

# 6000-Count Digital Multimeters

## Introduction

Hi, I am Tom, amateur radio call sign N8FDY. This video is part of a series comparing digital multimeters. I will be comparing a group of entry level digital multimeters for use in hobby electronics projects primarily related to amateur radio.

## Disclaimer

I am not a professional, I am a hobbyist. This video is not sponsored; I bought these multimeters with my own money. I only used and tested the multimeters in CAT I and CAT II environments. I do not have a way to review or test the safety of these meters. 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 document.

## Overview

I am comparing twelve digital multimeters that range in price from \$20.95 to \$530.10. They all have similar resolutions (4000 to 6000 count) but vary in accuracy and features. Each meter also has a dedicated review document and video.

## Resolution, Measurements and Accuracy

The resolution of a portable digital multimeter is usually described in counts. A 6000-count meter can display 5999 on the display. It could be 5.999, 59.99, 599.9 or 5999. The accuracy of a portable digital multimeter is usually expressed in +- % of reading +- n least significant digits. An example would be  $\pm(0.05\% + 1)$ , so a reading of 10.00 volts would give an uncertainty value of  $(10 \times .0005) + (1 \times .01) = (0.005) + (.01) = 0.015$  volts, so the value could be from 9.985 Volts to 10.015 volts.

## CAT I & CAT II

I am testing and demonstrating these multimeters in CAT I and CAT II measurement categories. CAT I is for measurements performed on circuits not directly connected to mains. For example, battery-operated electronics, or radio gear connected to 13V power supply.

CAT II is for measurements performed on circuits directly connected to the 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".

## Overview

First, we will look at the features of each multimeter, then we will compare the accuracy of the meters. We will then go over the pros and cons. We will wrap up with a recommendation.

## Test Leads

I will not be using the test leads that came with the meters. 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.

## Features

All the meters have AC Volts & Current, DC Volts & Current, Capacitance, Frequency & Duty Cycle, Resistance, Continuity, diode check, auto and manual range, hold, backlight and test leads.

### Thsinde 18b \$20.95

- 6000 Count.
- Basic DC Accuracy  $\pm(0.5\% + 3)$ .
- True-RMS.
- Min/Max.
- Rel/Delta.
- Non-contact Voltage Sensor (NVC).
- Extra Set of Test Leads and Alligator Clips.
- 9V Battery Included.
- 30-day Return from Amazon.

### Zotek ZT-300AB \$39.99

- 6000 Count.
- Basic DC Accuracy  $\pm(0.5\% + 3)$ .
- True-RMS.
- Min/Max.
- Rel/Delta.
- Auto Mode.
- K-Type Thermocouple.
- Bluetooth Smart Phone App.
- Carry Pouch.
- Two AA Batteries Included.
- 1-Year Warranty.

### Uni-T UT139S \$66.88

- ETL C US Listed.
- CAT III 600V.
- 6000 Count.
- Basic DC Accuracy  $\pm(0.7\% + 3)$ .
- 31 Segment Bar Graph.
- True-RMS.
- Min/Max.
- Rel/Delta.
- K-Type Thermocouple.
- LoZ AC Voltage.
- Low-Pass Filter.
- Two AA Batteries Included.
- 1-Year Warranty (for Triplett MM525 rebranded version).

### Triplett MM650 \$70.99

- 6000 Count.
- Basic DC Accuracy  $\pm(1\% + 3)$ .
- True-RMS.
- 61 Segment Analog Bar Graph.
- Min/Max/Avg.
- Hold.

- Rel.
- Peak (AC Voltage).
- K-Type Thermocouple.
- LoZ AC & DC Voltage.
- Flashlight.
- IP67.
- 1-Year Warranty.
- Four AAA Batteries Included.

#### [Triplet 9055 \\$90.99](#)

- 4000 Count.
- Basic DC Accuracy  $\pm(1\% + 4)$ .
- Hold.
- Rel.
- Light 1 to 40,000 Lux.
- Sound Level 35 to 100dB (C weighting, fast response).
- Ambient Temperature 32 to 122°F (0 to 50°C).
- Relative Humidity 33 to 99%RH.
- K-Type Thermocouple.
- Non-contact Voltage sensor (NVC).
- 3-year warranty.
- 9V Battery Included.

