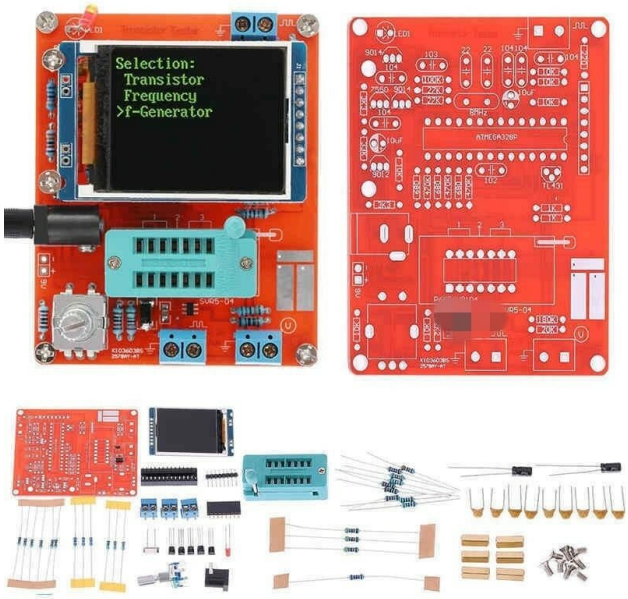


GM328 Transistor Tester Assembly

By Steven Vagts

Z-100 LifeLine
Insert, Issue #130

Tester Description:

The GM328 Transistor Tester is sold as a kit and requires some experience in soldering skills as three of the parts are small surface mounted devices. A soldering iron with a needle point tip would be very helpful here. I have seen some kits sold with the three surface mount parts already installed. The kit is often sold with an acrylic case, or the case may be purchased separately. Please see the separate document on GM328 Transistor Tester Operation for operational assistance. This manual will concentrate on Assembly.

The Tester will automatically detect NPN, PNP, and Field Effect Transistors (FET), diodes (including dual diode, zener diode and light emitting diode), triodes, thyristors, triacs, and SCRs, with automatic identification of the transistor pinout. The Tester detects power transistors with FET protection diodes built in. It also tests resistors (including adjustable potentiometers), capacitors, and inductors.

This Tester can also generate a single square wave with 20 set frequencies from 1Hz to 2.0MHz, can measure frequencies from 1Hz to 2.9MHz with resolution to 0.001mHz, and can use an AC/DC power adapter (6.8-12Vdc, 30mA current).

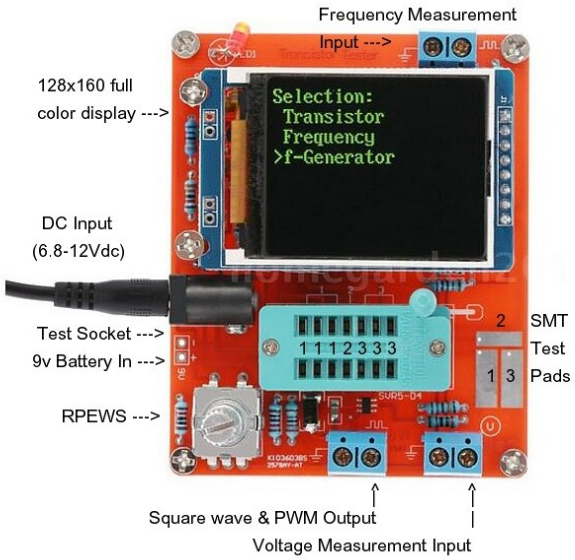
The Tester has amazing specifications in a small package:

Size:	3-1/8" long x 2-1/2" wide x 1-1/8" tall circuit board
Type:	Transistor Tester
Display:	128x160 pixel color display with backlight; 8x20 characters; 16-bit, 65k color
IC PROM:	Atmel Atmega328P 28-pin PROM DIP IC chip
Power:	9v battery or AC/DC power adapter (6.8-12Vdc, 30mA current)
Control:	Rotary Pulse Encoder With Switch (RPEWS); auto shutdown
Inductor:	Measures inductors, 0.01mH - 20H
Capacitor:	Measures capacitors, 25pF - 100,000uF
Capacitor ESR:	Displays ESR of capacitors >0.1uF
Resistance:	Measures resistors to 0.1 ohm resolution, maximum 50M ohms
Freq Counter:	1Hz to 2.9MHz (Megahertz), with resolution to 0.001mHz; Samples and reports the frequency every few seconds
Freq Generator:	Simple, single square wave at 20 set frequencies; From 1000mHz(1Hz) to maximum of 2000KHz(2.0MegaHertz).
PWM Generator:	Variable (1-99%) duty cycle pulse signal (10-bit PWM) at fixed 7812.5Hz frequency.

