ELEKTOR Internet Radio
Version 1.0

Hardware Manual

Manual Revision: 1.0
Issue date: May 2008

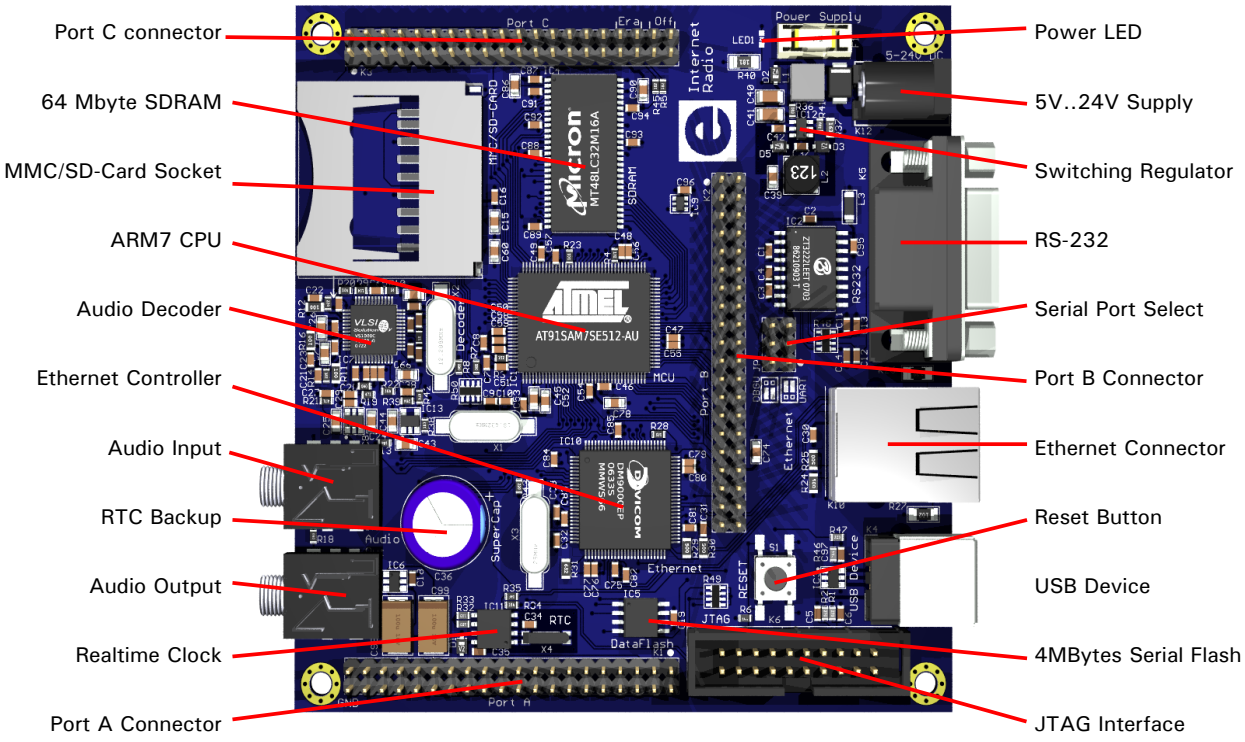
Contents

About the EIR Board

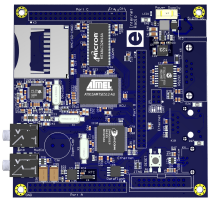
The EIR 1.0 is a small (100 x 100 mm) board combining Atmel's AT91SAM7SE512 RISC microcontroller with VLSI's VS1053 audio decoder and Davicom's DM9000E Ethernet controller. The main features are:

- ARM7TDMI microcontroller with internal 512 kBytes high speed Flash
- 64 MBytes SDRAM and 4 MByte serial Flash
- Full duplex IEEE 802.3 compliant 10/100 Mbps Ethernet
- RS-232 serial port
- Audio decoder with MP3, AAC+, WMA and Ogg Vorbis support
- Realtime clock with double layer capacitor backup
- MMC/SD-Card socket
- 16 programmable digital I/O lines and 4 analog inputs
- All CPU ports available at 2.54mm (0.5") pin headers
- LED indicators for power supply and Ethernet activity
- Single power supply 5-24V DC
- Lead-free and RoHS compliant

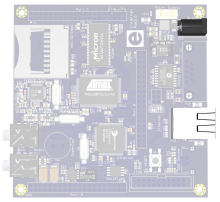
The following board overview shows the main components.



Mounting THT Parts

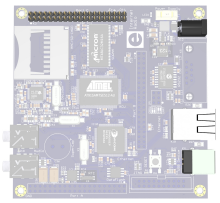


EIR boards may be shipped with SMD parts populated, but THT parts packed separately for DIY soldering.



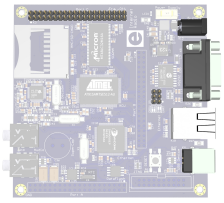
1. Ethernet connector
2. Power supply connector

If the firmware had been preloaded, you should be able to receive and listen to Internet radio stations.



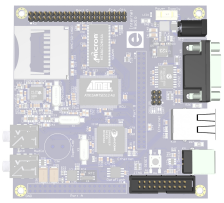
In order to be able to erase and the Flash memory and upload new firmware, we need to mount

1. Expansion port connector K3 (or at least pins 34 and 36)
2. USB connector



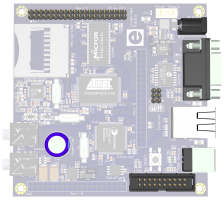
If things are not working as expected, it would be a good idea to make use of the serial port, where the following parts are needed.