#### [EEVblog Brymen BM235 \\$139.00](#)

- UL C USA Listed.
- CAT II 1000V, CAT III 600V, CAT IV 300V.
- 6000 Count.
- Basic DC Accuracy  $\pm(0.3\% + 2)$ .
- True-RMS.
- Min/Max/Avg (Rec button).
- Hold.
- Rel.
- Non-Contact EF-Detection (NCV) With Hi/Lo Selectable Sensitivities.
- AutoV LoZ Feature.
- VFD V Of Most Variable-Frequency-Drives.
- K-Type Thermocouple.
- Fuse Access Door.
- 240 Hour Battery Life.
- 1-Year Limited Warranty.
- Two AAA Batteries Included.

#### [Greenlee DM-510A \\$148.99](#)

- UL C USA Listed.
- CAT II 1000V, CAT III 600V, CAT IV 300V.
- 6000 Count.
- Basic DC Accuracy  $\pm(0.2\% + 3)$ .
- True-RMS.
- Twenty-four Segment Analog Bar Graph Updates 40/Sec.
- AutoCheck Feature (Automatic DCV, ACV & Ohms Selection).

- Lo-Z Volts Drain Ghost Voltages (AutoCheck Feature).
- Min/Max (Rec button).
- Hold.
- Rel.
- Non-Contact EF-Detection (NCV).
- K-Type Thermocouple.
- Fuse Access Door.
- Lifetime Limited Warranty.
- Two AAA Batteries Included.

#### [Fluke 17B MAX \\$149.97](#)

- CSA C US Listed.
- CAT III 600V.
- 6000 Count Voltage, 5000 Count Frequency, 4000 Count all others.
- Basic DC Accuracy  $\pm(0.5\% + 3)$ .
- Min/Max.
- Rel/Delta.
- Hold.
- Auto-off Override.
- Backlight Auto-off Override.
- K-Type Thermocouple.
- Two AA Batteries Included.

#### [Fluke 177 \\$274.49](#)

- CSA C US Listed.
- CAT III 1000V, CAT IV 600V.
- 6000 Count.
- Basic DC Accuracy  $\pm(0.09\% + 2)$ .
- True-RMS.
- Thirty-three Segment Analog Bar Graph.
- Min/Max/Avg.
- Rel/Delta.
- Hold.
- AutoHold.
- Auto-off Override.
- Backlight Auto-off Override.
- Disables beeper.
- "Smoothing" mode.
- 9V Battery Included.
- Limited Lifetime Warranty.

#### [Fluke 179 \\$359.99](#)

- CSA C US Listed.
- CAT III 1000V, CAT IV 600V.
- 6000 Count.
- Basic DC Accuracy  $\pm(0.09\% + 2)$ .
- True-RMS.
- Thirty-three Segment Analog Bar Graph.
- Min/Max/Avg.

- Rel/Delta.
- Hold.
- AutoHold.
- K-Type Thermocouple.
- Auto-off Override.
- Backlight Auto-off Override.
- Disables beeper.
- "Smoothing" mode.
- 9V Battery Included.
- Limited Lifetime Warranty.

#### [Fluke 87V \\$371.48](#)

- CSA C US Listed.
- CAT III 1000V, CAT IV 600V.
- 6000 Count, 19,999 Count, but no greater accuracy.
- Basic DC Accuracy  $\pm(0.05\% + 1)$ .
- True-RMS.
- Thirty-two Segment Analog Bar Graph.
- Min/Max/Avg.
- Peak Min/Max.
- AutoHold.
- Low Pass Filter.
- K-Type Thermocouple.
- Auto-off Override.
- Option to Disable Beeper.
- "Smoothing" mode.
- Enables zoom mode for the bar graph.
- Enables the Meter's mV dc high impedance mode.
- 9V Battery Included.
- Limited Lifetime Warranty.

