BATTERY DRIVEN MAINS AND HT CONVERTERS

PART TWO BY GEORGE KERRIDGE

FAILURES ARE MAINLY CHARGEABLE

Car batteries pack a lot of punch and can readily become a versatile power source for short mains failures.

The oscillator circuits looked at so far in part one are all suitable for use in situations where the oscillation frequency is relatively unimportant. As we have just seen such situations can arise where, for example, the end product needed is not an alternating voltage, but a very steady high voltage dc.

50HZ SUPPLY

Let's now move on to a circuit that can be used for driving low power 240Vac mains equipment and which requires an accurately controlled 50Hz frequency.

Certainly any of the oscillators shown can be set to run at 50Hz, but the accuracy with which they can be set and maintained at that frequency is less certain than it perhaps should be. Ideally, we need a very accurately controlled 50Hz source. One way is to use a crystal controlled oscillator. This can drive a sequence of sub-dividing counters, either as multiple chips, or as a chip specifically designed for this purpose.

One such readily available chip is the M706B1. (Fig.18). This is a cmos device designed for use as a 50Hz timebase. To achieve this, a 3.2768MHz crystal is connected across two of the pins, together with a couple of capacitors and a resistor. Circuitry within the chip subdivides the 3.2768MHz clock down to 50Hz. This appears at two outputs as squarewaves of opposing phase. The typical current available at the outputs is only about 7.5mA, but this can be used, via current limiting resistors, as the trigger source for controlling transistor driven transformer windings, as in Fig.8, of part one, for example. It can be operated from a power supply with a range of 7Vdc to 15Vdc.

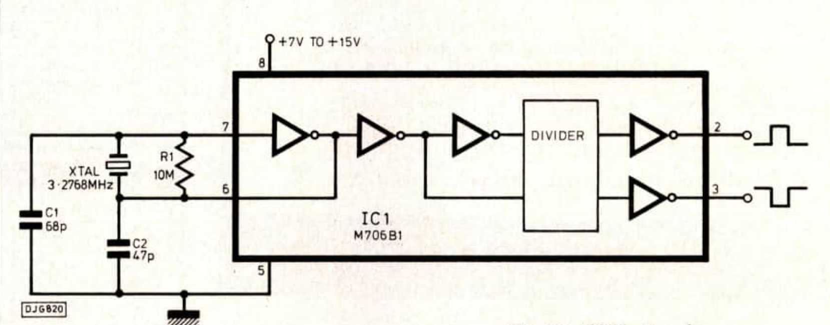

Fig.18. *50Hz timebase*

BATTERY POWER

One point that so far has not been mentioned is the amount of charge available from a battery. It is all very well having a battery to mains converter designed to deliver many amps to all the necessary equipment, but the battery power source is limited.

A battery is quoted as having a charge capacity of so many amp-hours. This means that when fully charged it can deliver that many amps for that many hours. A car battery for example may deliver 12Vdc at 40 amp hours. It should therefore be capable of supplying 12Vdc at one amp for 40 hours, or 40 amps for one hour. During this discharge time though, the voltage will not remain at precisely 12V (even if it was ever at 12V since it could have started off a volt or so higher than this when fully charged). The delivered voltage will gradually fall during use, and so the final converted ac voltage will drop accordingly.

A unit converting 12Vdc to 240Vac to run, say, a 100W lamp, will need a minimum current input to the converter of at least 8A and probably more. The light bulb will thus work for less than five hours with a 12V 40A hr battery. That is excellent for just a short power cut, but the cuts that some of us in the SE experienced in October 1987 far exceeded five hours.

Obviously there is no reasonable possibility of using a car battery to mains converter to power all the lights and other preferred household equipment. It is reasonable though, to use a dc to ac converter just for minimal power consumption for a short period of time. Limiting lamp wattage to just 15W at selected areas of the house is one possibility. (In reality, its probably better to use a car bulb powered direct from a spare car battery for many lighting situations).

