Brymen BM869s Review

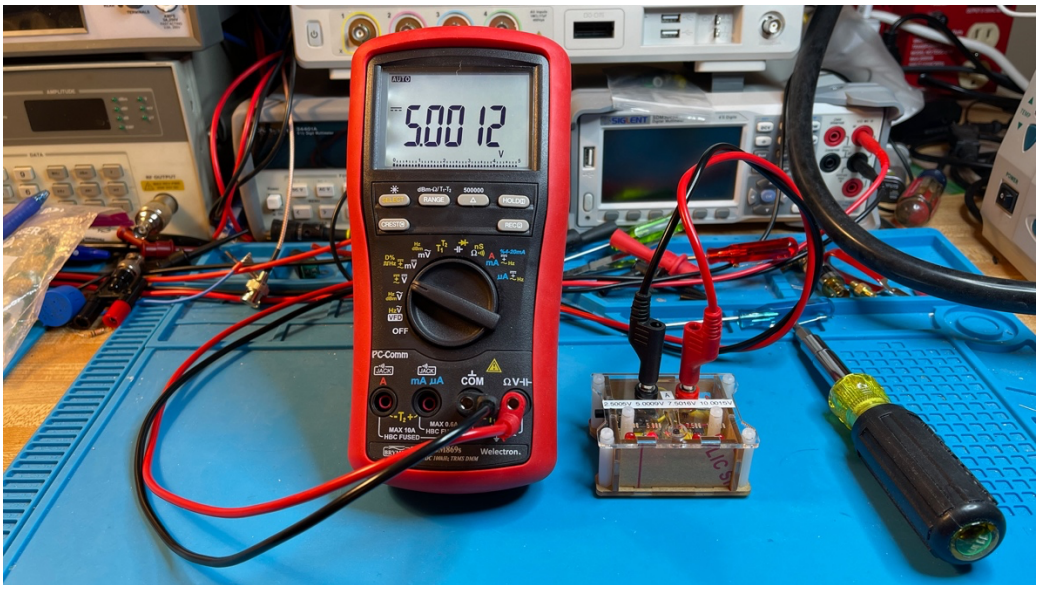
Introduction

Hi, I am Tom, amateur radio call sigh N8FDY. This is a review of the Brymen BM869s 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 Brymen BM869s multimeter that I purchased from Welectron in Germany for 192,44 € ($206.60 US exchange rate as of 8-31-2023). 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.

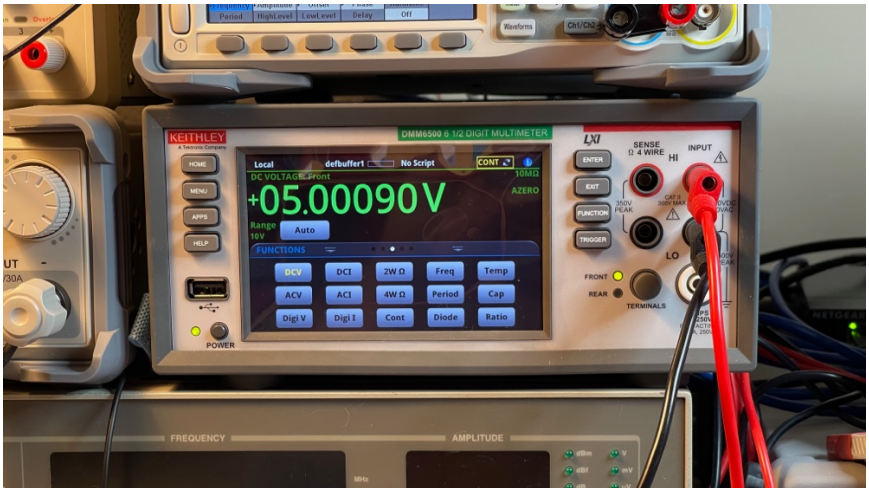
Objectives

This review was produced to help you decide if the Brymen BM869s multimeter will fit your purpose and budget. This is part of a series of multimeters reviews.
A good multimeter for hobby electronics 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