#### [Fluke 87V MAX \\$530.10](#)

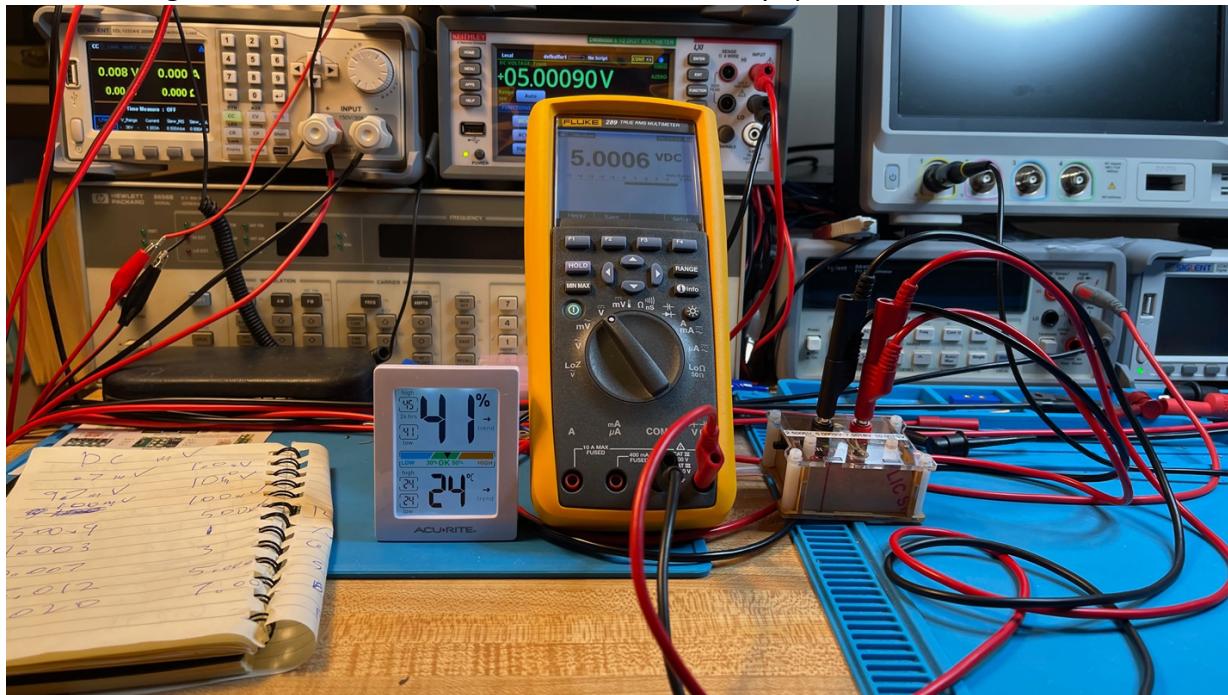
- CSA C US Listed.
- CAT III 1000V, CAT IV 600V.
- 6000 Count, 19999 Count, but no greater accuracy.
- Basic DC Accuracy  $\pm(0.05\% + 1)$ .
- True-RMS.
- Thirty-two Segment Analog Bar Graph.
- Min/Max/Avg.
- Peak Min/Max.
- AutoHold.
- Low-Pass Filter.
- K-Type Thermocouple.
- Auto-off Override.
- Backlight Auto-off Override.
- Can Disable beeper.
- "Smoothing" mode.
- Enables zoom mode for the bar graph.

- Enables the Meter's mV dc high impedance mode.
- IP67.
- Three AA Batteries Included.
- Limited Lifetime Warranty.

## Accuracy



I do not have reference standards. I use a Keithley DMM6500 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 compute the meter-under-test reading uncertainty value and subtract it from the lowest value and add it to the highest value and 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  $\pm(0.0025\% \text{ of reading} + 0.0005\% \text{ of range})$ ; 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 for DC Volts) reading of 5.0006. The Fluke 289's accuracy at this range is  $\pm(0.025\% \text{ of reading} + 2 \text{ least significant digits})$  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 Voltage

Value	Thsinde 18B+	Zotek ZT- 300AB	Uni-T UT139S	Triplet MM65 0	Triplet 9055	Brymen	Greenle e DM- 510A	Fluke 17B MAX	Fluke 177	Fluke 179	Fluke 87V	Fluke 87V MAX
DC Volts												
1 mV												
10 mV												
100 mV												
500 mV												
1 V												
3 V												
5 V												
7 V												
100 V												
200 V												
300 V												
400 V												
500 V												
600 V		N/A										
VDC Input	11 MΩ	0.9 MΩ	11 MΩ	11 MΩ	11 MΩ	11 MΩ	11 MΩ	11 MΩ	11 MΩ	11 MΩ	11 MΩ	11 MΩ
mVDC input	20 MΩ	10 MΩ	12 MΩ	11 MΩ	19 MΩ	10 MΩ	5 MΩ	18 MΩ	10 MΩ	10 MΩ	10 MΩ	10 MΩ

The Uni-T can't measure voltages over 600 volts. The Zotek has a low input impedance on the volts range and the Greenlee has a low input impedance on the millivolt range.

