Brymen BM789 Review

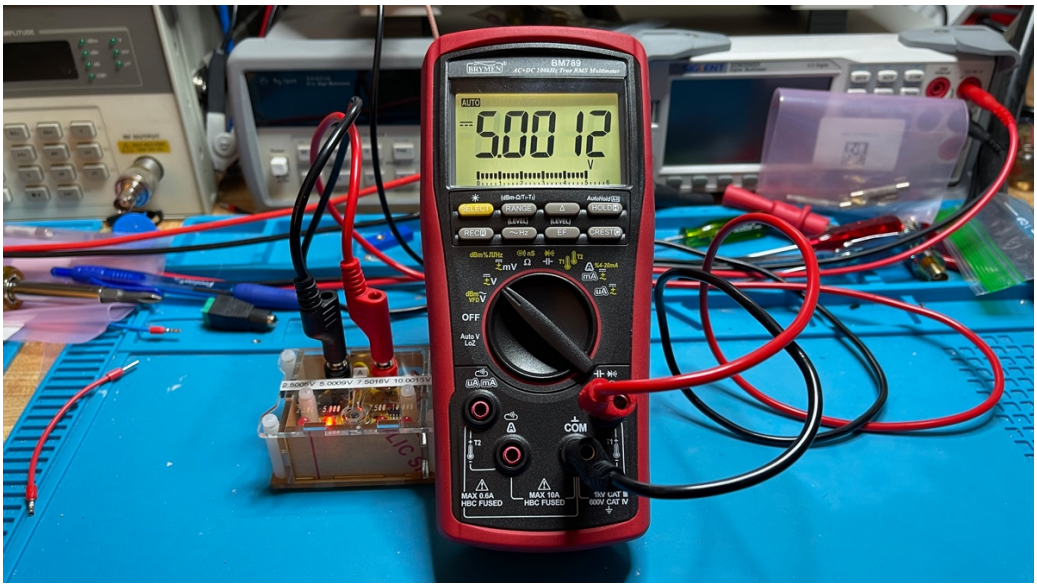
Introduction

Hi, I am Tom, amateur radio call sigh N8FDY. This is a review of the Brymen BM789 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 BM789 multimeter that I purchased from TME.com in Poland for $173.52. 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

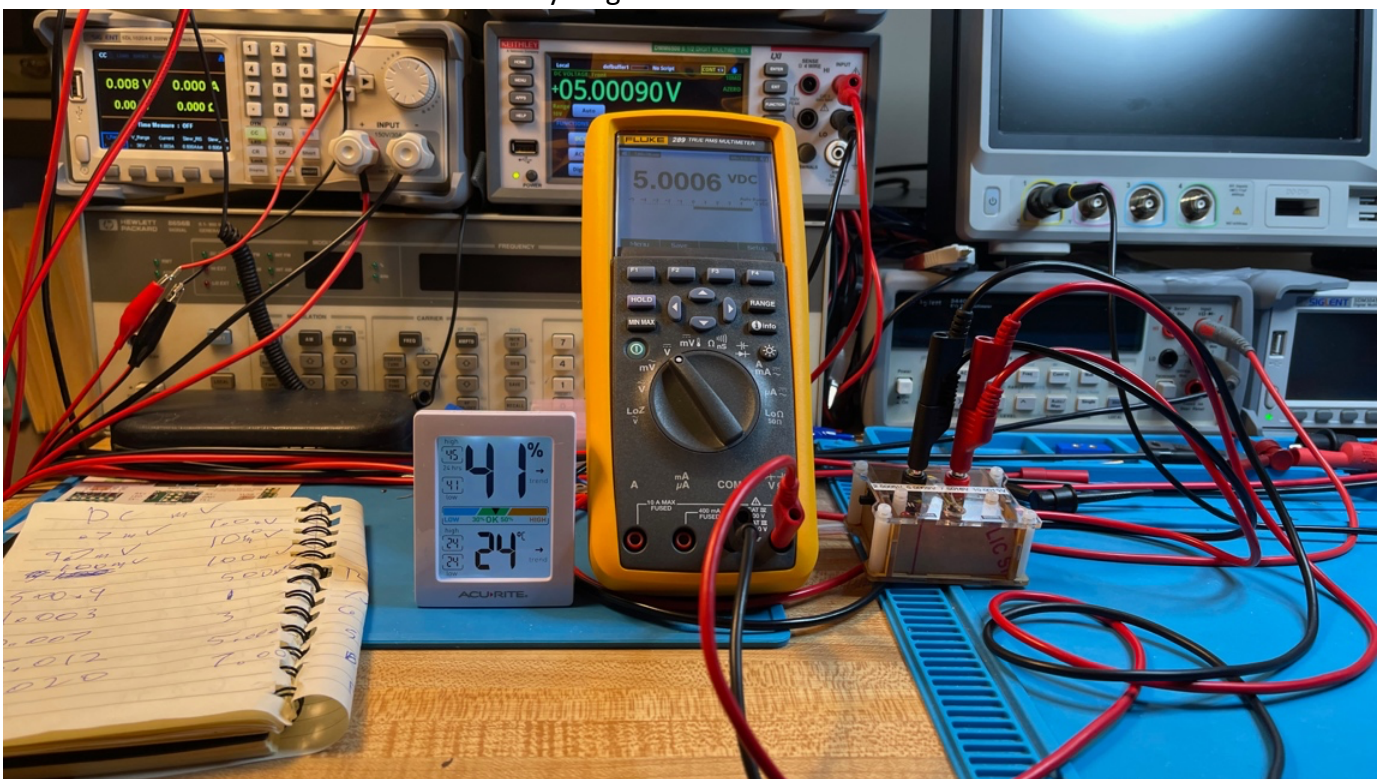
This review was produced to help you decide if the Brymen BM789 multimeter will fit your purpose and budget. This is part of a series of multimeters reviews.
A good multimeter for hobby electronics projects should be able to measure millivolts, volts, microamps, milliamps, amps, ohms, nanofarads and 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

