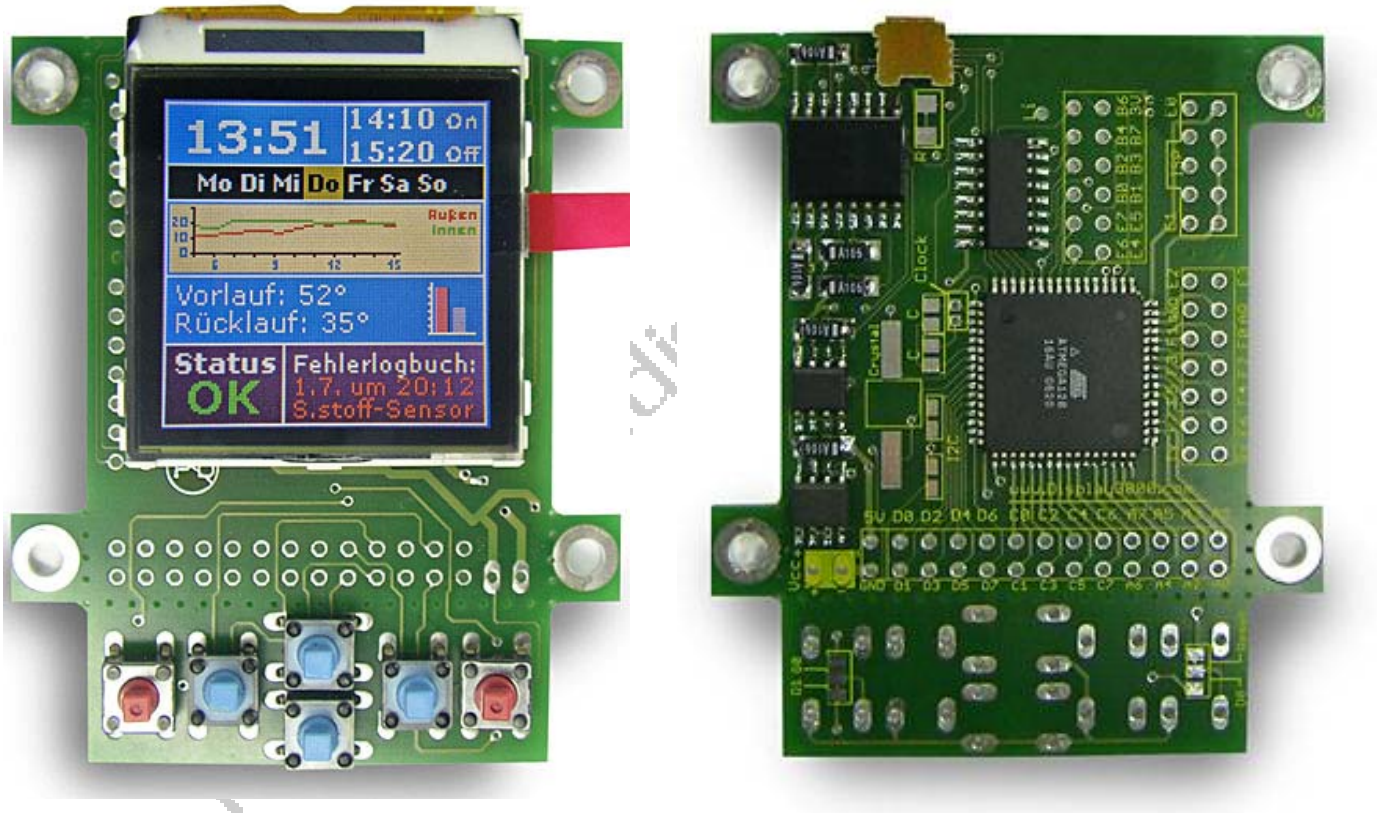
Supplement (hardware manual) for module

D062x

with Atmel Mikrocontroller:
ATMega128 or **ATMega2561** or **AT90CAN128**

V 3.00
05. August 2007

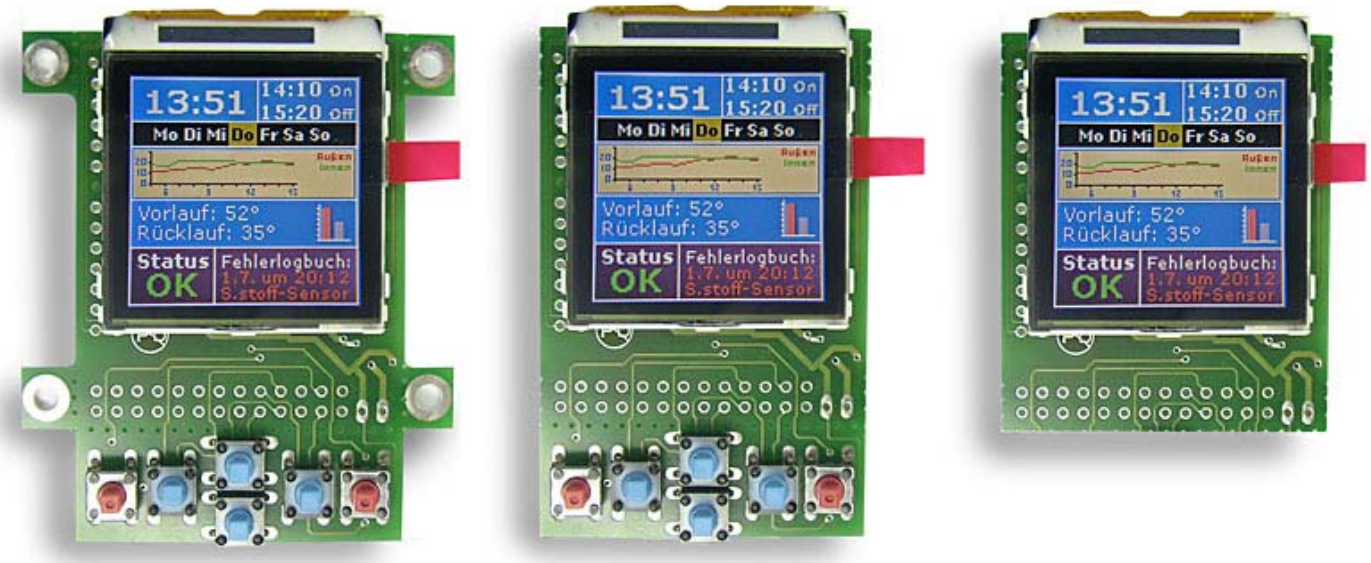


Congratulations for buying this D062X microcontroller module including color graphics TFT.

This module contains the microcontroller (depending on what you ordered a ATMega128, ATMega2561 or AT90CAN128), the electronics for the color display as well as PowerBooster technology, a RS232 interface, a I2C compatible interface. This module allows you to keep the complete electronics of your solutions on one board with minimal space. If you imagine, this module might have been able to run a moon rocket 30 years ago …… OK, lets say two modules would be able to run it ☺

At the left and right side of the module you will recognize our mounting pads for mounting the module. These pads can be easily removed by you. The same applies to the switch area below the display. The needed steps to remove frame or switches are shown starting from page 32.

You need to complete this module by clicking the display into the connector and by soldering your needed cables and eventually the switches. We did not soldering the delivered pins, as you might want to use a different kind of connection. Also the switches are not connected yet of the same reason. You may just push them into place now and they will work (for testing purposes) without soldering as of the through plated holes.



By the way – handle the TFT with care. If you take your computer monitor in front of you (which might be a TFT) and throw it from your table, it will, very likely, be broken. The same happens with our small TFT. If you drop it or if you press to hard on its surface it will break.

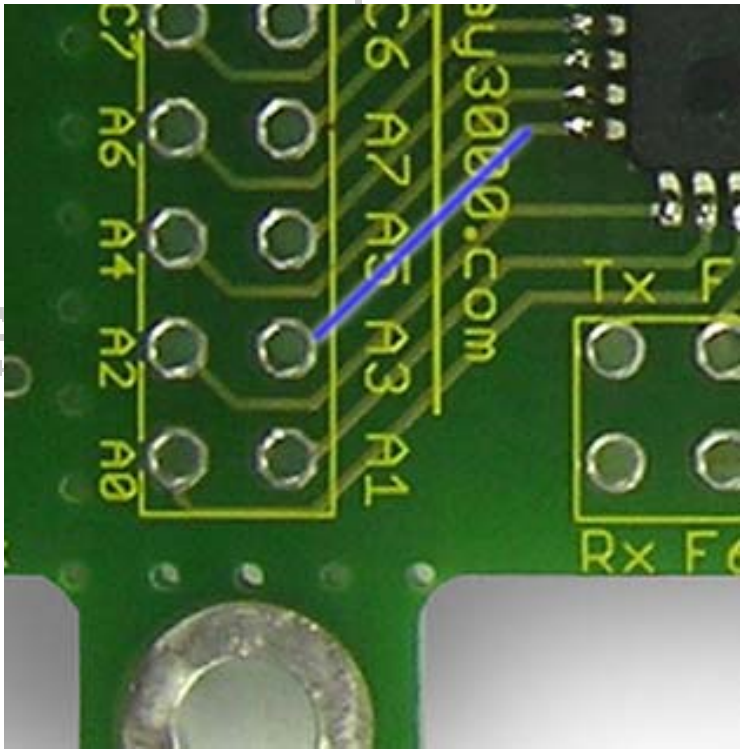
This manual shows you the needed hardware information of this board and gives you some hints for using it.

For the programming information of the color display please refer to our separate programming manual which is placed at the CD.

CAUTION:
1) Never attach the display or remove it, as long as power is switched on
2) Connect the display to its connector always correctly (see illustrations on next pages). Never attach differently around! If you wrongly attach the display, it is inevitably destroyed.

Bug on the PCB
Unfortunately it seems we clicked with our mouse one time too much between the prototype (which is OK) and the final produc:t one piece of a connection between the controller and a pad is missing. It is the connection of port A3.

See the photo beside: If you need port A3 you need to make the connection by yourself with a short piece of a thin cable. Sorry!



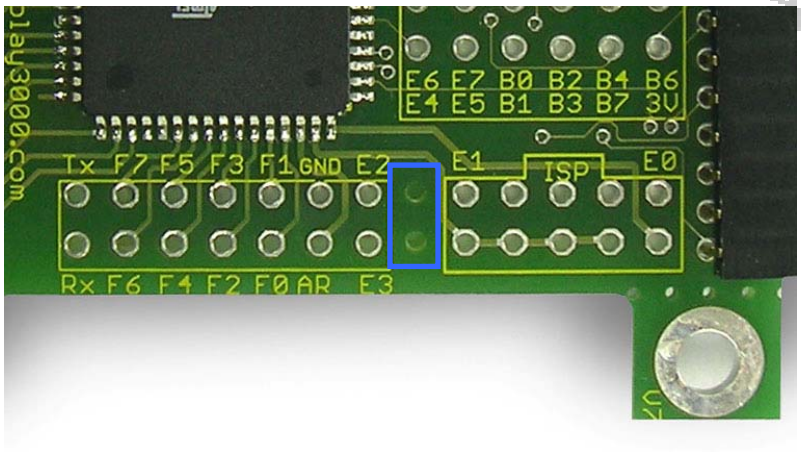
Delivery:

What you get delivered:

- 1 x PCB with micro processor ATMega 128 etc.
- 1 x TFT color display
- 6 switches
- connector bars (0,1" spacing)
- CD with sample software, documentation, utility software

First solder the connector bars to your PCB. Alternatively you may solder different types of connectors or even some wires to it of course. If you want to use this module for experimental usage you better think of purchasing our experimental board P006. This allows you to solder every external device to the extra PCB and then just plug the D062X into it without any soldering at the main module. Even after lots of experimenting and soldering your module looks like new.

Important: Before soldering the connectors to the board please read the following note.



