ElecBox

The electronic prototype box

1st preliminary edition still in preparation

2009-10-18 by urs@linurs.org
Latest published version of this document:
http://www.linurs.org

ElecBox Specification

Contents

Goal of the ElecBox

In prototyping, the same circuitries have to be breadboarded again and again. (Breadboarding = soldering electronic components manually onto a prototyping universal PCB and wire them up).

What follows here takes longer than breadboarding. However if this strategy has been accepted, you find after a while circuits to reuse and other circuits even lay-outed on a nice PCB (Printed Circuit Board), so you will be at the end faster. Therefore think about this packaging standard, when you breadboard, even when you do some small things!

Often it is worth to make a board with just a couple of connectors!

Example:

Lots of of electronic hacks make use of the PC's parallel port. Make a Master board that contains a Parallel Port connector and probably a USB connector to get the 5V from the PC, so a PC becomes a master and a power-supply of a ElecBox. Place the hack on a second board. If the hack works, you might replace the PC's parallel port interface with a small micro-controller as an AVR. Therefore just have to un-plug the Parallel Port PC card and insert the AVR card.

Writing this, I have to ask myself, how many PC parallel port adapters, I already have soldered and most of them ended up in the trash. Next time I promise to do it properly and do it the ElecBox way!

Some modern components are just available in SMD (Surface Mount Device) and therefore it is a significant effort to solder them. It would be nice to have a etched PCB for that. Working with small adapter PCB is the way out when breadboarding, but it is quite a hack and fragile. Therefore solder them to a ElecBox card and use them in different applications is very desirable.

The result of the prototype should have some aesthetic aspects and also have a certain robustness.

The aim of the ElecBox is to have modules that can be reused to increase efficient prototyping. If volume goes up or some of the PCB's satisfy, they could be replaced by etched PCB's.

You don't have to sticj to ElecBox, if once a configuration satisfies, it could be easily repacked in to a smaller mechanical enclosure.

Copyright stuff

An other goal is to share this specification with other people to create an open hardware platform. Once reached a certain quantity, the tool cost can be shared as well as the volume discount.

As usual when money gets involved, some thoughts should be made before:

The intellectual property stays at the developer and the usage of it remains free. The design can be copied, distributed and modified, however the original developer has to be indicated. New and modified designs shall also be free. When hardware (etched, PCB, mechanical parts and full function devices) is sold, it shall be allowed to resell it.

In simple words it should be something as Open Hardware and GPL for hardware.

1. Mechanics

A common mechanic interface is required, that allows different sizes of PCB's and allows also to easy measure signals and unplugging. The mechanical interface derived from the single Eurocard, with the 32*2 (or3) connector but shifted the front panel to the side. This allows smaller PCB's to be used and larger front panels. The maximum height of the PCB is 80mm what is half of the Eurocard (160mm).

This allows also to used the PCB program eagle from http://www.cadsoft.de or http://www.cadsoftusa.com/. Its free version has the limits of 100*80mm size PCB's.

Alternatively KiCad can be used that is pure GPL and has no such limitations: http://kicad.sourceforge.net/wiki/index.php/Main_Page.

1.1. Front and Back

The front panel contains the user interface, whereas the back panel holds additional connectors to peripherals attached (The cables that hang out!). The front or back panel could have its own specialized non standardizes PCBs. Double (or even more) slot modules are also possible.

Due to the backplane connector used, each pin can carry maximum 1Ampre (and the voltages are also specified). If more current (or higher voltage) is necessary, or when special cables have to be used, the connections have to be made via back panel.

For the front panel, but also back panel a 3mm plate is used containing all mechanical fixings. On top a thin Plexiglas or foil that allows to insert a regular piece of paper containing all necessary descriptions board. Adhesive label would also be possible.

The smallest backplane should have 4 slots that allows most applications. It can be expanded by putting a jumper backplane underneath to connect a second backplane.

On the backplane there can be just one master board. All other boards need to be connected to this board. The user of the modules is responsible to not create any signal contention (two masters, or two slaves that use the same signals). In general slaves should therefore contain jumper blocks to set where the signals should be put onto the backplane. The ElecBox concept requires Users that know what they do.

