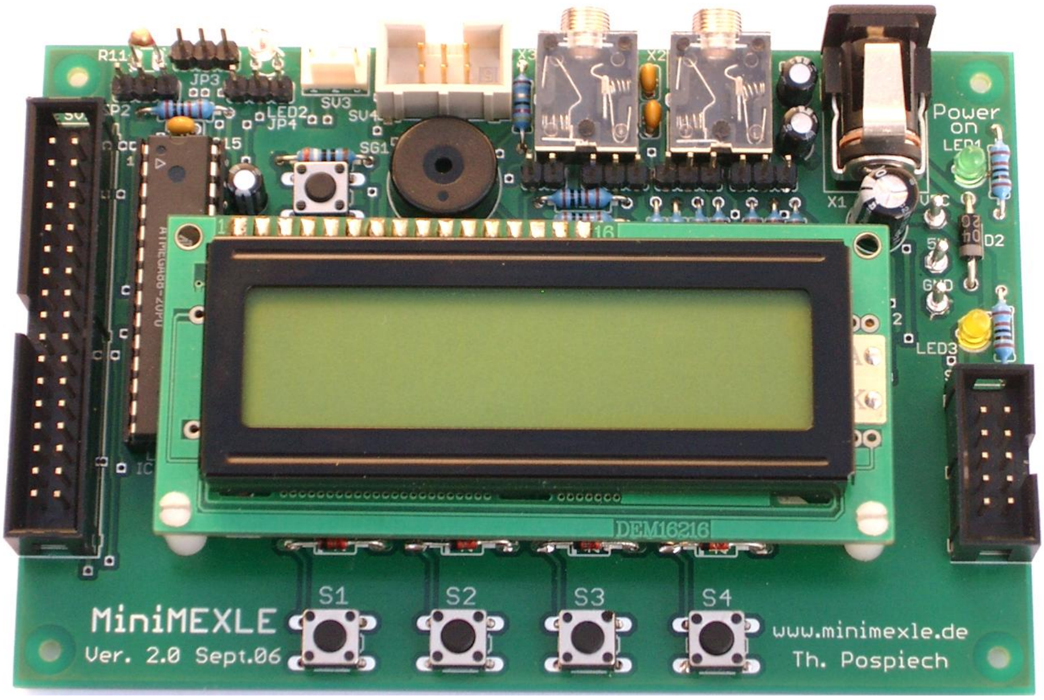
Manual
MiniMEXLE



This manual is supposed to be used as support while equipping and during the initiation of the MiniMEXLE. The single operation steps are shown in this case and special features are pointed out near corresponding places to them.
In addition a component list and a corresponding population print (as a picture) are enclosed in this instruction, so that it might come neither near the components, still during the population of the board to problems.

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Security and usage hints:

The following security and usage hints are important for working with the MiniMEXLE:

- No guarantees are given if the MiniMEXLE is assembled in a different way than the one provided within this instruction.
- The MiniMEXLE and the AVR-USB-PROGI are exclusively designed for teaching, learning and experimenting.
- Connecting external hardware or machines is at your own risk.
- The MiniMEXLE and the AVR-USB-PROGI must not be used without supervision. These devices have to be switched off when leaving alone.
- Only direct current up to 12V is allowed.
- No guarantee is given for eventual data loss while connecting the MiniMEXLE / AVR-USB-PROGI to a PC or laptop.
- The connection of blasting agent (or similar) onto the MiniMEXLE / AVR-USB-PROGI is strictly forbidden.

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In the case of questions, suggestions and money donations please write to:
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1 Introduction and Overview

This kit offers a cost-effective solution for a microcontroller board that is designed for the experimental, teaching and/or learning use. The fields of the electronics, the computer science and the physics can be united to the mechatronics by the numerous external interfaces.

The construction of this kit is through the use of only "wired" components relatively simple. In addition this detailed documentation and a population print (Component positions on the circuit board) offers a clear and structured procedure during the construction, during the initiation and while working later with the MiniMEXLE.

The heart of the MiniMEXLE is a 8-bit AVR-microcontroller of the company Atmel (ATmega88). The programming occurs via the AVR-USB-PROGI and a free USB port atf the PC or laptop. To mention at this place is that the microcontroller does not have to be removed from the MiniMEXLE for the programming rather the possibility withstands to program it directly (**I**n-**S**ystem-**P**rogramming)!

1.1 Features of MiniMEXLE

The development board MiniMEXLE has among other things subsequently listed properties and/or connection options:

1. ATmega88 (microcontroller 8-bit, data sheet under http://www.atmel.com available).
2. ISP-interface (In-System-Programming).
3. Voltage measurement with two independent channels (10 bit resolution).
4. Two independent PWM outputs (with activatable low-pass filter of 1st order).
5. Measurement of light intensity using a LED.
6. Temperature measurement using a NTC.
7. Sound output with integrated Buzzer.
8. Visualization with a 2x16 character display.
9. Possibility of data entry using four function keys.
10. Separate communications interface (based on USART).
11. Measurement of the board: 112 x 75 mm.
12. Circuit board in a double-sided way throughplated with population print.

The following picture shows the MiniMEXLE with a selection of the mentioned properties.

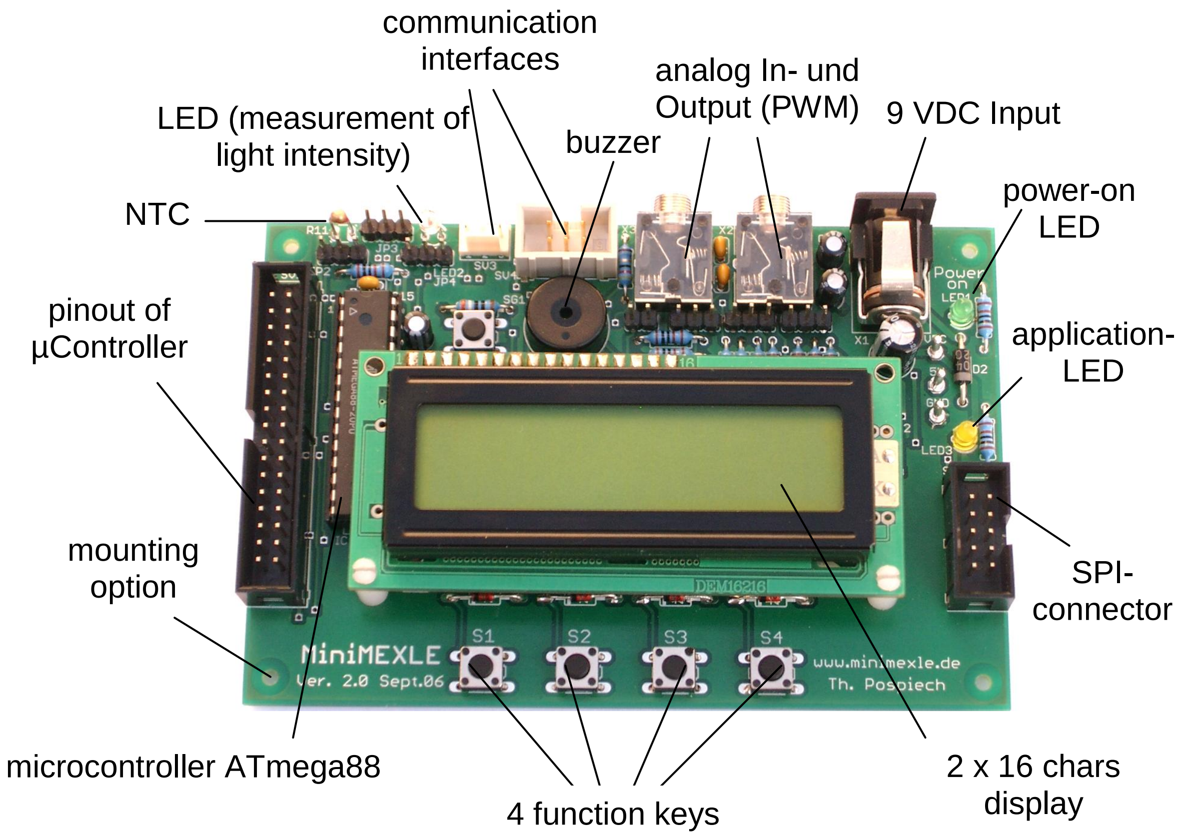

Figure 1: MiniMEXLE with a selection of the mentioned properties

This manual will now pay attention to the construction of the MiniMEXLE.

1.2 Circuit diagram of MiniMEXLE

The following figure shows the circuit diagram of MiniMEXLE.

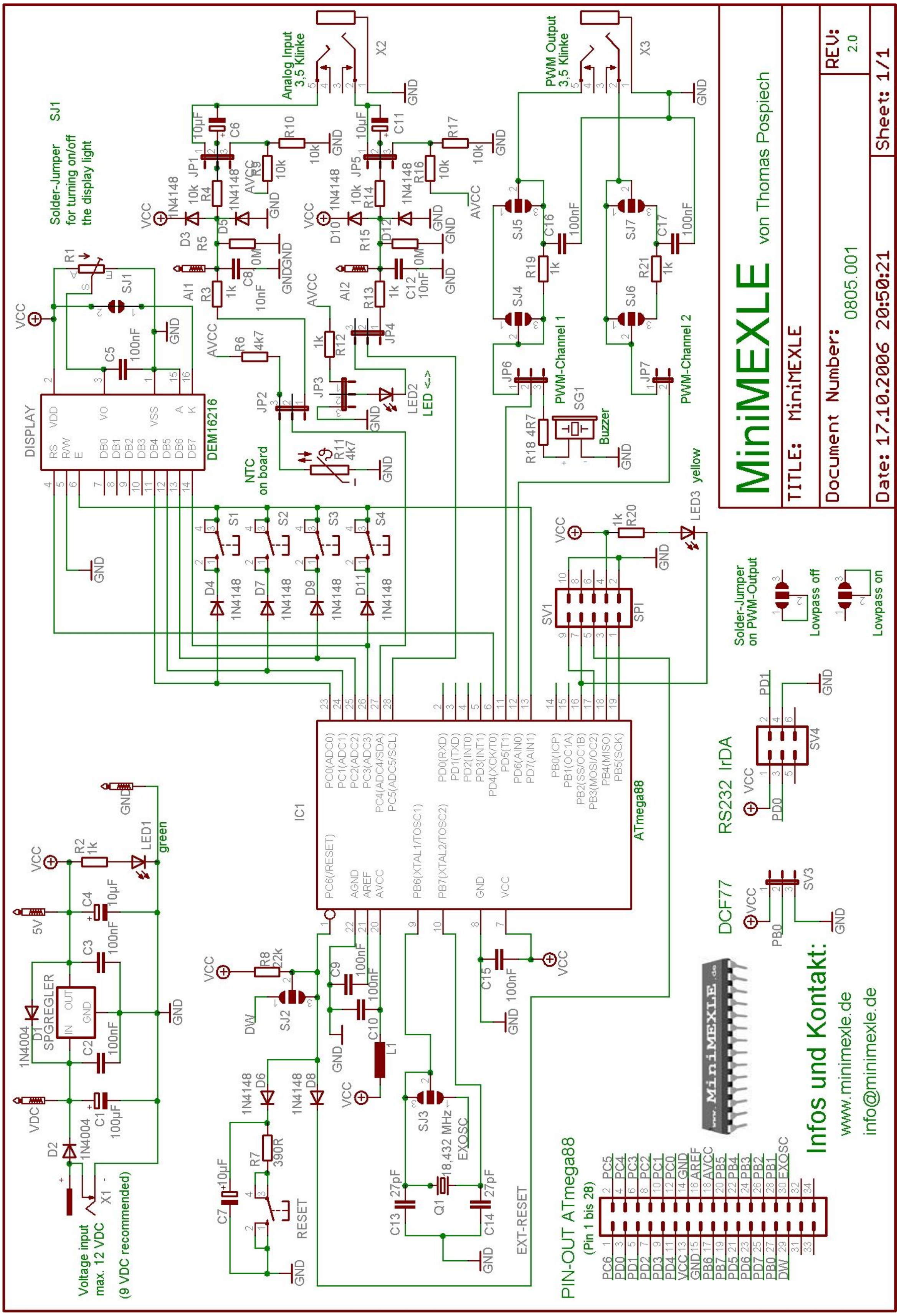

Figure 2: Circuit diagram of MiniMEXLE

In this circuit diagram all electronic and electron-mechanical components with their corresponding values can be seen (except for external plug connectors).

