

DSO 138 Oscilloscope Fault Analysis

A. Common faults

1. LCD is dark, no backlight
2. Nothing is displayed on the screen
3. no waveform
4. +5V power supply is abnormal
5. +3.3V power supply is abnormal
6. AV+ power supply is abnormal
7. AV-power supply is abnormal
8. When changing the coupling or sensitivity selector switch (SW1, SW2, SW3), the screen indication does not change accordingly

B. Tools required for Troubleshooting

1. **Voltmeter:**

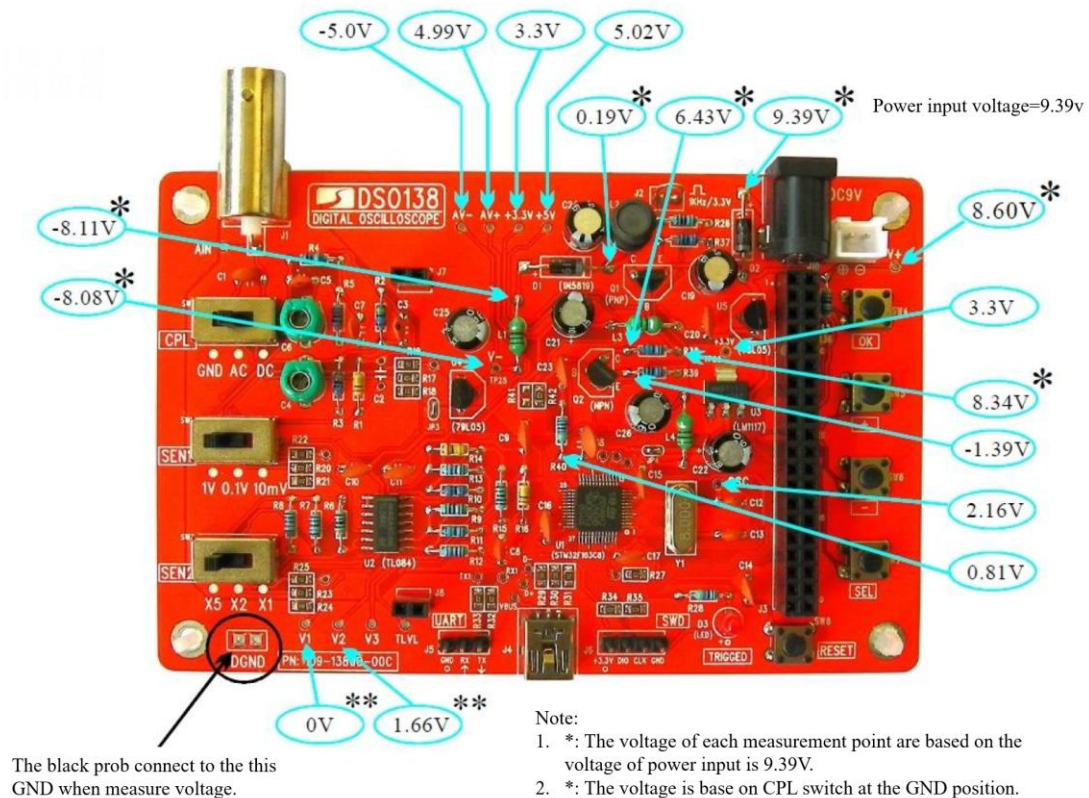
The user needs to prepare a voltmeter to measure the voltage. The voltmeter should preferably be digital. Generally, the voltage range of an ordinary digital multimeter can be used. If a digital voltmeter is not available, a pointer voltmeter can be used. However, since the internal resistance of a pointer voltmeter is generally not very high, the voltage reading may differ from the value given in this article.

2. **Ohmmeter:**

The ohmmeter is mainly used to check the resistance value of the resistor and whether the circuit is open or short-circuited. Generally, the resistance range of the digital multimeter can be used. The resistance range of the old pointer multimeter can also be used to check for open and short circuits. However, due to the large reading error, care should be taken when using it to check the resistance value.