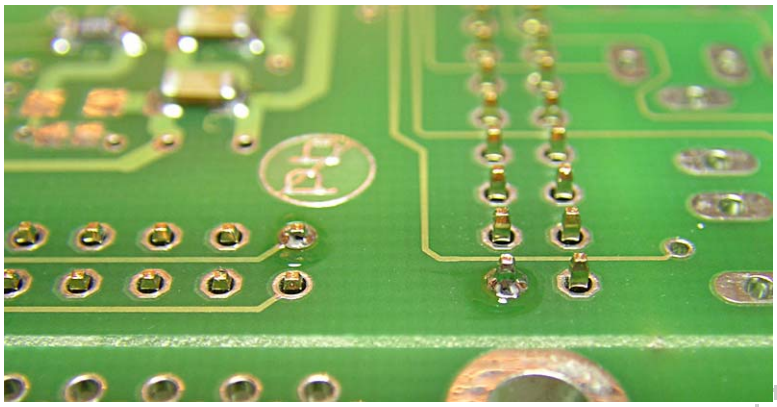
If you, as shown on page 14, want to connect the ISP connector directly with this module, you better split the connectors into two pieces with 2x5 and a 2x7 connectors. The holes marked by the blue frame shall be unused as otherwise there would be not enough room left for the ISP connector (the plastic frame around the connector) – you will then not be able to connect it to the pins then.
If you use one of our experimental PCB such as P005 or P006 this precaution is not needed and you may add all pins.

If you usually never read a manual or only after soldering this you might be glad that we expected this too: as the holes for the two unused pins does not have soldering pads you can pull them out later too as they are not soldered.

Soldering of the pins

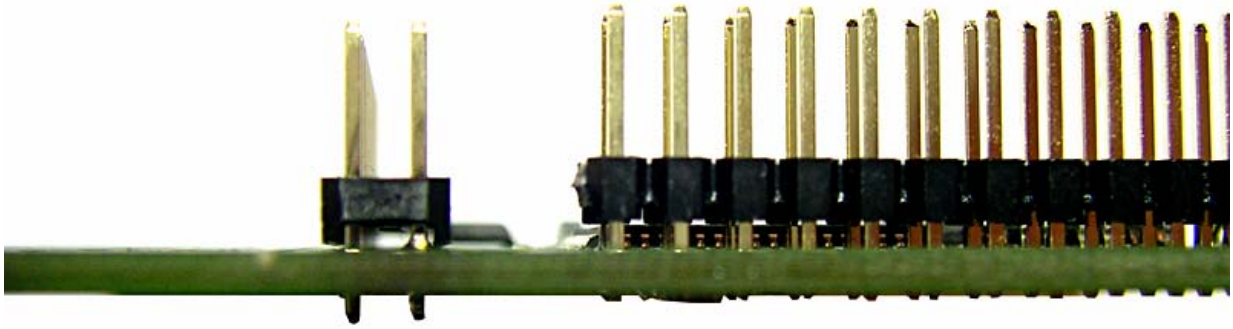
The soldering pads of the pin are located below the display. Therefore we recommend that you do not push the pins completely through the PCB but let them just barley look out of their holes – then they will not interfere with the display frame (same applies to cables if you want to solder them to the board directly).

See following two phots for illustrating what we mean:



Pins at right side of phote:
This is wrong. These are completely pushed through and we would not recommend this.

Pins at left side of phote:
This is correct. The pins are pushed just slightly through their holes.



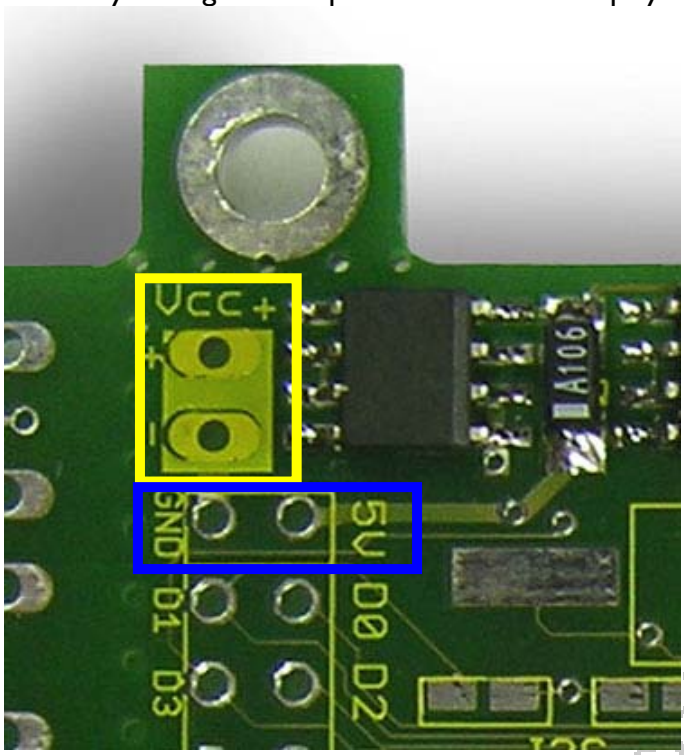
Above : View from the side. Left: pushed through too much. Right: correct.

For soldering the pins we recommend the following procedure:

1. Insert one double row of pins – then turn module (soldering pads upper side)
2. Pull PCB a bit until the pins barely look through the PCB
3. Solder on pin at one corner
4. Do the same with another pin at the opposite corne
5. Check if pins are right-angled to the PCB. You can easily do some correction now as only two pins are soldered
6. When everything if OK, solder all remaining pins.

Voltage supply

This board is delivered with complex voltage regulators to provide you an easy usage and to avoid any damage to the processor and the display.

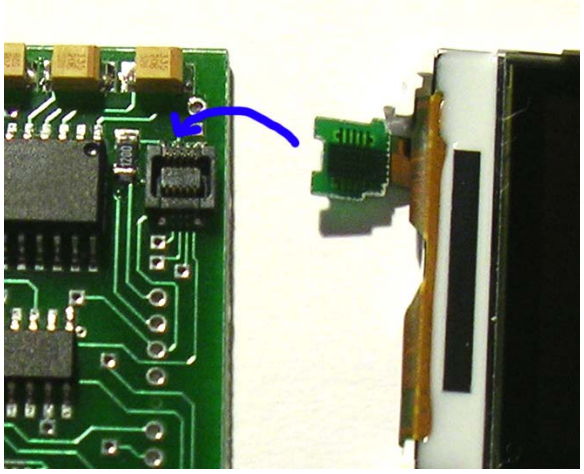


You may run this module with any DC voltage from 4,5 up to 20 Volt (yellow frame). The processor and the RS232 part is running with 5 Volt, the display electronics with 3 Volt. These voltage regulators are very-low-drop-regulators so you really can offer 4,5 Volt as a minimum to the board (and not approx. 6,5 V as a minimum as you would need with a usual 7805 regulator).

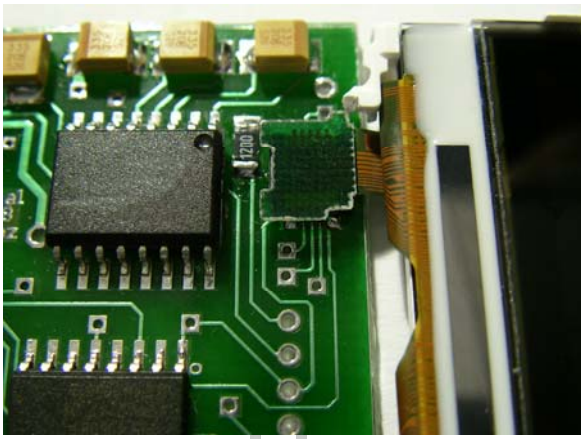
Caution:
The 5 Volt regulator is able to deliver up to 160mA current – the board itself needs about 50 mA as the 8 Volt for the display lighting is being produced at the board too. Please do not draw too much current from this board for any other items you are planning to connect to this board, you just have approx. 100mA left.
If you need more current, it would be a good idea to bridge the internal 5 Volt regulator (the one directly beneath the Vcc pad) and to use an external regulator which may provide larger current.
Alternative: offer 5 Volt or less directly at the pads 5V and GND (blue frame).
But then never provide a larger voltage to the board than 5,0 Volt. A higher voltage may destroy the display lighting and/or the processor on the board.

How to get it up and running

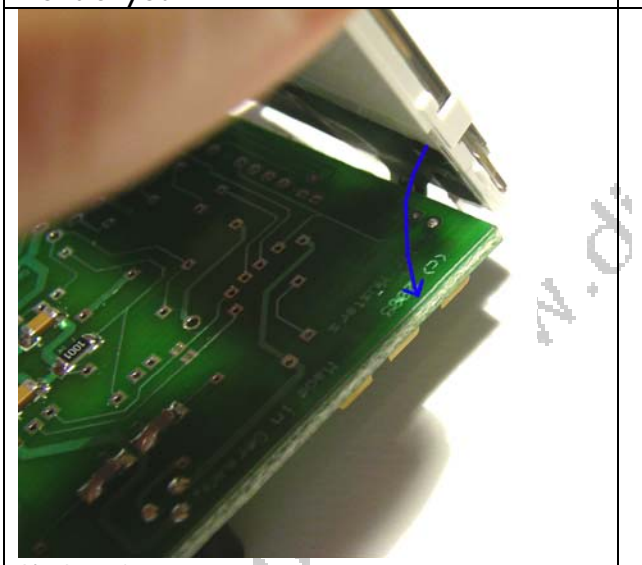
Connect the display and provide a voltage of 5 up to 20 Volts to the pads Vcc and GND.
The display should be mounted like shown at the following pictures:



1) Place PCB and display flat on a table in front of you



2) Press display connector into the SMD connector on the PCB



3) Carefully grip the display with one hand and the PCB with the other– then fold the display over to the opposite side of the PCB.

4) Ready

If you want to disconnect the display unfold it first, otherwise you may damage the connector and/or the cable. If you want to connect or disconnect the display, always switch off power before.

We already pre-programmed the controller so you will see a program showing you the status of each single port. The ports F4 to F7 show „0“ as they are prepared for the JTAG interface and are not usable otherwise until JTAG is disabled (see last page on details).

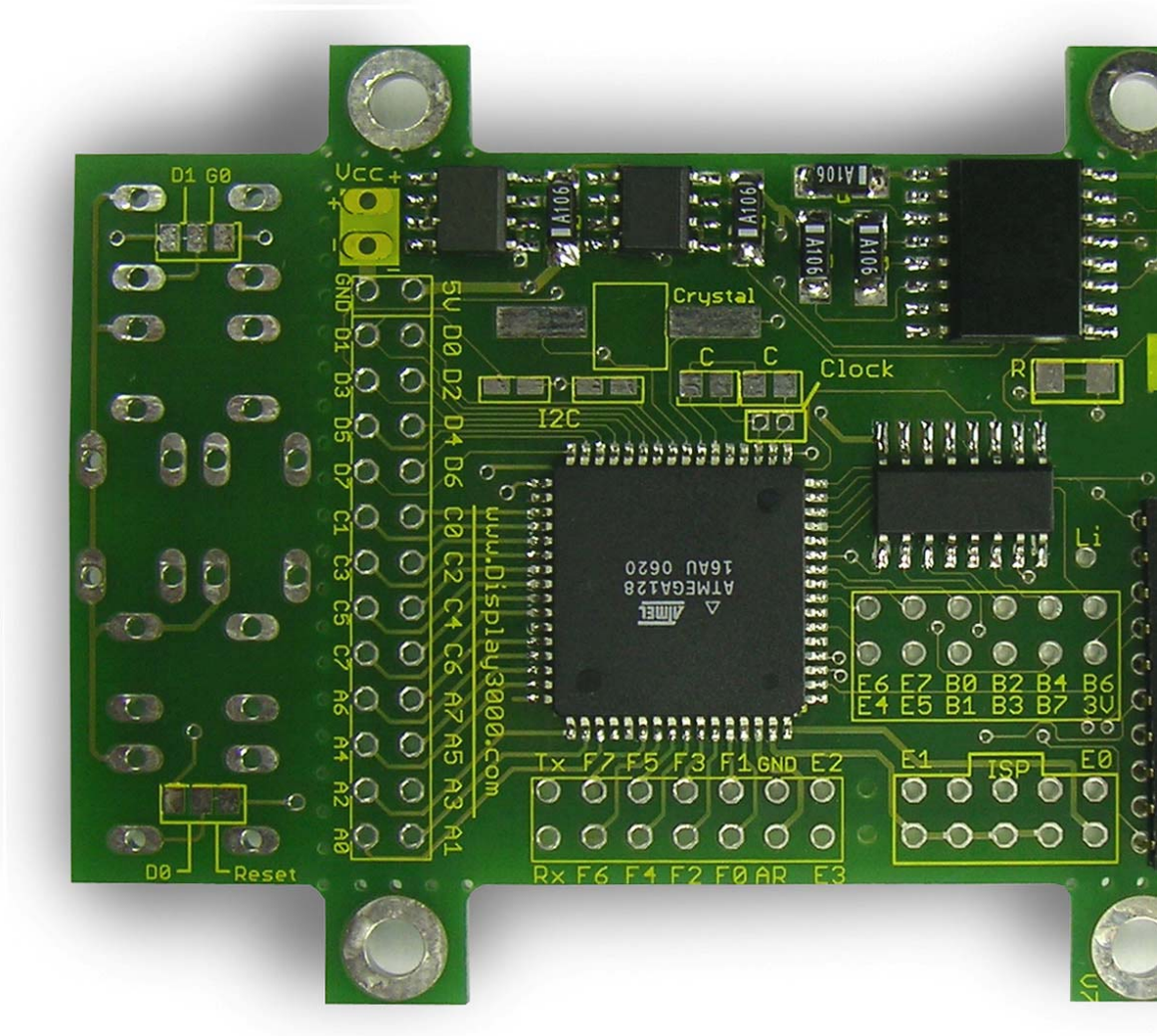
Programming interface
You need a separate ISP-programmer to be able to reprogram this board. This programmer is connected to the D062X board and your PC.

