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Bench Power Supply

Introduction

After some fooling around with batteries every hobbyist should think seriously investing into a decent power supply . You could buy one of course but if you would be a lot more rewarding to build your own and save yourself a bundle . Aside from saving a lot of money , you will also get to know what is inside your supply and be able to service it if anything goes wrong down the road .

Within the following descriptions of the power supply , you will be able to chose many options available to upgrade your project into a really versatile high precision instrument , such as a variable voltage output , presettable digitally selectable voltages , a current limiting function , digital LCD or LED read outs , or just a basic accurate power supply .

The Basic Circuit

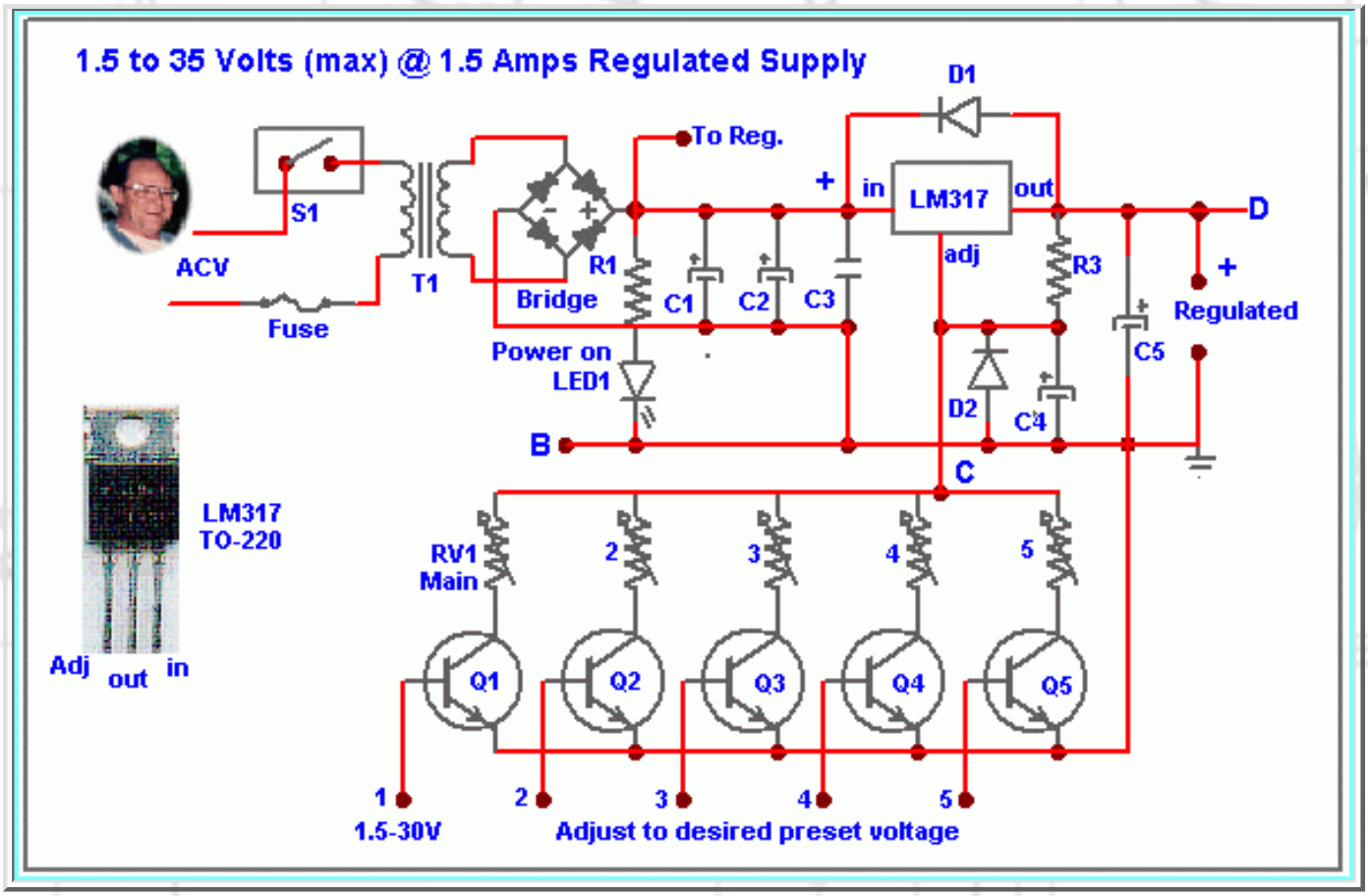
The circuit shown below is the basic variable supply using the LM317 adjustable regulator with RV1 being the main adjustable element to produce a regulated voltage output from 1.2 volts to a maximum of 37 volts at 1.5 amp current when used with a heatsink .

