Soldering Hints
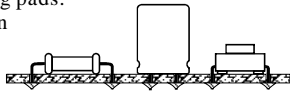
① Put leads through mounting holes from the side with part outline. Ensue component evenly touch PCB.

② Solder leads at the other side. Solder should fully fill and cover soldering pads.
Avoid bridges between neighboring pads.

③ Cut unused leads flush with cutter.

DSO 138 Oscilloscope DIY Kit
User Manual Rev. 05

Applicable models: 13803K, 13804K
Applicable firmware: 113-13801-060 or later

Tools you need

① Iron (20W)   ④ Screw driver
② Solder wire   ⑤ Flush cutter
③ Multimeter   ⑥ Tweezers

Before you start

① Check part values & quantities against part list
② Always meter resistor values before soldering
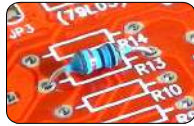③ Understand all part polarities and orientations

Step 1 — Assembly Main Board and LCD board (follow the order as numbered)

Important !!!
Install all SMD parts before proceeding to Step1 if you purchased kit 13804K.

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1. Resistors

Note:
Always meter resistor values before soldering

☐ R1, R14, R16 : 100K Ω	☐ R7, R36 : 180 Ω
☐ R2 : 1.8M Ω	☐ R8, R12, R13 : 120 Ω
☐ R3 : 200K Ω	☐ R9, R15, R26 : 1K Ω
☐ R4 : 2M Ω	☐ R10 : 3K Ω
☐ R5 : 20K Ω	☐ R11 : 150 Ω
☐ R6 : 300 Ω	☐ R38 : 1.5K Ω
	☐ R28, R40 : 470 Ω
	☐ R37, R39 : 10K Ω

2. HF-Chokes

☐ L1, L3, L4 : 100 μ H
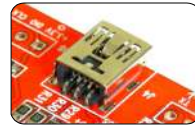
3. Diodes

Cathode

☐ D1 : 1N5819
☐ D2 : 1N4004
(or 1N4007)

4. Crystal

☐ Y1 : 8MHz

5. USB Socket *

☐ J4 : USB mini -B

Note:
This connector is optional.

6. Tact Switches

☐ SW4, SW5, SW6, SW7, SW8 : 6 X 6 X 5mm

7. Ceramic Capacitors

☐ C1, C9, C10, C11, C14, C15, C16, C17, C18, C20, C23 : 0.1 μ F
☐ C2 : 330pF
☐ C3 : 3pF
☐ C5 : 1pF
☐ C7, C8 : 120pF
☐ C12, C13 : 22pF

8. LED

Solder positive pole (the longer lead) to the square pad

☐ D3 : φ 3mm, green

9. Pin header (for power)

Face the opening outward

☐ J9 : 2 Pin

10. Transistors

☐ Q1 : 8550
☐ Q2 : 9014

Attention!
Packages are similar. Do not mix up!

11. Regulators

☐ U4 : 79L05
☐ U5 : 78L05

Attention!
Packages are similar. Do not mix up!

12. Capacitor trimmers

☐ C4, C6 : 5 - 30pF

13. Power inductor

☐ L2 : 1mH/0.5A

14. Electrolytic capacitors

Solder positive pole (the longer lead) to the square pad

☐ C19, C21, C22, C24, C25, C26 : 100 μ F/16V

15. Power connector
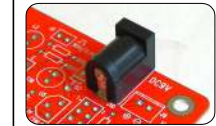
☐ J10 : DC005

16. Pin-header (male) *

☐ J5 : 1 X 3 pin
☐ J6 : 1 X 4 pin

Note:
These pin-headers are optional.

17. Pin-header (female)

☐ J7, J8 : 1 X 2 pin
☐ J3 : 2 X 20 pin

18. Slide switches

☐ SW1, SW2, SW3 : 2P3T

19. BNC connector

☐ J1 : BNC

Note:
The thicker pins need to heat up longer to get good soldering result.

