

DIGITAL MULTI-METER

**The definitive guide
on to effectively use your
digital multi-meter**



Carl Davidson

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What make up a Good Digital Multi-meter?

Chapter one

Understanding what multi-meter is all about?

Digital multi-meter is a test apparatus used to gauge at least two or more electrical qualities—mainly voltage (volts), current (amps) and resistance (ohms). It is a standard indicative apparatus for professionals in the electrical/electronic businesses.

Digital multi-meter sometime in the past replaced needle-based simple meters because of their capacity to gauge with more greater accuracy, unwavering quality and expanded impedance.

Accident presented its first advanced multi-meter in 1977.

Digital multi-meters join the testing abilities of single-task meters—the voltmeter (for estimating volts), ammeter (amps) and ohmmeter (ohms). repeatedly, they include a few additional exact highlights or progressed choices. Professionals with explicit necessities, accordingly, can search out a model focused to address their issues.

The substance of an advanced multi-meter commonly incorporates four parts:

- Display: Where estimation readouts can be seen.
- Buttons: For choosing different capacities; the alternatives fluctuate by model.
- Dial (or turning switch): For choosing essential estimation esteems (volts, amps, ohms).
- Input jacks: Where test leads are embedded.

Chapter two

Step by step guide to effectively Use a Multi-meter

So... how would I use a digital multi-meter? This instructional exercise will tell you the best way to make use of a digital multi-meter (DMM), a basic apparatus that you can use to analyze circuits, find out about others' electronic design, and even test a battery. Consequently the 'multi'- 'meter' (multi measurement) name.

The most fundamental things we measure are voltage and current. A multi-meter is likewise extraordinary for some fundamental once-overs to verify everything seems ok and investigating. Is your circuit not working?

Accomplishes the switch work? Put a meter on it! Digital multi-meter is the first thing you need to ensure safeguard while investigating a framework. In this instructional exercise we will cover estimating voltage, current, opposition and coherence.

Recommended Reading

These ideas might be useful with this instructional exercise: In these tutorial we will using the SparkFun VC830L all through the instructional exercise, yet these techniques ought to apply to most multi-meters.



Digital Multi-meter - Basic

Searching for the Multi-meter that is appropriate for you?

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Digital Multi-meter - Basic



USB Power Meter (Color TFT LCD)



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Parts of digital Multi-meter



A digital multi-meter is has three sections:

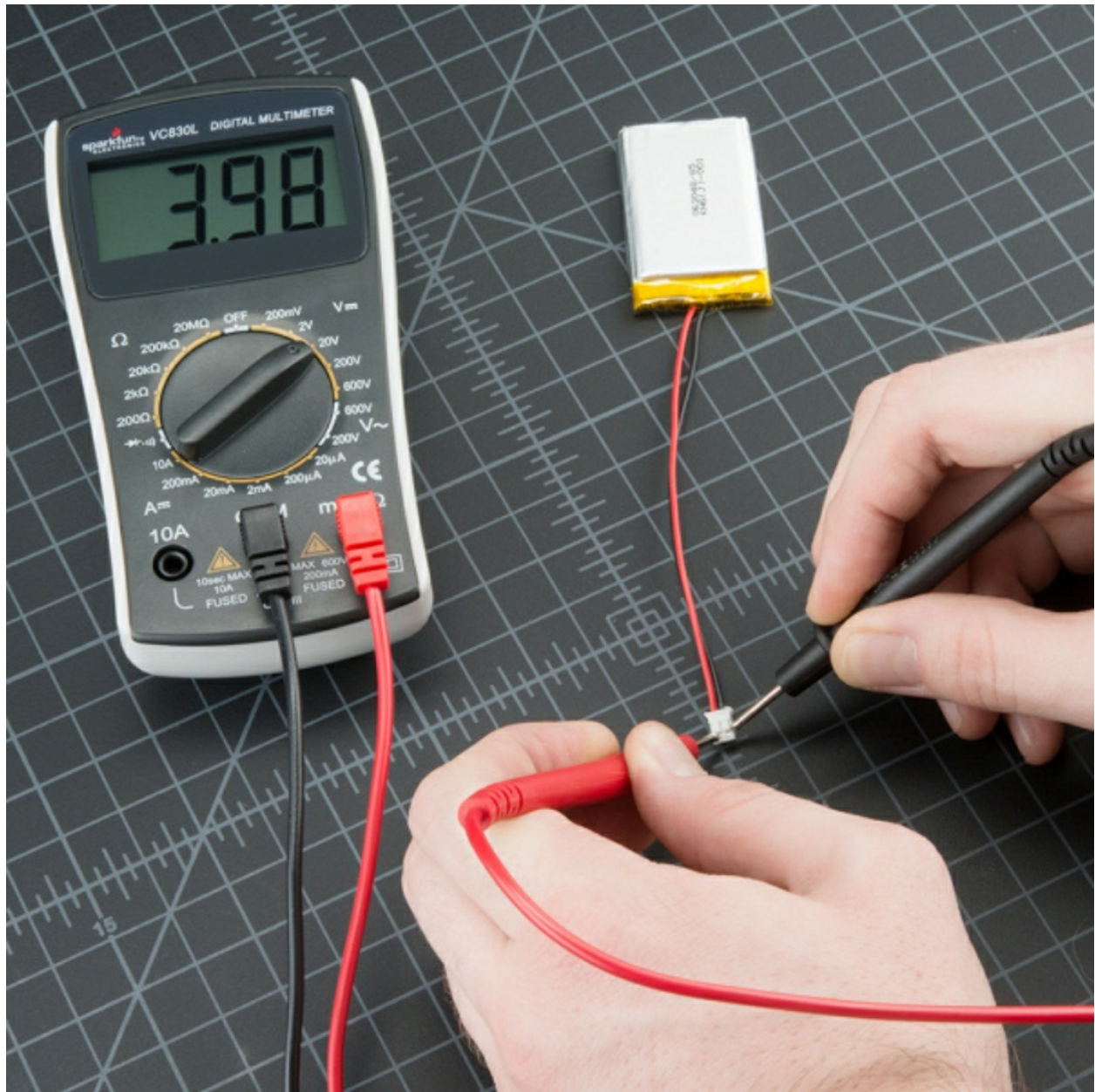
- Display

- Selection button
- Ports

The **display** normally has four digits and the capacity to show a negative sign. Some digital multi-meters have light up shows for better review should in case of low light circumstances.

The **selection button** permits the user to set the multi-meter to read various function, for example, milliamps (mA) of current, voltage (V) and obstruction (Ω).

Two tests are connected to two of the **ports** on the front wall of the unit. COM represents normal and is quite often associated with Ground or '-' of a circuit. The COM test is customarily black however there is no contrast between the red test and black test other than color. 10A is the extraordinary port used when estimating huge flows (more prominent than 200mA). mA V Ω is the port that the red test is ordinarily connected to. This port allow the measuring of voltage (up to 200mA), voltage (V), and impediment (Ω). The tests have a banana type connector on the end that connects to the multi-meter whatever test that have a banana part will surely work with this meter. This takes into consideration various kinds of tests to be used.



Chapter three

Making use of a Multi-meter to test the voltage on a LiPo Battery.

Test Types

There are so many various type of tests accessible for digital multi-meters. Here are a couple of our top choices:

- **Banana to Alligator Clips:** These are extraordinary links for interfacing with enormous wires or pins on a breadboard. Useful for performing longer term tests where you don't must have to hold the tests set up while you control a circuit.



- **Banana to IC Hook :** IC hook these function perfectly on littler ICs and legs of ICs.



- **Banana to Tweezers :** Tweezers are helpful on the off chance that you are expecting to test SMD parts.
- **Banana to Test Probes :** If you actually break a test, they are modest to supplant!