- If only the basic supply will be build , then, use only RV1 and connect it directly to ground marked "B " . But you migh still be interested into using the LCD readouts and current limiting function as described further , so read on .

With the additional components RV2 to RV5 and Q1 to Q5 we expand the one variable function privided by RV1 into four additional switchable preset voltage range for for fast highly accurate selectable voltage outputs .

You are going to ask "why don't we do away with Q2 - Q5 and connect the trimmers directly to the switch" Well we want precision and we cannot guaranty the switch contacts will not eventually build up resistance and affect the trimmer setting . By using transistors we can be assured that the setting will not drift even if the transistor base voltage from the switch may drift a few milivolts . You can omit the transistors if you wish but they are essential for the proper function of the push button circuit .

A list of parts is availble for your requirement to be selected depending on your application of the project . All transistors used are the 2N2222 or 2N3904 or equivalent NPN type .

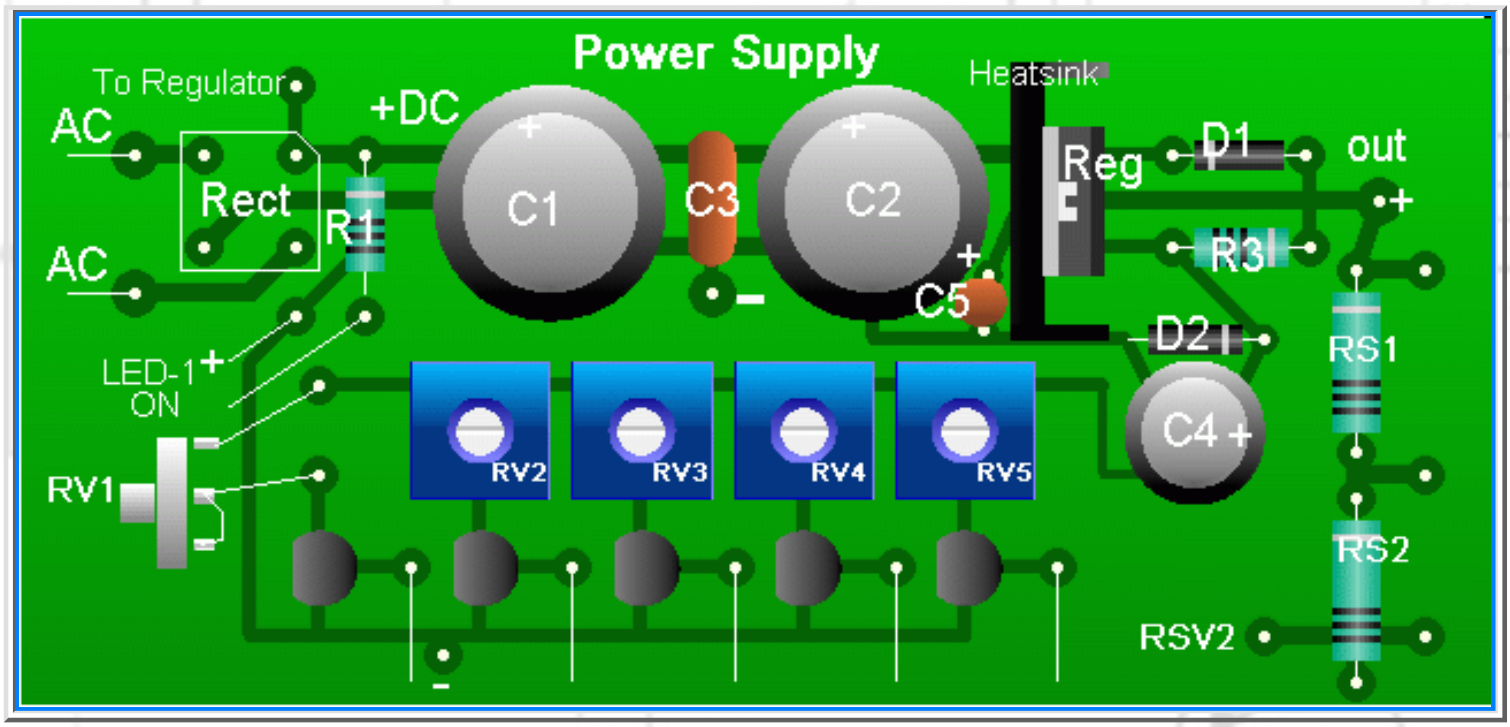


Options

The Transformer :

- The LM317 will regulate a voltage to a maximum of 37 volts under load and needs at least 1.5 volts above the required regulated voltage , based on this you must use a transformer which will output the required voltage and at a current output to meet your requirements . A center tapped or two wires output transformer may be used.
- The rectifier bridge may be substituted with four single rectifier diodes . If you are in doubt about this please go to Introduction for more informations on this subject .
