWM3
3	RxD of PWM3
4	DTR
5	GND
6	NC
7	RTS
8	NC
9	NC

3.7.2   Opto Isolated Sensor Inputs

The ATAVRMC200 has three opto isolated inputs that can be used for sensors connection. The connector J5 is dedicated to this inputs. By default opto isolated area must be powered using J4 connector, but if inputs signals have enought power to drive directly opto coupler, then power throught J5 is optional and if not used solder bridge must be closed on the board to bypass the PFET transistors associated to each inputs (refer to schematics).
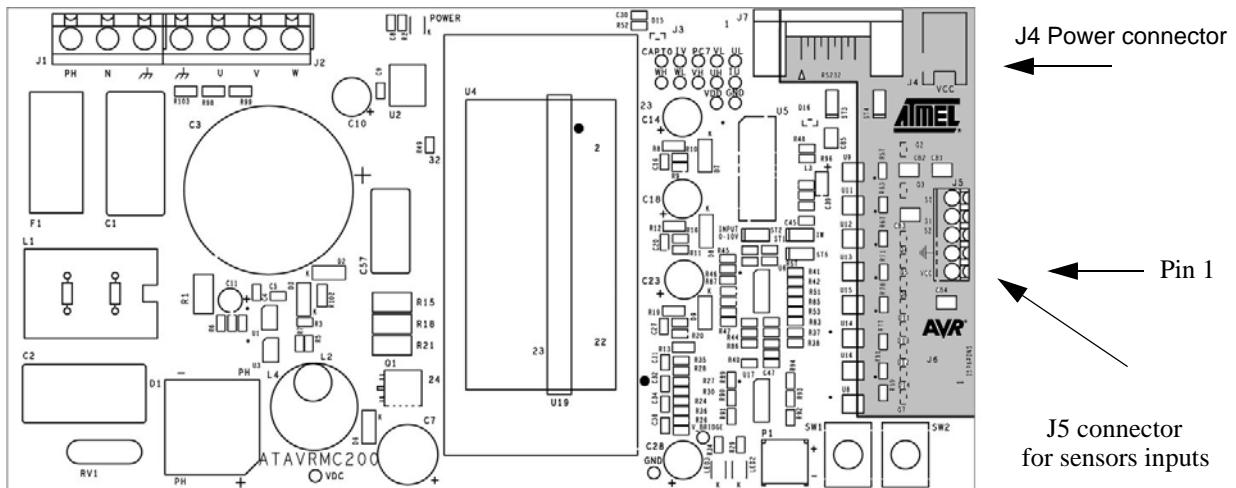
Table 3-4 . J5 pin number vs signal

Pin number	Signal
1	VCC
2	GND
3	Input 2
4	Input 1
5	Input 0

3.7.3   ISP Opto Isolated

Do not use, reserved for future extension

3.8 Test Points

The ATAVRMC200 board has test points for debug and engineering development.

The following table summarises all test points, please refer to schematics for detailed informations

Table 3-5 . Test Point vs signal name.

Signal Name	Test Point	Schematic page Number
GND	TP1	Page 1/4
VDC	TP2	Page 1/4
Vbridge	TP3	Page 1/4
VDD	TP4	Page 1/4
GND	TP5	Page 1/4
WH	TP6	Page 2/4
VH	TP7	Page 2/4
UH	TP8	Page 2/4
WL	TP9	Page 2/4
VL	TP10	Page 2/4
UL	TP11	Page 2/4
PC7	TP12	Page 3/4
IV	TP13	Page 3/4
CAPTO	TP14	Page 3/4
IU	TP15	Page 3/4

Figure 3-6 . ATAVRMC200 Test Points Position

TP2/VDC   TP1/GND   TP3/VBRIDGE
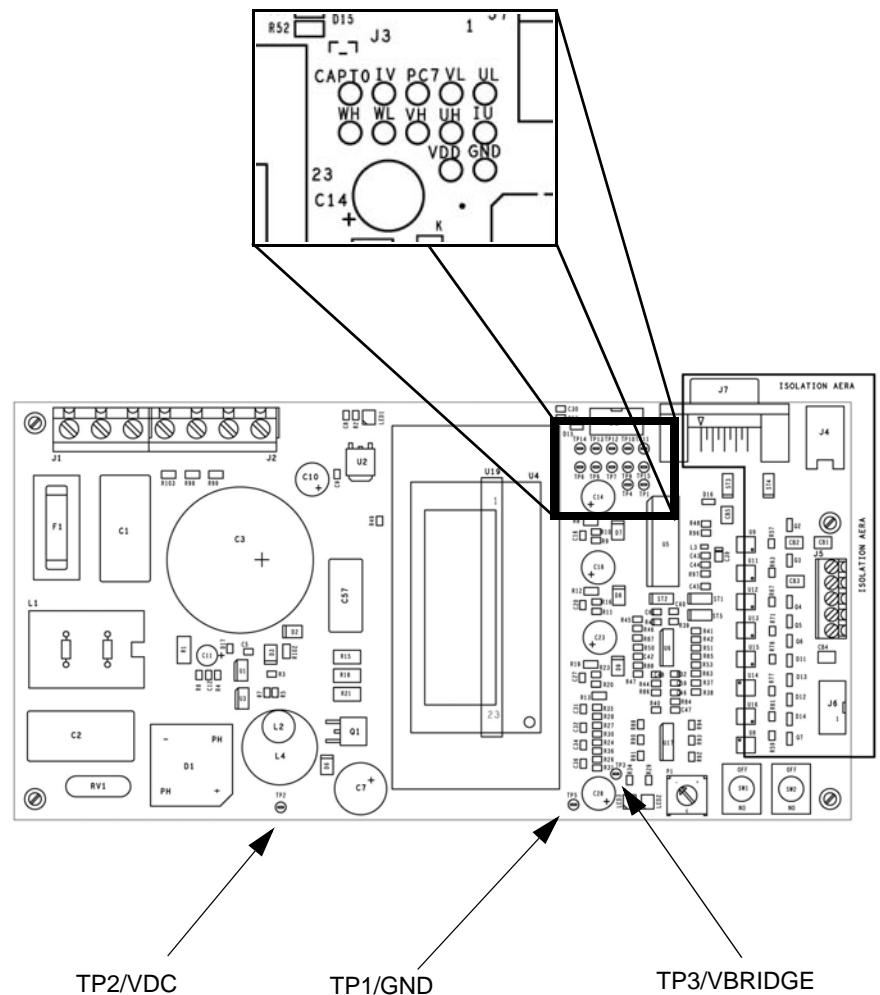
Section 4

Programming ATAVRMC200

Note: **Warning ISP interface must not be used when board is powered with 110V or 230V. It must be powered using 48VDC**

4.1   In-System Programming

The AT90PWM3 can be programmed using specific SPI serial links. This section explains how to connect the programmer.