Banana to IC Hook Cables

Banana to Alligator Cable

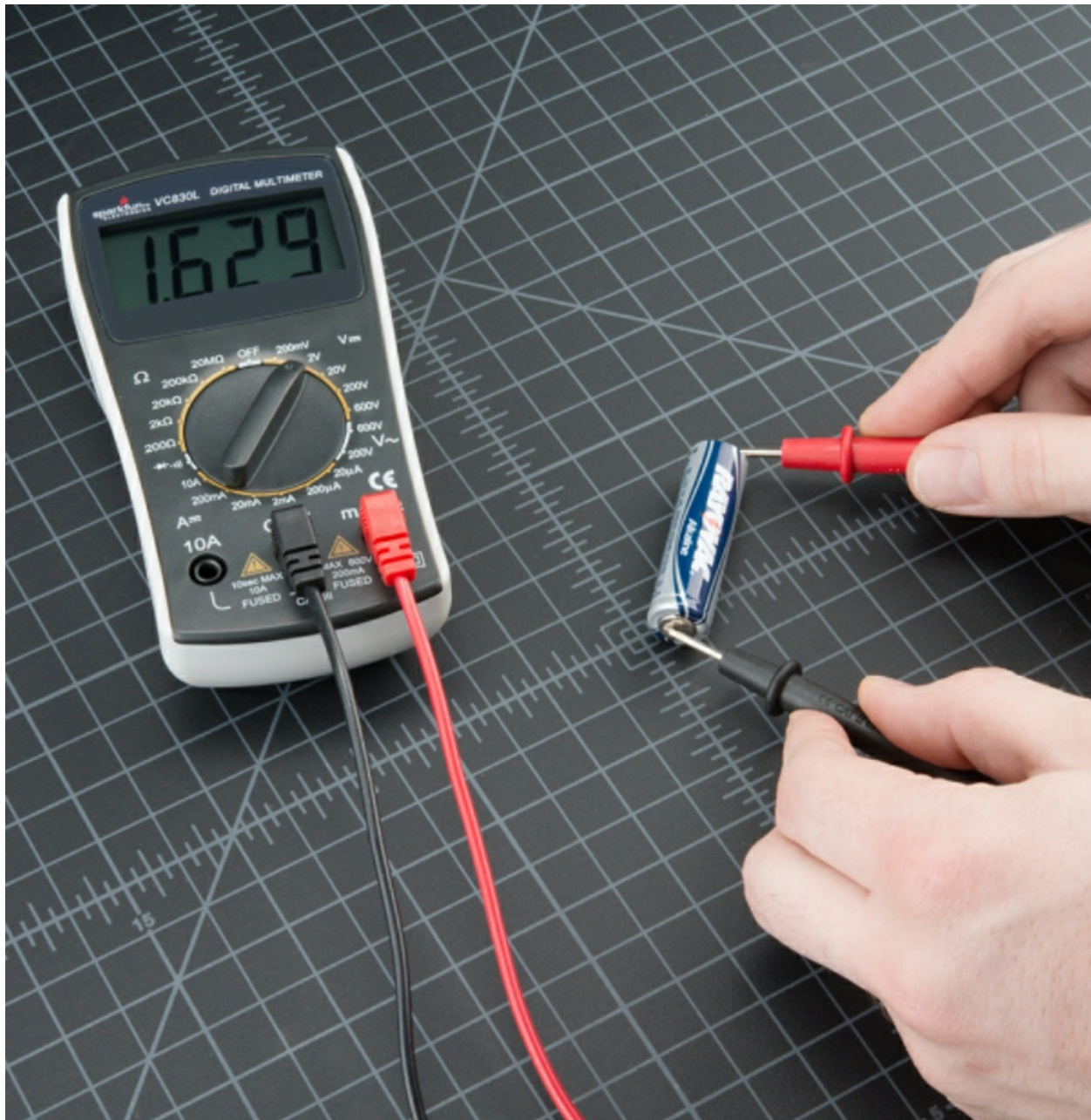
Multi-meter Probes - Needle Tipped

Multi-meter Probes - Tweezers

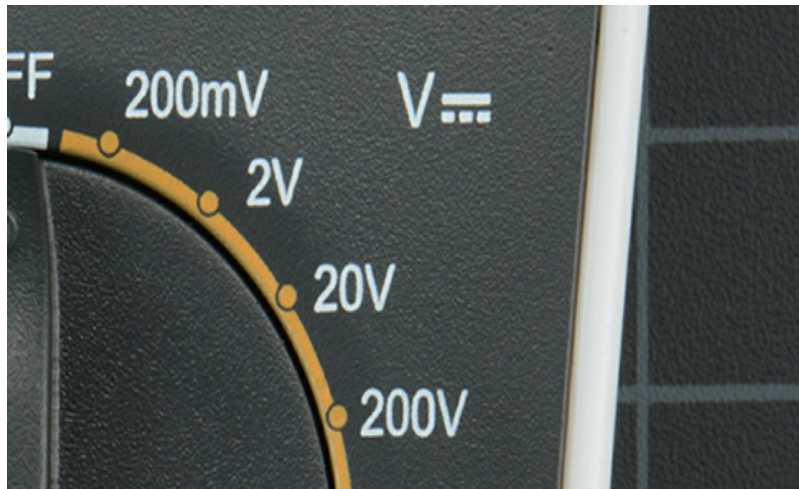


Measuring of voltage Voltage

To begin, how about we measure voltage on an AA battery: Plug the black test into **COM** and the red test into **mAVΩ** . the digital multi-meter should be program to "2V" in the DC also known (direct current) expand. Practically all compact hardware utilize direct current), not exchanging current. Associate the black test to the battery's ground or '-' and the red test to control or '+'. compress the tests with a slight weight against the positive+ and negative - terminals of the AA battery. On the off chance that you have a new battery, you should see around 1.5V on the presentation (this battery is fresh out of the plastic new, so its voltage is marginally higher than 1.5V).

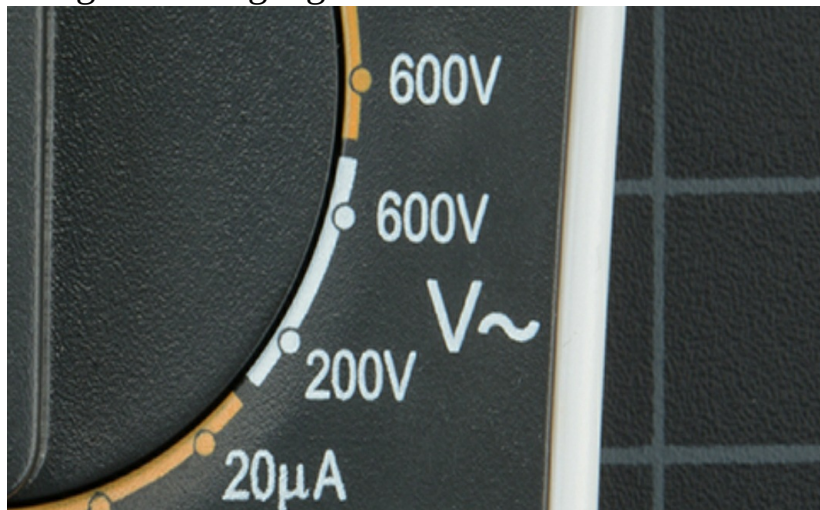


Just In case you're estimating DC current (i.e , a battery or a sensor snared to an Arduino) the user need to set the handle where the V has a straight line. Air conditioning voltage (like what emerges from the divider) can be perilous, so we infrequently need to utilize the AC voltage setting (the V with a wavy line close to it). In case you're playing with AC, we suggest you get a non-contact analyzer as opposed to utilize an advanced multi-meter.



Utilize the V with a straight line to gauge DC Volta

Utilize the V with a



Utilize the V with a wavy line to gauge AC Voltage What occurs in the event that you switch the red and black tests? The reading on the digital multi-meter is basically negative. Nothing bad occurs! The multi-meter measures voltage comparable to the basic test. What amount of voltage is there on the '+' of the battery contrasted with normal or the negative pin? 1.5V. On the off chance that we change the tests, we describe '+' as the standard or zero point. What sum of current is in the '-' of the battery contrast with our new zero? - 1.5V!

