Operating 24 volt Equipment in a 12 volt Vehicle

Simon Dabbs, G4GFN

I am the proud owner of a 1975 ex-British Army series 3, short wheel-base Land-Rover. I am a little puzzled as to its history. It has an antenna mast bearer on each side. It has a 35 amp 12 volt alternator and two 12 volt batteries, connected in parallel. Its ignition system has no anti-interference screening. So the question is this; was it ever a "Fitted for Radio" (FFR) vehicle? Probably not, as its Army data plate makes no mention of FFR. I suspect that the reason for the extra battery was that a previous owner (there are many!) had fitted it as an auxiliary battery for a caravan.

I toyed with the idea of converting the vehicle to 24v operation, but the cost of changing the alternator, starter motor, coil, windscreen wiper motor, heater blower motor, etc. soon put me off. Besides, I have 12v gear as well as 24v gear, so I decided it would probably be best to leave it as a 12v negative earth Land-Rover. It also makes it easier to find someone who can give you a jump-lead start, if you need one!

It occurred to me, of course, to obtain 24v from the two existing batteries by having an arrangement whereby they could be switched to be connected in series whenever 24v was required. Older Land-Rovers, however, are notoriously bad starters in cold or damp weather, so I decided it would be best to have the batteries in parallel at all times for maximum oomph when starting.

Ideas

So, how to get a 24v supply in a 12v vehicle? I obtained a rather nice 20 Amp-hour 12v gel battery (ex computer UPS) at Cold Ash car boot sale. This I mounted in the rear cabin of the Land-Rover, where I have my folding radio operator's table. With its negative terminal connected to the +12v rail of the vehicle, the positive terminal of the gel battery gives me +24v when operating. When the vehicle is on the move, a switch enables the gel battery to be connected across the vehicle supply for charging, with a hefty diode to prevent discharging when in this mode, and a 1 ohm resistor in series to limit the charging current in-rush.

The greediest 24v set I envisage using from the vehicle is my SR C13 transceiver, which draws up to 6 amps on transmit, and around 2 amps on receive. I realised that it would be nice to have a method of topping up the gel battery during prolonged periods of operation. What I needed to develop was a way of producing a "floating" 12v supply, which I could feed into the gel battery; i.e., this supply needs to provide 12v to the gel battery, but it must not be earthed, as of course the gel battery is not operating at earth potential.

Development

I needed to develop a 12vdc to 12vdc inverter. The key to this was to find a transformer with a 12-0-12 winding to use as the primary and an independent winding of a little over 12v as the secondary. By coincidence, a suitable transformer also turned up at Cold Ash in the form of a "Universal Low Voltage Transformer" by RS. As well as various mains voltage windings, which I didn't use, it had two windings of 10v at 4.5 amps, which would serve as the primary. As a secondary I would make use of a multitude of windings, configurable to any voltage between 10 and 19v in 1v increments, at 5 amps –ideal!

An inverter was built, based on the simple 50Hz (nominal) multivibrator circuit I used in my earlier article about replacing the rotary converter in a 62 set. This time, I introduced extra BFY51 transistors, configured to form Darlingtons with the 2N3055 power transistors, for extra power.

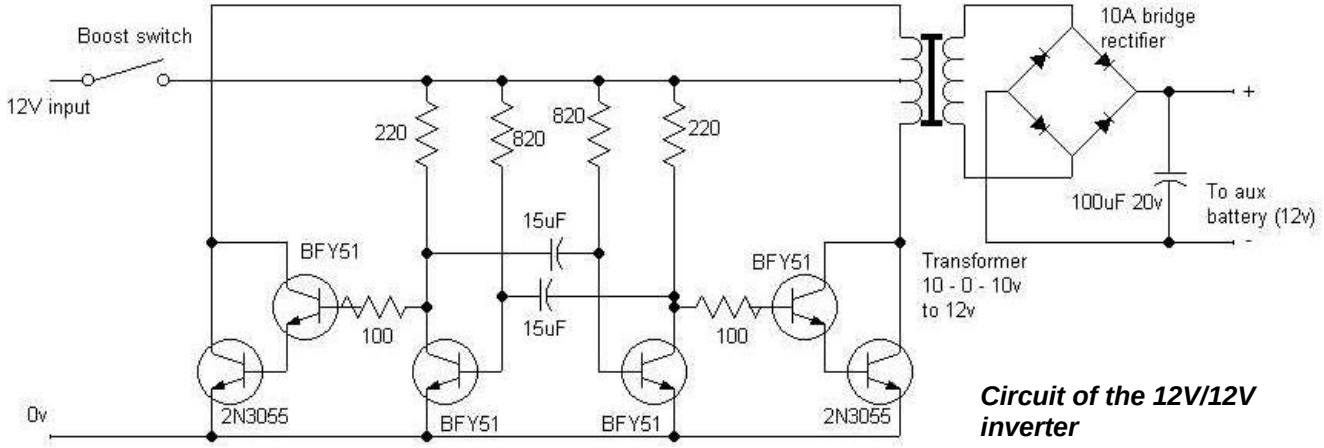
On the test bench, the 12v to 12v inverter was able to produce 13.5vdc at up to 5 amps into a test load lamp.

Voltage Stabilization

I had planned to build an inverter to produce about 16v at 5A, so that this could then be regulated down to 13.8v, to avoid the danger of over-charging the gel battery. Unfortunately, my inverter proved incapable of delivering sufficient overvoltage at the required current to make this possible.