Battery to mains converters are also of considerable use for perhaps powering equipment which it is vital to keep running for a short period of time. One such item is a computer, though the power requirement may be heavy. Other suitable candidates for power backup are alarm clocks, telephone answering machines, and even fish tank heaters.

This brings us to the next possibility, that of automatically switching over to a backup supply if power does fail.

CHANGEOVER

Considerable thought was given to possible circuitry for automatically switching a battery to mains converter on and off as required. Several options for the use of thyristors in changeover configurations were explored, but I eventually decided to opt for the simpler, and cheaper method of using a relay for the purpose.

Though relays suffer from a fractional time lag in switching over, they have the beauty of attaining absolute isolation of one circuit from another. Their practice

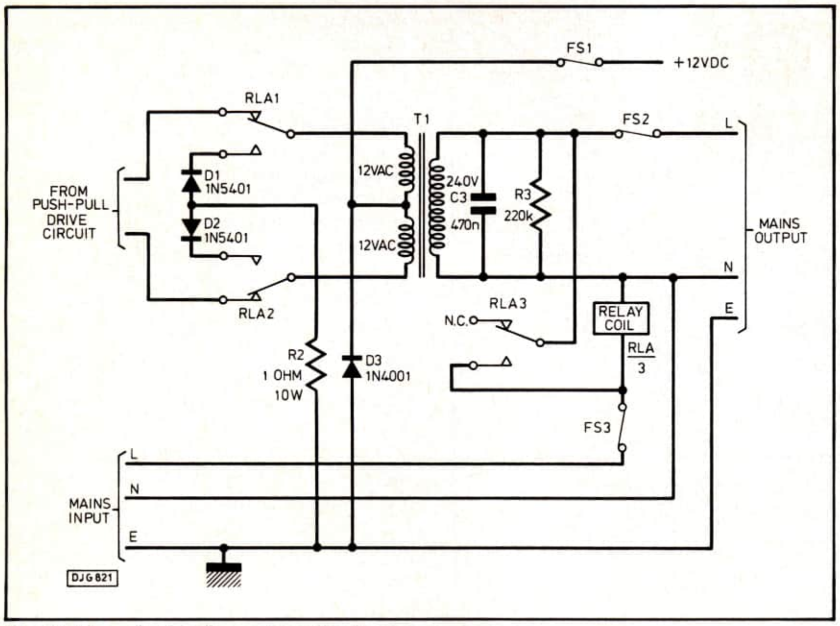

Fig.19. *Use of relay for automatic changeover operaton*

is also more readily understandable for those whose knowledge of electronics is only rudimentary.

Fig.19 shows a suggested relay changeover circuit. The relay coil is of the mains operated type, and only becomes active in the presence of mains supply current. When mains is available the relay contacts switch the live mains line to the output socket. Two other contacts switch the transformer primaries out of circuit from the drive transistors, or darlingtons, and across to two diodes acting as bridge rectifiers. In this mode the mains voltage appears across the 240Vac winding of the transformer and current is transferred to the two 12Vac windings. These pass power through the diodes and resistor to ground. Since the centre tap of the 12Vac windings is connected to the positive line from the battery, the effect is that the battery is put on trickle charge via the resistor. This is a slightly unusual way of doing things, but it works. Fig.20 shows the equivalent circuit.

If the mains power fails or is switched off, the relay coil deactivates and the contacts switch the live line out of circuit from the output socket, and connect the

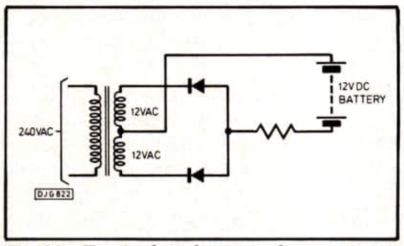

Fig.20. *Equivalent battery charge circuit*

12Vac windings back across the driving semiconductors. This is a good example of the point I made earlier, that a transformer can work in both directions.

Although the oscillator will be operational in either mode, and so consume a small amount of current, the drain is immaterial when the battery is on trickle charge. It also means that the oscillator is immediately ready for control the instant that mains power fails.