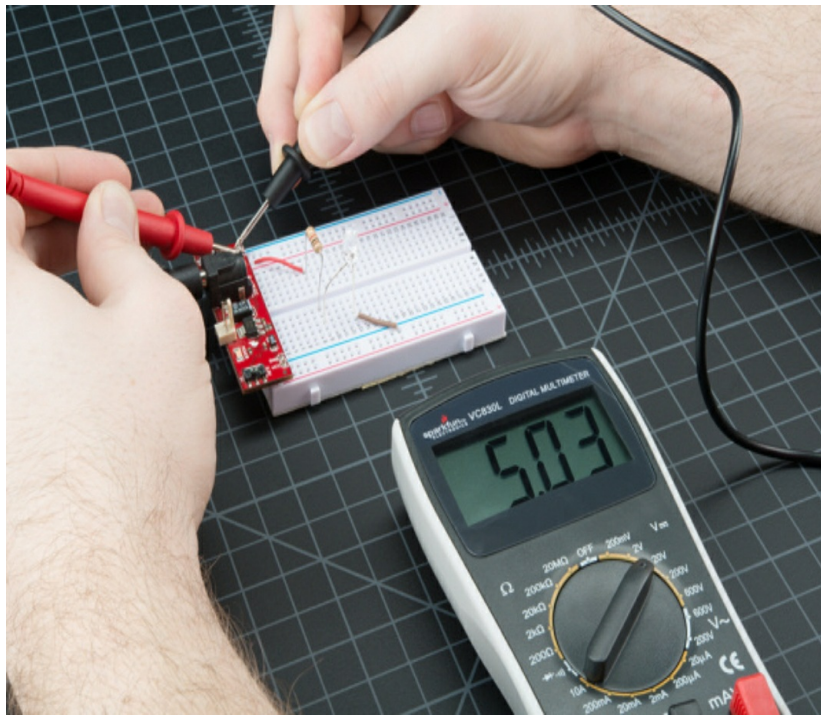


Chapter four

Measuring the voltage

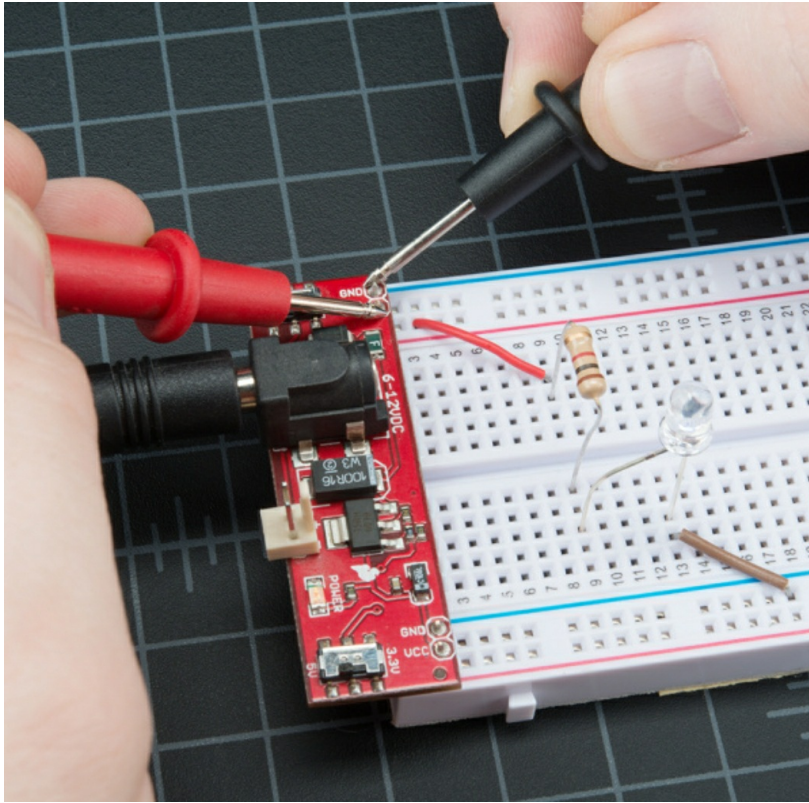
Presently we should develop a basic circuit to exhibit how to quantify voltage in a certifiable situation. The circuit is just a $1k\Omega$ and a Blue overly brilliant LED controlled with a SparkFun Breadboard Power Supply Stick. To start, how about we ensure the circuit you are taking a shot at is controlled up accurately. In the event that your undertaking ought to be at 5V however is less than 4.5V or more prominent than 5.5V, this would rapidly give you a

sign that something might went wrong and all you need to do is check your capacity properly associations or the wiring of your circuit.



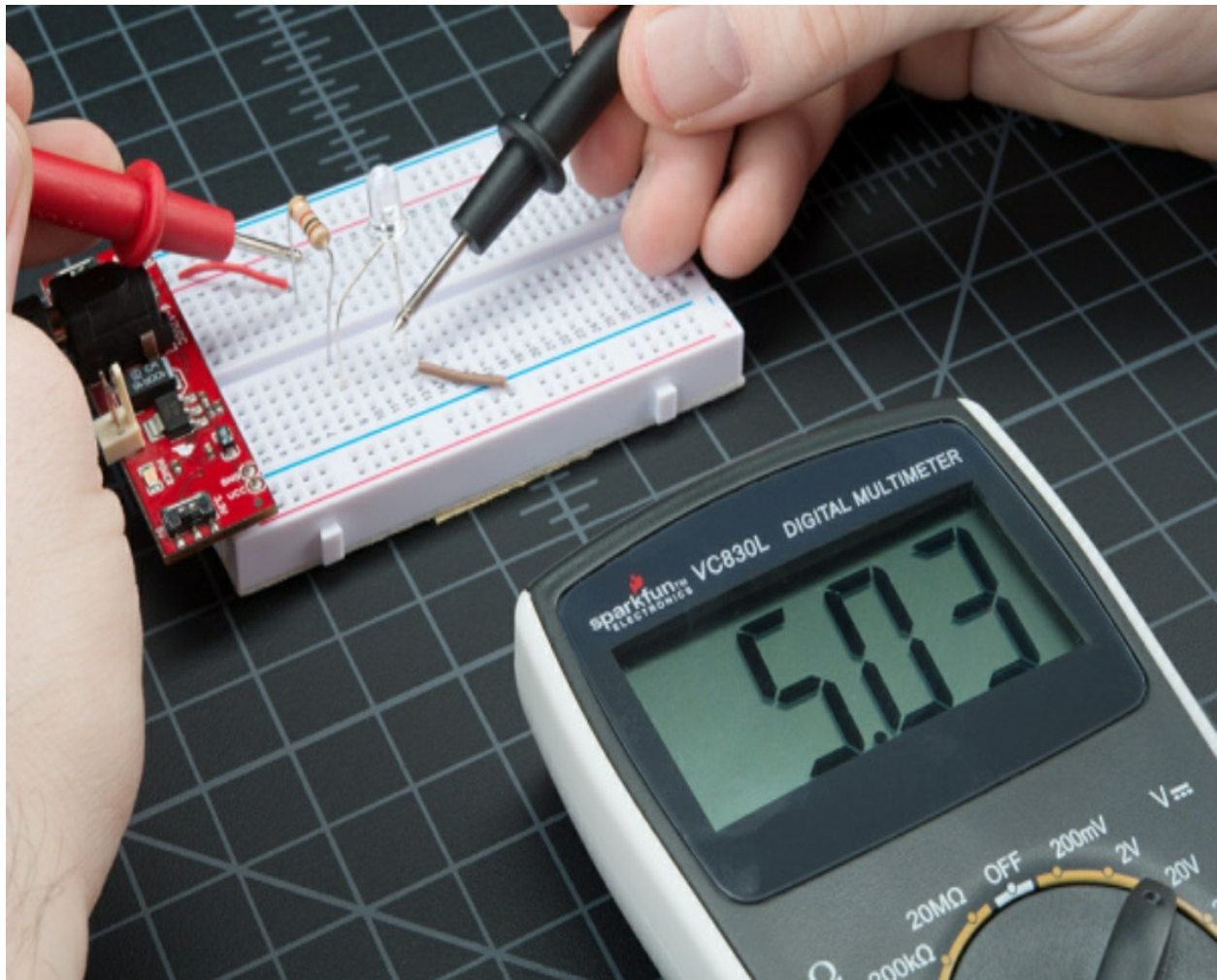
Quantifying the voltage falling off of a Power Supply Stick.

The handle should be set to "20V" in the DC expand (the DC Voltage run has a V with a direct line near to it). Multi-meters are for the most part not auto ranging. You need to set the digital multi-meter to a series that it can calculate. For instance, 2V estimates voltages up to 2 volts, and 20V estimates voltages up to 20 volts. So in the event that you've estimating a 12V battery, utilize the 20V setting. 5V framework? Utilize the 20V setting. On the off chance that you set it inaccurately, you will presumably observe the meter screen change and afterward read '1'.

