

Hacklace



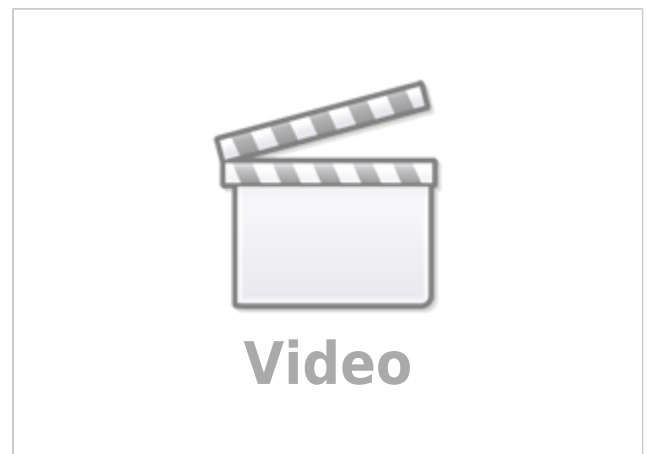
Hacklace - A hackable necklace

- You'd like to dive right into the fascinating world of electronics and microcontrollers? Hacklace offers you an easy and hands-on introduction sparking your creativity.
- You're looking for a special gift with an individual touch? Hacklace is a unique gadget to carry your personal message.
- You like to stand out on parties and show your enthusiasm for technology? Hacklace is a flashy accessory that highlights your passion for electronics.

An ideal beginners project for those who like pixel art and are willing to discover the realm of light, electronics and microcontroller programming. „Hacklace squared“ is a geeky electronic trinket with boundless possibilities. It's an arduino-compatible microcontroller system with a bright dot-matrix display running from a single coin cell battery.

Watch the video!

Write ticker texts and design your own animations. Program your own apps with ease by using set-up templates. Extend the Hacklace by attaching sensors and explore its many [applications](#).



Features

- ticker texts and pixel art animations - designed by yourself
- proportional character font (ISO8859) enriched by fancy special characters
- numerous ready-made pixel art animations
- super bright dot-matrix display with four intensity levels
- powerful microprocessor with lots of memory (ATmega328P)
- quick and easy assembly (all the tiny SMD components are pre-assembled)
- compatible to the beginner friendly Arduino development platform (which you get for free!)
- use the [Hack-Key](#) to program via USB (no special programmer needed)
- develop your own apps and realize the functionality you need
- attach extensions to the sensor or communications port

Where to buy


For more than four years the Hacklace2 has brought a smile to thousands of people's faces. But by now even the last batch is completely sold out. As my personal focus of interest has shifted I do not plan another production run in the foreseeable future. Many thanks to all Hacklace2 fans for their support and the great time.

How to build

The printed circuit board comes pre-assembled with all the tiny surface mount components. That makes building your Hacklace2 a breeze. With proper help and instructions even complete electronic noobs can do it. What you need are elementary soldering skills and some basic soldering tools. If you are lacking the skills or the tools ask for help in your local hackerspace. They will be happy to assist you. The Hacklace2 kit is an ideal entry-level project for learning electronics and getting a first hands-on experience in soldering.

What you need



 Tools for soldering

- temperature controlled soldering iron or soldering station
- appropriate soldering tip (e. g. 1 mm chisel tip)
- soldering iron stand
- electronics solder (approx. 1 mm diameter)
- wire cutter
- small pliers
- insulation strippers
- a heat-proof soldering mat

Contents of the kit





Hacklace2 kit



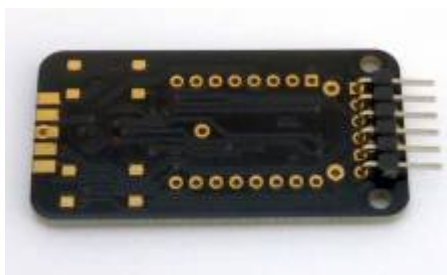
pre-assembled PCB

- 1 pre-assembled printed circuit board
- 1 dot-matrix display
- 2 SMD push buttons
- 1 pin header, 6 pins, 90 degrees
- 1 coin cell holder
- 1 lithium coin cell CR2032
- approx. 35 cm of wire

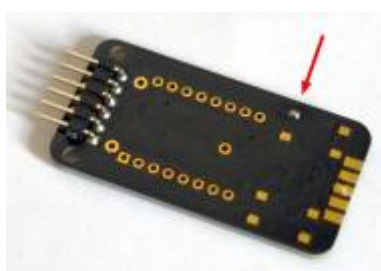
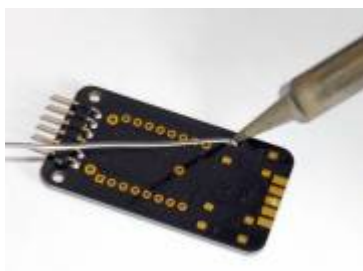
Building Instructions

The front of the Hacklace2 has no print whereas the back carries a white print on it.