Features:

- Automatically checks the component's pins and displays them on the LCD.
- Automatic detection of NPN and PNP transistors, N-channel and P-channel MOSFETs, diodes (Zener diodes <4.5 Vdc, dual diodes and LEDs), triodes, thyristors, triacs, resistors, inductors, capacitors (including ESR).
- Measures adjustable potentiometers, if wiper not positioned at one end.
- Measures capacitor ESR of capacitors >0.1uF, with resolution of 0.01 ohms.
- Measures the rate of decline (Vloss) of Capacitors >5000pF (Q value).
- Can identify zener diodes whose reverse breakdown voltage is <4.5 Vdc.
- Measures bipolar transistor current amplification factor and base-emitter threshold voltage.
- Measures the reverse capacitance of a single diode.
- Measures the collector or emitter junction reverse capacitance of bipolar transistors.
- Measures the gate threshold voltage and gate capacitance of a MOSFET.
- In the transistor, the MOSFET protection diode's amplification factor and base can be sensed to determine the forward bias voltage of the emitter transistor.
- Measures frequencies from 1Hz to 2.9MHz (Megahertz).
- Square wave generator for 20 set frequencies between 1Hz to 2MHz.
- PWM square wave generator with variable (1-99%) duty cycle pulse signal (10-bit PWM) at fixed 7812.5Hz frequency.

Physical Layout of the Assembled Tester:



Power:

The Transistor Tester requires power from 6.8V – 12Vdc. This can be from a 9V battery or an AC/DC power adapter. When the power is ON, the current is about 30mA at 9Vdc; after shutdown, it still draws about 20nA current.

The Tester will automatically switch OFF after a component test and no further action is performed by the user.

Control:

The Transistor Tester is controlled by a "Rotary Pulse Encoder With Switch" (RPEWS), which supports four operations:

- Power on
- Short-press
- Press and hold (long-press)
- Left and right rotation

The Tester is turned ON with a short-press of the RPEWS. If a component to be tested is placed in the test socket, the Tester will sense the component and attempt to identify it. If it is successful, the results will be displayed on the screen, as described later in this paper. If unsuccessful, the user will be informed of such action before shutting OFF.

Following the component check, and before automatically shutting OFF, the unit will wait 15 seconds for user action. A long-press OR rotation of the RPEWS left or right will enter the Function Menu. In the Function Menu, a ">" in the left column indicates the present menu item selected. To select another function, rotate the RPEWS left or right and do a short-press on the function selected.

To exit a Function, press and hold (long-press) the RPEWS knob until you are returned to the Function Menu.

Assembly:

Note: For a full, more detailed article on the assembly of the GM328 Transistor Tester, please check out the website:

https://www.instructables.com/id/Circuit-Circus-in-Depth-Tech/.

It was created with the novice in mind, with plenty of photographs.

The following description is provided here in the event that the website mentioned above is removed or becomes not available. This description also assumes a more experienced hobbyist and will provide more of a summary of procedures, with some details and hints that I found were omitted during my construction. Also, many of the photos used here are from that website. It is well worth checking it out.

As you can see from the first photograph, all the parts needed to construct the Tester are provided, except that there are NO assembly instructions. Some kits will also include an acrylic case which is easy to construct, but is beyond the scope of this document.

Assembly will require the following tools:

Ohmmeter and Capacitor Checker (recommended)
9v Battery or 6.8-12Vdc AC/DC power adapter
Needle tip soldering iron or gun
Thin electronics solder w/flux core
Fine solder wick or desoldering braid for mistakes
Needle nose pliers or tweezers (optional)
Diagonal side cutters
Phillip's head screwdriver
Masking tape

Before beginning construction, identify and compare the parts you received with the following list. I also suggest that you check those parts that you can with an ohm-meter and capacitor checker, if they are available. All parts are new; however, in the three kits that I have constructed, I found a shorted capacitor and a resistor included in one kit of the wrong value. A little extra time here to check components now, will save considerable time trying to troubleshoot a malfunctioning Tester.