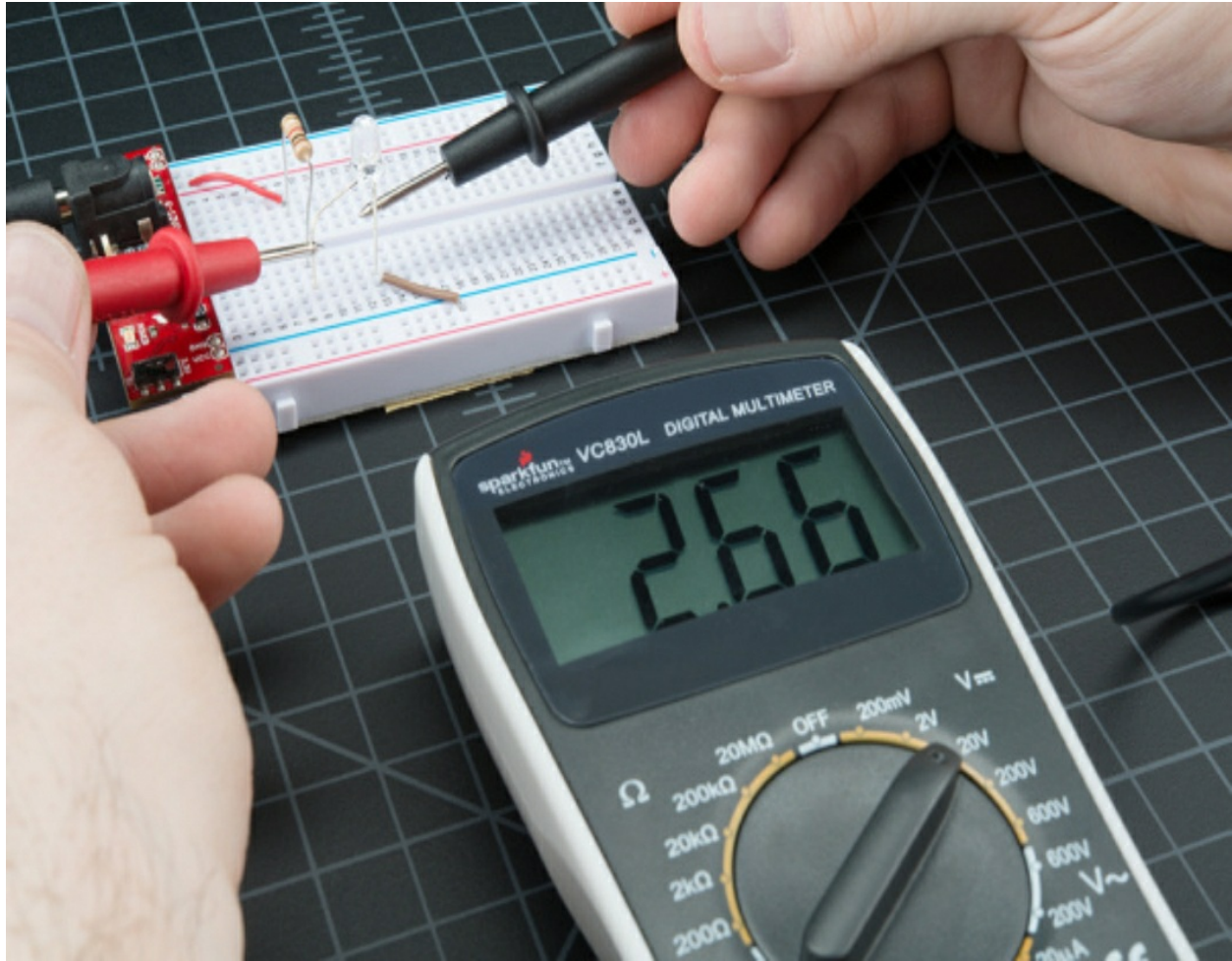


With some power (imagine sticking a fork into a bit of cooked meat), push the tests onto two uncovered bits of metal. One test should contact a GND association. Just a trial to the VCC or 5V association.

various pieces of the circuit can be test as well too. This training is called **nodal analysis**, and it is an essential structure block in circuit investigation. By estimating the voltage over the circuit we can perceive how much voltage every part requires. We should gauge the entire circuit first. Measuring from where the current is moving into the resistor and after that where ground is on the LED, we should see the full voltage of the circuit, expected to be around 5V.



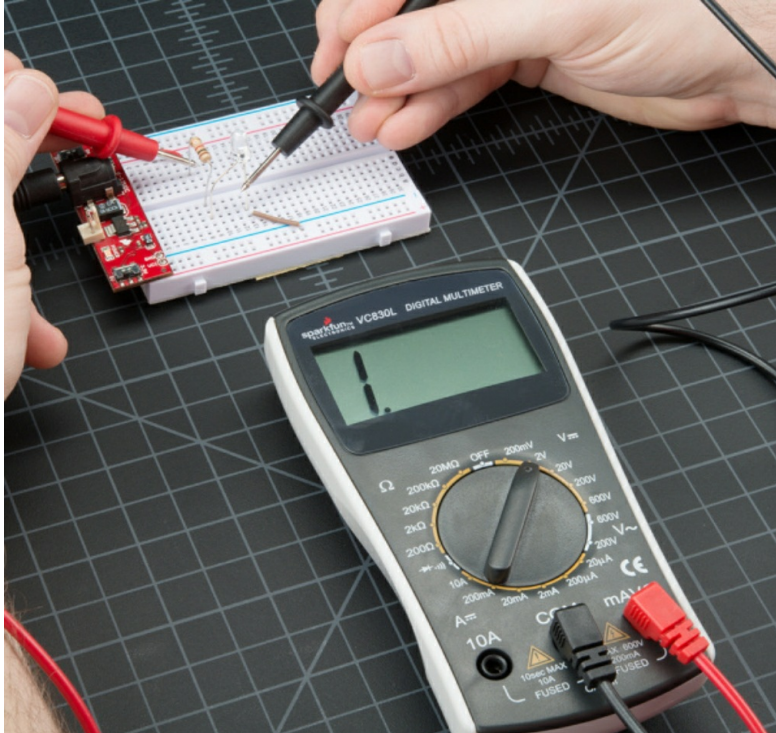
We would then be able to see how much voltage the LED is utilizing. This is what makes the voltage drop over the LED. In the event that that doesn't bode well presently, dread not. It will as you investigate the universe of hardware more. The significant thing to remove is that various pieces of a circuit can be estimated to examine the circuit all in all.



This LED is using 2.66V of the accessible 5V flexibly to light up. This is lower than the forward voltage expressed in the **datasheet** by virtue of the circuit just having modest quantity of current running however it, yet more on that in a piece.

Over load

What occurs on the off chance that you select a voltage setting that is excessively low for the voltage you're attempting to quantify? Not all that much. The meter will essentially show a 1. This is the meter attempting to reveal to you that it is over-burden or out-of-extend. What so ever you're intending to go after might be so much for that specific setting. Take a stab at changing the multi-meter handle to a the following most noteworthy setting.



understanding the 5V over this circuit is a lot for the 2V setting on the multi-meter.

Selection button



What is reason that makes the meter handle read 20V and not 10V? In case you're hoping to quantify a voltage under 20V, you go to the 20V setting. This will permit you to peruse from 2.00 to 19.99.

