# 10-20000 Count Digital Multimeter Summary Part 1

## Introduction

Hi, I am Tom, amateur radio call sign N8FDY. Part 1 of this summary is part of a series comparing digital multimeters. I will be comparing a group of 10000 to 20000 count digital multimeters that are third party safety testes for use in hobby electronics projects primarily related to amateur radio.
Part 2 will be comparing a group of 10000 to 20000 count digital multimeters that are NOT third party safety testes for use in hobby electronics projects primarily related to amateur radio and will be published later.

## 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 four digital multimeters that range in price from $115.77 to $461.00. They all have similar resolutions (10000 to 22000 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 50000-count meter can display 49999 on the display. It could be 4.9999, 49.999, 499.99, 4999.9 or 49999. The accuracy of a portable digital multimeter is usually expressed in +- % of reading +- n least significant digits. An example would be ±(0.05% + 1), so a reading of 10.00 volts would give an uncertainty value of (10 X .0005) + (1 X .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”.

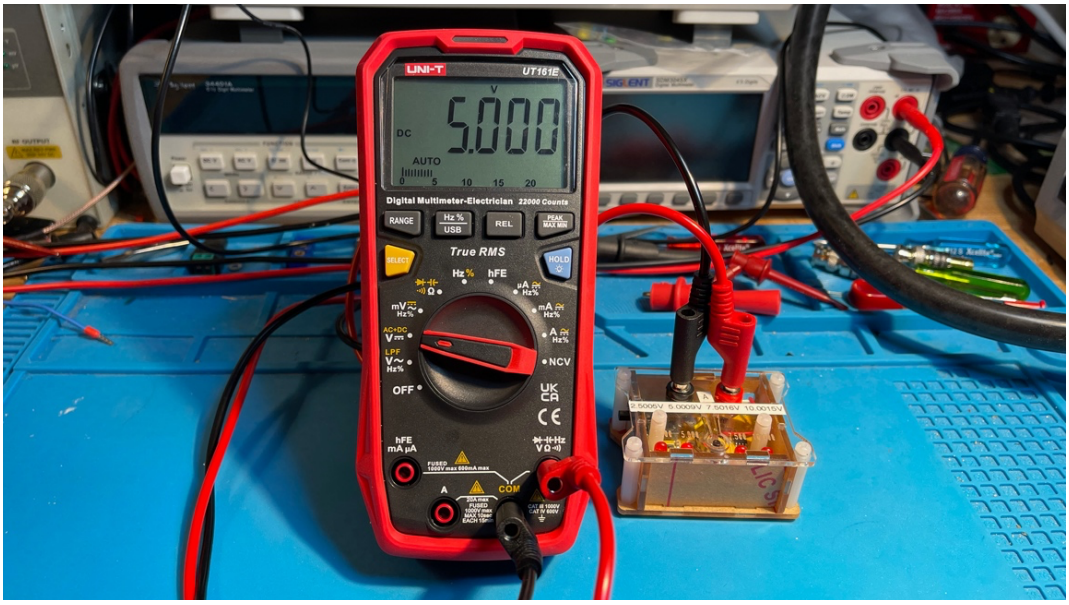
## Overview

For each multimeter we will look at the features, pros, cons, and recommendations. Then we will compare the accuracy performance of the meters.

## 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.

## UNI-T UT161E




Price: $115.77 as of 4-8-2024 from Amazon at the Uni-T Direct Store. I paid $128.77 from Amazon at the Uni-T Direct Store in 7-6-2023.

## Features

- ETL C US Listed.
- CAT IV 600V.
- CAT III 1000V.
- 22,000 Count.
- Basic DC Accuracy ±(0.05%+5).
- 46 Segment Bar Graph.
- True-RMS.
- Min/Max.
- Rel/Delta.
- Low Pass Filter.
- 1 GΩ Input Impedance for the mV range.
- Four AAA Batteries Included.
- 18 Month Warranty (if purchased from Uni-T Direct Store at Amazon.com).

