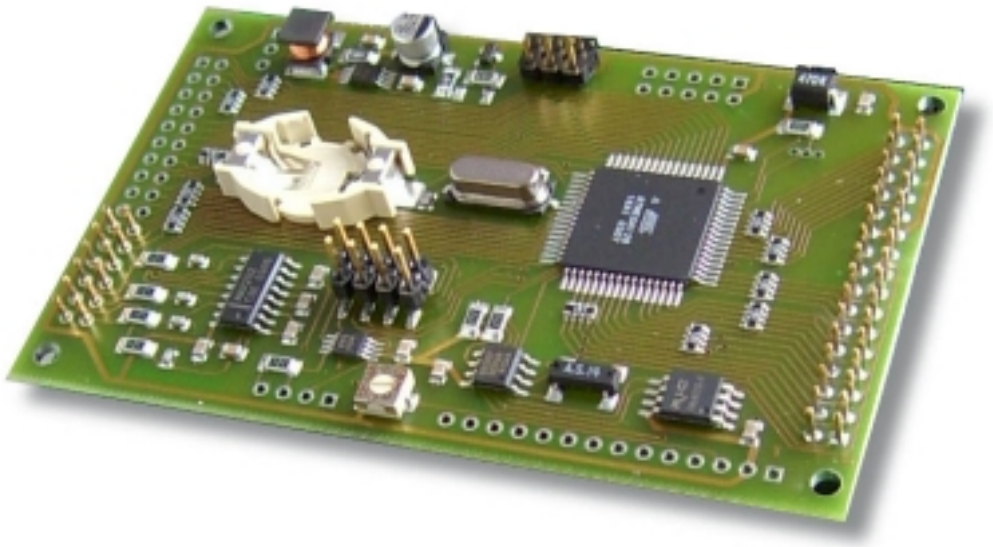

AVRcard

Microcontroller Core Module

User Manual

Board Rev.:	1.1
Document Rev.:	1.1a
Revision Date:	06.01.2004

www.avrcard.com

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Author: *Hans Kallen*
Keywords: *AVRcard, ATmega128, prototyping, RS-485, LCD, FM24C256*

Section 1
Product Overview

The AVRcard has been designed to enable developers to rapidly prototype AVR based applications. The board features the most powerful 8-bit RISC CPU to date from Atmel. The board has been designed by ESS Development AG. It supports rapid development of applications for the ATmega128 8-bit RISC CPU by providing a multitude of useful hardware features.

Key Features

- ATmega128 8-bit RISC CPU
- 32Kbytes, 2-wire serial ferromagnetic RAM (FM24C256-SE) for persistent data storage without backup power
- 2-wire serial real time clock providing additional square wave output 1-32KHz (DS1307)
- 3V lithium battery keeping time and date up to 5 years
- RS-485 driver for two wire networking up to 1.5 km (MAX485)
- RS-232 driver supporting two serial interfaces (MAX202)
- Step-up voltage converter for 2-5V battery power supply or long supply wiring (MAX1674)
- all SMD assembly except analog voltage reference and header connectors which can be soldered manually according to the user's requirements
- CPU ports routed directly to connectors for unrestricted use (ESD protected by series resistors)
- connector for standard LCD with adjustable negative contrast voltage output
- ISP connector
- JTAG connector
- 5V supply
- credit card size (87 x 54mm)

Additional Resources

- **Product Information** – All updated product information can be retrieved at the Web Site, www.avrcard.com.
- **Application Support** – Please check the Resources pages regularly at www.avrcard.com for design notes and application hints. Further support is available by email from support@avrcard.com.
- **Custom Designs** – Custom versions of the product are available. For inquiries please contact info@avrcard.com.

Section 2
Getting started

Handling Precautions

Most of the CPU ports on the AVRcard are protected by series resistors against electrostatic discharge. Please note that this is not a 100% protection and does not apply to all port pins. **Always observe ESD protection standards** while working with the board.

Especially the **RS-485 transceiver** chip is sensitive to electrostatic discharge. Therefore, an external protection circuit should be considered in rough environments. Refer to chapter RS485 - ESD protection.

Never use **battery power supply** and external supply simultainously! The step up converter can be damaged due to reverse current flow.

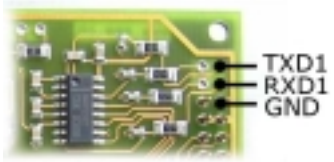
System Requirements

- Power Supply: 5VDC +/- 10%
- PC with terminal software, 19'200 bit/s, 8 data bits, no parity
- Cable for serial communications

Quick Start

Your AVRcard has been factory tested and shipped with the terminal software loaded. You can test basic functions of the board by using this preloaded software.

1. Connect a regulated 5VDC power supply to the AVRcard.
2. Connect a cable for serial communications between the serial port 1 of the AVRcard and your PC.



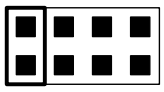
   Connect these signals to a female 9 pin D-Sub connector which plugs into the COM port of your PC, as follows:

   Pin 2: TXD1

   Pin 3: RXD1

   Pin 5: GND

3. Set jumper *RX1 select*.



4. Start your terminal program with the settings 19200 bps, 8 bits, no parity, 1 stop bit, no flow control.
5. Switch on the power supply. The AVRcard will report the command prompt '>'. Now you can send commands according to the table below. Enter '?'-'Return' to get a help text describing all the available commands.