1. First insert the pin header from the front. The short legs go into the board. Flip the board and solder the pins.

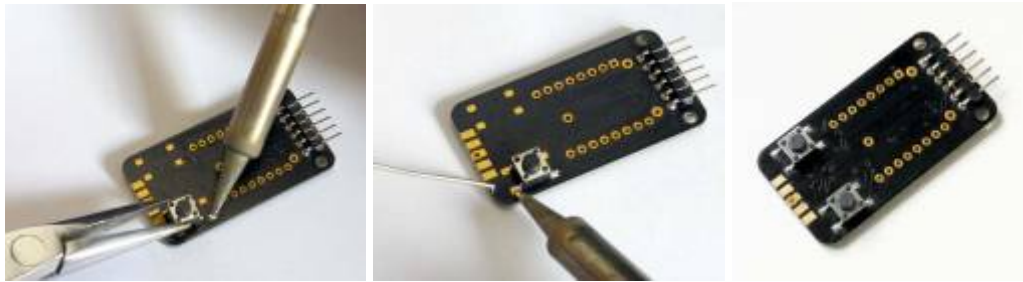


2. Then you assemble the push buttons on the front. There are four pads for each button. First put some solder on one of the pads.



In order to not burn your fingertips it is best to use some pliers to hold the push button. Your other hand carries the soldering iron. Soften the solder with the soldering iron and put down the button onto the pad. Adjust the position until the button is perfectly aligned with the four pads.

Now solder the remaining three pads. Do the same with the second button.



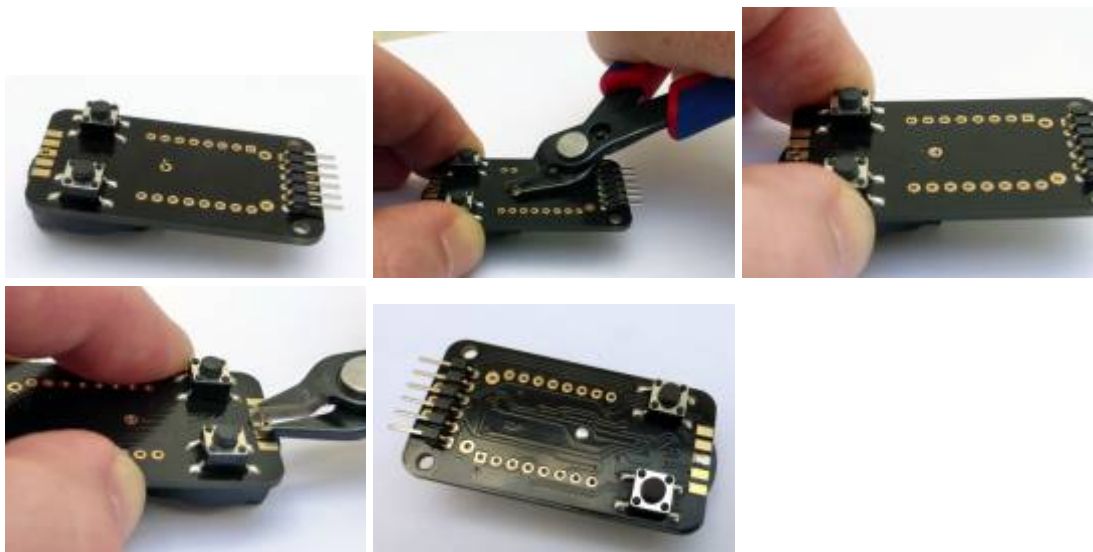
3. The coin cell holder is assembled on the back. It sits on the microcontroller.

Important: You have to watch out for the right polarity of the holder. A wrong polarity of the supply voltage will destroy the Hacklace!