Parts List: (Numbers in parentheses show component markings)

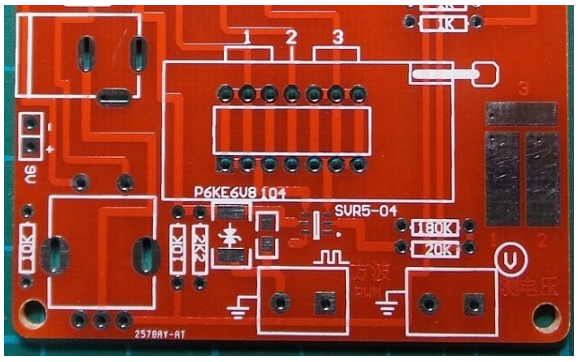
Component Description:	**Number:**	
220 ohm, 1/4W, 1%, Metal Film Resistor	1	[ ]
680 ohm, 1/4W, 1%, Metal Film Resistor	3	[ ]
1K ohm, 1/4W, 1%, Metal Film Resistor	2	[ ]
2.2K ohm, 1/4W, 1%, Metal Film Resistor	1	[ ]
3.3K ohm, 1/4W, 1%, Metal Film Resistor	1	[ ]
10K ohm, 1/4W, 1%, Metal Film Resistor	6	[ ]
20K ohm, 1/4W, 1%, Metal Film Resistor	1	[ ]
27K ohm, 1/4W, 1%, Metal Film Resistor	2	[ ]
33K ohm, 1/4W, 1%, Metal Film Resistor	1	[ ]
100K ohm, 1/4W, 1%, Metal Film Resistor	1	[ ]
180K ohm, 1/4W, 1%, Metal Film Resistor	1	[ ]
470K ohm, 1/4W, 1%, Metal Film Resistor	3	[ ]
22pF, 20%, (220), Ceramic Capacitor	2	[ ]

1000pF, 20%, (102), Ceramic Capacitor	1	[ ]	
0.01uF, 20%, (103), Ceramic Capacitor	1	[ ]	
0.1uF, 20%, (104), Ceramic Capacitor	5	[ ]	
0.1uF, 20%, (SMT), Ceramic Capacitor	1	[ ]	(surface mount)
10uF, 20%, Aluminum Electrolytic Capacitor	2	[ ]	
8MHz, Quartz Crystal	1	[ ]	
9012, PNP TO-92 Bipolar Junction Transistor	1	[ ]	
9014, NPN TO-92 Bipolar Junction Transistor	2	[ ]	
HT7550, TO-92 Regulator Transistor	1	[ ]	
TL431, TO-92 Precision Reference Transistor	1	[ ]	
ATMega328P-PU AVR MCU w/28-pin socket	1	[ ]	(both together)
SRV05-4 (MC5) Low Capacitance TVS Diode Array	1	[ ]	(surface mount)
P6KE6V8 (6V8C) Transient Voltage Suppressor	1	[ ]	(surface mount)
Red, 03MM, Light Emitting Diode	1	[ ]	
Test Socket	1	[ ]	
DC Jack	1	[ ]	
Rotary Pulse Encoder With Switch (RPEWS)	1	[ ]	
Connecting Terminal, Blue, 2-pin	3	[ ]	
Female Connecting Header, 8-pin, SIP	1	[ ]	
Copper Pillar, 3mm x 11mm	6	[ ]	
Bolt, 3mm	8	[ ]	
TFT LCD Module, 120x160 pixel w/16-bit color	1	[ ]	
Main Circuit Board, 77x60mm	1	[ ]	

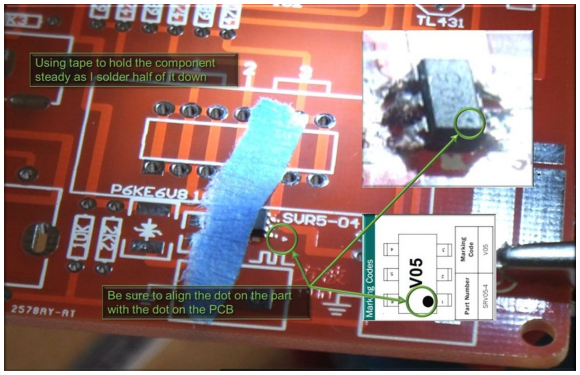
This Transistor Tester has three surface mount technology (SMT) components, identified as ZD (P6KE6V8), CESD (the 0.1uF SMT capacitor), and the ESD (Diode Array). The ESD diode array may be marked "MC5", "VC5" or "LC5". While some kits come with these already installed, most do not. These parts are TINY, in little containers. Do not remove until ready to install them. Take care not to lose them.