- UL C US Listed.
- 60000 Counts.
- ACV Bandwidth up to 100kHz.
- 31 Segment Analog Bar-graph Updates 50/Sec.
- True-RMS.
- DC+AC.
- Hold.
- AutoHold.
- Delta/Relative Zero Mode.
- Crest (Peak Hold) Captures MaxMin Changes > 0.25ms in Durations.
- MaxMinAvg.
- AutoV LoZ Ghost-Voltage-Buster.
- VFD-V & VFD-Hz Measures Fundamental V & Hz of Most Variable Frequency Drives.
- Dual Temperature Reading.
- Three 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 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					
1.0060	1.01	0.03% + 2	0.020303	0.9853	1.0267
10.0012	10.00	0.03% + 2	0.023000	9.9775	10.0249
100.0187	100.02	0.03% + 2	0.050006	99.9653	100.0721
500.097	500.10	0.03% + 2	0.170030	499.9085	500.2855
V					
1.000909	1.0010	0.03% + 2	0.0005003	1.0003	1.0015
2.00013	2.0002	0.03% + 2	0.00080006	1.9992	2.0010
2.50054	2.5007	0.03% + 2	0.00095021	2.4995	2.5016
3.00134	3.0015	0.03% + 2	0.00110045	3.0001	3.0026
4.00001	4.0003	0.03% + 2	0.00140009	3.9985	4.0016
5.00030	5.0007	0.03% + 2	0.00170021	4.9984	5.0022
5.00091	5.0012	0.03% + 2	0.00170036	4.9990	5.0028
6.00142	6.0018	0.03% + 2	0.00200054	5.9992	6.0036
7.00018	7.001	0.03% + 2	0.0041003	6.9959	7.0045
7.50167	7.503	0.03% + 3	0.0042509	7.4972	7.5062
10.00153	10.003	0.03% + 4	0.0050009	9.9962	10.0068
97.7528	97.77	0.05% + 5d	0.098885	97.6494	97.8562
191.276	191.33	0.05% + 5d	0.145665	191.1167	191.4353
281.295	281.31	0.05% + 5d	0.190655	281.0871	281.5029
381.899	381.98	0.05% + 5d	0.24099	381.6367	382.1613
490.268	490.018	0.05% + 5d	0.295009	489.9474	490.5886
601.023	601.34	0.05% + 5d	0.35067	600.6403	601.4057