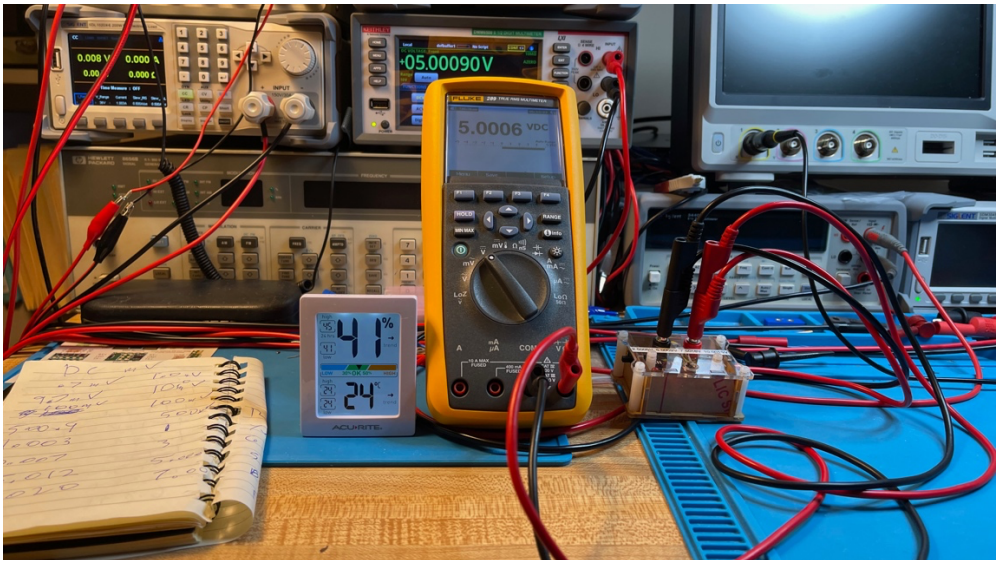
- Dual display shows two measurements, such as AC voltage and frequency, at the same time.
- Beep-JackTM audible warning alerts the user with a beep and an error message on the LCD if the test lead is plugged into the mA ŒºA or A input terminal while the selector switch is not in the mA ŒºA or A position.
- AC bandwidth to 100 kHz for voltage or 20 kHz for current.
- MAX/MIN function which stores the maximum, minimum, and average.
- Crest capture mode to capture voltage or current signal peaks.
- Selectable between 50000 or 500000 counts resolution when measuring DC voltage.
- Relative zero mode.
- Automatic or manual ranging.
- Intelligent automatic power off.
- Backlighted LCD for reading in dim conditions.
- One-Year Warrantee.

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 use the meter under test to 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 V. 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
mV					
1.0843	1.07	0.02% + 2	0.020214	1.06	1.10
50.0463	50.03	0.02% + 2	0.030006	50.01	50.08
100.0711	100.07	0.02% + 2	0.040014	100.03	100.11
250.0041	250.04	0.02% + 2	0.070008	249.92	250.09
500.055	500.06	0.02% + 2	0.120012	499.92	500.19
V					
1.008751	1.0087	0.02% + 2	0.0004017	1.0083	1.0092
2.00037	2.0004	0.02% + 2	0.0006001	1.9997	2.0011
2.50053	2.5006	0.02% + 2	0.0007001	2.4997	2.5013
3.00004	3.0001	0.02% + 2	0.0008	2.9991	3.0010
4.00107	4.0012	0.02% + 2	0.0010002	3.9999	4.0022
5.00039	5.0004	0.02% + 2	0.0012001	4.9990	5.0018
5.00090	5.0010	0.02% + 2	0.0012002	4.9995	5.0023
6.00093	6.000	0.03% + 2	0.0038	5.997	6.005
7.00019	7.000	0.03% + 2	0.0041	6.996	7.005
7.50160	7.501	0.03% + 2	0.0042503	7.497	7.506
10.00153	10.001	0.03% + 2	0.0050003	9.996	10.007
15.0005	15.000	0.03% + 2	0.0065	14.993	15.008
20.0001	20.001	0.03% + 2	0.0080003	19.991	20.010
96.3133	96.30	0.04% + 2	0.05852	96.25	96.38
189.408	189.41	0.04% + 2	0.095764	189.30	189.52
278.218	278.22	0.04% + 2	0.131288	278.07	278.37
376.387	376.39	0.04% + 2	0.170556	376.20	376.58
474.037	474.24	0.04% + 2	0.209696	473.80	474.27
590.992	591.0	0.15% + 2	1.0865	589.9	592.1

The meter met its accuracy specifications for all the DC voltages that I tested. The DC millivolts and low volts ranges' accuracy specification are the highest for this group of meters. The high DC volts accuracy specifications are in third place for this group of meters.