1.3 Component list of MiniMEXLE

In this subsection the complete component list of the MiniMEXLE is expressed in tabular form.

Pos.	Component	Value	Denomination	#
1	R1	0-2,5 kΩ	Potentiometer	1
2	R2, R3, R12, R13, R19, R20, R21	1 kΩ	Resistance	7
3	R4, R9, R10, R14, R16, R17	10 kΩ	Resistance	6
4	R5, R15	10 MΩ	Resistance	2
5	R6	4,7 kΩ	Resistance	1
6	R7	390 Ω	Resistance	1
7	R8	22 kΩ	Resistance	1
8	R11	4,7 kΩ	NTC	1
9	R18	4,7 Ω	Resistance	1
10	C1	100 µF	Elko	1
11	C2, C3, C5, C9, C10, C15 C16, C17	100 nF	Capacitor	8
12	C4, C6, C7, C11	10 µF	Elko (Submini 4mm ∅)	4
13	C 8, C12	10 nF	Capacitor	2
14	C13, C14	27 pF	Capacitor	2
15	D1, D2	1N4004	Diode	2
16	D3,D4,D5,D6,D7,D8,D9,D10,D11,D12	1N4148	Diode	10
17	JP1-JP7	Pins	Pin connector 36	1
18	Display	DEM16216	Display 2x16 chars	1
19	VDC, 5 V, GND, AI1, AI2	Solder nails	Solder nails 1,3 mm	5
20	LED 1	3 mm green	LED	1
21	LED 2	3 mm white	LED	1
22	LED 3	3 mm yellow	LED	1
23	Q1	18,432 MHz	Quartz	1
24	L1	100 µH	Inductance	1
25	RESET, S1, S2, S3, S4	Switch	Short shift pushbutton	5
26	SG1	Buzzer	Piezzo-Buzzer	1
27	SpgRegler	7805	Voltage regulator 5 V	1
28	SV1	10 pole	10 pole tank plug	1
29	SV2	34 pole	34 pole tank plug	1
30	SV3	3 pole	Plug connector	1
31	SV4	6 pole	6 pole tank plug	1
32	X1	DC-Conn	DC-socket	1
33	X2, X3	Audio	3,5 mm jack plug	2
35	IC1	ATMega88	µController	1
36	-	IC-Mount	28 pole IC-socket	1
37	-	-	16 pole connector strip	1
38	-	-	Jumpers	7
39	-	-	Spacer 9,5 mm	2
40	-	-	Bumpers ∅ 3,2 mm	4
41	-	-	Cyl. head bolt M3x4	1
42		-	3,5 mm jack plugs	2
43	-	-	nut DIN439 M3	1
44	-	ca. 0,1 m	Ribbon cable 6 pole	1
45	-	-	Post plug 6 pole	1
46	-	-	Stress relief	1
47	-	board	board MiniMEXLE	1

The indicated component denominations agree with the circuit diagram and the assembly print of the board.

Important:
The work begins with the control of the kit with help of this component list!

The two following figures show both edges of the board. With the aid of these one can be provided with a further overview and do thoughts thus corresponding before the actual equipping of the board.

The figure to be seen here shows the component side of the board (Top-edge).

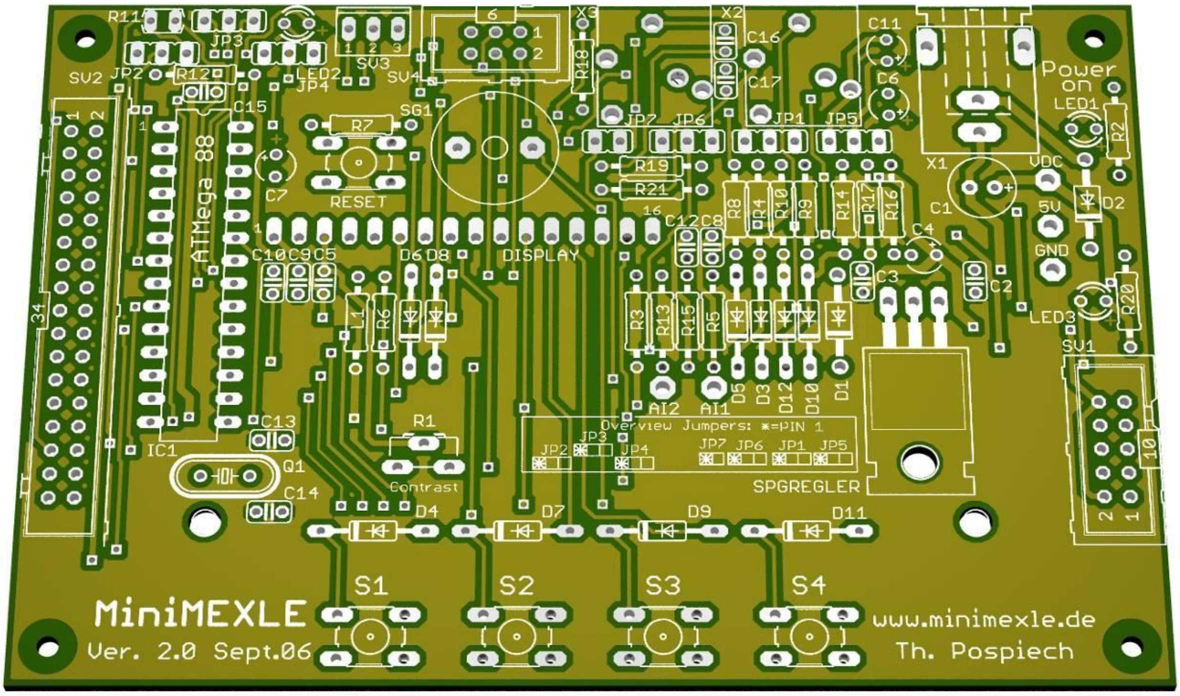

Figure 3: Component side of the MiniMEXLE board (with labels)

The following figure shows the underside of the board (bottom-edge).

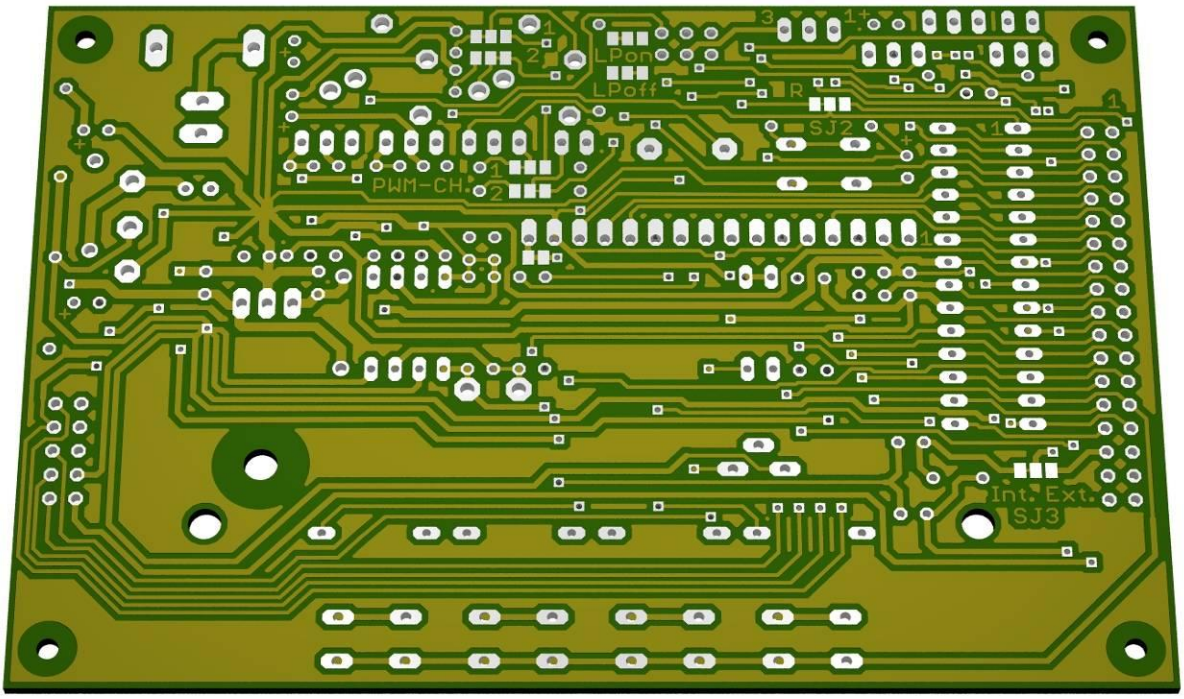

Figure 4: Underside of the MiniMEXLE board

At this place it has to be said that the figures above are not to scale.

1.4 Necessary tools

Following tools are needed and/or recommended for the structure of the MiniMEXLE:

- Soldering iron
- Lead-tin solder (and possible desoldering-cord)
- Multimeter (with continuity tester)
- Side cutting pliers
- Pair of pliers
- Bend help for resistances
- Magnifier
- Slotted-head screw turner (small)

The following chapter now describes the procedure of the equipping.

2 Equipping of the board

In this chapter the procedure is described during the equipping of the board as well as shown the single jobs.

2.1 Arrangement of the single working phases

While equipping, it is important to start with the components that have the least overall height and then always the nearest higher ones as next.