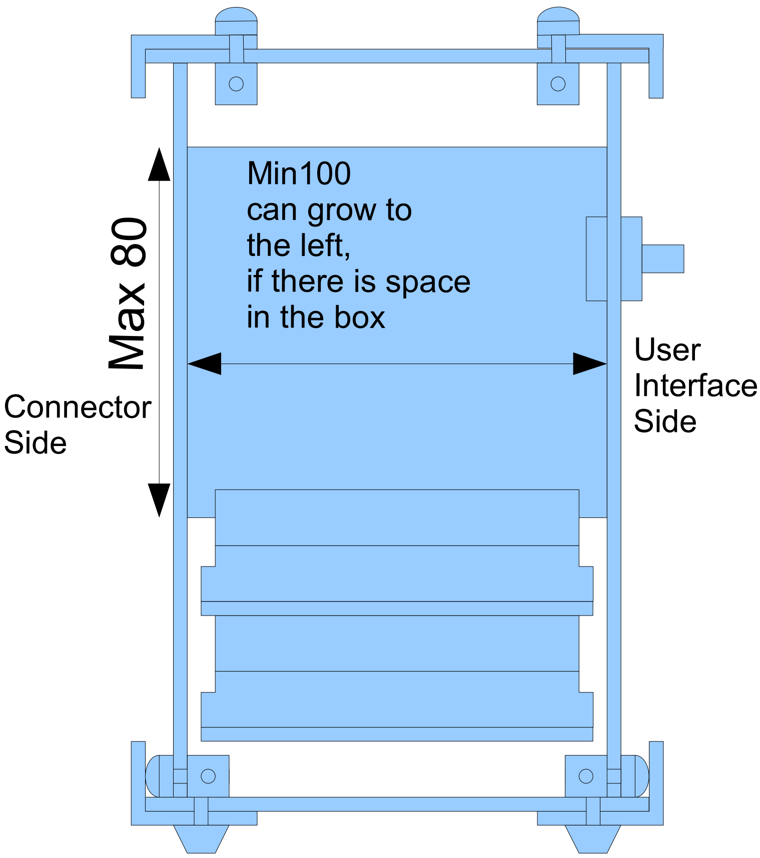
1.2.Shielding

Certain boards contain dangerous voltages or need to be shielded. Therefore a internal enclosure is possible:

- Optimal is the use of iron sheet metal to shield also magnetic fields.
- Optional would be aluminum
- When this project reaches really quantities and tooling can be afforded, then a low cost plastic enclosure would be possible.

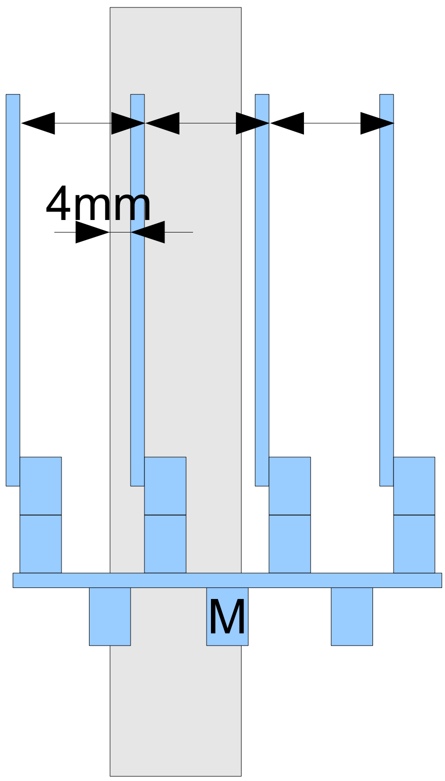
1.3.Overview

See the document mechanical drawings for the details. However here an overview:



9*2.54mm=22.86mm

22.86mm*4+3*2.54mm=99.06mm



2. Electrical

The digital signals are 5V. Analog signals maximum -10 to +10V. Power supply have to respect the maximal current. Two constraints exist:

1. 2A for all voltage (since 2 pins are used on the connector)
2. Maximal 4 A in the ground connection (since 4 pins are used on the connector)

All signals are fed parallel through the backplane.