The Flash, EEPROM memory (and all Fuse and Lock Bit options ISP-programmable) can be programmed individually or with the sequential automatic programming option.

WARNING: If debugWire fuse is enabled, AVR ISP can't be used. If debugWire fuse is disabled, JTAGICE mkII have to be used in ISP mode to enabled debug-Wire fuse.

4.1.1   Programming with AVR ISP or AVR ISP mkII Programmer

The AVR ISP (or JTAGICE mkII) programmer is a compact and easy-to-use In-System Programming tool for developing applications with AT90PWM3. Due to the small size, it is also an excellent tool for field upgrades of existing applications. The AVR ISP (or JTAGICE mkII) programming interface is integrated in AVR Studio.

To program the device using AVR ISP (or JTAGICE mkII) programmer, connect the 6-wire cable on the ISP connector of the ATAVRMC200 as shown in Figure 4-1.

Note: See AVR Studio on-line Help for information.

Figure 4-1 . Programming from AVR ISP (or JTAGICE MKII) programmer


```
MISO  | 1 | 2 | VCC
SCK   | 3 | 4 | MOSI
RESET | 5 | 6 | GND
```

ISP CON
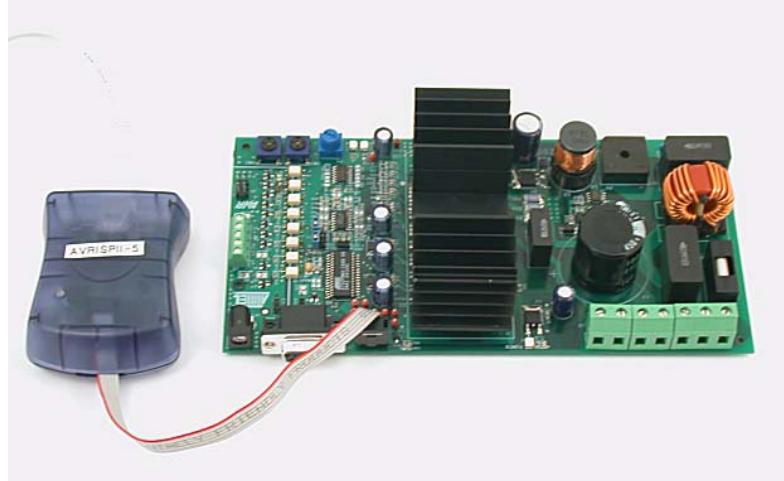
4.1.2   Programming with STK500

The AT90PWM3 can be programmed using the serial programming mode in the AVR Studio STK500 software. The software interface (In-System Programming of an external target system) is integrated in AVR Studio.

To program the device using ISP from STK500, connect the 6-wire cable between the ISP6PIN connector of the STK500 board and the ISP connector of the ATAVRMC200 as shown in Figure 4-2.

The STK500 board delivers sufficient power to supply the AT90PWM3 of the ATAVRMC200 board, so it is not necessary to supply the ATAVRMC200 board when it is used with the STK500.

Note: See AVR Studio on-line Help for information.

Figure 4-2 . Programming from STK500
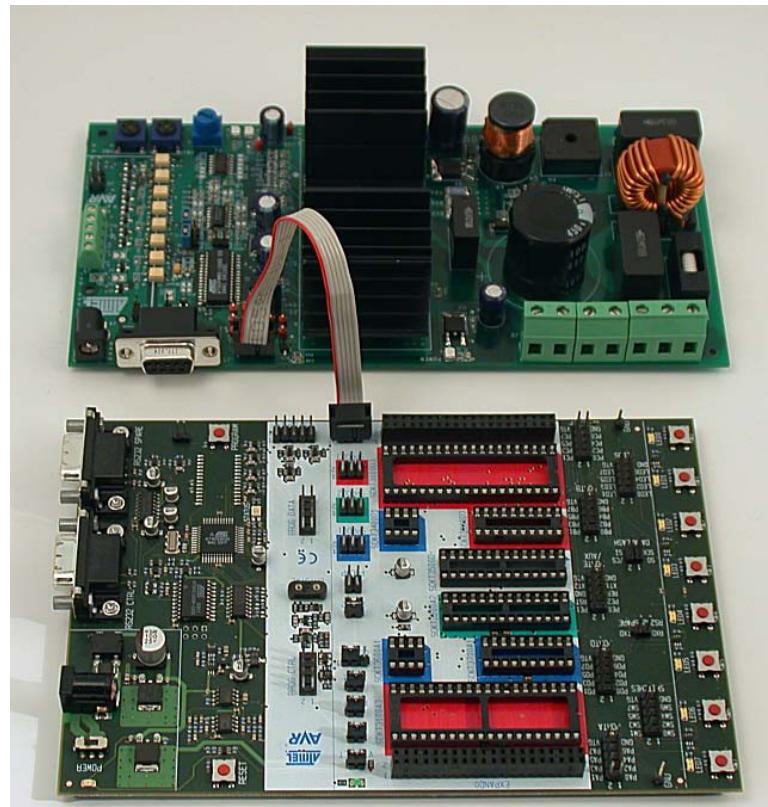
The Flash, EEPROM memory (and all Fuse and Lock Bit options ISP-programmable) can be programmed individually or with the sequential automatic programming option.

4.1.3   Programming using JTAGICE mkII

The AT90PWM3 can also be programmed using the JTAGICE mkII emulator in debug Wire mode. In this mode, AT90PWM3 starts running code only when JTAGICE is disconnected. All software is available in AVR Studio.