3. **Oscilloscope:**

Considering that most users of the DSO138 kit are new to oscilloscopes, this description assumes that the user does not have an oscilloscope. If the user has an oscilloscope, he or she can use it according to his or her own understanding.



C. Troubleshooting steps

Symptom 1: LCD is dark, no backlight

The backlight of the LCD is generated by 4 LEDs on the LCD screen. As can be seen from the circuit diagram, the power supply of these LEDs is provided by V+ through the current limiting resistor R36 (180 ohms). The circuit is V+ → R36 → J3 pin 16 → LED → ground. Therefore, the reasons why the diodes do not light up are as follows:

- There is no power supply, the LED diode will not light up.
- The resistance value of R36 is incorrect and too large, which causes the current flowing through the LED to be too small and insufficient to turn on.
- A certain link in the circuit is blocked (open circuit), and no current flows through the LEDs.
- The LED diode is shorted and current cannot flow through the LED.
- LED Diode damaged.

Inspection method: Based on the above analysis, you can check step by step according to the following steps:

- I. First check the voltage of V+ to see if it is normal. If it is not normal, check whether the diode D2 is open.
- II. Use an ohmmeter to check whether the resistance of R36 meets the nominal value.
- III. Measure the voltage of the 16th pin on the double-row pin J3 (J1 on the display board). The normal value of this voltage is about 3V. If the voltage measurement value is 0V, there are two possibilities. One is that there is an open circuit from the 16th pin of J3 to V+, and the current cannot pass; the other possibility is that the pin is short-circuited to the ground. For both cases, you can disconnect the power supply and check with an ohmmeter.
- IV. There is voltage on the 16th pin of J3. You can connect a light-emitting diode between this pin and the ground (the positive pole of the diode is connected to the 16th pin of J3, and the negative pole is grounded) to see if it emits light. If it does, it means that the diode on the display is either open or damaged.

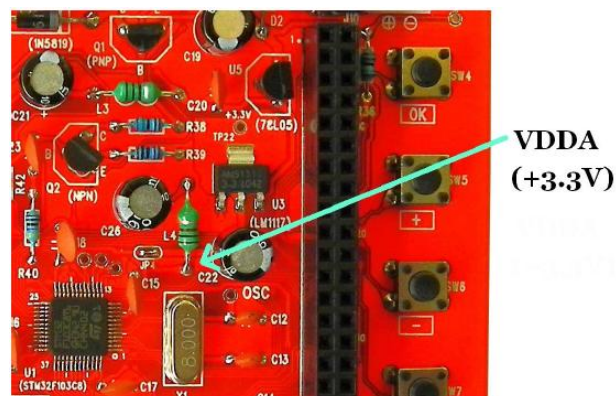
Symptom 2: Nothing is displayed on the screen

Since the screen display is completely controlled by the single-chip microcomputer U1, there are several possible reasons why the screen does not work:

1. The single-chip microcomputer U1 itself does not work.
2. The single-chip microcomputer U1 works, but there is a problem with the connection between U1 and the display screen, causing U1 to be unable to control the display screen.
3. The display screen is damaged internally.

Inspection method: Based on the above analysis, you can make a judgment step by step according to the following steps. First, determine whether the microcontroller U1 is working properly.

1. check if the power supply of the microcontroller is normal. Measure the voltage of the 3.3V test point TP22 to see if it is around 3.3V. If not, check the power supply first (see the following instructions);
2. Check whether the JP4 jumper is connected. When the 3.3V power supply is normal, JP4 should be short-circuited with solder;
3. When the above two points are normal, press the reset button on the lower right side of the board to see if the LED light flashes twice. If the LED flashes twice, it means that the microcontroller has started normally. If it does not flash twice, there are two possibilities. One is that there is a problem with the LED itself. At this time, check whether the LED welding is correct, whether the R28 value is normal, and whether there is a cold solder joint. If you have an LED, you can connect one in parallel to try. The other is that the microcontroller does not work. At this time, follow the steps below to further determine.
4. Measure the voltage at one end of resistor R40 close to microcontroller U1 (see Figure 1). If the microcontroller is working, the voltage should be around 0.8V. If the voltage is 0 or 3.3V, it can be determined that the microcontroller is not working properly.
5. Measure the VDDA voltage of the microcontroller U1 (see Figure 2) to see if it is 3.3V. If not, check whether the inductor L4 is open circuit. VDDA abnormality may also cause U1 to not work.
6. Check whether the resistor R27 (chip resistor) is soldered properly, and make sure that the jumpers JP1 and JP2 on the back of the circuit board are disconnected.