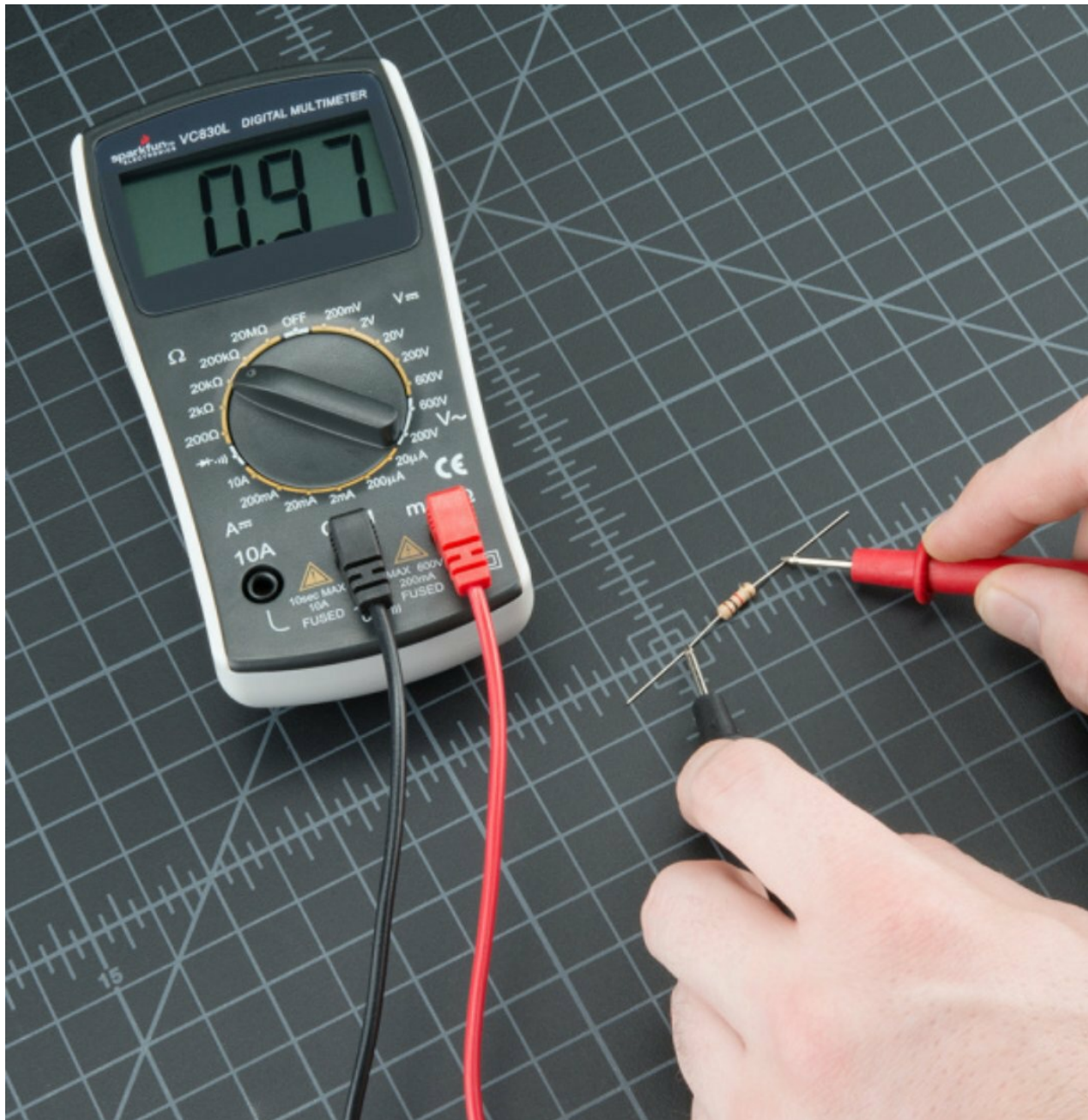
The main digit on numerous multi-meters is just ready to show a '1' so the reaches are restricted to 19.99 rather than 99.99. Consequently the 20V max run rather than 99V max run.

Caution! When all is said in done, adhere to DC circuits (the settings on the multi-meter with straight lines, not breathtaking lines). Most multi-meters can quantify AC (rotating current) frameworks, however AC circuits can be risky. A divider outlet with AC or 'fundamental voltage' is the stuff that can destroy you great. Carefully regard AC. In the event that you have to verify whether an outlet is 'on' at that point utilize an AC analyzer. Actually the main occasions we've expected to quantify AC are the point at which we have an outlet that is acting amusing (is it truly at 110V?), or in case we're attempting to control a warmer, (for example, a hot plate). Go moderate and twofold check everything before you test an AC circuit.

Chapter five

Measuring Resistance

Normal resistors have color codes on them. Just in case you don't know what that means, that is alright! There are a lot of online number calculator that are very simple to use. Just in case, in the event that you actually wind up without web access, a multi-meter is convenient at estimating opposition. Choose an arbitrary resistor and set the multi-meter to the 20k ω setting. At that point hold the tests against the resistor legs with a similar measure of weight you when squeezing a key on a console.



The meter will read one of three things, 0.00, 1, or the **genuine resistor esteem**.

- should in case, the meter closer to 0.97, which simply means this resistor has an evaluation of 970Ω , or about $1k\Omega$ (recollect you are in the $20k\Omega$ or $20,000\Omega$ mode you have to progress the decimal three spots to one side or 970Ω s).
- If the multi-meter understands 1 or showcases OL, it's over-burden. You

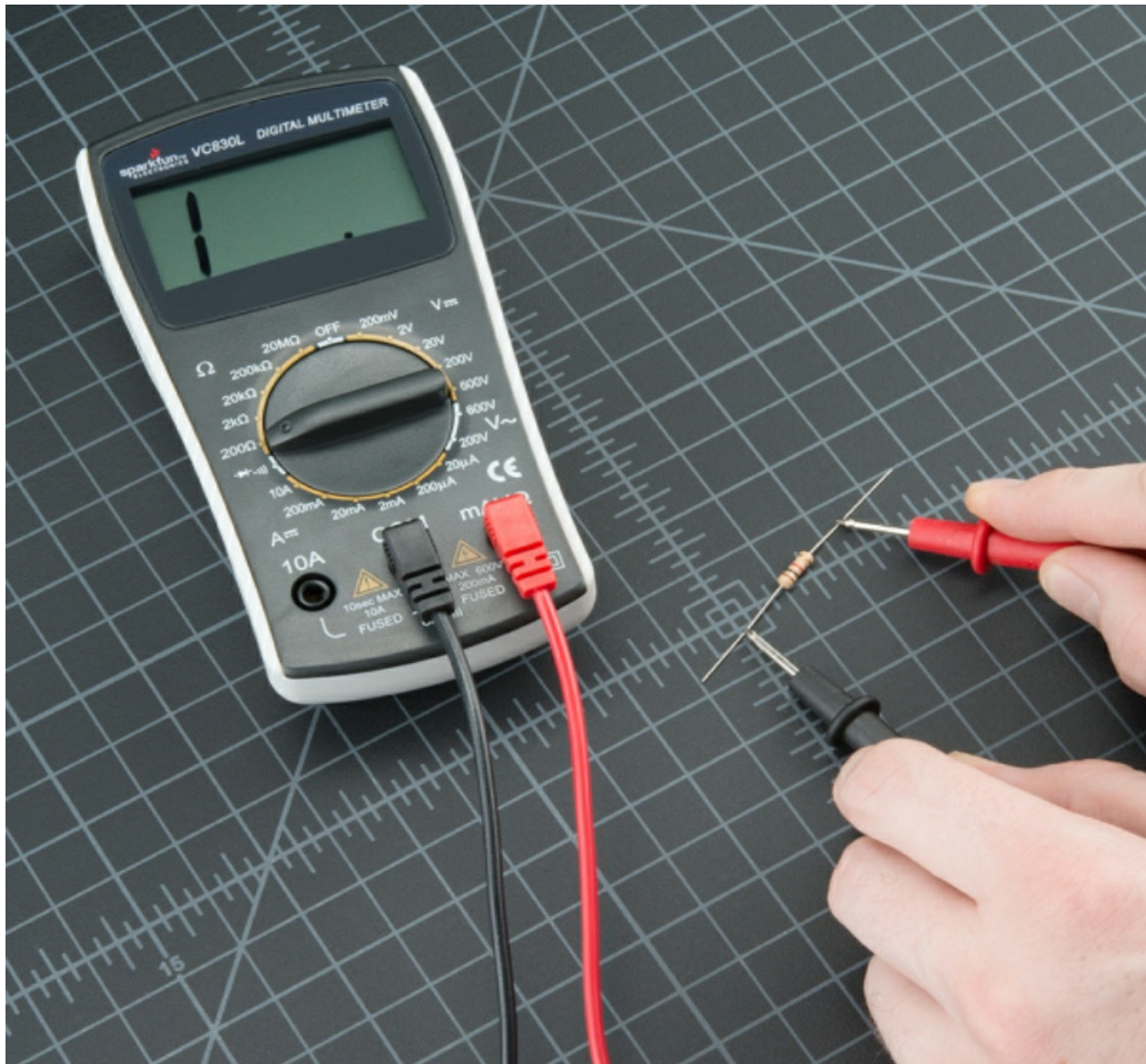
should attempt a higher mode, for example, 200k ω mode or 2M Ω (megaohm) mode. There is no mischief if this occur, it basically implies the range handle should be balanced.

- If the multi-meter peruses 0.00 or almost zero, at that point you have to bring down the mode to 2k ω or 200 ω .