5. RS-232 jumper
6. RS-232 connector (male)



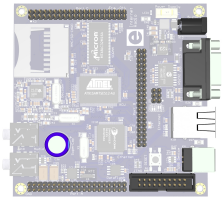
In order to use the JTAG interface, mount

7. JTAG connector



For RTC backup during power loss, mount

8. Double layer capacitor



Finally, if you intend to attach an add-on board, K3 should have been fully populated. Additionally mount

9. Expansion port connectors K1 and K2

I/O Ports

USB Device Port

This is a full speed USB 2.0 device, available at a standard B type connector K4. The interface is ESD protected and you can safely connect or disconnect the plug without power removal.

There is currently no USB software support available for the EIR. However, the USB port can be used to communicate with the SAM-BA boot loader, which is located in the internal ROM memory of the CPU. This way, new firmware can be uploaded to the EIR by using a simple USB cable between the EIR and a PC. Currently this method is only supported by PCs running the Windows operating system.

JTAG Port

The JTAG port can be used for uploading new firmware as well as in-circuit debugging and is available at the standard 20-pin header K6.

Note, that a JTAG programming adapter is required to use this port.

WARNING: The JTAG connector is not protected against overload. Make sure, that the power supply is switched off when attaching or detaching the programming adapter. Take proper precautions to avoid electrostatic discharge (ESD).

Ethernet Port

An on-board modular RJ-45 connector K10 with integrated magnetics and LEDs is provided for the twisted pair Ethernet port. This interface is connected to a Davicom DM9000E Ethernet controller. The galvanically isolated port supports the maximum cable length of 100 meters between the EIR Board and an Ethernet HUB or switch. You can safely attach or remove the plug without power removal.

Serial Port

The EIR provides an on-board male DB-9 connector K5 for RS-232 serial communication. IC2 is used to convert the required RS-232 voltage levels from the 3.3V power supply. The interface is ESD protected. You can safely connect or disconnect them without power removal.

Either the DBGU or the UART0 peripheral can be routed to the RS-232 port. This is controlled by jumper JP1. Available jumper configurations are explained on page 10.

Card Socket

The board provides a push-pull MultiMedia Card socket (K7), which may be used for SD-Cards too.

Expansion Port

Add-on boards can be added to the expansion port, which consists of the three 40-pin connectors (K1, K2 and K3). Such add-on boards may contain simple I/O circuits driven by the EIR, or may be equipped with their own processor, using the EIR as an Ethernet I/O processor only. All pins of all three CPU ports Port A, Port B and Port C are available at K1, K2, and K3 resp. In addition, the signals NRST (hardware reset), ERASE (firmware erase), JTAGSEL (boundary scan enable) and SHDN (power off), as well as the upper four analog inputs and power supply lines are available at these connectors.

For further informations about the expansion port refer to page 12.

Power Supply Input

A standard 2.1mm barrel connector with positive voltage at the center pin is used to supply power to the EIR. Any DC source from 5V up to 24V with sufficient current rating can be used. The on-board switching regulator draws about 220mA at 5V, 90mA at 12V and less than 60mA at 24V.

The input is protected against reverse polarity and voltage or current overload.

LED Indicators

The EIR is equipped with three status LEDs.

The red LED1 is directly connected to the power supply. It is lit when power is applied to the board. A green and a yellow LED are integrated into the RJ45 connector K10. The yellow LED indicates the network link status and is lit when the link status is OK. The green LED indicates receive and transmit activity from and to the network.

Integrated Circuits

For detailed informations please view the data sheets.

Memory Map

The following table shows the memory layout.

Byte Address	Description
0x0000 0000 – 0x000F FFFF	Boot Memory (Note 1)
0x0010 0000 – 0x0017 FFFF	Internal Flash Memory
0x0018 0000 – 0x001F FFFF	Reserved
0x0020 0000 – 0x0020 7FFF	Internal SRAM
0x0020 0000 – 0x002F FFFF	Reserved
0x0030 0000 – 0x003F FFFF	Internal SAM-BA ROM
0x0040 0000 – 0x0FFF FFFF	Reserved
0x1000 0000 – 0x1FFF FFFF	Chip Select 0, available for custom extensions
0x2000 0000 – 0x23FF FFFF	External SDRAM
0x2400 0000 – 0x2FFF FFFF	Reserved
0x3000 0000 – 0x3000 00FF	Ethernet Controller Registers (Note 2)
0x3000 0100 – 0x4FFF FFFF	Reserved
0x5000 0000 – 0x5FFF FFFF	Chip Select 4, available for custom extensions (Note 3)
0x6000 0000 – 0x6FFF FFFF	Chip Select 5, available for custom extensions
0x7000 0000 – 0x7FFF FFFF	Chip Select 6, available for custom extensions
0x8000 0000 – 0x8FFF FFFF	Chip Select 7, available for custom extensions
0x9000 0000 – 0xEFFF FFFF	Unassigned, access causes abort
0xF000 0000 – 0xFFFF FFFF	Internal Peripherals (Note 4)

Note 1: Can be ROM, Flash or SRAM, depending on GPNVM2 and REMAP.
Note 2: See DM9000E data sheet.
Note 3: Remove R7 before using NCS4, see EIR schematics.
Note 4: See AT91SAM7SE512 data sheet.