Figure 4-3 . Programming from JTAGICE mkII
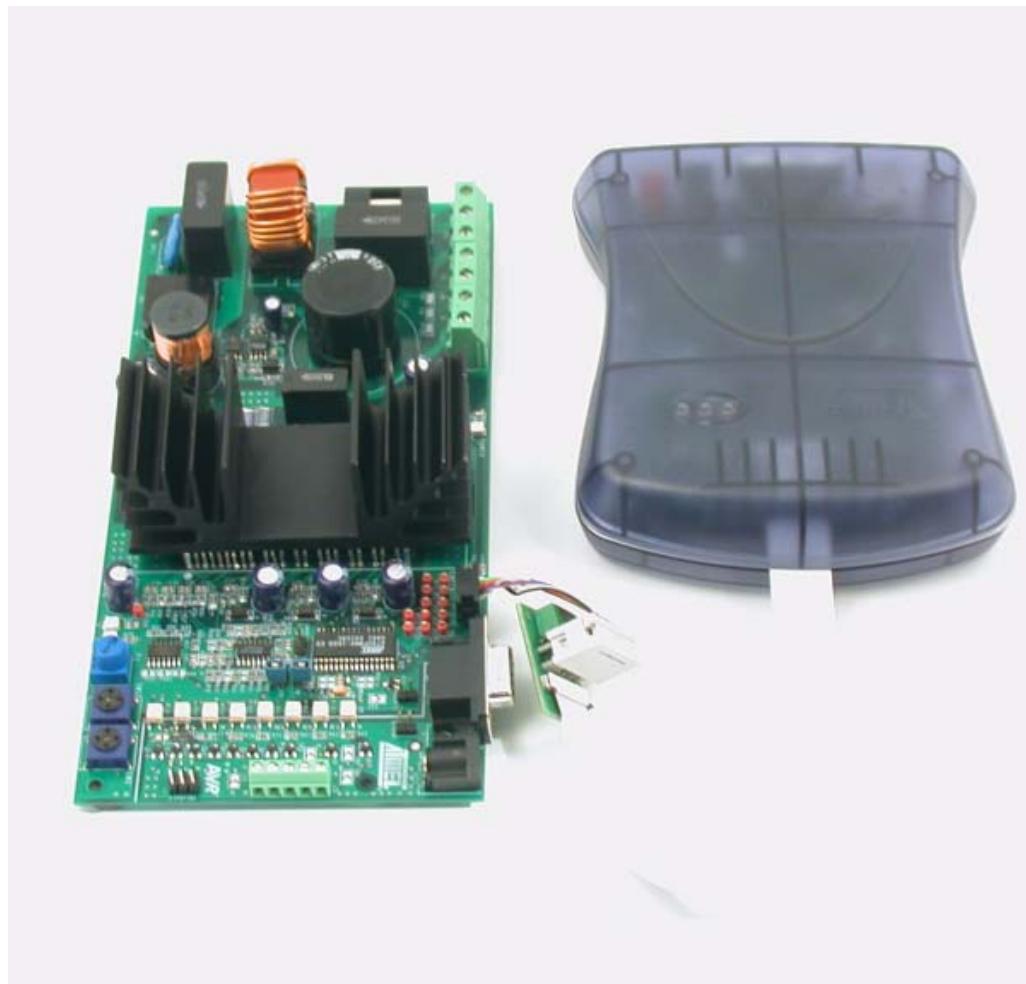
4.2   Debugging

AT90PWM3 has embedded On-chip debugWire that allows emulation with ATAVRMC2OO using JTAGICE mkII only.

WARNING: If debugWire fuse is enabled, AVR ISP can't be used. If debugWire fuse is disabled, JTAGICE MKII have to be used in ISP mode to enabled debug-Wire fuse.

Section 5

Basic Test Program

See Application Note AVR494 and AVR495 on Atmel web site.

Section 6

Troubleshooting Guide

Table 6-1 . Troubleshooting Guide

Problem Description	Reason	Solution
ATAVRMC200 does not work and LED1 led is off	No power supply	Check the power supply source , check the fuse

Section 7

Technical Specifications

- ◼ **System Unit**
  - – Physical Dimensions (Board only) ....L=200 x W=100 x H=50 mm
  - – Weight (Board only) ....351 g

- ◼ **Operating Conditions**
  - – Voltage Supply.. 11OV to 230VAC
  - – Operating Temperature range.. From 0°C to 70°C
  - – Maximum Power 370W

Section 8

Technical Support

For Technical support, please contact avr@atmel.com. When requesting technical support, please include the following information:

- Version number of AVR Studio. This can be found in the AVR Studio help menu.
- Hardware revision of ATAVRMC200 board (found on PCB).
- PC operating system and version/build
- PC processor type and speed
- A detailed description of the problem

Section 9

Complete Schematics

On the next pages, the following documents of ATAVRMC200 revision 2 are shown:

- Complete schematics
- Assembly drawing
- Bill of materials

Figure 9-1 . Schematics, Page 1 of 4
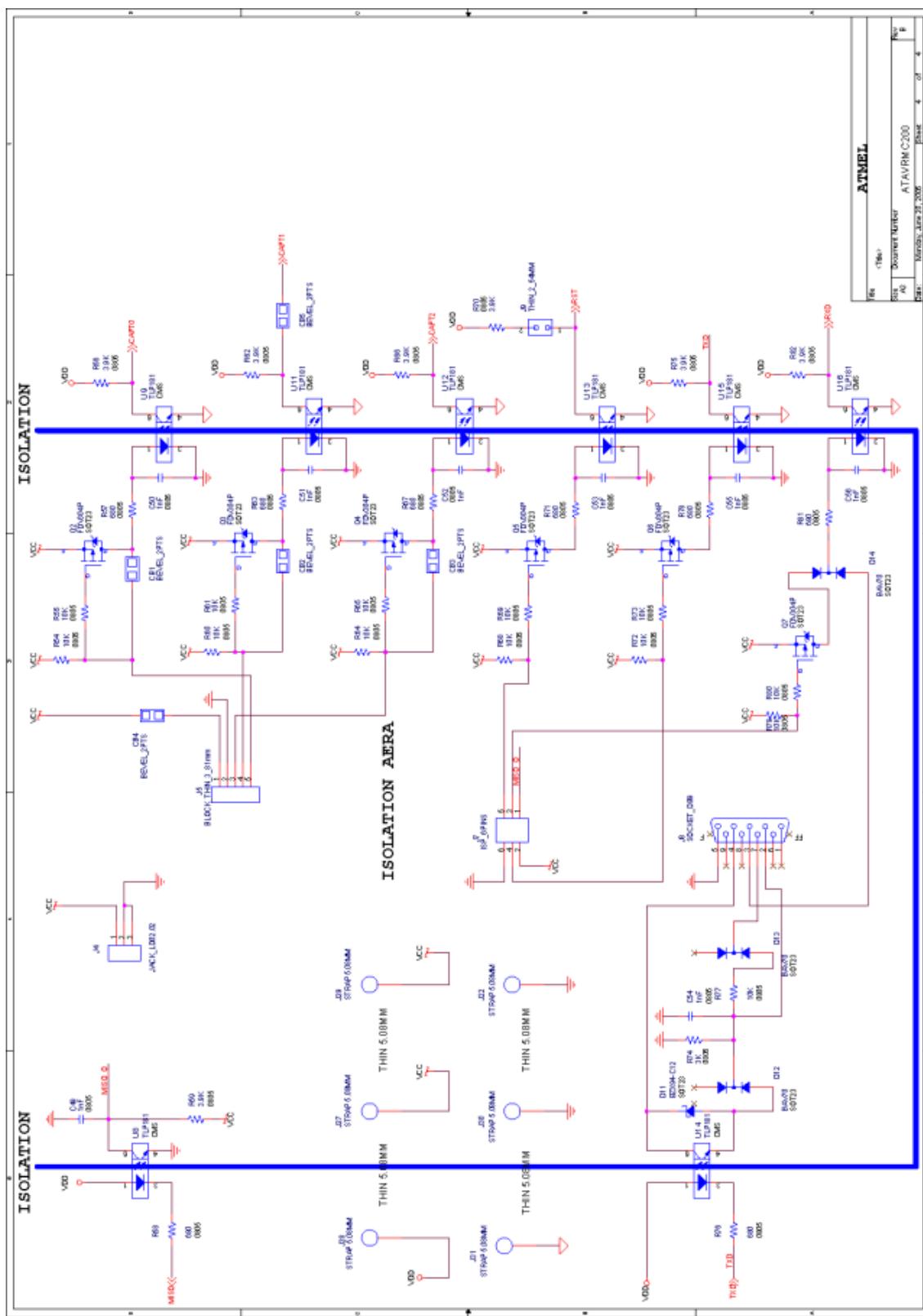
Figure 9-2 . Schematics, Page 2 of 4