- As shown on the Layout RS1 and RS2 are precision resistors used as shunts for the Current meter if used , if not , they can be omitted and the voltage output taken directly from the " OUT " position pad .
- Since the LM317 has built in overcurrent shut down function the Fuse may be optional but it is a wise investment .
- The Heatsink used is a vertical type , the larger you can fit , you can buy or make your own using 1/8" thick copper or aluminum plate about 1.5" square bolted to the regulator , no other support should be required .

The Circuit Layout (Enlarged)



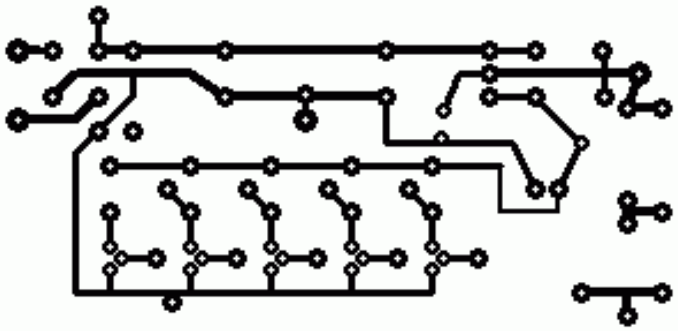
Parts list and actual size of PCB suggested layout

Power Supply Parts list

Fuse = Fast blow 1.75 amps
T1 = See text
Bridge or diodes = 50 V / 2 amps
Regulator = LM317 TO-220 with Heatsink
C1, C2 = 2000uF / 50 V
C3 = .1uF/ 50V
C4 = 10uF / 50V
C5 = 1.uF / 50V (Tantalum)
D1 , D2 = 1N4002
R1 = 2.7K 1/4w
R3 = 240 ohms 1/4w
LED 1-6 = Small , any colour
RV1 = 5K 1/2w (Main Control)
S1 = Miniature SPST 120V/ 3A
S2 = DP5P rotary switch (See text)

Sample setting of RV2-RV5

Volts	Trimmer		Fix Value
3V	RV2	500	320
5V	RV3	1k	700
9V	RV4	2k	1.45K
12V	RV5	3k	2K



Presettable Switching

Two methods are shown for presettable switching . One uses a rotary one pole 5 positions switch as shown below and the other using a single push button triggering a CMOS 4017 decade counter wich in turn activates in rotation the transistor to enable the selected voltage output .

- For both mode of switching a fixed supply voltage is required for the base of the transitors , the 4017 and the optional LEDs indicators which are used to indicate which voltage is selected .
- For that purpose a reguator is used as shown and the supply source is taken directly from the output of the rectifier bridge . The regulator can be a small TO-92 9 or 12 volts /100 mA or a zener type shown as an option .