Audio Codec

The VS1053B (IC7) audio codec decodes a number of different formats, including Ogg Vorbis, MP3, AAC and WMA. With a loadable software plug-in it can encode Ogg Vorbis. The chip includes an integrated headphone amplifier.

Realtime Clock

A Philips PCF8563 (IC11) is connected to the on-board I2C bus. During power loss it is supplied by a double layer capacitor (C36), which keeps the clock/calendar running up to a few days.

System Clocks

The microcontroller clocks are generated by an internal PLL, driven by an external 18.432 MHz crystal (X1). The audio decoder uses a 12.288 MHz crystal (X2) to support all common sample rates. The Ethernet controller is driven by a separate 25MHz crystal (X3) and an additional 32.768kHz crystal (X4) drives realtime clock hardware.

Flash ROM

The AT91SAM7SE512 provides 512 kBytes of on-chip, non-volatile flash memory, which can be (re-)programmed by in-system programming.

SDRAM

The EIR board is populated with a 64 MByte SDRAM chip (IC4).

DataFlash

An AT45DB321 4 MByte serial Flash (IC5) can used for configuration data storage.

Power Supply

In general the chips on the EIR board run at 3.3V, which is created by a switching regulator (IC12) from a wide input voltage range (5 – 24V). The CPU core and the audio decoder core need 1.8V. The CPU provides its own on-chip voltage regulator. An additional linear regulator (IC13) is used to generate a clean 1.8V supply, exclusively used for the audio decoder.

As soon as power is attached to the board, the red LED1 will light up.

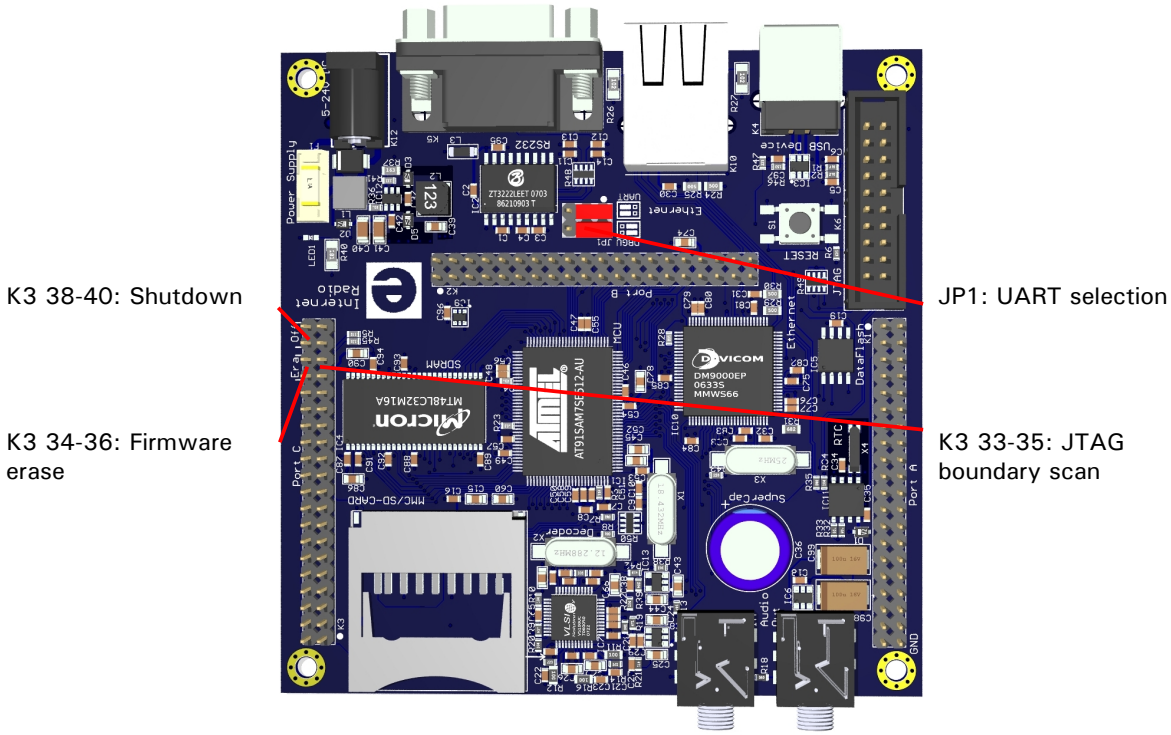
Jumper Configuration

Jumper Overview

The EIR has one jumper block (JP1) to switch the serial port output between DBGU and UART0.

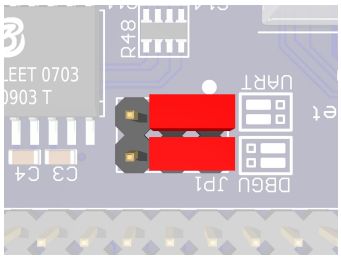
Three additional jumpers may be placed on specific pins of the Port C connector (K3).

The picture below shows the default jumper configuration of the EIR.