Options

This module offers some special options which we also explain in the upcoming chapters of this manual. **If you did not order these options from us, you need to upgrade your board by yourself before you are able to use these.**

1. Speed up your module by adding a SMD crystal
2. Add a clock crystal for the internal RTC (Real Time Clock)
3. Switch the display lighting on and off by a switch
4. Switch the display lighting on and off by the controller
5. Dim the display lighting by the controller
6. Usage of the TWI-Interface of the controllers (e.g. connection of I²C devices)
7. Usage of the CAN-Bus with a AT90CAN128

The pads of the module D062X

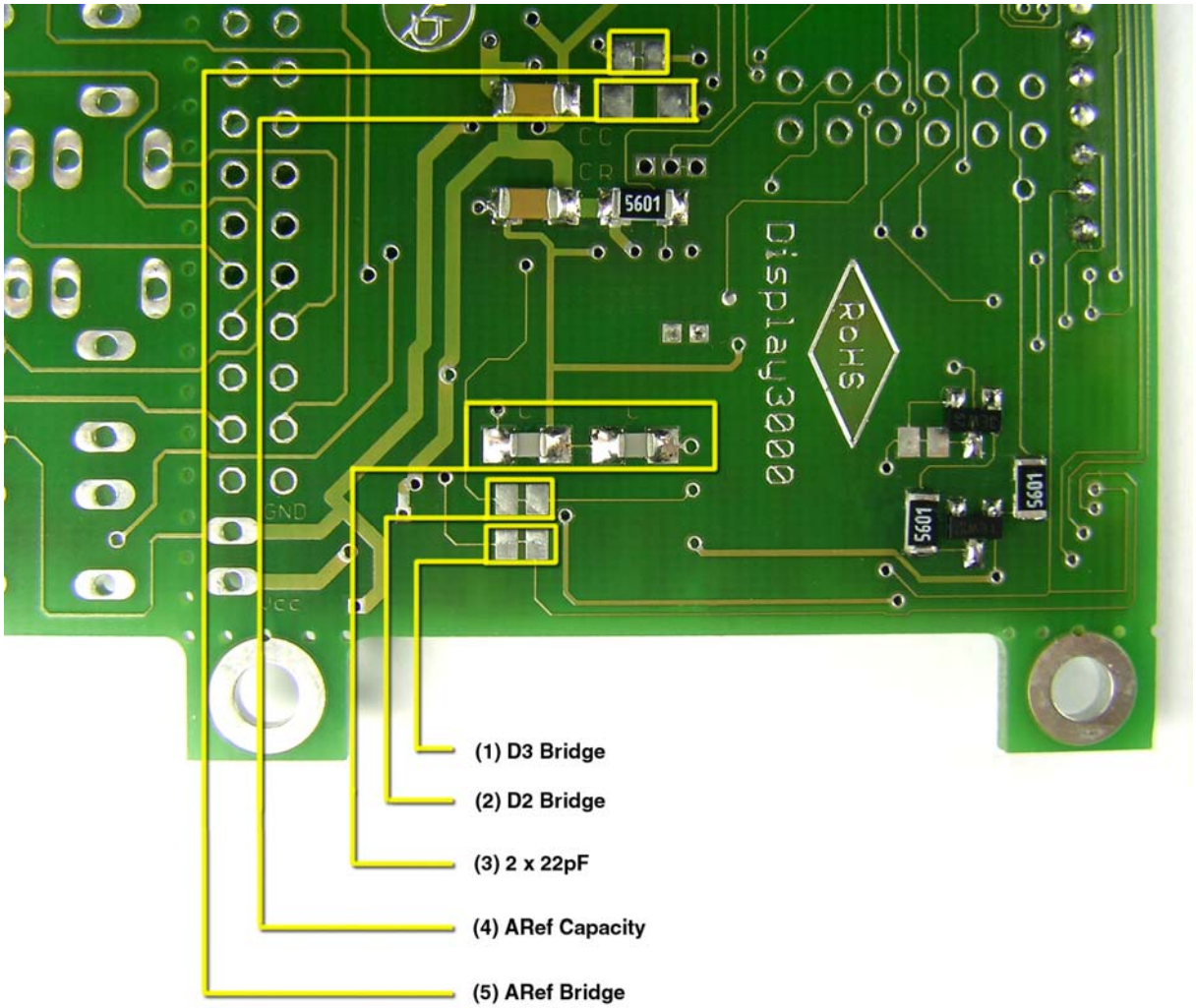


You received a board including the printing information of each pad.

The module does come with some extra options which are explained at the following pages.

Solder bridges

There are four solder bridges located at the board, all being closed by default! Three of these bridges are explained now, the fourth bridge will be explained at the chapter display lighting.



ARef bridge (5):
Some ports of the processor may work as analog inputs. If somebody needs very exact values they would like to use the Port ARef to offer the micro controller a reference voltage.

By default, we connected ARef to the 5 Volt voltage of the micro controller which is usually fine. If you need ARef for an input of your own reference voltage, you need to cut the small connection in the circle shown above. We included also soldering pads, so you may close this connection with a soldering iron easily.
As long as the connection is closed, the ARef pad offers the regular 5Volt voltage for any usage you need.

ARef capacity (4) can be used then for adding a capacitor (e.g. 100nF) if needed

D3. and D.2 solder bridges (1) and (2)
The ports D.2 and D.3 are used for the RS232 communication. If you are planning to use a real RS232 connection (using the RX and TX pads) you should not plan to use the ports D.2 and D.3 because the two signals will interfere and create either a non working port or a non working RS232 connection.

If you do not need RS232 and you want to use D.2 and D.3 then you should cut the connections shown in the circles as the RS232 chip provides a signal to the micro controller – even if you are not using RS232.
If you do not want to use RS232 and if you do not need the ports D.2 and D.3 just do not change anything – just remember to not use D.2 and D.3 (especially D.2 as this is the receive channel).

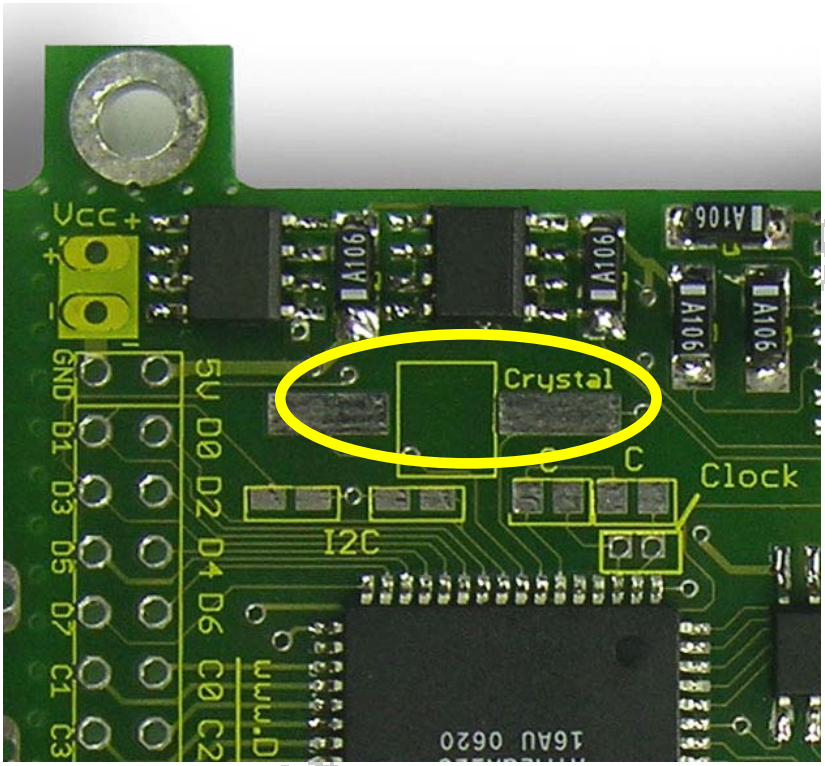
By cutting the connections in the circle shown on page 9, the connection of the ports D.2 and D.3 of the micro controller are still valid to the pads D.2 and D.3. You are only cutting the additional connection to the RS232 chip at the board. You may then either use the Ports D.2 and D.3 as regular ports or you may still use RS232 with regular TTL voltage of 5Volt – e.g. by connecting two micro controllers directly.

In short:
If you want to use RS232 do not cut and do not use ports D.2 and D.3.
If you do not want to use RS232, either cut the two lines or do not use D.2 and D.3.

We included also soldering pads at the cutting points, so you may close this connection with a soldering iron easily if you change your mind later.

Adding a clock crystal

If you ordered a board without an additional crystal and if you want to solder a crystal in by yourself, you need also to solder 2 capacities in. These are the shown 2 x 22pF capacities at page 9 (located below the crystal at the opposite side of the PCB). The crystal can easily being located at the following picture. Please make sure you buy a SMD crystal and SMD capacities.



The 22pF capacities are located **at the opposite side of the PCB directly underneath the crystal** (see page 10) the pads for these two capacities 1) are marked with a „C“ at the PCB. Hint: If you did not order a high speed board from us but want to solder these devices by yourself, make sure you buy a SMD crystal and SMD capacities with case 805 or 1206.

By default, without an ordered crystal, the micro controller at our board actually runs at 8 MHz with an internal resonator. You may enhance the speed by soldering a crystal and 2 x 22pF ceramic capacities to the board. You then need to reprogram the speed fuse from 0100 (8Mhz internal) to 1111 (external crystal).

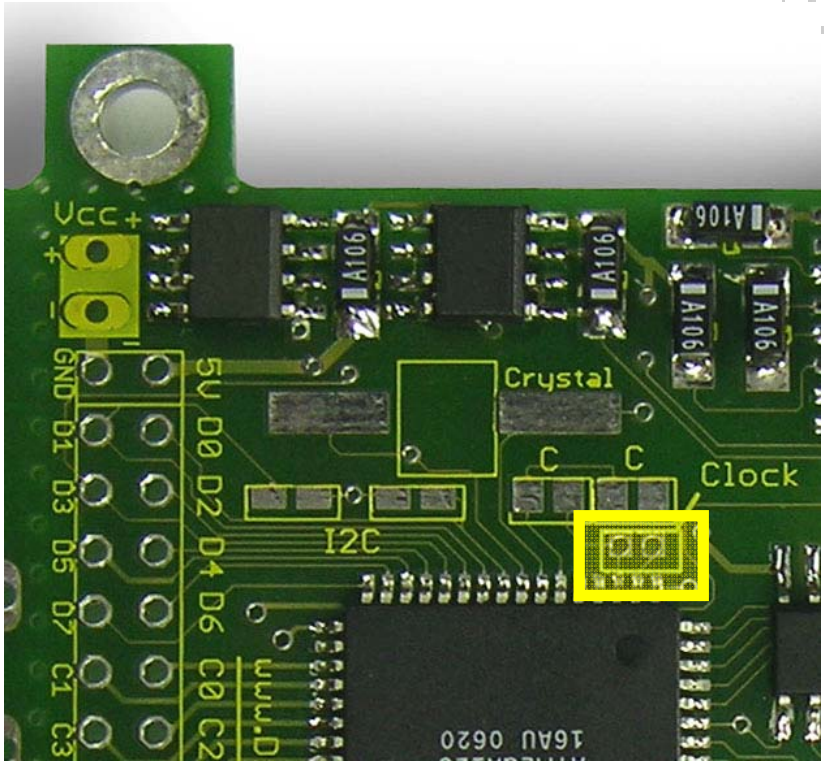
Caution: any other selection than 0001, 0100 and 1111 **may cause a malfunction** of your board!! It will also not work anymore if you select 1111 without having a crystal soldered in. **Fuses are very delicate** – if you are not experienced with them, **do not experiment with changes – quickly the board will not function anymore!!**

If you select 1111 as the fuse value, you may solder any crystal speed you want. 16 MHz is the official limitation of the ATMega128, however it can sometimes be overclocked up to 20 MHz.