As these SMT components are the smallest, they are installed first. Their role is to protect the MicroController Unit (MCU) against transient high voltage. The Tester can work **normally** without these three parts, if you would rather skip their installation, but they provide the only protection of the MCU ports from accidental high voltage.

I suggest beginning with the installation of the 6-pin ESD diode array.



Hint: Using a spare cotton towel under the circuit board helps protect the work surface and stabilize the board during soldering.



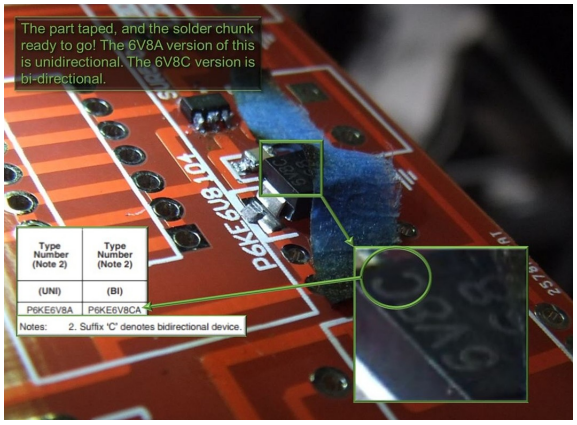
Note: All three circuit boards that I received did **NOT** have a silk-screened white dot to mark pin-1 for the ESD (incorrectly marked SVR5-04 at the lower center in the photograph at the left)! Look at the picture carefully, and before doing anything else, I suggest marking this pin 1 location with a indelible pen or a dot of white-out.

It is also near impossible to discern the dot on the ESD chip, but it is there. Using a magnifying glass and reflecting light off the surface of the chip will help to locate it.

Double-check for the dot, and carefully place the ESD (SRV05-04) on the six pads. Using a piece of tape to temporarily hold the ESD in place, carefully solder the right side of the ESD in place.

Note: If you accidently create a solder bridge across 2 or 3 pins, place solder wick over the solder bridge and carefully heat the wick only until solder flows into the wick. Take care not to overheat the component!

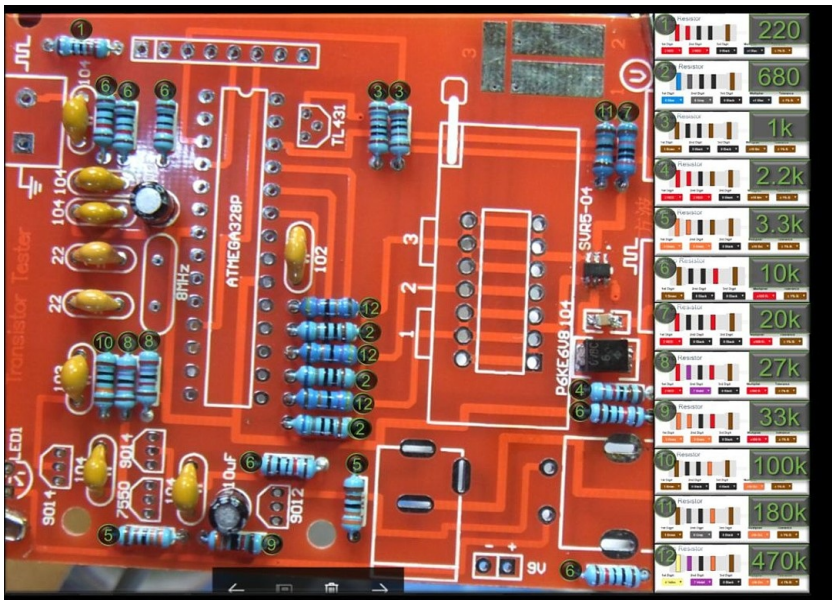
Remove the tape when satisfied with the solder work on the right side and, AGAIN rechecking the dot first, solder the ESD's left three tabs. Check for shorted pins with an ohmmeter. Use solder wick if necessary.



Next, and using the same tape trick, solder the SMT capacitor in place, under the 104 silk screen label. It is bi-directional (can be installed in either direction). In this photograph, it is located just above the Zener Diode (under the tape).

Finally, and still using the tape trick, install the P6KE6V8 zener diode. The 6V8A version of this part is unidirectional. But our part, the 6V8C version is bidirectional and can be installed in either direction.

Next we install the rest of the components, working from those with the lowest profile to the taller components. This routine keeps the board flat and the most stable on the work surface for as long as possible.