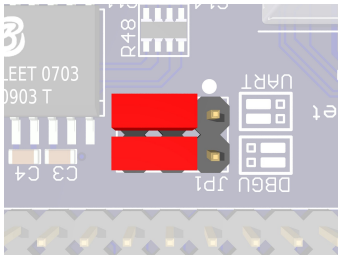


Serial Port Jumper Configuration

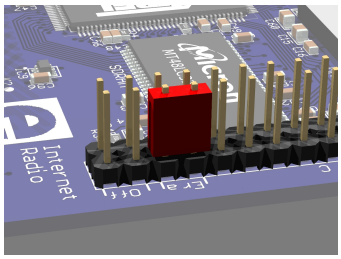
EIR provides an on-board male DB-9 connector for RS-232 serial communication. Either the DBGU or the UART0 device may be attached to this interface.



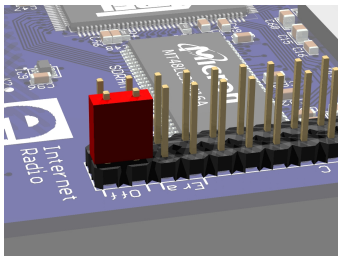
JP1 Shortening pins 1-3 and pins 2-4 will route DBGU transmit and receive lines to the DB-9 connector.



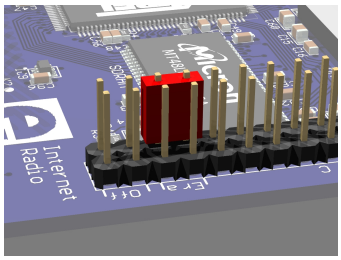
JP1 When pins 3-5 and pins 4-6 are connected, then the UART0 device is available at the DB-9 connector.



K3 Pressing the reset button while pins 34-36 are connected will erase the firmware and enable the SAM-BA bootloader.



K3 Connect pins 38-40 to switch off the board's power supply.



K3 Connect pins 33-35 to enable JTAG boundary scan. This is used for in-circuit hardware testing, which requires special equipment.

Hardware Expansion

Many applications will do just fine with nothing else than the EIR. Or external hardware may be connected to the RS-232 or RS-485 port. However, if more is required, the EIR expansion port is the first choice to add custom designed hardware.

Expansion Port

Add-on boards can be added to the expansion port. These boards may contain simple I/O circuits driven by the EIR board, or may be equipped with their own processor, using the EIR board as an Ethernet I/O processor only.

The expansion port contains CPU data and address bus, memory read/write signals, digital I/O ports, reset signal and power supply. Nearly all microcontroller pins are available at the expansion port connector, providing an interface with lots of features like PWM, I2C (2-wire), SPI (3-wire) or counter input and output lines, to name just a few. It is strictly recommended to consult the AT91SAM7SE512 data sheet before attaching hardware to the expansion port.

Although available at the connector, some signals are used internally by EIR and can't be used by external hardware. Carefully check the schematic.

The following three tables list the expansion port connector's pin assignments.

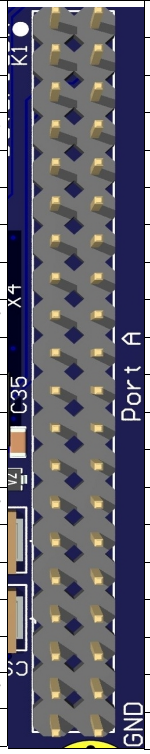
Table 1. Expansion connector K1						
Description	Signal	Pin		Pin	Signal	Description
Free	PA0	1		2	PA1	Free
Free	PA2	3		4	PA3	TWI SDA
TWI SCL	PA4	5		6	PA5	UART0 RxD via JP1
UART0 TxD via JP1	PA6	7		8	PA7	UART0 RTS
UART0 CTS	PA8	9		10	PA9	DBUG RxD via JP1
DBUG TxD via JP1	PA10	11		12	PA11	Data Flash Chip Select
SPI MISO	PA12	13		14	PA13	SPI MOSI
SPI SPCK	PA14	15		16	PA15	MMC Chip Select
MMC Clock	PA16	17		18	PA17	MMC Command
MMC DAT0	PA18	19		20	PA19	MMC DAT1 via R7
MMC DAT2 via R8	PA20	21		22	PA21	Free
Free	PA22	23		24	PA23	SDRAM DQMH
SDRAM A10	PA24	25		26	PA25	SDRAM CKE
SDRAM Chip Select	PA26	27		28	PA27	SDRAM WE
SDRAM CAS	PA28	29		30	PA29	SDRAM RAS
IRQ1, MP3 Interrupt	PA30	31		32	PA31	MP3 Command Select
AD Wandler Referenz	Vref	33		34	3,3 V	Power
Analogue input (free)	AD4	35		36	AD5	Analogue input (free)
Analogue input (free)	AD6	37		38	AD7	Analogue input (free)
Ground	GND	39		40	GND	Ground