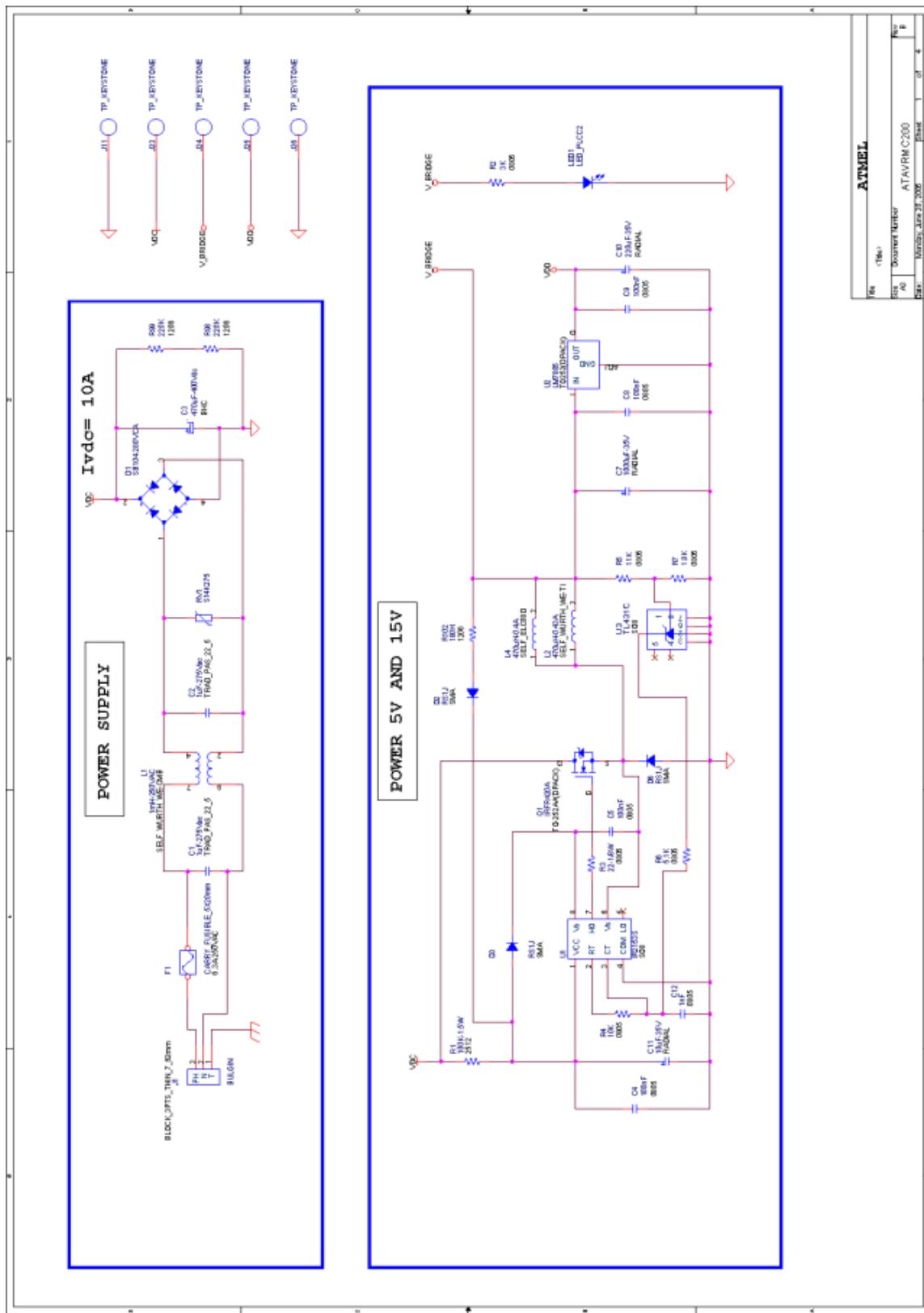
Figure 9-3 . Schematics, Page 3 of 4
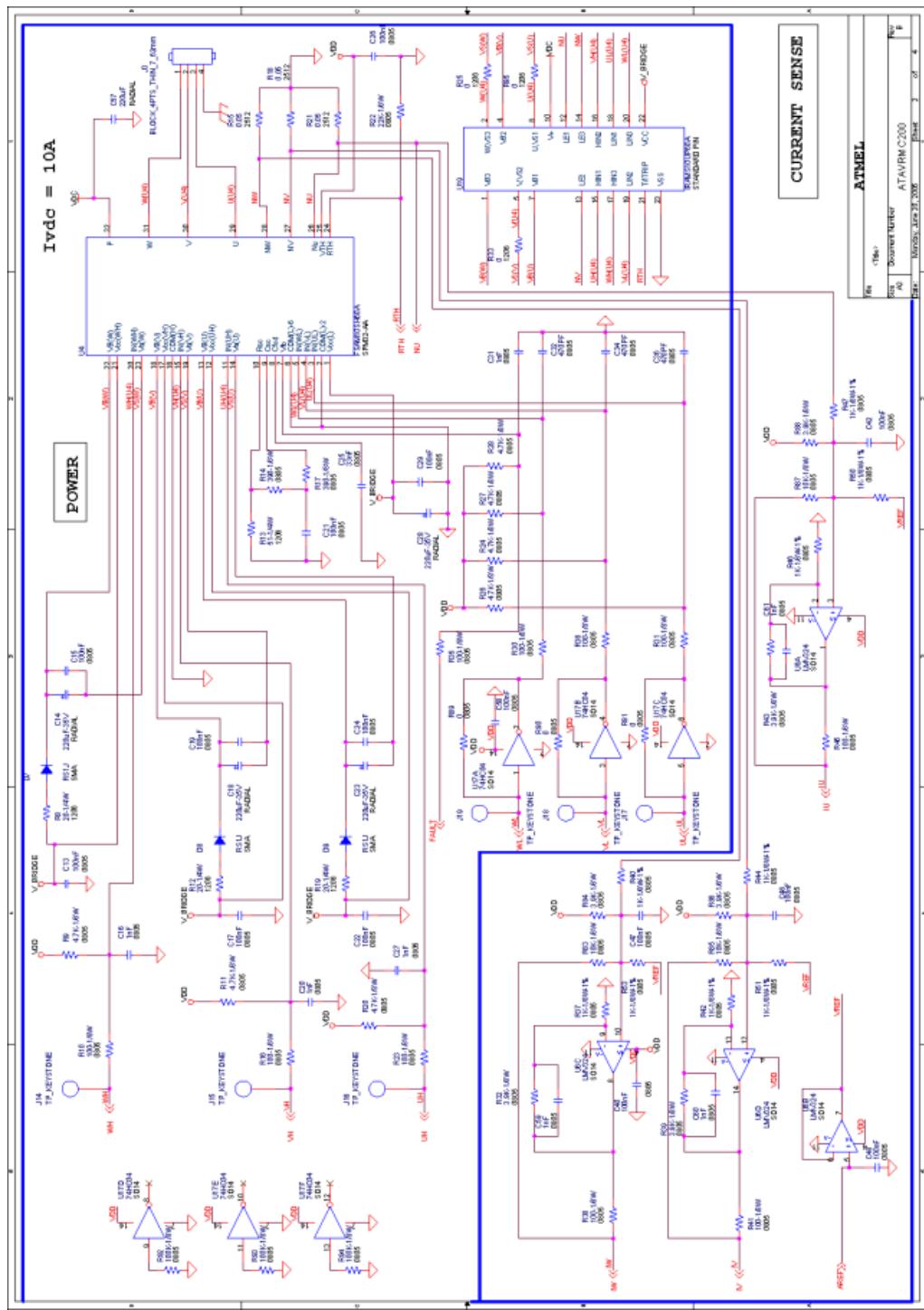
Figure 9-4 . Schematics, Page 4 of 4