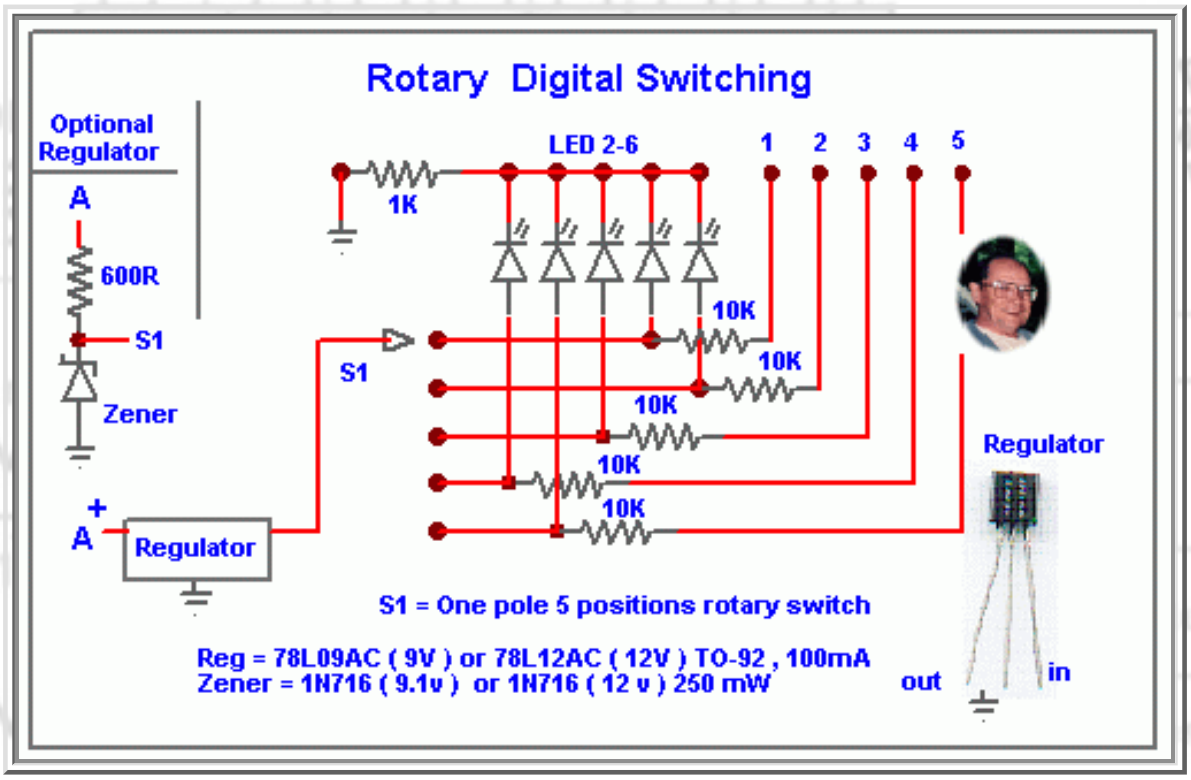
- Using the single push button method , the LEDs will be necessary to indicate which voltage range is in use and should be mounted on the panel face . The LEDs can be connected to the main board with multicoloured ribbon wires for easy tracing and indentification . Of course if digital read out are used the LEDs may be omitted .
- When using the rotary switch the LEDs can be omitted and the panel can be lettered indicating the switch position and the voltage output .
- For easy identification , again , coloured ribbon wires is suggested for connections from the 4017 or the panel mounted rotary switch to the bases of each transistors .