For this reason the equipping is divided into the following working phases:

1. Diodes of the TYPE 4148 (D3, D4, D5, D6, D7, D8, D9, D10, D11 and D12 → in total 10)
2. All resistances
3. Diodes of the TYPE 4004 (D1 and D2)
4. Inductance (L1)
5. Multilayer capacitors (C2, C3, C5, C8, C9, C10, C12, C15 C16 and C17 → in total 10)
6. Quartz (Q1)
7. IC socket (for IC1)
8. Short shift pushbutton switches (5)
9. Disk condensers (C13 and C14)
10. Light-emitting diodes (LED1 and LED3)
11. Voltage regulator (with screw and nut)
12. 3.5 jack plug (X2 and X3)
13. Buzzer (SG1)
14. Potentiometer (R1)
15. Electrolytic capacitors (C4, C6, C7 and C11)
16. Pens (VDC, 5 V, GND, AI1 and AI2)
17. Pin connectors R11 (NTC)
19. Light-emitting diode (LED2)
20. Plug connector (SV3)
21. tank plugs (SV1, SV2 and SV4)
22. Electrolytic capacitor (C1)
23. DC-socket (X1)
24. Display
25. Ribbon cable

In the following subsections guidelines, tips and hints to various working phases and for the soldering of the corresponding components are given now. The order of the chapter arrangement is according to the working phases. Because of some repeating work, not every single phase is shown in detail.

2.2 Diodes TYPE 4148

According to the mentioned order list the diodes of the type 4148 are equipped/soldered first.

The following figure shows a diode and the used grid spacing of the bend help.

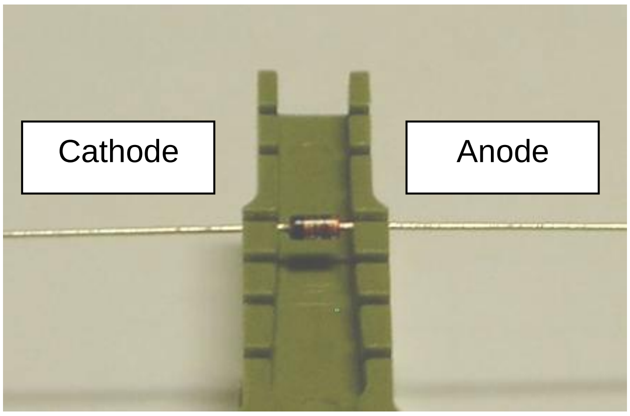

Figure 5: Diode with bend help.

After the diode was bent for the installation, it is necessary to pay attention to the correct polarity.

The layout was developed so the following is valid:

- All vertically built-in diodes (no light-emitting diodes) have the cathode below.
- All horizontally built-in diodes (no light-emitting diodes) have the cathode on the left edge.

The following figures show these circumstances.

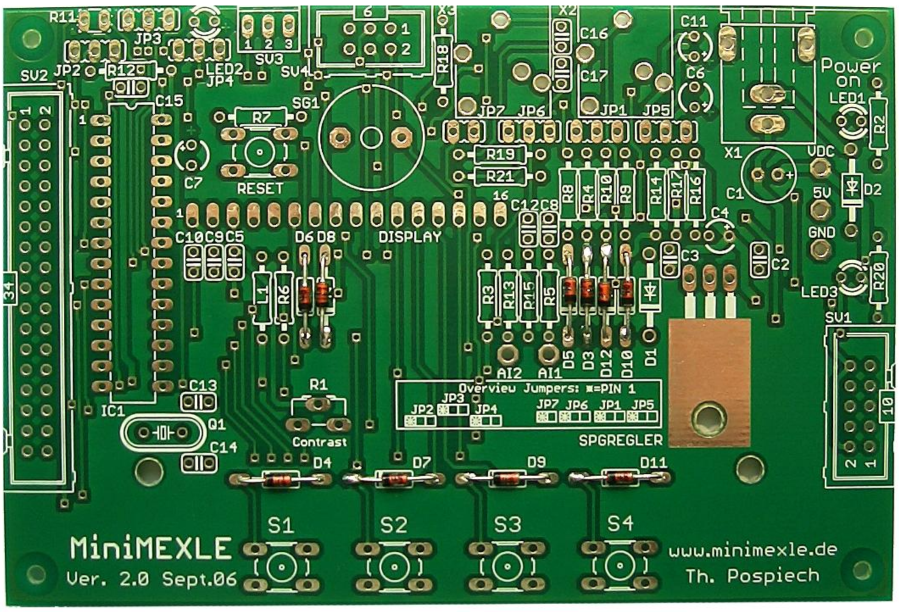

Figure 6: Placement of diodes type 4148 (overview)

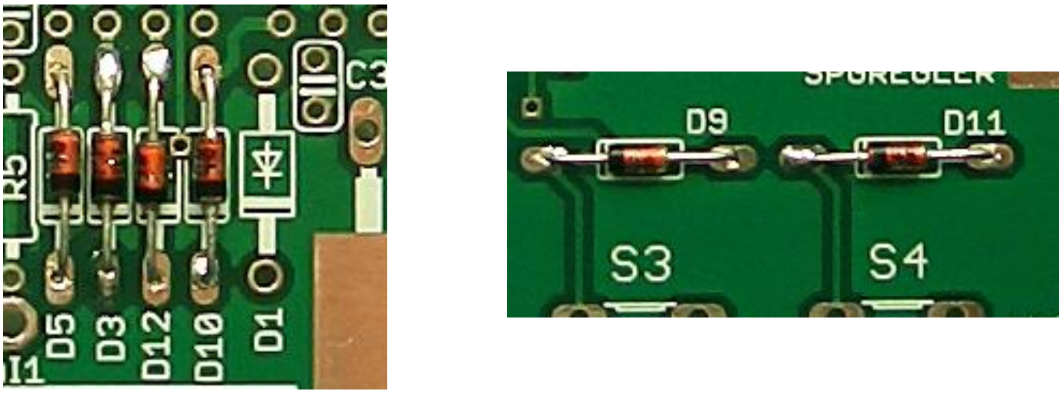

Figure 7: Placement of diodes type 4148 (detail)

2.3 Resistances

In total the MiniMEXLE owns 17 resistances (the potentiometer is not included here). Since the resistance values are not all identical it is recommended to sort the single resistances first of all, according to the table from chapter 1.2 so that mix-ups can be excluded while equipping.
It has to be mentioned at this place, that the appendix includes a color code table for resistances. With this table one can determine the value of the corresponding resistance.

During the installation of the resistances the same grid of the bend help is chosen – like described above at the diodes. The last position of this grid has to be used for the resistances. The following figure shows this.

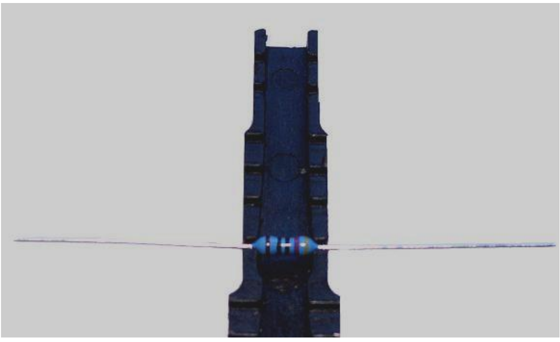

Figure 8: Resistance with bend help.

As might be known, resistances do not have any polarity. Nevertheless the resistances should be soldered according to their color code arrangedly (Order of the color rings). This facilitates the work at a possible necessary fault location. Furthermore the structure of the board seems more arranged.

2.4 Diodes Type 4004

Fundamentally the same rules are valid during the installation of these diodes as in chapter 2.2, only with the difference that the last position of the screen of the bend help must be chosen.

2.5 Inductance

The inductance L1 is to be equated concerning the installation with that of the resistances. Therefore a detailed description is renounced.

2.6 Condensers

In total the MiniMEXLE owns 10 ceramic multilayer capacitors (Disk condensers and electrolytic capacitors are not included here!). Since the condensers are not all identical it recommends to sort first of all the single condensers according to the table from chapter 1.2 so that confusion can be excluded while equipping.

Hint for reading the condenservalues:
On an edge of the condenser body the capacitance is impressed. The interpreting of the capacitances is as follows:
Label 104 → Value 100 nF
Label 103 → Value 10 nF

The actual installation is unproblematic and attention does not have to be paid to any polarity.

2.7 Quartz

The installation of the quartz does not need any further declaration.

2.8 IC-Socket

During the installation of the IC socket attention must be paid to the notch and the corresponding assembly print. The following figure shows the correct mounting position.

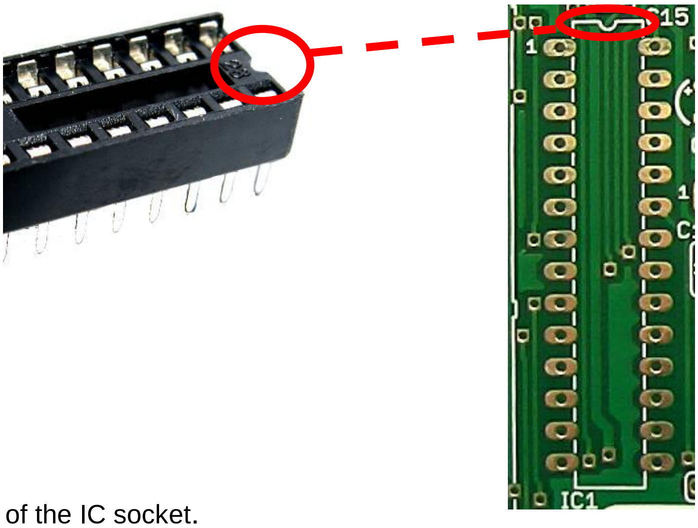

Figure 9: Installation of the IC socket.

2.9 Short shift pushbutton switches

The installation of the five short shift pushbutton switches is unproblematic and protected against polarity reversal through the own structure. Attention should be paid, however, that the buttons sit on the board completely so that no distance exists between the buttons and the board.

2.10 Disk condensers

The two circular disk condensers (C13 and C14) can be installed simply and like the multilayer capacitors, attention does not have to be paid to any polarity.
The disk condensers have the number 27 as a label. That means that the capacitance is 27 pF.

2.11 Light-emitting diodes

The two light-emitting diodes LED1 and LED3 are soldered without distance to the board. During the installation attention is to be paid to the correct polarity.
The anode is on the board labeled by a „+"-character through which the longer pin of the light-emitting diodes, which is the positive pole (anode), should be placed.
The following figure shows the mounting positions of the two light-emitting diodes LED1 and LED3.

Figure 10: Installation of LED1 and LED3.

Also here is valid, like at the other diodes: the cathode connection is on the left edge. The corresponding anode is on the board labeled by a „+"-character and has the longer leg of the diode.

2.12 Voltage regulator

The installation of the voltage regulator is protected against polarity reversal and the actual soldering unproblematic. Nevertheless one must pay attention during the installation of this component to several things and/or keep to the following order of the operation steps:

1. The legs must (for example: with a pair of pliers) be bent so that the two holes (voltage regulator and board) line up.
2. Then the screw has to be placed through the hole and fixed with the attached nut of the voltage regulators.
3. Then the voltage regulator is soldered.

If one would not stick to this line sequence and solder on the legs of the voltage regulator first, it could result in mechanical tensions which then would completely have to be neutralized by the land for soldering. With time this could affect the contact ability of the joints negatively. The built-in voltage regulator is represented in the following figure.

