# Design principles

The Dit Dit Dit Kit, is a Morse decoder kit with a built in key. It uses a 10 Character * 4 line OLED display, to decode the Morse code as its typed on the morse key that is screwed to the board.

The kits can used Handheld, with the inbuilt key, or can be box mounted with an external Morse key, clear screen key and Power supply.

It is designed to be built by young Scouting youth members with limited to no soldering experience. It has many design principles that should ensure lower assembly failure rate, and a longer lasting robust kit

- PCB Mounted battery holder, speakers and switches that will not fall off and break the leads
- Larger solder pads 2.5-3mm, to make soldering easier for Scouts
- Wider spacing for radial component leads to prevent solder bridges, and components
- Wider tracks so that if through holes are delaminated, then the component lead can be soldered to the track - saves replacing the board and starting again,
- No more than 1 track connected to a through hole to reduce the number of tracks to be reconnected if a pad is delaminated.
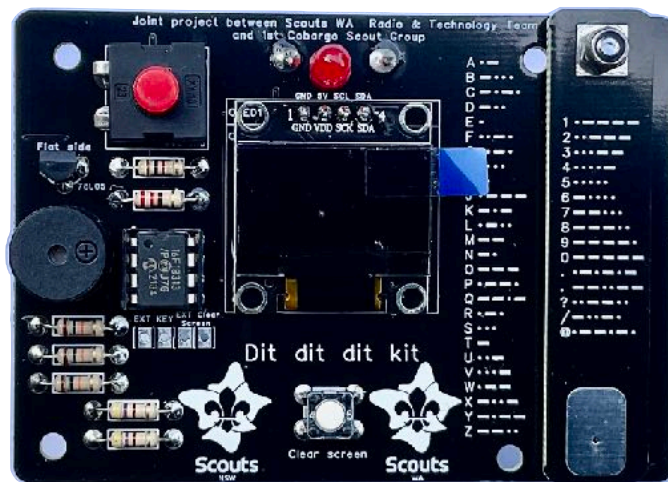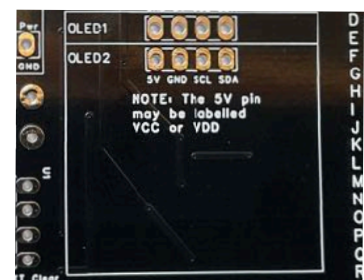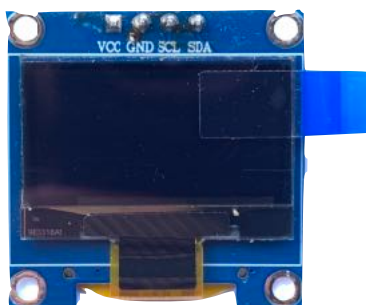
Circuit details

The circuit is based on a PIC16f18313 Microcontroller, running an SSD1306 OLED display via and I2C connection.
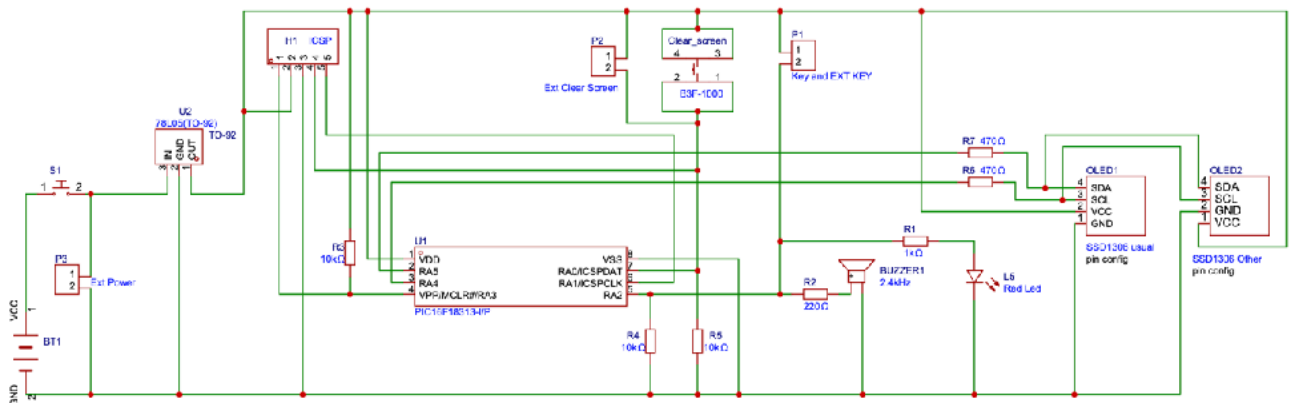
Parts information

1) The SSD1306 is available in 2 different pinouts
   There are 2 sets of pads on the board to match the 2 different display pinouts
   The assembly instructions, include details for how to work out which ones to use.