But be aware: The slowest part of the micro controller is the build-in Eeprom. While a 10% higher frequency is usually no problem, 20 MHz will often result in wrong data if you write or read from the Eeprom. If you do not use the Eeprom you can use higher frequencies. Any overclocking is at your own risk. If you plan to build critical applications – do not overclock!

The selection of the correct crystal is also depending on the general speed you need (by the way: the faster the ATMega runs, the more current it needs), but also on the need of a RS232 interface. For this, please read the RS232 section at page 23.

Adding a clock crystal for using the module for exact timing
We are prepared the board for the usual 32.768 KHz clock crystal. You should use this if you want to use an exact timer, like running a clock with your module.
This is also useful if you want to save battery power: you may send the ATMega to the sleep mode and wake it up e.g. once or twice a second, let it check some status and return to sleep if no action is needed. By this your microcontroller would sleep 99% of the time.
Hint: Bend the clock crystal after soldering by 90 degrees, so it may lie directly on top of the ATMega to get it out of the way.



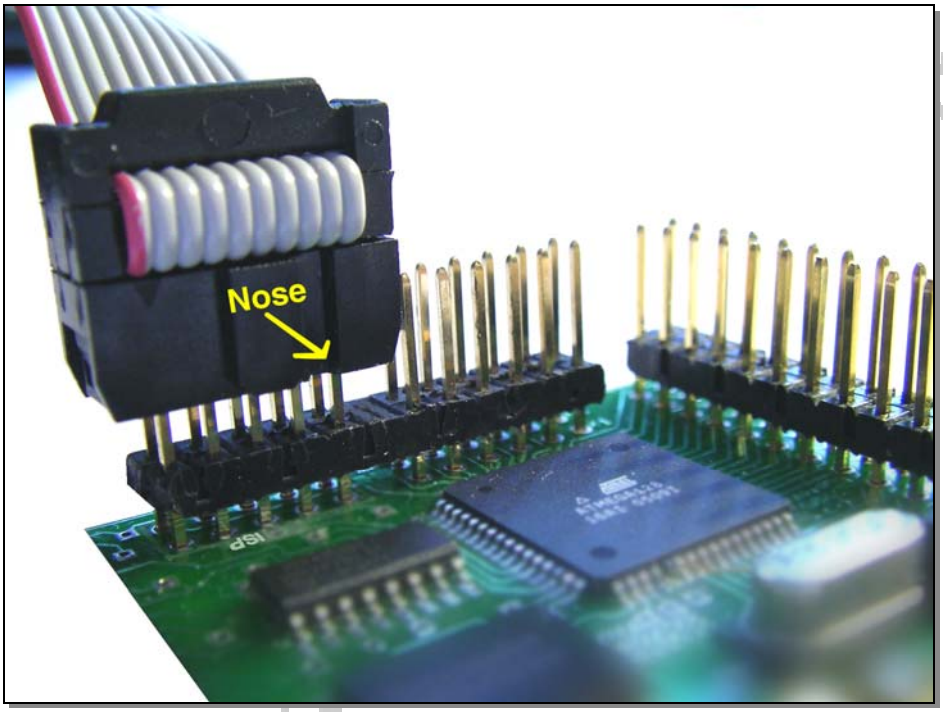
Special case: ATMega2561 and a clock crystal:
According to its datasheet, the ATMega2561 needs extra capacities of 22 pF when a clock crystal is being used. For this reason we prepared the PCB: Direcly above the two pads for the clock crystal there are 4 soldering pads for two SMD capacities (SMD size 805). You only need to add them when using a ATMega2561. If you order our board including clock crystal these are already soldered in.

The ISP-connector

As we tried to reduce the needed space as much as possible, there is no room for the standard-ISP connector including his plastic frame. Instead we do offer pins with the same spacing and contact scheme as the regular ISP connector.

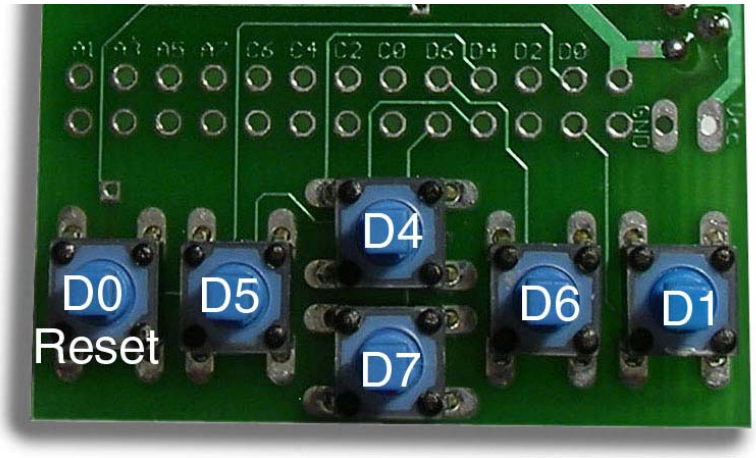
Please refer to the following picture, how you need to connect your ISP cable to our board. It is easy: just remember that the "nose" of the cable has to show towards the chips.

For making remembering easier, there is "ISP" printed on the board as a hint.



Do not try to connect to the ISP from the display-side. Always connect from the micro controller side as shown in the picture above.

The switches of the D062X

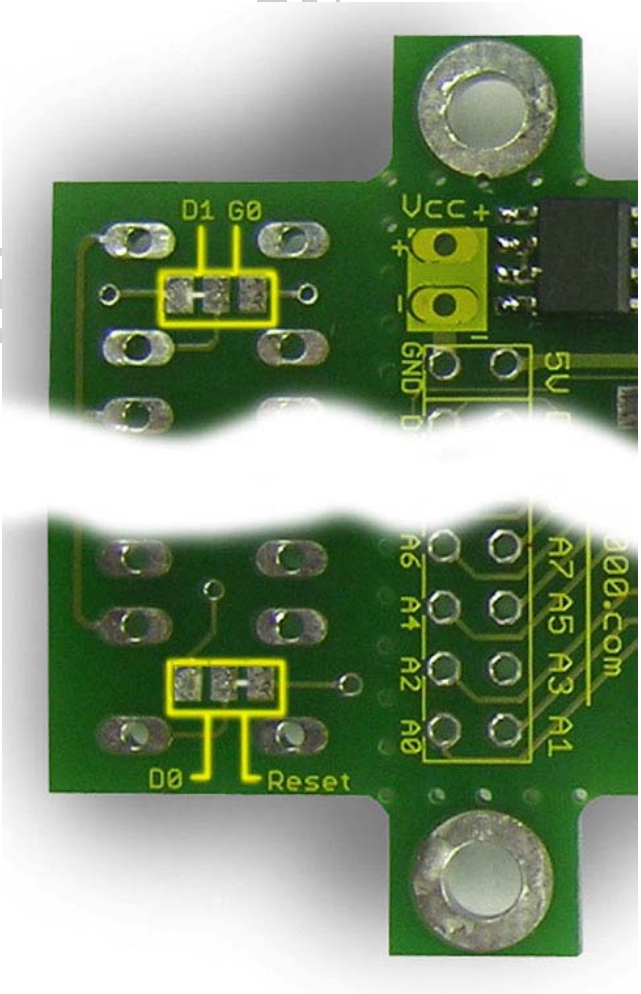


The switches of module D062X are already connected to Port D (see photo left). The connection of the outer left and the outer right switch could be changed by a soldering bridge. The left switch is connected to Reset by default. If you do not need Reset or if you need another input switch you may connect this switch to port D.0 instead.

The right switch is connected to port D1 by default. As the ATMega allows multiple usage of each port, this port D.1 does offer a multiple usage too: it might be the data line of a I²C bus system for example. If you want to connect your module to a I²C bus, you probably want to use a different port for this switch. We prepared the board so you may use port G.0 instead for the right switch.

If you would like to change the connection of a switch, you need to cut an existing bridge with the current connection (marked with D1 or Reset) and to close another bridge for the new connection with some solder.

Example: The left switch should be connected with D.0 instead of Reset. You need to cut (photo beside: bottom) the existing brigde between the middle and the right pad of the jumper pads (marked with Reset). Then you need to close the connection between the middle and the left pad (marked with D0).



Switching the display lighting

Especially with battery driven devices the current usage of the display lighting might become a problem. Having a possibility for switching it off would be nice. As the lighting LEDs does have a life span of about 50000 to 100000 hours (which means 5 to 10 years continuous run) this might also be important for devices which will run for years.

As the display lighting needs a higher voltage (at our board we create 16 volt for the lighting), some addition is needed: you may either add a manual switch or two SMD transistors and two SMD resistors. By default we ship our board with permanent lighting. If you did not order the board with a different lighting option, you need to modify/upgrade it by yourself.

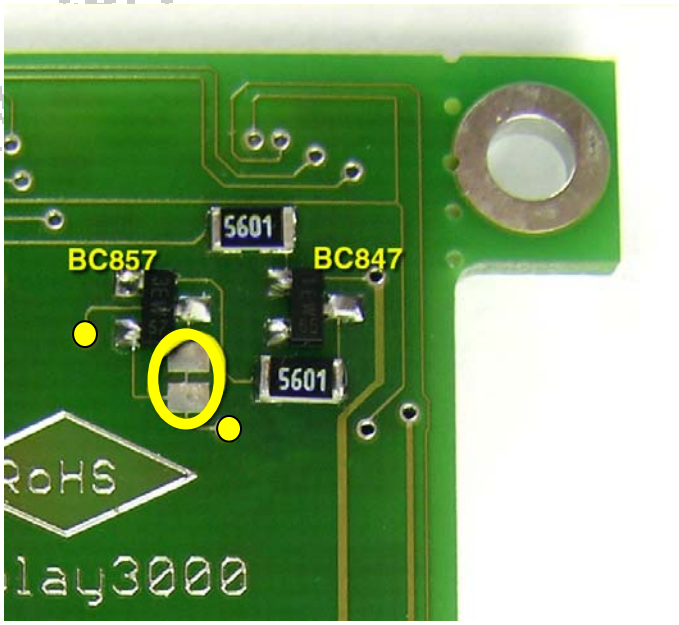
By default there is a direct connection from the PowerBooster to the display with its integrated lighting. The lighting is separated from the other electronics of the display and may therefore be disconnected during run time.

As there is a direct connection by default, you first have to cut it: Just cut the connection between the two small pads showing in the circle at the photo below. Remark: If you ordered the product without the electronics for switching the lighting with the micro controller the parts showed at the photo below are not soldered in.

Switching the lighting with a manual switch:

Solder two wires at the pads left and right of the wire you just cut (=the pads inside the circle) and connect these two wires with a manual switch. You now can switch the lighting on and off whenever you want. Switching it off will lower the current usage of the complete module by about 40mA.

You may also solder your wires to the vias of the board (push the wires through the vias from the bottom side of the PCB). These usable vias are marked with a yellow dot at the photo.



Switching the lighting with the microcontroller:

Instead the manual switch you may use your microcontroller to automate the lighting (e.g. microcontroller switches the lighting off after 10 minutes without any user input – as soon as a key is pressed the lighting will be switched on again).

