A Low Cost 1.5 to 2.2GHz Voltage Controlled Oscillator

Application Note

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The introduction of the Mitel Semiconductor range of 2GHz synthesisers and prescalers for low cost applications such as consumer satellite TV reception has created the requirement for an economic VCO design covering a frequency range from around 1.5GHz to 2.2GHz. Although suitable hybrid oscillator designs are available from various manuiacturers, these generally carry a price tag at least an order of magnitude higher than the synthesiser, thus making their use in consumer equipment hopelessly uneconomic.

The design shown in Fig.1 has been developed using low cost components which should be easily available, the varicap diodes being normal UHF TV tuning types and the transistor a standard catalog item.

A major problem when operating at these frequencies is that the series inductance of most capacitors becomes very significant compared with that required in the resonator circuit and also prevents good decoupling. These problems are overcome when designing fixed frequency oscillators by replacing the normal resonant circuits and decoupling capacitors with open or short circuited resonant transmission lines but a design requiring wide frequency variation must use more conventional techniques.

The transistor is biased to about 1.5mA using a 22kΩ resistor from collector to base. Any problems with decoupling at the emitter are avoided by connecting the emitter direct to ground. Stabilisation of the bias point relies on the 330Ω collector load resistor providing a degree of feedback A small inductor in series with the collector load resistor reduces any loading and improves the effectiveness of the +12V supply decoupling A series tuned circuit consisting of a small inductor and two varicap diodes is connected between collector and base with a 390pF capacitor providing DC isolation of the varicap diodes from the collector voltage. To avoid the introduction of any additional series inductance, the varicap diodes are connected direct to the transistor base without a coupling capacitor The oscillator frequency is varied bv adjusting the varicap bias voltage from 0 to 30V via a 47kΩ isolating resistor Output amplitude from the basic oscillator is much higher than the input requirements of the synthesiser or prescaler and therefore about 10dB of attenuation is provided by a resistive attenuator.

As might be expected with an oscillator operating at this frequency, layout is fairly critical and the layout shown in Fig.2 should be followed accurately or extensive trials made before any variations are attempted. The prototype oscillators were made on standard 1/16 inch fibreglass board, but it was found impossible to mount the frequency determining components on the board without greatly affecting the frequency range available; these components are therefore mounted off board, relying on short lead lengths to provide sufficient rigidity.

OSCILLATOR SPECIFICATION

Operating Voltage: +9V to +14V
Frequency Range: 1.5GHz to 2.2GHz
Varicap Voltage Range: 0V to +30V
Output Level: (with 10dB attenuator) -10dBm (70mV)