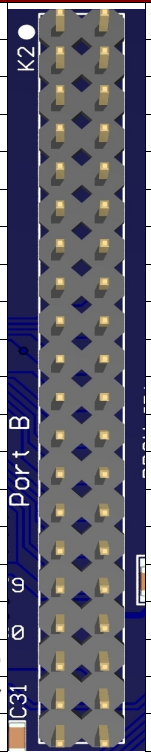
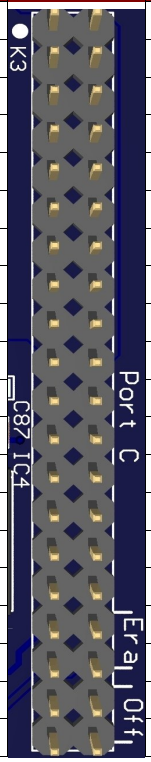
Table 2. Expansion connector K2						
Description	Signal	Pin		Pin	Signal	Description
SDRAM DQML	PB0	1		2	PB1	Free
Address Bus A2	PB2	3		4	PB3	Address Bus A3
Address Bus A4	PB4	5		6	PB5	Address Bus A5
Address Bus A6	PB6	7		8	PB7	Address Bus A7
Address Bus A8	PB8	9		10	PB9	Address Bus A9
Address Bus A10	PB10	11		12	PB11	Address Bus A11
Free	PB12	13		14	PB13	Address Bus A13
Address Bus A14	PB14	15		16	PB15	Free
SDRAM BA0	PB16	17		18	PB17	SDRAM BA1
Free	PB18	19		20	PB19	FIQ, RTC Interrupt
IRQ0, Ethernet Interrupt	PB20	21		22	PB21	Free
DataFlash Chip Select	PB22	23		24	PB23	USB Monitor
Free	PB24	25		26	PB25	Free
Free	PB26	27		28	PB27	Free
Free	PB28	29		30	PB29	Free
MP3 Data Select	PB30	31		32	PB31	MP3 Hardware Reset
Power	3,3 V	33		34	3,3 V	Power
Not used		35		36		Not used
Not used		37		38	NRST	Hardware Reset
Ground	GND	39		40	GND	Ground

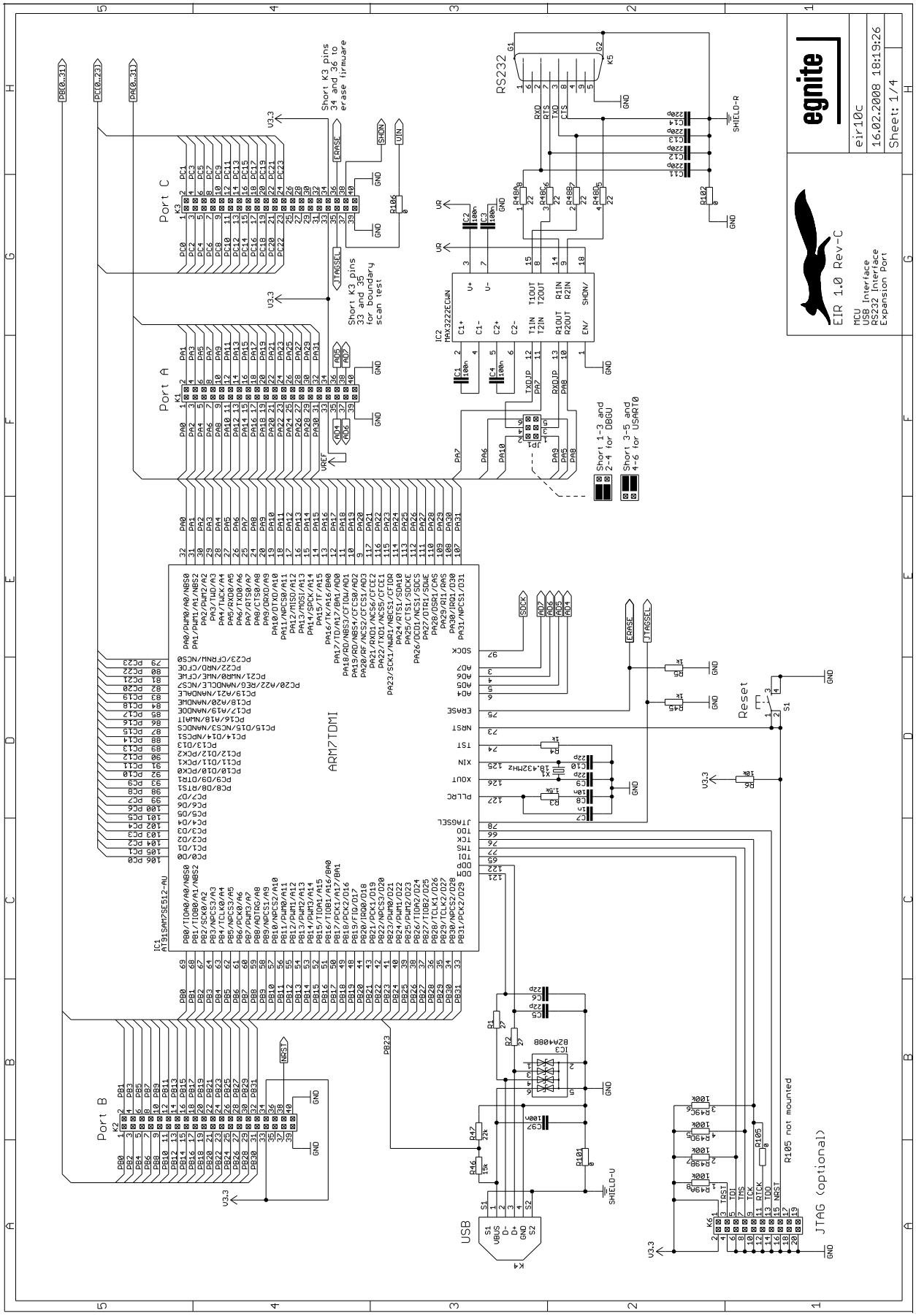
Table 3. Expansion connector K3						
Description	Signal	Pin		Pin	Signal	Description
Data bus D0	PC0	1		2	PC1	Data bus D1
Data bus D2	PC2	3		4	PC3	Data bus D3
Data bus D4	PC4	5		6	PC5	Data bus D5
Data bus D6	PC6	7		8	PC7	Data bus D7
Data bus D8	PC8	9		10	PC9	Data bus D9
Data bus D10	PC10	11		12	PC11	Data bus D11
Data bus D12	PC12	13		14	PC13	Data bus D13
Data bus D14	PC14	15		16	PC15	Data bus D15
Bus WAIT, Open Collector	PC16	17		18	PC17	Ethernet Hardware Reset
MMC Card Detect	PC18	19		20	PC19	MMC Write Protect
Free	PC20	21		22	PC21	Address/ Data bus NWE
Address/ Dada bus NRD	PC22	23		24	PC23	Ethernet Chip Select
Not used		25		26		Not used
Not used		27		28		Not used
Not used		29		30		Not used
Not used		31		32		Not used
Power	3,3 V	33		34	3,3 V	Power
Boundary Scan Enable	JTAGSEL	35		36	Erase	Firmware Erase
Unregulated 5–24 V via R106	VIN	37		38	SHDN	Power Shutdown
Ground	GND	39		40	GND	Ground