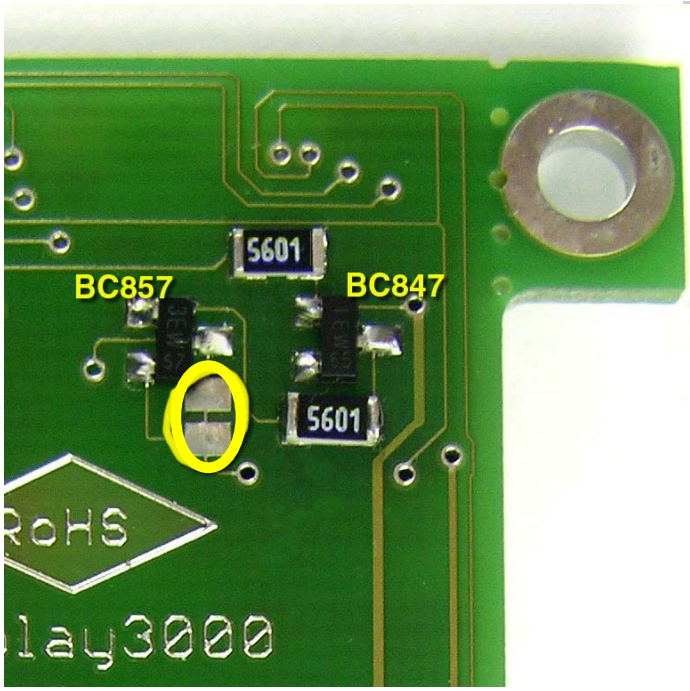
As the lighting need a higher voltage, we cannot use a direct connection from the controller to the display lighting. We will need transistors as electronical switches. In detail you need:

1 x SMD-PNP-Transistor BC858A (size SOT 23)
1 x SMD-NPN-Transistor BC847A (size SOT 23)
2 x SMD-resistors 5,6 KOhm (size 805)

We did prepare the board for the usage of the **port B.7**. **First cut the existing bridge** as shown at the last page.

Then you solder to the top side of the PCB the two transistors as shown at the following photo. Important: the upper transistor should be the **NPN-Transistor (BC847)** and the lower one should be the **PNP-Transistor (BC858).**

Next you need to solder in the resistors to the PCB. Thats it.



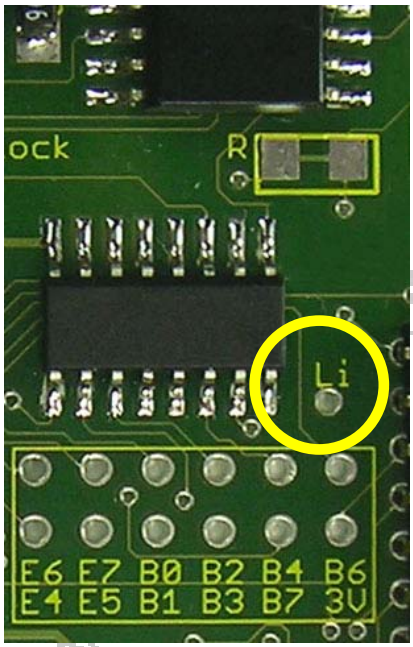
By connecting your module to power the display shall be dark. If you now define port B.7 as an output port and if you set the port to high-level, the display lighting should become alive. Of course port B.7 cannot be used now for anything else (see also next page).

Please be aware: in our sample programs port B is beeing used for he display data. Until now port B.7 was unused and was not being defined as an output port. You need to change the definition of port B.7 now.

Example for our Bascom code: Change the existing line
Ddrb = &B01100110 into **Ddrb = &B11100110**. With this your port B.7 is being defined as an output port. Now, with the line **Portb.7 = 1** or **Portb.7=0** you may switch the lighting on or off.

Changing the port for driving the display lighting:
When you need Port B.7 for something else but you would have another port left which you would like to use to drive the display lighting you may change this as we prepared the board for this.

Located at the top of the board (near the frame) there is a soldering pad marked with "Li" (see yellow circle in the photo). When you cut the wired from B7 to the "Li"-Pad with a knife (wire is located at the opposite side of PCB - display side) then you may set your own connection from any port you want to the pad "Li".

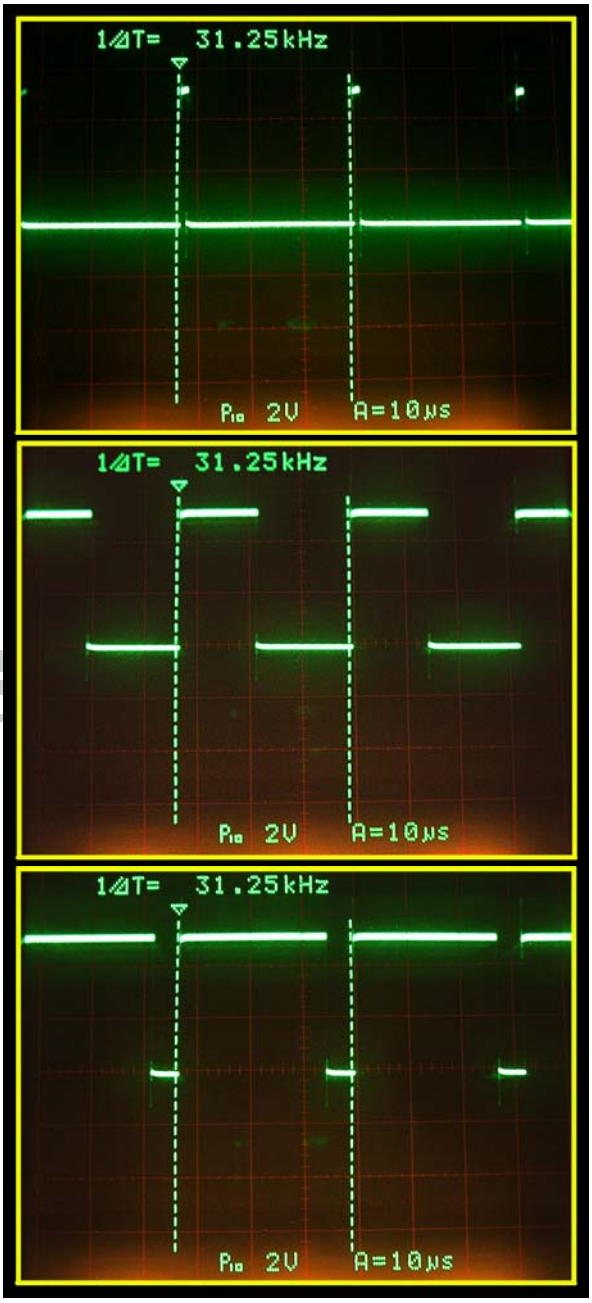


Another interesting alternative ist he driving of the display lighting by pulsed signals. With this you are able to simulate a dimmed lighting. More on this follows in the next chapter.

Running (dimming) the display lighting by PWM (pulse wide modulation)

PWM is often being used for controlling the energy usage of a technical system.

First some (simplified) theory:
If you switch on and off a LED five times a second for 0.1 seconds each you will of course recognize some bothering flickering. But also, the LED was switched off half of the time and will have emitted (and used) only 50% of the energy it might have used if it were switched on all the time.



Assumed, you speed up the on/off switching time to 0.001 seconds each, you would not be able to recognize any flickering anymore – but your eye would register a LED shining with reduced power. In fact the LED is still working only 50% of its time (500 times per second switched on for a 1/1000 of a second and the same time frame switched off) and therefore it is emitting only 50% of the energy.

If you now change the variation from the 1:1 example above to a 1:3 (means: the LED is still being switched on 500x a second but for 0.0005 seconds and being switched off for 0.0015 seconds) the brightness would being reduced again. Vice versa, if the LED is being switched on for a longer time than being switched off, the brightness would raise.

This is being called PWM – the frequency does not change but the variation between high and low.

The photos of our oscilloscope beside show this in detail: In the middle there is 1:1 variation (=50% brightness). The top picture shows a 1:15 variation thus shining pretty dark and the bottom picture shows a 7:1 variation where the LED is enabled most of the time and almost 100% bright.

By varying the enabling to disabling time in a defined time frame the used power of a device can be controlled. In this case, the ATMega controller is also able to do this to be able to varying the brightness of the display lighting.

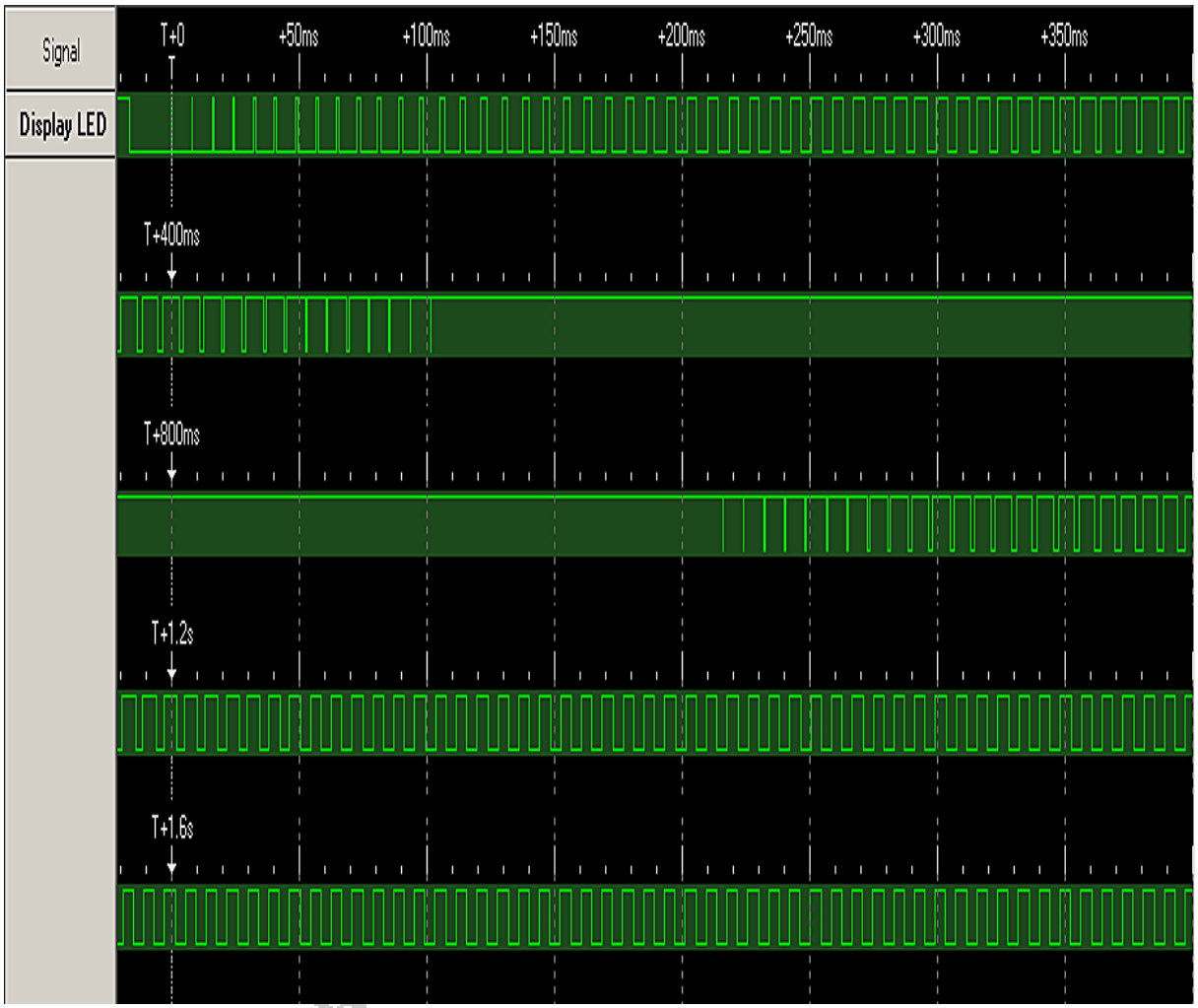
But wait – do not go and start writing a program which will do the needed pulsing. There is no need to do this as the ATMega controller offers hardware PWM. This is pretty cool, as you do not need to give any extra resources to the controller. It will just do the work without eating up any of your program space or time. You just need to enable it – then it will run by itself.