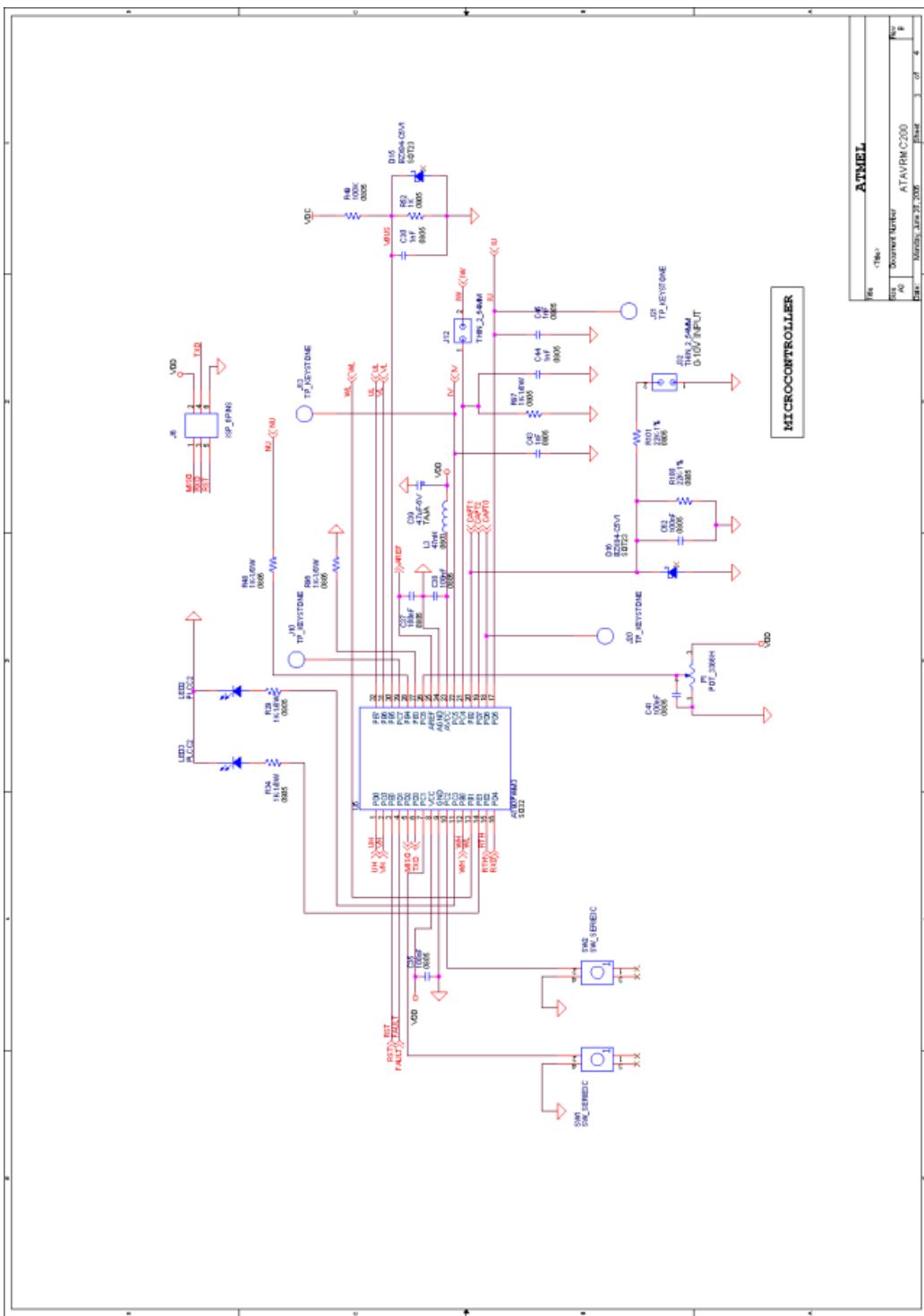
Figure 9-5 . Assembly drawings component side (left) and solder side (right)
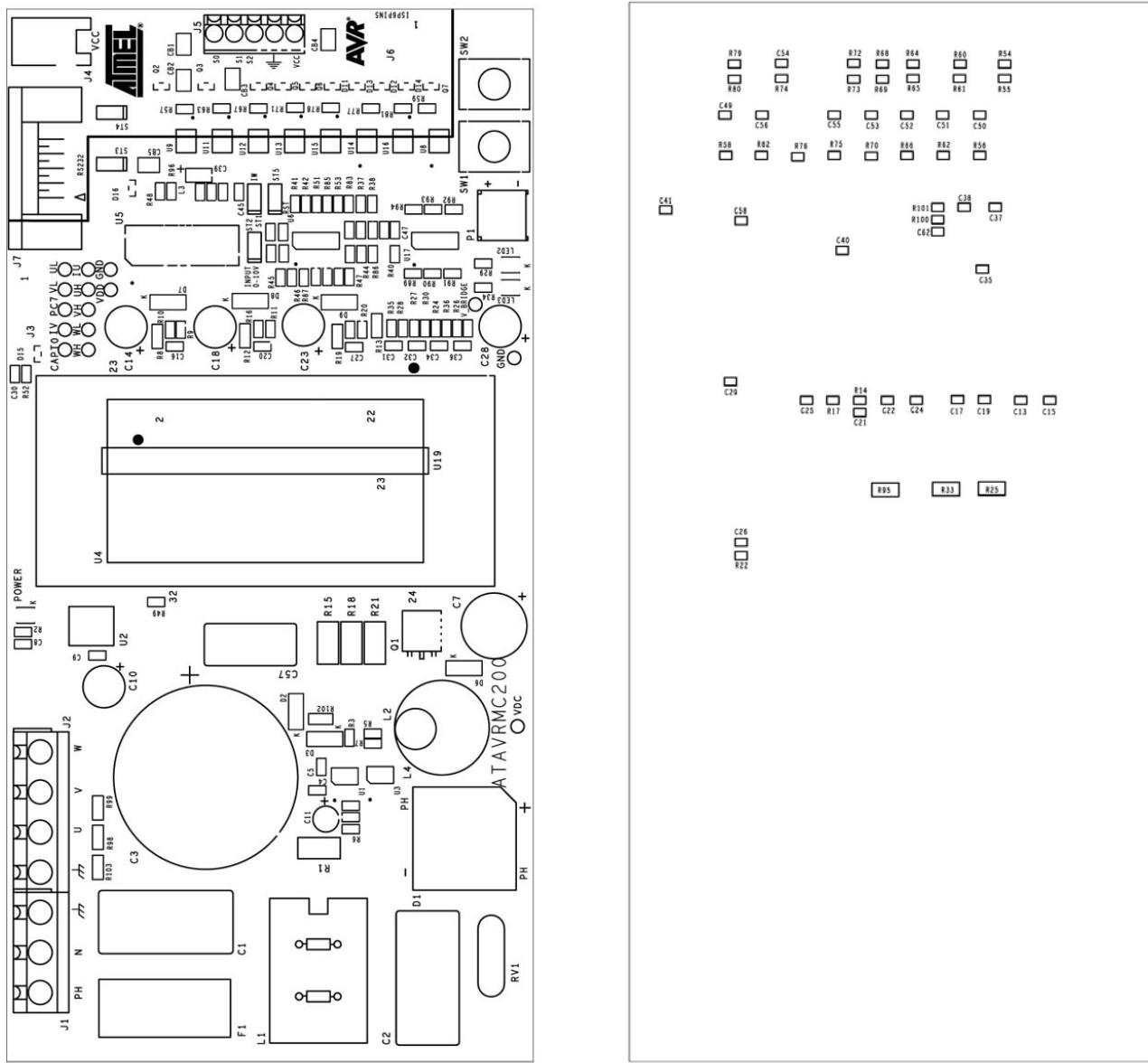
9.1   Bill of Materials

