

Introduction to Embedded System Development

Speaker

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Explore other fields, help animals and support equality.

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Don't read me, listen to Kuldeep!

Please don't mind if i brag a little bit. 😊

What is embedded system

An embedded system is a computer system with a dedicated function within a larger mechanical or electrical system, often with real-time computing constraints. – Wikipedia

Simply put: Gadgets you see all around.

Example: Projector, Keyboard, Mouse, Clocks ...

Some terms to scare you

PCB: Printed Circuit Board – To hold and connect all electronic parts

Soldering: The process of sticking electronic parts to PCB.

Microcontroller: Small computer on a single integrated circuit (has RAM, ROM, Microprocessor . . .)

Electronic parts: Resistor, Capacitor, Integrated circuits

How to make one?

To make one, you need to do one or more of the things depending upon your requirement.

- ▶ Think & Prepare
- ▶ Prototype
- ▶ Design PCB
- ▶ Manufacture PCB
- ▶ Buy component
- ▶ Soldering
- ▶ Write code
- ▶ Testing
- ▶ Show it to others!

Prototype

Prototype are built on breadboard or development board or depending upon your requirement.

In complex projects, the best way is to get a PCB or development board.

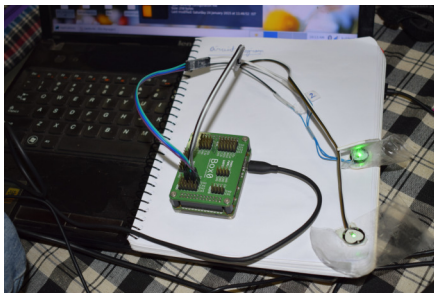


Figure: Sensing heartbeat using Reflection

PCB Design

Designing PCB is an Art, full of fun and with time one gets better. Though one can sketch PCB using hands, it is not recommended (not in practise now a days).

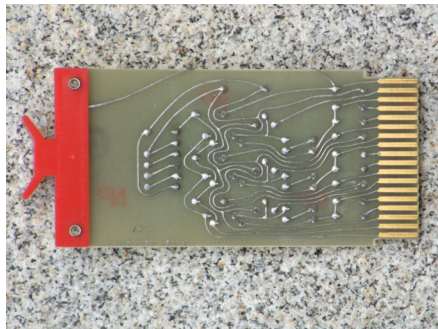


Figure: Hand sketched PCB

Source: <https://simple.wikipedia.org/wiki/File:S111FlipChipBack.jpg>

PCB Design

We now have sophisticated tools for the same (better results and easier).

Example: KiCAD – A Cross Platform and Open Source Electronics Design Automation Suite.

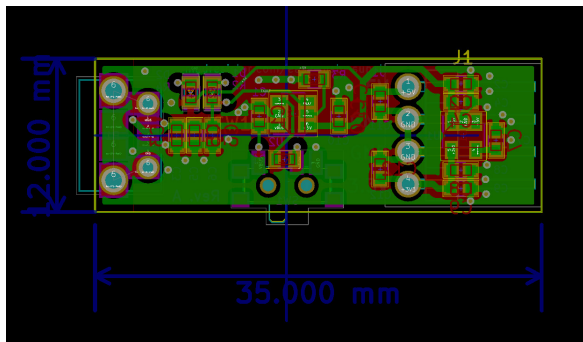


Figure: easy-usb-supply – A pet project of mine

PCB Design

- ▶ Build the schematics
- ▶ Select the footprints
- ▶ Layout the PCB
- ▶ Generate the manufacturing files

Note: Show a real demo instead of just annoying text.

Manufacture PCB

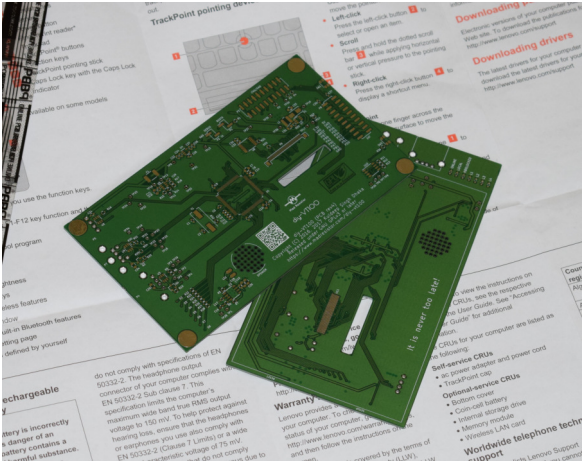


Figure: diy-VT100 rev3 soldering

Manufacture PCB

You can manufacture design in India.
Some services (not endorsing)

PCB Power: Professional PCB manufacturer in India.