The meter met its accuracy specifications for all the DC voltages I tested. The DC millivolts and low volts ranges accuracy specification is in third place for this group of meters. The high DC volts accuracy specifications are in fourth 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					
4.99906	5.0048	0.9% + 30	0.0480432	4.9450	5.0531
60 Hz Sinewave					
mV					
1.0335	0.90	0.5% + 30	0.3045	0.7283	1.3387
10.0397	9.92	0.5% + 30	0.3496	9.6840	10.3954
100.0742	100.26	0.5% + 30	0.8013	99.2128	100.9356
250.565	250.96	0.5% + 30	1.5548	248.8596	252.2704
500.110	500.11	0.5% + 30	2.80055	497.0091	503.2109
Volts					
0.500130	0.5004	0.5% + 30	0.005502	0.4940	0.5062
1.000213	1.0021	0.5% + 30	0.0080105	0.9913	1.0091
2.00184	2.0064	0.5% + 30	0.013032	1.9846	2.0191
3.01276	3.0178	0.5% + 30	0.018089	2.9899	3.0357
4.01248	4.0166	0.5% + 30	0.023083	3.9840	4.0410
5.01209	5.0124	0.5% + 30	0.028062	4.9780	5.0462
6.00816	6.0047	0.5% + 30	0.0330235	5.9685	6.0478
7.00644	7.017	0.5% + 30	0.038085	6.9612	7.0517

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

ACV 1V 3dB cutoff	651 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	2.0701	1.2% + 40	0.0288	2.0346	2.1005
3.3561	3.3601	1.2% + 40	0.0443	3.3075	3.4048
3.3628	3.3641	1.2% + 40	0.0444	3.3166	3.4090
4.7316	4.7195	1.2% + 40	0.0606	4.6685	4.7947

The meter met its accuracy specifications for all the AC+DC values I tested. The accuracy specifications for the AC+DC ranges is the worst for this group of meters.

Current

Source	Reading	Specification	Uncertainty	Low Bound	High Bound
AC 100Hz Squarewave					
0.999694	0.986	0.9% + 20	0.028874	0.9694	1.0300
DC µA					
0.89695	0.89	0.075% + 20	0.2006675	0.6954	1.0985
9.21851	9.21	0.075% + 20	0.2069075	9.0070	9.4301
99.0500	99.04	0.075% + 20	0.2742800	98.7261	99.3739
131.913	131.91	0.075% + 20	0.2989325	131.5542	132.2718
DC mA					
1.008954	1.009	0.075% + 20	0.02075675	0.9877	1.0302
9.99241	9.992	0.075% + 20	0.027494	9.9624	10.0224
99.4213	99.43	0.15% + 20	0.349145	99.0473	99.7953
100.7828	100.80	0.15% + 20	0.351200	100.4064	101.1592
200.666	200.69	0.15% + 20	0.501035	200.0846	201.2474
DC Amps					
0.500068	0.5003	0.3% + 20	0.0035009	0.4963	0.5038
1.000128	1.0004	0.3% + 20	0.0050012	0.9947	1.0056
2.000383	2.0008	0.3% + 20	0.0080024	1.9913	2.0095
3.000047	3.0003	0.3% + 20	0.0110009	2.9874	3.0127

The meter met its accuracy specifications for all the current values I tested. The DC microamps has the highest accuracy specifications for this group of meters.

A Shunt Resistance	.02 Ω
mA Shunt Resistance	2.41 Ω
µA Shunt Resistance	102.43 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	1.02	0.085%+10	0.100867	0.9030	1.1053
10.00762	10.01	0.085%+10	0.1085085	9.8981	10.1172
100.0731	100.06	0.085%+10	0.185051	99.8775	100.2687
Kiloohms					
1.000200	1.0002	0.085%+4	0.00125017	0.9989	1.0015
10.00230	10.002	0.085%+4	0.0125017	9.9890	10.0156
100.0375	100.04	0.15%+4	0.125034	99.9044	100.1706
Megaohms					
0.993891	0.9940	1.5%+5	0.01541	0.9784	1.0094
9.96999	9.993	2.0%+5	0.20486	9.7610	10.1789
100.1114	N/A				

The meter met its accuracy specifications for all the resistance values I tested. The accuracy specifications for the resistance low-megaohm ranges are the worst for this group of meters. The accuracy specifications for the resistance higher megaohm range is in second place for this group of meters.

