Free Running Crystal Oscillators

These free running crystal oscillators serve as pulse generator circuits. Each card provides an oscillator type circuit that produces pulses or voltage variations of a definite frequency. The oscillators consist of a basic current switching circuit whose output frequency is determined by a quartz crystal. The crystal vibrates at a specific frequency and develops a sinusoidal voltage that controls and stabilizes the output frequency of the oscillator. An inductively tuned tank circuit provides regenerative feedback to sustain the crystal oscillations.

Circuit Description

Assume that T5 in the circuit shown starts to conduct when power is first applied to the circuit and sets the common emitter voltage of T5 and T6 to −6.2v. The initial surge of current into the tank circuit of C6, L4, and R8 quickly drops the collector voltage of T5 toward −1.5v and shocks the crystal into oscillation. The negative voltage transition of the crystal (acting as a tank circuit) causes the base voltage of T6 to go negative. D9 limits this negative swing to −6.4v (0.4v drop across the diode) and holds T6 reverse-biased off. With T6 off, only a small back current flows into the coupling network and the output at pin A is near +0.68v.

When the crystal output at the base of T6 starts to go positive and increases above −6.2v, T5 becomes reverse-biased off and T6 becomes forward-biased on. The positive base voltage swing is limited by D11 to −5.6v. Current (about 6ma), from the −12v supply and R31, switches from T5 to T6 and flows into the coupling network of T6. The output at pin A decreases to −0.83v. With T5 held off, its collector voltage becomes positive and feeds a regenerative voltage to the crystal which re-energizes the mechanical vibrations of the crystal. When the negative voltage transition of the crystal again drops below −6v, T6 is reverse-biased off and T5 is forward-biased on. The output at pin A again goes positive, as only the small back currents flow into the coupling network. Current flow through T5 into the tank circuit quickly drops the collector voltage of T5 and provides the necessary feedback. This action continues as long as power is applied to the circuit and results in the approximate square wave output noted on the schematic.

The tank circuit components C6, L4, and R8 are selected so that the feedback voltage to the crystal is of the proper phase and amount to sustain oscillations. The tank circuit also serves as a high frequency filter to eliminate the effects of the higher harmonics. D9 and D11 limit the drive to T6 so that it is not biased too far in cut off or near saturation. This permits linear operation of the circuit with little distortion of the output and quick switching of the output signal. Output specifications are noted in the chart shown.

Circuit operation is similar for all cards in this family. The values of C6, L4, R8, and the crystal are varied and provide output pulses of different frequencies. The chart relates the card code and component values to the various output frequencies.

Application

Typical loading on the oscillator circuit is noted in the circuit schematic. A maximum load of 5 current switching blocks is permissible. Back panel wiring of pin B is required when driving into standard current switching blocks. If the load circuit contains its own coupling network the back panel wire from A to B is disregarded and the output is taken from pin A.