MAINS CIRCUIT

Since there are so many options and circuits for generating ac voltages and high level dc supplies, I am only showing a printed circuit board for the simple substitute mains supply.

The circuit as shown in Fig.21 consists of the 50Hz timer in Fig.18, a darlington drive circuit, and the transformer and relay circuit of Fig.19. Two additional current amplification transistors, TR1 and TR2, are used between the two, enabling the use of darlingtons capable of sinking up to 20A each from a 12Vdc supply. With the correct choice of transformer, the final output could supply up to about 200W at 250Vac rms. (To achieve the full current rating ofTR3 and TR4 it may be necessary to change TR1 and TR2 for types capable of delivering greater drive current).

Note that the oscillator and the centre tap of the transformer could be fed from different batteries if preferred. The transformer supply may also be at a higher voltage level than the oscillator if the situation demands (but not at a lower one). For example, the main current might need to come from a 24Vdc battery, in which case the transformer and darlingtons must be selected to suit the supply. The oscillator would then run from another dc supply between 7V and 15V, provided that this is equal to or less than the main battery supply.

The automatic changeover circuit has not been allowed for on the pcb shown in Fig.22 and the relay should be fixed to the case chassis. If the relay is not used, the relevent links on the pcb should be connected. Although the darlingtons are mounted on the pcb ***THEY MUST ALSO BE BOLTED TO HEAT SINKS, OR TO THE CHASSIS. IT IS ESSENTIAL TO USE INSULATING WASHERS*** between them and the chassis to prevent them shorting out the supply. The battery charger diodes D1 and D2 may get warm during charging and so should be mounted slightly above the pcb. R2 will probably be supplied in a heat sink mount and should be bolted to the case.

Two other important points are that the diodes on the base of each darlington should be included to suppress inductive spikes. The capacitor and its associated resistor across the 240Vac winding must also be included for similar reasons. It should also be noted that despite the capacitor and inductive nature of the