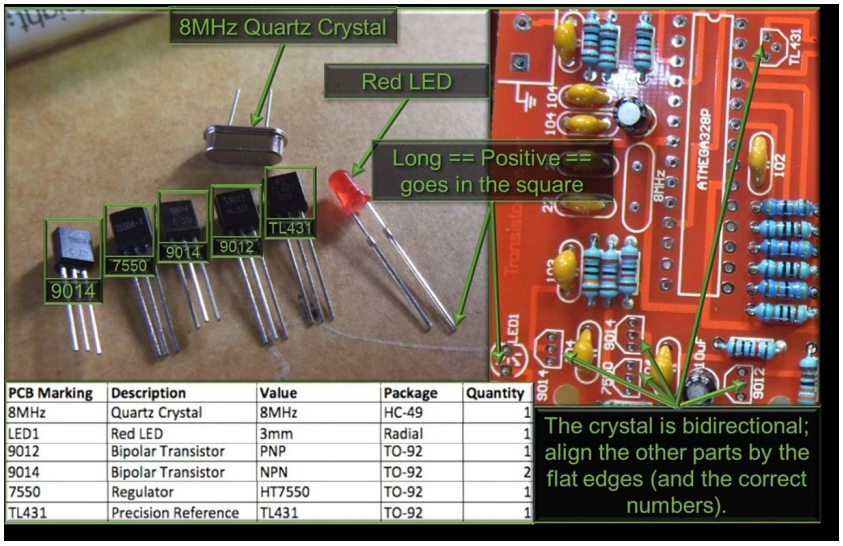


Next, install the resistors. You can install them one at a time, or insert all the resistors, bending the leads slightly to keep them in place, then turning the board over and soldering all the leads at once, clipping off the excess leads as you go.

For a small project such as this, the group method also ensures that all of the resistors are used correctly and in their proper location, BEFORE soldering any in place! Note that this photo also includes the color code and location of each resistor.

Next, install the ceramic capacitors (next in the height profile) and use the same techniques we used for the resistors; inserting them all, bending the leads to ensure they stay in place, then soldering and clipping the leads at one time, if you desire.

Install the crystal, (next photo), and finally the two electrolytic capacitors, being mindful of the polarity while installing. On the shell of the capacitor can, a wide band with white color and a minus sign is the negative terminal.



PCB Marking	Description	Value	Package	Quantity
8MHz	Quartz Crystal	8MHz	HC-49	1
LED1	Red LED	3mm	Radial	1
9012	Bipolar Transistor	PNP	TO-92	1
9014	Bipolar Transistor	NPN	TO-92	2
7550	Regulator	HT7550	TO-92	1
TL431	Precision Reference	TL431	TO-92	1

The board is getting crowded as we continue with the LED and semi-conductors.

Install the LED as shown at left.

Note: In some other kits, the transistors sometimes must have their leads rearranged before installing them. But in this kit, all the transistor leads are installed just as they are depicted in the silk screen image.

Hint: When you install multi-pin components, such as the 28-pin IC socket, the Test Socket or even the RPEWS control, always solder one lead at each end of the component first, check to insure the component is fully inserted in the board (not tilted to one side or one end is not fully seated), before soldering the remaining pins. It is much easier to fix a tilted socket with only one pin to heat to reposition the socket.

When you install the 28-pin IC socket, watch the half-moon notch on one end! Install the socket so that this notch is over the similar notch symbol on the silk-screened circuit board. Do **not** install the IC until after the rest of the components have been installed and the solder side of the board has been inspected and cleaned.

When you install the three two-pin connector terminals, make sure that the connectors for the wires face **OUT**, to the outside of the board!

When you install the Test Socket, keep the hand lever in the UP, unlocked position!

Install the 9-pin SIP socket for the LCD display, the DC Jack Input connector, and battery connector. Do NOT install a battery yet!

This should only leave the RPEWS rotary pulse encoder left to install. Before installing this last part, it is time to visually check your work looking for solder bridges, parts with cold solder joints (meaning a poor connection, not having the same appearance of smooth solder flow as the other solder joints), or open, unsoldered joints. If you have an ohmmeter, check joints near each other for shorts. Especially check the DC Input connector and Battery connector for shorts.

