Triplett MM650 Review

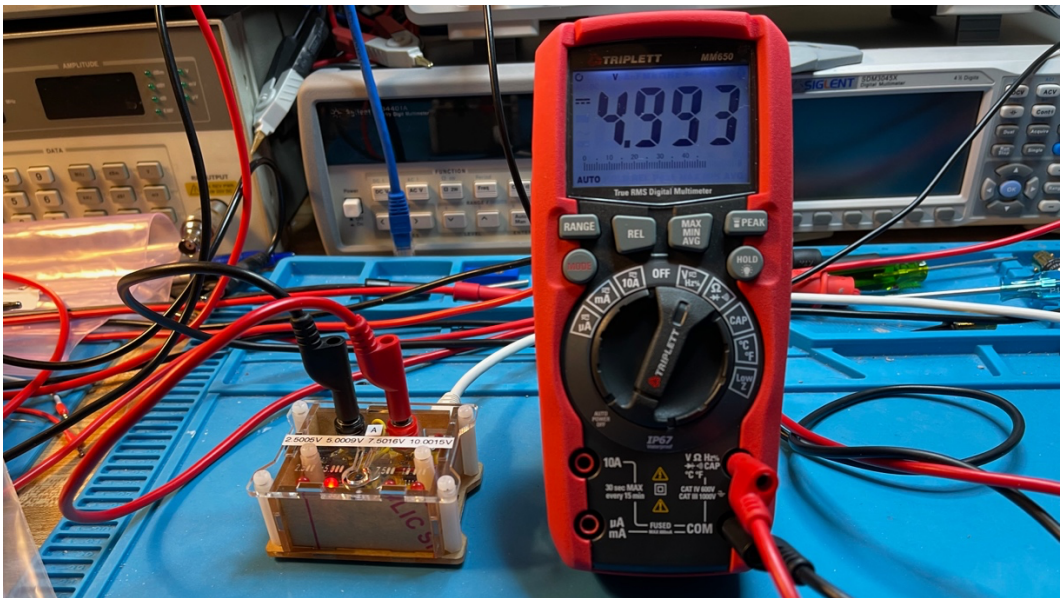
Introduction

Hi, I am Tom, amateur radio call sigh N8FDY. This is a review of the Triplett MM650 multimeter for use in hobby electronics projects primarily related to amateur radio.

Disclaimer

I am not a professional, I am a hobbyist. This review is not sponsored; I bought this multimeter with my own money. I only used and tested this multimeter in CAT I and CAT II environments. I do not have a way to review or test the safety of this meter. I leave the CAT III and CAT IV environments to trained and licensed professionals. It may seem like I am a Fluke fan boy, but I recognize their flaws along with their advantages. There may be unintended mistakes and/or errors in this review.

Overview



I am testing and demonstrating this Triplett MM650 multimeter that I purchased from the Triplett online store for $70.99. It was a refurbished unit. The refurbished meter had some malfunctions and I contacted Triplett support and two days later UPS showed up with a brand new MM650. All the tests were done on the new replacement meter. I only used it in CAT I and CAT II environments.

CAT I is for measurements on circuits not directly connected to mains. For example, battery-operated electronics, or radio gear connected to a 13V DC power supply.

CAT II is for measurements performed on circuits directly connected to 120V (240V in some countries) power outlets at least 15 feet from the distribution panel. For example, your 120V AC to 13V DC power supply or a vintage piece of ham radio gear we lovingly call “boat anchors” that plug into a 120V AC outlet.

First, we will look at the features of the multimeter, then we will look at the accuracy of the meter. We will then go over the ergonomics. We will wrap up with the pros, cons and conclusion.

I will not be using the test leads that came with the meter. I have not liked any test leads that came with multimeters except the Fluke TL175 TwistGuard® test leads that were bundled with the Fluke 87V MAX. I also use Probe Master Series 8000 Test Leads.