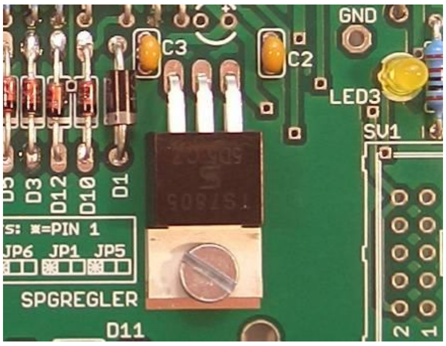

Figure 11: Installed voltage regulator.

2.13 3.5 Jack plugs

The two jack plugs are soldered directly to the provided mounting positions (X2 and X3). It has to be said at this place, that all pins should be soldered on, so that a corresponding mechanical stability can be guaranteed.

2.14 Buzzer

This Buzzer does not have any polarity and the installation can be carried out without greater comments.

2.15 Potentiometer

The potentiometer is protected against polarity reversal because of the arrangement of the three connection. Also here a further description of the building is renounced.

2.16 Electrolytic capacitors

During the installation of the electrolytic capacitors attention must be paid to the polarity. A corresponding marking for the positive pole is on the board available with a „+“-character. One recognizes the polarity of the electrolytic capacitor by means of two distinguishing features:

1. Label at the electrolytic capacitor (Marking of the negative pole)
2. The longer connection leg is the positive pole of the electrolytic capacitor

2.17 Solder nails

The five single pens (test points) can be soldered directly at the respective mounting positions. They serve for the later measurement of tensions and/or signals. Finally there are not any further remarks.

2.18 Pin connectors

Before the single pin connectors for the jumpers and the display can be soldered, the 36 pole pin connector has to be divided. The division of the 36 pole pin connector turns out as follows and is to be carried out on the best with some side cutting pliers:

- 1 x 2 pins
  → JP7

- 6 x 3 pins
  → JP1, JP2, JP3, JP4, JP5, JP6

- 1 x 16 pins
  → Display

The 16 pole pin connector (later fixture of the display) must be shortened in the height before the installation. For this purpose approx. **1 mm** with the side cutting pliers on the longer pin side is pinched like shown in the following figure.

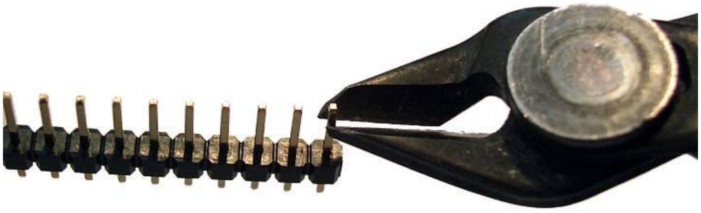

Figure 12: Modification of the 16 pole pin connector

This operation step is neccessary to ensure the correct alignment of the display.

After all 16 pens were shortened the pin connector can be soldered on.
Then the 2 and 3 pole pin connectors can be soldered directly into the board.

2.19 NTC

During the installation of the NTC attention does not have to be paid to any polarity. At this place it has to be said, however, that the NTC, as also the later diode (next subsection) is soldered with distance to the board. The distance can be chosen individually. It is recommended to choose the distance so that the top edge of the casing with the 2 and/or 3 pole pin connectors is at the same height like the NTC. Through that a certain flexibility is available and one is able to turn the NTC for a temperature measurement easy. In the next subsection a corresponding figure is available for the mounting position.

2.20 Light-emitting diode LED2

The light-emitting diode LED2 is soldered (as the NTC) to the board with a distance. The anode is labeled on the board by a „+“-character where the longer pin (positive pole (anode)) of the light-emitting diode should be placed through.
The following figure shows the installation of the light-emitting diode and the NTC.

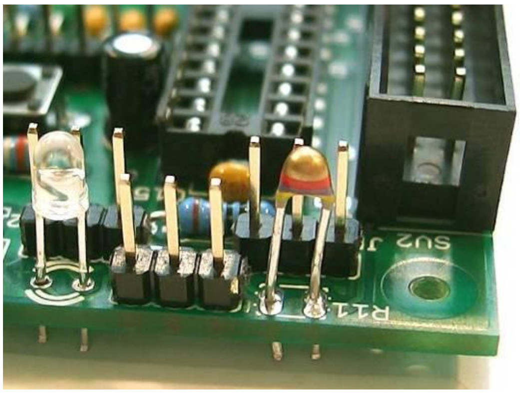

Figure 13: Installation of LED2 and NTC.

Comment:
This figure was made from a readily equipped board! At this place in the manual the different plug connectors are not soldered yet and are described first in the following subsection.

2.21 Plug connectors

All plug connectors are protected against polarity reversal. During the installation of these plug connectors attention is to be paid to the corresponding markings. The following figures show the markings and the correct mounting position of the in total four plug connectors.

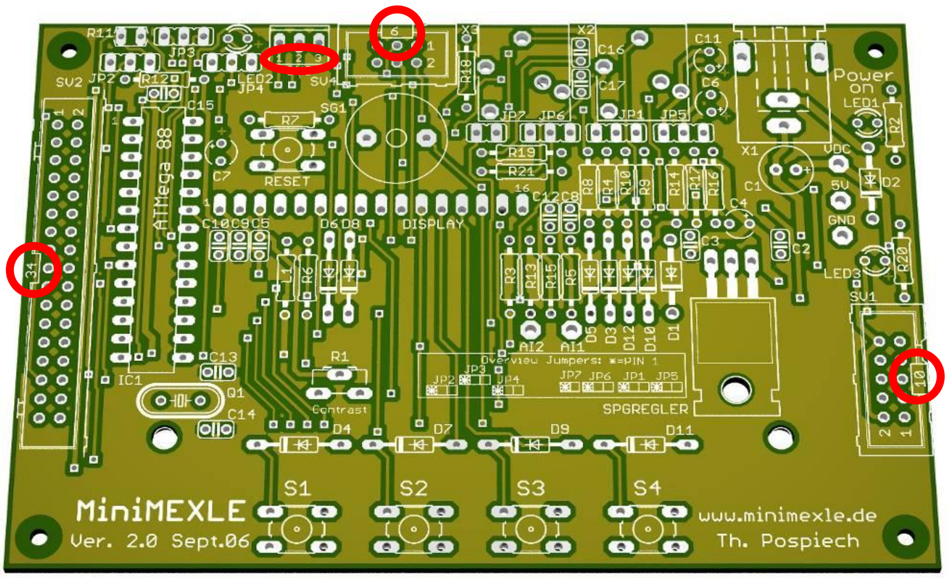

Figure 14: Markings of the correct positions for mounting the plug connectors

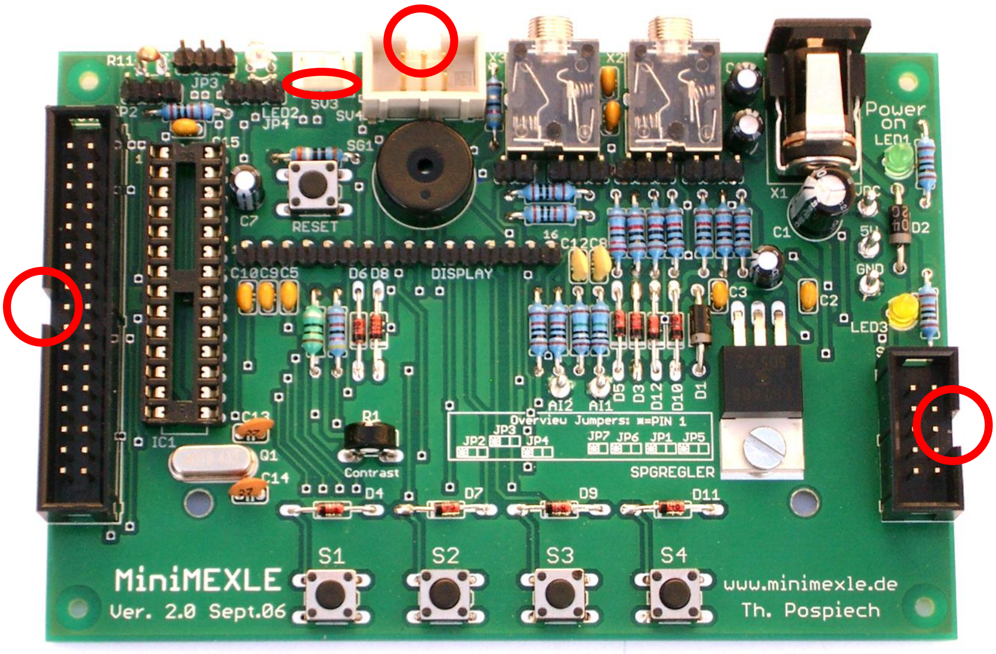

Figure 15: Installed plug connectors.

Otherwise the installation of the plug connectors and/or tank plugs is unproblematic!

2.22 Electrolytic capacitor C1

During the installation of the electrolytic capacitor C1 attention must be paid to the polarity. A corresponding marking for the positive pole is on the board with a „+ -sign available. One recognizes the polarity of the electrolytic capacitor by means of two distinguishing features:

1. Label at the electrolytic capacitor (Marking of the negative pole)
2. The longer connection leg is the positive pole of the electrolytic capacitor

Figure 15 shows the correct mounting position for the electrolytic capacitor C1.

2.23 DC-socket

The DC-socket (Voltage supply entry) is the highest component of the board. It has to be said at this place, that all pin's of the DC socket have to be soldered so that a corresponding mechanical stability can be guaranteed.

Figure 15 shows the correct mounting position for the DC-socket.

Even if all components are wired-in now on the board the processing is not yet very ready. Definitively the arrangement of the display is carried out.

2.24 Display

Before the display is mounted onto the board, something must be adapted before. For this purpose following steps are necessary:

1. Soldering of the 16 pole female connector strip

The 16 pole female connector strip is connected to the lower edge of the display and is soldered from the opposite side (from top of the display). The next figure shows this.

Figure 16: The 16 pole female connector strip at the lower edge of the display

2. Bend the „holders“ of the display casing

So that the display is not abhorrent later onto the electrolytic capacitor C4, as shown in the following figure a holder must be bent a little.

Figure 17: Bending a holder of the display.

3. Installation of the spacers

The two spacers must be clipped into the corresponding holes. The next figure shows the installation of these spacers.

Figure 18: Spacers of the display

Important:
Before the display is put onto the board, this must be checked before. The inspection and/or the startup of the board is declared in the following chapter.

3 Startup

In this chapter the startup of the MiniMEXLE is shown. The initial state for the startup is expressed with the following figure.