Table 1. Bill of Materials

Reference	Designation	Q	Remarks	Package	Manufacturer
Power Supply					
D1	Diode bridge 10A Taiwan Semiconductor ref SB104	1		Trad	Taiwan Semi.
F1	Fuse holder - 5 x 20	1			
F1	Delayed Fuse 5 x 20 mm 10A 250 Vca	1			
L1	Common Mode Shoke 1,0 mH 250Vca Wurth serie WE-CMB ref 744824101	1		Trad	Wurth®
C1, C2,	Capacitor polyester metal Class X2 1uF 250Vac / 22,5mm Panasonic® ref ECQU2A105ML	2		Trad	Panasonic
C3	Capacitor electrolytic radial 470µF 400V Nichicon serie LS ref LLS2G471MELC	1		Trad	Nichicon
RV1	Varistor 275Vac 0,6W EPCOS SIOV-S14K275	1		Trad	Epcos®
R102	Resistors 180 Ohms 1% 1/4W 1206	1		1206	
R98, R99, R103,	Resistors 150k Ohms 1% 1/4W 1206	3		1206	
J1	3 points connector Phoenix Contact ref GMKDS 3/3-7,62	1		Trad	Phoenix Contact
TP1, TP2,	Test Point Keystone® type1 ref 5000	2		Trad	Keystone
Power 5V and 15V					
U1	Power Supply Driver IR2153S	1		SO8	IR®
U2	Voltage Regulator 5V National LM1117DT-5,0	1		D-PAK	National®
U3	Voltage Reference LM431ACM	1		SO8	National
D2,D3,D6	Fast Power Diode RS1J	3		SMA	Fairchild
D17	Zener Diode 15V BZX284-C15	1		SOD110	Philips
Q1	Transistor MOSFET chanel N 500V 3,3A IRFR420A	1		D-PAK	IR
LED1,	LED SMD red PLCC-2 Fairchid QTLP670C-2 ou Agilent HSMS-A100-J00J1	1		PLCC2	Fairchild Agilent
C11	Capacitor electrolitic radial series M 10µF 35V Panasonic ref ECA1VM100	1		Trad	Panasonic
C10	Capacitor electrolitic radial series M 220µF 35V Panasonic ref ECA1VM221	1		Trad	Panasonic
C7	Capacitor electrolitic radial series M 1000µF 35V Panasonic ref ECA1VM102	1		Trad	Panasonic

Table 1. Bill of Materials (Continued)

Reference	Designation	Q	Remarks	Package	Manufacturer
C12	Capacitor ceramic 1 nF 50V X7R	1		0805	
C5, C8, C9	Capacitor ceramic 100 nF 50V X7R	3		0805	
L2	Inductor Panasonic radial series ELC08B 470 µH 400mA Ø=8,5mm h=7,5mm pas 5,0mm	0	Not mounted	Trad	Panasonic
L4	Inductor Panasonic radial series ELC18B 4,7 mH 550mA Ø=18mm h=27mm pas 7,5mm	1		Trad	Panasonic
R1,	Resistors 100K Ohms 1% 1,5W package 2512	1		2512	
R3	Resistors 22 Ohms 1% 1/8W package 0805	1		0805	
R7,	Resistors 1,8k Ohms 1% 1/8W package 0805	1		0805	
R2,	Resistors 3,9k Ohms 1% 1/8W package 0805	1		0805	
R4,R6	Resistors 5,1k Ohms 1% 1/8W package 0805	2		0805	
R5	Resistors 11k Ohms 1% 1/8W package 0805	1		0805	
TP3, TP4, TP5	Test Point Keystone type1 ref 5000	3		Trad	Keystone
Power FSAM10SH60A					
U4	H Bridge Smart Power Module Fairchild 600V 10A 3-phase IGBT ref FSAM10SH60	1		SPM32-AA	Fairchild
U17	Inverter 74HC04AD en package SO14	1	Not mounted if R89, R90, R91 are mounted	SO14	
D7,D8,D9	Power diode fast recovery RS1J	3		SMA	Fairchild
C57	Capacitor polyester metalic Classe X2 220nF 250Vac pas 15mm Panasonic ref ECQU2A224ML	1		Trad	Panasonic
C14, C18, C23, C28	Capacitor electrolitic radial series M 220µF 35V Panasonic ref ECA1VM221	4		Trad	Panasonic
C16, C20, C27, C31, C32, C34, C36,	Capacitor ceramic 1 nF 50V X7R	7		0805	
C25	Capacitor ceramic 33 nF 50V X7R	1		0805	
C13, C15, C17, C19, C21, C22, C24, C26, C29, C58	Capacitor ceramic 100 nF 50V X7R	10		0805	
R15, R18, R21	Resistors 0,05 Ohm 1% 2W package 2512	3		2512	
R8, R12, R19,	Resistors 20 Ohms 1% 1/4W package 1206	3		1206	
R13	Resistors 51 Ohms 1% 1/4W package 1206	1		1206	

Table 1. Bill of Materials (Continued)

Reference	Designation	Q	Remarks	Package	Manufacturer
R89, R90, R91	Resistors 0 Ohms 1% 1/8W package 0805	3	Not mounted if U17 not monted	0805	
R10, R16, R23, R30, R31, R35, R36,	Resistors 100 Ohms 1% 1/8W package 0805	7		0805	
R14, R17,	Resistors 390 Ohms 1% 1/8W package 0805	2		0805	
R9, R11, R20, R24, R26, R27, R28,	Resistors 4,7k Ohms 1% 1/8W package 0805	7		0805	
R92, R93, R94,	Resistors 10k Ohms 1% 1/8W package 0805	3	Not monted if U17 not monted	0805	
R22	Resistors 22k Ohms 1% 1/8W package 0805	1		0805	
J2	Bornier 4 pts pas de 7,62mm Phoenix Contact ref GMKDS 3/4-7,62	1		Trad	Phoenix Contact
TP6, TP7, TP8, TP9, TP10, TP11,	Test Point Keystone type1 ref 5000	6		Trad	Keystone
U4	SCHWA408 – Dissipator WA 408.0 H: 35 mm / L: 88 mm / l : 31mm	1			
U4	Thermal Grease	1			
U4	Screw M4x30mm	2			
	Washer 4mm	2			
Power IRAMX10UP60A					
U19	H Bridge Integrated Power Module International Rectifier 600V 10A 3-phase ref IRAMX10UP60A	1		Trad	IR
U17	Inverter 74HC04AD en package SO14	1	Not mounted if R89, R90, R91 are monted	SO14	
C14, C18, C23,C28	Capacitor electrolitic radial series M 220µF 35V Panasonic ref ECA1VM221	4		Trad	Panasonic
C57	Capacitor polyester metalic Classe X2 220nF 250Vac pas 15mm Panasonic ref ECQU2A224ML	1		Trad	Panasonic
C16, C20, C27, C32, C34, C36,	Capacitor ceramic 1 nF 50V X7R	6		0805	
C15, C19, C24, C29, C58	Capacitor ceramic 100 nF 50V X7R	5		0805	

Table 1. Bill of Materials (Continued)