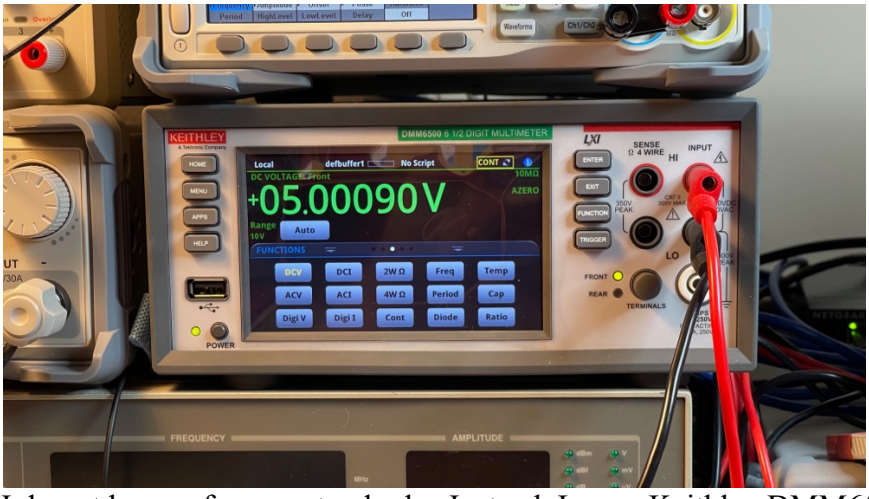
Objectives

This review was produced to help you decide if the Triplett MM650 multimeter will fit your purpose and budget. This is part of a series of multimeters reviews.
A good multimeter for hobby electronic projects should be able to measure millivolts, volts, microamps, milliamps, amps, ohms, nanofarads and microfarads.
If you want to measure picofarads, nanohenrys, microhenrys or reactance you will need an LCR meter. I cover the two LCR meters I own in another review.

Features

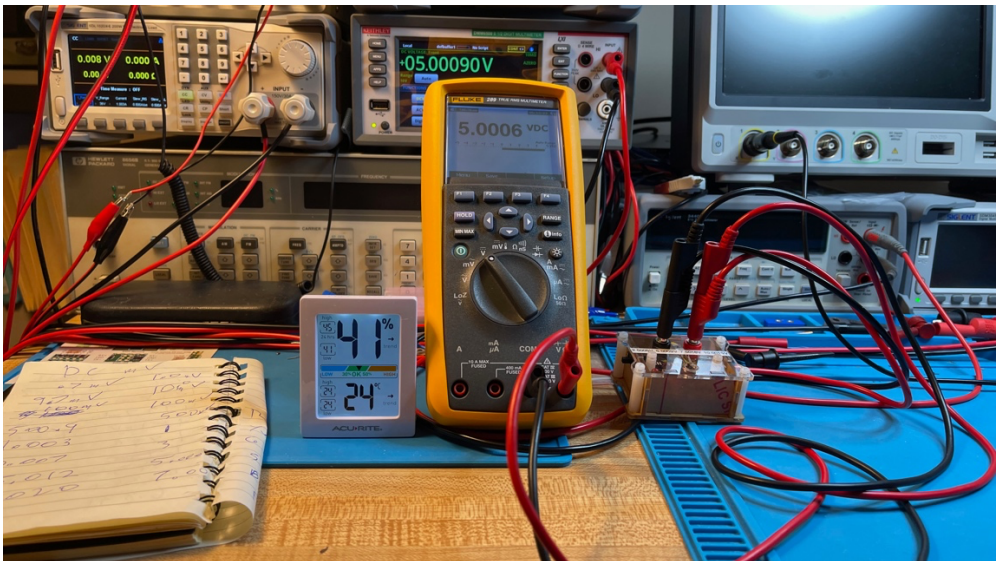
- 6,000 Count
- Basic DC Accuracy ±(1% + 3)
- True-RMS
- 61 Segment Analog Bar Graph
- Min/Max/Avg
- Hold
- Rel
- Peak (AC Voltage)
- K-Type Thermocouple
- LoZ AC & DC Voltage
- Flashlight
- IP67
- Three Year Warranty
- 4 AAA Batteries Included

