Solar Workshop Handout

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Voltage Drop Chart

This table provides the **maximum one-way wire run** (in feet) for a **3% voltage drop**, based on current load and wire gauge. Values are for **copper wire** and assume a **12V system**.

12 VOLT DC SYSTEM

LENGTH OF CONDUCTOR *from Source of Current to Device and Back to Source (feet)*

TOTAL CURRENT ON CIRCUIT (amps)	3%	10	15	20	25	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
	5	18*	16	14	12	12	10	10	10	8	8	8	6	6	6	6	6	6	6	6
	10	14	12	10	10	10	8	6	6	6	6	4	4	4	4	2	2	2	2	2
	15	12	10	10	8	8	6	6	6	4	4	2	2	2	2	2	1	1	1	1
	20	10	10	8	6	6	6	4	4	2	2	2	2	1	1	1	0	0	0	2/0
	25	10	8	6	6	6	4	4	2	2	2	1	1	0	0	0	2/0	2/0	2/0	2/0
	30	10	8	6	6	4	4	2	2	1	1	0	0	0	2/0	2/0	3/0	3/0	3/0	3/0
	40	8	6	6	4	4	2	2	1	0	0	2/0	2/0	3/0	3/0	3/0	4/0	4/0	4/0	4/0
	50	6	6	4	4	2	2	1	0	2/0	2/0	3/0	3/0	4/0	4/0	4/0				
	60	6	4	4	2	2	1	0	2/0	3/0	3/0	4/0	4/0	4/0						
	70	6	4	2	2	1	0	2/0	3/0	3/0	4/0	4/0								
	80	6	4	2	2	1	0	3/0	3/0	4/0	4/0									
	90	4	2	2	1	0	2/0	3/0	4/0	4/0										
	100	4	2	2	1	0	2/0	3/0	4/0	4/0										

NOTE: The numbers shown are based on the distance from power source to light and back (round trip).

* For single conductor wire, ABYC requires a minimum of 16 AWG with some limited exceptions.

*Wire Gauges for a **3%** Voltage Drop in a **12 Volt DC System***

Key Electrical Concepts

When water flows through a pipe, increasing or decreasing either the size of the pipe or the flow rate of the water will accordingly increase or decrease the ammount of water you get out of the end of the pipe. Let's look at three electrical concepts and how they relate to the water in the pipe:

Voltage (V) - (measured in **volts**, represented as V) is the electrical potential, or size of the pipe. It's not exactly correct, but it helps to think of it as a bigger pipe means there's a bigger potential amount of water that could flow through, and a higher voltage the larger potential for electricity you have.

Current (I) - (measured in **amps**, represented as A) is the rate at which electrons flow through a circuit, or in the pipe how fast water is moving through it. The faster then water flows, the more water you have at the end. The higher the current (or amperage or amps) the more eletricity you have.

Power (P) - (measured in **watts**, represented as W) is the ammount of electricity used or produced. So in the pipe it's the ammount or volume of water you get out at the end of the pipe.

Resistance (R) - (measured in **ohms**, represented as Ω) The opposition to the flow of electric current. So in our water example it's any kink or obstruction in the pipe.

Formulas

Power: $Power(W) = Voltage(V) \times Current(A)$

> You can find voltage if you have current and power $V = P/I$ or current if you have voltage and power $I = P/V$.