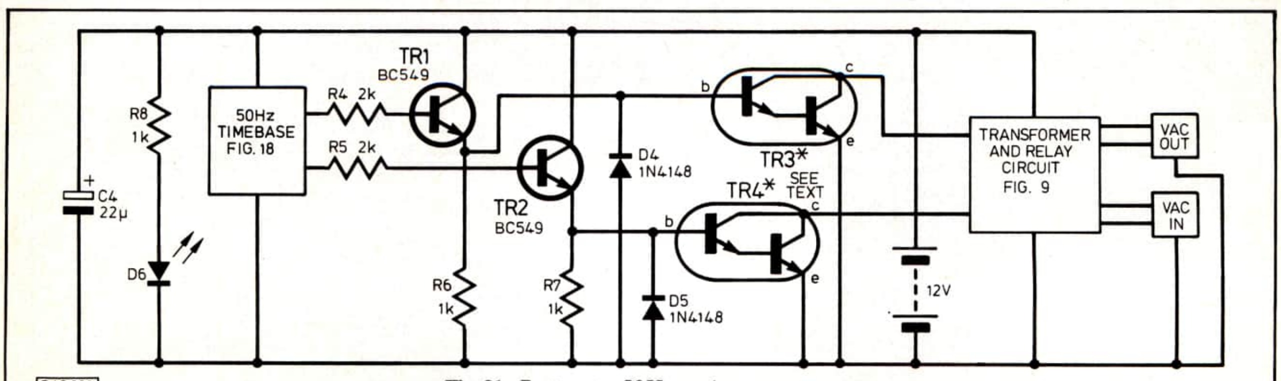

Fig.21. *Battery to 50Hz mains converter*

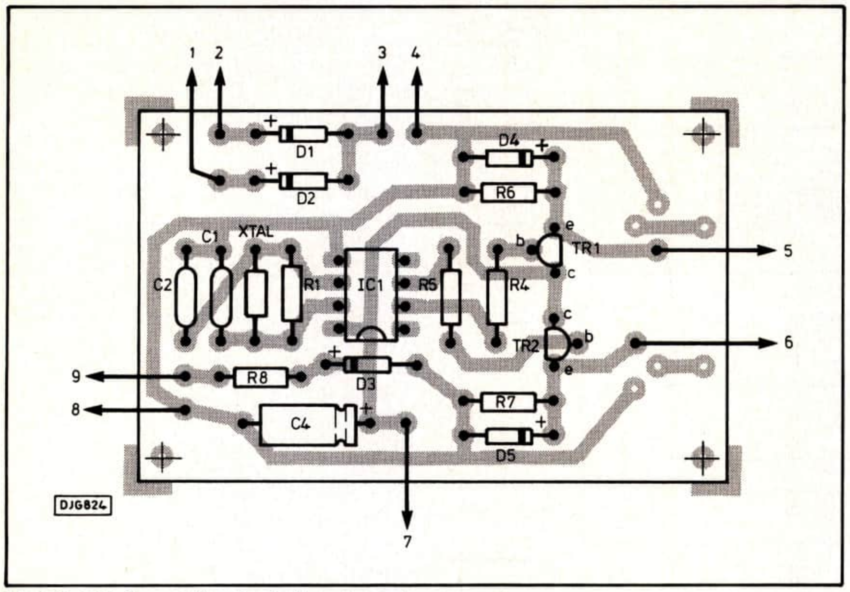

Fig.22. *Pcb layout for the battery to mains converter*

COMPONENTS

RESISTORS

R1	10M
R2	1Ω 10W
R3	220k
R4,R5	2k (2 off)
R6-R8	1k (3 off)

CAPACITORS

C1	68p
C2	47p
C3	470n 250V min wkg.
C4	22µ16V (or larger)

SEMICONDUCTORS

D1,D2	IN5401 3A 100V (2 off)
D3	IN4001 1A 50V
D4,D5	IN4148 (2 off)
D6	led
TR1,TR2	BC549 or similar npn (2 off)
TR3,TR4	MJ1004 175W 20A npn darlington, or TIP132 70W 8A npn darlington, or select to suit needs (see text). (2 off)
IC1	M706B1 50Hz time base

MISCELLANEOUS

XTAL	3.2768MHz crystal
T1	0-12V 0-12V transformer at current to suit needs, max 20A
FS1-FS3	Fuses and holders to suit current (3 off)

Mains input and output sockets, 12V heavy duty battery, heat sinks to suit TR3 and TR4, relay 240Vac 3pco contacts to suit current, battery input socket, case to suit, connecting wire to suit currents concerned, printed circuit board 286A.

CONSTRUCTOR'S NOTE

The PCB is available from Phonosonics, 8 Finucane Drive, Orpington, Kent, BR5 4ED.

transformer, the output waveform will not be a pure sinusoid, though it will be far more rounded than the squarewave input.

Remember when testing or using this circuit that mains ac voltages will be present and adequate safety precautions must be observed at all times. The stepped up supply can be just as hazardous as that coming from the normal mains. If in doubt seek qualified advice.

EXPERIMENTAL BOOSTER

I have shown a fair selection of possible circuits for generating both ac and dc high voltage supplies from a battery source. Any of the circuits can be modified by using alternative components to suit individual needs of frequency, current and voltage. I will conclude by showing one other circuit that should make interesting experimenting, in Fig.24.

It is a variation on the cmos inverter circuit, but uses a ferrite inductor as both voltage amplifier and frequency control component. The value of the inductor determines the feedback frequency from its output via the resistor back to the first inverter. Each of the subsequent inverters acts as a high gain amplifier that keeps the circuit oscillating. The ac output voltage level from the inductor can rise to several hundred volts under the correct conditions. The three main factors are the inductance and output capacitance values, and the load put on the inductor's output. The load also includes that of the feedback resistor, and of any attached monitoring equipment.

It will appear at first sight that this full voltage will appear at the input of the first inverter. In practise the swing at that point is only a few millivolts due to the limiting factor of the resistor.