VDC Input	11 MΩ
mVDC input	10 MΩ

Both VDC and mVDC inputs have 10 MΩ or greater 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					
4.99903	5.0002	0.3% + 40	0.0190006	4.9740	5.0240
60 Hz Sinewave					
mV					
1.0362	0.90	0.3% + 20	0.2027	0.83	1.24
5.0246	4.86	0.3% + 20	0.21458	4.81	5.24
10.0442	9.87	0.3% + 20	0.22961	9.81	10.28
50.0638	49.92	0.3% + 20	0.34976	49.68	50.44
100.0621	99.99	0.3% + 20	0.49997	99.50	100.62
250.529	250.59	0.3% + 20	0.95177	249.43	251.63
500.131	499.53	0.3% + 20	1.69859	498.13	502.13
Volts					
1.000152	0.9996	0.3% + 30	0.0059988	0.9933	1.0071
2.00174	2.0026	0.3% + 30	0.0090078	1.9912	2.0122
3.01244	3.0130	0.3% + 30	0.012039	2.9956	3.0293
4.01195	4.0104	0.3% + 30	0.0150312	3.9915	4.0324
5.01050	5.0043	0.3% + 30	0.0180129	4.9865	5.0345
6.00730	5.996	0.3% + 30	0.020988	5.980	6.035
7.00463	6.994	0.3% + 30	0.050982	6.946	7.063

The meter met its accuracy specifications for all the AC voltages that I tested. The AC millivolts for 60 Hz accuracy specification is the best in this group of meters.

ACV 1V 3dB cutoff	760 kHz

The frequency of the cutoff is second place in this group of meters.

AC+DC

This meter has an AC+DC measurement mode.
The formula for measuring True-RMS with AC and DC components:

$$Vrms = \sqrt{\mathrm{Vac}^2 + \mathrm{Vdc}^2}$$

A meter with AC+DC calculates this for you.

Source	Reading	Specification	Uncertainty	Low Bound	High Bound
AC+DC					
2.0675	2.0677	0.7%+80	0.0225	2.0410	2.0941
3.3561	3.3705	0.7%+80	0.0316	3.3202	3.3921
3.3628	3.3567	0.7%+80	0.0315	3.3295	3.3962
4.7316	4.7213	0.7%+80	0.0410	4.6880	4.7752

The meter met its accuracy specifications for all the AC+DC values I tested.

Current

Source	Reading	Specification	Uncertainty	Low Bound	High Bound
AC 100Hz Squarewave					
0.999675	0.983	0.7% + 50	0.056881	0.9414	1.0580
DC µA					
0.89712	0.89	0.15% + 20	0.201335	0.69	1.10
9.21827	9.21	0.15% + 20	0.213815	9.00	9.44
99.0472	99.06	0.15% + 20	0.34859	98.65	99.45
131.932	131.94	0.15% + 20	0.39791	131.47	132.39
DC mA					
1.009024	1.005	0.15% + 20	0.0215075	0.987	1.031
9.99224	9.991	0.15% + 20	0.0349865	9.955	10.030
99.4295	99.43	0.15% + 30	0.449145	98.96	99.90
200.497	200.48	0.15% + 30	0.60072	199.85	201.14
500.308	500.10	0.15% + 30	1.05015	499.06	501.56
DC Amps					
1.000205	0.9994	0.5% + 20	0.006997	0.9928	1.0077
2.000795	2.0008	0.5% + 20	0.012004	1.9879	2.0136
3.001434	3.0021	0.5% + 20	0.0170105	2.9828	3.0201

The meter met its accuracy specifications for all the current values I tested.

A Shunt Resistance	0.02 Ω
mA Shunt Resistance	1.77 Ω
µA Shunt Resistance	101.93 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
Ohms					
1.004105	1.03	0.07% + 10	0.100206	0.90	1.10
10.00762	10.10	0.07% + 10	0.10202	9.90	10.11
100.0731	100.09	0.07% + 10	0.120018	99.94	100.20
Kiloohms					
1.000200	0.9998	0.07% + 2	0.0008999	0.9992	1.0012
10.00230	9.998	0.1% + 10	0.0089986	9.992	10.012
100.0375	99.99	0.1% + 10	0.089993	99.94	100.14
Megaohms					
0.993891	0.9941	0.3% + 6	0.0035823	0.9902	0.9976
9.96999	9.951	2% + 6	0.20502	9.761	10.179
100.1114	N/A				

The meter met its accuracy specifications for all the resistance values I tested.