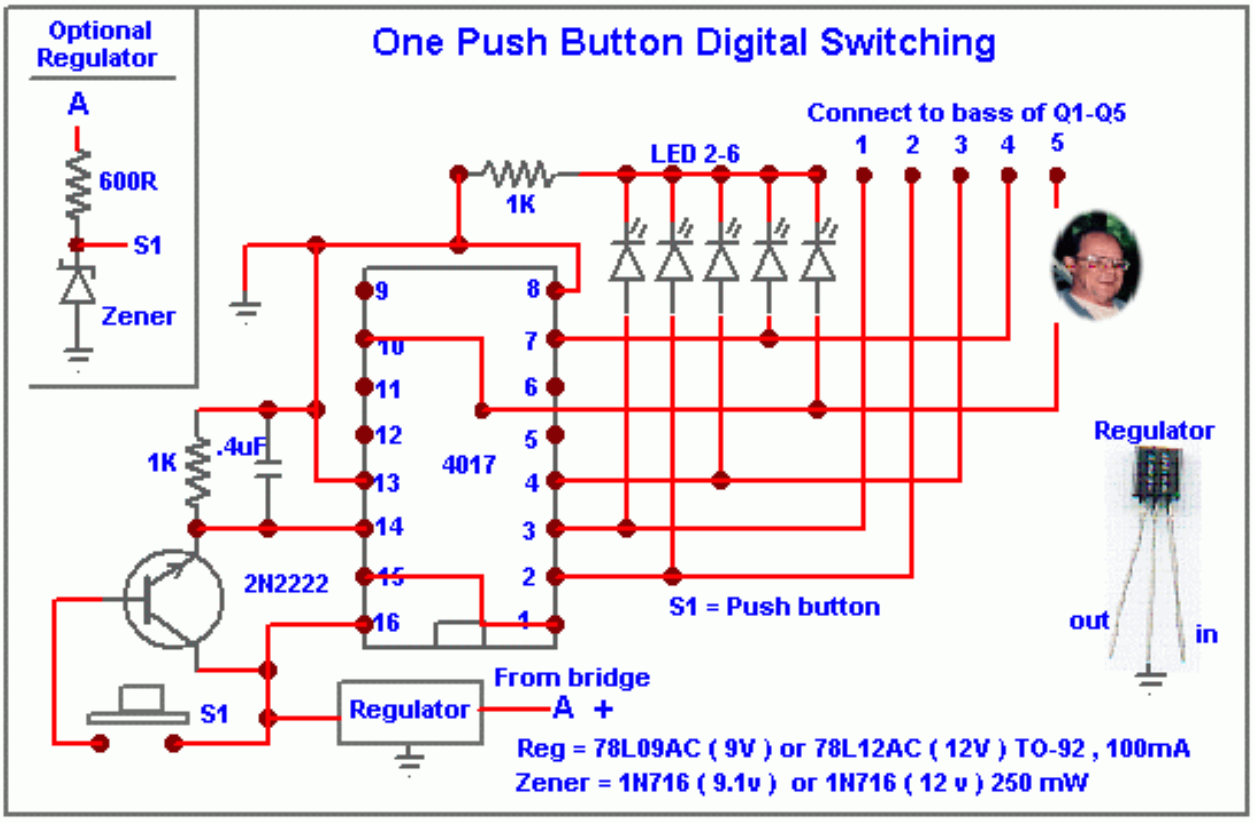
Calibration

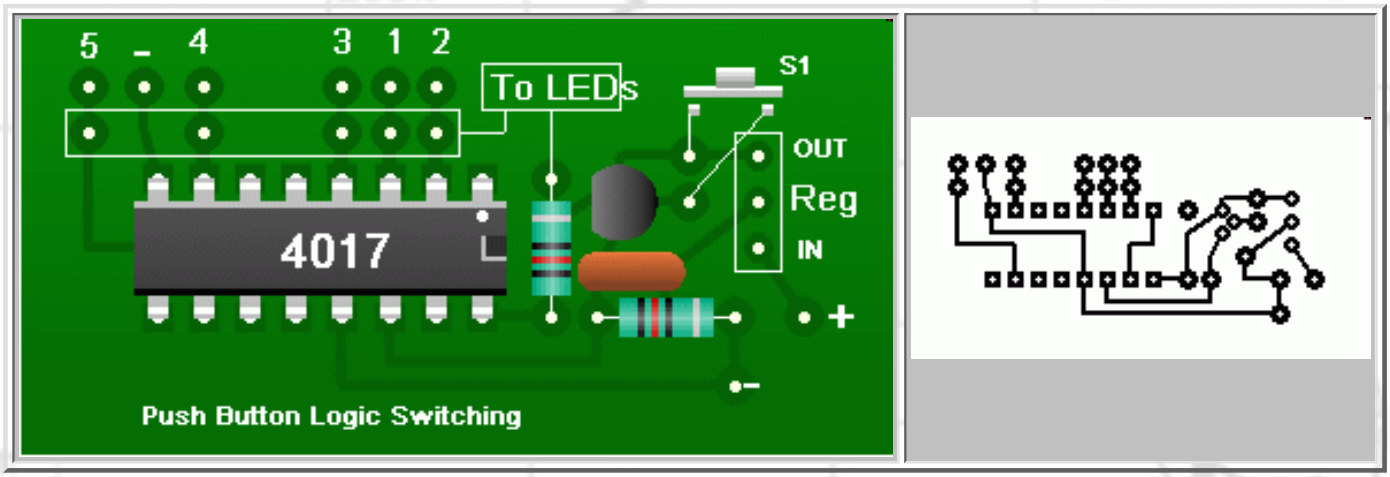
Once the circuit is assembled , select the main RV1 position and set RV1 to its minimum , connect a voltmeter between ground and the positive of the rectifier output and apply power . Note the voltage output , it must be higher by at least 1.5 volts than the ***expected*** maximum regulated voltage output .