Solder requirements

You can build this kit with about 30-35cm of 0.8mm Solder. I recommend putting 40cm in with each kit.

Battery holder

The pins on the battery holder are at one end, this can make the other end of the battery holder sag off the board. It is recommended to have piece of double sided tape to hold the other end to the board.
The tape i use is 2mm thick and 10mm wide.
The parts list has a link to suitable tape.

On/Off switch

The on/off switch is 12mm * 12mm with 90 degree pins.
This switch is very robust, but the pins come out one side, so it requires a piece of 0.8mm tape to hold it firmly on the board and stop it getting bent up if knocked from the other side. The parts list has link to suitable tape.

NOTE: This is 3M VHB Tape. It does not stick very well initially, and takes up to 72 hours to fully cure, at which point its very hard to remove. This must be put on well before you run the activity, to ensure it sticks to the switch, so that when the scouts take of the red cover tape, the VHB tape will stay on the switch.

Ordering the board

To make ordering the board easier, i have hosted it on the PCBWAY website. Just click on the "Board Order Link" listed under documentation, and that will take you to the relevant page on the PCBWAY website, where , you simply click "Add to Cart", then put in quantities etc. (you will also need to create an account with PCBWAY) https://www.pcbway.com/

NOTE ON ORDERING ISSUES
This board has a "panelized" break of section (the morse key). This usually costs more to order, as this is usually done when you have an extra circuit on a separate board, but attached to the same board in the same order. However in this case it is only 1 circuit as the key breaks off and connects to the main PCB.

When you are ordering the board, PCBWAY may look at it and considerate it panelized, and send you a note about the increased cost. Just respond to it and let them know that its only one circuit, not 2. There are no additional components on the key, and the key is attached to the main PCB with a screw. They accepted this when i told them about it, and the order went through as a non panellised board.

Box mounting Options

The Kit can be mounted in a box, and has standard 2.54mm pin header connections for external power options, external Morse Key and external Clear Screen Key, and can take a larger display. There are also 4 mounting holes that will take an M3 screw.

External Morse Key and Screen Clear button

There are 4 connections, 2 for the external morse key and 2 for the External Clear Screen key, both of these are Normally Open Switches,
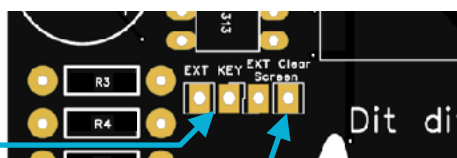
Will fit a standard 2.54mm spacing pin header
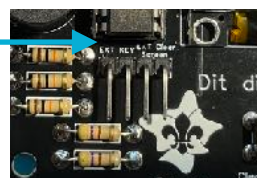
External Power options

The circuit can be powered externally 2 ways

1) Leave in the 78L05 Voltage regulator and feed in from 7v DC or more, ensuring that you are not exceeding the 1/2W power dissipation limits (and 78L05 voltage limit) - its not a Switch mode regulator so you will need to calculate this.
   Max current is approximately 25ma, with the SSD1306 display full of characters and the buzzer going
   (Will fit a standard 2.54mm spacing pin header)
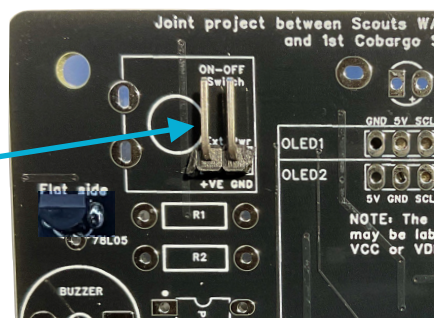
2) Take out the 78L05 and feed a regulated 5v in (e.g from a USB   power adapter) and place a short across the 78L05 input and output pins, to feed the 5V directly in.
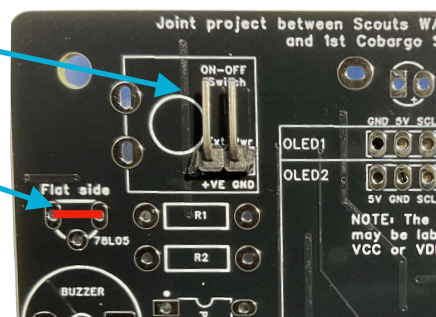
External Display