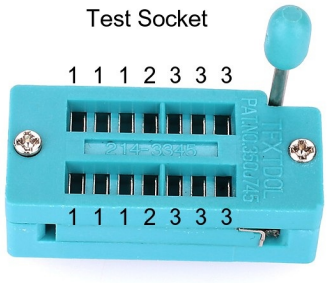
Next, clean the solder side of the board. Many use a special flux cleaner product to clean the soldering side. Personally, I check each solder connection and use a fine screwdriver or dental pick to scrape away any flux residue, then use a toothbrush and a little water to remove the scraped residue.

When you are satisfied that the board is as good as you can make it, install the RPEWS rotary switch. Do NOT let any cleaner or water come in contact with the internal parts of the RPEWS rotary switch! The cleaner, and even plain water, will destroy the internal parts. Scrape these last few pins as described earlier, or leave alone.

Likewise, do not let water or cleaner near the LCD display module.

Install the 28-pin MEGA328 IC and the LCD display with two standoffs and bolts, and the assembly is complete. Congratulations!

Introductory Operation:



The Transistor Tester has three Test Points (TP1, TP2, TP3) within the test socket and three pads for surface mount components.

The Test Points in the test socket are arranged in the pattern displayed on the circuit board silk screen just above the test socket. The left six (3+3) belong to TP1, the middle two (1+1) belong to TP2, and the right six (3+3) belong to TP3.

To the right of the test socket are three test pads that can be used to test surface mount components.

Note: The numbers of the test pads on the silk screened board, if labeled at all, may NOT be numbered correctly. Please check them with an ohmmeter to match the pins of the Test Socket. Mine had to be labeled as shown in the second picture, above.

When testing two or three lead components, the leads must be placed between different test points, that is, place a component in the test socket such that each pin of the component is in a separate test point.

Note: If TP1 and TP3 are selected, the Tester will enter a "series test mode", where repeat tests are done automatically. You may change components at any point in this series. Exit the series with a long-press of the RPEWS. The test may be started again with a short-press of the RPEWS.

Self-test & Calibration:

Note: This Tester requires calibration before use.

The Self-test & Calibration can be started by either:

- Shorting all test points and turning the device ON
- Selecting it from the Function Menu

Note: To short the Test Points together, simply construct a small test component of three short lengths of wire, such as the cut resistor leads from construction, twisted and soldered together.

Upon sensing the shorted test pins, the Tester will prompt with *Selftest mode..?* and a RPEWS short-press (within 2 seconds) will direct the tester into self-test mode. The color of the Tester's LCD will change to white on a black background. If not short-pressed within 2 seconds, the Tester will resume normal measurement.

The Tester will sense the shorted probes and report:
Selftest mode..
R0=.32 .35 .30Ω (Yours may be different)

When the test procedure prompts *Isolate Probes!* ... remove the shorted test component from the test socket. The Tester will sense the disconnection of the Test Points and report the values of Ri_Hi and Ri_Lo, such as:
Ri_Hi=22.4Ω
Ri_Lo=20.3Ω

Then it reports C0 on a new page, such as:
C0 41 42 47pF,
OK

The calibration procedure begins next, if the unit has not been calibrated, by prompting:

1-||-3 > 100nf
0nF ...

Insert any capacity capacitor from 100nF to 20µF between TP1 and TP3. With this capacitor, the offset voltage of the analog comparator will be compensated for better measurement of capacity values.

Note: Do not insert the capacitor until it is asked for.

The test procedure ends and the Tester reports the calibration values.

At the end of a test (before auto-off), a long-press or rotation of the RPEWS will enter the Function Menu. In the Function Menu:

- RPEWS rotation changes the selection
- RPEWS short-press selects Function action
- RPEWS long-press will exit the Function Menu

Function Menu Brief Descriptions:

- **Switch off** - The Tester will shut down immediately.
- **Transistor** - Transistor test; it is also the default Function at switch ON.
- **Frequency** - Measurement of frequency. For frequencies below 25kHz, the normal measurement is followed by a measurement of time period. This additional measure only follows after a normal frequency measurement.
- **F-Generator** - This Function can output a square wave, with 20 set non-adjustable frequencies to choose.
- **10-bit PWM** - The function ”10-bit PWM” (Pulse Width Modulation) generates a fixed frequency (7812.5Hz) with selectable pulse width at the pin TP2. With a short-press (< 0.5 sec), the pulse width is increased by 1%; with a long-press, the pulse width is increased by 10%. If 99% is overstepped, 100% is subtracted from the result. The function can be exited with a very long key press (> 1.3 sec).
- **C+ESR@TP1:3** - The function "C+ESR@TP1:3" selects a stand-alone capacity measurement with ESR (Equivalent Series Resistance) measurement at the test pins TP1 and TP3. Capacities from 2µF up to 50mF can be measured. Because the measurement voltage is only about 300mV, in most cases the capacitor can be measured ”in circuit” without previous disassembling. The series of measurements can be finished with a long-press of RPEWS.
- **Selftest** - The menu function ”Selftest” is a full self test with calibration. With that call, all the test functions T1 to T7 and also the calibration with external capacitor is done every time.
- **Voltage** - Voltage measurement. Because a 9:1 (180K:20K) voltage divider is connected, the maximum external voltage can be 50V. The measurement can also be exited by continuous rotation of the RPEWS.
- **Show data** - The function, ”Show Data” shows the version number of the software and the data of the calibration. These are the zero resistance (R0) of the pin combinations 1:3, 2:3 and 1:2. In addition, the resistance of the port outputs to the 5V side (RiHi) and to the 0V side (RiLo) are shown. The zero capacity values (C0) are also shown with all pin combinations (1:3, 2:3, 1:2 and 3:1, 3:2, 2:1). Lastly, the correction values for the comparator (REF_C) and for the reference voltage (REF_R) are also shown. Every page is shown for 15 seconds, but you can select the next page by a key press or a **right** turn of the rotary encoder. With a **left** turn of the rotary encoder, you can repeat the output of the last page or return to the previous page.
- **FrontColor** - This function can change the color of the font, the 16-bit color is encoded in RGB(565) format; that means red maximum = 31, green maximum = 63, blue maximum = 31 respectively. In the function, a short-press can index the base color to change, turn **left** to decrease its value and turn **right** to increase its value. A long-press will save the result and exit the function. Please keep in mind the FrontColor and the BackColor can **not** be the same - the LCD would show nothing. If this happens, however, do a Selftest. Selftest will change the back color to black and front color to white automatically.

When the Selftest is finished, you can to modify the color settings again.

- **BackColor** - This function is the same as FrontColor, except it changes the background color.
- **1-||-3** - This function can measure the series capacitance between TP1 and TP3. This function can measure a very small capacitor. A long-press will exit the function.
- **1-(resistor & inductor symbols)-3** - This function can measure the series resistance and inductance between TP1 and TP3. A long-press will exit the function.
- **DS18B20** - The DS18B20 is a Digital Thermometer with 1 wire communicating protocol. It looks like a transistor due to its TO-92 component package, so it can fit into the Tester. When entering this function, Row 2 of the LCD will show a string "*1=GND 2=DQ 3=VDD*". This means to connect TP1 of the Tester to GND of the DS18B20, and so on. The Tester can **not** sense the pin configuration of the DS18B20 because it is an integrated circuit. Therefore, you must install the DS18B20 according to the string given. To exit this function, press and hold the RPEWS > 3 sec.
- **DHT11** - The DHT11 is a sensor with temperature and humidity measurements. The degree of accuracy is +-5% in Relative Humidity (RH) and +-2 degrees Centigrade. The Tester measures temperatures from 0 to 50 degrees Centigrade and measures relative humidity from 20-90% RH. When entering this function, Row 2 of the LCD will show a string "*1=GND 2=DQ 3=VDD*". This means to connect TP1 of the Tester to the GND of the DHT11, the "N/A" pin of the DHT11 can be floating or connected to GND. TP2 of the tester is connected to DATA of the DHT11, and TP3 of the Tester is connected to VCC of the DHT11. The Tester can **not** sense the pin configuration of the DHT11; therefore, you must install the DHT11 according to the string. For additional information, please see the Operations Manual. To exit this function, press and hold the RPEWS > 3 sec.
- **IR_decoder** - The function of decoder is achieved by a IR receiver module. When entering the IR_Decoder Function, Row 2 of the LCD shows a string, "*1=DOUT 2=GND 3=VCC*". This means to connect TP1 of the tester to the GND of the IR receiver module, and so on. For further information, please see the Operations Manual.
- **IR_Encoder** - This function is a simulation of an IR Remote Controller. It can drive an IR LED connection at the tester's PWM output interface associated with the user input. Since the Tester can only provide about 6mA current, the Control distance is less than a regular IR Remote Controller. For further information, please see the Operations Manual.
- **C(uF)- correction** - This function sets the correction value for big capacitor measurement. Positive values will reduce the measurement results.