## Pros

- Third-party safety testing by ETL to meet US and Canada standards.
- Lowest cost meter with .05+5 DC Volts accuracy.
- All the measurements taken met the accuracy specifications as stated in the manual.
- 1 GΩ Input Impedance for the mV range.
- Includes USB interface with free software downloadable from the Uni-T website.
- $30 Bluetooth adapter available with free IOS and Android software.

## Cons

- The µA shunt resistance is higher than usual.

- Beeps every time you move the rotary switch.
- Can’t measure temperature.

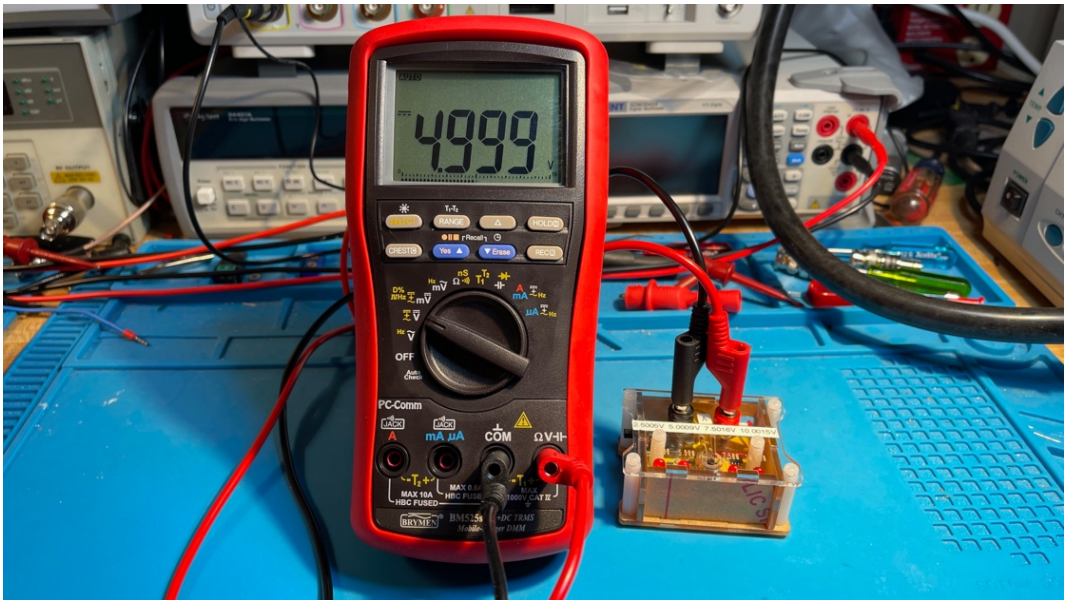
## Recommendation

The Uni-T UT161E is the lowest cost 22,000 count meter that I can recommend without reservations. If you are just starting out with you first digital multimeter or replacing or supplementing your old analog meter this is a good meter to get started with. This is also the lowest cost 22,000 count third party safety tested meter that has a PC interface and has an optional Bluetooth adapter. Many higher cost meters don’t have any PC or mobile interface available.

For voltage and current accuracy specifications this is an improvement over the UT161D for an about $39 increase in cost and all you give up is temperature measurements.

If you need higher accuracy specifications or more resolution, you will have to look at higher cost meters.

## Brymen BM525s




Price: I paid 158.82 € excl. VAT ($170.34 US as of 9-13-2023) from Welectron in Germany. The price is still the same as of April 2024, but the exchange rate changes often.