If mounting this circuit in a box, you can either used the SSD1306 which fits nicely on the board or use a larger SSD1309. The pin spacing for the OLED is a standard 2.54mm. No changes are needed for the program to accommodate the larger display. However it does use more power to run it, but still within the limits of the 78L05. I would recommend measuring it before using an external supply, to ensure you do not exceed the78L05 limits. It uses more power the more it is displaying.
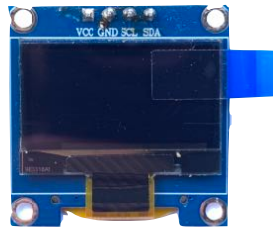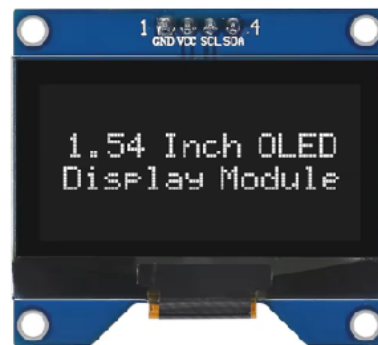
SSD1306 - 0.96 inch   SSD1309 - 1.54 inch

Programming the PICS
You will need a PIC programmer

The following programmer and ZIF socket does the job nicely,
just get the **PicKit 3.5 with ICD2**

https://www.aliexpress.com/item/4001283158851.html?
spm=a2g0o.order_list.order_list_main.25.10f01802ENwKsh

Note **MPLAB version 6.2** supports this programmer, higher versions no longer
support PicKit 2,3 or 3.5

Source Code
The code is available for download on the same page you found this documentation.
It is available in a complied Hex file ready to program the Pic using MPLAB IPE.

Programming methods
There are 2 methods you can use to program the PIC

1) Program them beforehand in a pic programmer, So that they just need to be put into the IC
socket, once the Scouts have soldered it together - This is by far the easiest Option.

2) Program the Pic using ICSP, once the Scouts have soldered it together.

WARNING - This option is a lot more involved and I have only included it for those that like to do
ICSP, and just because I could add it in - call it over the top design - i just could not help myself !!!
If you have designed PIC boards before you will understand/sympathise - LOL !!!!

The Board has ICSP contacts on it. You would need to ensure that the Battery holder is not
soldered in until the PIC has been programmed and Board tested using this method as a blank
PIC will not run the display, so you will not know if there are any assembly issues, and the battery
holder is hard to remove once soldered on as the double sided tape is rather strong.

ICSP Pins

Also its important not to have batteries installed when you program the PIC as there is no
blocking diode - to reduce component count and cost.

To program the PIC using ICSP, you will need one of the following - get a 5 pin Single row 2.54mm
spacing

https://www.aliexpress.com/item/1005006358713448.html?
spm=a2g0o.order_list.order_list_main.57.50371802Un3mEP

Connecting to the ICSP Pins

Careful alignment when putting the clip on, is required as the clip will rotate off the pins.
Clever people with 3D printers will come up with a solution for this !!!

