+12 volts to the ULA, memories and video circuit when D[illegible] is not conducting. If the +12 volt supply starts to fall too low, this causes TR5 [illegible] conduct more. The oscillation frequency of the oscillator then increases, boosting the voltage back up to its original level.

## THE −5 VOLT POWER SUPPLY

Again refer to fig 2b. The −5 volt part of the circuit consists of C46, D11, R55, D12, D17, R54 and C47. This circuit operates on the "charge pump principle". Remember that the collector of TR4 in the 12 volt circuit is oscillating rapidly between about +13 volts and 0 volts. When rising up to 13 volts, C46 is charging via D11 up to a maximum of about 12 volts (0.7 volts are dropped across all silicon diodes during conduction). When the collector of TR4 drops to 0 volts, this pushes the negative plate of C46 down to −12 volts. C47 then charges via D12 and R55 from C46. The voltage across C47 is held constant at −5 volts by the zener diode D17. C46 is then charged up again on the next oscillator cycle and so on.

## CURRENT LIMITS

Currents which can be drawn from the Spectrum's own internal power supply for use by external circuits are fairly limited. For the 16K Spectrum, about 300 mA extra can be taken from the +5 volt supply. The absolute maximum limits are rather difficult to define. Generally, the more you take from the power supplies, the worse the regulation becomes. Bad regulation can cause the computer to crash more frequently, but shouldn't cause any damage provided that you stay within the limits recommended above. For 48K Spectrum owners, it is advisable to add an extra +5 volt supply for all external circuits. The current limits on the other supplies are similar to those for the 16K version.

## THE −12 VOLT SUPPLY

You may now be wondering what has happened to the −12 volt supply. It is shown on the edge connector in the Sinclair BASIC manual. However, it isn't shown on the main circuit diagram. In fact, it doesn't exist. The '−12 volt' connection was wrongly labelled. It should really be 'unregulated +12 volt', since it is connected to the collector of TR4. Luckily, it is very easy to use this oscillating +12 volt supply to produce a −12 volt supply, with the addition of a few common components.

Referring to fig 2c, you will almost instantly recognise a circuit very similar to that for the −5 volt supply in the Spectrum. It works on exactly the same charge pump principle. No zener diode has been incorporated in this circuit, because the 33 uF capacitor charges up to 12 volts anyway and is therefore at the correct voltage. Regulation of this type of circuit is never very good under load. The voltage will rise to about −10.5 volts if you take 20mA from the circuit, so this is the recommended maximum current. If you decide to build the circuit then make sure that the two capacitors are rated at 16 volts or above. Apart from this, none of the component values are critical.

## EXTRA +5 VOLT SUPPLIES

For all but very low current circuits on the 48K Spectrum (such as the simple resistor and switches type of experiments in this book), you will have to add an external power supply. The same will apply to the 16K version if you want to draw more than 300 mA from the +5 volt supply. In either case, you have two options:



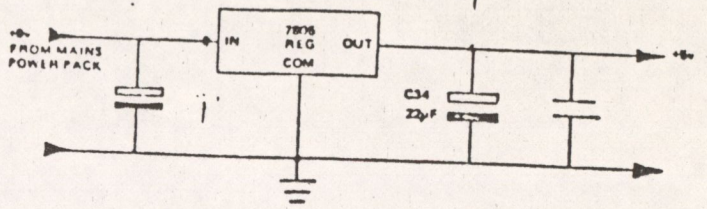


FIG 2a – +5volt POWER SUPPLY CIRCUIT DIAGRAM

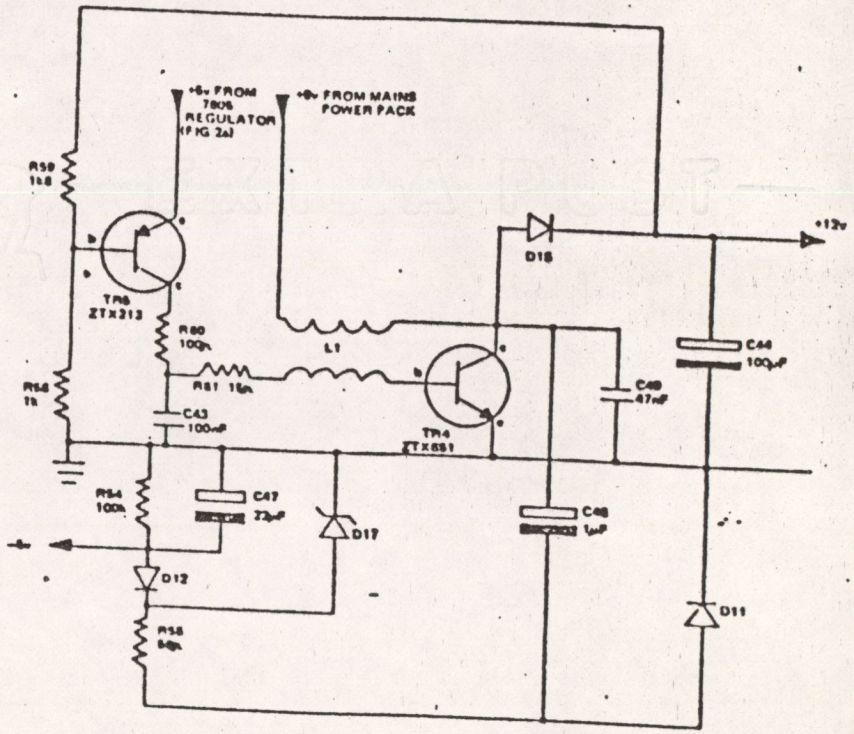


FIG 2b – +12volt AND-5volt POWER SUPPLY CIRCUIT DIAGRAM