## Features

- UL C US Listed
- CAT IV 1000V
- 10,000 Count
- Basic DC Accuracy ±(0.08%+2)
- 41 Segment Bar Graph
- True-RMS
- Min/Max
- Crest (Peak Hold)
- Rel/Delta
- Stand-Alone Data-Logging
- Optional PC Logging
- Lo-Z Volts
- AutoCheck™ Feature (Automatic DCV, ACV, Lo-Z Volts, & Ohms Selection)
- One 9 Volt Batteries Included
- 1 Year Warranty

## Pros

- Third-party safety testing by UL to meet US and Canada standards.
- All the measurements taken met the accuracy specifications as stated in the manual.
- Good accuracy specifications for a 10,000-count meter.
- Stand-Alone Data-Logging for 43,000 data point in dual display mode.
- Optional PC USB interface with free software.

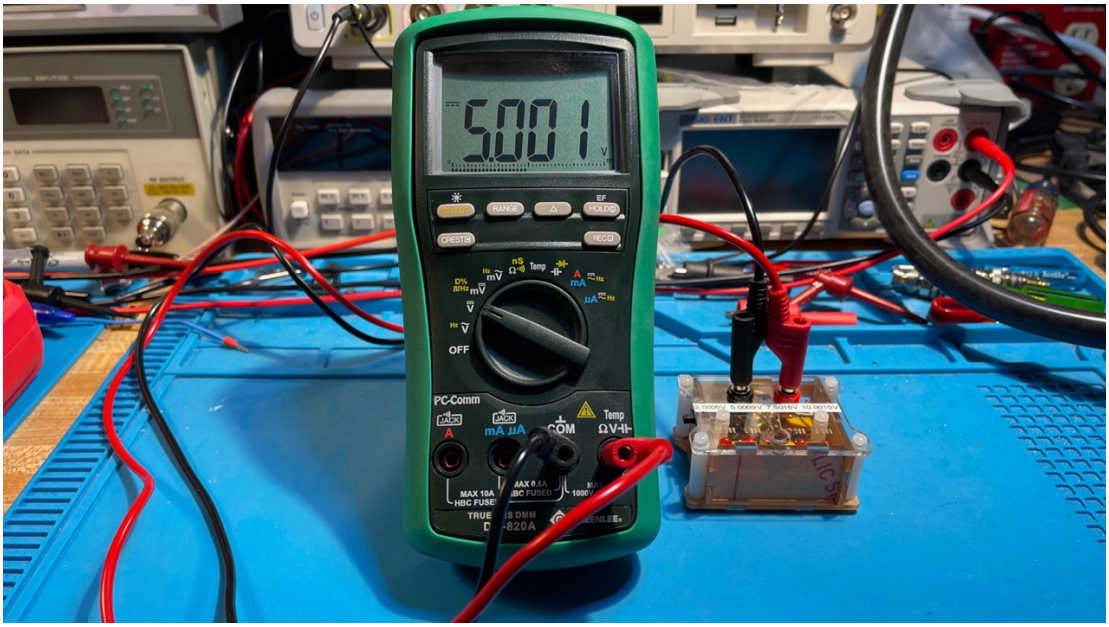
## Cons

- The backlight only stays on for 32 seconds.
- No Bluetooth interfaces.
- Must send to Taiwan for service.

## Recommendation

This is a good 10,000-count meter with stand-alone logging.  It also has an optional USB connection with freely downloadable windows software to access the stored data in the meter.

## Greenlee DM-820




Price: $222.99 from Amazon.com.  I paid 201.37 from Amazon.com on 3-Jun-2023.

## Features

- UL C US Listed
- CAT IV 1000V
- 10,000 Count
- Basic DC Accuracy ±(0.08%+2)
- 41 Segment Bar Graph
- True-RMS
- Min/Max/Avg (Rec)
- Crest (Peak Hold)
- Rel/Delta
- Optional PC Logging
- One 9 Volt Batteries Included
- Lifetime Limited Warranty

## Pros

- Third-party safety testing by UL to meet US and Canada standards.
- All the measurements taken met the accuracy specifications as stated in the manual.
- Good accuracy specifications for a 10,000-count meter.
- Optional PC USB interface with free software.
- Limited lifetime warranty with USA support