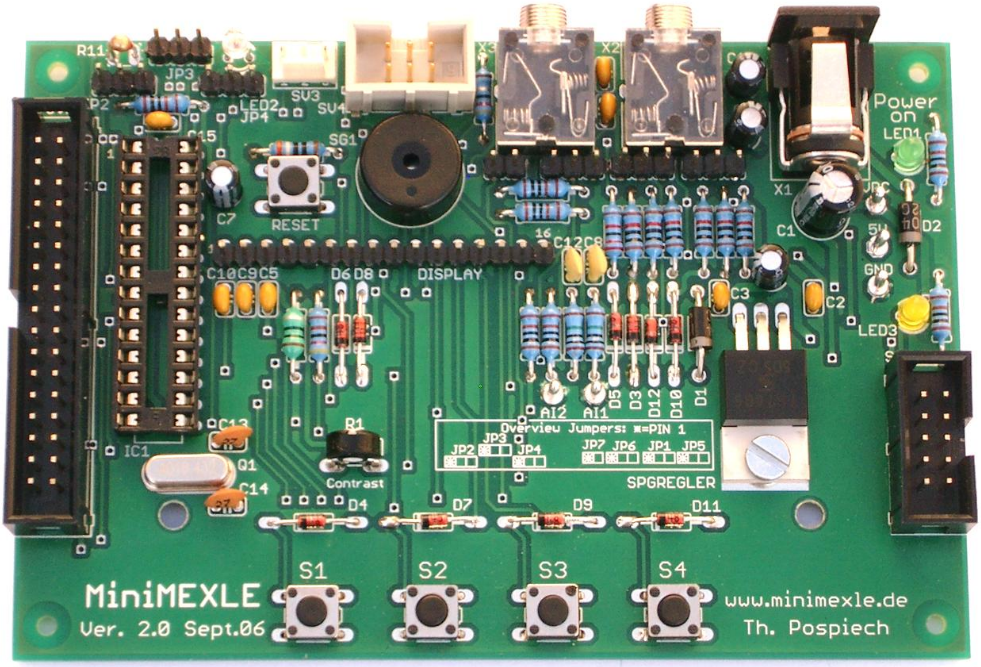

Figure 19: Initial state for the startup

3.1 Optical board examination

In this subsection the single steps are explained for the optical board inspection.

1. Inspection of the joints

The startup begins with the optical inspection of the board. For this purpose the Component- and the solder side have to be controlled onto bad solder bonds and solder splatters so that no hazard of bad contact ability and short-circuits that arose through solder splatters withstands.

2. Inspection of the polarity of components

Then all components should be checked again for their polarity. At the electrolytic capacitors and the „normal“ diodes the corresponding component markings can be matched with the assembly print of the board.
At the light-emitting diodes the flattened edge of the actual body is the cathode, that is the negative pole. This edge must be provided to the left at all light-emitting diodes when considering the board from in front (the anode is always to the right).

3. Inspection of the component values

The inspection of the component values must be carried out due to component of the same types and to prevent confusion hazard. The single resistance values can be determined by the color code. Since the resistance numbering is concealed by the components, the allocation with figure 3 and the component list should be used.
The respective condenser values can be read directly from the component.

3.2 Electric inspection

Before the optical board inspection the electric control may not be carried out. It is important, that neither the display nor the microcontroller are mounted on the board.

The board can now be supplied with a corresponding plug-in power supply with tension and current. For this purpose maximum 12 volts of d.c. voltage are permissible. So that, however, the power dissipation of the voltage regulator does not become too large, the MiniMEXLE should be supplied with **9 VDC.**

After connecting the main voltage the green light-emitting diode must be on. If this should not be the case, the voltage supply must be removed immediately and the optical inspection of the board must be carried out again. If the optical inspection does not lead to any result, the resistance between main voltage and mass and/or between 5 V and mass (Test points) should be measured.

Provided that the green light-emitting diode starts, the residual tension points can be measured 5 V with the multimeter. Important is to pay attention that during the measuring no short-circuit is being caused. The most important measurement points are:

- IC-socket (Pin 7 und 20)
- Display-connecting strip (Pin 2 und 16)
- Tank plug 10 pole (Pin 4)
- Tank plug 6 pole (Pin 1)
- Plug connector (Pin 1)

Measurement takes always place against mass (GND-pin on the board).

The following figure shows the measurement points on the board.

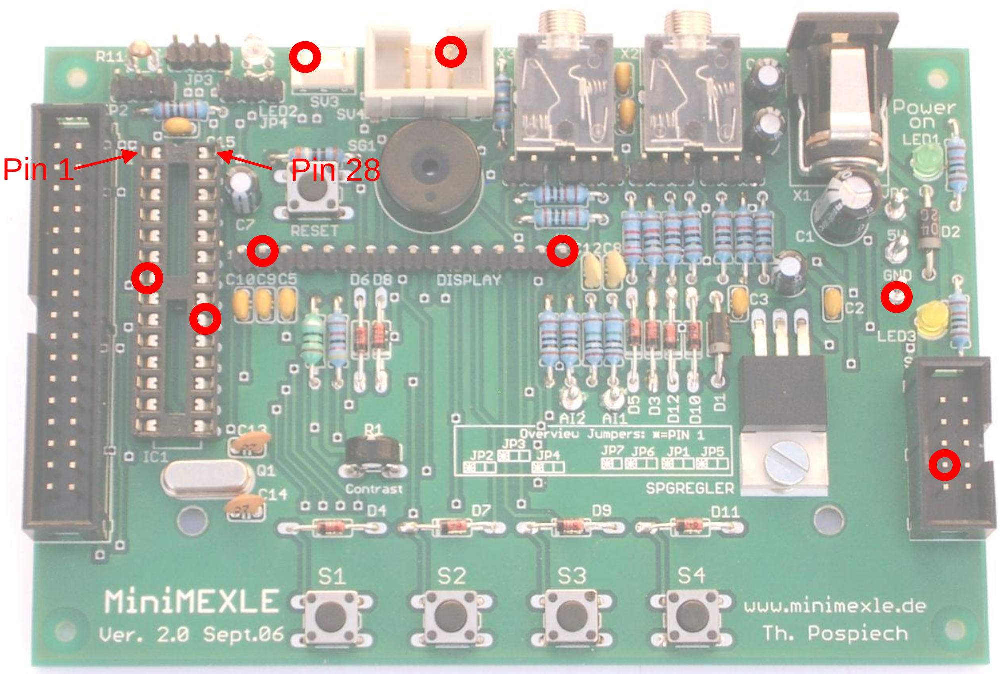

Figure 20: Measurement points for the inspection of the supply voltage

Then the voltage supply is removed again. Definitively the earth wires are controlled with the continuity tester. The most important measurement points are:

- IC-socket (Pin 8 und 22)
- Display-connecting strip (Pin 1, 5 und 15)
- Tank plug 10 pole (Pin 2 und 10)
- Tank plug 6 pole (Pin 4)
- Plug connector (Pin 3)

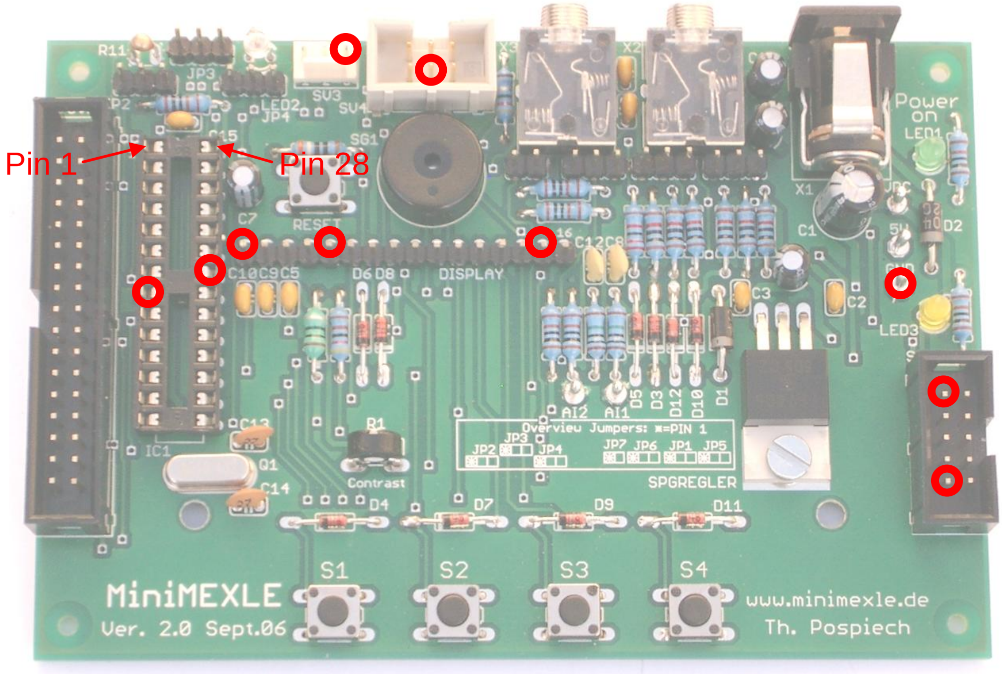

Figure 21: Measurement points for the mass continuity tests.

At this place it is to say that these inspections do not cover all functions of the MiniMEXLE by far but are sufficient for a first test!
At a total inspection of the MiniMEXLE will be worked and it will be available in a separate documentation!

On the next page the definitive display arrangement is explained.

3.3 Display arrangement

Before connecting the display to the MiniMEXLE, the IC (ATMega88) has to be placed into the IC-socket. In this case attention must be paid to the notch the IC-socket like while soldering the IC-socket.

Then the finished display (after successful inspection of the board) can be taken directly onto the pin connector and the provided holes for the spacers.

The following figure shows the completed MiniMEXLE.

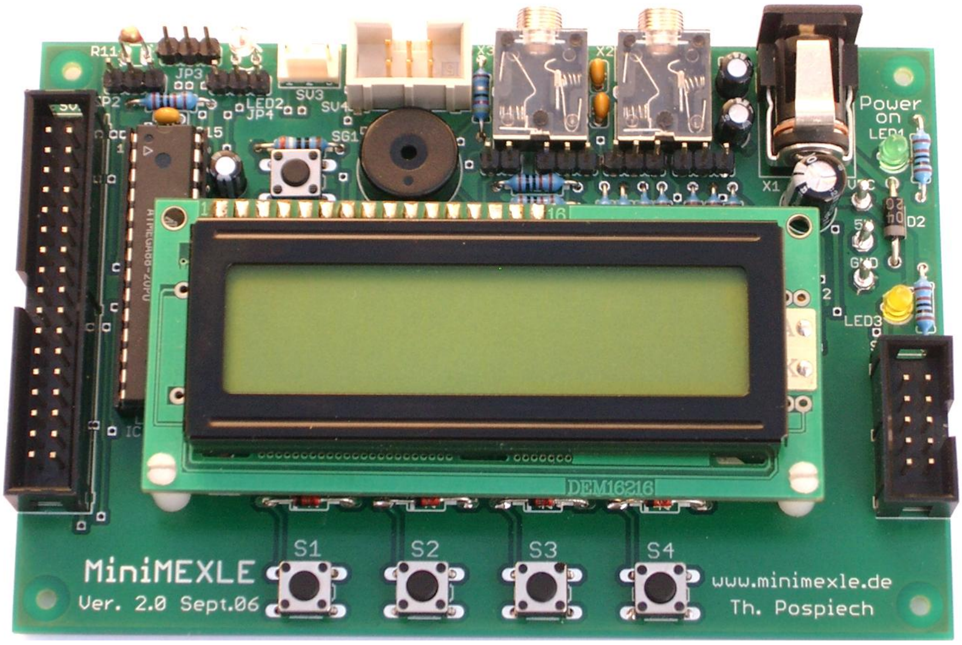

Figure 22: The completed MiniMEXLE.