Move your meter connections to the regulated voltage output position , the reading should be 1.2 to 1.5 volts , rotate RV1 slowly toward its maximum setting and ensure the voltage increases to its maximum ***expected*** voltage , If so all is well . If not go over all your connections , capacitors and diode polarity connections as well as the regulator pins connections , see the LM317 connections on the diagram .

Once you have confirmed that the main control RV1 is producing a variable voltage output , it is time to calibrate the other selections . Using your ohmmeter across each trimmer from RV2 to RV5 , adjust the trimmer to indicate the sample resistance value for each corresponding voltage shown on the part list .
Connect your voltmeter to the output , power up and select each position in turn and read the voltage output , it should be very close to the corresponding sample voltage output listed . Adjust each trimmer for the precise listed sample , or you can adjust to any other voltage you chose . While you're at it , confirm that the LED is on and indicate the proper position , if not , do a tracing and adjust connection as required .







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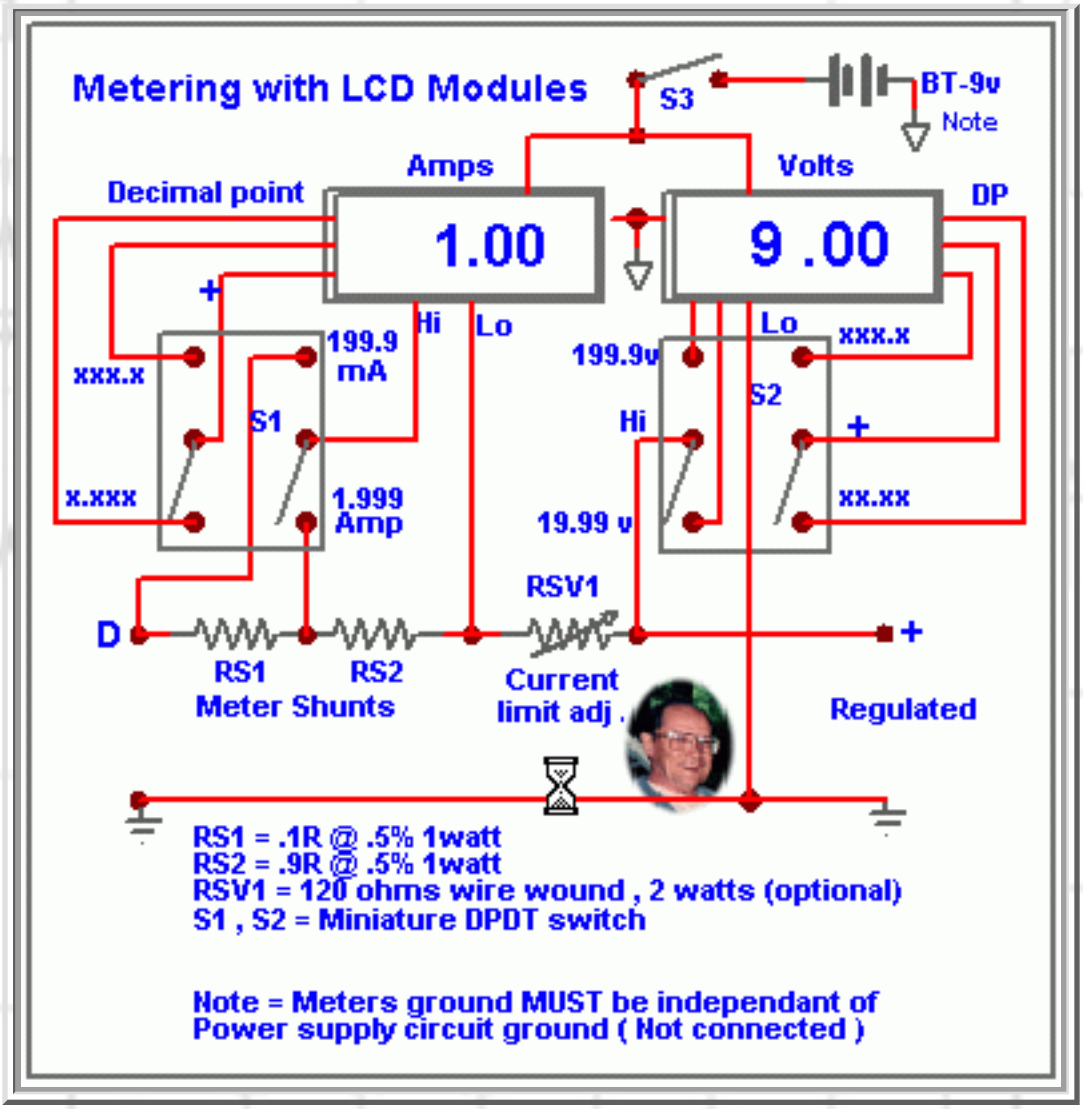
Page Two