2.1.Pinouts

The pinouts are not included on this spec since they are available in a spread sheet that can be sorted as you desire. Signal names containing numbers below 10 have a preceding zero to allow easy sorting.

2.2. Common board considerations

A I2C memory device should be put on every board to identify it.
Master boards do not have a I2C memory device here, since they do not have to identify themselves

2.3.Output signals of slave boards

Care has to be taken with slave output signals since they could cause contention with other slave output signals on the same pins. Therefore it is desired to have the slave output pin assignment flexible and put some jumpers on the board to offer alternative pins.

Example: An analog sensor, could have a jumper that allows to put its sensor signal on any of the 8 analog signals,

2.4.Master boards

Usually the slave boards are just interfaces and the master board does the signal processing. On a backplane, there can be just one master to process different slave boards. Otherwise an output conflict occurs. To prevent this, the boards could be mechanically coded to Master and Slave boards. Master boards support a limited number of Slave boards and not all signals have to be supported.

Master boards can be:

- Micro controller board
- FPGA, CPLD
- Analog computing (Multiplier, RMS, Filters, ...)
- Interface (Parallel Port to PC)

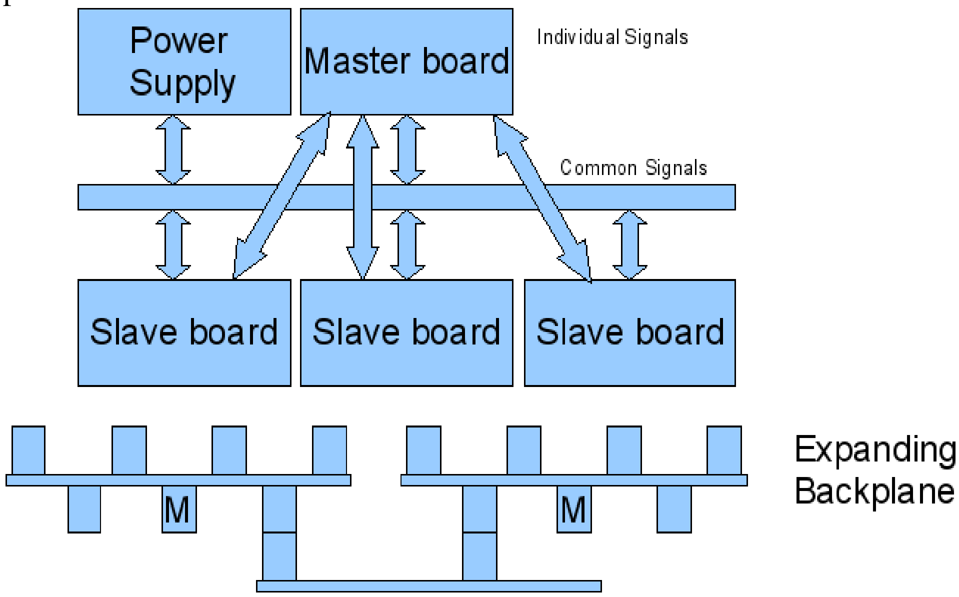
The pin out is different since most signals are unidirectional. This means where a slave has an output the master has an input. Other reasons for an other pin out are:

- One slave supports more than one slave

- Have pins for multi master support.

2.5.Jumper backplanes

If a backplane is to short it can be expanded by a jumper backplane, since all signals are parallel.