Resistance Test Voltage	
Low Range	2.93 V
Medium Range	1.05 V
High Range	0.54 V

Capacitance

Source	Reading	Specification	Uncertainty	Low Bound	High Bound
nF					
0.0149	N/A				
0.1040	0.08	0.8% + 3	0.03064	0.07	0.14
1.0073	1.00	0.8% + 3	0.038	0.96	1.06
9.940	9.93	0.8% + 3	0.10944	9.78	10.10
99.48	99.50	0.8% + 3	0.826	98.16	100.80
µF					
1.0083	1.009	1.5% + 3	0.018135	0.985	1.031
10.841	10.96	2.5% + 3	0.304	10.48	11.20
112.81	112.50	3.5% + 5	4.4375	107.82	117.80
1005.5	1004.00	5% + 5	55.2	944.77	1066.23

The meter met its accuracy specifications for all the capacitance values I tested. The meter could not read the 10pF value. The nanofarad range had the highest accuracy specifications of this group of 50000-count meters. The highest microfarad range had the lowest accuracy of this group of 50000-count meters.

Diode

Max Diode Voltage	2.935 V
Max Diode Current	367 µA

This lit the LEDs I tested and the Schottky, Small Signal and Power diodes measured correctly.

Continuity

It is fast and latches.

dBm

This meter can measure dBm (decibel-milliwatts) using a selected impedance value from 4, 8, 16, 32, 50, 75, 93, 110, 125, 135, 150, 200, 250, 300, 500, 600, 800, 900, 1000, 1200 Ω.

Test Leads

The test leads were a soft silicone type. The meter also came with a thermocouple for measuring temperature. I did not test temperature measurements.

Ergonomics

The rotary switch is easy to turn and firmly clicks into place.
It has a large display with big numbers on the primary display and small numbers on the secondary display.
The backlight is bright and evenly lit except for a hotspot on the left.
The following functions are enabled when you hold down a button when you turn on the meter:

Button	Power On Action
Range	Disable beep tone
SELECT	Disable Auto Power Off (APO)

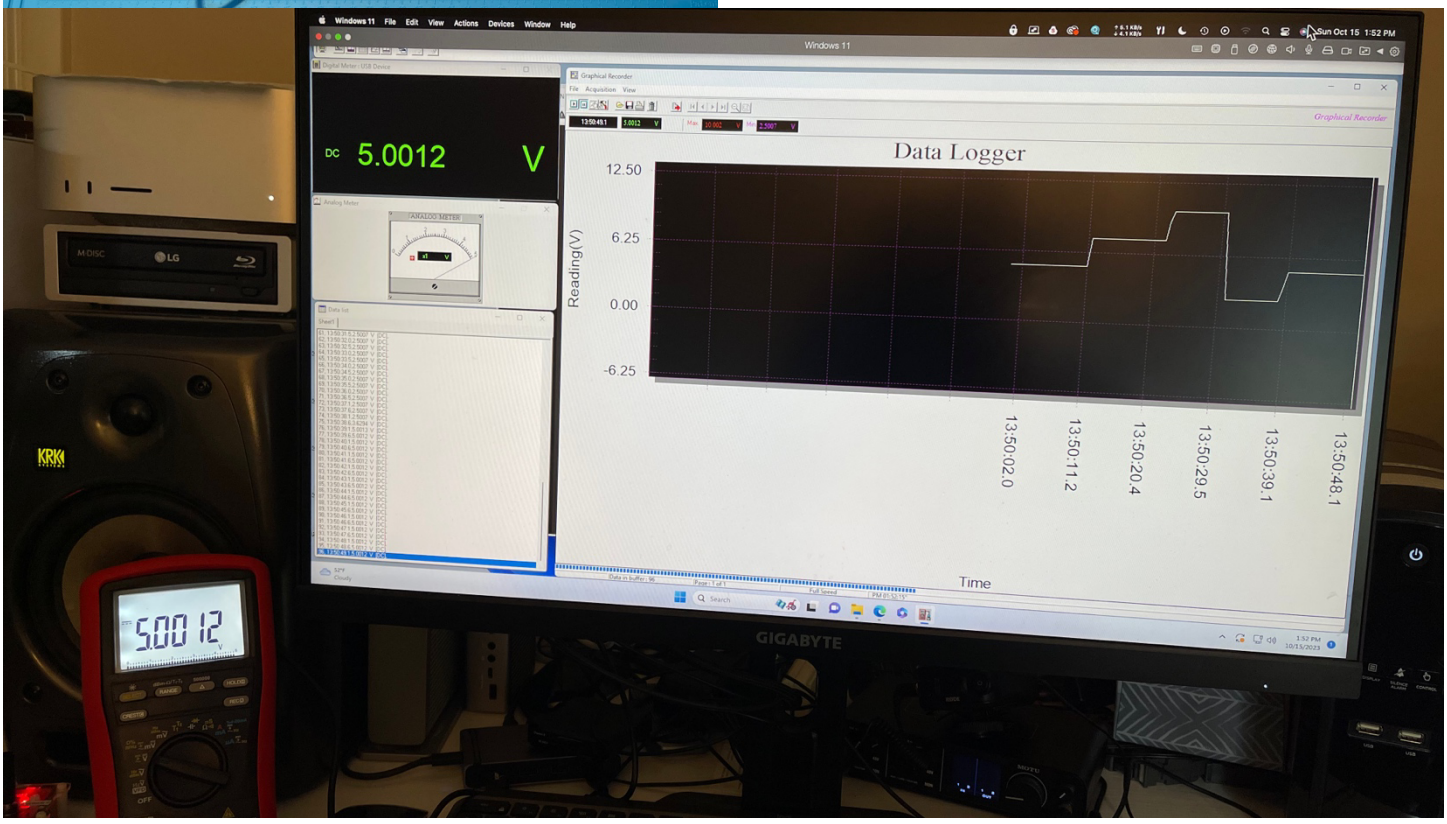
Accuracy Specifications Within the Group