20. Test signal ring

1) Make a small ring with a lead cut-off.
2) Solder the ring to the two holes of J2 (as shown in the photo).

21. JP3

Short JP3 with solder

22. LCD Board

Note: Install to the side opposite to LCD panel.

☐ J1   : 2 X 20 pin
☐ J2, J3   : 1 X 2 pin

Finished look

Step 2   Test and Use

Notes: 1) JP1, JP2, JP5, and JP6 at bottom side should be kept open for normal running mode.
2) The USB connector do not have function. It was provided for future or user own use.
3) A 9V DC power supply (> 200mA capacity) is required to run the scope. Power supply is not included in the kit.

A. Check voltages

① Apply 9V power to J10 (or J9).
② Check voltage at TP22. It should be around +3.3V.
③ If voltage at TP22 is good disconnect power. Short JP4 with solder permanently .
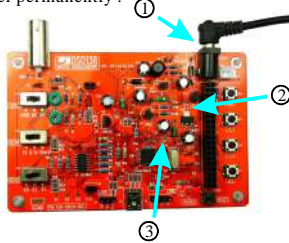
B. Attach LCD board

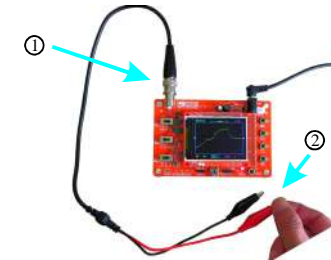Plug LCD board into the female headers J3, J7, and J8 on the main board.

C. Verify

① Connect power supply again. You should see LCD lights up and oscilloscope panel displayed.
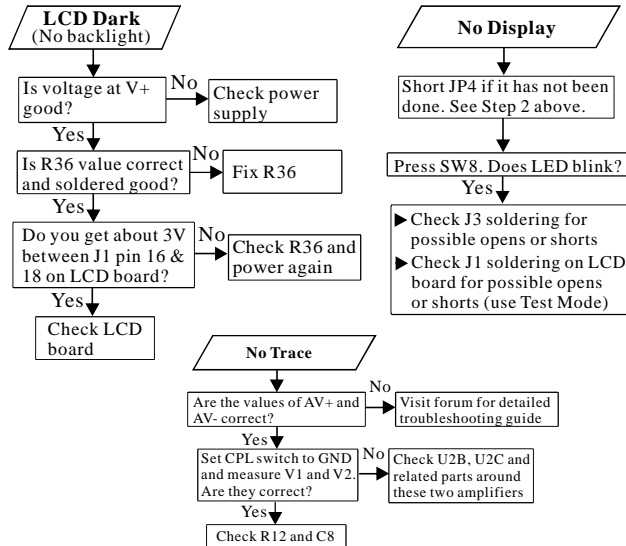② Press various buttons and move switches to verify their functions.

"Trigger" LED blinking twice indicates booting-up is good.

A. Use

① Attach probe clips to J1.
② Touch the red clip with your finger. Do you see signal from your finger?

Troubleshooting

LCD Dark (No backlight)

Is voltage at V+ good? — No → Check power supply
↓ Yes
Is R36 value correct and soldered good? — No → Fix R36
↓ Yes
Do you get about 3V between J1 pin 16 & 18 on LCD board? — No → Check R36 and power again
↓ Yes
Check LCD board

No Display

Short JP4 if it has not been done. See Step 2 above.
↓
Press SW8. Does LED blink? — No → ▶ Check +3.3V voltage ▶ Check Y1, C12, C13 ▶ Check LED installation
↓ Yes
▶ Check J3 soldering for possible opens or shorts
▶ Check J1 soldering on LCD board for possible opens or shorts (use Test Mode)

No Trace

Are the values of AV+ and AV- correct? — No → Visit forum for detailed troubleshooting guide
↓ Yes
Set CPL switch to GND and measure V1 and V2. Are they correct? — No → Check U2B, U2C and related parts around these two amplifiers
↓ Yes
Check R12 and C8

NOTE 1: The voltages in the photo are for reference only. The voltages on your board could be different. But they should be close to the values shown.