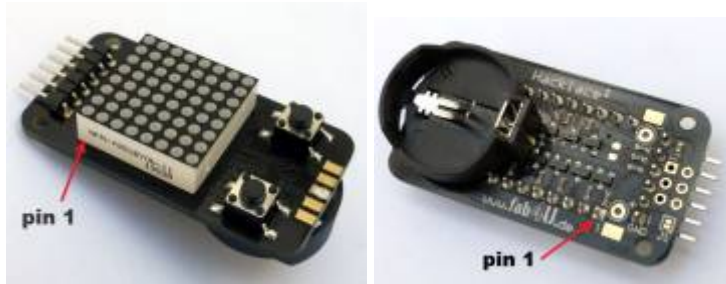
The pin at the round end of the holder is the negative terminal, the pin at the rectangular end is the positive terminal. On the board the corresponding pads are marked '-' and '+'. If the battery holder is in correct position its round end will protrude somewhat from the edge of the board.



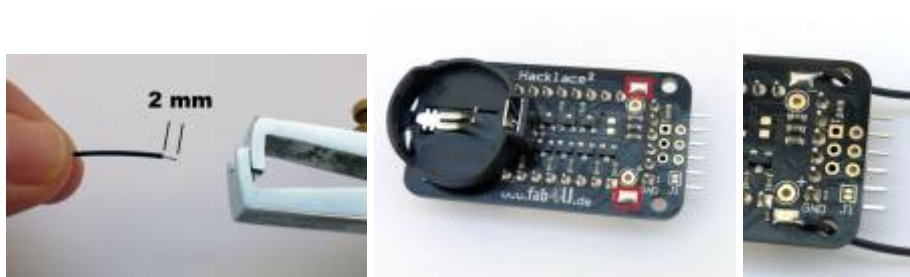
With a wire cutter cut the pins so that they are flat with the board surface. Then solder the pins.



4. With the display you also have to pay attention to the correct position. If you are looking on the side print of the display, pin 1 is on the left front. On the board the pad for pin 1 is square and marked by a '1', all other pads are round. Insert the display from the front. When soldering the pins next to the coin cell holder please take care not to touch the holder with the soldering iron (it would melt).



5. The wire has no electrical function. It merely serves as a support string if you are carrying the Hacklace as a necklace. Strip off the insulation at both ends by approx. 2 millimeters and tin the ends with solder. As a strain-relief measure guide each wire end through one of the big drill holes. Then solder it to the large rectangular pad. Make sure you use the rectangular pads as they have no electrical contact. If you used the round pads you would have built a short circuit.



If you like you can replace the wire by a leather strip or small chain.

Congratulations, you've made it!

Simply insert the coin cell (plus on top) and the Hacklace2 will come to live showing „DL“, which means that the Hacklace is now in download mode.



Operating Instructions

You operate the Hacklace with its two push buttons.

- Browse through the texts and animations by pressing the left button.
- If it was off press the left button to turn it on. Hold the left button pressed for 1 second and it turns off again. When turned off the Hacklace consumes almost no energy so there is no need to remove the battery.
- The function of the right push button may vary with the currently executing app. E. g. if the Hacklace is showing text or animations the right button increases the display intensity.

In general each app can assign the push buttons a different functionality.

Hardware

The Hacklace hardware is described by the schematic and assembly drawings. They are provided in the [download section](#).

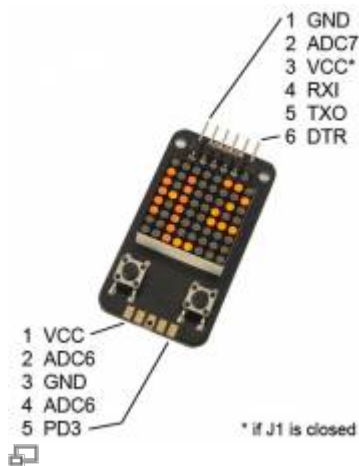
Technical Specs

- display: dot-matrix with 8 x 8 LEDs
- flash memory (for program and apps): 32 kbytes
- EEPROM (for texts and animations): 1 kbyte
- clock speed: 8 MHz \pm 0,5 %
- power supply: 2.5 V - 3.3 V
- dimensions: 48.0 mm x 25.5 mm

Arduino Compatibility

Hacklace2 is arduino-compatible and can be used with the [Arduino development platform](#). It is equipped with an ATmega328P microcontroller from Atmel running at 3 V / 8 MHz. The Hacklace2 can therefore be seen as an Arduino Pro Mini extended by a battery supply, push buttons and a dot-matrix display. For programming you need a 3,3 volt USB-to-serial converter, like e. g. the [Hack-Key](#).