Website: <http://pcbpower.com/>

Board: Box0

Cost: Around INR 1600

Peices: 3

Time: 7 days + Shipping

LionCircuit: Low cost PCB manufacturer in India

Website: <http://lioncircuits.com/>

Board: easy-usb-supply

Peices: 3

Cost: Around INR 150

Time: Around 15 days + Shipping

Selecting components

Searching for the right part is another work of its own.
Best way is to look for generic parts that are made by multiple companies.

Always prefer parts that are easily available in market.
Only go for special parts only when required.

Do internet search, read datasheets to understand suitability.
See others design to know what parts people are using.

You can ease your search process using services like:

<http://octopart.com/>

<http://parts.io/>

Buying components



Figure: diy-VT100 USB connector

Buying components

You can buy components from many places in India.
Some services we used (not endorsing)

RS Component:

Website: <http://in.rsdelivers.com/>

Note: Free Shipping, Not much Fuzz, Office in Noida

Semikart:

Website: <http://semikart.com/>

Note: Buying anything that is on Mouser, *website need improvement*

Sunrom: Website: <http://sunrom.com/>

Note: Has a good collection of generic part

Buying components

Some more (not endorsing, have used most):

<http://ebay.in/>

<https://www.exploreembedded.com/>

<https://www.comkey.in/>

<http://www.digibay.in/>

<https://www.fabtolab.com/>

<http://www.inkocean.in/>

<http://aliexpress.com/>

<https://in.element14.com/>

<https://www.digikey.com/>

<http://mouser.com/>

The list goes on ...

Buying components [outside]

If you are importing stuff from outside.
Here are some hidden information.

- ▶ Handling charge (DHL, FedEx take INR 500) is additional to shipping charge.
- ▶ Import duty and tax (need KYC, submit as early as possible)
- ▶ Read the invoice (terms and condition) carefully!

Soldering

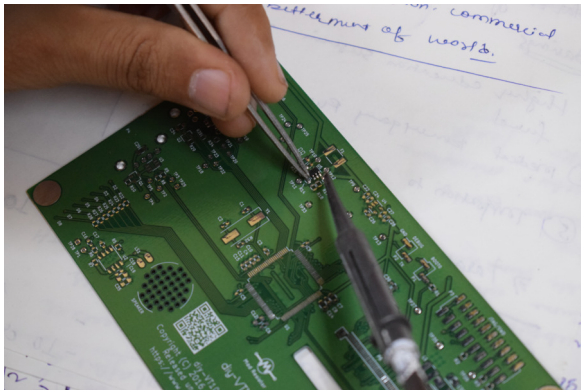


Figure: diy-VT100 rev3 soldering

Soldering using Hot air gun



Figure: diy-VT100 rev4 soldering using hot air gun

Writing code

When your project have a microcontroller or anything else programmable, you need to write code.

We need to compile the code we write for the microcontroller using a cross compiler designed for it.

For example, for ARM - we use ARM GCC.

Note: Show a demo instead of ranting more jargons.

Note: Scare a little more so that people think that compilation process is complex.

Flashing and debugging

Using a debugger you can reset the processor, read memory, overwrite memory etc. . .

One has to write code to the microcontroller flash.
Usually a debugger can do the task too.

This is done using GDB and OpenOCD.

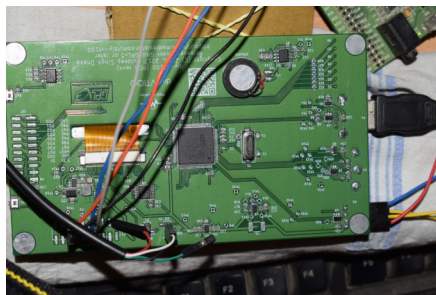


Figure: diy-VT100 rev4 debugging using SWD

Enclosure design

There are programs to design enclosure.