## AC Voltage

Value	Thsindle 18B+	Zotek ZT-300AB	Uni-T UT139S	Triplett MM650	Triplett 9055	Brymen BM235	Greenlee DM-510A	Fluke 17B MAX	Fluke 177	Fluke 179	Fluke 87V	Fluke 87V MAX
AC Volts 60 Hz Sinewave												
1 mV				N/A	N/A					Yellow		
10 mV												
100 mV												
500 mV												
1 V												
3 V												
5 V												
7 V												
ACV 1V 3dB cut	3 kHz	4 kHz	2.98 kHz	2.96 kHz	7 kHz	3 kHz	8.4 kHz	6 kHz	6.8 kHz	6.7 kHz	135 kHz	108 kHz
AC Voltage 100 Hz Square Wave												
5 V		Yellow		Yellow				Yellow				
AC Current 100 Hz Square Wave												
1 mA					Yellow			Yellow				

The Uni-T did not meet its specifications for the 5volt AC square wave. The Triplett 9055 and Fluke 17B MAX are not Ture-RMS meters so they could not accurately measure the square wave voltage or current. The Fluke 179 gave an incorrect reading at 1mV, but it is a 20-year-old meter.

## DC Current

Value	Thsindle 18B+	Zotek ZT-300AB	Uni-T UT139S	Triplett MM650	Triplett 9055	Brymen BM235	Greenlee DM-510A	Fluke 17B MAX	Fluke 177	Fluke 179	Fluke 87V	Fluke 87V MAX
DC Current												
1 uA									N/A	N/A		
10 uA										N/A		
100 uA												
131 uA												
1 mA												
10 mA												
100 mA												
1 A												
3 A												

The Fluke 177 and 179 do not have a dedicated  $\mu$ A range and are not good for projects that need low current measurements.

## Resistance

Value	Thsinde 18B+	Zotek ZT- 300AB	Uni-T UT139S	Triplett MM650	Triplett 9055	Brymen BM235	Greenlee DM-510A	Fluke 17B MAX	Fluke 177	Fluke 179	Fluke 87V	Fluke 87V MAX
Resistance												
1 Ω	█	█	█	█	█	█	█	█	█	█	█	█
10 Ω												
100 Ω	█	█	█	█	█	█	█	█	█	█	█	█
1 kΩ	█	█	█	█	█	█	█	█	█	█	█	█
10 kΩ	█	█	█	█	█	█	█	█	█	█	█	█
100 kΩ	█	█	█	█	█	█	█	█	█	█	█	█
1 MΩ	█	█	█	█	█	█	█	█	█	█	█	█
10 MΩ	█	█	█	█	█	█	█	█	█	█	█	█
100 MΩ	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Much rejoicing. All the meters met their resistance specifications. None of the meters can measure up to 100 M Ω.

## Capacitance

Value	Thsinde 18B+	Zotek ZT- 300AB	Uni-T UT139S	Triplett MM650	Triplett 9055	Brymen BM235	Greenlee DM-510A	Fluke 17B MAX	Fluke 177	Fluke 179	Fluke 87V	Fluke 87V MAX
Capacitance												
10 pF	N/A	N/A	N/A	N/A	N/A	█	█	N/A	N/A	N/A	N/A	█
100 pF	█	█	N/A	N/A	█	█	█	█	N/a	N/A	█	█
1 nF	█	█	█	█	█	█	█	█	█	█	█	█
10 nF	█	█	█	█	█	█	█	█	█	█	█	█
100 nF	█	█	█	█	█	█	█	█	█	█	█	█
1 μF	█	█	█	█	█	█	█	█	█	█	█	█
10 μF	█	█	█	█	█	█	█	█	█	█	█	█
100 μF	█	█	█	█	N/A	█	█	█	█	█	█	█
1000 μF	█	█	█	█	N/A	█	█	█	█	█	█	█

Much disappointment in this area. The only meters that held up were the Brymen DM235 and the Fluke 87V MAX. For accurate capacitance measurements an LCR Meter would be a better choice.