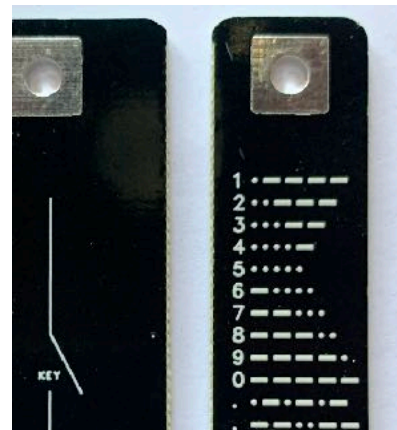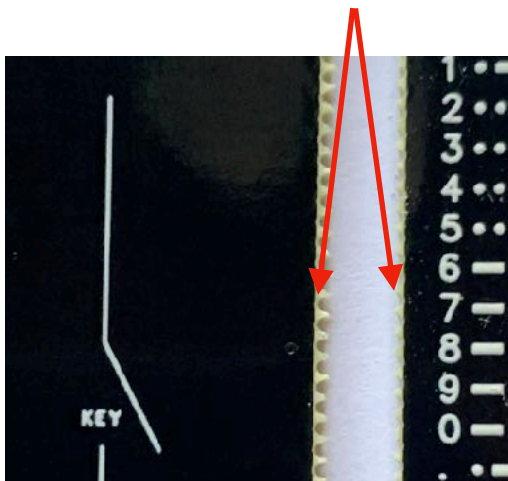The Square Pin on the ICSP pads labelled MCLR is connected to the pin with the triangle on the PicKit (pin 1 MCLR).

Remove the Battery if using ISCP

Remove the Battery if using ISCP
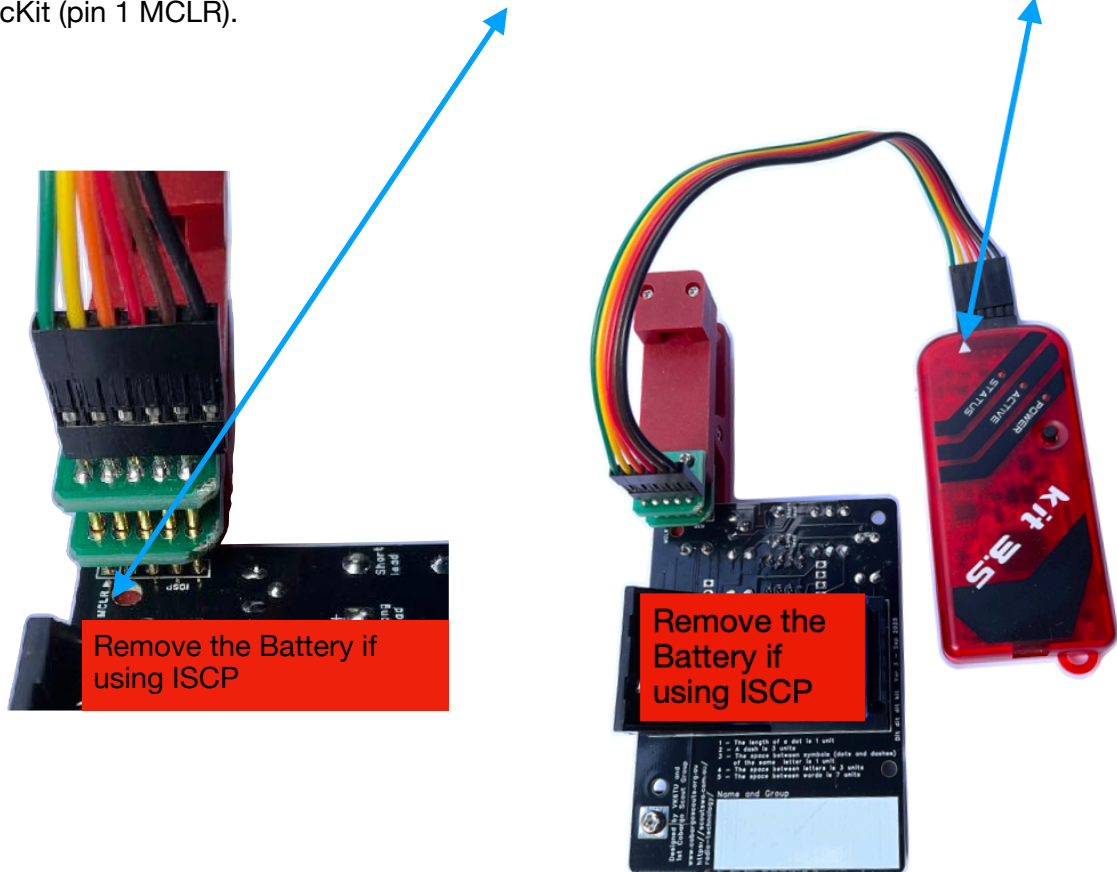
Preparing the Morse Key