Table 1 – Commands of the preloaded terminal monitor

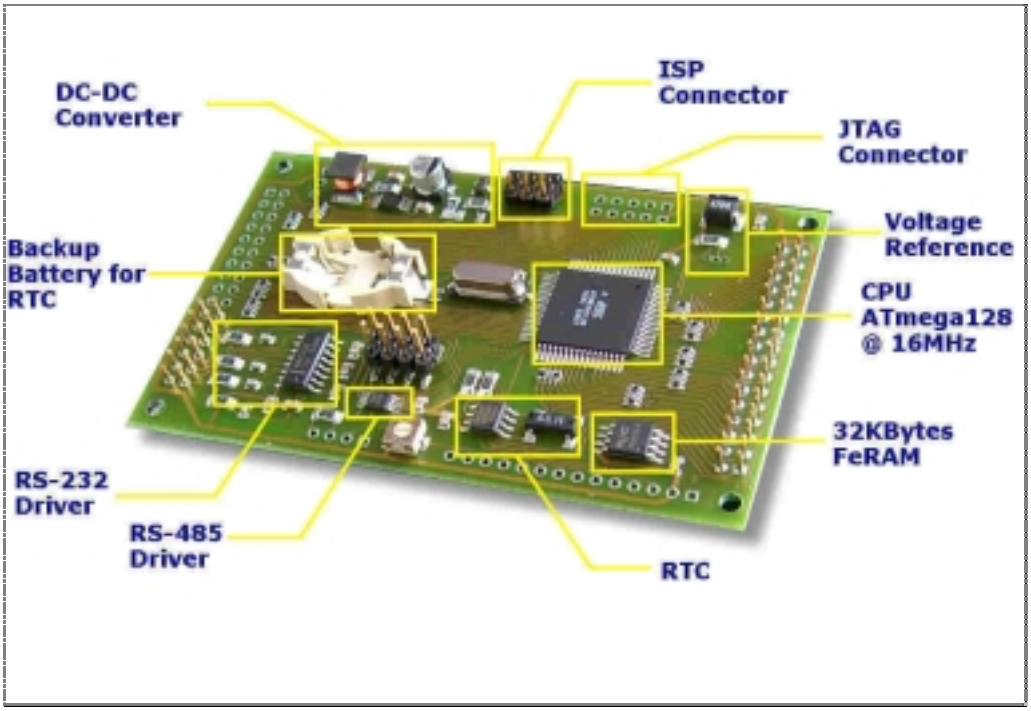
Command	Description
?<cr>	display this help text
help<cr>	display this help text
<ctrl><q>	serial port transparent mode (on/off)
dt<cr>	display current date and time
st<cr>	set date and time
wr<cr>	write hex byte to fram
wrtxt<cr>	write text to fram
rdump<cr>	fram hex dump
sp<cr>	show i/o port
wd<cr>	write i/o port data direction
wp<cr>	write i/o port bit
reg<cr>	read control registers
cf<cr>	create file
df<cr>	delete file
wf<cr>	write text to file
rf<cr>	read file content
fseek<cr>	read file content at specific address
fdump<cr>	file hex dump
dir<cr>	show files on virtual disk
disk<cr>	show free virtual disk space
format<cr>	format virtual disk
vref<cr>	set reference voltage for adc
adc<cr>	read voltages at adc ports

Section 3
Hardware Description

Functional Blocks

Figure 1 shows the board and its different functional areas. These areas are detailed in the following sections.

Figure 1 – Functional Blocks of the AVRcard



CPU

Some of the ATMEGA128 ports are routed to more than one connector or used internally. See chapter Available Connectors.

FRAM

The FM24C256 is a 256-kilobit nonvolatile memory employing an advanced ferroelectric process. A ferroelectric random access memory or FRAM is nonvolatile and performs reads and writes like a RAM. It provides reliable data retention for 10 years while eliminating the complexities, overhead, and system level reliability problems caused by EEPROM and other nonvolatile memories.

The FM24C256 performs write operations at bus speed. No write delays are incurred. The next bus cycle may commence immediately without the need for data polling. In addition, the product offers write endurance orders of magnitude higher than EEPROM. Also, FRAM exhibits much lower power during writes than EEPROM since write operations do not require an internally elevated power supply voltage for write circuits.

RTC

The DS1307 Serial Real-Time Clock is a low-power, full binary-coded decimal (BCD) clock/calendar plus 56 bytes of NV SRAM. Address and data are transferred serially via a 2-wire, bi-directional bus. The clock/calendar provides seconds, minutes, hours, day, date, month,and year information. The end of the month date is automatically adjusted for months with fewer

than 31 days, including corrections for leap year. The clock operates in either the 24-hour or 12-hour format with AM/PM indicator. The DS1307 has a built-in power sense circuit that detects power failures and automatically switches to the battery supply.

DC-DC Converter

The MAX1674 step-up DC-DC converter features a built-in synchronous rectifier, which improves efficiency and reduces size and cost by eliminating the need for an external Schottky diode. Quiescent supply current is only 16µA. The input voltage ranges from 0.7V to Vout, where Vout can be set from 2V to 5.5V. Start-up is guaranteed from 1.1V inputs. The MAX1674 has a preset, pin-selectable output for 5V or 3.3V. On the AVRcard, the output voltage is preset to 5V by R13, R24 is omitted.