Accuracy



I do not have reference standards. Instead, I use a Keithley DMM6500 6.5 digit bench multimeter that was calibrated recently to measure voltages, currents, resistances and capacitances. I take a reading from the Keithley and based on the Keithley stated tolerance for that range and reading, I compute the lowest and highest value the reading could be, then I take the meter under test and take a reading. I calculate the meter-under-test reading uncertainty value and subtract it from the lowest value and add it to the highest value. If the reading is within the range of the lower and higher limits, it meets meter-under-test accuracy specification.
For example, I have a voltage source that is 5 Volts. I take a reading with the Keithley and I get a value of 5.00090 and based on the Keithley specifications for that range ±(0.0025% of reading + 0.0005% of range);

that value could be anywhere from 5.00072 to 5.00108. I then use the meter under test (for this example my Fluke 289, my most accurate hand-help meter) reading of 5.0006. The Fluke 289's accuracy at this range is ±(0.025% of reading + 2 least significant digits) for an uncertainty value of 0.00145015 Volts. So, subtracting this from the lowest value the Keithley reading gives us 4.99927V for the low value limit and adding to the highest value the Keithley gives us 5.00253V for the high value limit. The meter-under-test reading (5.0006) is within the limits, so the meter under test meets its accuracy target for 5 volts.



DC Volts

Source	Reading	Specification	Uncertainty	Low Bound	High Bound
1 mVDC	0.9	1% + 8	0.809	0.18747	1.81253
10 mVDC	9.9	1% + 8	0.899	9.0972	10.9028
100 mVDC	99.7	1% + 8	1.797	98.1965	101.8035
500 mVDC	499.0	1% + 8	5.79	494.1915	505.8085
1 VDC	0.998	1% + 3	0.01298	0.98699	1.01301
3 VDC	2.996	1% + 3	0.03296	2.966915	3.033085
5.009 VDC	4.993	1% + 3	0.05293	4.95589478	5.06210523
7 VDC	6.98	1% + 3	0.0998	6.899975	7.100025
10.00148 VDC	9.98	1% + 3	0.1298	9.87138	10.13158
102.4519 VDC	102.3	1% + 3	1.323	101.12420	103.77960
201.437 VDC	201.3	1% + 3	2.313	199.10994	203.76406
297.09 VDC	296.6	1% + 3	3.266	293.80612	300.37388
404.711 VDC	404.7	1% + 3	4.347	400.34181	409.08019
506.515 VDC	505.8	1% + 3	5.358	501.13074	511.89926
634.227 VDC	633	1.2% + 3	10.610724	623.58491	644.86909

The meter met its accuracy specifications for all the DC voltages I tested. 1% + 3 is below average for this group of 6,000 count meters.

VDC Input	11 MΩ
mVDC input	11 MΩ

Both VDC and mVDC inputs have over 10 MΩ resistance, which is good, so the meter is less likely to load down a high-impedance circuit when checking voltage.

AC Volts

Source	Reading	Specification	Uncertainty	Low Bound	High Bound
100Hz Squarewave					
4.999 VAC	4.949 V	1% + 5	0.18997	4.8090	5.1890
60 Hz Sinewave					
1.02 mVAC	N/A	1% + 5			
10 mVAC	0.007	1% + 5	0.00507	0.004894	0.015106
100.7 mVAC	0.099	1% + 5	0.00599	0.09461958	0.10678042
500 mVAC	0.501	1% + 5	0.01001	0.48939	0.51061
1.000 VAC	1.000	1% + 5	0.015	0.9841	1.0159
3.012 VAC	3.006	1% + 5	0.03506	2.9721328	3.0518672
5.010 VAC	5.001	1% + 5	0.05501	4.948984	5.071016
7.003 VAC	6.98	1% + 5	0.1198	6.8759982	7.1300018

The meter met its accuracy specifications for all the AC voltages that I could test. The meter could not read a 1 mVAC signal. The accuracy specification is average for this group of meters.

ACV 1V 3dB cutoff	2.96 kHz

The low frequency of the cutoff is typical of low-cost meters.

