Low Voltage Drop PS

By G8MNY (Updated Jan 13)
(8 Bit ASCII graphics use code page 437 or 850, Terminal Font)

Here are some principles to design your own low power 12V equipment PS that can also run on recharged internal battery or external 12V with very little voltage loss. Special low drop out voltage regulator ICs are made for this aplication, but not in most people's junk box!

```
    External +12V >──o   fuse
    ┌──────┬───┬─────o<──o-o┬───────┬────┐ PNP ┌───────┬───┬────┬─>+12V to
   /+\     │  _│_   ┌─o      │       │     \e  /T3      │   │    │  equipment
  /     \   │  \_/  │        │       │    ──────     C3│   │    │  @ design
~\ B1  /~  │  D1│   │        │       │    6mA│I/HFE3  ===   │2mA │  current.
   \-/     │    │   │        │       │       │       47u│  3k3   │  e.g. 300mA
    │      │   │   │       _│_      ├───────)───┐      │  R4    │
    │     +│   100 │    D2 /_\     10k      │   │      │   │   +│
    │    ===  R1  │        │      R2       │   │      │   │   ===C4
    │ 1000u│   ├───┘        │     .6mA│   T1│/     \│T2   │  Set   │100u
    │    C1│  ─┴─ 12V       │       ├─────┤NPN NPN├────┴─>12V   │
    │      │   ┬ Battery    │   ┌───┤ 60uA│\e   e/│60uA   1k    │
    │      │   │            │ C2│+          └─┬─┘          │    │
    │      │   │            │  ===  _│_ Z1     │ 5.5V      3k3   │
    │      │   │            │ 10u│  /_\'6V    1k          R5    │
    │      │   │            │   │   │         R3          │    │
    └──────┴───┴────────────┴───┴───┴─────────┴───────────┴────┴─>-ve
                                  HFE1/2 = 100, HFE3 ¸ 50
```

PRINCIPLE OF OPERATION
Bridge B1 rectifies the un-shown transformer secondary & feed current to C1, this charges up the peak voltage (AC off load x 1.4). This voltage is also fed via D1 & R1 to charge the internal battery (use a charging regulator system if battery is a lead acid type!) so R1 determines the charge current!

The 3 way switch then selects the power source for the kit regulator. Diode D2 the fuse protect against reverse external voltage without the voltage loss that a series diode would insert.

The regulator consists of only 3 transistors, 2 low current NPNs (e.g. BC 108) & a PNP on a heatsink. It is the low voltage drop of the single PNP T3, that enables this design to give around only a 100mV drop at 300mA when fed with DC less than the ideal e.g. under normal battery conditions. For the lowest voltage drop use a high current PNP, possibly an old Ge type or even an FET design. The 2 NPNs T1 & T2 from a long tail pair with little thermal drift.

On turn on R2 charges up C2 until zener Z1 conducts at 6V. T1 turns on & passes the emitter current (5.5V across R3) into T3's base. The value of R3 determines the peak current of the output & needs to pass slightly more than the load current divided by the current gain (HFE3) of T3 as the gains often drop at higher current. Note that this current limit is independ of the supply rail unlike some designs. T3 conducting charges up output filter C4 until the sample fed into T2 base from R4/R5 & preset pot reaches 6V. When this happens T2 takes a proportion if the emitter current in R3 to maintain the 6V.

For proper voltage stabilisation T1 & T2 base currents, must not affect either the zener Z1 voltage (unlikely as zener is low Z & has 10x that current in it), or the potential divider voltage, so this arm has 30x the T2 base current in it for good measure. C3 is also included to bypass the potential divider with any output ripple & feed it straight back to T2. With the zener Z1 also hum bypassed with C2 there should be very little hum.

PSU DESIGN CONSIDERATIONS
AC
The transformer needed is 15-18V @ 1.5 x load current you need. A very low current slow blow mains fuse of is recommended for best protection.

The bridge needs to handle the high current pulses, all silicon diodes easily do this with a typical peak rating 40 x the RMS rating.

The value of C1 needs to be big enough to store the half cycle (100Hz) voltage at the load current without dropping below the minimum regulator drop out voltage. So say a peak voltage of 22.5V gives 10V drop before we are in trouble with this design. Now knowing that a 1F cap drops 1V/S @ a 1A load (defintion of 1F), then for 1/3A @ 100Hz & 10V p-p drop we need a C of at least..

```
       1 Farad 10^6                 1,000,000
  --------------------------   =   -------------- = 333 uF
  Amps x Ripple Freq x Volts       1/3 x 100 x 10
```

That is 22V peak on load! or possibly 30V off load or 22V RMS! You can see were we are heading, the more C you use the less over headroom you need & the cooler & more efficient the PSU.

```
    .---._  333uF   .---. ------22.5V
   /     \~-._     /     \ 10V Ripple          _._.__1000uF  _._  .....16V
  |22V RMS|   ~-._|       | _____12.5V       .'15V`. ~~--_..'   `. ___12.5v
 |   OFF   |     |         |-----<Drop      /RMS OFF\     /       \----Drop
|    LOAD   |   |           |     out?     |  LOAD   |   |         |   out
   H O T  R E G U L A T O R              C O O L   R E G U L A T O R
```

The 1000uF chosen gives only a 3V p-p ripple, & therefore only about 16V peak on load is needed, or 18V off load so a 15V transformer should do OK.

The above example assumes no low mains, no transformer or, added diode losses, capacitor values are what they actually are etc.

Why Don't U send an interesting bul?

73 De John, G8MNY @ GB7CIP