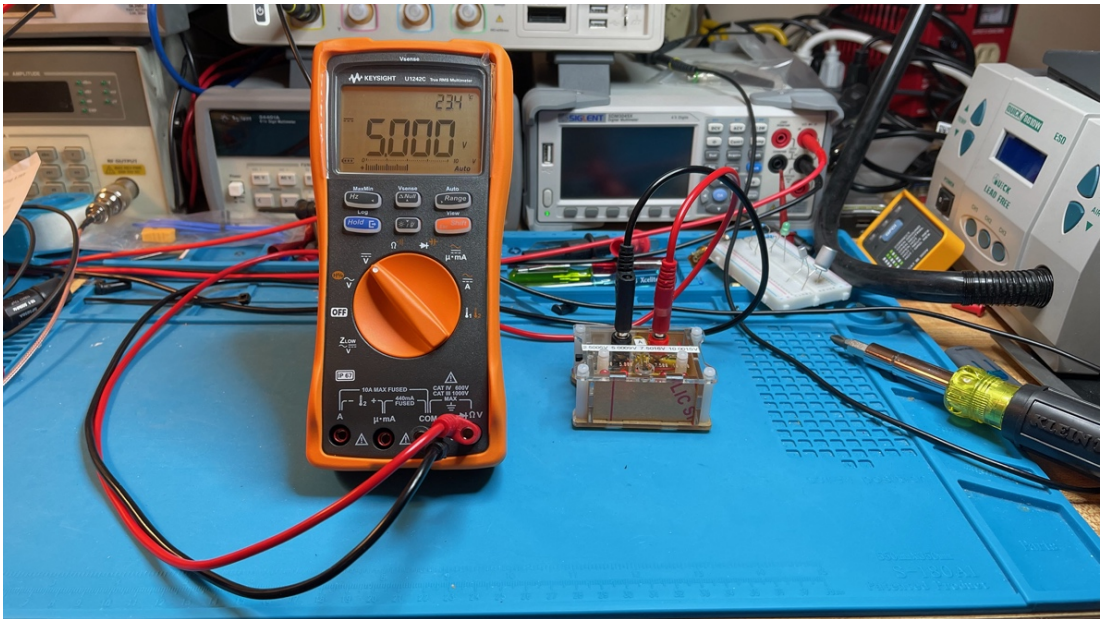
## Cons

- The backlight only stays on for 32 seconds.
- No Bluetooth interface.

## Recommendation

If you want a 10,000-count meter with US support and can use the PC based data logging this is a good choice. The DM-820A is more expensive than the BM-525s (that has more features), but you get the Greenlee limited lifetime warranty.

## Keysight U1242C




Price: $461 from TEquipment.com.

## Features

- Third party safety tested by CSA for Canada and US.
- CAT IV 600V, CAT III 1000V.
- 10000-count.
- IP 67 rated for dust and water resistance.
- 3-meter drop tested.
- 0.09% DC basic accuracy.
- ZLOW, low impedance mode.
- Vsense for non-contact voltage detection.
- Harmonic ratio measurement.
- T1 – T2 differential temperature measurement.
- Includes IR-to-USB adapter with free downloadable PC (Windows 10) software.
- Built-in flashlight.
- 400-hour battery life using included four AAA batteries.
- 3-year Warranty.

## Pros

- Third-party safety testing by CSA for Canada and US.
- Lowest µA Shunt Resistance I have measured.
- All but one reading met the accuracy specifications.
- Extensive customization options.
- IP67 rated and three-meter drop tested.
- Includes IR-to-USB adapter.
- Fuses can be changed from the battery compartment.

## Cons

- 1 mV AC reading did not meet accuracy specifications.
- Optional Infrared (IR)-to-Bluetooth adapter is listed as obsolete with no replacement.
- PC logging software has not been updated since 2015.
- The meter will support two thermocouples, but none are provided, they are extra cost optional.
- Must disable external temperature measurements in setup to measure millivolts accurately.