Current

Source	Reading	Specification	Uncertainty	Low Bound	High Bound
AC 100Hz Squarewave					
0.999 mA	0.99 mA	1.5% + 3	0.017985	0.9810	1.0170
DC					
0.896 µA	0.8	1% + 3	0.308	0.5870968	1.2049032
9.217 µA	9.1	1% + 3	0.391	8.82135235	9.61264765
99.03 µA	99.0	1% + 3	1.29	97.6904365	100.369564
131.86 µA	131.8	1% + 3	1.618	130.182613	133.537387
1.0088 mA	1.00	1% + 3	0.04	0.96829604	1.04930396
9.9917 mA	9.98	1% + 3	0.1298	9.85940166	10.1239983
99.415 mA	99.3	1% + 3	1.293	98.097117	100.732883
1.000 A	1.00	1.5% + 8	0.095	0.90455	1.09545
3.000 A	3.00	1.5% + 8	0.125	2.87338	3.12662

The meter met its accuracy specifications for all the current values I tested. The µADC and mADC current's accuracy is average for this group of 6,000 count meters and the ADC accuracy is below average.

A Shunt Resistance	.036 Ω
mA Shunt Resistance	11.6 Ω
µA Shunt Resistance	101.11 Ω

It is always good to know how much resistance you are adding to your circuit when you make current measurements.

Resistance

Source	Reading	Specification	Uncertainty	Low Bound	High Bound
1.0054 Ω	1.0	1.5% + 5	0.515	0.49011454	1.52068546
10.007 Ω	10.0	1.5% + 5	0.65	9.35594941	10.6580506
100.07 Ω	100.2	1.5% + 5	2.003	98.0564941	102.083506
1.0011 kΩ	0.999	1.5% + 5	0.019985	0.98103392	1.02116608
10.001 kΩ	9.98	1.5% + 5	0.1997	9.80048993	10.2015101
100.01 kΩ	99.8	1.5% + 5	1.997	98.0044993	102.015501
0.9936 MΩ	0.997	2% + 10	0.02994	0.96355464	1.02364536
9.97 MΩ	9.93	2% + 10	0.2986	9.667312	10.272688

The meter met its accuracy specifications for all the resistance values I tested. The accuracy values for the ranges up to and including 6 MΩ are below average for this group of 6,000 count meters. Many meters have less accuracy in the high ohm ranges.

Resistance Test Voltage	
Low Range	1.00 V
Medium Range	0.90 V
High Range	0.50 V

Capacitance

Source	Reading	Specification	Uncertainty	Low Bound	High Bound
0.0093 nF	N/A				
0.1024 nF	N/A				
1.008 nF	1.00	5% + 35	0.4	0.594936	1.421064
9.941 nF	10.04	5% + 35	0.852	9.039236	10.842764
99.45 nF	100.4	3% + 5	3.512	95.4402	103.4598
1.00081 µF	0.991	3% + 5	0.03473	0.9683376	1.0478624
10.916 µF	10.99	3% + 5	0.3797	10.482636	11.349364
113.83 µF	112.8	3% + 5	3.884	109.39068	118.26932
986.5 µF	1034	5% + 5	56.7	919.8675	1053.1325

The meter met its accuracy specifications for all the capacitance values I tested but could not read the 10 pF and 100 pF capacitor. The accuracy for capacitance is below average for this group of 6,000 count meters.

Diode

Max Diode Voltage	3.239 V
Max Diode Current	.948 mA

This will light some LEDs, for those who test LEDs with multimeters.

Continuity

Slow, but it does latch.

LowZ

The meter has a LowZ position on the rotary switch. It measures AC or DC voltage with 3.3 kΩ resistance. It is used by electricians to eliminate ghost voltages when checking a circuit. I did not test this feature.

Test Leads

If you are in the market for an under-$100 meter, you probably will not buy $40 Probe Master test leads to use with it, so I looked at the included test leads. The test leads were a rigid plastic type. The meter also came with a thermocouple and an adapter for measuring temperature. I did not test temperature measurements.

