JeeNode V2

A small *duino-ish MPU board with a wireless RF module

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Overview

The "JeeNode" is a small micro-controller board which can be used for a variety of Physical Computing[1] tasks. From measuring things like temperature and other environmental data to tracking / controlling energy consumption around the house. It was inspired by the fascinating Arduino[2] board and its IDE, which open up a whole new world of C/C++ computing on tiny devices.
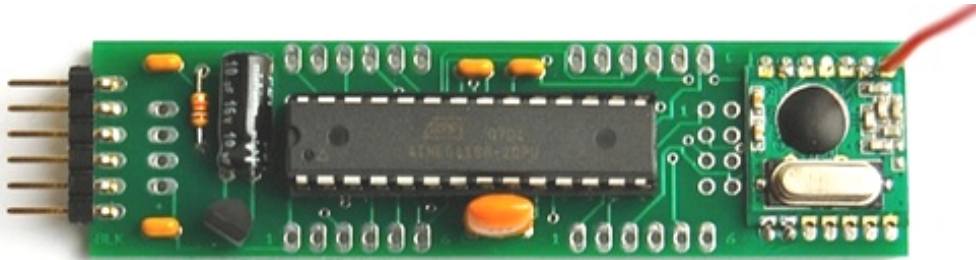
What's on the board

From left to right:

- a 6-pin FTDI-compatible serial I/O port

- a 4-pin combined TWI/Power connector

- a 3.3V power regulator which accepts 3.5 ... 12V as external power source

- an ATmega168 or ATmega328 MPU with 16 MHz ceramic resonator, by Atmel

- a 2x4-pin combined ISP/SPI connector, with 2 select lines

- a RFM12B wireless RF module for the 433, 868, or 915 MHz ISM band, by Hope RF

Plus on both long sides of the board: two I/O "ports" each, with 1 analog/digital I/O, 1 digital I/O, +3.3V, ground, PWR, and IRQ line. All four ports have an identical pinout.

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[1] http://en.wikipedia.org/wiki/Physical_computing

[2] http://arduino.cc/

Similarities with Arduino boards

- they run the same bootstrap code, and can therefore run Arduino IDE "sketches"

- same micro-controller as the current range of Arduino / Freeduino / and other *duinos

Differences with Arduino boards

- there's a wireless RF module on board, whee!

- completely different physical layout, incompatible with Arduino "shields"

- a JeeNode runs internally at 3.3V, not 5V - this also affects all I/O ports & pins

- not all the Arduino pins are brought out on connectors, pins are assigned fixed roles

- the ISP connector has an extra 2 pins, to allow re-using it as SPI bus for 1 or 2 devices

- the TWI bus has been permanently assigned to its own connector

- runs at 16 MHz[3] - but with a less accurate ceramic resonator i.s.o. a crystal

- there are no LEDs, to reduce power consumption when running off batteries

Rationale

The main reason for creating the JeeNode was that Arduinos are not yet very convenient for 3.3V devices such as the RFM12B module. By including a 3.3V regulator, the JeeNode can be powered from USB with an FTDI cable/board, a DC power adapter, or various types of 3.6 … 4.5V batteries.

The second reason was to have a configuration which includes wireless connectivity by default. The RFM12B module is a low cost option with sufficient power and range to provide reliable communication around the house - a basic packet protocol can be implemented in just 2 Kb of C code.

The third reason is that I constantly ran out of power and ground connectors when hooking up a few sensors to an Arduino. While there are nice "proto shields" to overcome this, it seemed logical to try and come up with a different connector scheme for the common case of just a few sensors / actuators. Furthermore, being identical, all four JeeNode ports have the same features and connections, allowing sensors to be switched around as needed.

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[3] Using an ATmega168/328 at 16 MHz with 3.3V exceeds the specs by some 2.7 MHz - *but it works just fine.*

Supporting software

JeeNodes are so similar to Arduinos that they can be used with the same IDE as Arduinos. This was a major design choice. Not only is the Arduino IDE very convenient with so many libraries written for it, it also happens to run equally well on Windows, Macintosh, and Linux.

The following libraries have been added to better support JeeNodes:

- The "Ports" library makes it easy to connect sensors to a port, and to re-use the same code when re-connecting those sensors to a different port later on. It contains a few extras over what the standard Arduino / Wiring code offers: a bit-banging TWI driver which can run on any port (even on all of them in parallel) and simple shift functions to drive SPI-like devices.

- The "RF12" library contains a driver for the RFM12B module. It makes it easy to send packets of up to 66 bytes of data around, either as broadcasts or in point-to-point mode. There is some logic to support sending acknowledgements, as starting point for building more reliable communication on - with retransmits and timeouts to deal with packet errors and loss.

These libraries, and all other code related to the Jee projects can be found at Google Code[4].