It is a circuit worth experimenting with. Try varying the inductance, capacitance and resistance values, as well as the output load applied. Be sure to keep the suppressing diode in circuit prior to the inductor to avoid killing the chip — the inductor could produce an adverse voltage at the input to the inductor if a significant current or voltage change occurs on the inductor's output. It's best to have a spare chip or two available in case of experimental mishaps! The variable resistor is used to vary the maximum output level from the inductor.

This last circuit is one which I have used as the ht source for powering an

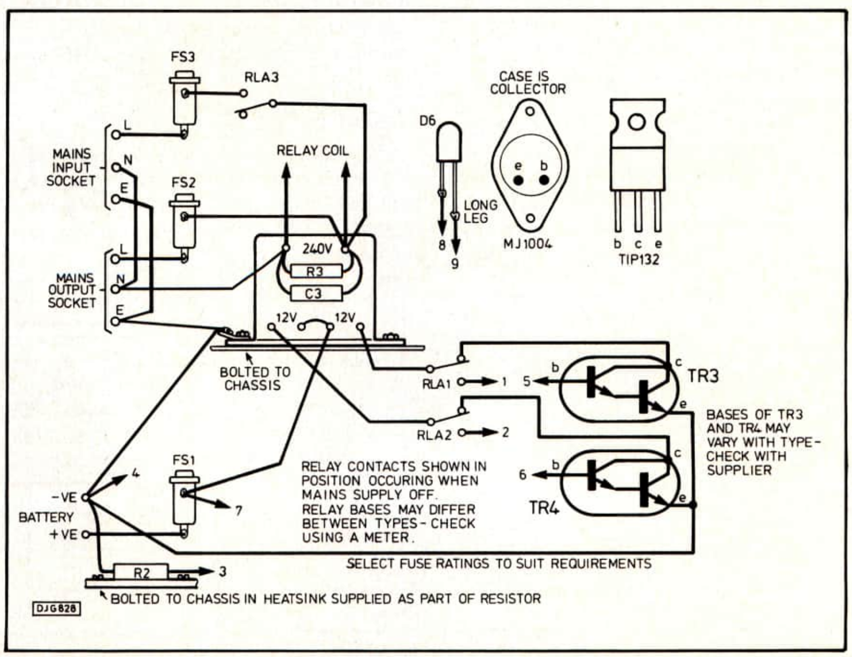

Fig.23. *Wiring details for the battery to mains converter.*

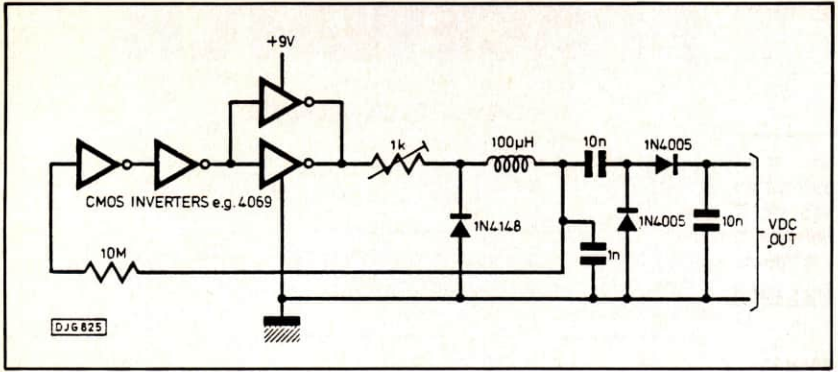

Fig.24. *Experimental dc to ht generator*

experimental geiger counter. There are probably other uses for it where a high voltage is needed at only a very low current. The final ht can be further boosted by feeding the output to a voltage multiplier circuit, like those in Fig.16. One area in which a negative ht version might be exploited is in air ioniser circuits.

SUPERCHARGED

What ever application you have in mind for battery to ht generators I hope that I've given you food for thought. Remember, though, to keep your batteries charged! PE