1) Break the key off with a pair of pliers

2) Sand down both sides with a file or sandpaper to remove the rough edges

Rough edges

The key is screwed onto the board, with a M3 Screw, nut and Nyloc Nut. It is recommended that you use a 5.5mm Socket screwdriver to tighten the screws

5.5mm Socket screwdriver

https://www.aliexpress.com/item/1005006859798111.html?spm=a2g0o.order_list.order_list_main.16.7b4d1802

When assembling the kits, you need to put a large blob of solder on the lower key pad. It takes a lot of solder to do this, and will remain in a liquid state and quite hot for some time. It is recommended that you do this as part of the kit preparation for younger youth members for safety reasons.
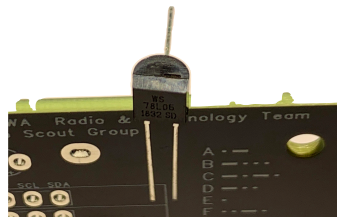
78L05 leads

Lead bending
  The 78L05 leads need to be bent so that it fits the pads on the board

Bend the middle
lead Backwards

Put it over the board, and
bend the lead down

It should look like this.

78L05 Placement/orientation

It is important that when the 78L05 is
soldered in, the flat side with the writing on it
faces the top of the board, please check the
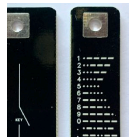orientation before putting the battery in

Top

To Do list before the Day

1) Order Boards

2) Order Components
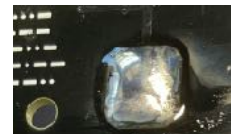
3) Put the double sided tape on the battery holder.

4) Put the double sided tape on the Switch

5) Break of the Key and sand it down.

6) For younger youth assembling the kits, i recommend putting the blob of solder on for them for safety reasons, and bending the 78L05 pins.

7) Download the Dit Dit Dit Kit, Hex Production File from the Cobargo website and program and test the PIC IC's, so that they are ready to be put into the boards

8) Print one copy of the Component Sorter per Soldering station, and laminate them. These are used by the Scouts to sort the components, do not let them start soldering until you have checked that they have sorted them correctly

9) Print two copies of the Assembly guide (double sided) per table (4 - 6 scouts) - they can just share them. It is recommended that you laminate them.

10) Package only the following components

- 7 * Resistors
- 1* IC socket
- 1 * SSD1306
- 2 * Switches
- 1* Buzzer
- 1* LED
- 1*78L05 Voltage regulator
- PCB
- Solder
- 10mm Screw, 1 nut, 1 Nyloc Nut

<u>I strongly recommend that you do not give out the battery holder, battery or IC with the other parts</u>

When the youth members are assembling them, get the Youth to assemble all the components up to and including step 15 on the assembly guide, then thoroughly check the soldering for any issues.

Then put in the ic and test the board 1st. If it does not work, either fix the soldering or get them to fix it.

Only give out the Battery holder when the board works, otherwise they will solder it in, and its hard to remove because of the double sided tape to fix any soldering issues that it covers.

It also ensures that if there are any shorts, or components that are in the wrong way, nothing will "burn out". Its not good when the smoke leaks out !!!!!

Assembly guide suggestion

Install the components in the following order (the board will stay relatively flat on the bench this way, and will not require you to splay the wires much to keep the component from falling out.

1. Resistors - 7
2. IC Socket
3. B3F-1000 (clear screen switch)
4. LED
5. Buzzer
6. 78L05 Voltage Regulator
7. On/Off Switch
8. Display

Check the soldering before going any further

1) Check the soldering for dry joints, shorts etc
2) Put in the IC
3) Test the board by putting a batteries in the battery holder and just putting it into the board and twisting is slightly so that it contacts the battery socket pads, and check that it works. Also check that the switch turns off and on, and that the clear screen button works

   If all is ok, let them solder the battery holder in, if not fix the issues 1st.

   If you put the battery holder in without testing it, its hard to remove because of the strength of the double sided tape, so please test it 1st.

4. Battery Holder - remember to remove the double sided tape cover, this will hold the bottom end of the battery holder onto the board, to help prevent it getting broken off
5. Get them to write their name and Scout Group on the label on the back of the board.
6. Put the Kapton tape on the back