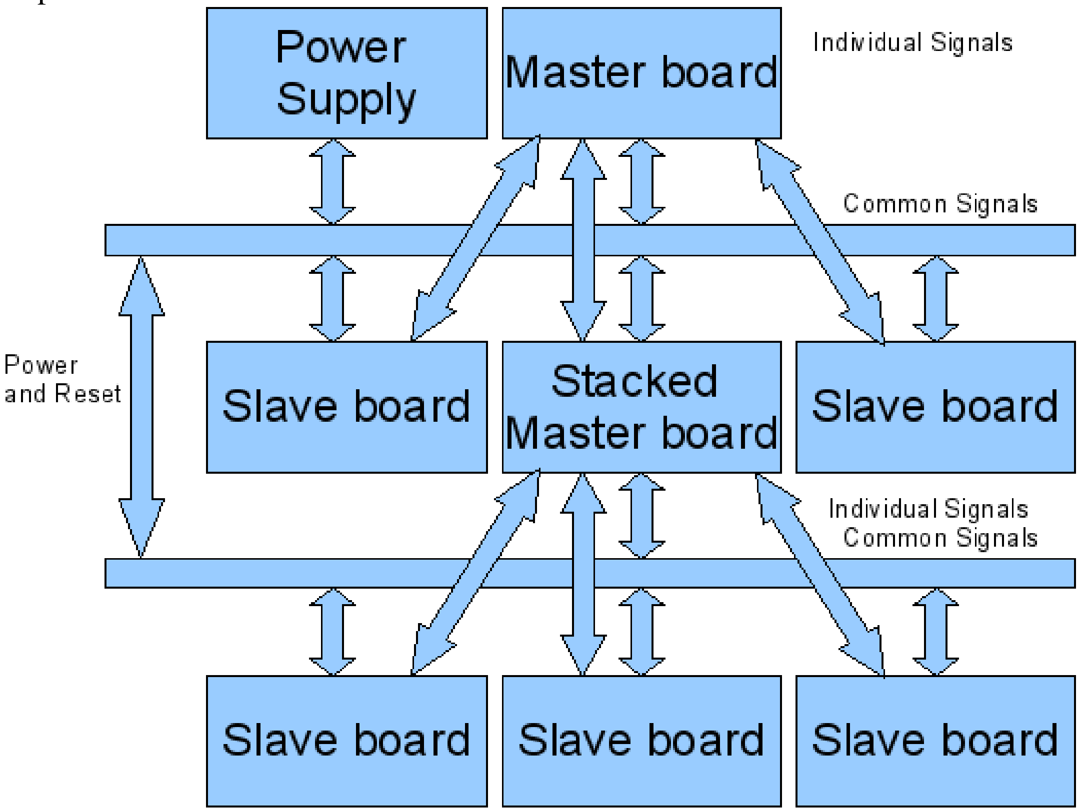


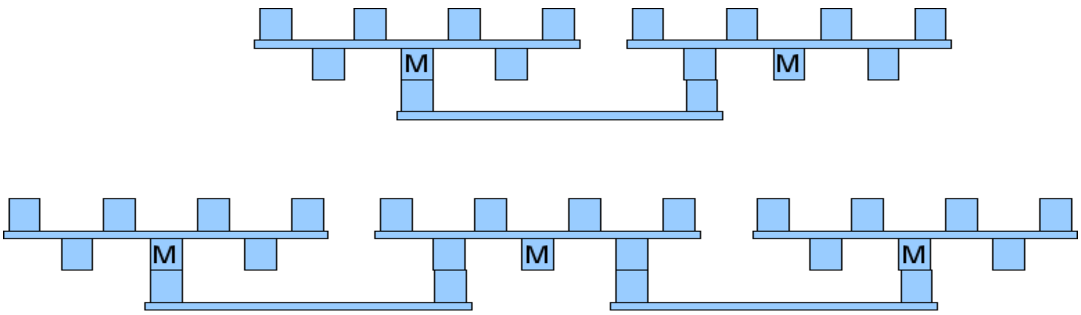
Note: there can still be just one master for those application.

2.6.Multi Master

To have multiple masters, multiple backplanes are required to create a hierarchic structure of Masters boards.

The same method as used for regular expansions with jumper backplanes is used. However a connector with a special pin out (Master connector) is placed underneath the backplane. Master boards that allow stacking make use special signals on Row b. Those signals are fed to the Master connector and make the master board on the other backplane as a slave board. On this Row b a I2C memory chip should be present to identify the master board on the slave backplane to the master board of the master backplane.