## Diode Test

Value	Thsinde 18B+	Zotek ZT- 300AB	Uni-T UT139S	Triplett MM650	Triplett 9055	Brymen BM235	Greenlee DM-510A	Fluke 17B MAX	Fluke 177	Fluke 179	Fluke 87V	Fluke 87V MAX
Diode Test												
Voltage	3.245 V	3.979 V	3.227 V	3.239 V	1.5 V	3.24 V	1.533 V	2.338 V	7.30 V	2.689 V	7.305 V	2.38V
Current	1.49 mA	1.6 mA	1.345 mA	0.948 mA	0.640 mA	0.324 mA	0.456 mA	0.502 mA	1.00 mA	0.977 mA	1.00 mA	1 mA

I know LEDs are diodes, but so are Zeners and most of them can't be tested on a multimeter. I also know it is quite popular to use multimeters for testing LEDs. The Fluke 177 and Fluke 87V have the highest test voltage and the Triplett 9055 and Greenlee DM-510A have the lowest.

## Accuracy Specifications

Value	Thsinde 18B+	Zotek ZT-300AB	Uni-T UT139S	Triplet MM650	Triplet 9055	Brymen BM235	Greenlee DM-510A	Fluke 17B MAX	Fluke 177	Fluke 179	Fluke 87V	Fluke 87V MAX
DC mV	0.5%+3	0.5%+3	0.5%+2	1.0%+8	1.0%+4	0.3%+2	0.4%+5	1.0%+10	0.09%+2	0.09%+2	0.1%+1	0.1%+1
DC V	0.5%+3	0.5%+3	0.7%+3	1.0%+3	1.5%+4	0.4%+2	0.2%+3	0.5%+3	0.09%+2	0.09%+2	0.05%+1	0.05%+1
AC mV	0.8%+5	1.0%+3	1.0%+3	N/A	1.5%+15	1.0%+3	1.0%+5	3.0%+3	1.0%+3	1.0%+3	0.7%+4	0.7%+4
AC V	0.8%+5	1.0%+3	0.8%+3	1.0%+5	1.5%+4	0.7%+3	1.0%+5	1.0%+3	1.0%+3	1.0%+3	0.7%+2	0.7%+2
DC $\mu$ A	0.8%+10	1.2%+3	0.7%+2	1.0%+3	1.0%+4	1.0%+3	0.5%+5	1.5%+3	N/A	N/A	0.2%+4	0.2%+4
DC mA	2%+30	1.2%+3	0.7%+2	1.0%+3	1.2%+4	0.7%+3	0.5%+5	1.5%+3	1.0%+3	1.0%+3	0.2%+4	0.2%+4
DC A	2%+30	1.2%+3	1.0%+3	1.5%+8	2.0%+5	0.7%+3	1.2%+6	1.5%+3	1.0%+4	1.0%+4	0.2%+4	0.2%+4
AC $\mu$ A	0.8%+10	1.5%+3	1.0%+3	1.5%+3	1.2%+4	1.5%+3	1.0%+3	1.5%+3	N/A	N/A	1.0%+2	1.0%+2
AC mA	2%+30	1.5%+3	1.0%+3	1.5%+3	1.5%+4	1.0%+3	1.0%+3	1.5%+3	1.5%+3	1.5%+3	1.0%+2	1.0%+2
AC A	2%+30	1.5%+3	1.2%+3	2%+8	2.0%+5	1.0%+3	1.2%+6	1.5%+3	1.5%+4	1.5%+4	1.0%+2	1.0%+2
$\Omega$	0.8%+5	0.5%+3	1.0%+2	1.5%+5	1.5%+4	0.3%+3	0.5%+4	0.5%+3	0.9%+2	0.9%+2	0.2%+2	0.2%+2
Low k $\Omega$	0.8%+3	0.5%+3	0.8%+2	1.5%+5	1.5%+3	0.3%+3	0.5%+4	0.5%+2	0.9%+1	0.9%+1	0.2%+1	0.2%+1
High k $\Omega$	0.8%+3	0.5%+3	0.8%+2	1.5%+5	1.5%+3	0.5%+3	0.5%+4	0.5%+2	0.9%+2	0.9%+2	0.6%+1	0.2%+1
Low M $\Omega$	0.8%+3	0.5%+3	1.2%+3	2%+10	2.0%+3	0.9%+2	0.7%+4	0.5%+2	0.9%+3	0.9%+3	0.6%+1	0.2%+1
High M $\Omega$	1.0%+25	1.5%+3	1.5%+5	2%+10	2.5%+3	0.9%+2	1.2%+4	1.5%+3	1.5%+3	1.5%+3	1.0%+3	1.0%+1
nF	3.5%+20	5%+20	4%+10	5%+35	15%+70	1.5%+8	2%+5	2%+5	1.2%+2	1.2%+2	1%+2	1.0%+2
Low $\mu$ F	3.5%+20	2%+5	4%+5	3%+5	4%+5	1.5%+2	1.5%+5	5%+5	1.2%+2	1.2%+2	1%+2	1.0%+2
High $\mu$ F	5%+5	5%+5	10%	5%+5	N/A	4.5%+10	2%+5	5%+5	10%	10%	1%+2	1.0%+2