Perhaps a better way to do it would be to use an op-amp as a voltage comparator and an optically coupled arrangement to turn on or off the multivibrator circuit in the inverter. This is for the future.

(left) Simon operating from the Landrover



Circuit of the 12V/12V inverter

Installation and Testing

The multivibrator was constructed on a piece of Veroboard and mounted in a fairly large die-cast box, together with the transformer and other components. A heat sink was mounted on the outside of this and onto this the 2N3055's were mounted, using insulating kits and a smear of heat sink compound. The unit was then carefully wired up.

The gel battery and inverter unit were mounted in a compartment of the Rover near the operating position (where a sturdy 12v vehicle supply had been brought in from the main batteries in the engine bay using 50 amp cable).

The output of the inverter was wired directly to the gel battery. The series/parallel discharge/charge switch was mounted at the operating position, as was the inverter on/off "boost" switch. Terminals were installed at the operating position for 0 volts (earth), +12 volts, and +24 volts.

The C13 (on dummy load) was used as a test load. With the engine running at 1500 rpm, and the boost inverter switched off, the 12v line was 14.0volts and the 24v line 26.5 volts on receive and 26.0 volts on transmit.

The engine was turned off and the C13 receiver was kept running for 30 minutes.The voltage had dropped to 24.2v.

The engine was started. The 12v line came up to 14V and the 24v line to 26.1v. At this stage the boost inverter was switched on. The 24v line came up to 27.6v and remained there for about 10 minutes. It then started to rise quite rapidly and I switched off the booster when it reached 28 volts.

Conclusions

I am pleased with the performance of the system so far. With a mean output capability of about 4 amps, it should be capable of maintaining a proper voltage across the gel battery indefinitely, when running the C13, given a typical transmit/receive duty cycle.

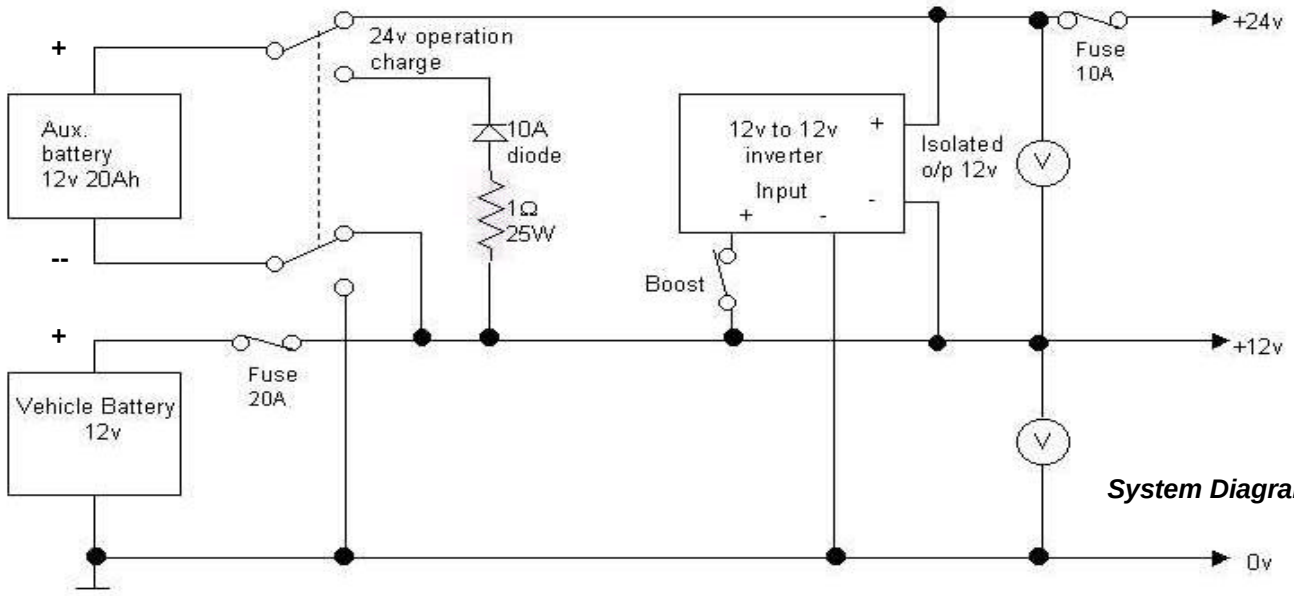
Close monitoring of the auxiliary battery's voltage is necessary to avoid overcharging. It is hoped to automate control of the inverter booster circuit at a later date.

Postscript

As I write this during the Advent Season, I notice Maplins are running a Christmas offer of a 300W 12vdc to 230vac inverter for a very respectable £29.99. This would also be a cost-effective way to provide 24volts in a 12v vehicle; i.e. use the inverter to power a 24 volt stabilised "mains" power supply, at up to about 10 amps output. Alternatively, use the inverter to power a floating 13.8v power supply to top up a gel battery and feed current into a 24v load as per my ideas above. The advantage of this is you get more amps out at 24v for a given inverter rating, since only half the power is going through the inverter.

References

Replacing a Worn Out Rotary Converter in a 62 Set with a Solid State DC to DC Power Supply; Simon Dabbs; VMARS Newsletter 22 (April, 2002).



System Diagram