Ports



Pinout of the communication port (top) and sensor port (bottom)

Communication Port

This port gives you access to the serial interface of the microcontroller. It serves to exchange data with a PC or to re-program the Hacklace. One can also use the RX- and TX-pins as general I/O pins for individual applications and there is even an analog input (ADC7) available.

< 8em 2em >	
Pin	Signal
1	GND

2	ADC7
3	VCC(*)
4	RXI
5	TXO
6	DTR

(*) Usually pin 3 is not connected. By closing solder jumper J1 the supply voltage of the Hacklace is routed to this pin. This can be useful if you want to supply external hardware from the battery of the Hacklace.

If J1 is closed please remove the jumper plug on your [Hack-Key](#).

Important: Most USB-to-serial converters provide a voltage of 3.3 or 5 volts on pin 3. If this is the case jumper J1 must not be closed! If it were closed the external voltage would be impinged on the battery. This would cause excessive heat in the battery and might even lead to explosion. If you use the [Hack-Key](#) with its jumper plug removed you are safe.

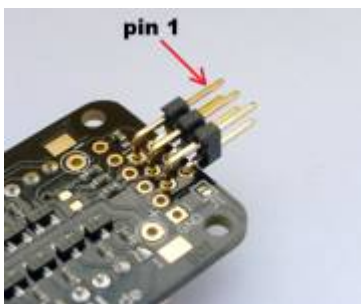
Sensor Port

External sensor circuits can easily be attached to the sensor port. This gives room for a whole range of new applications not possible with the former Hacklace classic.

< 8em 2em >	
Pin	Signal
1	VCC
2	ADC6
3	GND
4	ADC6
5	PD3

The pads are quite large so that many components can be directly soldered onto the board, e. g. resistors, smd components of size 0805 or 1206 and leds. Or you can attach a pin header for easy plugging and unplugging of external hardware.

ISP Connector



Hacklace with ISP connector

Thanks to the integrated bootloader programming of the Hacklace can be done via USB using the [Hack-Key](#) and the Arduino-IDE. The ISP connector is not needed and therefore not populated.

However if you don't use Arduino and prefer ISP-programming you can solder a 2×3 pin header to the back of the board. Ideally this is done before assembling the 6-pin header for the communication port. For programming you will need a special programmer (like Atmel AVRISP or USBASP).

< 16em 6em 2em 2em 6em >			
Signal	Pin	Pin	Signal
MISO	1	2	VCC
SCK	3	4	MOSI
RESET	5	6	GND

For occasional use of the ISP you can insert a 2×3 pin header without soldering. During programming a slight sideways pressure will tilt the pins in the drill holes of the pads to give a good electrical contact.



Connecting to a PC

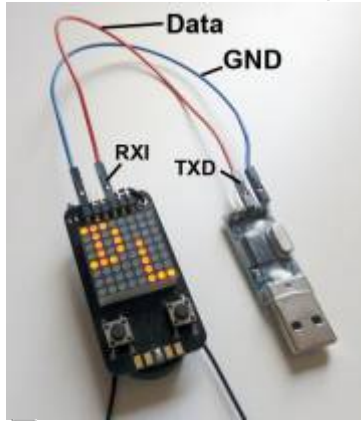


 Hacklace2 with FTDI breakout v2





Hacklace2 with Hack-Key



Hacklace2 with PL2303 adapter

For the Hacklace to exchange data with your PC you need a USB-to-serial adapter. There are many types and brands using different ICs. Ideally the adapter should operate with 3.3 volt logic levels but 5 volts are also tolerated. For downloading texts and animations a simple adapter that only provides RX and TX signals is sufficient. If you also want to program your own apps or modify the firmware an adapter that can issue a reset via the DTR signal is needed to start the bootloader of the Hacklace. You can find suitable adapters by searching the web for „arduino mini usb adapter“. Here are some examples:

- <http://www.watterott.com/de/CP2102N-Breakout-Light>
- <http://www.exp-tech.de/adafruit-ftdi-friend-extras-v1-0>
- <http://www.watterott.com/de/FTDI-Breakout-Reloaded-V2>
- <http://www.exp-tech.de/micro-usb-ftdi-buddy>
- <http://www.adafruit.com/product/3309>
- <http://www.sparkfun.com/products/9873>

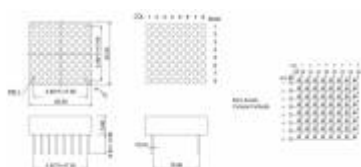
If your operating system does not recognize the converter automatically you have to download and install the appropriate drivers. After that you will find a new virtual serial interface on your computer by which you can communicate with the Hacklace. Parameters are:

2400 baud, 8 data bits, no parity, 1 stop bit

For a description of the data format see "[Downloading Texts and Animations](#)".

Important: Most USB-to-serial converters provide a voltage of 3.3 or 5 volts on pin 3. If the solder jumper J1 on the Hacklace board has been closed, you have to take care that the voltage from the converter is not impinging on the battery (this can make the battery explode). When using the [Hack-Key](#) simply remove its jumper plug. For other converter brands you have to remove the Hacklace battery.

LED Matrix



LED-Matrix

The Hacklace2 comes with a bright orange-colored display. If you are familiar with LEDs and you like a different color better you may want to swap the display for a compatible one (for specifications see picture).

Power Supply

For the power supply of the Hacklace2 you can choose from three options:



1.



Coin cell battery

Coin cell holder attached to the back of the board

This is the standard way. The Hacklace will become very compact and fit easily into a housing.



2.