The accuracy specifications are from the meters' respective manuals. The color code shows the extreme low and high accuracy specifications. Green is the highest, yellow is lowest, and white is everything in-between. The pink background in the meter's name and model indicate that meter does not have third-party safety testing indications in the manual or on the meter.

## Pros and Cons

### Thsinde 18b \$20.95

#### Pros

- Inexpensive.
- All my tests show that it meets the manual's stated accuracy specifications.
- Good AC Volts Accuracy.
- Good AC  $\mu$ A Accuracy.
- Large Easy-ToRead numbers.
- Bright Backlight.

#### Cons

- No indication of any third-party safety testing.
- Most current ranges have low accuracy.
- Capacitance ranges have low accuracy.
- Poorly written manual that contains obvious errors.
- Beeps every time you change the function knob.
- Backlight turns off too quickly.

## Conclusion

The biggest drawback to the Thsinde 18B+ is that there is no third-party safety testing. If you are on a very tight budget or want to experience using a multimeter at a low cost, give this a try.

It is good for voltages, OK for resistance, not so good for current and bad for capacitance measurements.

If you are new to using multimeters, the manual is not very useful. You will need supplemental documentation.

In general, I would not recommend the Thsinde 18B+ to a friend, or even give it to anyone.

## Zotek ZT-300AB \$39.99

### Pros

- Under \$50.
- All but one of my tests show that it meets the manuals stated accuracy specifications.
- DCV accuracy good for a low-cost meter.
- Large easy-to-read numbers.
- Detailed manual that seems mostly correct.
- Bright backlight.
- Bluetooth connectivity.

### Cons

- No indication of any third-party safety testing.
- Low DCV input impedance.
- DC current ranges are below average accuracy in the 6000-count group.
- Capacitance ranges have low accuracy.
- Beeps every time you change the function knob or push a button.
- No protective boot.
- Must disassemble the meter to change fuses.

### Conclusion

The biggest drawback to the Zotek ZT-300AB is that there is no third-party safety testing. If you are on a tight budget or want to experience using a multimeter at a low cost and want to monitor the meter from your phone, give this a try.

It is good for voltages, OK for resistance, not so good for current and bad for capacitance measurements. If you are new to using multimeters, the manual can help. It has simple step-by-step instructions for each function.

In general, if you only plan to use the Zotek ZT-300AB in a low-voltage and low-energy environment, I would say as a low-cost entry-level meter that you could give it a try. As you get more involved with electronics projects you could soon outgrow this meter.

## Uni-T UT139S \$66.88

### Pros

- Third-party safety tested by ETL to meet US and Canada standards.
- Above-average AC current accuracy for this group.
- 600 mA fuse accessible from the battery door.
- Met specifications for all DC voltage, currents, and resistances tested.
- Available in the US as Triplett model MM525 with 1-year warranty.

### Cons

- 600 volt maximum.
- Short battery life.
- Below-average capacitance specifications.
- Must disassemble the meter to change the 10A fuse.