Reference	Designation	Q	Remarks	Package	Manufacturer
R15, R18, R21	Resistors 0,05 Ohm 1% 2W package 2512	3		2512	
R25, R33,R95	Resistors 0 Ohms 1% 1/4W package 1206	3		1206	
R89, R90, R91	Resistors 0 Ohms 1% 1/8W package 0805	3	Not monted if U17 monted	0805	
R10, R16, R23, R30, R31, R36,	Resistors 100 Ohms 1% 1/8W package 0805	6		0805	
R9, R11, R20, R24, R26, R27,	Resistors 4,7k Ohms 1% 1/8W package 0805	6		0805	
R22	Resistors 6,8k Ohms 1% 1/8W package 0805	1		0805	
R92, R93, R94,	Resistors 10k Ohms 1% 1/8W package 0805	3	Not monted if U17 not monted	0805	
J2	Con 7,62mm Phoenix Contact ref GMKDS 3/4-7,62	1		Trad	Phoenix Contact
TP6, TP7, TP8, TP9, TP10, TP11,	Test Point Keystone type1 ref 5000	6		Trad	Keystone
U19	Thermal Dissipator 5°C/W AAVID THERMALLOY type 0S550 H=58,6mm L=100mm l=31,8mm	100mm			AAVID® THERMAL-LOY
U19	Thermal Grease	1			
U19	Screw M4x10mm	2			
Current sense 1 (direct)					
C42, C46, C47	Capacitor ceramic 1 nF 50V X7R	3		0805	
R84, R6, R88	Resistors 1,5k Ohms 1% 1/8W package 0805	3		0805	
R83, R85, R87	Resistors 10k Ohms 1% 1/8W package 0805	3		0805	
R40, R44, R47	Resistors 47k Ohms 1% 1/8W package 0805	3		0805	
Current sense 2(AOP)					
U6	Quad Op Amplifier rail to rail LMV324M	1		SO14	National
C42, C46, C47, C59, C60, C61	Capacitor ceramic 1 nF 50V X7R	6		0805	
C40, C48,	Capacitor ceramic 100 nF 50V X7R	2		0805	
R38, R41, R45	Resistors 100 Ohms 1% 1/8W package 0805	3		0805	

Table 1. Bill of Materials (Continued)

Reference	Designation	Q	Remarks	Package	Manufacturer
R37, R40, R42, R44, R46, R47, R50, R51, R53	Resistors 1k Ohms 1% 1/8W package 0805	9		0805	
R32, R39, R43	Resistors 3,9k Ohms 1% 1/8W package 0805	3		0805	
Current sense 3(differential)					
C44, C46	Capacitor ceramic 1 nF 50V X7R	2		0805	
R85	Resistors 0 Ohms 1% 1/8W package 0805	1		0805	
R44, R48, R96, R97	Resistors 1 kOhms 1% 1/8W package 0805	4		0805	
Microcontroller					
U5	AT90PWM3 microcontroller	1		SO32	Atmel
D15, D16	Zener Diode 5V1 BZX84-C5V1	2		SOT23	
LED2, LED3,	LED SMD green package PLCC-2 Fairchid QTLP670C-4 or Agilent HSMM-A100-S00J1	2		PLCC2	Fair-child Agilent
L3	Inductor 4,7nH 600mA package 0603	1		0603	
C39	Capacitor tantale 4,7uF 6V package A	1		package A	
C30, C43, C45	Capacitor ceramic 1 nF 50V X7R	3		0805	
C35, C37, C38, C41, C62	Capacitor ceramic 100 nF 50V X7R	5		0805	
P1	Potentiometer Trimmer cermet monotours 10k 1/2W serie 3386F-TW	1		Trad	Bourns®
R29, R34, R52	Resistors 1 kOhms 1% 1/8W package 0805	3		0805	
R100, R101	Resistors 22kOhms 1% 1/8W package 0805	2		0805	
R49	Resistors 100 kOhms 1% 1/8W package 0805	1		0805	
SW1, SW2	Switch MEC serie 3C ref 3CTH9	2		Trad	MEC
J3	Con 2,54 mm 2x3 pts	1		Trad	
ST1, ST2,	Con 2,54 mm 2 pts	2		Trad	
ST1, ST2,	Jumper 2 pts aupas 2,54 mm	2			
TP12, TP13, TP14, TP15	Test Point Keystone type1 ref 5000	4		Trad	Keystone

Table 1. Bill of Materials (Continued)

Reference	Designation	Q	Remarks	Package	Manufacturer
Isolation area					
U8, U9, U11, U12, U13, U14, U15, U16	Opto-isolater Toshiba ref TLP181	8		SO	Toshiba®
Q2, Q3, Q4, Q5, Q6, Q7	MOSFET Transistor P channel FDV304P	6		SOT23	Fairchild
D11	Zener Diode 12V BZX84-C12	1		SOT23	
D12, D13, D14,	Double Diode BAV70	3		SOT23	
C54	Capacitor ceramic 1 nF 50V X7R	1		0805	
C49, C50, C51, C52, C53, C55, C56	Capacitor ceramic 1 nF 50V X7R	0	not mounted	0805	
R55, R61, R65, R69, R73, R80	Resistors 0 Ohms 1% 1/8W package 0805	6		0805	
R57, R58, R63, R67, R71, R76, R78, R81,	Resistors 680 Ohms 1% 1/8W package 0805	8		0805	
R56, R59, R62, R66, R70, R75, R82,	Resistors 1k Ohms 1% 1/8W package 0805	7		0805	
R74	Resistors 3k Ohms 1% 1/8W package 0805	1		0805	
R54, R60, R64, R68, R72, R77, R79,	Resistors 10k Ohms 1% 1/8W package 0805	7		0805	
J5	Con 3,81mm Phoenix Contact ref MKDS 1/5-3,81	1		Trad	Phoenix Contact
J6	Con 2,54 mm 2x3 pts	1		Trad	
J7	Supply connector diam int 2,1mm diam ext 5,5mm EEE ref LD02.02	1		Trad	EEE
J8	Sub D 9 pts connector DB9	1		Trad	
ST3,ST4,ST5	Connector 2,54 mm 2 pts	3		Trad	
ST5	Jumper 2 pts / 2,54 mm	1			
Assembly					
	PCB MC4 FR4 2VE 1,6mm 35 µm 200 x 100 mm	1			

![ATMEL logo]

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