Understanding Current Measurement with a Multimeter

When your multimeter displays **20mA**, it means that at **this exact moment**, the current flowing **through the circuit is 20mA**.

Current (**Amperes, A**) is measured in **Coulombs per second**, meaning:

- **1 Ampere (A) = 1 Coulomb per second**
- **1 milliampere (mA) = 0.001 Coulombs per second**

So when your multimeter shows **20mA**, it means that **0.020 Coulombs of charge (electrons) are flowing through the circuit per second**.

Does 20mA Mean Per Second, Per Hour, or What?

Current is an instantaneous value—it tells you how much charge is flowing at that exact moment.
It is **not measured per second, per minute, or per hour**—it is simply **the rate of flow** at the time of measurement.

If you want to calculate **total charge flow over time**, use:

$$Charge(Coulombs) = Current(Amps) * Time(seconds)$$

For example, if **20mA flows for 10 seconds**:

$$Charge = 0.020A * 10s = 0.2\,Coulombs$$

How Does the Multimeter Measure Current?

A **multimeter in current mode** (A/mA setting) actually **becomes part of the circuit** in **series**.

1. Inside the multimeter, there is a **very small internal resistor (shunt resistor)**.
2. When current flows through this small resistor, **a tiny voltage drop** happens (Ohm's Law: V = IR).
3. The multimeter measures this voltage drop and calculates the current using **Ohm's Law**.
4. It then displays the calculated **current in Amps or mA**.

Understanding Current (Amps) in Battery Charging

When your **bench power supply displays 2A** while charging a battery, it means that **at that exact moment, 2A of current is flowing** into the battery.
It does **not** mean "per hour"—it is simply the **instantaneous current** flowing at that moment.
If the battery or the charging process changes, the current may increase or decrease over time.

What Does "3Ah" (Amp-Hour) Mean in a Battery?

Your battery is labeled **20V 3Ah** (3 amp-hours), which means:

- The battery can theoretically **supply 3A for 1 hour** before being fully discharged.
- Alternatively, it could provide **1.5A for 2 hours, or 6A for 30 minutes**, etc.
- This **does not** mean it always draws 3A—only that it has a total energy storage capacity of **3A × 1h = 3Ah**.

Difference Between "Amps" (Instantaneous) and "Amp-Hours" (Capacity Over Time)

Term	Meaning
Amps (A)	**Instantaneous current**—the rate of electron flow at a given moment. Example: Your power supply displays 2A, meaning **2 Coulombs per second are flowing at that exact moment**.
Amp-Hours (Ah)	**Total charge capacity**—the amount of current a battery can supply over time. Example: A **3Ah** battery can deliver **3A for 1 hour, 1.5A for 2 hours, etc.**

Example Calculation: Charging a 3Ah Battery with 2A

If your **power supply provides 2A** to a **3Ah battery**, you can estimate charging time:

$$Time\ to\ charge\ =\ \frac{Battery\ Capacity\ (Ah)}{Charging\ Current\ (A)} = \frac{3Ah}{2A} = 1.5\ hours$$

However, real-world charging is **not 100% efficient**—so it may take **longer** due to energy losses, heat, and charge tapering.

Amp-Hours (Ah) and Total Charge

Your battery is labeled **3Ah**, meaning:

- It can **deliver 3A for 1 hour** before being fully discharged.
- Or **1.5A for 2 hours**, or **6A for 30 minutes**, etc.

But this does **not** mean the total amount of **amps** in the battery is 180A - 3A * 60 minutes or 10800A - 3A * 3600 seconds.

How to Calculate Total Charge (Coulombs)

Amps (A) measure current, which is charge per second.

1 Ampere (A) = **1 Coulomb per second (C/s)**

To find the total **charge stored** in the battery (measured in Coulombs), use:

$$Charge(Q)\ =\ Capacity(Ah)\ *\ 3600\ seconds\ per\ hour$$

For your **3Ah** battery:

$$Q\ =\ 3Ah\ *\ 3600s/h\ =\ 10800\ Coulombs$$

This means the battery **stores a total of 10.800 Coulombs of charge**.

Why It's NOT 180A or 10800A

- **Amps (A) is a rate**—how fast charge flows at any given moment.
- **Amp-hours (Ah) is a total capacity**, not a total count of amps.
- If the battery provides **3A continuously**, then **every second** it delivers:

$$3A = 3C/s$$

Over **1 hour (3600 seconds)**:

$$3C/s * 3600s = 10800C$$

So the battery delivers **10.800 Coulombs** total, NOT "180A" or "10800A"—because **Amps measure flow rate, not stored quantity**.

Saying **10.800 Coulombs is 10.800 Amps** would be incorrect because Amps **require a time factor**.

If your battery **somehow** delivered all **10,800C in 1 second**, then:

$$I = \frac{Q}{t} = \frac{10800C}{1s} = 10800A$$

This would mean a **very high current of 10.800A**, which doesn't happen in real-world battery use!

- **10,800 Coulombs is NOT 10,800 Amps**.
- **10,800 Coulombs is a total charge**—it must be divided over time to get current.
- **Amps (A) tell you how fast the charge flows**, not the total charge itself.
- **The battery delivers 10,800C over 1 hour at 3A** → It's a **controlled flow of charge**.

Key Takeaways

- The **20mA reading is instantaneous**, meaning at that moment, **20mA (0.020 Coulombs per second) is flowing**.
- It is **not measured per hour**—if you want to find charge over time, multiply by time.
- The **multimeter measures a small voltage drop across an internal shunt resistor** and calculates current using Ohm's Law.
- **Amps (A) is instantaneous**—when your power supply shows 2A, **that's the current at that moment**.
- **Amp-hours (Ah) is a capacity measurement**—it tells how much current a battery can supply over time.
- Your **20V 3Ah battery means it can supply 3A for 1 hour** or equivalent variations.
- Charging with **2A will take around 1.5 hours**, assuming ideal conditions.
- A **3Ah battery does NOT store 180A or 10800A**—it **delivers current at a rate** but does not "contain" a fixed amount of amps.
- The **total charge stored is 10,800 Coulombs (C)**.
- **Amp-hours (Ah) tells you how long the battery lasts at a given current**—it does not mean there's a fixed amount of "amps" inside.