## Conclusion

I have had the Uni-T UT139S since November 2022. I had great hopes that this could be the economical multimeter that I could recommend to everyone. Sadly, it's not. The picture of the screens looks better than the screen in person. The capacitance range is disappointing. I think my expectations were just too high for an under-\$100 meter.

Resetting my expectations, this meter does OK with voltage, current and resistance, and is third-party tested for safety. If you buy it in the US under the Triplett name, you will get a 1-year warranty. With a different Triplett meter, I had a very positive experience with Triplett's customer support.

If you are a beginner and must stay under \$70 (plus tax & shipping) then this meter will do fine. You may have to shop around the internet to get it for under \$70, but I would not pay much more for it.

## Triplett MM650 \$70.99

### Pros

- Under \$100.
- Met 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 10 AC 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 of 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.

## Triplett 9055 (4000 count) \$90.99

### Pros

- Under \$100.
- Almost all measurements met the specifications in the manual.
- Measures light.

- Measures sound.
- 3-year warranty.

#### Cons

- No indication of third-party safety testing.
- Most specifications were below average for this group of 6000-count meters.
- Must disassemble the meter to change fuses.

#### Conclusion

You may want to get the Triplett 9055 to measure sound or light, but for everything else I would use a different meter.

### [EEVBlog Brymen BM235 \\$139.00](#)

#### Pros

- Under \$150.
- Third-party safety tested by UL.
- All measurements met accuracy specification.
- Above-average accuracy AC volts.
- Above-average accuracy AC millamps & amps.
- Above-average accuracy 600 Ω, 6 kΩ, 6 MΩ and 60 MΩ ranges.
- Fuses accessible from battery compartment.
- 1-year warranty.

#### Cons

- Capacitance readings below 1nF are not useful.
- Must send to Taiwan for warranty service.

#### Conclusion

I think the EEVBlog BM-235 is one of the two meters in the sweet spot of price vs performance in this group of 6000-count meters.

The only drawback is sending the meter to Taiwan for warranty work. You may be able to send it to EEVBlog for warranty repair but that is in Australia.

In this group of 6000-count meters I reviewed, this is the lowest-cost one I would recommend.

### [Greenlee DM-510A \\$148.99](#)

#### Pros

- Under \$150.
- Third-party safety tested by UL.
- All but one measurement met the accuracy specification.
- Fuses accessible from battery compartment.
- Limited Lifetime Warranty.

#### Cons

- A little off specification for 1000 μF reading.

- Lower than average DC amps accuracy specification.
- Lower than average mVDC input impedance.
- Backlight turned off after thirty seconds.

#### Conclusion

I think the Greenlee DM-510A is one of the two meters in the sweet spot of price vs performance in this group of 6000-count meters.

The only drawback is below-average DC amps range accuracy specification.

In this group of 6000-count meters I reviewed, this is the second lowest-cost one I would recommend.

#### Fluke 17B MAX (4000 count) \$149.97

##### Pros

- Under \$150.
- Third-party safety tested by CSA.
- The DC and AC volts ranges accuracy specifications are OK.
- Resistance ranges accuracy specifications are OK.
- You can override the auto power off and the auto backlight off functions.

##### Cons

- Capacitance ranges either have low accuracy specifications or have readings that don't meet the accuracy specifications.
- Must download English manual.
- The DC and AC millivolt ranges accuracy specifications are below average.
- DC current ranges accuracy specifications are below average.
- No measurement range accuracy specification on the meter is above average.
- Only available in US via grey market with no support.
- Must disassemble unit to change fuses.

#### Conclusion

It is interesting to see what meter is being sold by Fluke in the Asia and India markets. It is CSA safety tested. The AC & DC volts ranges, and the resistance ranges are OK. The current and capacitance ranges aren't very good compared to some of the lower-priced meters in this group of 6000-count meters.

If you are a meter collector, I would say pick up one of these for your collection.

#### Fluke 177 \$274.49 and Fluke 179 \$359.99

##### Pros

- Third-party safety tested by CSA.
- DC millivolts accuracy specifications are the best in this group of 6000-count meters.
- DC volts accuracy specifications above average in this group of 6000-count meters.
- Limited Lifetime Warranty.

##### Cons

- No  $\mu$ A range.
- Battery door is secured with self-tapping screws into plastic.
- Must disassemble the meter to change fuses.