Hint:

The contrast of the display can be modified using the potentiometer R1. With ex-works condition of the potentiometer the axis of rotation normally is on the left stop. However this means an extremely weak contrast for the display. For this reason the potentiometer should be rotated to the right so that the top of the axis of rotation stands on approx. three o'clock. A corresponding precision adjustment can be carried out later with activated display. The following figure shows the potentiometer position for an acceptable contrast.

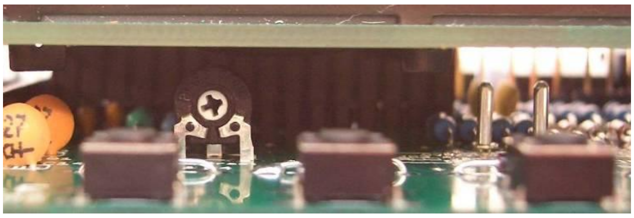

Figure 23: Rotation of the potentiometer for good contrast.

The next chapter deals with the first usage of the MiniMEXLE. A short view on working with the MiniMEXLE, the AVR-USB-Progi and the AVR Studio is provided.

3.4 Arrangement possibilities

To ensure that the MiniMEXLE has not to be placed directly on a surface like a table or similiar, the following arrangement possibilities exist:

- Rubber bumpers
- Boreholes for a possible case arrangement

The attached rubber bumpers can simply be stuck on at the four edges of the board. Through that the underside of the board has a distance to the supporting surface.

Furthermore one can insert the MiniMEXLE using four boreholes into a casing. The boreholes have a diameter of 2 mm. At this place it may be said that there is sufficient place still available around the boreholes in order to bore these correspondingly (for example ∅ 3 mm).

4 Program download

The working with the AVR-USB-PROGI and the MiniMEXLE is relatively simple and becomes pointed out in this chapter using the AVR Studio.

Preconditions for these chapters are:

- assembled AVR-USB-PROGI (incl. Installation of drivers and verification).
- assembled and verified MiniMEXLE.
- installed AVR Studio.

It has to be said at this place that in this chapter only the first operation steps are shown. It is not a complete documentation concerning programming, AVR Studio and MiniMEXLE.

4.1 Connecting the MiniMEXLE to a PC

First the MiniMEXLE should be connected to the AVR-USB-PROGI. The connection occurs via the included 10 pole ribbon cable, as in the following figure is to be seen.

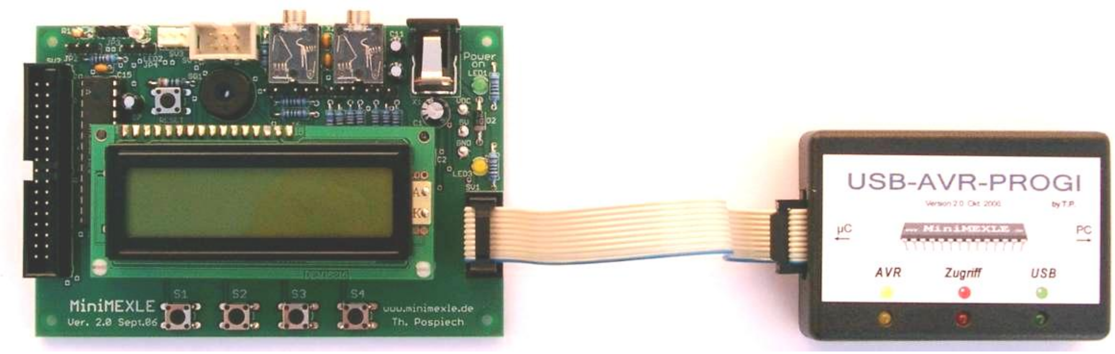

Figure 24: MiniMEXLE and AVR-USB-PROGI

Then the AVR-USB-PROGI is connected to the PC via the USB cable and the MiniMEXLE is supplied with tension.

Then the green and the yellow light-emitting diodes should turn on. The green light-emitting diode shows that the AVR-USB-PROGI is connected to the PC (Voltage supply comes over USB) and the yellow light-emitting diode indicates that the MiniMEXLE is connected and is supplied with tension. The green light-emitting diode of the MiniMEXLE indicates also its voltage supply.

4.2 AVR Studio

In this chapter the first steps using the AVR Studio are described. It is shown in this case how an already available program is broadcasted to the MiniMEXLE. This small demo program tests then a few functions of the MiniMEXLE simultaneously, as for example: the display, the keys, the light-emitting diode and the Buzzer.

First of all start the AVR Studio so that the next represented work environment is shown.

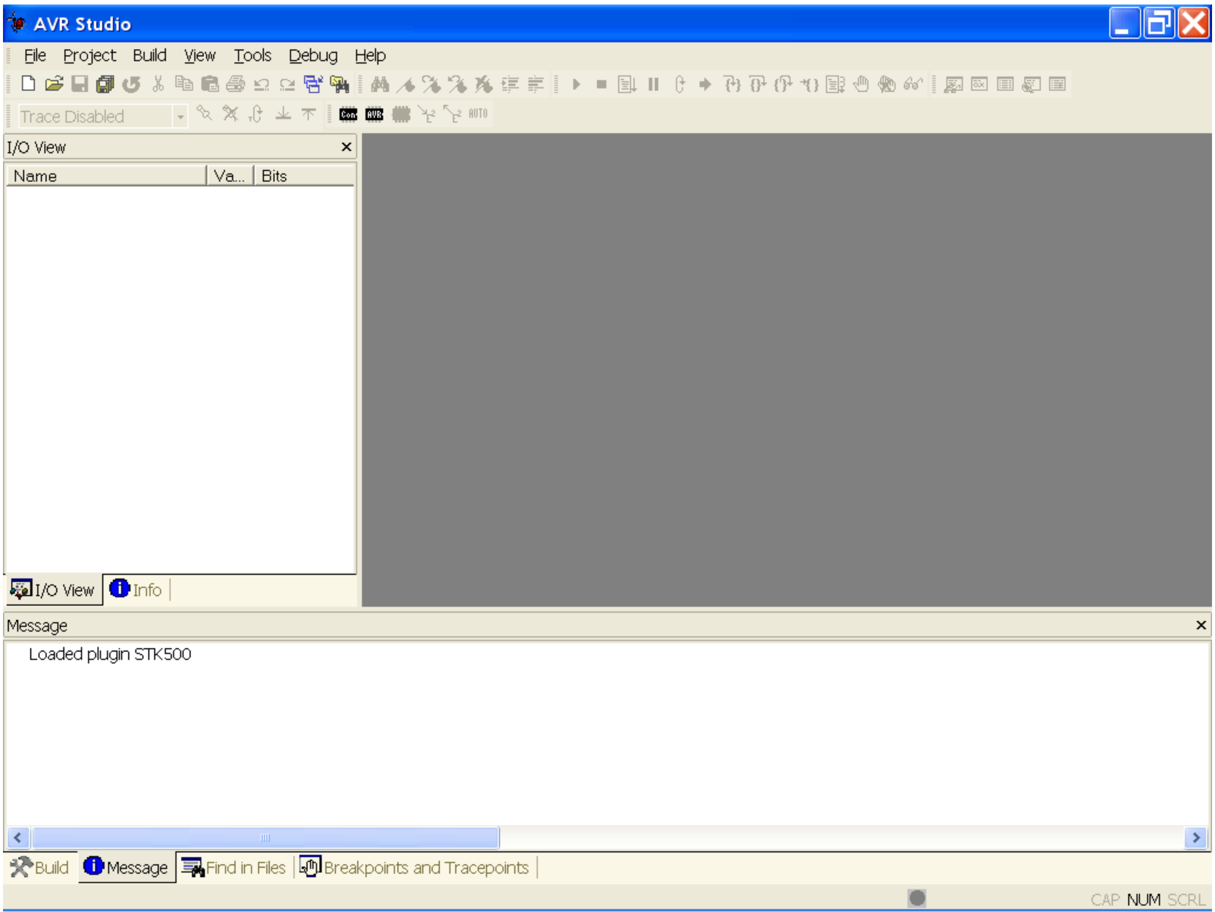

Figure 25: Programming environment AVR Studio

In increased scale the relevant buttons are represented in the following figure.

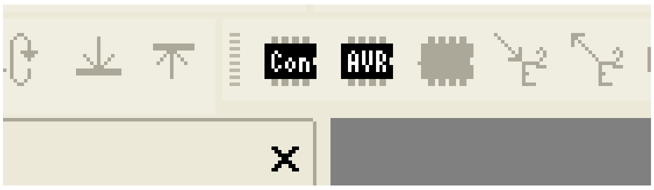

Figure 26: Relevant buttons for programming the MiniMEXLE

If one activates the button with the label ***„Con“***, the following represented window is opened. Here one is asked to now carry out the corresponding connection regulations.

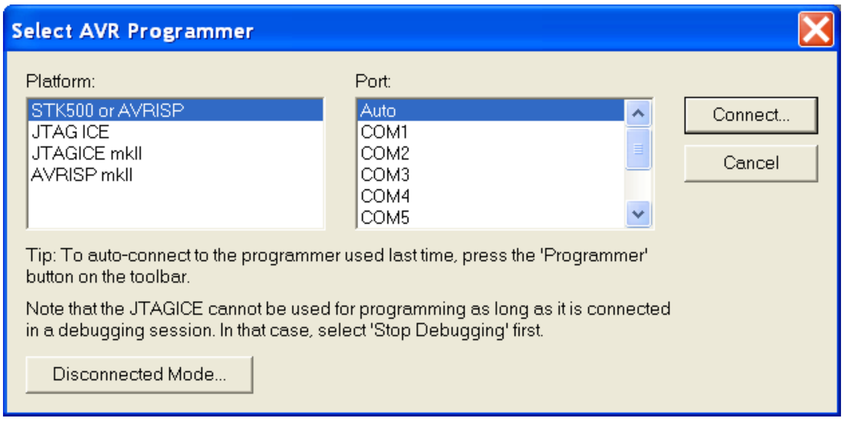

Figure 27: Selection of the AVR Programmer and the corresponding port

In this window the choice ***STK500 or AVRISP*** must be selected at ***Platform*** since the STK500-protocol (Version 2) is imitated by the AVR-USB-PROGI and/or his ATmega88.

Under the ***port*** column the regulation can be left on ***auto,*** so that the AVR Studio scans all ports of the PCs, until finally the employed AVR-Programmer is found.
If one do not choose the ***auto regulation***, but directly the corresponding port COM instead, the AVR Studio attempts to set up a direct connection with the Programmer and/or the connected target hardware.

After activating the button ***Connect...*** the AVR-USB-PROGI connects to the PC and the MiniMEXLE and the following window will open itself (when successfully connected).

During the opening of the window the ***program*** category is the default view, what will prove pleasant while working with the AVR Studio.

The lower section in this figure and/or window supplies information about the connected AVR-USB-PROGI and about the soft- /firmware running on the ATmega88 (Firmware version etc.).