If it is confirmed that the microcontroller U1 is working, then check whether the connection between the microcontroller and the LCD is normal. The specific inspection method is as follows:

- I. check if the power supply voltage of the LCD screen is normal. Measure the voltage of pins 6, 32, and 33 on the double-row pin J3 (display module J1) to see if it is 3.3V. If not, check if there is any cold soldering at the relevant soldering points.
- II. Carefully check the pins corresponding to DB0-DB7 and the signal lines starting with LCD_ on the main circuit board J3 and display board J1 (see the circuit diagram) to see if they are well soldered and whether there is any cold soldering or touching the wire (short circuit).
- III. Use the "test mode" to check the connection of LCD related signals. The method is: first press and hold the switch SW4, then press the reset button SW8 to put the microcontroller into the "test mode". At this time, you can see that the LED flashes with a cycle of about 2 seconds, and all I/O ports of the microcontroller will alternately output 0V and 3.3V levels with a cycle of about 2 seconds. Use a voltmeter to measure the LCD related signal lines on the main board J3 (or display board J1) to see if their voltage jumps between 0V and 3.3V. If it is found that a certain signal line does not jump, or the jumping voltage range is not 0V and 3.3V, then the signal connection may have problems.

Symptom 3: The screen displays normally, but there is no waveform

The oscilloscope displays normally, so it can be assumed that the digital part of the oscilloscope is basically working properly, and there is no waveform problem in the analog part. Specifically, it is due to some reason that the waveform cannot be displayed within the screen display range. If you observe carefully, you will see that the upper or lower border of the screen is yellow, which means that the waveform is outside the upper or lower part of the screen. There are many reasons for this failure, which can be summarized as follows:

- I. The reference voltage of the ADC converter is incorrect, which directly causes the signal value to be incorrect.
- II. The analog power supply (AV+ and AV-) is abnormal, causing the analog channel to not work properly.
- III. There is a problem with one or more links in the attenuator, amplifier or DC level

shift circuit of the analog channel.

Inspection method: First, set the trigger mode of the oscilloscope to "AUTO" to prevent the oscilloscope from not updating the waveform due to no triggering, which will cause the illusion of no waveform display. After confirming that there is no waveform display, according to the above analysis, follow the following steps to step by step. Note that during the inspection, the display module needs to be removed in order to check the motherboard components under the display module. After the inspection, re-insert the display module to check the results. Remember to disconnect the power supply before plugging in and unplugging the display module.

1. Measure VDDA to see if it is 3.3V (see Figure 2). This voltage is the power supply voltage of the analog part of the microcontroller U1, that is, the reference voltage of the ADC. If this voltage is not present, check if L4 is open or falsely soldered.
2. Measure AV+ and AV- to see if they meet the specified values. If not, check according to the instructions for troubleshooting the power supply part later in this article.
3. After confirming that AV+ and AV- are normal, start to check the analog channel circuit. First, turn the coupling switch CPL to the GND position, the sensitivity selection switch SEN1 to the 10mV position, and the sensitivity selection switch SEN2 to the X1 position. The purpose of this is to ensure that the analog channel input signal is 0V and the channel amplification factor is the maximum. Then use a voltmeter to measure V1 and V2 at the lower left of the board. V1 is the output of the impedance converter (U2B), which should be 0V. V2 is the output of the main amplifier (U2C). Due to the effect of the level shift circuit, its output level should be about 1.6V.
4. If V1 is not 0V, check whether the pins of IC U2 are properly soldered, whether switches SW1 and SW2 are soldered properly or short-circuited, and whether resistor R1 is properly soldered.
5. If V2 is not near 1.6V, check whether U2 is well soldered, whether resistors R9, R10, and R11 are well soldered, and whether their resistance values are correct.