You can print enclosure using 3D printer.

3D services are available online (or make friends :).



Figure: Box0 Enclosure, 3D printed

Enclosure design

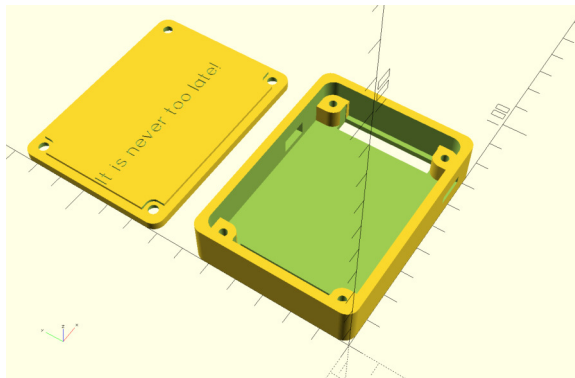


Figure: Box0 Enclosure using OpenSCAD

Acrylic case

You can use make acrylic case for your project easily.

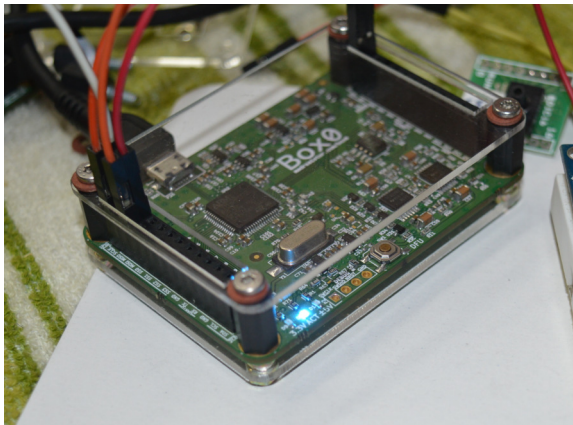


Figure: Box0 Acrylic top

Acrylic case

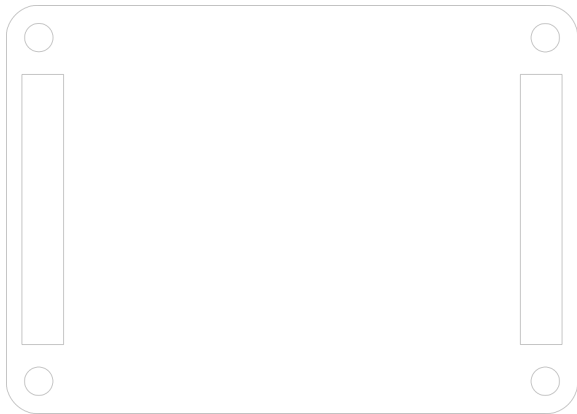


Figure: Box0 Acrylic top in Inkscape

Free/Libre/Open Source tools

- ▶ KiCAD - "A Cross Platform and Open Source Electronics Design Automation Suite"
- ▶ OpenSCAD - "The Programmers Solid 3D CAD Modeller"
- ▶ Fritzing - "an open-source hardware initiative that makes electronics accessible as a creative material for anyone"
- ▶ ARM GCC - "GNU toolchain for ARM Cortex-M and Cortex-R processors"
- ▶ OpenOCD - "Free and Open On-Chip Debugging, In-System Programming and Boundary-Scan Testing"
- ▶ texane/stlink - "stm32 discovery line linux programmer"
- ▶ IceStorm - "reverse engineering and documenting the bitstream format of Lattice iCE40 FPGAs and providing simple tools for analyzing and creating bitstream files"

IOT

The Internet of things (IoT) is the network of physical devices, vehicles, home appliances and other items embedded with electronics, software, sensors, actuators, and connectivity which enables these objects to connect and exchange data. – Wikipedia.

Simply put: Electronics that communicate and do something useful.

Electronics Industry

- ▶ SoC – things are getting minaturized to one IC.
- ▶ Low Power electronics
- ▶ Power saving
- ▶ Communication, Connected electronics
- ▶ Portable electronics
- ▶ Artificial Intelligence, Machine Learning on chip
- ▶ Open Source Instruction Set Architecture (RISC-V)
- ▶ Processors based on RISC-V (SiFive Freedom E310)
- ▶ Open source FPGA tools

Thank you!

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