Testing Components:

General Notes:

- Normally, the Tester begins in Transistor Test mode, automatically checking if a component is found at the Test Socket or test pads. The Tester also shows the battery voltage with every start.
- If the voltage falls below a limit, a warning is shown behind the battery voltage. If you use a rechargeable 9V battery, you should replace the battery as soon as possible or you should recharge.
- The measured supply voltage will be shown in display Row 2 for 1 second with "*VCC=x.xxV*".
- When checking two-lead passives, such as resistors, capacitors, and inductors, these can all be measured in the default test mode between TP1 and TP3, but can be tested between any two test points.
- If TP1 and TP3 are selected to check these passives, the test will enter 'series test' mode, where the test is repeated every few seconds. You can replace the component with another component at any time. The test may be exited with a long-press of the RPEWS, and restarted with a short-press of the RPEWS.
- If a component is polarized (for example, electrolytic capacitors), favor TP1 for the negative lead/cathode.
- Capacitors should be discharged before measuring. Otherwise the Tester can be damaged before the start button is pressed.

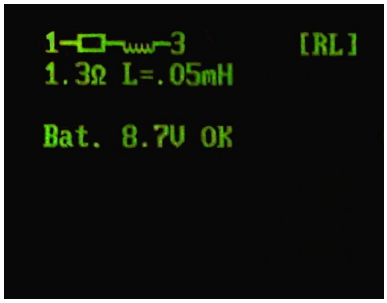
- If you try to measure components within an assembled circuit, the equipment should always be disconnected from its power source. Furthermore you should be sure that no residual voltages reside in the equipment. All electronic equipment has capacitors that store power inside!
- If you try to measure little resistor values, you should keep the resistance of plug connectors and cables in mind. The quality and condition of plug connectors and the resistance of cables used for measurement are important.
- The same is true for the ESR measurement of capacitors. With a poor connection cable, an ESR value of 0.02 ohms can grow to 0.61 ohms.
- While interpreting transistor measurement results, keep in mind that the circuit of the Tester is designed for small signal semiconductors. In normal measurement conditions, the measurement current can only reach about 6mA. Power semiconductors often cause identification difficulty and inaccurate measurement because of residual current value.
- You should not expect very good measurement accuracy from this simple Tester, especially in ESR and inductance measurements.

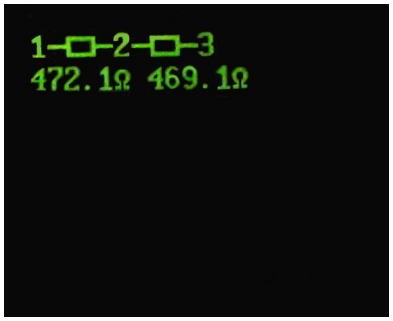
Push the RPEWS button to turn the Tester ON. The Tester will sense any component installed and attempt to identify it. If it is successful, the Tester will display the component name, diagram and measured values for about 25 seconds, then shut OFF. If unsuccessful, the tester will display a large question mark '?' and "No, unknown or damaged part." for 10 seconds before shutting OFF. You may change components while the results of the present test are being shown and press the button again to restart the test without waiting for the Tester to turn off.

The Tester shows the model number and battery voltage with every start. If the voltage falls below a limit, a warning is shown behind the battery voltage. If you use a rechargeable, 9V battery, replace the battery as soon as possible or recharge.

Note: Two resistors may be placed in series by using three test points and may be tested at the same time. This is great for finding and testing for a matched pair of resistors. However, this will not work with other two-lead components. For whatever reason, only one component is generally found or, such as testing an inductor and resistor at the same time, the Tester may report both as resistors.

For the full description on use of the GM328 Tester, with examples of each type of component under test, please see the GM328 Transistor Tester Operations Manual, also by Steven Vagts of Z-100 LifeLine.





Just to get you started, the following is an example of testing a simple resistor.

To test, insert a resistor between any two test points.

Note: If you try to measure small resistor values, you should keep the resistance of plug connectors and cables in mind. The quality and condition of plug connectors are also important. So keep any cable leads short and connectors in good condition.

A diagram of the resistor between the two test points chosen, the resistance (to 0.1 ohm resolution; maximum 50M ohms), and any associated inductance values will be shown. The last line shows the Battery voltage.

You can also measure two resistors, end to end in series, or variable potentiometers. For the potentiometer, attach test leads to the three leads in 1, 2, 3 order and the display should be similar to that shown here.

Please report any errors or suggestions to the author by email at: z100lifeline@swvagts.com. Thank you.