Troubleshooting

The red LED does not go on when applying power.	The fuse may be blown. Remove any kind of attached hardware and remove all jumpers. Make sure the board is placed on a non conductive surface like a piece of paper. Replace the fuse (Littelfuse part #0453 001) and supply the board via the barrel connector K12 with no more than 12V DC. Best use a lab power supply with current control and carefully increase the voltage starting from 3V. The board should not draw more than 250 milliamps at 5V, going down to 60 milliamps at 24V .
The yellow LED at K10 will not light up after starting the Webradio or similar network enabled software.	The yellow LED will go on only if EIR is connected to an Ethernet network and the EIR software properly initialized the LAN controller hardware on the EIR. Replace the Ethernet cable and try the same connection with your PC to make sure that the network link is working.
The board seems to work unreliable. I'm not able to program the microcontroller.	This problem is typically caused by a wrong power supply. Make sure to use one with 5-24V DC. The EIR will not work with AC supply.
EIR doesn't respond to pings. The green LED does not go on.	Configuring TCP/IP looks generally simple after one has understood the principle, but may still become confusing under some circumstances. For example, changing EIR's MAC address can disable a link, which had been running fine before the change. This happens, because the PC remembers the MAC/IP relations for some minutes. Check your configuration again. Make sure, that EIR and the PC are located in the same network, sharing the same IP mask and network IP address. If you don't know what all this means, check the Web, there are some excellent TCP/IP tutorials.
EIR works fine after pressing reset, but not after switching on the power supply.	The LAN controller's power on reset requires a minimum supply raise time, while some power supplies do have an intentionally slow rise.

Schematics

Full schematics are provided on the next 4 pages.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eir10c
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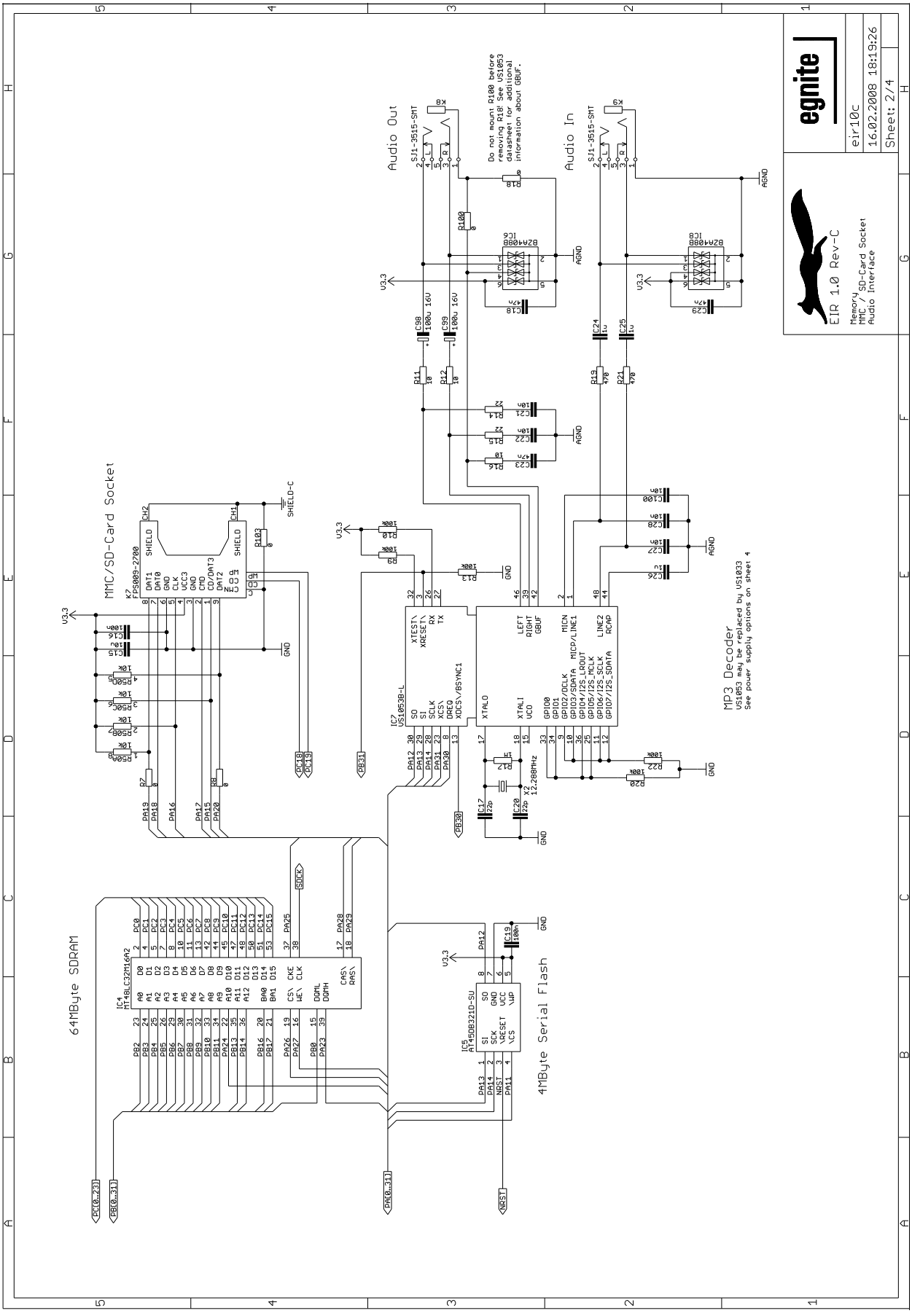
Sheet: 1/4
EIR 1.0 Rev-C
MCU
USB Interface
RS232 Interface
Expansion Port
ARM7TDMI
IC1
AT91SAM7SE512-AU
MAX3222ECAN
IC2
RS232
USB
JTAG (optional)
R105 not mounted
Port A
Port B
Port C
Short K3 pins 34 and 36 to erase firmware
Short K3 pins 33 and 35 for boundary scan test
Short 1-3 and 2-4 for DBGU
Short 3-5 and 4-6 for USART0
Reset
SHIELD-R
SHIELD-U