Resistance Test Voltage	
Low Range	2.28 V
Medium Range	2.54 V
High Range	0.21 V

Capacitance

Source	Reading	Specification	Uncertainty	Low Bound	High Bound
nF					
0.0149	0.01	1%+10	0.1001	0.0000	0.1201
0.1040	0.11	1%+10	0.1011	0.0000	0.2109
1.0073	1.04	1%+10	0.1104	0.8838	1.1308
9.940	9.95	1%+10	0.1995	9.6907	10.1893
99.48	99.7	1%+2	1.197	97.7851	101.1749
µF					
1.0083	1.008	1%+2	0.01208	0.9912	1.0254
10.841	10.94	1.8%+4	0.23692	10.5507	11.1313
112.81	112.5	1.8%+4	2.425	109.8338	115.7862
1005.5	996	1.8%+4	21.928	978.0445	1032.9555

The meter met its accuracy specifications for all the capacitance values I tested. The uncertainty values are too high for the 10pF and 100pF reading to be meaningful.

Diode

Max Diode Voltage	3.178 V
Max Diode Current	0.5096 mA

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

Continuity

It is fast and latches; the backlight also flashes.

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, up to 1200.
Typical 600 reference impedance ranges:
In ACmV: -42.22 dBm to -2.22 dBm
In ACV: -17.78 dBm to 62.22 dBm

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. The backlight is bright and evenly lit except for a hotspot on the bottom.
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)
EF	Enable centigrade and Fahrenheit temperature readings
CREST	Enable centigrade only or Fahrenheit only temperature readings

Accuracy Specifications Within the Group

Value	Brymen BM789	EEVblog 121GW	Greenlee DM-860A	Uni-T UT181A	Fluke 289FVF
Cost	$173.52	$225.00	$346.44	$399.75	$876.59
Count	60,000	50,000	50,000	60,000	50,000
DC mV Low	0.03%+2	0.1%+10	0.02%+2	0.025%+20	0.05%+20
DC mV High	0.03%+2	0.1%+10	0.02%+2	0.025%+5	0.025%+2
DC V Low	0.03%+2	0.05%+5	0.03%+2	0.025%+5	0.025%+2
DC V High	0.05%+5	0.1%+10	0.04%+2	0.03%+5	0.03%+2
AC mV	0.5%+30	0.8%+10	0.3%+20	0.6%+60	0.3%+25
AC V	0.5%+30	0.3%+10	0.3%+30	0.3%+30	0.3%+25
AC V + DC V	1.2% + 40	1.0% + 10	0.5% + 80	1% + 80	0.5% + 80
DC µA	0.075%+20	1.5%+15	0.15%+2	0.08%+20	0.075%+20
DC mA	0.15%+20	0.25%+5	0.15%+2	0.15%+10	0.15%+2
DC A	0.3%+20	0.75%+15	0.5%+2	0.5%+10	0.3%+10
AC µA	0.9%+20	2.0%+20	0.5%+5	0.6%+40	1%+20
AC mA	0.9%+20	1.0%+5	0.5%+5	0.6%+20	0.6%+5
AC A	1%+30	1.5%+15	0.5%+5	1%+20	0.8%+20
Ω	0.085%+10	0.5%+20	0.07%+1	0.05%+10	0.15% + 20
Low kΩ	0.085%+4	0.2%+5	0.07%+2	0.05%+2	0.05%+2
High kΩ	0.15%+4	0.2%+5	0.1%+2	0.05%+2	0.05%+15
Low MΩ	1.5%+5	0.3%+5	0.3%+6	0.3%+10	0.15%+4
High MΩ	2.0%+5	1.2%+20	2%+6	2%+10	3.0%+2
Low nF	1%+10	2.5%+5	0.8%+3	3%+10	1%+5
High nF	1%+2	2.5%+5	0.8%+3	2%+5	1%+5
Low µF	1%+2	2.5%+5	1.5%+3	2%+5	1%+5
High µF	1.8%+4	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.