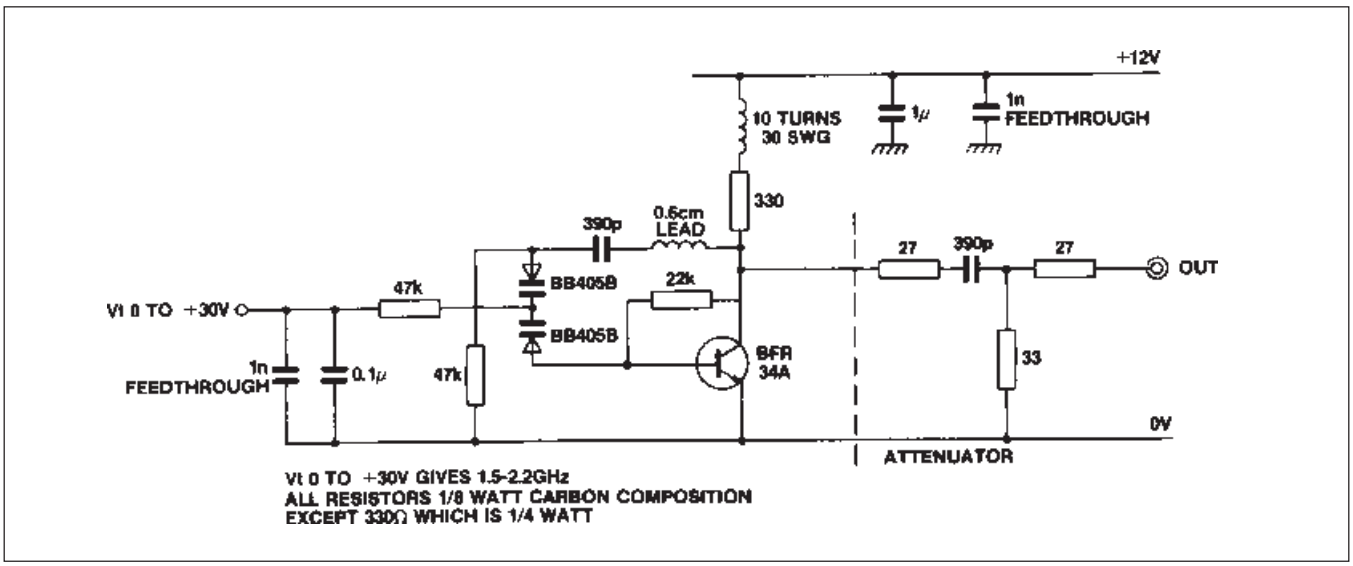

Figure 1: 2GHz VCO Circuit Diagram

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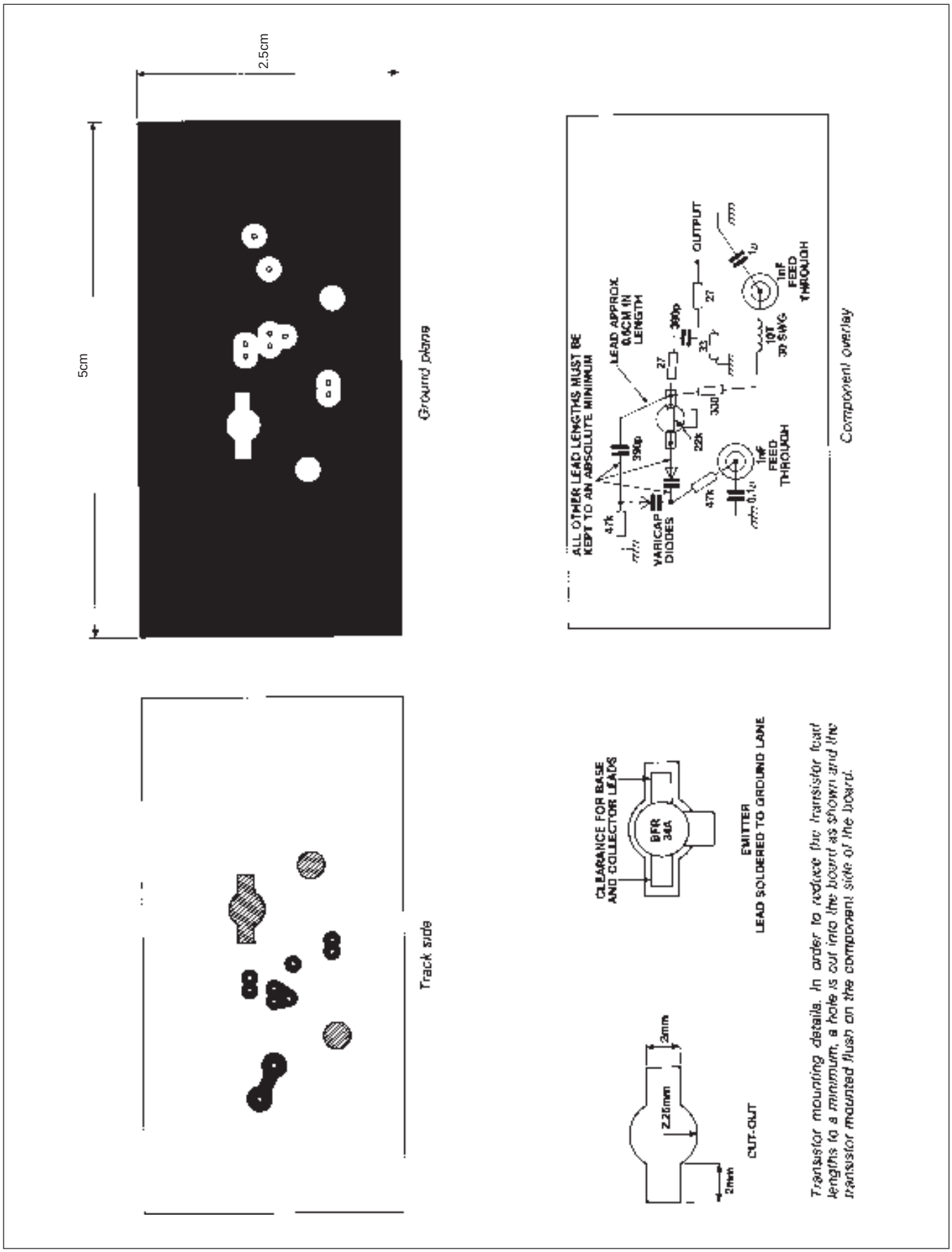

Figure 2: Simplified Block Diagram of Block Conversion Satellite Receiver

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