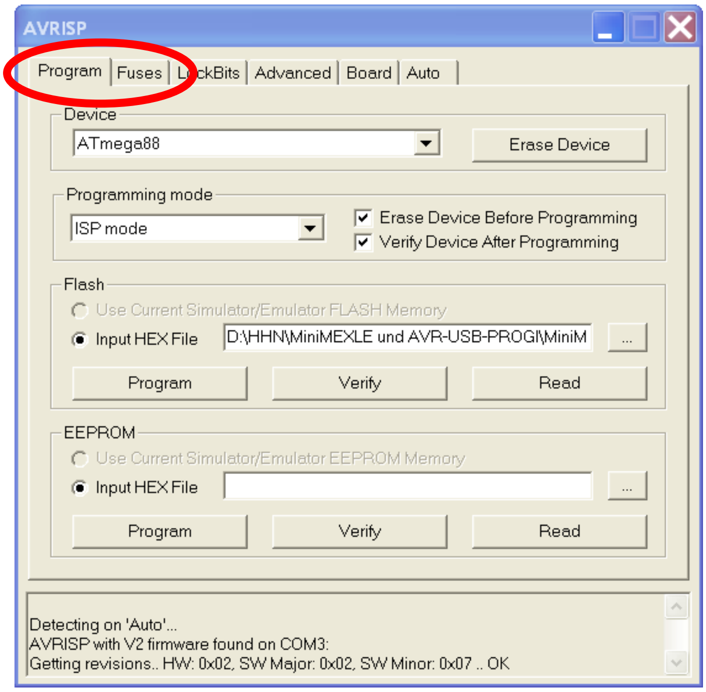

Figure 28: Successful connection between the PC and the MiniMEXLE

Before a program can be read or played onto the microcontroller such-called fuses must be set on virgin microcontrollers. For this purpose the category ***Fuses*** has to be selected. The contents of this window shows the following figure.

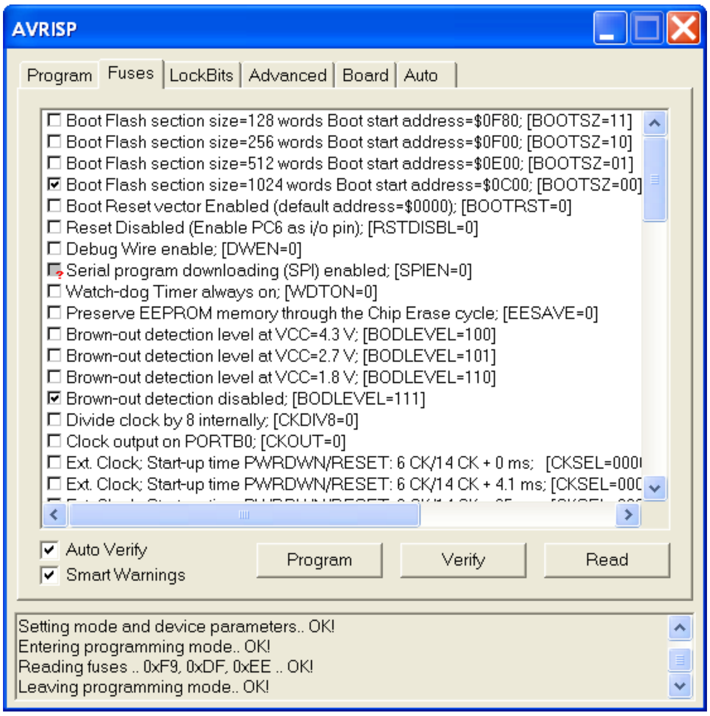

Figure 29: Setup of fuses

The figure 27 does not show all possible setting by far. For reasons of the overview, the complete list of the fuses for a ATmega88 is shown at the following figure.

- [ ] Boot Flash section size=128 words Boot start address=$0F80; [BOOTSZ=11]
- [ ] Boot Flash section size=256 words Boot start address=$0F00; [BOOTSZ=10]
- [ ] Boot Flash section size=512 words Boot start address=$0E00; [BOOTSZ=01]
- [x] Boot Flash section size=1024 words Boot start address=$0C00; [BOOTSZ=00] ; default value
- [ ] Boot Reset vector Enabled (default address=$0000); [BOOTRST=0]
- [ ] Reset Disabled (Enable PC6 as i/o pin); [RSTDISBL=0]
- [ ] Debug Wire enable; [DWEN=0]
- [x] Serial program downloading (SPI) enabled; [SPIEN=0]
- [ ] Watch-dog Timer always on; [WDTON=0]
- [ ] Preserve EEPROM memory through the Chip Erase cycle; [EESAVE=0]
- [ ] Brown-out detection level at VCC=4.3 V; [BODLEVEL=100]
- [ ] Brown-out detection level at VCC=2.7 V; [BODLEVEL=101]
- [ ] Brown-out detection level at VCC=1.8 V; [BODLEVEL=110]
- [x] Brown-out detection disabled; [BODLEVEL=111]
- [ ] Divide clock by 8 internally; [CKDIV8=0]
- [ ] Clock output on PORTB0; [CKOUT=0]
- [ ] Ext. Clock; Start-up time PWRDWN/RESET: 6 CK/14 CK + 0 ms; [CKSEL=0000 SUT=00]
- [ ] Ext. Clock; Start-up time PWRDWN/RESET: 6 CK/14 CK + 4.1 ms; [CKSEL=0000 SUT=01]
- [ ] Ext. Clock; Start-up time PWRDWN/RESET: 6 CK/14 CK + 65 ms; [CKSEL=0000 SUT=10]
- [ ] Int. RC Osc. 8 MHz; Start-up time PWRDWN/RESET: 6 CK/14 CK + 0 ms; [CKSEL=0010 SUT=00]
- [ ] Int. RC Osc. 8 MHz; Start-up time PWRDWN/RESET: 6 CK/14 CK + 4.1 ms; [CKSEL=0010 SUT=01]
- [ ] Int. RC Osc. 8 MHz; Start-up time PWRDWN/RESET: 6 CK/14 CK + 65 ms; [CKSEL=0010 SUT=10]; default value
- [ ] Int. RC Osc. 128kHz; Start-up time PWRDWN/RESET: 6 CK/14 CK + 0 ms; [CKSEL=0011 SUT=00]
- [ ] Int. RC Osc. 128kHz; Start-up time PWRDWN/RESET: 6 CK/14 CK + 4.1 ms; [CKSEL=0011 SUT=01]
- [ ] Int. RC Osc. 128kHz; Start-up time PWRDWN/RESET: 6 CK/14 CK + 65 ms; [CKSEL=0011 SUT=10]
- [ ] Ext. Low-Freq. Crystal; Start-up time PWRDWN/RESET: 1K CK/14 CK + 0 ms; [CKSEL=0100 SUT=00]
- [ ] Ext. Low-Freq. Crystal; Start-up time PWRDWN/RESET: 1K CK/14 CK + 4.1 ms; [CKSEL=0100 SUT=01]
- [ ] Ext. Low-Freq. Crystal; Start-up time PWRDWN/RESET: 1K CK/14 CK + 65 ms; [CKSEL=0100 SUT=10]
- [ ] Ext. Low-Freq. Crystal; Start-up time PWRDWN/RESET: 32K CK/14 CK + 0 ms; [CKSEL=0101 SUT=00]
- [ ] Ext. Low-Freq. Crystal; Start-up time PWRDWN/RESET: 32K CK/14 CK + 4.1 ms; [CKSEL=0101 SUT=01]
- [ ] Ext. Low-Freq. Crystal; Start-up time PWRDWN/RESET: 32K CK/14 CK + 65 ms; [CKSEL=0101 SUT=10]
- [ ] Ext. Full-swing Crystal; Start-up time PWRDWN/RESET: 258 CK/14 CK + 4.1 ms;[CKSEL=0110 SUT=00]
- [ ] Ext. Full-swing Crystal; Start-up time PWRDWN/RESET: 258 CK/14 CK + 65 ms; [CKSEL=0110 SUT=01]
- [ ] Ext. Full-swing Crystal; Start-up time PWRDWN/RESET: 1K CK /14 CK + 0 ms; [CKSEL=0110 SUT=10]
- [ ] Ext. Full-swing Crystal; Start-up time PWRDWN/RESET: 1K CK /14 CK + 4.1 ms;[CKSEL=0110 SUT=11]
- [ ] Ext. Full-swing Crystal; Start-up time PWRDWN/RESET: 1K CK /14 CK + 65 ms; [CKSEL=0111 SUT=00]
- [ ] Ext. Full-swing Crystal; Start-up time PWRDWN/RESET: 16K CK/14 CK + 0 ms; [CKSEL=0111 SUT=01]
- [ ] Ext. Full-swing Crystal; Start-up time PWRDWN/RESET: 16K CK/14 CK + 4.1 ms;[CKSEL=0111 SUT=10]
- [ ] Ext. Full-swing Crystal; Start-up time PWRDWN/RESET: 16K CK/14 CK + 65 ms; [CKSEL=0111 SUT=11]
- [ ] Ext. Crystal Osc.; Frequency 0.4-0.9 MHz; Start-up time PWRDWN/RESET: 258 CK/14 CK + 4.1 ms; [CKSEL=1000 SUT=00]
- [ ] Ext. Crystal Osc.; Frequency 0.4-0.9 MHz; Start-up time PWRDWN/RESET: 258 CK/14 CK + 65 ms; [CKSEL=1000 SUT=01]
- [ ] Ext. Crystal Osc.; Frequency 0.4-0.9 MHz; Start-up time PWRDWN/RESET: 1K CK /14 CK + 0 ms; [CKSEL=1000 SUT=10]
- [ ] Ext. Crystal Osc.; Frequency 0.4-0.9 MHz; Start-up time PWRDWN/RESET: 1K CK /14 CK + 4.1 ms; [CKSEL=1000 SUT=11]
- [ ] Ext. Crystal Osc.; Frequency 0.4-0.9 MHz; Start-up time PWRDWN/RESET: 1K CK /14 CK + 65 ms; [CKSEL=1001 SUT=00]
- [ ] Ext. Crystal Osc.; Frequency 0.4-0.9 MHz; Start-up time PWRDWN/RESET: 16K CK/14 CK + 0 ms; [CKSEL=1001 SUT=01]
- [ ] Ext. Crystal Osc.; Frequency 0.4-0.9 MHz; Start-up time PWRDWN/RESET: 16K CK/14 CK + 4.1 ms; [CKSEL=1001 SUT=10]
- [ ] Ext. Crystal Osc.; Frequency 0.4-0.9 MHz; Start-up time PWRDWN/RESET: 16K CK/14 CK + 65 ms; [CKSEL=1001 SUT=11]
- [ ] Ext. Crystal Osc.; Frequency 0.9-3.0 MHz; Start-up time PWRDWN/RESET: 258 CK/14 CK + 4.1 ms; [CKSEL=1010 SUT=00]
- [ ] Ext. Crystal Osc.; Frequency 0.9-3.0 MHz; Start-up time PWRDWN/RESET: 258 CK/14 CK + 65 ms; [CKSEL=1010 SUT=01]
- [ ] Ext. Crystal Osc.; Frequency 0.9-3.0 MHz; Start-up time PWRDWN/RESET: 1K CK /14 CK + 0 ms; [CKSEL=1010 SUT=10]
- [ ] Ext. Crystal Osc.; Frequency 0.9-3.0 MHz; Start-up time PWRDWN/RESET: 1K CK /14 CK + 4.1 ms; [CKSEL=1010 SUT=11]
- [ ] Ext. Crystal Osc.; Frequency 0.9-3.0 MHz; Start-up time PWRDWN/RESET: 1K CK /14 CK + 65 ms; [CKSEL=1011 SUT=00]
- [ ] Ext. Crystal Osc.; Frequency 0.9-3.0 MHz; Start-up time PWRDWN/RESET: 16K CK/14 CK + 0 ms; [CKSEL=1011 SUT=01]
- [ ] Ext. Crystal Osc.; Frequency 0.9-3.0 MHz; Start-up time PWRDWN/RESET: 16K CK/14 CK + 4.1 ms; [CKSEL=1011 SUT=10]
- [ ] Ext. Crystal Osc.; Frequency 0.9-3.0 MHz; Start-up time PWRDWN/RESET: 16K CK/14 CK + 65 ms; [CKSEL=1011 SUT=11]
- [ ] Ext. Crystal Osc.; Frequency 3.0-8.0 MHz; Start-up time PWRDWN/RESET: 258 CK/14 CK + 4.1 ms; [CKSEL=1100 SUT=00]
- [ ] Ext. Crystal Osc.; Frequency 3.0-8.0 MHz; Start-up time PWRDWN/RESET: 258 CK/14 CK + 65 ms; [CKSEL=1100 SUT=01]
- [ ] Ext. Crystal Osc.; Frequency 3.0-8.0 MHz; Start-up time PWRDWN/RESET: 1K CK /14 CK + 0 ms; [CKSEL=1100 SUT=10]
- [ ] Ext. Crystal Osc.; Frequency 3.0-8.0 MHz; Start-up time PWRDWN/RESET: 1K CK /14 CK + 4.1 ms; [CKSEL=1100 SUT=11]
- [ ] Ext. Crystal Osc.; Frequency 3.0-8.0 MHz; Start-up time PWRDWN/RESET: 1K CK /14 CK + 65 ms; [CKSEL=1101 SUT=00]
- [ ] Ext. Crystal Osc.; Frequency 3.0-8.0 MHz; Start-up time PWRDWN/RESET: 16K CK/14 CK + 0 ms; [CKSEL=1101 SUT=01]
- [ ] Ext. Crystal Osc.; Frequency 3.0-8.0 MHz; Start-up time PWRDWN/RESET: 16K CK/14 CK + 4.1 ms; [CKSEL=1101 SUT=10]
- [ ] Ext. Crystal Osc.; Frequency 3.0-8.0 MHz; Start-up time PWRDWN/RESET: 16K CK/14 CK + 65 ms; [CKSEL=1101 SUT=11]
- [ ] Ext. Crystal Osc.; Frequency 8.0- MHz; Start-up time PWRDWN/RESET: 258 CK/14 CK + 4.1 ms; [CKSEL=1110 SUT=00]
- [ ] Ext. Crystal Osc.; Frequency 8.0- MHz; Start-up time PWRDWN/RESET: 258 CK/14 CK + 65 ms; [CKSEL=1110 SUT=01]
- [x] Ext. Crystal Osc.; Frequency 8.0- MHz; Start-up time PWRDWN/RESET: 1K CK /14 CK + 0 ms; [CKSEL=1110 SUT=10]
- [ ] Ext. Crystal Osc.; Frequency 8.0- MHz; Start-up time PWRDWN/RESET: 1K CK /14 CK + 4.1 ms; [CKSEL=1110 SUT=11]
- [ ] Ext. Crystal Osc.; Frequency 8.0- MHz; Start-up time PWRDWN/RESET: 1K CK /14 CK + 65 ms; [CKSEL=1111 SUT=00]
- [ ] Ext. Crystal Osc.; Frequency 8.0- MHz; Start-up time PWRDWN/RESET: 16K CK/14 CK + 0 ms; [CKSEL=1111 SUT=01]
- [ ] Ext. Crystal Osc.; Frequency 8.0- MHz; Start-up time PWRDWN/RESET: 16K CK/14 CK + 4.1 ms; [CKSEL=1111 SUT=10]
- [ ] Ext. Crystal Osc.; Frequency 8.0- MHz; Start-up time PWRDWN/RESET: 16K CK/14 CK + 65 ms; [CKSEL=1111 SUT=11]