An example in Bascom shows this:
The follwing lines will enable PWM and will then dim the display from 0 to 100%, wait 500ms with full power and then dim the display from 100% to 50%. Then the program stops. Question: What will happen with the display lighting now? Will it be shut off, stays at 50% or will it be 100%. The answer will be given on the next page.

```
Gosub Lcd_cls
Call Lcd_print( "Display3000" , 1 , 1 , 2 , white , darkred)

Config Timer1 = Pwm , Pwm = 8 , Compare C Pwm = Clear Up , Compare C Pwm =
       Clear Down , Prescale = 256

For I = 0 To 255 Step 5
   Pwm1c = I
   Waitms 10
Next I

Waitms 500

For I = 255 To 130 Step -5
   Pwm1c = I
   Waitms 10
Next I

End
```

A short explanation: Port B.7 is connected to the hardware PWM channel C. With *Pwm1c* the corresponding register will be set.

To make it clearer we did record the PWM signal of the above program with our logic analyzer. The complete record is 2 seconds long, each line divided in 400ms. It is very easy to recognize, how the variation from high to low changed during the time.



The first 510ms are needed to bring the brightness up from 0 to 100% - 51 steps with 10 ms waiting time each. Then a pause of 500ms (Waitms 500) is visible, during this pause the display lighting is still at 100%. Then, the lighting is being driven from 100% to 50% in 25 steps, and then (at position 1.25 seconds) the program is finished (command END). This gives you the answer of the question on the last page: Even if the program is finished and the controller is not running a program anymore, the hardware PWM is still working with the given parameters thus not needing any resources.

I²C / TWI – Two wire interface

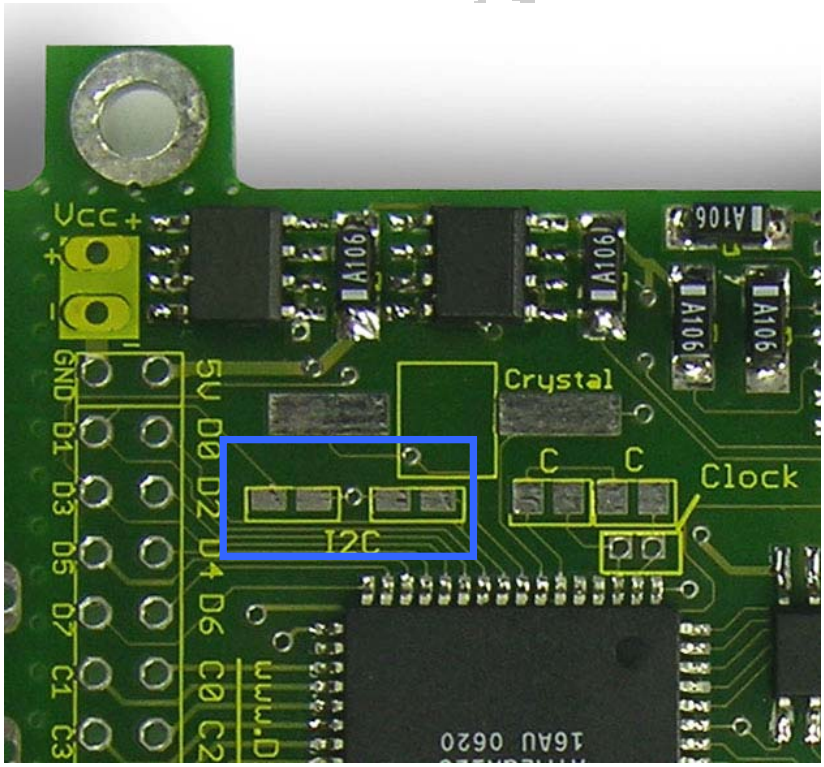
The ATMega offers a TWI, which means two wire interface. A well known TWI is I²C, (pronounced: I square C) which is compatible to the ATMega (or better: the ATMega is compatible to I²C).

This interface is called two wire interface as this bus only needs two wires for a bidirectional communication (plus GND and VCC). It is a seriell synchronous two wire bus, one wire with the clock signal, the other with the data signal.

What is it for? In many modern electronic systems, a lot of different devices need to communicate with each other. If you do not want to have lots of cables running back and forth, a bus system allows to have all devices connected with each other through a bus thus allowing them to talk to each other to be controlled by a master system

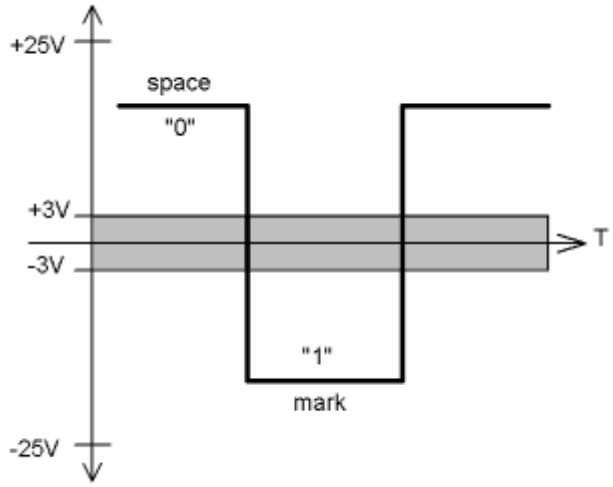
A big advantage of the I²C-Bus is the easy usage: No fixed clock rates are needed thus small and fast deviced can be connected to the same bus, all running different chips and run by different programming languages. That should be enough for a short explanation. The internet offers tons of information on I²C.

Our module D062X offers the direct connection to a I²C-bus on Ports D0 and D1. A I²C-bus always need pull up resistors at one device to draw the voltage to a defined level. If the D062X shall work as the master system on the bus and if there are no other pullup resistors set up on the bus, these may be soldered to the board. We are offering two places for these needed I²C pullup resistors. The following photo are showing the two places, where each a 10 KOhm-resistor (size 805) should become soldered to. Beside some software, there is nothing else needed for I²C.



RS232
RS-232 is a serial communication protocol. It sends information as bit after bit and has two signal levels:

- a voltage between -3 and -25 Volts is a logic one (1)
- a voltage between +3 and +25 Volts is a logic zero (0)



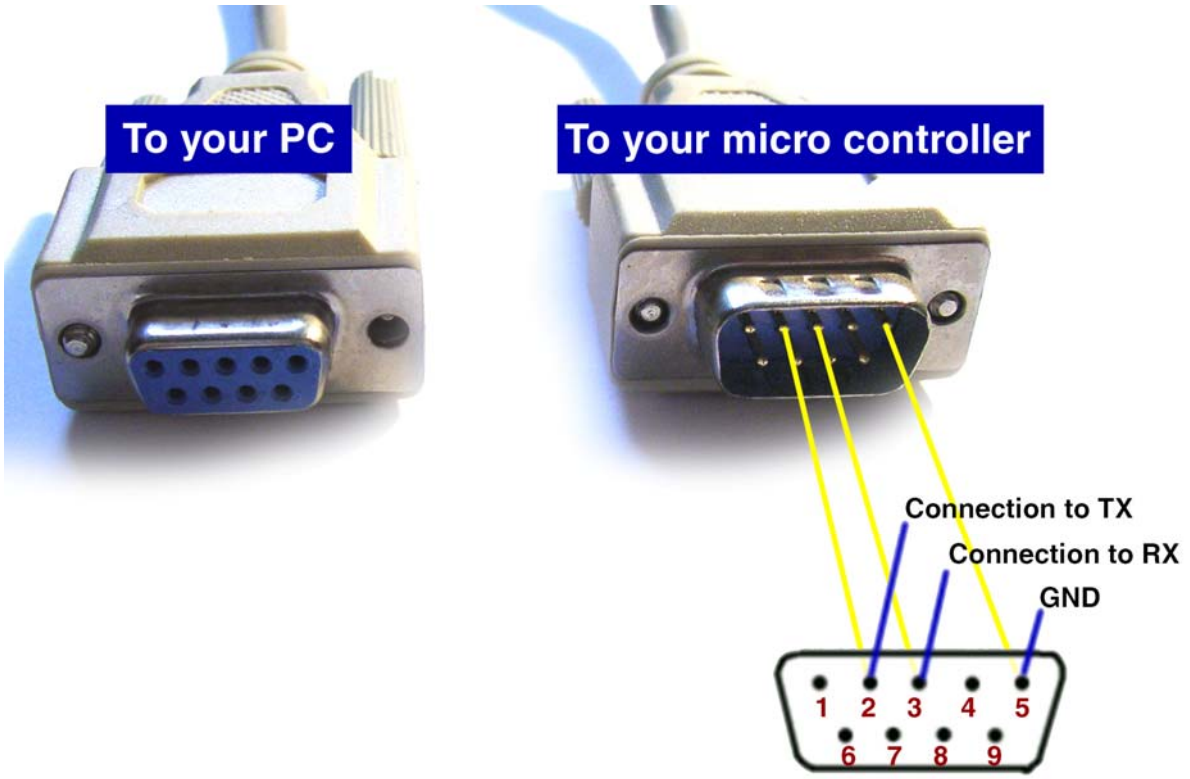
As the picture above shows, the voltage level between -3 and +3 Volts is undefined. In practice this is not so. Most often, any voltage level above 2.5 Volts is seen as a logic zero, anything below as a logic one.
The electrical specification of RS-232 is quite robust, all outputs must be able to sustain a full short-circuit and all inputs must have a schmitt-trigger action. This makes a full-standard RS232 port on a PC much less vulnerable than a TTL-level parallel port.
RS-232 is an a-synchronous protocol, meaning that no separate clock is transmitted with the data. Both sides must know the communication speed (we use the term baud-rate) beforehand.

RS-232 usually defines a complete hardware handshaking system using several wiring pins. We use only the most important three:

- RxD : receive data, pin number 2
- TxD : transmit data, pin number 3
- Ground, pin number 5

These pin numbers refer to a standard male DB9 connecter on your PC or laptop.

If you want to build a cable to connect our board to your PC you need a regular serial cable with one male and one female DB9-connector. The female will be connected to your PC, the male needs to become connected to you board. The following picture will help you to build a adapter and to connect the cable to your board.



Pin 2 is the receive channel of the PC – but for this you need to connect this channel to the transmit channel (TX) of the micro controller. Also at Pin 3 the data of the PC are transmitted to our board and therefore you need to connect Pin 3 with the receive channel (RX) of the board.

The ATMega 128 offers two separate RS232 interfaces, we are only using interface 1 (the other one is interface 0 – see ATMega128 data sheet for this). At the ports D2 and D3 the used RS232 interface 1 of the ATmega is located. These two ports (D.2 and D.3) are connected to the RS232 interface chip at the board and this chip is connected to the Rx and Tx Pad. The chip decouples the high voltage RS232 signals from your PC. If you would connect the PC directly with the ATMega, the micro controller would become destroyed.

Caution:
The Rx and Tx pads are located beneath the pads for Port F. The Tx and Rx lines may show a voltage of much more than 5 Volt. If you accidentally connect these lines to any other pad of the board, you may damage the whole micro controller and/or the display – at least some ports will be destroyed after that. So be careful that you never use the Tx and Rx line for anything else than connecting a RS232 cable.

If you want to use the RS232 interface, the following example might be helpful for you. Using the interface is also helpful during debugging of your code, as you just "print" variable values to the interface and check at the terminal program of your connected PC if the variables contain what you expect. At MS Windows ® you may use either the Hyperterminal® which comes with MS Windows® or with Bascom® you may use the internal monitor for this. You may use the following program to test the output of your module and the terminal program of your PC.

```
'sample program RS232 output
$regfile = "m128def.dat"
$crystal = 8000000
$baud1 = 9600

Open "COM2:" For Binary As #1
Do
  Print #1 , "Hello world"
  Wait 1
Loop
Close #1
End
```

RS232 and the crystal / Overclocking the board

If you are planning of sending a lot of information through the RS232 interface you need to know, that the frequency for the selected baud rate is calculated by the micro controller using the current clock rate. Two facts are important to know:

a) The internal resonator is not very accurate and varies with different temperatures etc. So if the board runs with internal 8 MHz, using of the RS232 interface may result in transmission problems. You better use an external crystal then.

b) Using the usual 16 MHz crystal as the external clock will result in a wrong frequency of the RS232 interface – varying by the selected baud rate. You better use a crystal of 14.7456 MHz or 18.432 MHz instead, as they will result in 100% correct frequency. At 14.7456 the micro controller is a bit slower, with 18.432 you are overclocking the micro controller. Usually this will not result in problems as the ATMega128 can easily run at a even higher clock rate. The internal EEprom is the area which will first show errors during overclocking – you will not be able to read or write correctly to it. If you do not need the Eeprom you may run the board even at 20 MHz.