Note: The MAX1674 may not be reversely fed. Therefore, never use battery power supply and external supply simultainously. The step up converter can be damaged.

RS-232 Driver

The MAX202E line driver/receiver is designed for RS-232 and V.28 communications in harsh environments. Each transmitter output and receiver input is protected against ±15kV electrostatic discharge (ESD) shocks,without latchup. The drivers and receivers meet all EIA/TIA-232E and CCITT V.28 specifications at data rates up to 120kbps, when loaded in accordance with the EIA/TIA-232E specification.

RS-485 Driver

The MAX485 is a low-power transceiver for RS-485 communication. Each part contains one driver and one receiver. The driver slew rates of the MAX485 is not limited, allowing it to transmit up to 2.5Mbps. These transceivers draw between 120µA and 500µA of supply current when unloaded or fully loaded with disabled drivers. The device operates from a single 5V supply. Drivers are short-circuit current limited and are protected against excessive power dissipation by thermal shutdown circuitry that places the driver outputs into a high-impedance state. The receiver input has a fail-safe feature that guarantees a logic-high output if the input is open circuit.

Interfaces

I2C

Internal FRAM and RTC use I2C bus on PD0 (SCL) and PD1 (SCA). These lines are pulled up to VCC by 2K7 resistors. This allows external I2C devices to be attached directly. The DS1307 limits bus speed to 100kHz.

Serial Communication

The two serial interfaces of the Atmega128 can be configured in various ways:

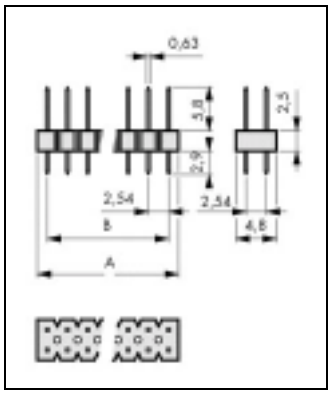
- Serial port 1 (PE0, PE1) transmits to TTL and RS-232 simultainously. Receives from TTL
- Serial port 1 receives from RS-232.
- Serial port 2 (PD2, PD3) transmits to TTL and simultainously to RS-232
- Serial port 2 transmits to TTL and RS-485
- Serial port 2 receives from TTL
- Serial port 2 receives from RS-232
- Serial port 2 receives from RS-485.

Note: Whenever reception from RS-232 or RS-485 is selected no TTL input signal must be connected to the corresponding pins on the AVRcard as it would interfer with the signal from transceivers Refer to chapter Jumpers*.*

Port Connectors

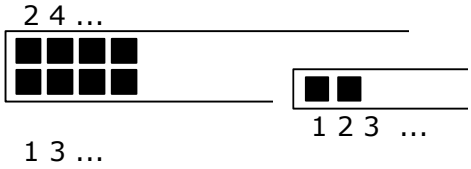
Connectors have to be soldered onto the AVRcard according to the application's requirements. Standard headers (grid 0.1") should be used.

Figure 2 – Header dimensions



Pin number 1 is marked on the AVRcard for each connector. Pins are numbered as follows:

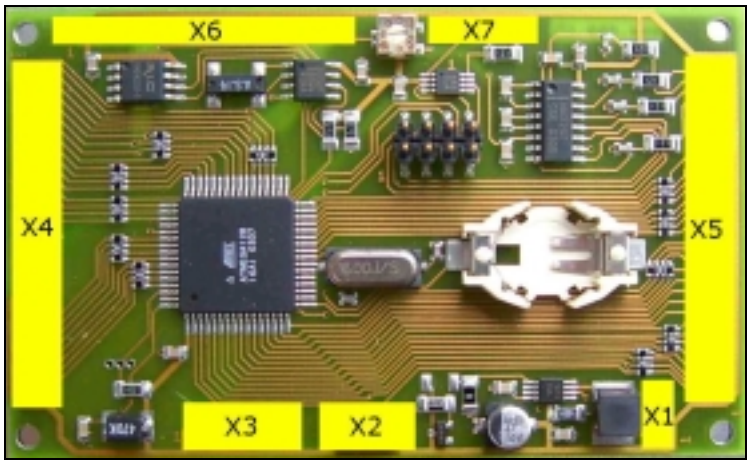
Numbering:



Available Connectors

The following connectors are available:

Figure 3 – Available Connectors



X1: battery power
X2: ISP (in circuit programming)
X3: JTAG
X4: CPU and additional ports
X5: CPU and additional ports
X6: LCD
X7: RS-485

X1 - battery power

Table 2 – Battery Connector Pinout

Pin	Function	Description
1	BATT+	+2..5V battery power input
2	BATT-	0V battery (GND)
3	/LOWBATT	is pulled low if battery voltage drops below 1.3V

X2 - ISP

Table 3 – ISP Connector Pinout

Pin	Function		I/O	Description
1	PE1	TXD	i/o	
2	VCC		pwr	
3	PB1	SCK	i/o	
4	PE0	RXD	i/o	
5	RST		i	
6	GND		pwr	

X3 - JTAG

Table 4 – JTAG Connector Pinout

Pin	Function		I/O	Description
1	PF5		i/o	
2	VCC		pwr	
3	PF4		i/o	
4	PF7		i/o	
5	RST		i	
6	GND		pwr	
7	PF6			
8	-		-	not connected
9	-		-	not connected
10	-		-	not connected

X4 - common ports

Please note that the ports on the connector are not always numbered in the same direction.