Figure 30: Complete list of fuses for the ATmega88

It has to be said at this place that the various microcontrollers of the company Atmel use different fuses. Therefore this list is valid only for a ATmega88.

IMPORTANT!!!
The fuses marked in figure 30 have to be set!
If the marked fused are not set or other fuses than the marked ones get activated, the hazard exists that the test-application won't work or the programming of the microcontroller via the AVR-USB-PROGI won't work anymore.

After setting the correct fuses, the button ***Program*** has to be activated.

The status indicator lines give information about the success of the programming of the fuses. If one activates the button ***Verify*** after the programming, the fuses of the microcontroller are read and compared with the currently employed fuses.

After correctly setting the fuses, the view can be switched to ***Program*** again.

One can select the path to the programming-file using the windows-typical button here.
The already compiled program **Test_the_MiniMEXLE.hex** has to be selected at this time. Then the test-application can be transferred to the microcontroller via the button ***Program***.

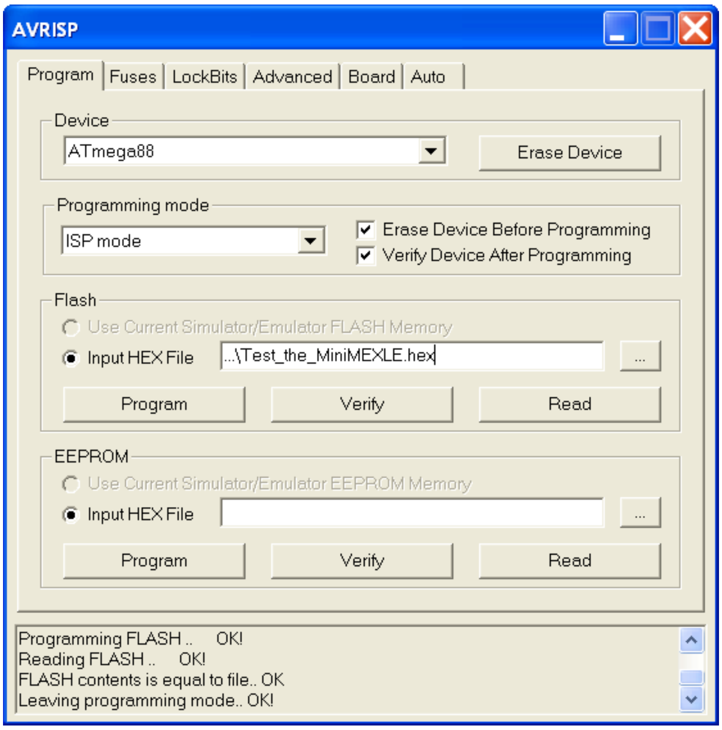

Figure 31: Downloading the test-application

During the transfer the single (ending automatically) operation steps are shown in the lower section of the window. The following figure shows these operation steps.

```
Reading FLASH input file.. OK
Entering programming mode.. OK!
Erasing device.. OK!
Programming FLASH ..     OK!
Reading FLASH ..     OK!
FLASH contents is equal to file.. OK
Leaving programming mode.. OK!
```

Figure 32: Operation steps during the transfer of the test-application

After correctly transferring the test-application to the hardware, the result can be evaluated using the MiniMEXLE.

In the present application version the following functions are available:

- Initial screen on the display. After a short moment the features are expressed on the display automatically.
- With pressing the button S2 the light-emitting diode LED3 can be switched on and off.
- With pressing the button S3 the buzzer outputs a siren-like and contiguous sound.
- With pressing the button S4 a melody is output (with single tones) using the buzzer.

This manual is finished with the successful download of the program.

At this place I may wish you personally a lot of fun with the further works using the MiniMEXLE!

5 Appendix

In this chapter further information with respect to the AVR-USB-PROGI and his equipping and/or startup is listed.

5.1 Color codes for resistances

The following table and figures show the different color codes for resistances and how to understand them.

	Farbe	1. Ring	2. Ring	Multiplikator	Toleranz +/-
	keine				20 %
	silber			$10^{-2} = 0{,}01$	10 %
	gold			$10^{-1} = 0{,}1$	5 %
	schwarz	-	0	$10^{0} = 1$	
	braun	1	1	$10^{1} = 10$	1 %
	rot	2	2	$10^{2} = 100$	2 %
	orange	3	3	$10^{3} = 1K$	
	gelb	4	4	$10^{4} = 10K$	
	grün	5	5	$10^{5} = 100K$	0,50 %
	blau	6	6	$10^{6} = 1M$	0,25 %
	violett	7	7	$10^{7} = 10M$	0,10 %
	grau	8	8	$10^{8} = 100M$	0,05 %
	weiß	9	9	$10^{9} = 1G$	

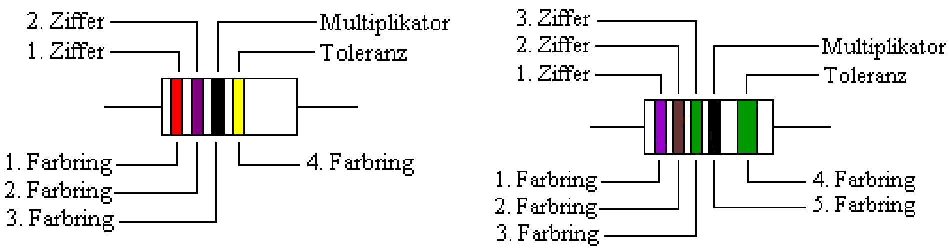

Figure 33: Color codes for resistances

5.2 Links to extending websites

In this subsection a selected link collection to topic-similar internet sites is listed.

Programming/developing environments:

- Atmel: http://www.atmel.com
  The microcontroller manufacturer. Here one finds data sheets, application examples and the programming environment AVRStudio.

- WinAVR: http://sourceforge.net/project/showfiles.php?group_id=68108
  Download-Pages of the C-Compiler WinAVR („Add-on“ for AVRStudio).

- AVRDude: http://savannah.nongnu.org/projects/avrdude/
  Very useful Freeware-Programmer

- PonyProg: http://www.lancos.com/prog.html
  Programming application to directly flash the AVR-USB-PROGI within Windows via USB.

- CodeVisionAVR: http://www.hpinfotech.ro/
  Complete developing environment – sadly not freeware.

Software, example projects:

- MEXLEWiki: http://mexlewiki.hs-heilbronn.de
  Wiki of Heilbronn University. Delivers all information about the MEXLE project, including the MiniMEXLE.

- MEXLE: http://www.mexle.hs-heilbronn.de/
  The official homepage of MEXLE! Provides documentation, examples, projects and much more.

- Mikrocontroller: http://www.mikrocontroller.net/
  Microcontrollers and their programming.

- AVRFreaks: http://www.avrfreaks.net/
  Information about AVR microcontrollers.