DSO138mini Troubleshooting Guide

Applicable main board: 109-13800-00I
Applicable analog board: 109-13801-00H

1. Frequently Found Problems

1) LCD completely dark. No backlight
2) LCD lights up but no display (while screen)
3) Incorrect V+
4) Incorrect V-
5) Incorrect AV+
6) Incorrect AV-
7) Grids displayed and buttons working but no trace
8) When moving slide switches (SW1, SW2, or SW3) their screen indicators don't change accordingly
9) Incorrect vertical sensitivity
10) Can not reach good compensation for cap trimmer C4 or C6

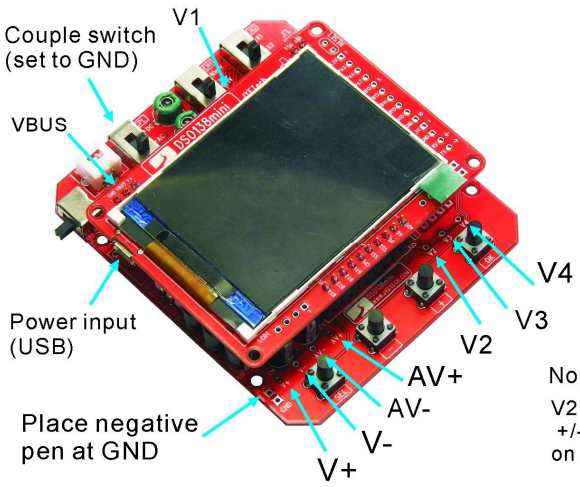
2. Tools You Need

- **Volt-Meter** Prepare a commonly available digital multi-meter that has reasonable accuracy. In case you only have old style mechanical volt-meter the voltage reading could be lower than its real value due to low impedance of the meter.
- **Ohm-Meter** Ohm-meter is used to check resistance and continuity. Again you can use the ohm-meter in a digital multi-meter.
- **Oscilloscope** We assume many users of this kit are beginners who do not have oscilloscope so we are not going to discuss the troubleshooting methods with oscilloscope. Users who have oscilloscope can use it to check and view signals basing on their own understanding.

3. Troubleshooting Skills

- Unless otherwise stated voltage measurements should be made by placing the negative pen to the reference point of circuit board (usually denoted as GND) and positive pen to the point of interest. See the photo below.
- At resistance measurement please make sure to follow the rules below.
    1) Power supply must be turned off if measurement is made to in-circuit components.
    2) To measure the resistance of in-circuit resistor you must disconnect at least one end of the resistor to get correct reading. If you don't the resistance formed by the rest components in circuit will lower the reading.
- Use ohm-meter to find out opens and shorts. Similarly, you must cut power before doing the checking.
- Always check power supplies first when you have problems. Make sure power supply voltages are within acceptable ranges.
- When you measure resistors with large resistance avoid touching both pens with your hands because the resistance of human body would lower the reading significantly.

4. Reference Voltages



References
(*) Input dependent

VBUS	+5.10V
V+ (*)	> 3.5V
AV+ (*)	> 3.5V
V- (*)	< -3.5V
AV- (*)	< -3.5V
V1	0V
V2	1.05V
V3	2.1 V
V4	-1.05V

Note:
V2 - V4 could have up to +/- 0.2V variance depending on power supply voltage.

Fig. 1

5. Detailed Checking Steps for Commonly Found Problems

Symptom 1: ***LCD completely dark.. No backlight***

Analysis: This indicates the LCD backlight LED does not get powered or is broken. LCD backlight is powered by V+ via R4 (on the main board). So the problem cause should be with V+, R4, LCD backlight itself, or the connections between them.

Solution: Check by the following procedures.

1) V+.
2) R4 (on main board) soldering and value.
3) Continuity from V+ to R4 and from R4 to LCD pins. For access to LCD pins you might need to remove the adhesive tape that sticks LCD to PCB.
4) LCD pin soldering.

Symptom 2: ***LCD lights up but no display (white screen)***

Analysis: Since the LCD is controlled by the MCU (U1) the possible causes for this problem could be:

1) The MCU is not running.
2) The MCU is running but can not communicate with the LCD due to poor connections between them.
3) The LCD is bad.

Solution: Basing on analysis above we can

1) Verify MCU is running. At powering up the LED D1 on the main board will blink three times. If you don't see this it is likely that the MCU is not running. Please check MCU power supply (+3.3V) and the crystal and soldering.
2) If MCU is running check the connections between MCU and LCD by referring to the schematic. Because the pins of MCU and LCD are small and density is high it is difficult to do continuity check with ohm-meter

unless you have sharp pens. Visual check is advised.

Symptom 3: ***Incorrect V+***

Analysis: By referring to the schematics you can see that V+ comes from either of two sources. One is the USB power from J7 on the main board. The other is battery from J6 on the analog board. If you power the device by USB V+ is from VBUS via diode D2 (on the main board) and BOB1 if installed (on the analog board). If you power the device by battery V+ is from the battery via BOB1. The problem of V+ could be caused by open or higher than normal resistance in these connections. On the other hand, V+ problem could also be caused by too large load current because large current would drag down input voltage.

Solution:

1) Check input voltage. If input voltage is significantly lower than its normal value disconnect the board and check the input voltage again. If the value returns normal that indicates the board is over current. There could be shorts somewhere between VBUS/V+ and GND. Sometimes a reversely installed IC would create very large current.
2) If input voltage is normal check the connections from input to V+ for opens.

Symptom 4: ***Incorrect V-***

Analysis: V- is generated by the negative voltage generator formed by U2 (ICL7660 on the analog board), C12, and C13. Most of time problems of V- are caused by defects in these components. But V- could also be dragged low by over large load current. It is suggested to disconnect loading before troubleshooting the negative voltage generator.