## Recommendation

I like and dislike this meter all at the same time. I wonder why there is two different ways to measure millivolts. Why is the least accurate way the default? Why can't the meter measure accurate millivolts and external temperature? There is room on the rotary dial for another position.

What I like:

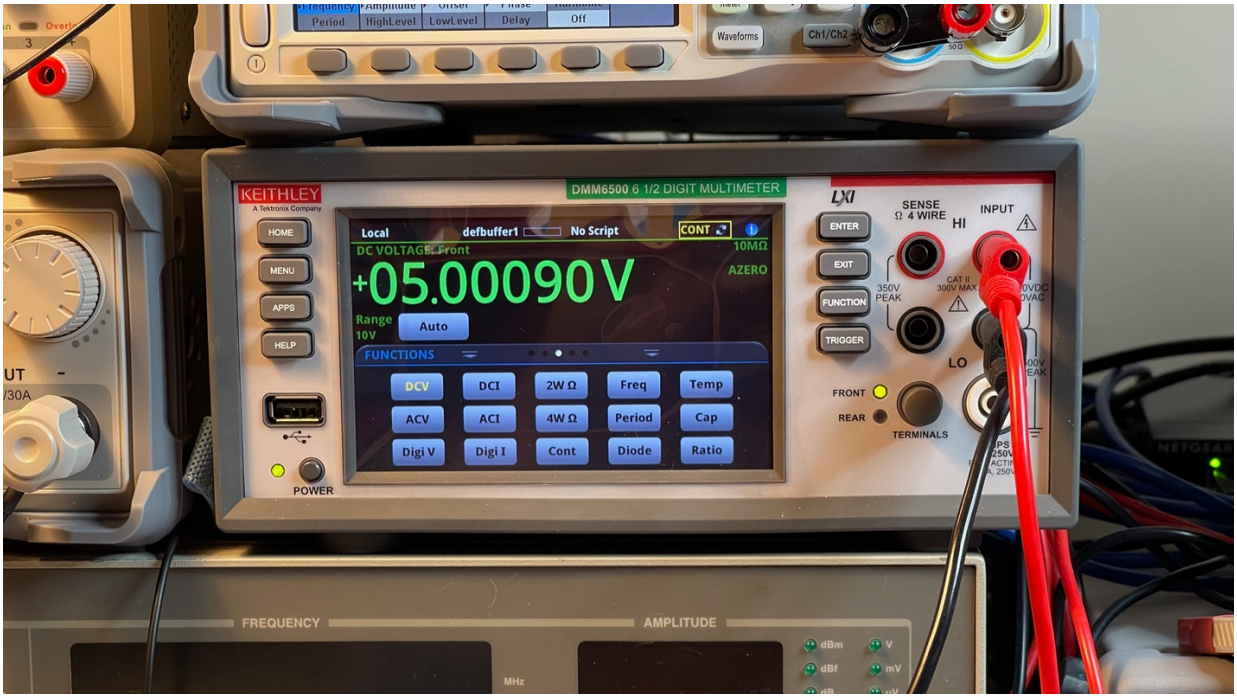
- Great customization options.
- Fuses are accessible from battery compartment.
- Size and weight.
- Good User Guide.
- Certificate of calibration provided.
- IP 67

What I don't like:

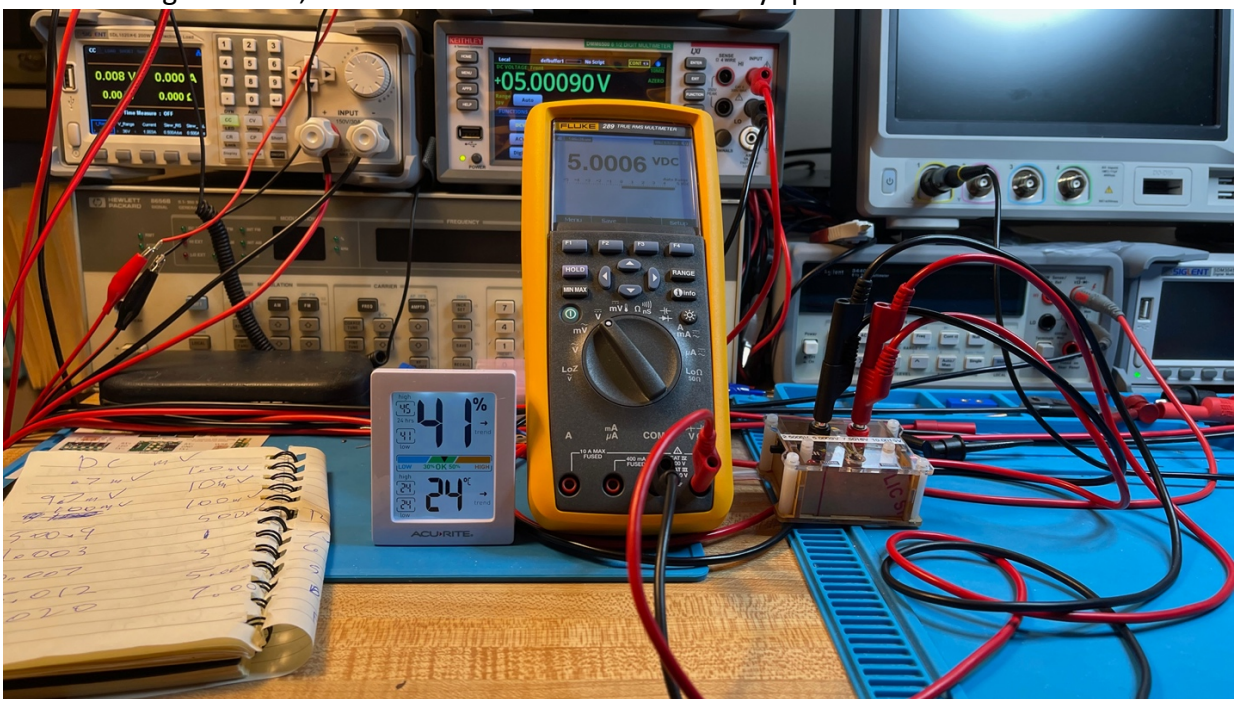
- Default millivolt measurements are inaccurate and must go into options and eliminate external temperature measurements to have dedicated and accurate (except for under 6 mV) millivolt measurements.
- Accuracy specifications are lower than what I expected in a 10,000-count meter.
- Hard copy manual not provided.
- Orange backlight.
- Unconventional rotary switch and button layout and function groupings.
- Very old PC software.

If you want an IP67 meter I would recommend the Fluke 87V MAX. If you want logging and an IP67 in the same meter, then the Keysight U1242C is it, but I would recommend rethinking needing IP67 and logging in the same meter.
I had high expectations for a Keysight meter, but I was disappointed.
The bottom line, I am not keeping this meter and I am not recommending it to anyone either.

## 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 **±**( 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 for DC Volts) 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.

