



## Using the tuxgraphics embedded web server to control scientific equipment



### *Abstract:*

This article describes a more advanced version of the "switch on/off software" for the tuxgraphics ethernet board. This software is based on [HTTP/TCP with an atmega88 microcontroller](#) but provides more features.

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## Under extreme conditions

The Forschungszentrum Jülich (<http://www.fz-juelich.de/portal/home>), a major research center in Germany, needed a small ethernet board to control scientific instruments for high altitude atmospheric research on the out side of an airplane. The special atmospheric research airplane has its own web page at <http://www.halo.dlr.de/>.



The High Altitude and Long Range research aircraft, photo with permission of Dr. Zierys from the DLR.

We knew that the tuxgraphics web server would be a reliable and performing server at room temperature but would it be able to control million dollar equipment on the outside of a special high altitude airplane? Would it still work at -40'C or colder?

I looked the datasheets for all the components on the tuxgraphics ethernet board and it seemed possible if we would replace some of the components with special versions rated for industrial and military use.

Fortunately this request came in Canadian winter month February. In January and February we can get some days with a light wind from the north and then the temperature can suddenly drop to -30'C on the outside of our balcony. Perfect test conditions! We built a special version of the tuxgraphics ethernet board with components rated for extreme temperatures. I took the board and a can of ice spray. I went outside to connect it to ethernet and power.

Most electronic components and even the PCBs are made of compound materials with many different temperature coefficients. One could expect some problems if this goes all of a sudden from +25'C to -40'C.

It was night and freezing cold, -26'C. I had gloves and my warmest jacket on. The web server was still functioning very well. Now I took the can of ice spray and cooled it down until the board had well below -40'C. Amazingly this board was still functional!

I started to feel cold too. Let's go for a real shock test. Let's go back inside. The board was so cold that the humidity of the air in the room would turn it immediately into something that looked like a snow ball. .... the board was still functioning.

Once the board had completely defrosted I took a magnifying glass and looked at it carefully. Everything was normal. Test passed!