6. If V1 and V2 are correct but there is still no waveform, then check whether R12 is soldered properly. If R12 is open, the voltage of the analog channel cannot reach the input end of the ADC (pin 10 of U1).
7. When V1 and V2 are normal and R12 has no problem, do a "vertical position calibration" (see the instructions) to align the small arrow on the left side of the screen with the 0V level, and move the vertical position to see if the waveform can be moved into the screen.

Symptom 4: +5V power supply is abnormal

Fault analysis: As can be seen from the circuit diagram, the +5V power supply is generated by the input power supply through the voltage regulator integrated circuit U5.

The reasons for the incorrect +5V power supply are as follows:

- I. There is no input power supply.
- II. There is a problem with U5 itself.
- III. There is a problem with the load of U5, causing the output of U5 to be incorrect.

Inspection method:

- I. First check if the voltage of V+ is normal. If V+ is not normal, check if the diode D2 is installed correctly and if the welding is good.
- II. If V+ is normal, check if the U5 model is correct (note that the package of U5 is the same as that of U4, Q1, and Q2, which is easy to confuse) and if the welding is good.
- III. Pay attention to whether U5 is hot. If U5 is hot, the load of U5 may be short-circuited. At this time, check if the electrolytic capacitor C20 is reversed, and then disconnect the inductor L3 to disconnect the load behind from U5 and see if the output of U5 returns to normal.
- IV. If the cause cannot be found after the above checks, you can find another 78L05 to replace U5 and try.

Symptom 5: +3.3V power supply is abnormal

Fault analysis: +3.3V power is generated by 5V power after U3 voltage regulation. If +5V power is normal but 3.3V power is abnormal, the possible reasons are:

- I. U3 itself is damaged or not soldered well.
- II. U3's load causes U3's output to be abnormal.

Inspection method:

- I. First check whether U3 is soldered.
- II. Check whether the polarity of C22 soldering is correct.
- III. Disconnect jumper JP4, eliminate the influence of the load, and see if the 3.3V voltage is normal.
- IV. After the above inspection, if the 3.3V voltage is still abnormal, then you can consider replacing U3.
- V. If 3.3V is normal after disconnecting JP4, it means that the 3.3V load may have a short circuit. It is necessary to check each component connected to 3.3V to see if their installation polarity is correct and whether there is a short circuit.

Symptom 6: AV+ power supply is abnormal

Fault analysis: AV+ is formed by filtering the +5V power supply through inductor L3 and electrolytic capacitor C21. If AV+ is abnormal, the possible reasons are:

- I. Inductor L3 is open circuit.
- II. Capacitor C21 is reversely connected or other components connected to AV+ are short circuited.

Inspection method:

- I. First check whether L3 is open circuit.
- II. Check whether the installation polarity of capacitor C21 is correct and whether there is a short circuit.
- III. Check whether the installation polarity of the components connected to AV+ is correct and whether there is a short circuit. Pay special attention to whether the installation direction of U2 is correct and whether the welding of the three toggle switches SW1, SW2 and SW3 has a short circuit. Note that the distance between the pins of the toggle switch is relatively small, and the switch shell is grounded.

It is easy to cause a short circuit between the pins and the shell during welding, so pay special attention.

Symptom 7: AV- power supply is abnormal

Fault analysis: The generation of AV- is relatively complex. The power supply V+ first generates a negative voltage V- through the switching power supply circuit composed of transistor Q1, inductor L2 and diode D1, and then outputs AV- after filtering by L1, C25 and stabilization by U4. The on-off of the switch tube Q1 is driven by the square wave signal VGEN generated by the microcontroller through Q2. Therefore, the cause of the AV- fault can be found in the following order:

- I. Is there a driving signal VGEN? Without the VGEN signal, the negative voltage converter cannot work normally.
- II. Is the driving transistor Q2 normal?
- III. Is the switch tube Q1 normal?
- IV. Is the inductor L2 or diode D1 normal?
- V. Are the filter circuit L1 and C25 normal?
- VI. Is the voltage regulator integrated circuit U4 normal?