Recollect that numerous resistors have a 5% resilience. This implies the shading codes may demonstrate 10,000 Ohms (10k ω), but since of inconsistencies in the assembling cycle a 10k ω resistor could be as low as 9.5k ω or as high as 10.5k ω . Try not to stress, it'll stir fine and dandy as a draw up or general resistor. We should drop the meter down to the following least setting, 2K Ω . What occurs?



Not so many changes. Since this resistor (a $1\text{K}\Omega$) is under $2\text{K}\Omega$, it actually appears on the showcase. In any case, you'll notice that there is one more digit after the decimal point giving us a somewhat higher goal in our perusing. Shouldn't something be said about the following most minimal setting?



Presently, since $1k\omega$ is more prominent than 200ω , we've maximized the meter, and it is revealing to you that it is over-burden and that you have to attempt a higher worth setting.

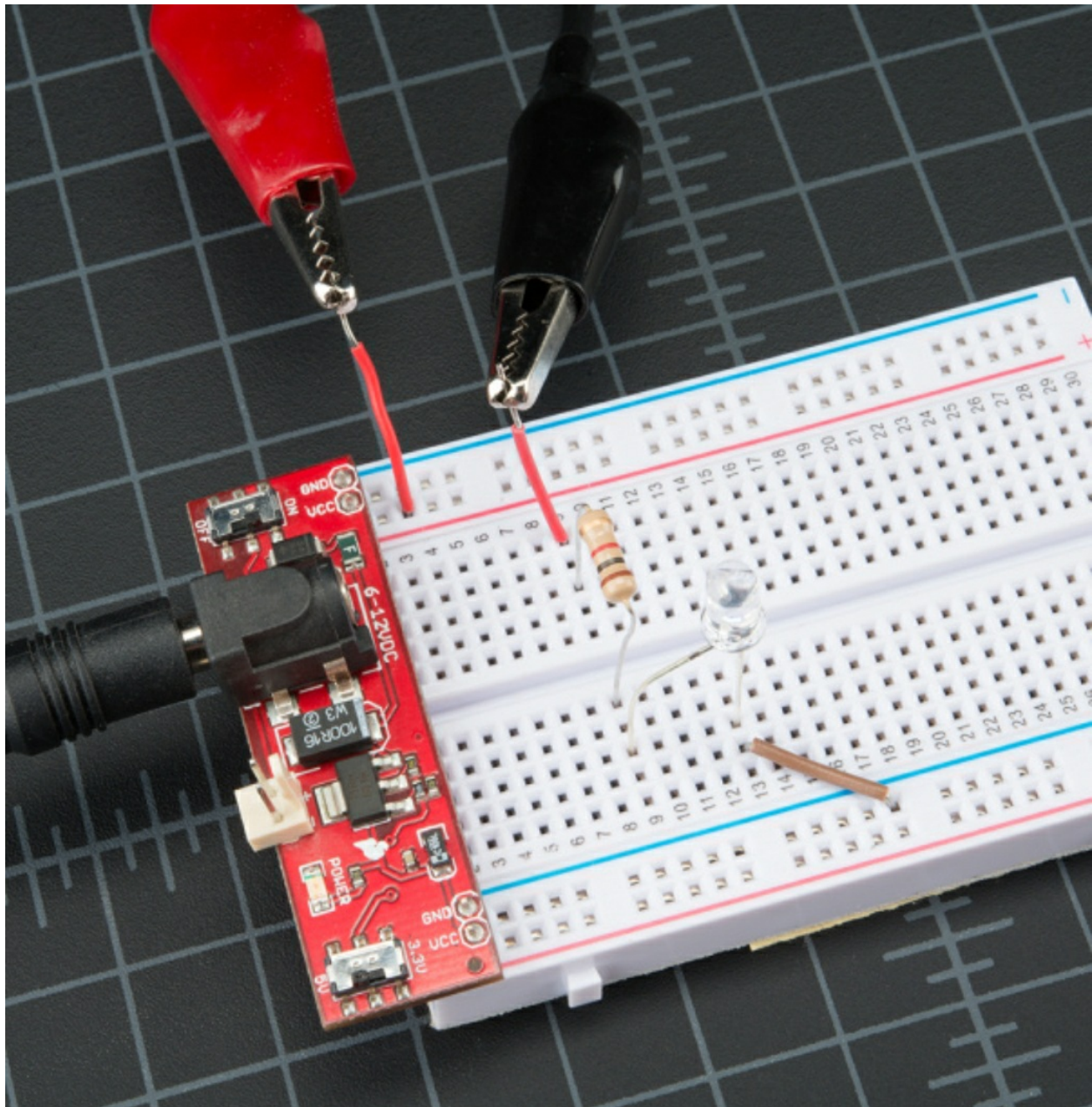
As a dependable guideline, it's uncommon to see a resistor under 1 Ohm. Recall that estimating opposition isn't great. Temperature can influence the perusing a ton. Additionally, estimating opposition of a gadget while it is truly introduced in a circuit can be exceptionally dubious. The encompassing parts on a circuit board can extraordinarily influence the perusing.

Chapter six

Estimating or measuring Current

The ability to understand current can be tricky sometimes and most quick readings in the world of embedded electronic. It's dubious in light of the fact that you need to quantify current in arrangement. Where current is estimated by jabbing at VCC and GND (in equal), to measure current you need to truly interfere with the evolution of current and put the meter in-line. To exhibit this, we'll utilize a similar circuit we used in the estimating voltage area.

The primary thing we'll require is an additional bit of wire. As referenced, we'll have to genuinely interfere with the circuit to quantify the current. Said another way, pull out the VCC wire heading off to the resistor, include a wire where that wire was associated, and afterward test from the force nail to the force flexibly to the resistor. This adequately "breaks" capacity to the circuit. We at that point embed the multi-meter in-line so it can quantify the current as it "streams" through to the multi-meter into the bread load up. For these photos, we cheated and used croc cuts. When estimating current, it's frequently acceptable to watch what your framework does after some time, for a couple of moments or minutes. While you should remain there and hold the tests to the framework, now and again it's simpler to let loose your hands. These croc cut tests can prove to be useful. Note that practically all multi-meters have similar measured jacks (they're designated "banana plugs") so in case you're after all other options have been exhausted, you can utilize your friend tests.



With the multi-meter associated, we would now be able to set the dial to the best possible setting and measure some current. The measuring of current works the same to voltage and opposition - you need to get the correct range. Set the digital multi-meter to 200mA, and begin your work from that point. The current utilization for some, breadboard ventures is as a rule under 200mA. Ensure the red test is connected to the 200mA intertwined port. On our most loved multi-meter, the 200mA gap is a similar port/gap as voltage and opposition perusing (the port is marked mAV Ω). This implies you can keep the red test in a similar port to gauge current, voltage, or opposition. In

any case, in the event that you speculate that your circuit will utilize near or more than 200mA, change your test to the 10A side, as a sanity check. Overburdening the current can bring about a blown breaker as opposed to only an overload show. More on that in a piece.