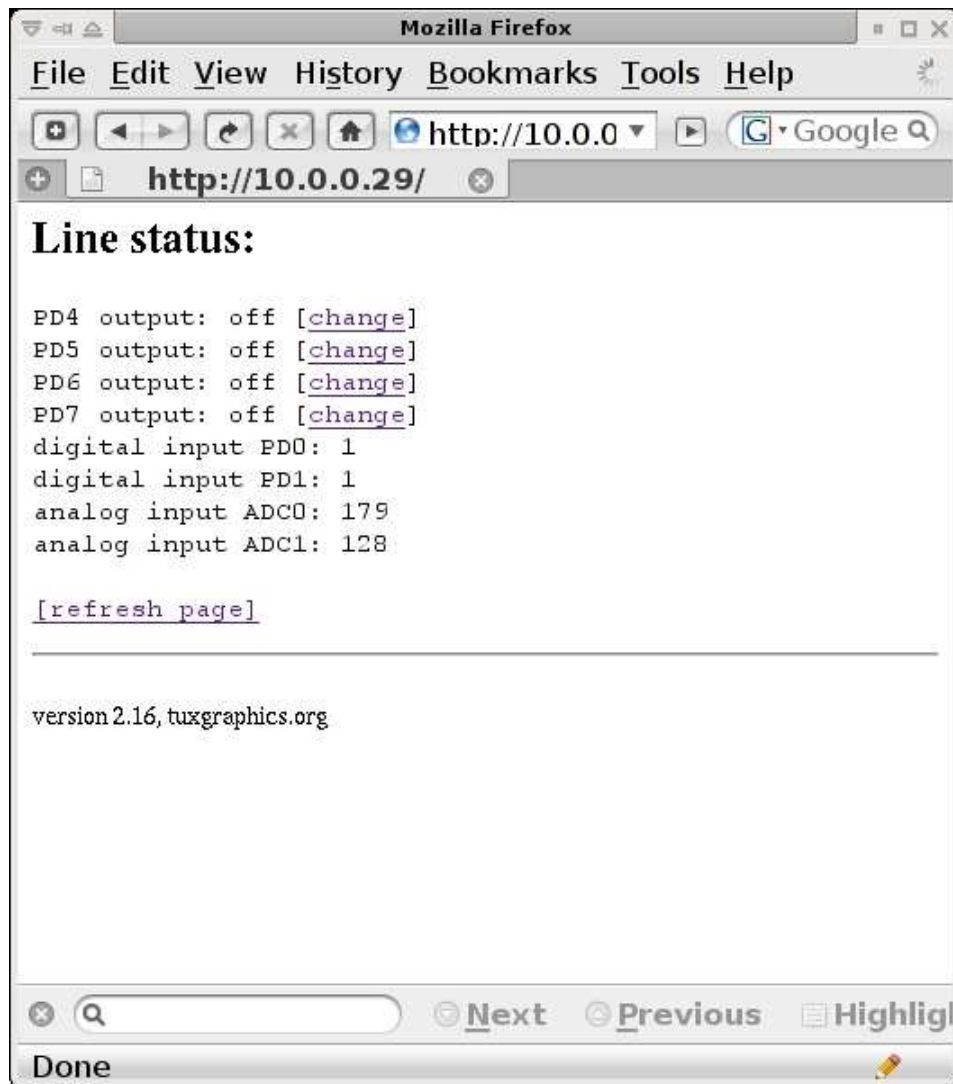
## What the software can do

The software is conceptually similar to the software described in the article [HTTP/TCP with an atmega88 microcontroller](#). It offers however some interesting additions:

- The possibility to switch on/off 4 digital io ports
- The possibility to read two digital inputs
- The possibility to read two analog inputs
- The possibility to change the IP address without re-compiling the software.

The digital inputs are adapted for 3.3V logic but the board can easily inter-work with 5V or other logic levels if you put 470 Ohm or 1K Ohm resistor in series with the digital inputs. This offers also some protection against accidental over-voltage.