Shunts , Current limiting , Digital panel meters

The drawing below shows all the elements required to be added to the main power supply circuit previously described to enable us to control the current and display voltage and current .

The two shunts RS1 and RS2 are two high precision (0.5%) resistances used to by-pass most of the current flow from the digital voltage display to obtain two ranges , 0 to 199.9 mA and 0 to 1.999 A by measuring the voltage drop across the selected shunts . Switch S1 , a miniature DPDT switch , is wired on one side to select the range to the inputs normally labelled " HI and LO " of the digital module and the other side to select the decimal point setting of the display .
On my power supply , I invested a little more money by using two miniature 3 poles 2 positions switches and connected small LEDs indicating low (red) and high range (green) that can easily seen at a glance .

S2 is used for voltage ranging in the same manner with the exception that the voltage is measured across from positive to the negative regulated voltge output and after the current limiting variable resistor (RSV1) if use . Two voltage ranges are used ,0 to 19.99 volts and 0 to 199.0 volts .
Some module do not include voltage dividing resistors for range selection and additional resistances need to be connected externally to achieve the proper range . If this is required read the instructions in the section titled Metering a power supply for voltage dividing methods and resistance values .



- 3-1/2 Digit LCD voltmeter modules are readily available at very reasonable cost , the larger the module the higher the cost and a size 2-1/2" by 1" module will be easy to read a fair distance . If possible obtain all the information about available functions on board before you select one .
- Most LCD modules are powered by a " floating " supply , that means that an independant supply source must be used and NO connection is permitted to any other part of the circuit from which you take input measurements . Usually a single 9 volts battery will do the job for the two modules and will last a long time . Just make sure that the ON/OFF function is either made with a single switch or to one side of a DPDT switch substituted for S1 used for the main board as listed in the parts list .
- A few LCD modules use a 5 volts common supply at a slightlty higher cost . it means that the module negative supply should be connected to the common supply ground . It is convenient that a single small 5 volts regulator can be used to power the modules and the power source can be taken from the rectifier output .
- LED digital modules can also be used and ususally have also a common ground connection but they do require a much higher current source and a regulator to match . Bear in mind that with all LED segments on the current may exceed a 100mA rating regulator and a TO-220 -1.5A regulator must be used for both

modules current source .

Where to get digital modules

In Canada on the west coast , you can order different sizes modules from RPE Electronics at a very reasonable cost starting at $Can 16.95 ($ US 11.61) for the smallest one , they have a good selection of LCD and LED modules with or without common supply application .