NOTE 2: LED will be blinking constantly if MCU (U1) can not detect valid LCD controller. Check LCD pin-header soldering.

NOTE 3: Make sure U1 and LED working (you see LED blinks twice at pressing RESET) before using Test Mode.
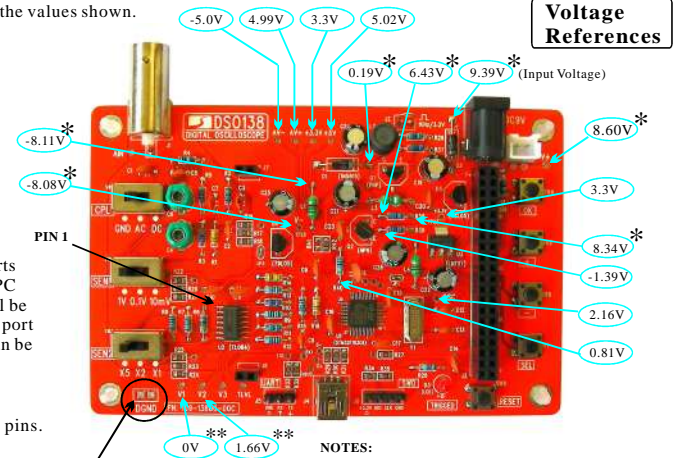
Test Mode

What it is and how it works
Test Mode is used to find out possible opens (for all port pins) and shorts (for pins PB0 - 15 and PC13-15). When entered it first checks PB and PC pins with special patterns to find out possible shorts. If found LED will be fast blinking. Otherwise, it generate 3.3V and 0V alternatively at each port pins (PA, PB, PC and PD) in cycle of about 4 seconds. These signals can be used to check for opens.

How to use
1. Hold down SW4 and press RESET to enter Test Mode.
2. If you see LED fast blinking that means there are shorts on PB or PC pins. You need to find out the shorts first.
3. If you see LED slowly blinking use a volt-meter to check each pin related connections that are suspected open. When you don't see voltage change at a spot which is supposed being connected to a port pin there may be open between the spot and the port pin.

Voltage References

-5.0V   4.99V   3.3V   5.02V
0.19V   6.43V   9.39V (Input Voltage)
-8.11V
-8.08V
8.60V
3.3V
8.34V
-1.39V
2.16V
0.81V

PIN 1
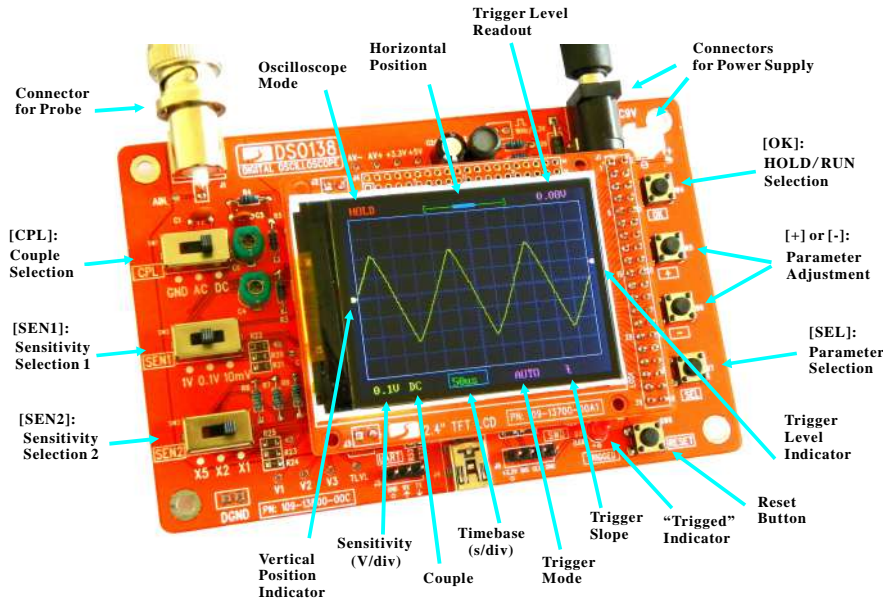
Place the negative pen of volt-meter here to do voltage measurements.