Ergonomics

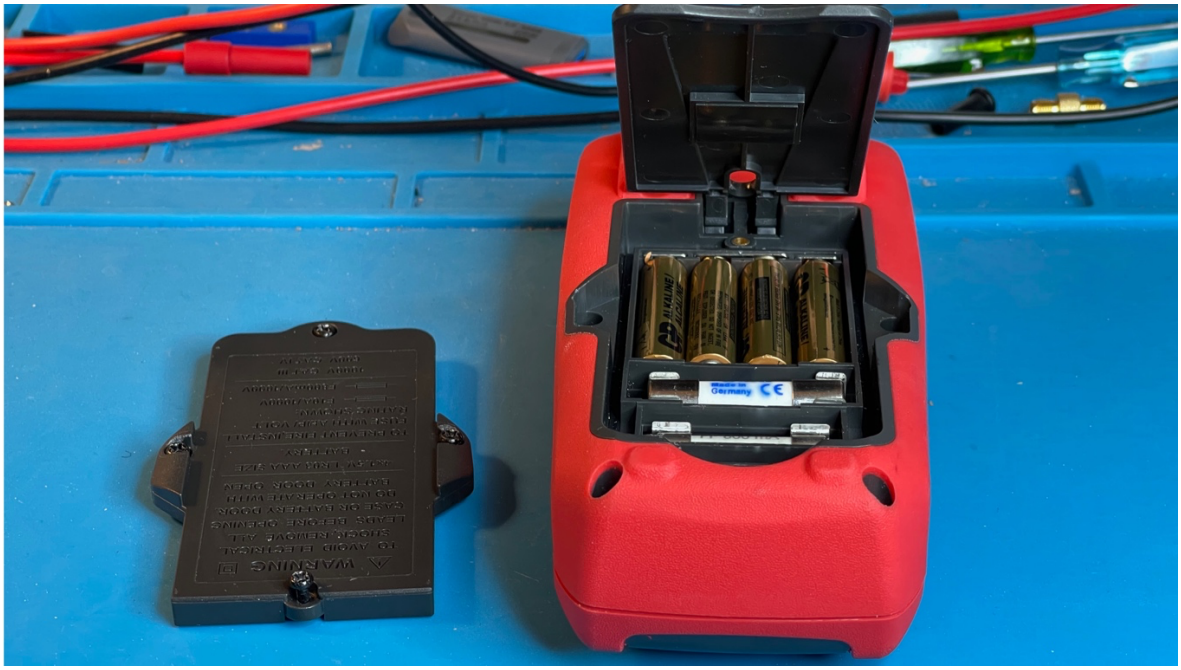
The rotary switch is easy to turn.
The meter is a little slippery when using the bail on a smooth surface.
The display is big with easy-to-read numbers. The backlight is on by default and has a light level sensor that will turn off the backlight when bright light is falling on the face of the meter.

IP67

This manual claims the mater has an ingress protection of IP67 but only if all four lead connection holes are in use with the provided test leads and the 2 plugs. A set of plugs are included in the box. I did not test to see if the meter is waterproof.