In the USA Digi-key is the place to order from if you do not have a local source .

Adjusting current limit

- The LM317 regulator has good over current shut down protection to protect the power supply , BUT, your projects under test have no protection and the possibility of a failed smoke test when turning on power could be catastrophic resulting in a heart breaking if not expensive experience . Knowing what the estimated amount of current required to power your project under test , it would be very reassuring to know that your current source is limited to approximatly and only a few addtional miliamps. You could safely determine by the amount of current flow indicated on your current meter that if it is excessive then something is not right and indicate a faulty or shorted circuit but without total destruction of the circuit under test .

- RCV1 is used to set the current limit at any voltage to a load from your power supply . I could not be without one . I have installed a 5 watts wire wound variable resistor and since most of my projects use less than 100 miliamps up to about 12 volts the current limit is set to that amount of current . For other applications requring more current I simply increase the current to the maximum required amount for that application up to the maximum capability of the power supply . At that point I can determine if more current is required in excess of the power supply .
- To set the current limit it is only required to select a voltage and short the output of power supply then adjust the current limit with RCV1. But this is not a safe and good way to do this , and I always use a load across the output for that setting .
- Not shown on the circuit , you might want to install as I have on my power supply and additional normally open push button rated at 3 amps which is connected in series with a 30 ohms 10 watts (square ohms type) between the positive and negative output of the power supply . When the voltage selected is 30 volts the current flow will be one amp , so by pressing the button momentarely I simply adjust

for the required current limit then release the button .
At 30 volts setting the current limit set at one amps will then be 700 mA @ 20 v , 500mA @ 15 v , 300mA @ 9v and so on , so I have no fear of facing any disaster. This is only one setting exemple and in most cases should be set at a lower level . For lack of using a wire wound variable rehostat you migh want to use instead one or more high watt resistors in the same manner connected to a rotary switch to select pre-fixed current limit settings . Select at least 10 watts resistances by dividing voltage by the current required .

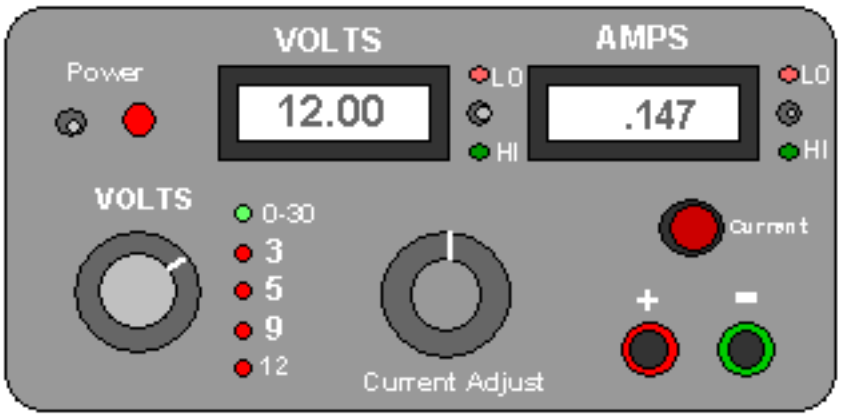
Other uses for a current limting function are batteries charging , small DC motor testing , voltage and current reference source and endless unmentioned tasks .

To charge batteries , simply select the required charging voltage , press the button and adjust maximum charging current indicated on the battery under charge and power on . The current meter will indicate the charging current and gradually diminish to zero indicating that the battery or batteries ***in parallel*** are fully charged .

Power supply enclosure

Select a sturdy plastic enclosure large enough to accomodate your transformer and PCB or wired circuits with separate removable cover and face plate . The face plate should be large enough to accomodate the displays modules and all the controls . In addition to the parts listed , you may want to install LEDs . You will also require two output plugs one red (+) one balck or green (-) , a power cable , colour ribbon wires , some dry transfer lettering for functions identification . For a good job protecting the lettering a few ligh spray over the front panel with a flat clear finish and the total cost should be les than $75.00 in any currencies this is well below the purchase price of a comparable commercial power supply , better quality , and the pride of your efforts .

Your power supply could look like this



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