Value	EEVblog Brymen BM786	Brymen BM789	Brymen BM869s	EEVblog 121GW	Greenlee DM-860A	Uni-T UT181A	Fluke 289FVF
Cost	$154.11	$173.52	$206.60	$225.00	$346.44	$400.99	$876.59
Count	60,000	60,000	50,000	50,000	50,000	60,000	50,000
DC mV Low	0.03%+2	0.03%+2	0.02%+2	0.1%+10	0.02%+2	0.025%+20	0.05%+20
DC mV High	0.03%+2	0.03%+2	0.02%+2	0.1%+10	0.02%+2	0.025%+5	0.025%+2
DC V Low	0.03%+2	0.03%+2	0.02%+2	0.05%+5	0.02%+2	0.025%+5	0.025%+2
DC V High	0.05%+5	0.05%+5	0.04%+2	0.1%+10	0.04%+2	0.03%+5	0.03%+2
AC mV	0.5%+30	0.5%+30	0.3%+20	0.8%+10	0.3%+20	0.6%+60	0.3%+25
AC V	0.5%+30	0.5%+30	0.4%+30	0.3%+10	0.3%+30	0.3%+30	0.3%+25
AC V + DC V	0.7%+40	1.2% + 40	0.7%+80	1.0% + 10	0.5% + 80	1% + 80	0.5% + 80
DC µA	0.075%+20	0.075%+20	0.15%+20	1.5%+15	0.15%+2	0.08%+20	0.075%+20
DC mA	0.15%+20	0.15%+20	0.15%+20	0.25%+5	0.15%+20	0.15%+10	0.15%+2
DC A	0.3%+20	0.3%+20	0.5%+20	0.75%+15	0.5%+2	0.5%+10	0.3%+10
AC µA	0.9%+20	0.9%+20	0.5%+50	2.0%+20	0.5%+50	0.6%+40	1%+20
AC mA	0.9%+20	0.9%+20	0.5%+50	1.0%+5	0.5%+50	0.8%+40	0.6%+5
AC A	1%+30	1%+30	0.5%+50	1.5%+15	0.5%+50	1%+20	0.8%+20
Ω	0.085%+10	0.085%+10	0.07%+10	0.5%+20	0.07%+1	0.05%+10	0.15% + 20
Low kΩ	0.085%+4	0.085%+4	0.07%+2	0.2%+5	0.07%+2	0.05%+2	0.05%+2
High kΩ	0.15%+4	0.15%+4	0.1%+2	0.2%+5	0.1%+2	0.05%+2	0.05%+15
Low MΩ	1.5%+5	1.5%+5	0.3%+6	0.3%+5	0.3%+6	0.3%+10	0.15%+4
High MΩ	2.0%+5	2.0%+5	2%+6	1.2%+20	2%+6	2%+10	3.0%+2
Low nF	1%+10	1%+10	0.8%+3	2.5%+5	0.8%+3	3%+10	1%+5
High nF	1%+2	1%+2	0.8%+3	2.5%+5	0.8%+3	2%+5	1%+5
Low µF	1%+2	1%+2	1.5%+3	2.5%+5	1.5%+3	2%+5	1%+5
High µF	1.8%+4	1.8%+4	5% + 5	3.0%+5	5% + 5	5% + 5	1%+5