Table 5 – Common Ports Connector Pinout

Pin	Function		I/O	ESD	Internal Connections
1	PC0	A8	i/o	✓	X6/11
2	PC1	A9	i/o	✓	X6/12
3	PC2	A10	i/o	✓	X6/13
4	PC3	A11	i/o	✓	X6/14
5	PC4	A12	i/o	✓	X6/6
6	PC5	A13	i/o	✓	X6/4
7	PC6	A14	i/o	✓	X6/5
8	PC7	A15	i/o	✓	data direction select for RS-485
9	PA7	AD7	i/o	✓	
10	PA6	AD6	i/o	✓	
11	PA5	AD5	i/o	✓	
12	PA4	AD4	i/o	✓	
13	PA3	AD3	i/o	✓	
14	PA2	AD2	i/o	✓	
15	PA1	AD1	i/o	✓	
16	PA0	AD0	i/o	✓	
17	ALE		o		
18	/RD		o		
19	/WR		o		
20	SQW		o		
21	VCC		pwr		
22	VCC		pwr		
23	GND		pwr		
24	GND		pwr		
25	PF7	ADC7	i/o	✓	
26	PF6	ADC6	i/o	✓	
27	PF5	ADC5	i/o	✓	
28	PF4	ADC4	i/o	✓	
29	PF3	ADC3	i/o	✓	
30	PF2	ADC2	i/o	✓	
31	PF1	ADC1	i/o	✓	
32	PF0	ADC0	i/o	✓	

X5 - common ports

Table 6 – Common Ports Connector Pinout

Pin	Function		I/O	ESD	Internal Connections
1	PE0	RXD	i/o	✓	
2	PE1	TXD	i/o	✓	
3	PE2	AC+	i/o	✓	
4	PE3	AC-	i/o	✓	
5	PE4	INT4	i/o	✓	
6	PE5	INT5	i/o	✓	
7	PE6	INT6	i/o	✓	
8	PE7	INT7	i/o	✓	
9	PB0	SS	i/o		
10	PB1	SCK	i/o		
11	PB2	MOSI	i/o		
12	PB3	MISO	i/o		
13	PB4	OC0	i/o	✓	
14	PB5	OC1A	i/o	✓	
15	PB6	OC1B	i/o	✓	
16	PB7	OC2	i/o	✓	
17	PD0	INT0	i/o	✓	SCL on FRAM and RTC
18	PD1	INT1	i/o	✓	SDA on FRAM and RTC
19	PD2	INT2	i/o	✓	
20	PD3	INT3	i/o	✓	
21	PD4	IC1	i/o	✓	
22	PD5		i/o	✓	
23	PD6	T1	i/o	✓	
24	PD7	T2	i/o	✓	
25	VCC	VCC	pwr		
26	VCC	VCC	pwr		
27	GND	GND	pwr		
28	GND	GND	pwr		
29	RX1		i	✓	
30	RX2		i	✓	
31	TX1		o	✓	
32	TX2		o	✓	

X6 - LCD

Table 7 – Standard LCD Connector Pinout

Pin	Function	I/O	ESD	Internal Connection
1	GND	pwr		
2	VCC	pwr		
3	V0	pwr		
4	PC5	i/o	✓	X4/6
5	PC6	i/o	✓	X4/7
6	PC4	i/o	✓	X4/5
7	-			
8	-			
9	-			
10	-			
11	PC0	i/o	✓	X4/1
12	PC1	i/o	✓	X4/2
13	PC2	i/o	✓	X4/3
14	PC3	i/o	✓	X4/4

X7 - RS485

Table 8 – RS-485 Connector Pinout

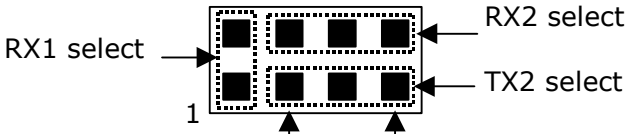
Pin	Function	I/O	ESD prot	Description
1	GND	-	no	
2	B	-	no	
3	A	-	no	
4	-	-	no	120Ω bus termination resistor. Bus can be terminated by placing a bridge on external connector (pin4 to pin 2) at far end node.

Jumpers

Jumpers are installed on the AVRcard to select the different possible combinations of serial transmission and reception supplied by the two UARTs on the ATmega128. RS-232, RS-485 and serial port with TTL level can be selected.

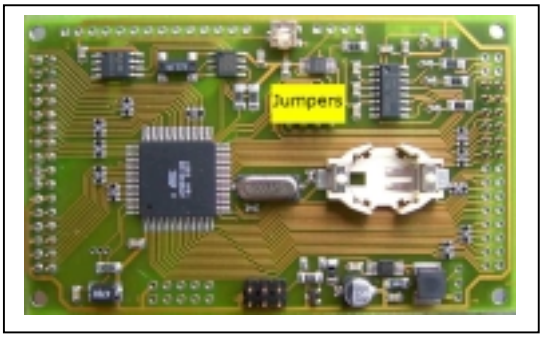
Jumpers are standard (0.1").