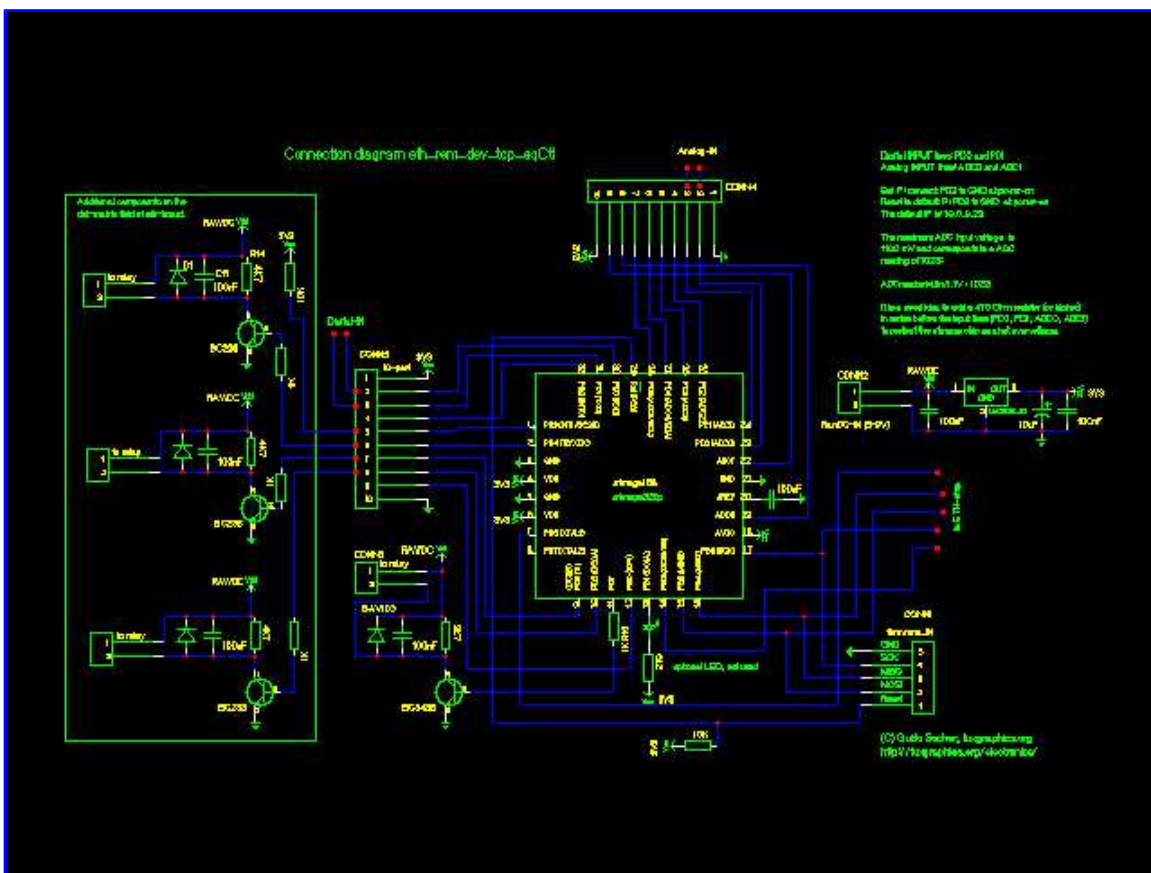
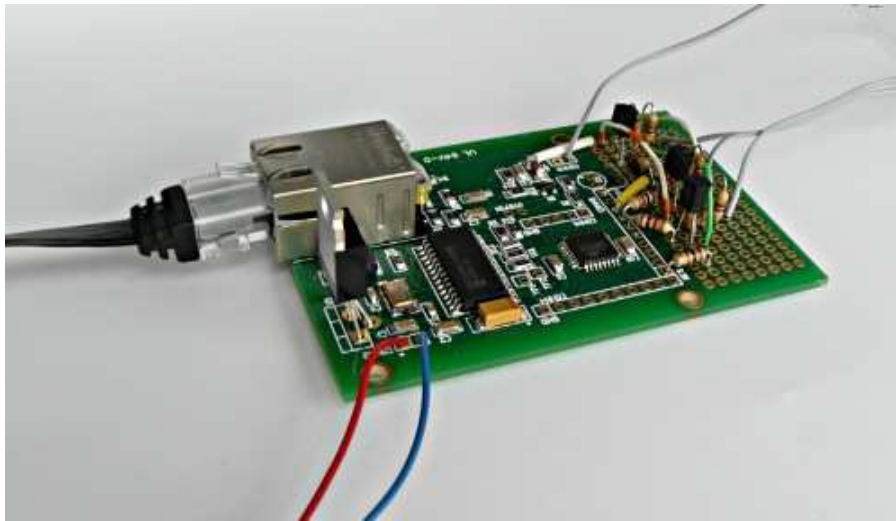
The analog input lines use 1.1V as reference voltage. In other words 1.1V corresponds to a read-out of 1023 and 0V to a read-out of 0. To adapt to other voltage levels one can add a voltage divider in-front. I recommend to use for this resistors somewhere in the range from 10kOhm to 500kOhm. There is enough space left in the software to add also add some conversion formula in the microcontroller and display directly values that make sense to the user.



Screen shot of the web interface

## Adding your own ideas to the board

The tuxgraphics ethernet board has a dot-matrix field to add own components. You can add e.g amplifiers or output drivers. In this specific case we add transistors and protection diodes to be able to control relays.



The circuit diagram with the appropriate transistors to drive relays. Click to get a printable PDF version.

## The possibility to change the IP address

This software has also the possibility to change the IP address at run-time without recompiling and loading new software into the microcontroller.

To do this you just set a jumper wire on the board and power cycle it to bring it into the IP address change mode. After that you point your web browser to it and you can change the IP address. A detailed step by step description of this procedure is included in the software archive in a sub-directory called "hardware".



You should however keep in mind that every ethernet equipment on the same LAN needs its own MAC-address. If you want to connect a second board to the same LAN then you need to change the MAC address in the software before loading it into the microcontroller.