2.7.Board names and versions

A board or module shall have its proper and preferably short name. Any printable ASCII character is allowed except hyphen and dot. Also numbers are allowed to indicate important things as number of microprocessor. A hyphen character indicates that the following numbers are part of the board or module number. The first numbers followed are the major versions of the board. Different number tell that there is a incompatibility but the board still having the same name still serves the same purpose. Small improvement, enhancements and bug fixes increase the number after the major version number, as character to separate a dot is used. This number is considered as modification number and should no create any incompatibility to previous boards.

It is still possible to develop and enhance boards of older major version numbers.

Example:

Atmega16.1.0	Cpu Board with a Atmega16 microprocessor, fist version, no modifications so far.

2.8.Brain storming

Signal adapter: row of signals banana plugs cabling

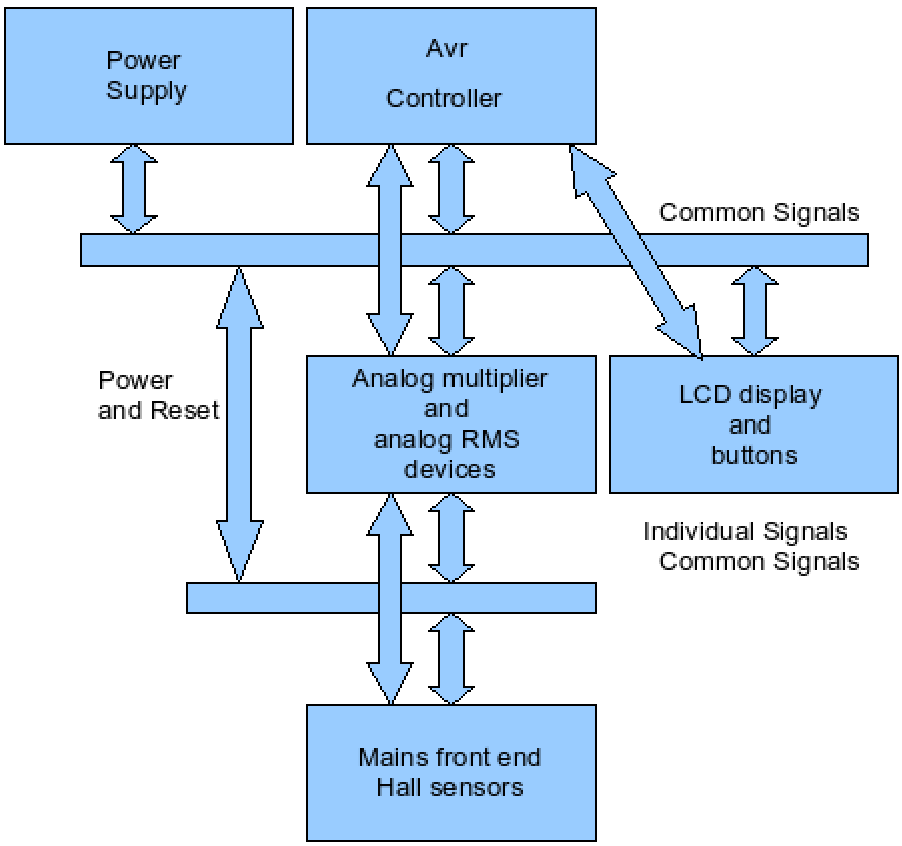
3. Examples

3.1.High precision Watt meter

Energy counters are for billing kWh's but not to see find the devices consuming some Watt standby. Cheap Watt meter are confusing, since they can show 0W but the stereo still plays music (Some require a starting current). Additionally it is questionable how they behave on non sinusoidal signals and phase shift.

- The LCD button interface is kept as a slave board to be reused also with other controller boards.
- The mains front end is also separated and kept well galvanic isolated. The signals are amplified to a decent 10V level.
- The Power supply of cause will serve many other applications. In this application it is important that no magnetic fields will be emitted toward the hall sensors.
- An AVR micro controller will be used that could well fit in other applications
- The analog multiplier and RMS devices form a second master in the ElecBox, since they process the signals from the current hall sensors. Those devices are rather expensive and could be replaced by software. However they offer a nice clean solution, where all the signals can be verified with an oscilloscope.