Figure 4 – Serial Port Configuration Jumpers



RS232 RS485

Serial port 1 can be configured for RS-232 only. For serial port 2, RS-232 or RS-485 can be selected.

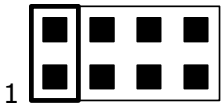


J1 - RX/TX select

RX1 select:

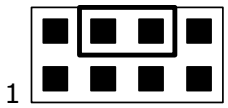
In transmit direction the TTL signal is routed from the ATMEGA128 to the RS232 transceiver (X5/pin31 [TX1]) as well as to the TTL port (X5/pin2 [PE1]). So that the receive direction signal from the RS232 transceiver (X5/pin29 [RX1]) does not interfere with the TTL port signal (X5/pin1 [PE0]), this jumper should be set accordingly.

jumper on: RS232 RX
jumper off: TTL RX



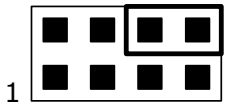
RX2 select:

In receive direction the serial port 2 can accept it's signal from TTL (X5/pin19 [PD2]), RS232 (X5/pin30 [RX2]) or RS485 (X7) inputs.



RS232 RX

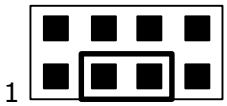
jumper off: TTL RX
jumper left: RS232 RX
jumper right: RS485 RX



RS485 RX

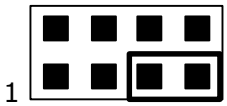
TX2 select:

In transmit direction the serial port 2 can be connected to TTL (X5/pin10 [PD3]), RS232 (X5/pin32 [TX2]) or RS485 (X7) outputs.



RS232 and TTL TX

jumper off: TTL TX only
jumper left: RS232 and TTL TX
jumper right: RS485 and TTL TX



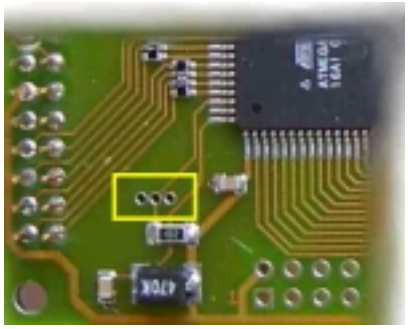
RS485 and TTL TX

ADC reference voltage

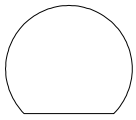
The ATMEGA128 provides several internal analog to digital converters.

Whenever you want to use a more precise or a different reference voltage (i.e. LM4040AIM) than the internal one you can solder this element manually as needed. The footprint of U2 fits to a TO-92 case.

Figure 5 – Location of ADC Reference Voltage Regulator



LM4040 orientation (top view)



Section 4
Programming

Programming

For programming you can use the ISP connecter as well as the JTAG connector. It is advised to refer to datasheets of ATmega128 and your programmer as well as this document for the exact connection method. Pin allocation matches ATMEL starter kit programmer as well as ISP/JTAG programmers manufactured by e-Lab (www.e-Lab.de).

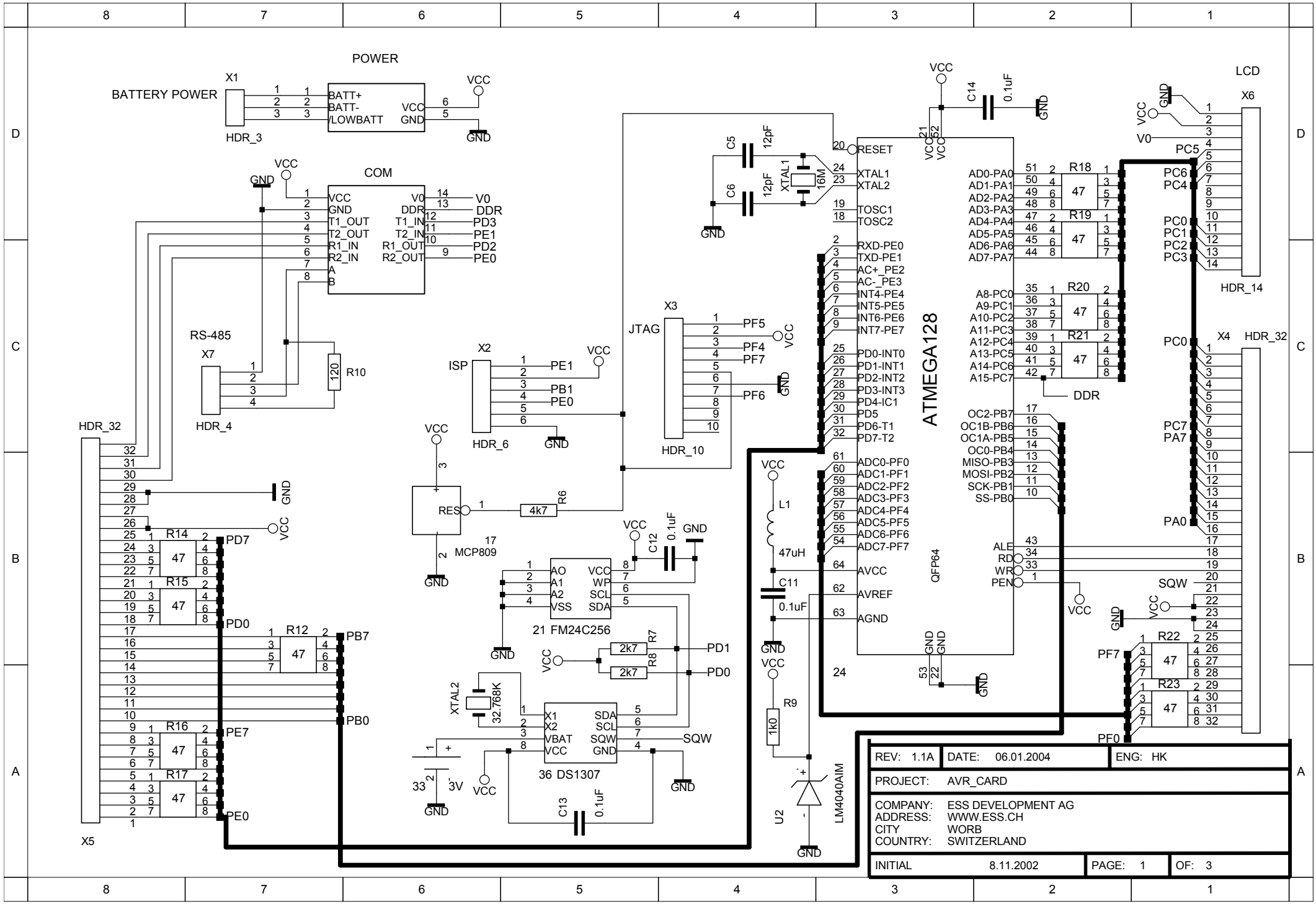
Never use battery power supply while programming !