0V   1.66V

NOTES:
*: These voltages are input voltage dependent. The values shown were measured when input voltage was 9.39V.
**: These voltages are measured when CPL switch (SW1) is set to GND position.

How to Use

Display and Controls

Trigger Level Readout

Horizontal Position

Oscilloscope Mode

Connectors for Power Supply

Connector for Probe

[OK]: HOLD/RUN Selection

[CPL]: Couple Selection

[+] or [-]: Parameter Adjustment

[SEN1]: Sensitivity Selection 1

[SEL]: Parameter Selection

[SEN2]: Sensitivity Selection 2

Trigger Level Indicator

Reset Button

Vertical Position Indicator

Sensitivity (V/div)

Timebase (s/div)

Trigger Slope

"Trigged" Indicator

Couple

Trigger Mode

Connections

Power Supply: Connect DC power supply to J9 or J10. The power supply voltage must be in the range of 8 - 12V.

Probe: Connect probe to J1.

<div style="border">

Attention

1. Power supply voltage must not exceed 12V. Otherwise U5 will get hot.
2. Allowed maximum signal input voltage is 50Vpk (100Vpp) with the clip probe.

</div>

Operations

Press on [SEL] button: Select parameter to be adjusted. The selected parameter will be highlighted.

Press on [+] or [-] button: Adjust the parameter selected by [SEL] button.

Press on [OK] button: Freeze waveform refresh (entering HOLD state). Press on it again will de-freeze.

Change [CPL] switch: Set couple to DC, AC, or GND. When GND is selected the scope input is isolated from input signal and connected to ground (0V input).

Change [SEN1] or [SEN2] switch: Adjust sensitivity. The product of [SEN1] and [SEN2] settings makes the actual sensitivity which is displayed at the lower-left corner of the panel.

Press on [Reset] button: Perform a system reset and re-boots the oscillscope.

Tips

Vpos Alignment
This is to fix the mismatch between 0V trace and VPos indicator. To do this set couple switch [CPL] to GND position. Press on [SEL] button to make VPos indicator highlighed. Hold down [OK] button for about 2 seconds. You will see VPos indicator aligned to 0V trace when you release [OK] button. You may see some residue mismatch remains at the highest sensitivity settings. This is normal.

Restore Factory Default
Hold down [+] and [-] buttons simultaneously for 2 seconds.

Auto-center Trigger Level
Highlight trigger level indicator and hold down [OK] button for 2 seconds.

Auto-center Horizontal Position
Highlight HPos indicator and hold down [OK] button for 2 seconds.

Probe Calibration

Leave black clip un-connected

Connect red clip to test signal output

Because there is always some capacitance between scope input and ground probe needs to be calibrated to achieve better measurement results for high frequency signals. This can be done with the help of the built-in test signal. To do this please follow the steps below.
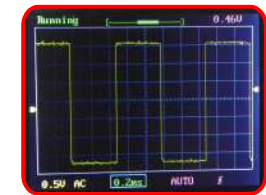
1. Connect the red clip to the test signal terminal and leave the black clip un-connected (see photo at right).
2. Set [SEN1] switch to 0.1V and [SEN2] switch to X5. Set [CPL] switch to AC or DC.
3. Adjust timebase to 0.2ms. You should see waveform similar to that shown in photos below. If traces are not stable adjust trigger level (the pink triangle on right screen border) so as you get a stable display.
4. Turn C4 (capacitor trimmer) with a small screw driver so that the waveform displays sharp rightangle (photo C).
5. Set [SEN1] switch to 1V and [SEN2] switch to X1 while keep all other settings unchanged. Adjust C6 so that sharp rightangle waveform is displayed.