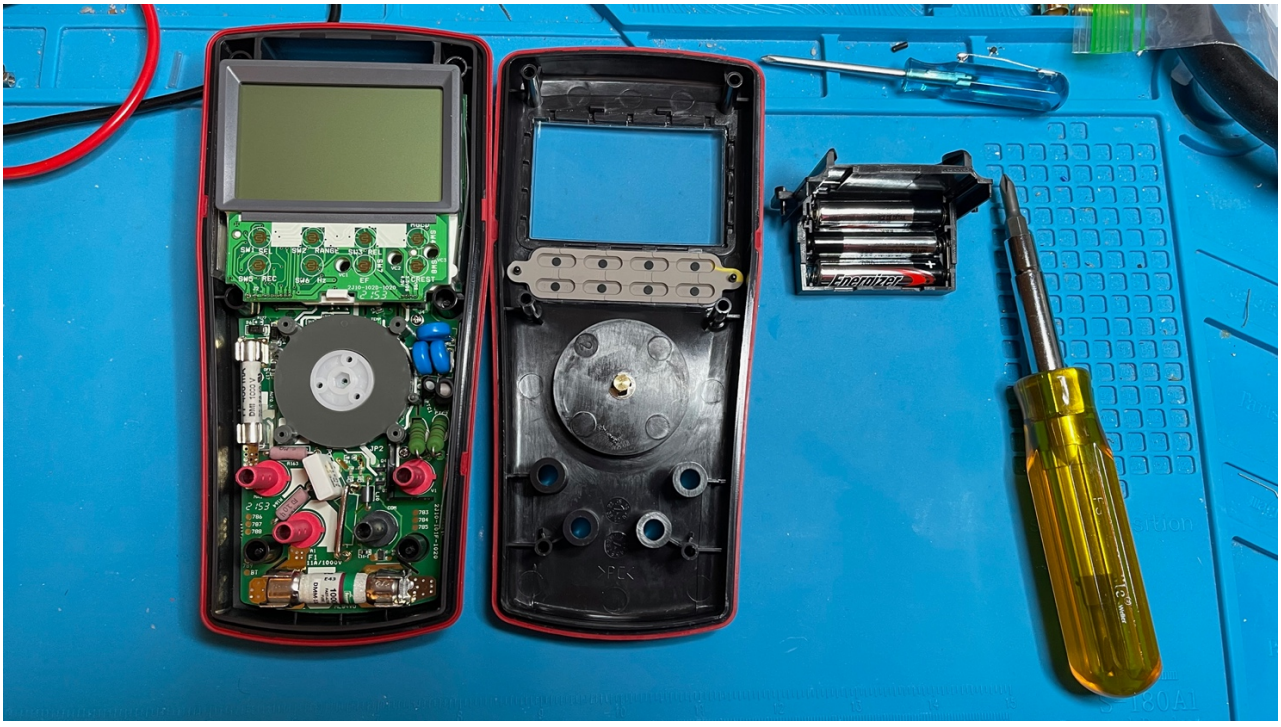
The Brymen BM789 is in about fourth place in overall accuracy specifications. It is one of the two meters in this group that met its accuracy specifications for all measurements taken.

Battery

The meter uses three AAA batteries accessible from the back by removing the boot, then removing the battery holder. The battery holder has two Philips screws.