egnite
eir10c
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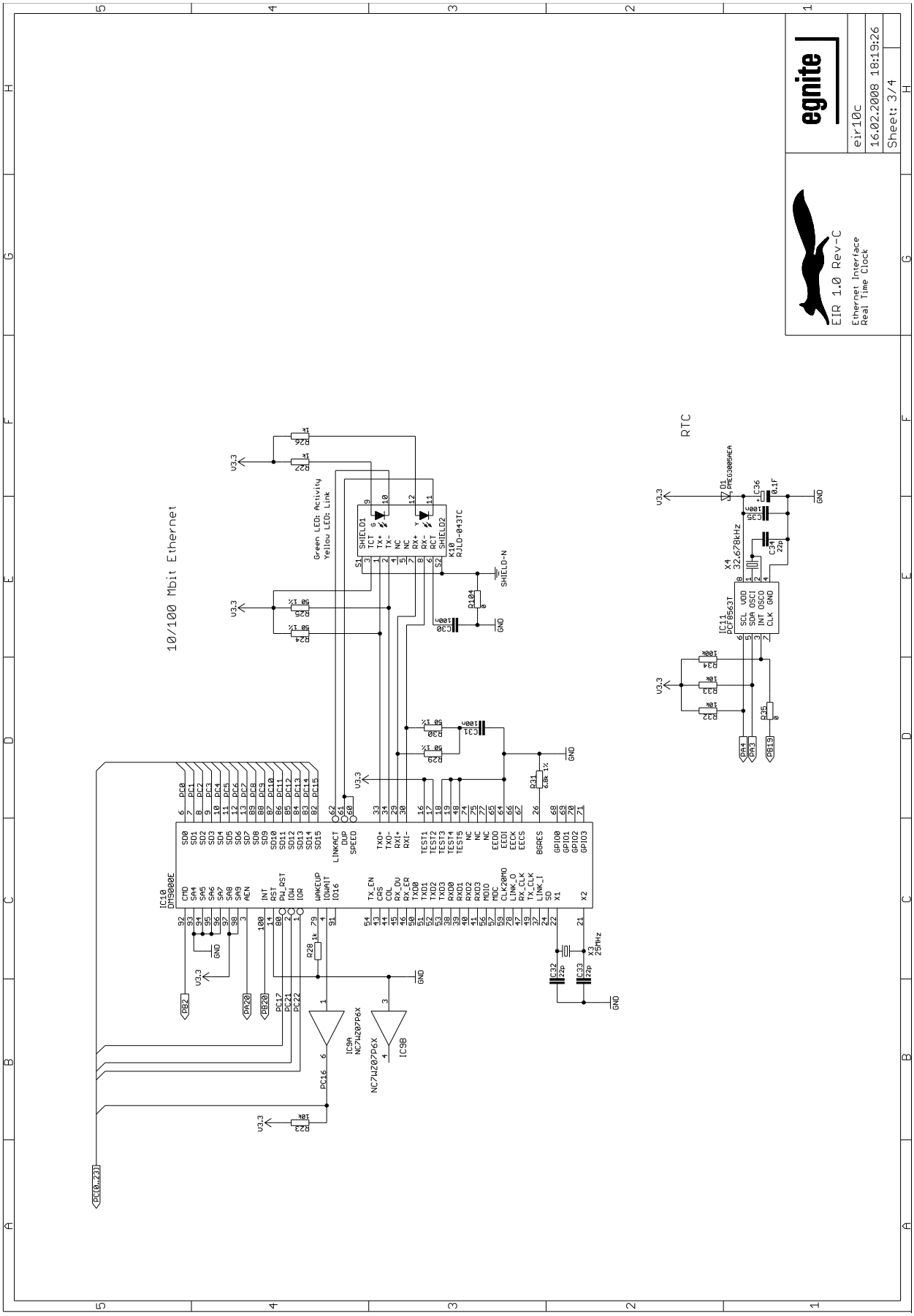
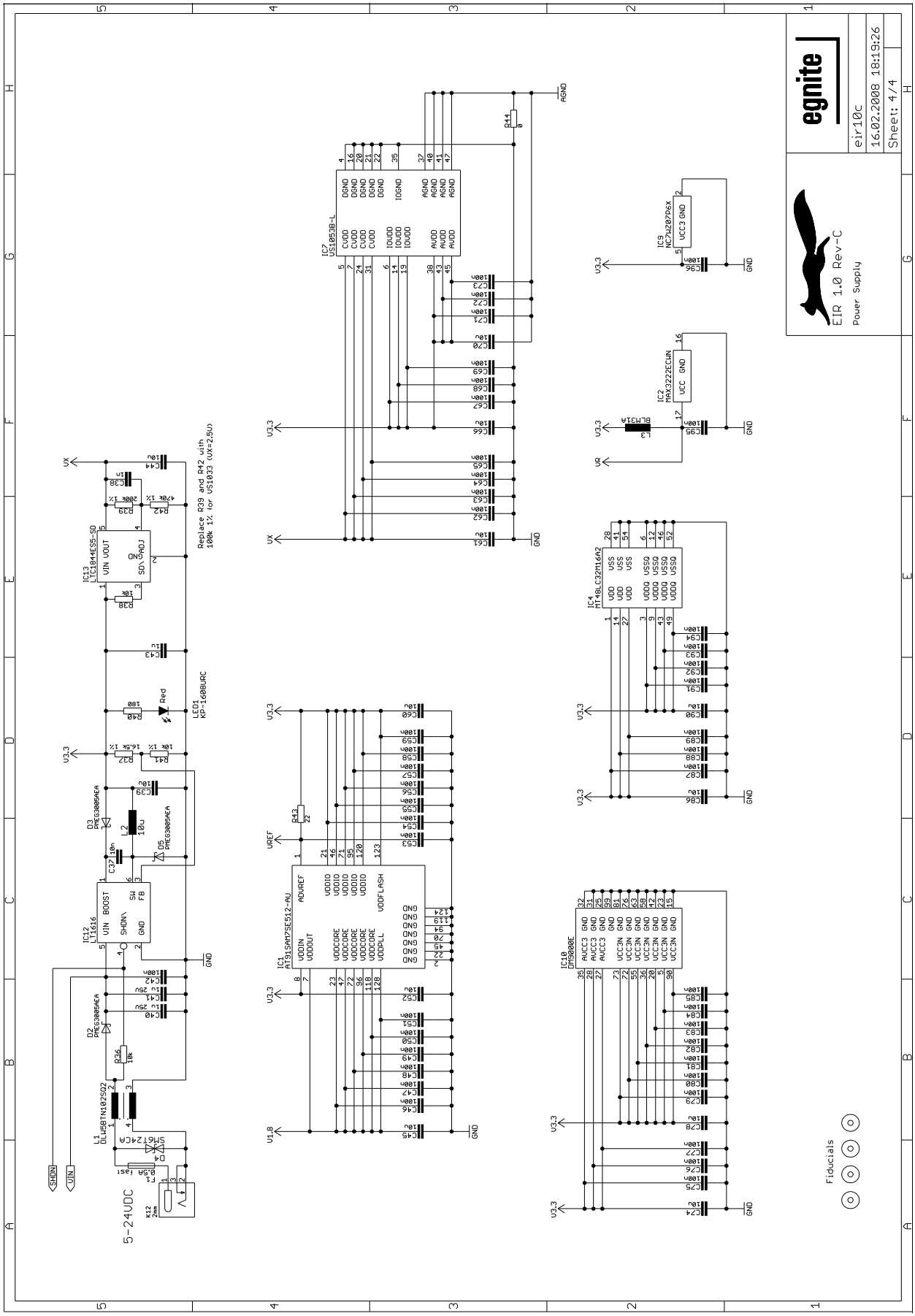
Sheet: 2/4
EIR 1.0 Rev-C
Memory
MMC / SD-Card Socket
Audio Interface
Audio Out
Audio In
MMC/SD-Card Socket
64MByte SDRAM
4MByte Serial Flash
MP3 Decoder
VS1033 may be replaced by VS1033
See power supply options on sheet 4
Do not mount R100 before removing R18! See VS1053 datasheet for additional information about GBUF.


egnite
EIR 1.0 Rev-C
Ethernet Interface
Real Time Clock
eir10c
16.02.2008 18:19:26
Sheet: 3/4
10/100 MBit Ethernet
RTC
Green LED: Activity
Yellow LED: Link
IC10
DM9000E
IC11
DS1856GT
X4
32.678kHz
X3
25MHz
IC9A
NC7WZ07P6X
IC9B
NC7WZ07P6X
S1
S2
K10
RJLD-0413C
SHIELD-N
GND
V3.3


egnite
eir10c
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Sheet: 4/4
EIR 1.0 Rev-C
Power Supply
Fiducials
5-24VDC
Replace R39 and R42 with
100k 1% for VS1033 (VX=2.5V)

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