Solution:

1) Disconnect L2 and check if V- returns to normal. If it does that means V- problem was caused by large load current. This large current is usually created by shorts between AV- and ground. You need to uncover the short spot.
2) If V- problem persists with L2 disconnected first replace C12 and C13 one by one to see if you can get V- normal. If not replace U2.

Symptom 5: ***Incorrect AV+***

Analysis: AV+ is from V+ through L1. If V+ is good but no AV+ that usually means L1 is open. If both V+ and AV+ are significantly lower than normal that means there are possibly shorts between AV+ and ground.

Solution:

1) If V+ is good and AV+ is low check the resistance of L1. The resistance of L1 is 2 – 3 ohm maximum. If you find its value too large replace it.
2) If both V+ and AV+ are low check the resistance between AV+ and GND. If you find its value is close to zero that means there are shorts. You need to uncover the short spots.
3) Check the orientation of U1 on the analog board. If U1 is installed reversed it will draw large current from AV+ that would make both AV+ and V+ low.

Symptom 6: ***Incorrect AV-***

Analysis: AV- is from V- through L2. If V- is good but no AV- that usually means L2 is open. If both V- and AV- are significantly lower than normal that means there are possibly shorts between AV- and ground.

Solution:

1) If V- is good and AV- is low check the resistance of L2. The resistance of L2 is 2 – 3 ohm maximum. If you find its value too large replace it.
2) If both V- and AV- are low check the resistance between AV- and GND. If you find its value is close to zero that means there are shorts. You need to uncover the short spots.
3) Check the orientation of U1 on the analog board. If U1 is installed reversed it will draw large current from AV+ that would make both AV- and V- low.

Symptom 7: ***Grids displayed and buttons working but no trace***

Analysis: There are two possible causes for this problem. One is the ADC inside U1 on the main board is broken. The other is the input voltage (i.e. output voltage of the analog board) is off too much from its center value which is about 1V. At real world the first cause is rare to see. In most case it is the second cause that makes the problem.

Solution:

1) Make sure AV+ and AV- are correct.
2) Set the couple switch SW1 to GND position. Check the voltages V1 and V2 on the analog board. V1 should be very close to 0V and V2 should be close to 1.05V.
3) If V1 is off from 0V check the soldering of U1 and components R1 – R6 and C2 – C6.
4) If V1 is good but V2 is off from 1V for more than 0.5V check V4. V4 should be around -1.05V. If V4 is correct check U1B and resistors R9, R10, and R11.
5) If V4 is not good check V3. V3 should be around 2.1V. If V3 is good check U1A and resistors R13 and R15.
6) If V3 is not good check R14 and zener D1.

Symptom 8: ***When moving the slide switches（SW1, SW2, or SW3）their screen indicators don't change accordingly***

Analysis: When moved the A poles of these switches do the functions they were designed to do while the B poles serve as position detector. MCU determines switch position by measuring voltages at B poles (via signals CPLSEL, VSENSEL1, and VSENSEL2 respectively) and changes indicators accordingly. The levels of signal CPLSEL, VSENSEL1, and VSENSEL2 can be AV+, Vz (2V), and 0V depending on switch position. The indicator display problem indicates that the MCU does not detect the signals correctly.

Solution:

1) Depending on which indicator is wrong place that switch at different position and check the corresponding pads of connector J4 on the main board. If the measured level is correct the problem is inside the main board. Check the connection from the pad to MCU pins by following schematic and see if there is open.
2) If the level at J4 pads is wrong check the soldering of related switches and pin-header J5 on the analog board and J4 on the main board.

Symptom 9: ***Incorrect vertical sensitivity***

Analysis: Vertical sensitivity is determined by the overall gain of the analogue channel. All the following components play a part in determining the overall gain:

- The first attenuation stage. This stage includes the following components.
  10mV range -- R1, C2
  0.1V range -- R2, R3, C3, and C4
  1V range -- R4, R5, C5, C6, and C7
- The first amplifier. This includes U1D.
- The second attenuation stage. This stage includes R6, R7, and R8
- The second amplifier. This includes R9, R10, R11, and U1B.

Solution:

1) If you find gain error is the same for all ranges the issue is likely with components in the first and second amplifiers and the second attenuation stage. Check the related parts.
2) If gain error happens only to some ranges check the parts relating to those ranges.
3) Pay close attention to resistor values since they are easy to misread.

Symptom 10: ***Can not reach good compensation for cap trimmer C4 or C6***

Analysis: In theory the ideal value of C4 would make the following equation true.

$$C4 / C3 = R2 / R3$$

Similarly the ideal value of C6 would make the following equation true.

$$(C6//C7) / C3 = R4 / R5$$

At calibrating C4 (C6) if you see waveform with rounded angle that means C4 (C6//C7) is too large or C3 (C5) is too small. On the opposite if you see waveform with overshoots that means C4 (C6//C7) is too small or C3 (C5) is too large.

Solution:

1) If waveform appears round angled and you can not make it right-angled by turning C4 try increasing C3 by adding a small capacitor (0.5pF or so) in parallel with C3 or replacing C3 with a slightly larger capacitor.
2) If waveform appears round angled and you can not make it right-angled by turning C6 try reducing C6//C7 by replacing C7 with a smaller capacitor (10 – 20pF less).
3) If waveform appears overshoot and you can not make it right-angled by turning C4 try reducing C3 by replacing it with a slightly smaller one.
4) If waveform appears overshoot and you can not make it right-angled by

turning C6 try increasing C6//C7 by replacing C7 with a larger capacitor (10 – 20pF greater).

Revision History

Version	Date	Summary
v01	2018.06.08	Draft