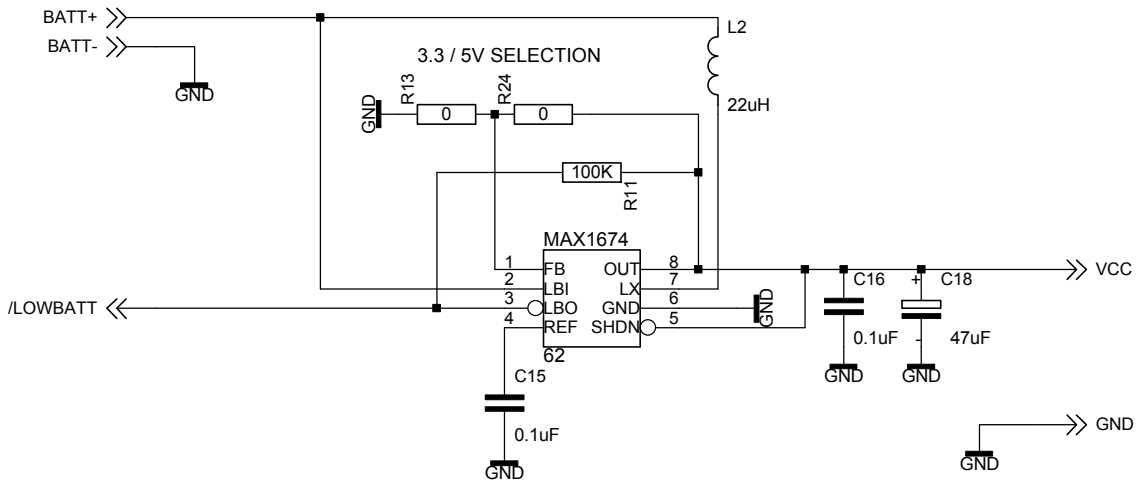
The step up convertor can be damaged due reverse current flow as VCC is also provided on programming connectors.

Section 5
Circuit Diagrams

These diagrams are also availabe as a separate document.

- Main circuit
- Power
- Communication
- Parts Placement


POWER
BATTERY POWER
X1
HDR_3
BATT+
BATT-
/LOWBATT
VCC
GND
COM
RS-485
X7
HDR_4
R10
120
HDR_32
X5
R14
R15
R16
R17
R12
47
PD7
PD0
PB7
PB0
PE7
PE0
X2
ISP
HDR_6
PE1
PB1
PE0
X3
JTAG
HDR_10
PF5
PF4
PF7
PF6
RES
MCP809
R6
4k7
21 FM24C256
C12
0.1uF
R7
R8
2k7
PD1
PD0
XTAL2
32.768K
36 DS1307
SQW
33
3V
C13
C5
C6
12pF
XTAL1
16M
ATMEGA128
QFP64
RESET
XTAL1
XTAL2
TOSC1
TOSC2
RXD-PE0
TXD-PE1
AC+_PE2
AC-_PE3
INT4-PE4
INT5-PE5
INT6-PE6
INT7-PE7
PD0-INT0
PD1-INT1
PD2-INT2
PD3-INT3
PD4-IC1
PD5
PD6-T1
PD7-T2
ADC0-PF0
ADC1-PF1
ADC2-PF2
ADC3-PF3
ADC4-PF4
ADC5-PF5
ADC6-PF6
ADC7-PF7
AVCC
AVREF
AGND
L1
47uH
C11
0.1uF
R9
1k0
U2
LM4040AIM
AD0-PA0
AD1-PA1
AD2-PA2
AD3-PA3
AD4-PA4
AD5-PA5
AD6-PA6
AD7-PA7
A8-PC0
A9-PC1
A10-PC2
A11-PC3
A12-PC4
A13-PC5
A14-PC6
A15-PC7
R18
R19
R20
R21
DDR
OC2-PB7
OC1B-PB6
OC1A-PB5
OC0-PB4
MISO-PB3
MOSI-PB2
SCK-PB1
SS-PB0
ALE
RD
WR
PEN
LCD
X6
HDR_14
X4
HDR_32
PC5
PC6
PC4
PC0
PC1
PC2
PC3
PC7
PA7
PA0
SQW
PF7
PF0
R22
R23
REV: 1.1A
DATE: 06.01.2004
ENG: HK
PROJECT: AVR_CARD
COMPANY: ESS DEVELOPMENT AG
ADDRESS: WWW.ESS.CH
CITY WORB
COUNTRY: SWITZERLAND
INITIAL 8.11.2002
PAGE: 1
OF: 3