C6

C4
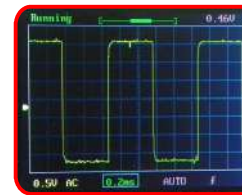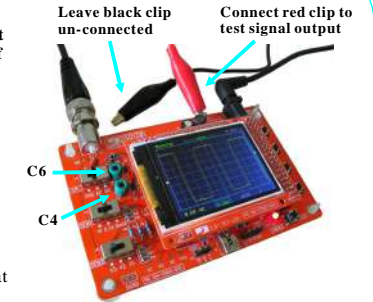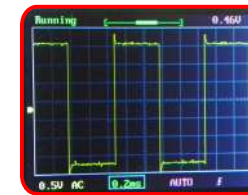
A – Not enough   B – Too much   C – Good

Turn On/Off Readouts
Press [SEL] so that timebase is highlighted. Hold down [OK] button for about 2 seconds. This will turn on/off measurement readouts.

Waveform Save/Recall
Press [SEL] & [+] simultaneously: Save currently displayed waveform to non-volatile memory.
Press [SEL] & [-] simultaneously: Recall saved waveform

Triggers and Their Modes
Triggers are events that indicate signal voltage acrossing a set level (i.e. trigger level) along a specified direction (i.e. trigger slope, rising or falling). Oscilloscope uses triggers as reference points in time for stable waveform display and measurements.

Auto Mode
In auto mode oscilloscope will perform display refresh no matter triggers happen or not. When triggers are detected waveform display will be displayed with reference to trigger points. Otherwise, display waveform at ramdom reference points.

Normal Mode
In normal mode oscilloscope will only perform display refresh when there are triggers. If no triggers happen waveform display will stay unchanged.

Single Mode
Single mode is the same as normal mode except that oscilloscope will enter HOLD state after a trigger has been detected and waveform display has been updated.

Normal and single modes are useful for capturing sparse or single waveform.

Specifications	
Max realtime sample rate	1MSa/s
Analog bandwidth	0 -- 200KHz
Sensitivity range	10mV/div - 5V/div
Max input voltage	50Vpk (1X probe)
Input impedance	1M ohm/20pF
Resolution	12 bits
Record length	1024 points
Timebase range	500s/Div -- 10us/Div
Trigger modes	Auto, Normal, and Single
Trigger position range	50%
Power supply	9V DC (8 – 12V)
Current consumption	~120mA
Dimension	117 x 76 x 15mm
Weight	70 gram (without probe)

CPL
MCU
SEN1
SEN2
V1 0V **
V2 1.6V **
V3

AIN
J1 BNC
TP1

** These voltages were measured when SW1 is at GND position.

Analog Channel

U2A TL084/SO
U2B TL084/SO
U2C TL084/SO
U2D TL084/SO

SW1A SW2A SW3A
SW1B SW2B SW3B

C1 0.1u
C2 220pF
C3 3pF
R1 100K 10mV
R2 1.8M 1% 0.1V
R3 200K 1%
R4 2M 1% 1V
C4 30pF
C5 1pF
C6 30pF
C7 120pF
R5 20K 1%
R6 300
R7 180
R8 120
R9 1K
R10 3K
R11 150
R12 120
R13 120
R14 100K
R15 1K
R16 100K
R17 10K
R18 3.3K
R19 1.5K
R20 10K
R21 3.3K
R22 1.5K
R23 10K
R24 3.3K
R25 1.5K
C8 120pF
C9 0.1u
C10 0.1u
C11 0.1u