The accuracy specifications are from the meters' respective manuals. Red lettering for the meter's name indicates the meter has failed to meet an accuracy specification. The red lettering in the accuracy specification indicates that one, or more meter readings did not meet this accuracy specification. 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.
The Brymen BM869s met all its accuracy specifications unlike the very similar Greenlee DM-860S. The Brymen BM869s is in tied for first place in overall accuracy specifications.

Logging

Brymen has an optional Optical to USB cable interface with software (from Welectron, Germany for 33.53 €, $35.56 US) to connect the meter to a PC running Windows. It also worked in a virtual Windows 11 on a Mac Studio.



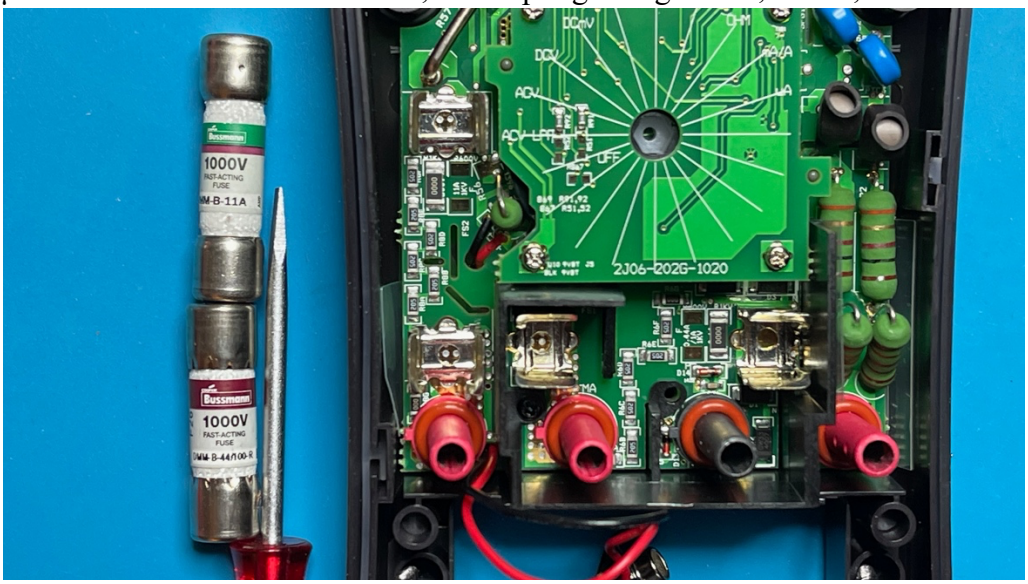
Battery

The meter uses one 9-Volt battery accessible from the back by removing the boot, then removing the battery door. The battery door has two captured Philips screws.

Fuses

The meter must be disassembled to change the fuses. You must remove the battery door and remove four Philips captured self-tapping screws.

The manual states the fuses are:
11 A/1000 V fuse, interrupting rating 20 kA, F fuse, 13/32" x 1-1/2"
µA and mA: 0.44 A/1000 V fuse, interrupting rating 10 kA, F fuse, 13/32" x 1-3/8"



Pros

- Third-party safety tested by UL.
- Met all accuracy specifications for all measurements taken.
- Leader in accuracy specifications in more categories than any other meter in this group.
- Dual Display with bright backlight.

Cons

- USB PC interface is an extra-cost option.
- No Bluetooth support.
- Must disassemble meter to change fuses.

Conclusion

I think the Brymen BM869s is a very good price for performance meter. If you don't need the graphing functions of the two higher priced meters in this group of 50,000-count meters but you want the PC interface for an extra $36, this could be the one for you.