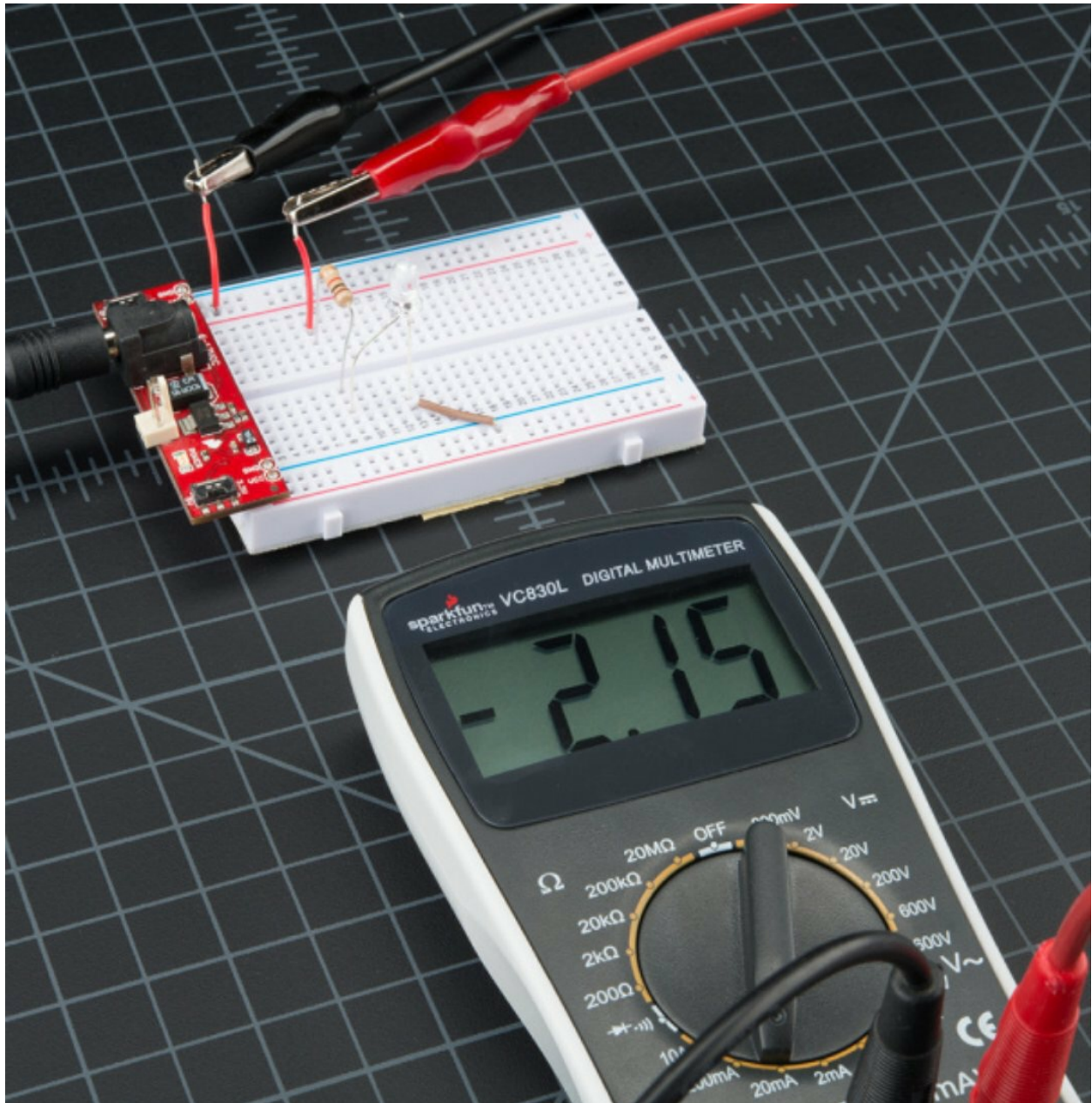


This circuit was just pulling 1.8mA at the hour of estimation, not a great deal of current. The normal perusing was nearer to 2.1mA.

Understand that the multi-meter is only acting as a piece wire - you've presently finished the circuit, and the circuit will on. This is significant in light of the fact that over the long haul the LED, microcontroller, sensor, or whatever gadget being estimated may change its capacity utilization, (for example, switching on a LED can bring about a 20mA increase for a second, at that point decline for a second when it eliminate). On the multi-meter show you should see the prompt current perusing. All multi-meters take readings after some time and afterward give you the normal, so anticipate that the perusing should change. When all is said in done, less expensive meters will average all the more brutally and react all the more gradually, so think about each perusing while taking other factors into consideration. In your mind, take a normal range, for example, 7 to 8mA under ordinary 5V conditions

(not 7.48mA).

Like different estimations, when estimating current, the shade of the tests doesn't make a difference. What occurs on the off chance that we switch tests? Nothing terrible occurs! It basically motivations the current perusing to get negative:



Current is as yet coursing through the framework, you've recently changed your viewpoint and now the meter understands negative.

Keep in mind! At the point when you're finished utilizing the meter, consistently return the meter to understand voltage (return the tests to the voltage port, set the meter to peruse the DC voltage run if fundamental). It's entirely expected to snatch a meter and start to rapidly gauge the voltage between two pins. On the off chance that you have left your meter in 'current' mode, you won't see the voltage on the showcase. Rather you'll see '0.000' demonstrating that there is no current among VCC and GND. Inside that brief moment you will have associated VCC to GND through your meter and the 200mA breaker will blow = not great. So before you put the meter down for the evening, make sure to leave your meter in an amicable state.

Estimating current can be tricky a couple of times. Try not to stress on the off chance that you blow the wire - we've done it many occasions! We'll tell you the best way to supplant the wire in a later segment.

Continuity

Continuity testing is the demonstration of testing the resistance between two points. On the off chance that there is extremely low resistance (not exactly a couple of Ω s), the two points are connected electrically, and a tone is radiated. In the event that there is in excess of a couple of Ω s of opposition, then the circuit is open, and no tone is discharged. This test protects that associations are made effectively between two points. This test likewise encourages us identify if two focuses are associated that ought not be.

Progression is perhaps the absolute most significant capacity for implanted equipment masters. This component permits us to test for conductivity of materials and to follow where electrical associations have been made or not made.

Set the multi-meter to 'continuity' mode. It might differ among DMMs, yet search for a diode image with spread waves around it (like sound originating from a speaker).



Multi-meter is set to continuity mode.

Presently contact the tests together. The multi-meter ought to transmit a tone (Note: Not all multi-meters have a continuity setting, yet most should). This shows that a limited quantity of current is permitted to stream without obstruction (or if nothing else a minuscule opposition) between tests.

Caution! As a rule, turn OFF the framework before checking for progression. On a breadboard that is not fueled, use the tests to punch at two disconnect ground pins. You ought to hear a tone showing that they are associated. Jab the tests from the VCC nail to a microcontroller to VCC on your capacity flexibly. It ought to emanate a tone showing that force is allowed to spill out of the VCC pin to the miniature. On the off chance that it doesn't produce a tone, at that point you can start to follow the course that copper follow takes and tell if there are breaks in the line, wire, breadboard, or PCB. Continuity is an extraordinary method to test if two SMD pins are contacting. On the off chance that your eyes can't see it, the multi-meter is normally an incredible second testing asset.

At the point when a framework isn't working, progression is one more thing

to help investigate the framework. Here are the means to take:

1. If the framework is on, cautiously check VCC and GND with the voltage setting to ensure the voltage is the right level. In the case that the 5V framework is running at 4.2V a proper check should be done on your controller cautiously, it could be a case of hot demonstrating the framework is pulling an excess of voltage.
2. Power the framework down and check coherence among VCC and GND. In the event that there is continuity (in the event that you hear a blare), at that point you have a short some place.
3. Power the framework down. With rationality, watch that VCC and GND are correctly wired to the pins on the microcontroller and different gadgets. The framework might be fueling up, yet the individual ICs might be wired wrong.
4. Assuming you can get the microcontroller running, saved the multi-meter, and proceed onward to sequential troubleshooting or utilize a rationale analyzer to investigate the digital signals.

Chapter Seven

continuity and huge capacitors:

During ordinary investigating. you will be examining for coherence among ground and the VCC rail. This is a decent once-over to make sure everything seems ok before driving up a model to ensure there is certifiably not a short on the force framework. In any case, don't be amazed in the event that you hear a short 'blare!' while examining. This is on the grounds that there is regularly critical measures of capacitance on the force framework. The multi-meter is searching for exceptionally low protection from check whether two focuses are associated. Capacitors will act like a short for a brief instant until they top off with energy, and afterward act like an open association. In this way, you will hear a short blare and afterward nothing. That is alright, it's

simply the covers energizing.

Changing the Fuse One of the most well-known mix-ups with another multi-meter is to gauge current on a bread load up by testing from VCC to GND (terrible!). This will promptly short capacity to ground through the multi-meter causing the bread load up power flexibly to brown out. As the current hurries through the multi-meter, the interior wire will warm up and afterward wear out as 200mA moves through it. It will occur in a brief instant and with no genuine discernible or physical sign that something isn't right.

Goodness, that was perfect. Presently what? Well first, recollect that estimating current is done in arrangement (intrude on the VCC line to the breadboard or microcontroller to quantify current). On the off chance that you attempt to quantify the current with a blown circuit, you'll presumably see that the meter peruses '0.00' and that the framework doesn't turn on like it should when you connect the multi-meter. This is on the grounds that the inward wire is broken and goes about as a torn wire or open. Try not to stress, this happens constantly, and it costs about \$1 to fix. To change the breaker, locate your helpful dandy small screw driver, and begin taking out screws. The SparkFun DMM is quite simple to pull separated. Start by eliminating the battery plate and the battery.