CPLSEL TP6
VSENSEL1 TP7
VSENSEL2 TP8
TP2 TP3 TP4 TP5
TLVL
Trigger Level

X1 X2 X5

U1 STM32F103Cx

PA0 10
PA1 11
PA2 12
PA3 13
PA4 14
PA5 15
PA6 16
PA7 17
PA8 29
PA9 30
PA10 31
PA11 32
PA12 33
PA13 34
PA14 37
PA15 38
PB0 18
PB1 19
PB2 20
PB3 39
PB4 40
PB5 41
PB6 42
PB7 43
PB8 45
PB9 46
PB10 21
PB11 22
PB12 25
PB13 26
PB14 27
PB15 28
PC13/TEMPER/RTC 2
PC14/OSC32_IN 3
PC15/OSC32_OUT 4
PD1/OSC_OUT 6
PD0/OSC_IN 5
BOOT0 44
nRST 7
VBAT 1
VDDA 9
VSSA 8
VDD_1 24
VDD_2 36
VDD_3 48
VSS_1 23
VSS_2 35
VSS_3 47

ADCIN
VSENSEL2
VSENSEL1
CPLSEL
V-MON
TESTSIG
TRIG
TX1
RX1
USBDM
USBDP
SWDIO
SWCLK
LED
DB0 DB1 DB2 DB3 DB4 DB5 DB6 DB7
TL_PWM
VGEN
LCD_nRD
LCD_nRESET
BTN4 BTN3 BTN2 BTN1
LCD_nCS
LCD_RS
LCD_nWR

TP9
Y1 8MHZ
C12 22pF
C13 22pF
JP1
R27 1K
TP10
C14 0.1u
SW8
L4 100uH
C15 0.1u
C26 100uF
C16 0.1u C17 0.1u C18 0.1u
LED R28 470 D3 +3.3V
JP2
JP3
TP11 TP12 TP13

USB
J4 USB_mini_B
VBUS 1
D- 2
D+ 3
ID 4
GND 5
TP33
R31 1.5K
R29 22 USBDM TP14
R30 22 USBDP TP15

Uart
J5
R32 1K RX1 TP16
R33 1K TX1 TP17

Buttons
OK SW4 BTN1
+   SW5 BTN2
-   SW6 BTN3
SEL SW7 BTN4

Test Signal Terminal
J2 R26 1K TESTSIG

SWD Port
USE SWD DEBUG MODE ONLY
J6
R34 10K +3.3V
SWDIO
SWCLK
R35 10K

LCD Module Connector
J3 LCD HEADER
LCD_nCS LCD_RS
LCD_nWR LCD_nRD
IM0
+3.3V JP5
LED-K1 LED-A
LED-K3 LED-K2
JP6 IM3 LED-K4 R36 180 V+
DB0 DB1
DB2 DB3
DB4 DB5
DB6 DB7
LCD_nRESET +3.3V
+3.3V
J7 J8

Power Supply

Caution:
Power supply voltage can not be higher than 12V.

J9
9.3V *
J10
D2 1N4004
V+
C19 100uF
DC 9V
U5 LM78L05/T92
VIN VOUT GND
8.6V *
+5V
C20 0.1u
L3 100uH
C21 100uF
TP20 TP24 5V
AV+
TP27 TP28 TP29 TP30

U3 LM1117-3.3/TO263
VIN VOUT VOUT GND
TP21 TP22
JP4 +3.3V
TP23 3.3V
C22 100uF

Q1 8550 8.6V *
D1 1N5819 -8.1V *
TP25 V-
L1 100uH
L2 1mH/1A
C24 100uF
C25 100uF
R37 10K
R38 1.5K
8.3V *
6.4V *
0.2V *
U4 79L05/TO92
IN OUT GND
TP26 -5V *
AV-

Q2 9014
R39 10K
C23 0.1u
R40 470 VGEN
-1.4V *
0.8V
+3.3V
R41 10K V-MON
R42 1K
TP31 TP32

* These voltages are power voltage dependent. The values shown were measured at 9.3V power voltage.

Notes:
1. Part values used could be different to the values shown. Please refer to part list.
2. Parts in dash-line boxes are SMD devices.