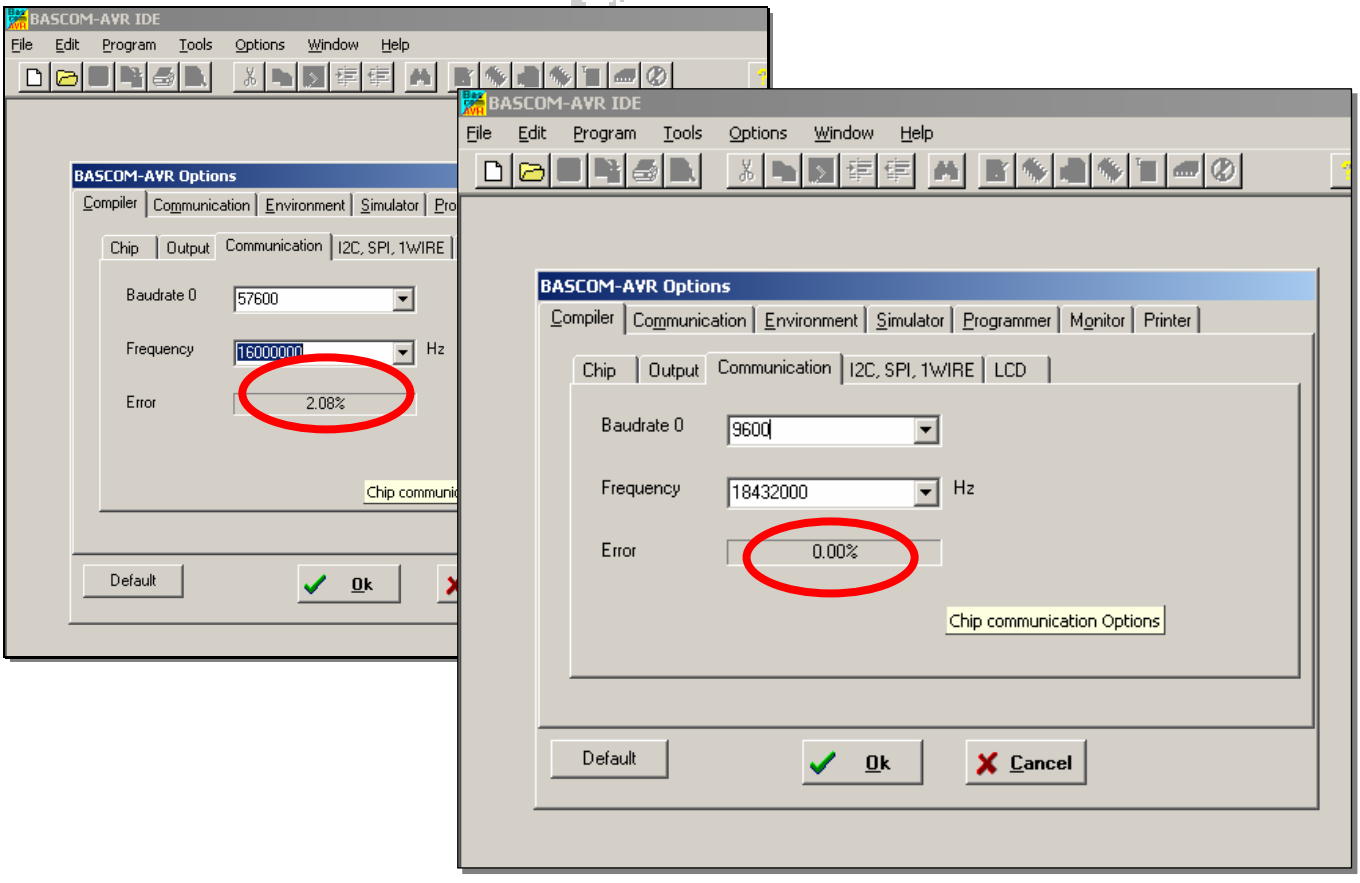
c) You need to tell the compiler, what clock frequency you are providing – otherwise the wrong calculation is done and the transmission will not work. In Bascom® you do this with the command **`$crystal = 8000000`** at the beginning (8000000 for 8 MHz; 16000000 for 16 MHz, 14745600 for 14.7456 MHz etc.).

You always need to enter the exact speed of your crystal – do not enter any different value, as this will cause in a wrong timing.

The following table shows you the error rate splitted on baud rate and clock rate of the controller. As black number means OK, a red number might result in a higher error rate during transmission.

	Clock rate of the mikrocontroller in MHz										
Baud	**1,00**	**2,00**	**4,00**	**7,373**	**8,00**	**11,059**	**14,318**	**14,746**	**16,00**	**18,432**	**20,00**
2400	0,2%	0,2%	0,2%	0,0%	0,2%	0,0%	0,0%	0,0%	-0,1%	0,0%	0,0%
4800	0,2%	0,2%	0,2%	0,0%	0,2%	0,0%	0,2%	0,0%	0,2%	0,0%	0,2%
9600	-7,0%	0,2%	0,2%	0,0%	0,2%	0,0%	0,2%	0,0%	0,2%	0,0%	0,2%
14400	8,5%	-3,5%	2,1%	0,0%	-0,8%	0,0%	0,2%	0,0%	0,6%	0,0%	-0,2%
19200	8,5%	-7,0%	0,2%	0,0%	0,2%	0,0%	-0,8%	0,0%	0,2%	0,0%	0,2%
28800	8,5%	8,5%	-3,5%	0,0%	2,1%	0,0%	0,2%	0,0%	-0,8%	0,0%	0,9%
38400	-18,6%	8,5%	-7,0%	0,0%	0,2%	0,0%	1,3%	0,0%	0,2%	0,0%	-1,4%
57600	8,5%	8,5%	8,5%	0,0%	-3,5%	0,0%	-2,9%	0,0%	2,1%	0,0%	-1,4%
76800	-18,6%	-18,6%	8,5%	0,0%	-7,0%	0,0%	-2,9%	0,0%	0,2%	0,0%	1,7%
115200	-45,7%	8,5%	8,5%	0,0%	8,5%	0,0%	-2,9%	0,0%	-3,5%	0,0%	-1,4%
230400	-72,9%	-45,7%	8,5%	0,0%	8,5%	0,0%	-2,9%	0,0%	8,5%	0,0%	8,5%
250000	-75,0%	-50,0%	0,0%	-7,8%	0,0%	-7,8%	-10,5%	-7,8%	0,0%	-7,8%	0,0%

At Bascom®, there is a calculator included, which baudrate is possible with the selected frequence. You will find this at the menu **Options / Compiler / Communications**. This will help you to check if you get an error free transmission with your crystal.



Hints for selecting the correct crystal:

Any timing is always ascertained by dividing the main clock frequency. As the internal 8 Mhz clock generator of the microcontroller is not ver accurate (just a RC-combination) you **always** should use an external crystal if you want to use RS232 or if you need an exact timing for a clock etc.

Otherwise the selection of the speed of the crystal is only dependent of the needed speed of you program or if the divergence of the error rate from the ideal # is acceptable when you use RS232.

RS232 / RS485 / CAN-Bus:
14.7456 MHz or 18.432 MHz will result 0,00% error rate and are the ideal selecting then. Unfortunately these crystals are sometimes hard to get. If you read this before you plan to buy such a module you might consider to order the board including such a crystal. This is not expensive and we then already preprogrammed the microcontroller fuses to the selected speed.

Using a 16 MHz crystal will result in a 0.16% error rate which is still OK if you plan to use 9600 baud (see preceding page) – anything below 0.5% is usually acceptable.

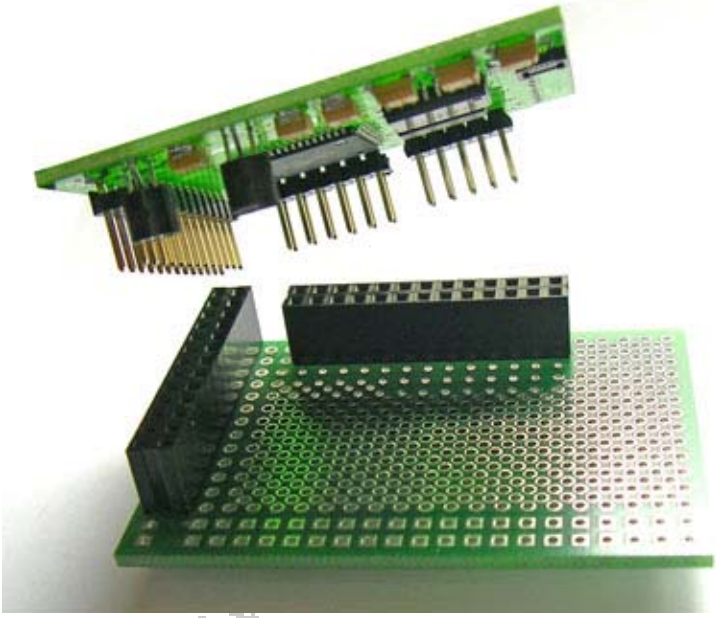
Timing:
An even crystal (e.g. 16 Mhz) does has another advantage: as all timings are being created by dividing, even crystals are always exact. An uneven crystal like a 14.7456 Mhz will result in minimal division variation. A clock for example will always have a slight inaccuracy then. Here you need to weigh the pros and cons. Hint: if you want to use the buildt in real time clock (RTC) of the controller, you might also consider add an extra clock crystal to the module (can also be ordered including soldered clock crystal) – then the clock is independent of the main crystal.

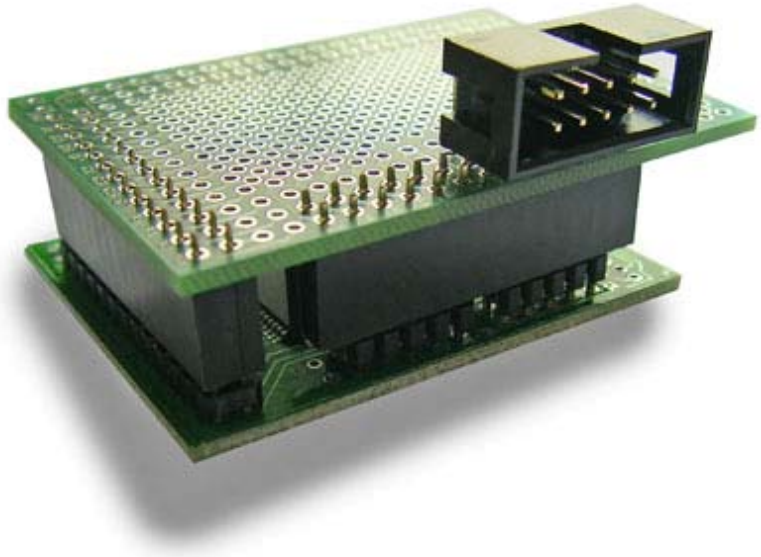
Needed power:
Another aspect which should be mentioned: The higher the clock frequency, the higher is the needed current of the module.