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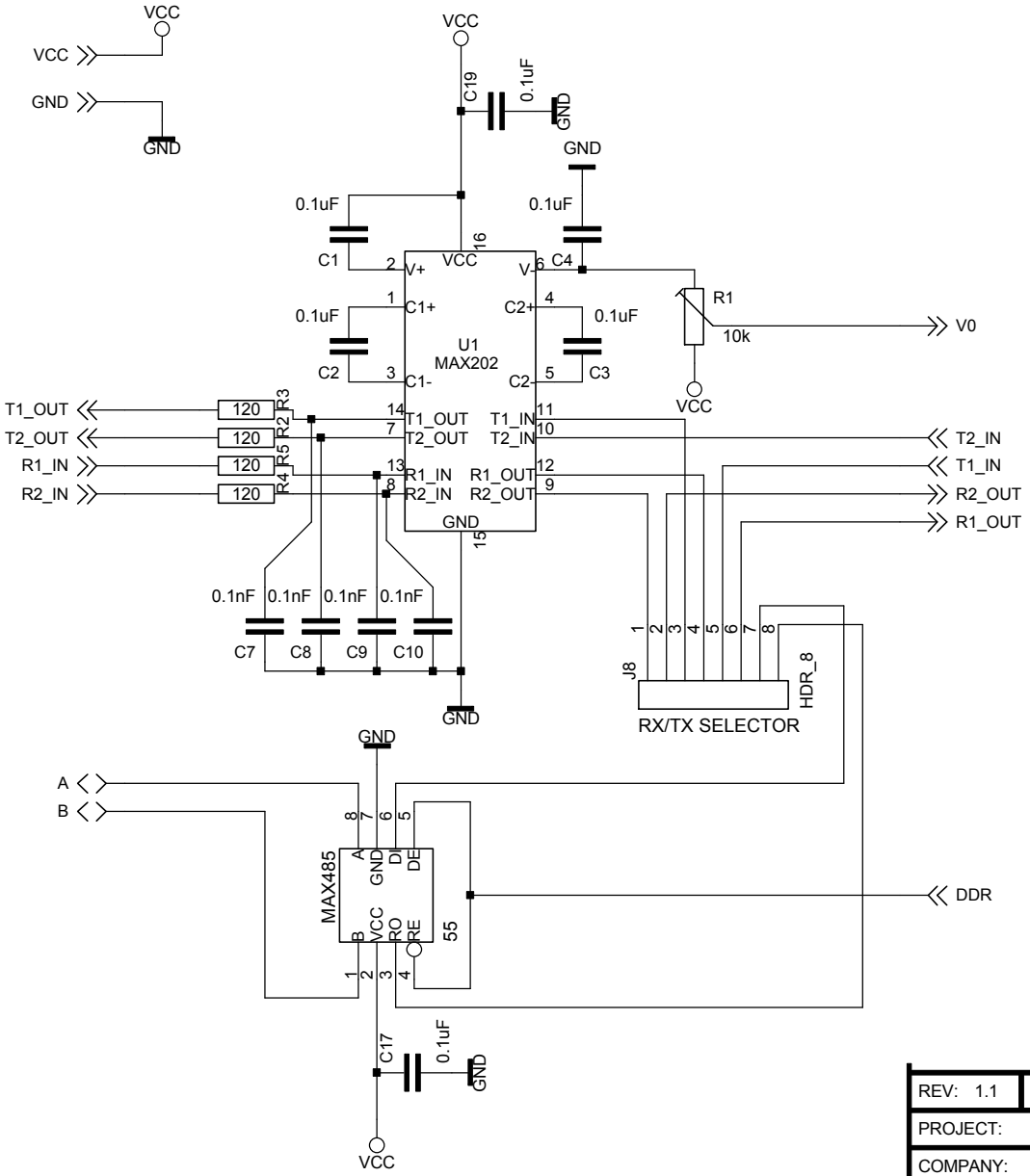
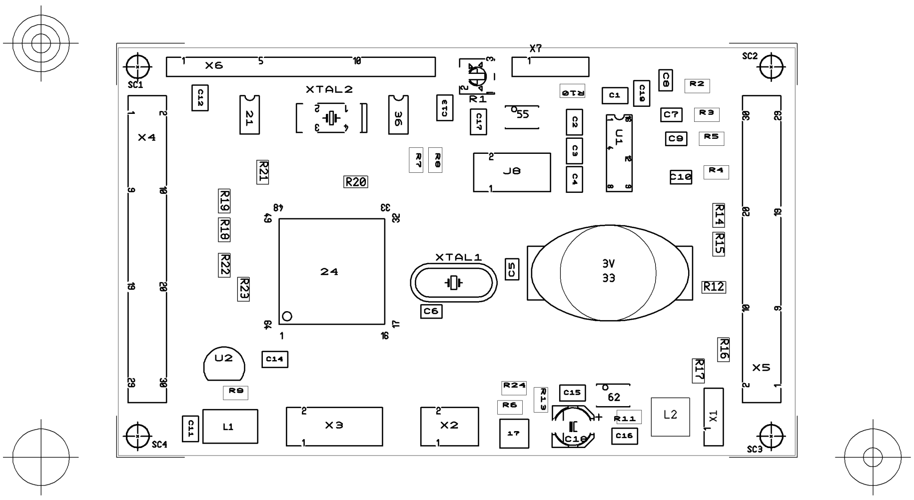
PROJECT: AVR_CARD		
COMPANY: ESS DEVELOPMENT AG ADDRESS: WWW.ESS.CH CITY WORB COUNTRY: SWITZERLAND		
INITIAL 8.11.2002	PAGE: 3	OF: 3