## Accuracy Specifications

| Value | **UNI-T UT161E** | **Brymen BM525s** | **Greenlee DM-820** | **Keysight U1242C** |
|---|---|---|---|---|
| Cost | 115.77 | 170.34 | 222.99 | 461.00 |
| Count | 22,000 | 10,000 | 10,000 | 10,000 |
| DC mV | 0.1%+5 | 0.06%+2 | 0.06%+2 | 0.09%+2 |
| DC V | 0.05%+5 | 0.08%+2 | 0.08%+2 | 0.09%+2 |
| AC mV | 1%+10 | 0.5%+3 | 0.5%+3 | 1.0%+3 |
| AC V | 0.8%+10 | 0.5%+3 | 0.5%+3 | 1.0%+3 |
| DC µA | 0.5%+10 | 0.2%+4 | 0.2%+4 | 0.1%+2 |
| DC mA | 0.5%+10 | 0.2%+4 | 0.2%+4 | 0.2%+2 |
| DC A | 1.2%+50 | 0.2%+4 | 0.2%+4 | 0.3%+5 |
| AC µA | 0.8%+10 | 0.6%+3 | 0.6%+3 | 1.0%+3 |
| AC mA | 1.2%+10 | 1.0%+3 | 1%+3 | 1.0%+3 |
| AC A | 1.2%+10 | 0.8%+6 | 0.8%+6 | 1.2%+5 |
| Ω | 0.5%+10 | 0.1%+3 | 0.1%+3 | 0.2%+5 |
| Low kΩ | 0.5%+10 | 0.1%+3 | 0.1%+3 | 0.2%+2 |
| High kΩ | 0.5%+10 | 0.1%+3 | 0.1%+3 | 0.2%+2 |
| Low MΩ | 1.5%+10 | 0.4%+3 | 0.4%+3 | 0.2% +2 |
| High MΩ | 3%+50 | 1.5%+5 | 1.5%+5 | 0.8% +2 |
| Low nF | 3%+5 | 0.8%+3 | 0.8%+3 | 1.0%+5 |
| High nF | 3%+5 | 0.8%+3 | 0.8%+3 | 1.0%+5 |
| Low µF | 3%+5 | 1%+3 | 1%+3 | 1.0%+5 |
| High µF | 4%+5 | 5%+5 | 3.5%+5 | 1.2%+5 |

The accuracy specifications are from the meters' respective manuals. The background color code shows the extreme low and high accuracy specifications. Green is the highest, yellow is lowest, and white is everything in-between.

## IP67 Meters I Reviewed Accuracy Specifications

| Value | **Keysight U1242C** | **Fluke 87V MAX** |
|---|---|---|
| Cost | $461.00 | $487.95 |
| Count | 10,000 | 6,000/20,000 |
| DC mV | 0.09%+2 | 0.1%+1 |
| DC V | 0.09%+2 | 0.05%+1 |
| AC mV | 1.0%+3 | 0.7%+4 |
| AC V | 1.0%+3 | 0.7%+2 |
| DC µA | 0.1%+2 | 0.2%+4 |
| DC mA | 0.2%+2 | 0.2%+4 |
| DC A | 0.3%+5 | 0.2%+4 |
| AC µA | 1.0%+3 | 1%+2 |
| AC mA | 1.0%+3 | 1%+2 |
| AC A | 1.2%+5 | 1%+2 |
| Ω | 0.2%+5 | 0.2%+2 |
| Low kΩ | 0.2%+2 | 0.2%+1 |
| High kΩ | 0.2%+2 | 0.2%+1 |
| Low MΩ | 0.2%+2 | 0.2%+1 |
| High MΩ | 0.8%+2 | 1%+1 |
| Low nF | 1.0%+5 | 1%+2 |
| High nF | 1.0%+5 | 1%+2 |
| Low µF | 1.0%+5 | 1%+2 |
| High µF | 1.2%+5 | 1%+2 |

The accuracy specifications are from the meters' respective manuals. The background green color code shows the higher accuracy specifications.

## Conclusion

In this group of meters, the Brymen and Greenlee standout for accuracy specifications. All four have a PC USB interface, the Uni-T and the Keysight include the interface in the box, the Brymen and Greenlee interfaces are an extra cost option. Keysight is the only IP67 meter in this group.

If you need an IP67 rated meter I recommend the Fluke 87V MAX.

If you need a 10000-count meter, go with either the Brymen or Greenlee depending on the features you need.

If you are on a tight budget and still want a meter with more resolution then a 6000-count meter and need a PC interface and Bluetooth interface the Uni-T is the only option and still have a third party safety tested meter.

If you need to spend less and you don't want a third party safety tested meter, look at part 2 of the summary when it comes out.