## Pulling automatically measurement data

The web page of this sever is simple enough to be able to read it with a script. So you can take a command line web-browser like wget, lynx, w3m and grep to periodically pull measurements and fill a spreadsheet. Those command line tool are available for Linux, Mac any Unix system but some of them also for Windows (see e.g <http://gnuwin32.sourceforge.net/packages/wget.htm> or <http://home.pacific.net.sg/~kennethkwok/lynx/> and <http://gnuwin32.sourceforge.net/packages/grep.htm>).

Here is an example reading the line with the string "ADC0" every 120sec:

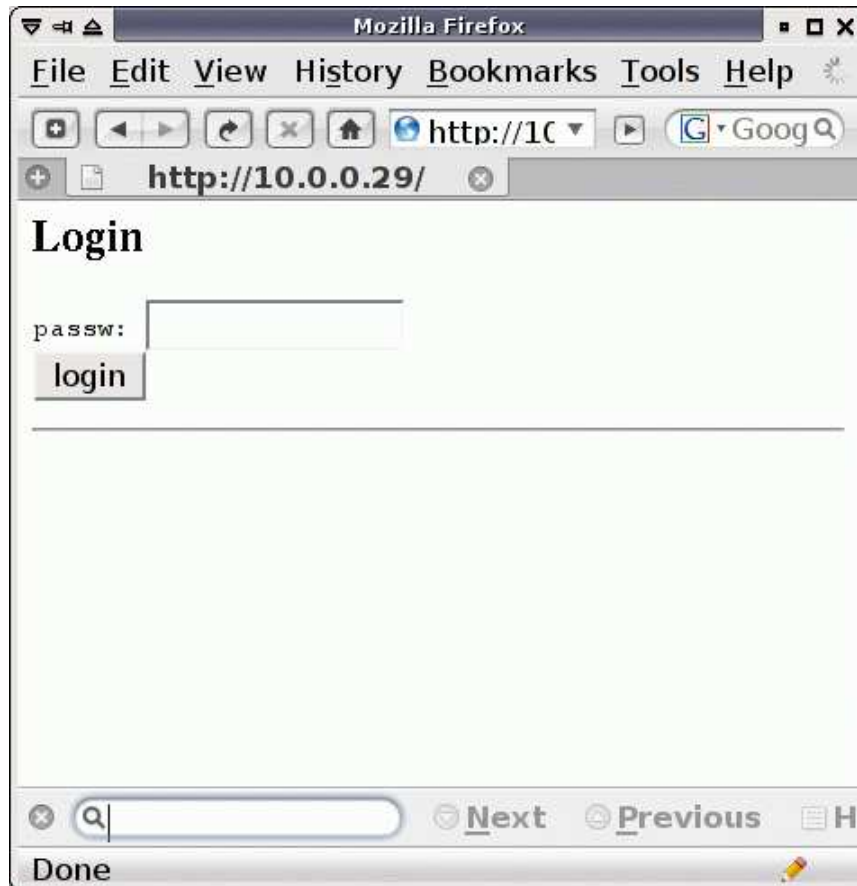
```
#!/bin/sh
while true; do
  date
  lynx -dump http://10.0.0.29 | grep ADC0
  sleep 120
done
```

## Password protection/login page

As of software version eth\_rem\_dev\_tcp\_eqCtl-2.18 there is also an optional password protection. It is optional because you can decide at compile time if you want that feature or not. Open file main.c and change the line with LOGINPAGE as needed:

```
// set this to 1 if you want a login page, otherwise to 0
#define LOGINPAGE 1
```

This gives you then a password protection. The password becomes part of the URL. This is useful if you want to access the page from your mobile phone because you can bookmark it and you avoid typing.



Optional: login page with password protection

With the password protection in place this is also a very useful software for remote control of things like heating or air conditioning in your home. You can activate it before you leave from work and save a lot of energy.

## Conclusion

This is just one more example on how to use the web server. With a bit of C-programming knowledge you can always adapt the system to your own needs. It is good to have examples at hand from where you can copy pieces of code. Just read over main.c and you will probably understand how it works. The code presented here is small enough to still run on an atmega88 chip. Bigger chips like atmega168 and atmega328 will of course work too.

## References/Download

- [Download section](#)
- The avr ethernet board is available in our online shop: [shop.tuxgraphics.org](http://shop.tuxgraphics.org)