REV: 1.1	DATE: 17.01.2003	ENG: SK
PROJECT:	AVR_CARD	
COMPANY: ESS DEVELOPMENT AG ADDRESS: WWW.ESS.CH CITY WORB COUNTRY: SWITZERLAND		
INITIAL 8.11.2002	PAGE: 2	OF: 3

Ultiboard- avr_card - 06-Jan-2004 11:46 Silkscreen Top REFLECTED



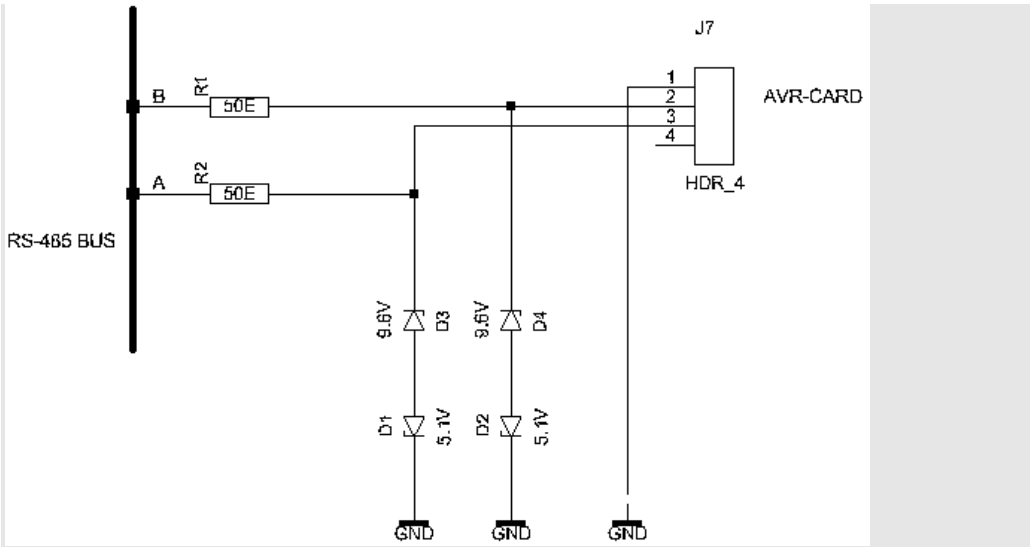
Bill of Materials

Table 9 – List of Parts

Qty.	DEVICE	VALUE	Refdes
1	ATMEGA128		24
1	BATT	3V	33
1	COIL	22uH	L2
1	COIL	47uH	L1
1	DS1307	-	36
1	ELCO	47uF	C18
1	FM24C256		21
1	HDR_10	-	X3
1	HDR_14	-	X6
1	HDR_3	-	X1
1	HDR_4	-	X7
1	HDR_6	-	X2
1	HDR_8	-	J8
1	LM4040AIM		U2
1	MAX1674		62
1	MAX202	-	U1
1	MAX485	-	55
1	MCP809	-	17
1	POT_METER	10k	R1
1	RESISTOR	100K	R11
1	RESISTOR	1k0	R9
1	RESISTOR	4k7	R6
1	XTAL	16M	XTAL1
1	XTAL	32.768KHz	XTAL2
11	RARRAY	47	R14,R15,R16,R17,R18,R19, R20,R21,R22,R12,R23
12	CAPACITOR	0.1uF	C12,C2,C13,C3,C14,C4,C15 ,C16,C17,C19,C11,C1
2	CAPACITOR	12pF	C5,C6
2	HDR_32		X4, X5
2	RESISTOR	0	13,R24
2	RESISTOR	2k7	R7,R8
4	CAPACITOR	0.1nF	C7,C8,C9,C10
5	RESISTOR	120	R2,R3,R4,R5,R10

RS485 - ESD protection

The following circuit is recommended for RS-485 busses that go beyond the lab desk.



Section 6
References

Data Sheets

ATMEGA128:	www.atmel.com
FM24C256-SE:	www.ramtron.com
DS1307, MAX202, MAX485, MAX1674:	www.maxim-ic.com

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