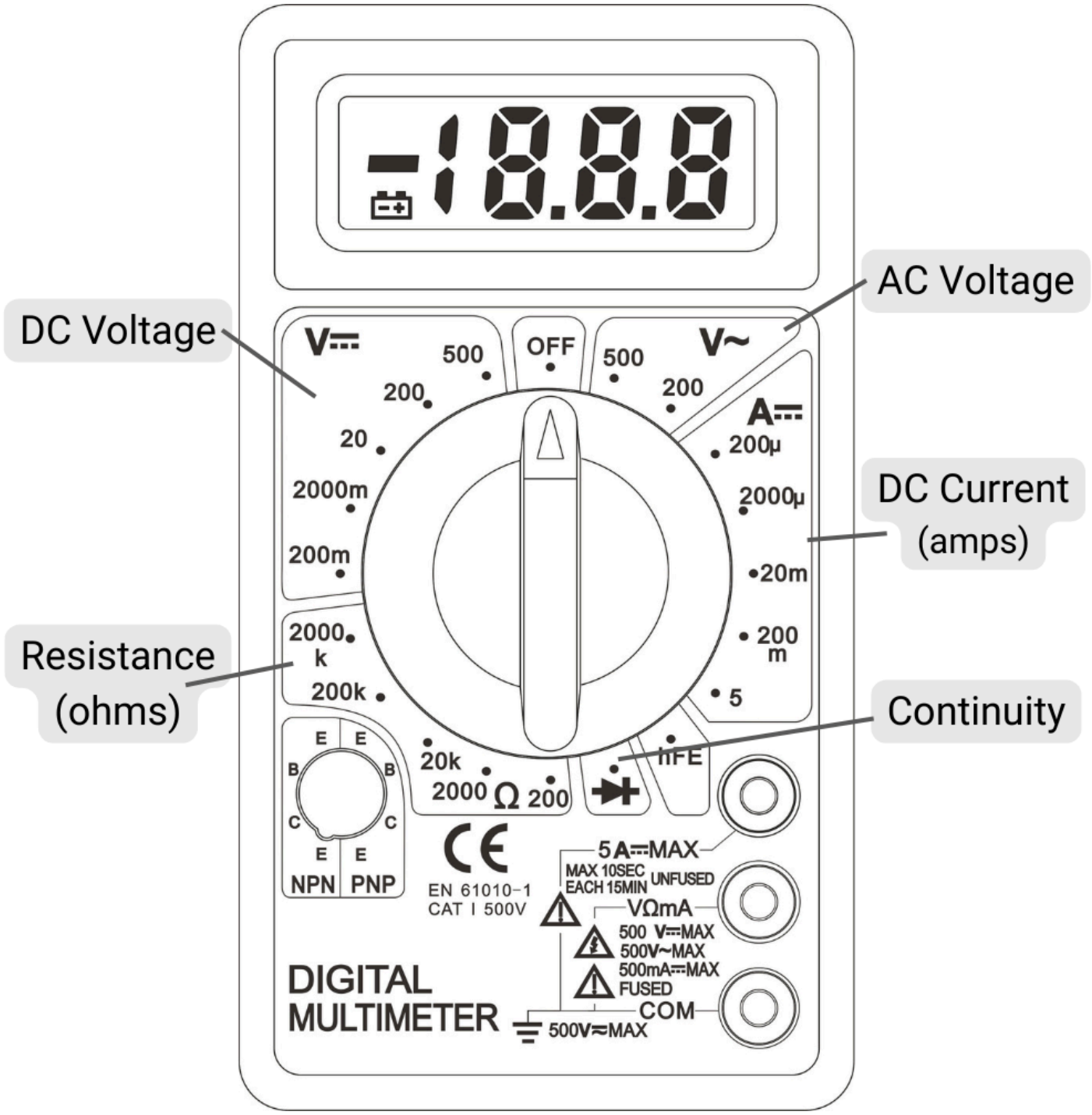
Amp-Hours: $AmpHours(Ah) = Current(A) \times Time(hours)$

> Tells you how much current a battery can supply for **one hour** before it is depleted.

Watt-Hours: $WattHours(Wh) = Volts(V) \times AmpHours(Ah)$

> Tells you **how much power a system can deliver over time**. Since power is measured in watts (W), Watt-Hours indicate the total energy available.

Multimeter Layout



Solar Panel Measurements

Label Term	What It Means	Typical Values (Example for a 100W Panel)
Max Power (Pmax)	The maximum wattage output under ideal conditions.	**100W**
Voltage at Max Power (Vmp)	The voltage the panel produces under load (when connected to a system).	**18V - 20V**
Current at Max Power (Imp)	The current (amps) the panel produces under load.	**5A - 6A**
Open Circuit Voltage (Voc)	The voltage when the panel is not connected to anything (no load).	**22V - 24V**
Short Circuit Current (Isc)	The maximum current the panel can produce when shorted.	**5.5A - 6.5A**
Operating Voltage Range	The panel’s recommended working range.	**12V (nominal) or 24V (nominal)**

Battery Measurements

Measurement	Definition	Expressed As	Why It Matters	Example
Depth of Discharge (DoD)	How much energy you can safely use before recharging.	Percentage (%)	Batteries last longer if not fully discharged. Lead-acid: ~50%; Lithium: ~80–90%.	Lead-acid: 50% DoD; Lithium: 80-90% DoD
State of Charge (SoC)	How full the battery currently is.	Percentage (%)	Helps prevent over-discharge and ensures battery health.	Fully charged = 100%; fully empty = 0%
C-Rate (Charge/Discharge Rate)	The speed at which a battery is charged or discharged relative to its capacity.	Number (1C, 0.5C, etc.)	Charging/discharging too fast can shorten battery life or cause damage.	1C: full charge/discharge in 1 hour; 0.5C: in 2 hours
Cycle Life	Number of full charge/discharge cycles before battery capacity significantly decreases.	Number of cycles	Indicates lifespan. Lithium generally has higher cycle life than lead-acid.	500 cycles (typical lead-acid); 2000+ cycles (typical lithium)