Next, eliminate the two screws holding up behind the battery plate.



Lift the substance of the multi-meter marginally.



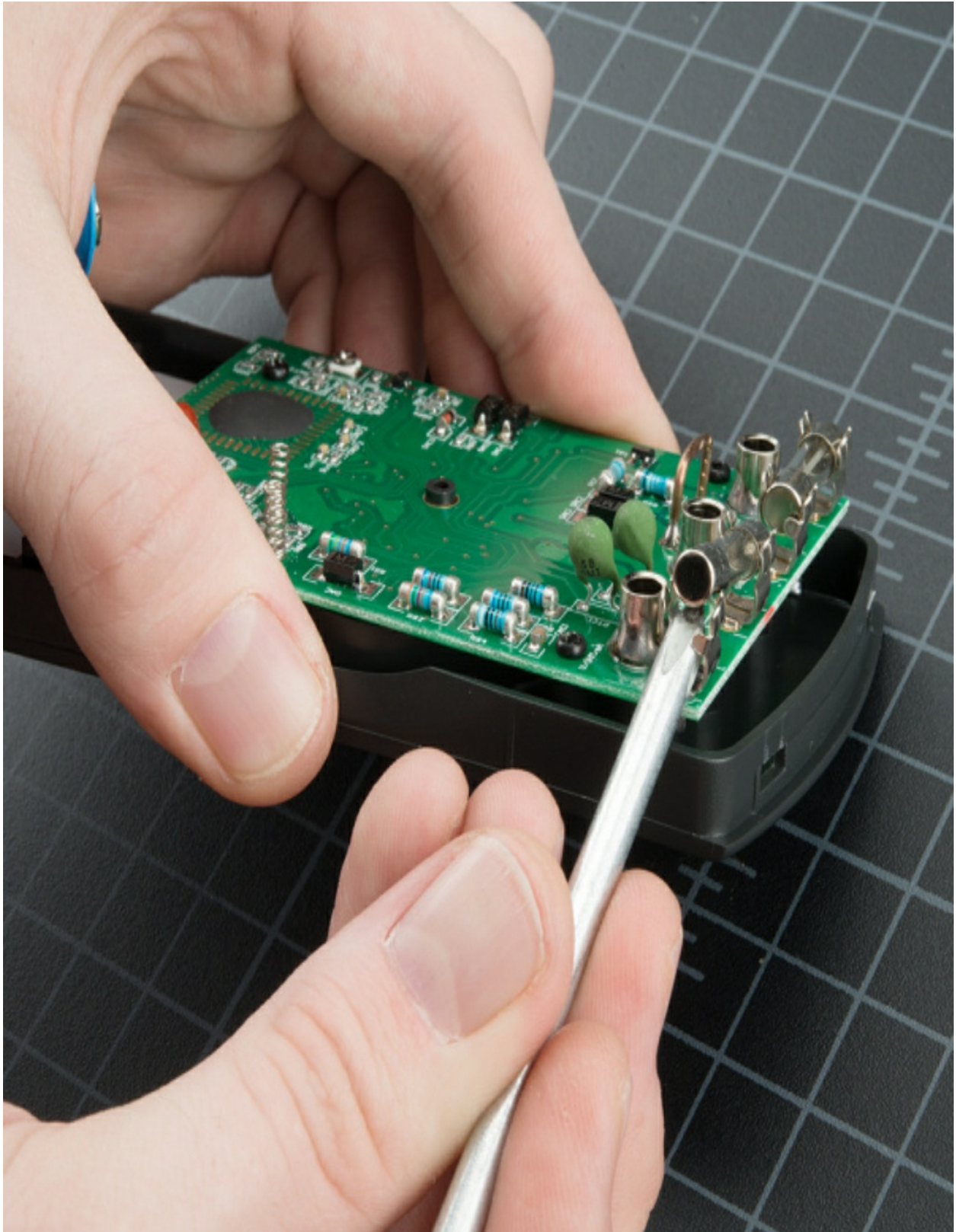
Presently notice the snares on the base edge of the face. You should slide the face sideways with a little power to separate these hooks.



When the face is unfastened, it should come out without any problem. Presently you can see inside the multi-meter!



Delicately lift up on the circuit, and it will jump out.



Try to supplant the right circuit with the right kind. As it were, supplant the

200mA wire with a 200mA fuse.

Caution! Try not to put a 10A wire where a 200mA circuit ought to go. The arrangement of the breakers may not coordinate the position of the test ports. Peruse the metal cap on either end of the wire to twofold check which will be which. The parts and PCB follows inside the multi-meter are intended to take various measures of current. You will harm and conceivably ruin your multi-meter on the off chance that you incidentally push 5A through the 200mA port.

There are times where you have to gauge high current gadgets like an engine or warming component. Do you see the two spots to put the red test on the facade of the multi-meter? 10A on the left hand and mAV Ω on the right hand? On the off chance that you attempt to gauge more than 200mA on the mAV Ω port you risk blowing the circuit. In any case, on the off chance that you utilize the 10A port to quantify current, you run a much lower danger of blowing the circuit. The compromise is affectability. As we discussed above, by utilizing the 10A port and handle setting, you might have the option to peruse down to 0.01A or 10mA. The majority of my frameworks utilize more than 10mA so the 10A setting and port functions admirably enough. In case you're attempting to gauge extremely low force (miniature or nano amps) the 200mA port with the 2mA, 200uA, or 20uA could be what you need.



Keep in mind: If your framework can possibly utilize more than 100mA you should begin with the red test connected to the 10A port and 10A handle setting.

With sub \$50 digital multi-meters, the estimations you are probably going to take are simply investigating readings, not logical trial results. In the event that you truly need to perceive how the IC utilizes current or voltage after some time, utilize an Agilent or other excellent seat unit. These units have higher exactness and offer a wide scope of extravagant capacities (some incorporate Tetris!). **Bunnie** Huang, equipment architect behind **Chumby**,

utilizes high-exactness current readings to investigate sheets during the last testing strategies of a **Chumby**. By taking a gander at the current utilization of various sheets that have fizzled (for instance a given bombed board utilizes 210mA over the ordinary), he could distinguish what wasn't right with the board (when the RAM comes up short, it by and large uses 210mA over typical). By pinpointing what might be possibly off-base, the modify and fix of sheets is made a lot simpler.

Chapter Eight

What make up a Good Digital Multi-meter?

Everybody has their preference, however as a rule multi-meters that have progression are liked. Each and every other element is simply good to beat all.



There are extravagant multi-meters that are **auto-ranging**, which means they

naturally change their inside range to endeavor to locate the right voltage, obstruction, or current of the thing you're jabbing at. Auto-extending can be extremely useful in the event that you realize how to utilize it. As a rule, auto-ranging multi-meters are higher caliber and by and large have more highlights. So in the event that somebody gives you a multi-meter with auto-extend, put it to utilize! Simply realize how to get it into manual mode. A circuit's voltage or current can change rapidly. With a portion of the frameworks, the current or voltage is inconsistent to the point that the auto-go can't keep up reasonably.

An illuminated LCD is extravagant, yet when was the last time you estimated your circuit in obscurity? We for the most part avoid alarming woods and circumstances that expect us to test stuff in the night, however a few people may need or need a dim benevolent multi-meter.

A decent snap on the range selector is really a significant in addition to in our book. A delicate handle is normally demonstrative of a disgraceful meter.

Fair tests are an or more. After some time the leads will in general separate at the flex point. We've seen wires come totally out of tests - and it's consistently right now you need the tests to work! In the event that you do break a test, they are sensibly modest to supplant.

Auto-off is an extraordinary component that is once in a while observed on less expensive multi-meters. This is a component that can profit amateurs and progressed clients the same, as it's anything but difficult to neglect to kill the meter at 2AM. The SparkFun advanced multi-meter doesn't have this component, however fortunately the meter is exceptionally low-power. We've left the multi-meter for two days in a row before the 9V battery started to get low. All things considered, remember to kill your meter!

You're presently prepared to utilize your digital multi-meter to begin estimating your general surroundings. Don't hesitate to begin utilizing it to respond to numerous inquiries. I accept my LED is getting 20mA, is it truly? What amount of voltage does a lemon have? Is a glass of water conductive? Would i be able to utilize aluminum foil to supplant these wires? An advanced multi-meter will answer these and a lot more inquiries concerning hardware