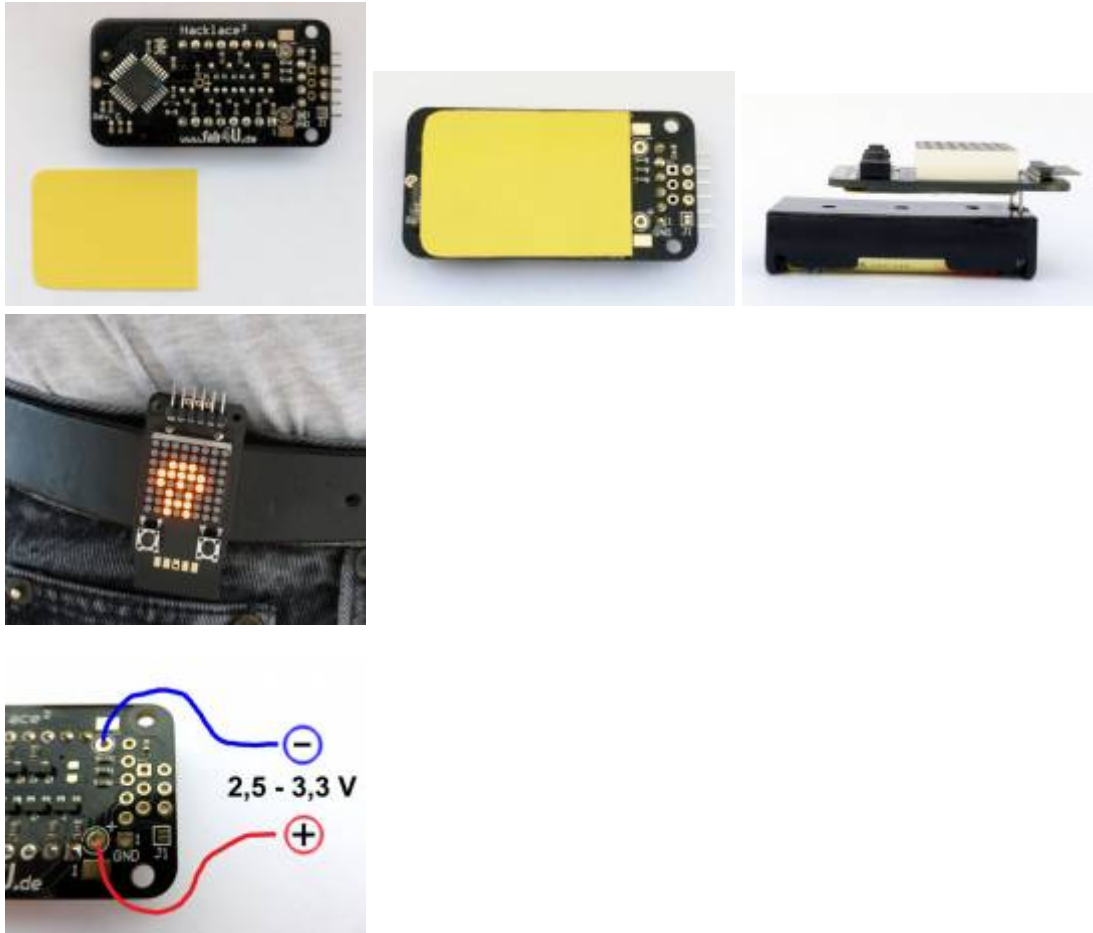


Supply with two AAA-type batteries

Big battery holder

As an option you can get the big battery holder for two AAA-type batteries. The battery holder is soldered to the back of the board. The big batteries will supply plenty of power offering a much longer time of operation

If you keep a gap between the battery holder and the board you can clip the Hacklace to your belt. For this application it is advisable to trim the display pins before soldering the display in. If you like you can hot-glue a small plastic sheet to the board to cover the electronic components.



3.



Connections for an external supply

External supply

The Hacklace can be supplied externally via the two larger round pads. The pads are encircled and marked with '+' and '-'.

Battery Lifetime

Battery lifetime depends on many different factors and it is impossible to make a general statement. Especially the selected display brightness and the kind of content (more or less pixels turned on) have a huge effect on power consumption. In addition different battery brands may have different energy content. The Hacklace is able to operate at rather low voltages. After which time the battery is „empty“ depends on, when you consider the display brightness to be insufficient. That is a very subjective decision.

As a rough estimate with the Hacklace showing ticker texts at low brightness and using a CR2032 coin cell battery from Panasonic the time of operation should exceed 40 hours.

Enclosures

The Hacklace comes without a housing. But with little effort you can build your own.

The two drill holes in the PCB have a diameter of 2.5 mm and are intended to fix the board to a case.

If necessary you can re-bore them to 3 mm. At the long edges of the board there are no components within a 1.5 mm margin, making it easy to slide the board into two grooves that are 26 mm apart.

Here are some inspirations for you:

Standard Housing



Electronics housing

You can get a standard electronics housing type 1551HBK from Hammond Manufacturing. Drill and mill the openings for the Hacklace. The push buttons will be replaced by taller ones so that they protrude from the housing. For the communications port replace the 90 degree pin header by a straight one. A piece of plastic foam will hold the board in place.

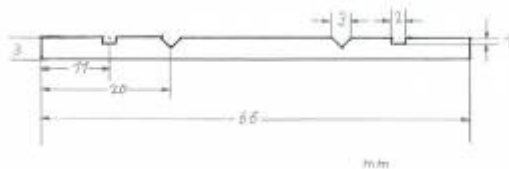


Acrylic Cover



Acrylic cover

Cut an acrylics board to size (66 mm x 53 mm). Mill two V-grooves for bending and two U-grooves that will hold the circuit board. Heaten the plastic along the V-grooves and bend it by 90 degrees. This will make a U-shaped cover that snaps onto the Hacklace.



Wooden Block



Wooden block

A frame is constructed from beech wood. The height of the push buttons should match the height of the display. You may use a piece of paper or a thin piece of veneer as front cover. That the block is not just solid will only become apparent when the Hacklace is switched on.



Crochet



Crocheted Hacklace jacket

If you like working with wool you might think of knitting or crocheting some „clothes“ for your Hacklace. With that you are at the fashion peak and with a message that fits the occasion you silently communicate.



3D-Printer

Some folks have used a 3D printer to realise their own ideas of a Hacklace case. See <http://gpio.kaltpost.de/?p=2278>

Software

Go to the [software documentation](#).

Applications



Hacklace as an electronic amulet

Find many more [applications here](#).

Download

File	License
schematic	CC-BY-SA
assembly drawing	CC-BY-SA
configuration file	CC0
Hacklace2 sourcecode	see license.md
Image2Hacklace2 ⁽¹⁾	GPL
Hacklace Bitmap Calculator ⁽²⁾	CC-BY

⁽¹⁾ = Java command line tool for converting graphics; developed by SubOptimal

⁽²⁾ = Excel- resp. Calc-sheet to design Hacklace2 graphics; developed by Johannes

(*) = Java command line tool developed by SubOptimal

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