## *Conclusion*

The Fluke 179 shows me why Fluke has a reputation for reliable meters. After twenty years it is almost as accurate as the new Fluke 177. The newer 17x line of meters has some function that my old 179 doesn't, so it shows Fluke is quietly upgrading the series.

If you need millivolt DC accuracy specification from a 6000-count meter above all else, consider the Fluke 177, if you can find it at a low price. Also, if you want a small voltage and resistance meter and you don't need microamps, the Fluke 177 would be a good fit. If you need temperature readings, the Fluke 179 would work but it seems to cost more than the Fluke 87V when Lowe's website has the 87V on sale.

I would not recommend this meter for electronics projects because it lacks a microamp range.

## *Fluke 87V \$398.18*

### *Pros*

- Third-party tested for safety by CSA.
- Met **all** accuracy specifications for all tests.
- Highest accuracy specifications for DC volts and DC current among the 6000-count meter tested.
- Highest accuracy specifications for AC volts, AC millivolts, AC milliamps and AC amps among the 6,000-count meters tested.
- Highest accuracy specifications for 600  $\Omega$ , 6 k $\Omega$ , 60 k $\Omega$  and 50 M $\Omega$  ranges among the 6000-count meters tested.
- Highest accuracy specifications for capacitance ranges among the 6000-count meters tested.
- Above-average accuracy specifications for DC millivolts and AC microamps among the 6000-count meters tested.
- Highest diode test voltage among the 6000-count meters tested.
- Lifetime Limited Warranty.

### *Cons*

- Only average accuracy specifications for 600 k $\Omega$  and 6 M $\Omega$  ranges among the 6000-count meters tested.
- Meter must be disassembled to change fuses.

## *Conclusion*

This is my meter of choice for the radio shack, so I am a little biased in favor of the Fluke 87V. If you want a 6000-count meter with high accuracy (except for the 600 k $\Omega$  and 6 M $\Omega$  ranges) this is the meter for you, especially if you can get it for \$318.62 (Lowe's web price on 28-June-2023).

## *Fluke 87V MAX \$530.10*

### *Pros*

- Third-party tested for safety by CSA.
- IP67 water and dust protection.
- Met **all** accuracy specifications for all tests.
- Highest accuracy specifications for DC volts and DC current among the 6000-count meter tested.
- Highest accuracy specifications for AC volts, AC millivolts, AC milliamps and AC amps among the 6000-count meters tested.
- Highest accuracy specifications for resistance ranges among the 6000-count meters tested.
- Highest accuracy specifications for capacitance ranges among the 6000-count meters tested.

- Above-average accuracy specifications for DC millivolts, AC microamps among the 6000-count meters tested.
- Ability to disable backlight auto-off.
- Lifetime Limited Warranty.

## Cons

- Dim backlight.
- Bulkier and heavier than the other meters in this 6000-count group.
- Most expensive in the group of 6000-count meters.

## Conclusion

This is my meter of choice for outside work, so I am a little biased in favor of the Fluke 87V MAX. If you want a 6000-count meter with high accuracy and water and dust resistance, this is the meter for you, especially if you can get it for \$500.98 at TEquipment.com (price as of 1-July-2023). If they run out, try Newark; their price is \$530.10.

## Recommendation

If you are just starting out and want a good starter meter, or you want to upgrade to a new meter, I would recommend one of the following:

- Buy an EEVblog Brymen BM235 from Amazon for \$139.00. It is a good compromise of performance and price, but 1-year warranty return to Taiwan.
- Buy a Greenlee DM-510A from Amazon for \$148.99. This is the second-best compromise of performance and price with Greenlee's "Lifetime Limited Warranty".
- Buy a Fluke 87V from lowes.com for \$318.62 (as of 28-June-2023). It has above-average accuracy specifications for most measurement range tests in this group of 6000 count meters and has Fluke's "Lifetime Limited Warranty".
- Buy a Fluke 87V MAX from tequipment.net for \$ 500.98, or from Newark for \$530.10. It has best accuracy specifications for most measurement range tests in this group of 6000-count meters and is IP67 waterproof and dustproof and has Flukes "Lifetime Limited Warranty".
- Look into the 10000 to 20000-count meter reviews (estimated ready by winter 2023).
- Look into the 50000-count and above meter review (estimated ready by fall 2023).