Using additional hardware
There are two additional hardware items available for the board D062X and D062X:

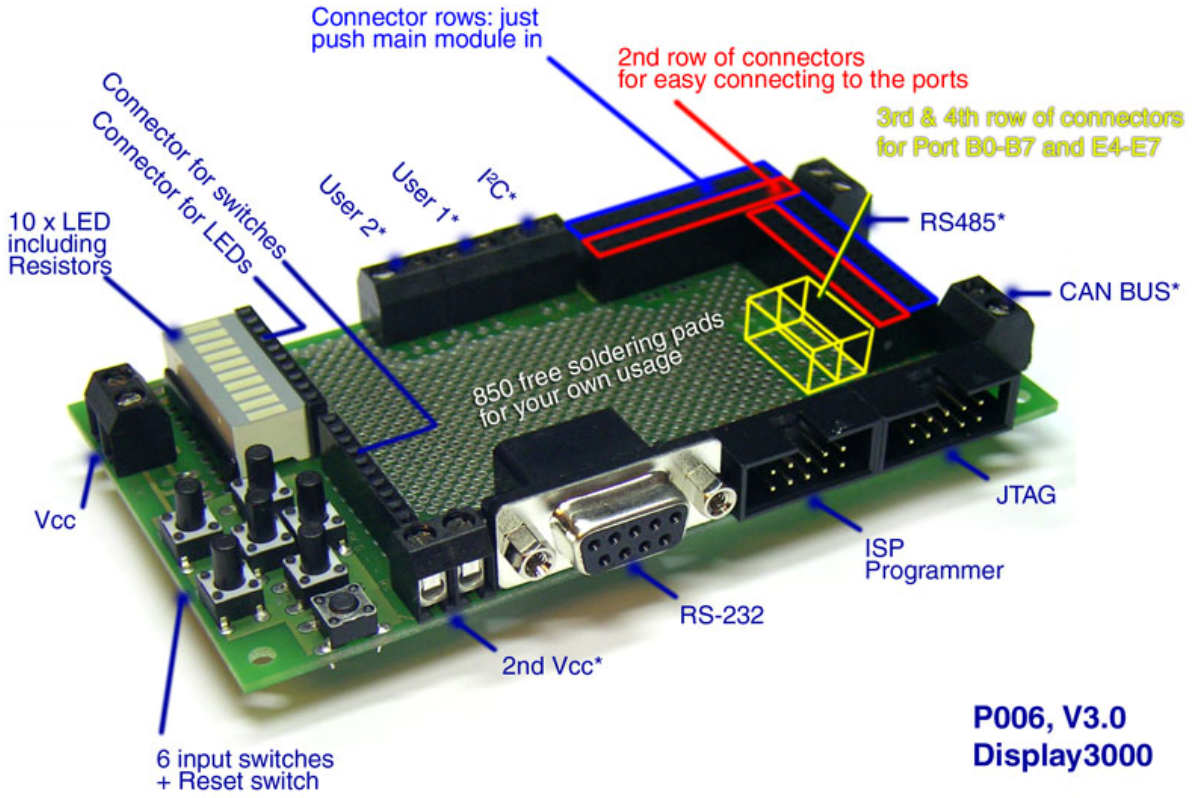
First there is the **mini-development PCB #P005:**

This double sided PCB has a size of just 60 x 51mm and fits behind the display module. Due to the connectors which come with it you may easily mount the display module D062X to it. By using this development PCB you can easily enhance our board by some devices your application needs (like relais, transistors etc.). You may also add a standard ISP connector by just soldering it to the prepared space.





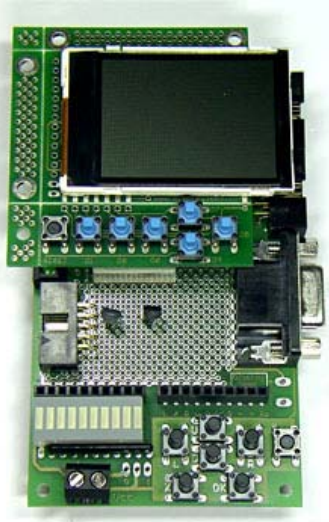
Then there is the **larger development PCB P006** which contains also 5 switches plus reset switch, a standard RS232 connector, a power input plus space for a larger voltage regulator and lots of soldering pads which allows you to set up any application you want.



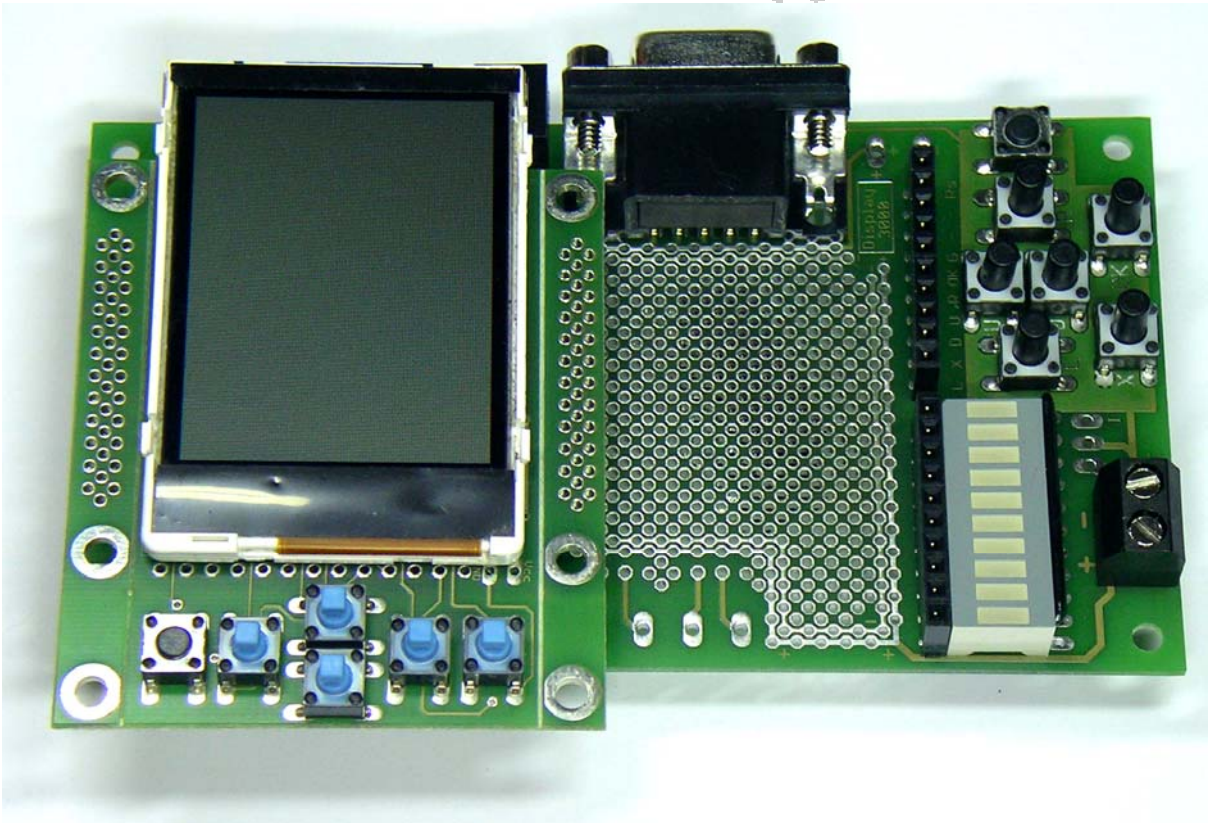
Here also, just push the D062X module to the connectors and you are able to use RS232, ISP adapter, switches, LEDs, etc. Of course you may use this PCB not only for development but also for a final application. Remark: the following pictures are showing the large brother of this D062x module – the D072 (older edition) with 2.1" display.

1. Place your devices

2. Add the needed wires
either at top and/or bottom side of the PCB



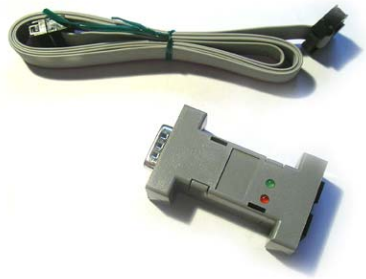
3. Push main modul into place
Changes to schematics? Just pull out the main module - it stays like new



And this it how it looks if a module is pushed to the development board P006.

Option: ISP Programming interface

An ISP programming interface is needed to transmit the compiled program from your PC to the module. We are offering three different ISP variants:

Parallel port (printer – Centronics)	**Serial programmer for RS232**	**USB-Interface (consists of USB-RS232 adapter together with our serial programmer**
		

The most flexible (and least expensive) programmer is the parallel programmer. Unfortunately this interface is not build into newer computers anymore. Then you should consider of purchasing a serial or USB programmer.

The removal of the mounting frame

The mounting pads has been prepared by perforating them and can easily be removed by just breaking it off with a plier. Remove the display before you do this to avoid any damage to it.

The above photo shows you two alternatives: left: as you get it delivered, middle: without mounting pads, right: no mounting pods and removed switch area (Remark: all photos showing D072 instead D062x)

Hint for a cleaner and smoother removal: Before removing the pads or the switch area: use a sharp knife to carve the surface of the PCB once - just follow the perforation.

Switch area:
The same applies to the switch area. If you do not need them, just break it away. Before you do this you should use a knife to cut the 8 wires of the switches at the perforation area – or even better: Cut the PCB from both sides with a knife once as explained in the paragraph above.

The current need of the module

The display lighting of course needs power to be able to produce light. The total current needed is depending on several factors:

a) **Speed** of the ATMega Controllers (the faster the higher the current need)

b) **Display lighting:** The display lighting of course also needs power to be able to work. The lighting at our module is being driven with 16 Volt. We produce this by a 2 x voltage doubling. Well, there is no perpetuum mobile – so the needed current will raise by the doubling. With a less bright lighting, the needed current decreases.

The follwing table shows some variable parameters with its consequences to the current need:

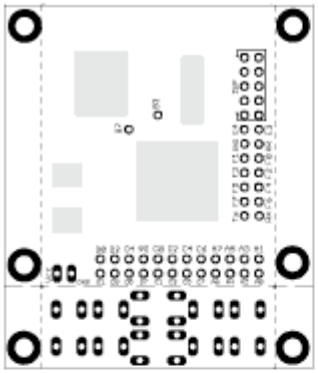
Current need for complete module (Controller 100% active, no idle-mode etc.)

Clock rate	**Display lighting 0% (off)**	**Display lighting 50%**	**Display lighting 100%**
8 Mhz	19 mA	41 mA	58 mA
16 Mhz	28 mA	50 mA	65 mA

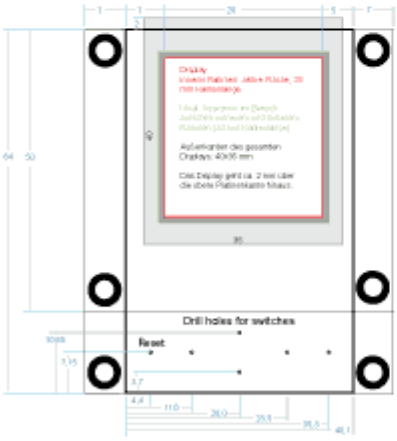
Drawing and pads

At the CD there is a separate PDF file with the following drawing showing this in 1:1 measuerment. This following graphics does not have 100% correct size.

Pads from bottom view / Bauteilseite



Top view / Displayseite



Height of display: 3mm

Total height of module incl. display, without switches:
8 mm (without crystal)
10 mm (with crystal)

Make sure you print this PDF 1:1 - deselect automatic resizing in printing options

Bitte diese PDF 1:1 drucken. Die automatische Größenanpassung in den Druckoptionen muss abgeschaltet sein.

D062x Drawing 1:1	
Measurement: mm	
by: Display3000	Rev. 1
Date: 28.11.2006	Sheet: 1/1

Technical data of display module kit:

Item D062X:

Size:

With frame and switch area:	ca. 54 x 64 mm
With frame, without switch area:	ca. 54 x 50 mm
Without frame, with switch area:	ca. 41 x 64 mm
Without frame, without switch area:	ca. 41 x 50 mm
Height:	ca. 8 mm inkl. Display

Voltage: 4.5 to 20 Volt DC

Controller (depending on ordered item):

	Programm memory	**RAM**	**Eeprom**	**Clock rate**
ATMega 128	128 KByte	4 KByte	4 KByte	Max. 16 Mhz
ATMega 2561	256 KByte	8 Kyte	4 KByte	Max. 16 Mhz
AT90CAN128	128 KByte	4 KByte	4 KByte	Max. 16 Mhz

Display: 132x132 Pixel, 65.536 colors
Active diagonal size: 1,5“ (38mm)

We did reprogram the processor – it is not using the standard like ATMEL is delivering the processor. This is what we changed:
Fusebit A987: Speed: 8 MHz internally**.** If you ordered an external crystal we already prepared the internal fuse to the correct speed (then usually 1111: external crystal, high speed)
Fusebit G: Preserve EEPROM when chip erase
Fusebit P: ATMega 128 Mode (at a ATMega128)
With ATMega2561 and AT90CAN128 we also set the internal clock division to 1 (no division).

We programmed EEprom and flash for testing purposes (item is delivered incl. installed testing program). If you need JTAG access to your microcontroller you should keep it enabled. If you do not need JTAG you may change the **Fusebit F to JTAG disabled**: the ports F4, F5, F6, F7 are then available for other usage.

Manufacturer:

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Further information and updates: www.display3000.com

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