Board layout
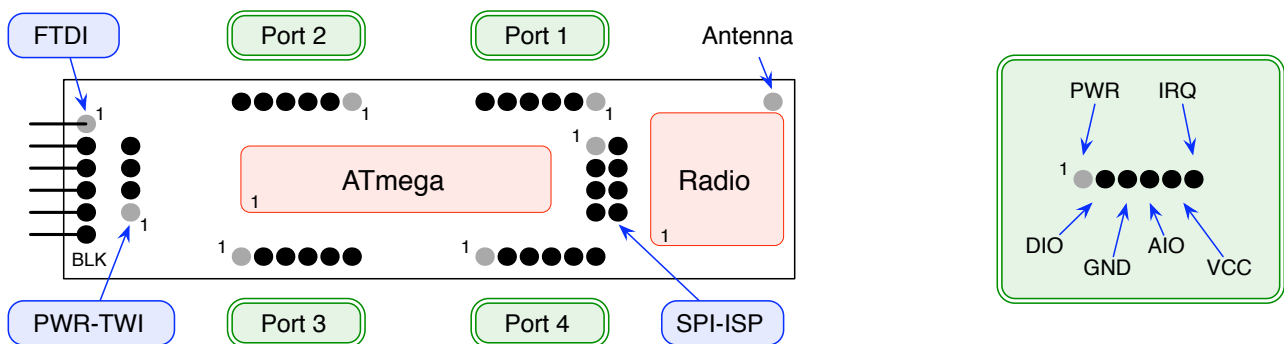
Port / pin mapping

PORT	TYPE	EXTRAS	ARDUINO	SIGNAL	CHIP
Port 1	DIO	-	Digital 4	PD4	pin 6
	AIO	Analog-in	Digital 14 / Analog 0	PC0	pin 23
Port 2	DIO	PWM (timer 0)	Digital 5	PD5	pin 11
	AIO	Analog-in	Digital 15 / Analog 1	PC1	pin 24
Port 3	DIO	PWM (timer 0)	Digital 6	PD6	pin 12
	AIO	Analog-in	Digital 16 / Analog 2	PC2	pin 25
Port 4	DIO	-	Digital 7	PD7	pin 13
	AIO	Analog-in	Digital 17 / Analog 3	PC3	pin 26

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[4] http://code.google.com/p/jeelab/source/browse/trunk

Pinout - JeeNode V2

(pins are numbered 1…up from left to right when looking towards the upper side of the board)

PORTS 1 … 4

PIN	NAME	DESCRIPTION
1	PWR	external power (+)
2	DIO	digital I/O line
3	GND	ground
4	AIO	analog I/O line
5	VCC	+3.3V
6	IRQ	interrupt (tied to INT1)

FTDI CONNECTOR

PIN	NAME	DESCRIPTION
1	DTR	for bootstrap / reset
2	TX	serial transmit
3	RX	serial receive
4	PWR	external power (+)
5	N.C.	not connected
6	GND	ground

ISP/SPI CONNECTOR

PIN	NAME	DESCRIPTION
1	SEL0	tied to PB0 (A. pin 8)
2	SEL1	tied to PB1 (A. pin 9)
3	MISO	master in / slave out
4	VCC	+3.3V
5	SCK	SPI clock
6	MOSI	master out / slave in
7	RST	reset
8	GND	ground

TWI/POWER CONNECTOR

PIN	NAME	DESCRIPTION
1	PWR	external power (+)
2	GND	ground
3	SDA	TWI data
4	SCL	TWI clock

Parts list - JeeNode V2

PART	VALUE	DETAILS	DIGI-KEY#
R1	10 kΩ	reset pull-up	
C1, C2, C3, C4	0.1 µF	decoupling	
C5	10 µF	electrolytic, polarity matters!	
IC1	ATmega168-20	could also use ATmega328	ATMEGA168-20PU
X1	16 MHz resonator	3-pin, built-in capacitors	X908-ND
IC2	MCP1702-33	3.3V LDO (alt: LP2950-3.3)	MCP1702-3302E/TO