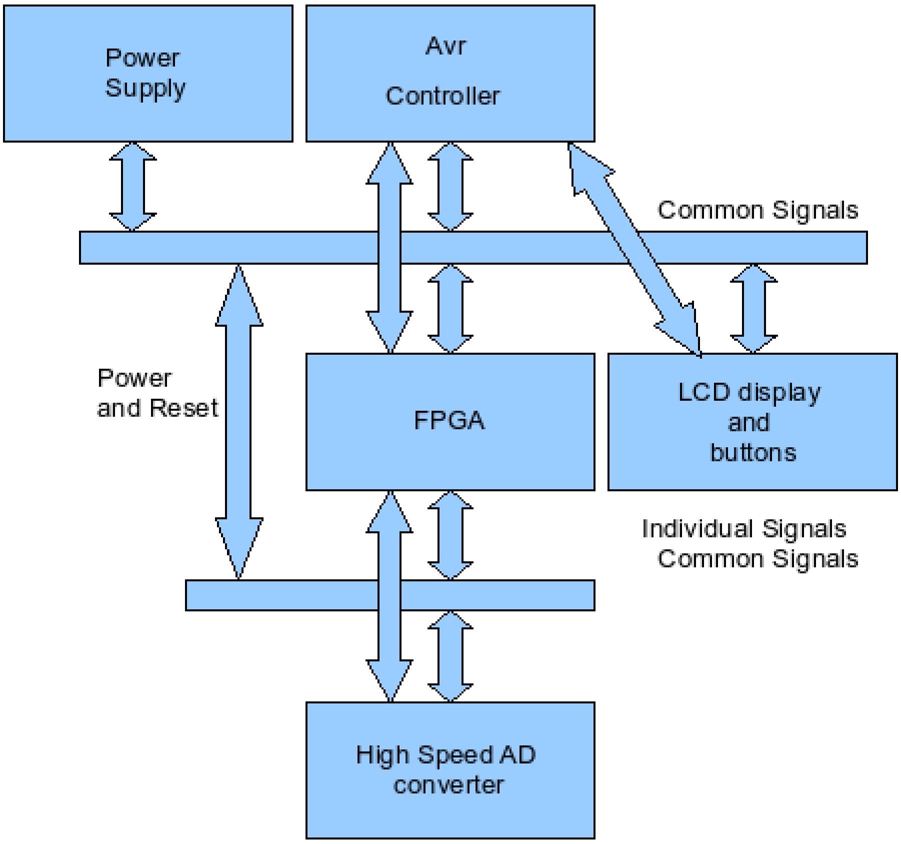
This project is a one level stacked ElecBox application with two master boards.



3.2.100MHz digital storage oscilloscope

FPGA's bury SRAM blocks and are high speed and allow different state machines to implement. It is therefore easy to attach high speed 250 to 1000 M Samples/s flash AD converters. A low cost digital storage oscilloscope can be made that can nicely sample frequencies in the x 100MHz ranges.

This project is a one level stacked ElecBox application with two master boards.



4. Connector pinouts

Whenever possible standard pinouts are used. Where no standards exist the following standards are created:

4.1. Uart without RS232 level shifter

Microprocessors usually have an UART. When the application does not require an UART, the UART could be still very helpful to print out debugging information. However the reasons to print debug information does not justify to put a relatively expensive RS232 level shifter and a big Sub D 9 connector on the board. Therefore the UART can be wired to a 2.54mm pin header where a RS232 level shifter can be plugged in. This RS232 level shifter should have the following pin out:

2.54mm header (one in a row)

1	TX
2	RX
3	Vcc
4	Gnd

5. Annex A: Bibliography

Books in German (Writing this chapter, I found out, that I do not have English books that I can recommend):

[1] Steuerungsaufgaben mit LINUX lösen; Eine Einführung anhand praktischer Beispiele
Andreas Zickner ISBN 3-7723-5109-3

[2] Messen, Steuern, Regeln mit Linux
Einsatzmöglichkeiten für Linux in Embedded Systems
Klaus-Dieter Walter ISBN 3-7723-4484-4

Alphabetical Index