Inspection method:

- I. First measure the voltage at the end of R40 close to the microcontroller (see figure) to see if it is about 0.8V. If it is, it means that the microcontroller U1 has a VGEN signal output. Otherwise, the 46th pin of U1 may not be soldered well, or U1 is not working properly (for this, please refer to [Fault phenomenon 2] for the method to check whether U1 is working).
- II. Measure the base voltage of transistor Q2. The voltage should be around -1.4V. If not, check whether the capacitor C23, resistor R39 and transistor Q2 are correctly installed and welded, especially whether the installation polarity of Q2 is correct.
- III. Check the collector voltage of Q2 (Vc2) and the base voltage of Q1 (Vb1). Under normal circumstances, Vc2 is about 6.4V and Vb1 is about 8.3V (assuming V+ is 9V). If it is not correct, the following situations will generally occur:
 - I. Vc2 is close to 0V, while Vb1 is close to 8.5V. At this time, R38 may be open, or the collector and emitter of Q2 may be short-circuited internally;
 - II. Vc2 and Vb1 voltages are equal, but not 0V, indicating that the collector of

Q2 may be open;

- III. Vb1 is very close to V+, which means that the emitter of Q1 may be short-circuited;
- IV. The voltage difference between Vb1 and V+ is significantly greater than 0.6V, which means that the emitter of Q1 may be open;

For the above situations, you should first check whether the polarity of Q1, Q2, R37, and R38 is installed correctly, whether there is any cold soldering or wire contact, and then consider replacing Q1 or Q2 (note that Q1 is a PNP tube and Q2 is an NPN tube. You can use a general-purpose PNP or NPN transistor to replace it. Pay attention to the polarity when replacing it).

- IV. Measure the positive and negative voltages of diode D1. Normally, the negative pole of D1 has a positive voltage of about 0.2V, and the positive pole of D1 has a negative voltage of about -8V (or greater). If it is not correct, the possible reasons are Q1 damage, inductor L2 open circuit or short circuit, C24 reverse connection, or diode D1 reverse connection. Whether inductor L2 is damaged can be checked by measuring its resistance (which can be measured directly on the board). Its normal resistance is about 5-8 ohms. If the resistance is close to 0, it means L2 is short circuited. If it is very large, it may be open circuited.
- V. Measure the V- voltage at TP25. The voltage should be around -8V. If it is not correct, check whether the inductor L1 is open circuit and the electrolytic capacitor C25 is reversely connected.
- VI. Measure AV- at TP26. If V- is normal but AV- is not, check whether the IC U4 model is correct and whether the welding is good. In addition, check whether other components connected to AV- (such as U2) are short circuited.

Symptom 8: When changing the coupling or sensitivity selector switch (SW1, SW2, SW3), the screen indication does not change accordingly

Fault analysis: As can be seen from the circuit diagram, the toggle switches for selecting coupling and sensitivity are composed of two sets of switches. When the switch is toggled, the two sets of switches are synchronized (the circuit diagram uses dotted lines to indicate the linkage of the two sets of switches). One set is used to change the parameters of the circuit, and the other set is used to detect the position of the switch. When the switch is toggled, the corresponding display on the screen does not change. This basically determines that there is a problem with the switch position detection circuit, causing the microcontroller to be unable to detect the change in the switch position.

Inspection method:

- I. If the indication of the coupling selection switch is abnormal, check whether the welding of switch SW1 and chip resistors R17, R18, and R19 is open or short.
- II. If the indication of the sensitivity selection switch is abnormal, check whether the welding of switches SW2, SW3 and chip resistors R20-R25 is open or short.

End