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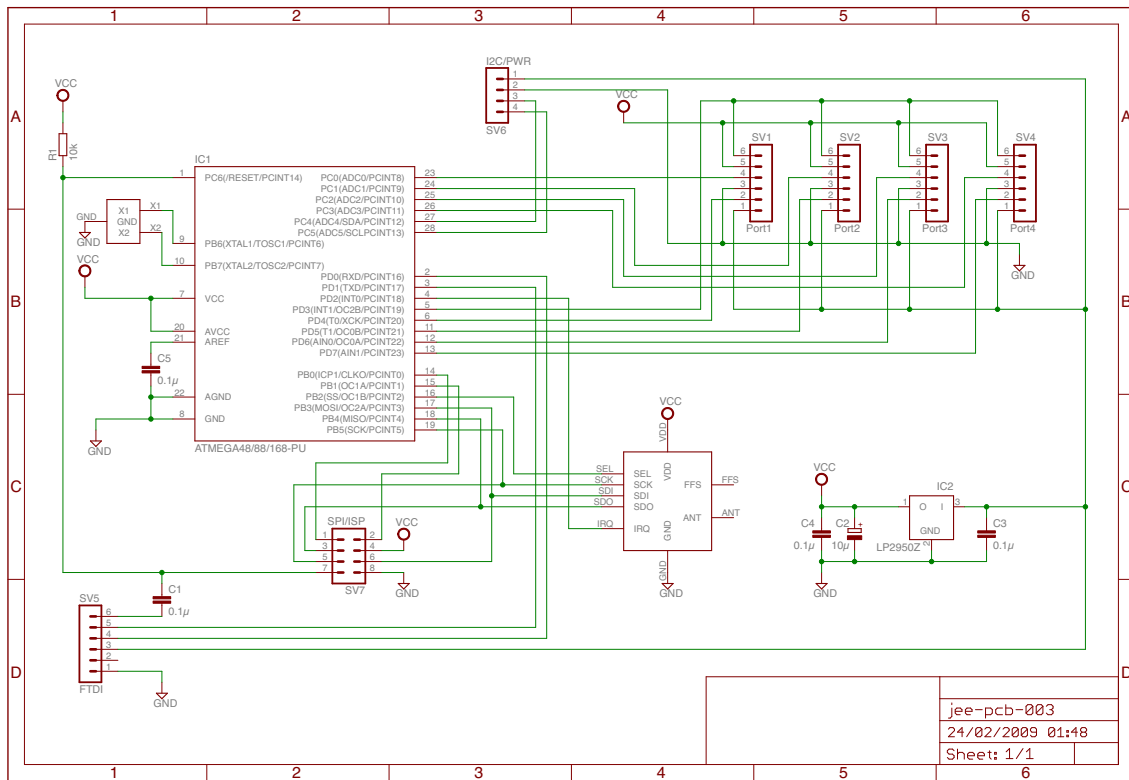
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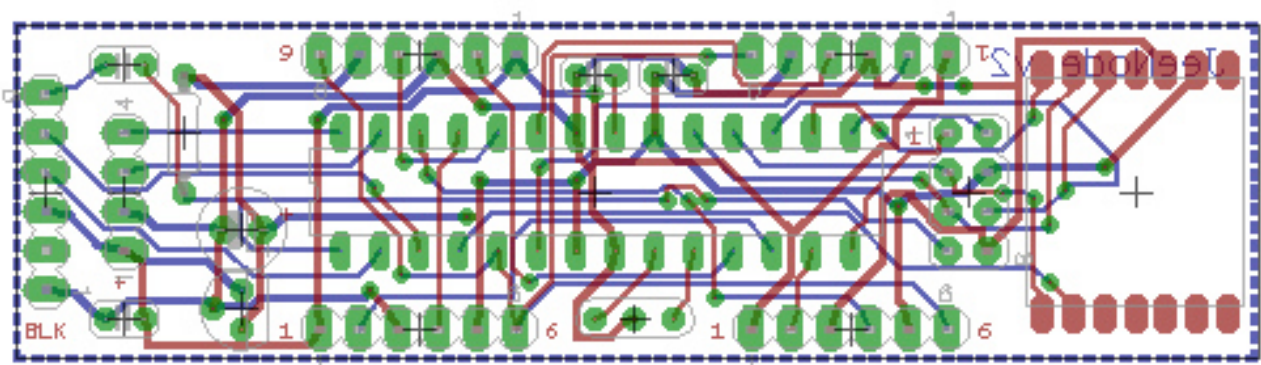
(files created with EAGLE[5])

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[5] http://www.cadsoft.de/info.htm

Differences between JeeNode v1 and v2

The "JeeNode v2" board has some changes, but is still mostly identical to the first prototype:

- Flipped the FTDI connector over, so an FTDI breakout board connects the "right way up".

- Exchanged outer pin 1 and 6 on all ports, to reduce potential damage on accidental shorts.

- Made changes to the TWI/Power connector pinout.

- Moved things around slightly, port pairs 1/2 and 3/4 are both 0.1" further apart.

- All connectors are now labeled with some text on the top copper layer.

- Added "JeeNode v2" label to the bottom copper layer, as well as a ground plane.

- The board was made slightly narrower, with excess borders trimmed off.

- Three mounting holes were dropped.

Document revisions

12 Mar 2009 - First draft, incomplete.

14 Mar 2009 - Photo updated, added board version differences.

18 Mar 2009 - Added board layout diagram.

19 Mar 2009 - Added port pinout and pinout mapping table, fixed some typo's.