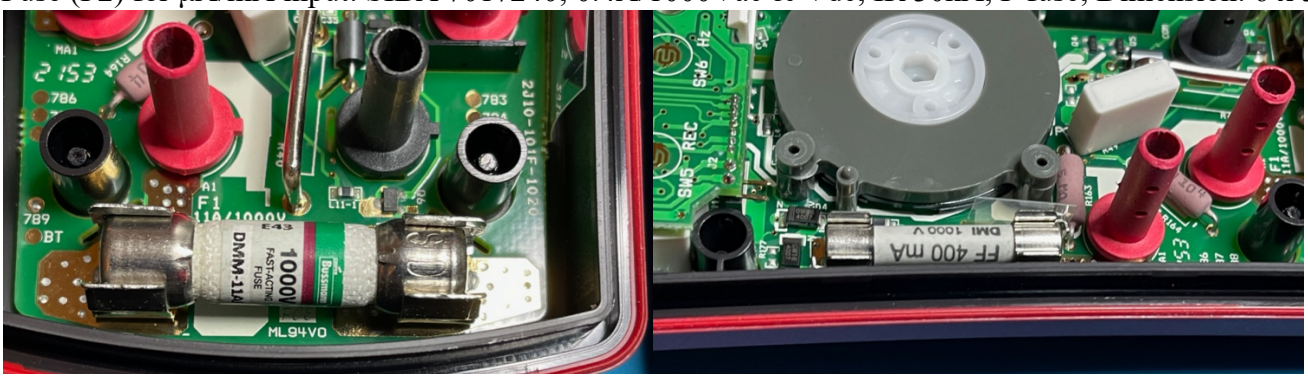
Fuses

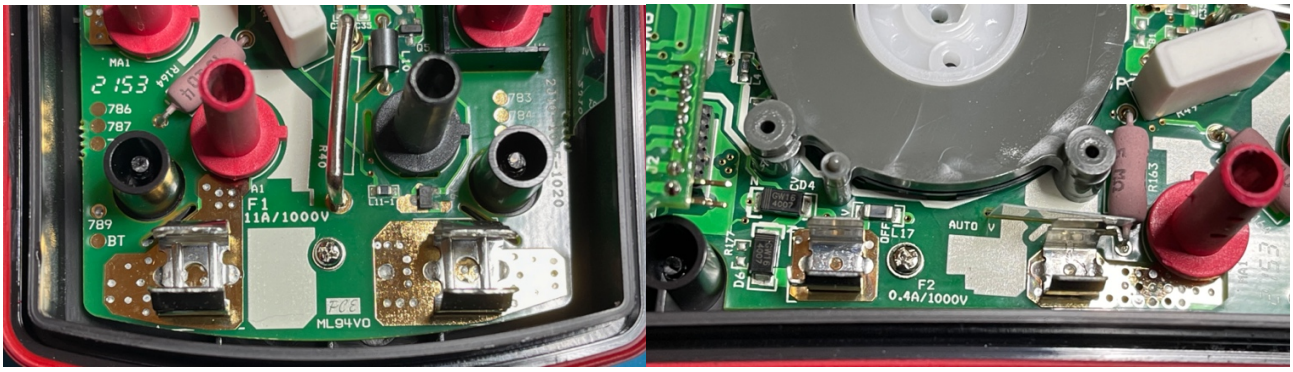
The meter must be disassembled to change the fuses. You must remove the battery holder and remove six Philips self-tapping screws.



The manual states the fuses are:
Fuse (F1) for A input: Bussmann DMM-11AR; 11A/1000Vac & Vdc, IR 20kA, F fuse; Dimension: 10 x 38mm

Fuse (F2) for µA/mA input: SIBA 7017240; 0.4A/1000Vac & Vdc, IR 30kA, F fuse; Dimension: 6 x 32 mm





Pros

- Third-party tested for safety by UL.
- Lowest cost 50000-count meters tested.
- All measurements taken met the accuracy specifications in the manual.
- One of the best DC microamps accuracy specifications.
- The best low microfarad accuracy specifications.
- One of the smaller and lighter 50000-count meters

Cons

- Not available in the US, must buy from the EU.
- Worst AC volts accuracy specifications.
- Worst AC+DC volts accuracy specifications.
- Worst low megaohms accuracy specifications.
- Must disassemble the meter to change fuses.

Conclusion

The Brymen BM789 is the only meter in the 50000-count group I tested that does not have some form of data logging. In general, it has higher accuracy specifications than 6000-count meters and of course higher resolution. If also has AC+DC True-RMS, albeit the lowest accuracy in the bunch. It also can measure dBm and a variety or impedances.
If the Brymen BM789 was available and supported in the US I would recommend it as a good entry level 50000-count meter for people in my country. If you are in the EU or any other area of the world that can buy the Brymen BM789 and get support in your country, then yes, if you want an entry level 50000-count meter that does not do any data logging, this is the meter for you.