Battery

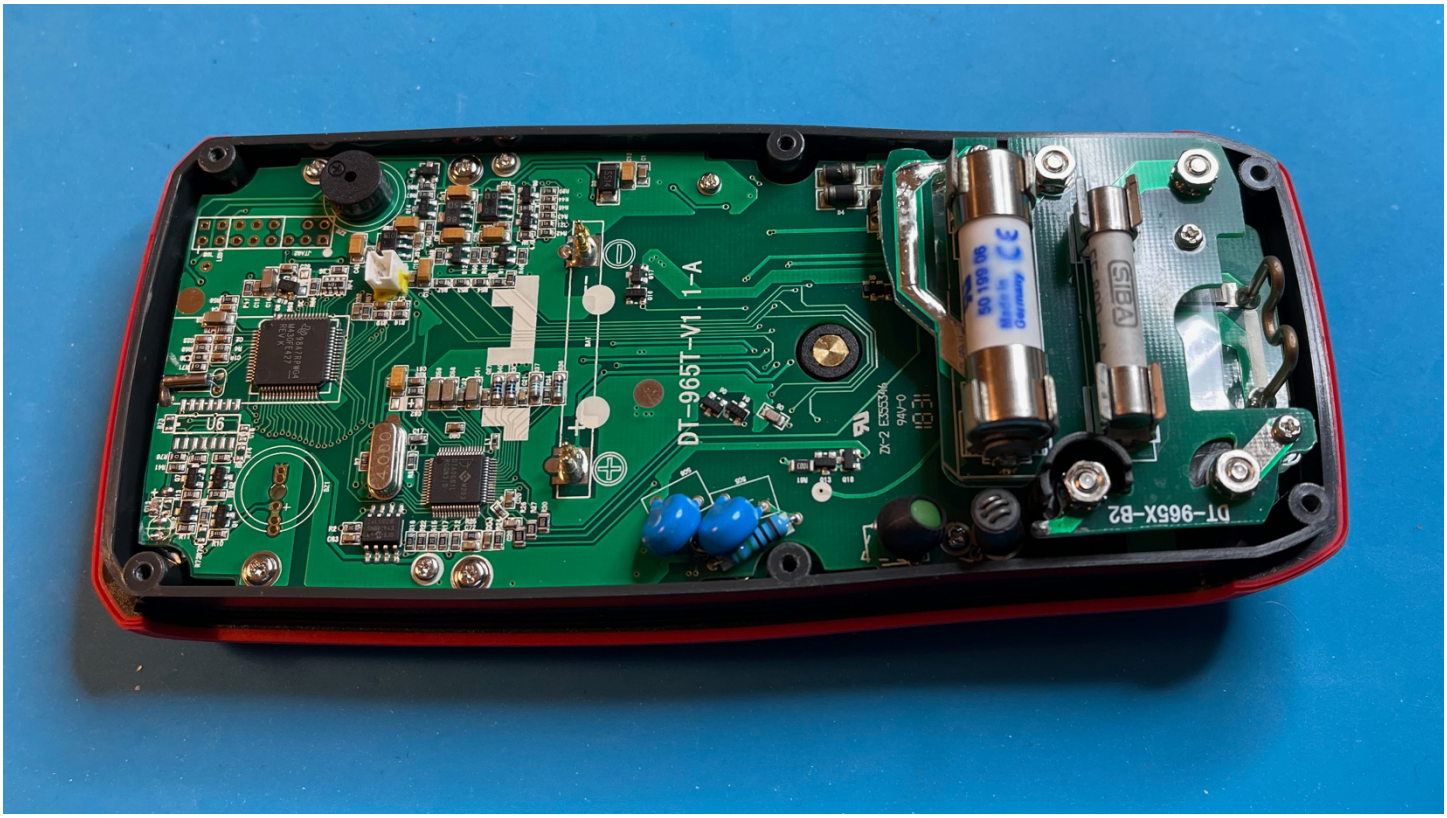
The meter uses four AAA batteries accessible from the back by removing the battery cover. The battery cover has four captured Philips screws that mate with brass inserts. Holding the battery door in with four screws is needed to maintain an IP67 rating.



Fuses

The fuses are accessible from the battery door.

The manual states the fuses are 800mA/1000V (6.3 x 32mm) fast-blow for the µA/mA ranges and 10A/1000V (10 x 38mm) fast-blow for the 10A range. Both should be UL recognized.



Pros

- Under $100
- Meets specifications for all the measurements taken
- Most measurements are more accurate than specifications indicate
- Fuses seem correct for its CAT rating
- IP67 water and dust protection
- Fuses accessible from the battery door
- 3 year warranty

Cons

- No indication of safety testing by a third-party lab
- Below average DC Volts specifications
- Below average AC 10-amp ranges specifications
- Below average resistance specifications
- Below average capacitance specifications
- IP67 rating requires leads and plugs be installed

Conclusion

I like the solid feel of the Triplett MM650 and the positive click of the rotary switch. I like the display and the backlight with its auto detect light level. It is nice to have IP67 ingress protection in such an affordable meter. I just hope I remember to keep those plugs in. This was the only meter in the bunch for which I needed support and Triplett support was very responsive. I had a replacement meter in two days, and they did not want the

broken one back. This is the lowest-priced meter in the group that lets you change the fuses without disassembling the unit.
The biggest drawback to the Triplett MM650 is no indication of third-party safety testing. The second biggest drawback is the low accuracy specifications, but with my sample of one, in most cases its measurements are more accurate than the specifications indicate.