Crystal Oscillator Reduces EMI from Computers

Spread Spectrum Oscillators Released July 4th, 1997

Spread Spectrum Oscillators

Overview

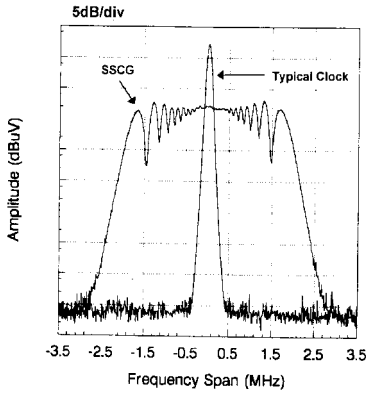
NEL announces the release of their "Spread Spectrum" HS-7800 line of crystal controlled oscillators. These oscillators are designed to reduce radiated emissions by more than 10db. The oscillator is available in a standard fourteen pin dip package using only the four corner pins for ease during layouts.

This line of oscillators uses phase locked loop (PLL) technology to obtain wide deviation and crystal accuracy at frequencies up to 135MHz. By frequency modulating the clock output frequency with a low frequency carrier, EMI is reduced by 10 dB or more. The applications include any device that must meet specific EMI criteria and keep accurate time, such as a computer. This reduction in system EMI allows systems to pass increasingly difficult EMI testing without costly enclosure designs.

EMI Suppression

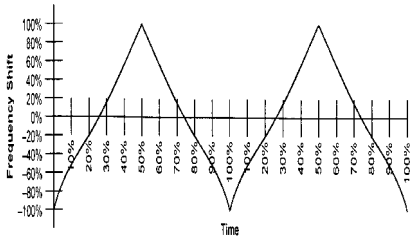
This method of EMI suppression was patented in 1942 by Hedy Lamar and George Antheil. The patent was for using a frequency hopping method to shield radio-controlled torpedoes in World War II. Frequency modulation has a much lower harmonic amplitude than that of an unmodulated signal, as is shown in figure 1. The reduction in amplitude is dependent on the harmonic number and the amount of frequency deviation.

Figure 1



The optimal reduction occurs when the spreading of the harmonics is even. This occurs when the waveform has a "Lexmark" shape. This is a modified triangle wave, as shown in figure 2.

Figure 2



The rate of the modulation is above 20 kHz to keep it inaudible and below 100 kHz so that phase locked loops with a tracking of 10 µsec can use this device as the source.

EMI reduction of 3 dB at 50 MHz and more than 10 dB of reduction on the higher harmonics are realized on these units. All units are screened for demodulated waveform and EMI reduction.

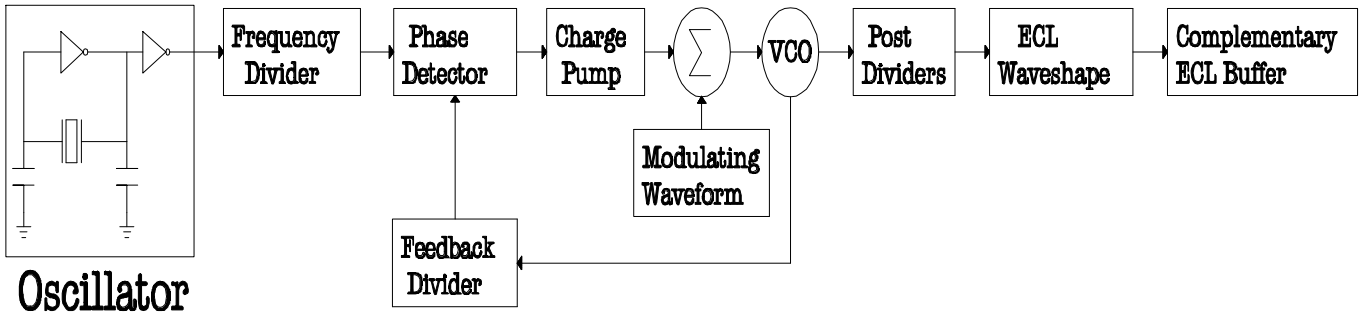
This unit features an input to power down the modulation. This is useful in trouble shooting and margin testing. Deviation specification ranges from 0.5 percent to 3 percent. The larger the deviation the greater the harmonic suppression.

Jitter

The contribution of the deviation to cycle to cycle jitter is between 0.25 picoseconds to 0.5 picoseconds. NEL's HS-7800 oscillator has less than 40 picoseconds of cycle-to-cycle jitter. These are results from tests by outside sources.

Phase locked loop devices are commonly very noisy and exhibit very poor jitter performance.

Figure 3 Oscillator Block Diagram



NEL uses a series of noise suppression devices within this device to provide good noise immunity. The noise suppression and the noise isolation of the different stages contribute to the low jitter readings.

Operation

A block diagram of the internal operation of this product is shown in figure 3. There are three main parts; the oscillator section, the phase locked loop section and the ECL output section.

The oscillator section was custom designed by NEL to provide a high stability oscillation over varying conditions. This oscillator meets a plus or minus twenty-three parts per million tolerance from 0°C to 70°C. This includes a plus or minus ten parts per million tolerance for temperature deviations, plus or minus ten parts per million for tolerance of setting the center frequency, and plus or minus three parts per million for voltage and load variations. This section provides a low power crystal oscillation that tracks the crystal angle. This unit is specially processed to be final plated to the exact average frequency over time while it is being modulated. This accounts for any nonlinearities in the deviation causing an average frequency error.

The frequency divider and the feedback divider sections are programmed to divide each output until the frequencies are equal. This is at about four MHz. These are CMOS devices of 0.35 micron line widths technology.

The frequency detector system detects the offset between the voltage-controlled oscillator and the crystal oscillator. The detector activates the charge pump to compensate the voltage-controlled oscillator to track with the crystal oscillator.

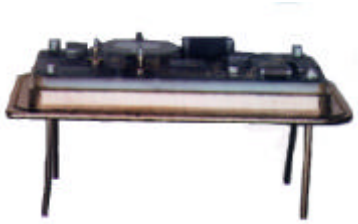
The modulating waveform was discussed above in the EMI suppression section. The waveform is 20 kHz to 100 kHz pseudo triangle wave. The frequency of modulation is divided from the input to the phase detector from the input divider. This modulation rides on top of the offset charge pump and is sent into the voltage controlled oscillator.

The voltage-controlled oscillator will operate at frequencies more than 135 MHz and holds a 45 to 55 percent symmetry on its CMOS-output waveform. Post dividers make this product operable from 10 MHz to 135 MHz.

This waveform is then shaped from CMOS to ECL using an ECL gate. The output of the wave shaping gate is fed into a buffer stage for isolation and waveform integrity.

The ECL output buffer is a complementary output 10K ECL gate. The output symmetry will hold plus or minus 2.5 percent versus all conditions. The measure of jitter is less than forty picoseconds when measured cycle to cycle.

The unit is fabricated on ceramic substrate material and with conductive epoxies. The construction is all chip and wire. NEL does not use plastic packaged part within the oscillator. This allows for better aging and there is no chance of the plastic package exploding during solder reflow. The oscillator is able to withstand up to 253 °C of reflow heat. This chip and wire construction also allows NEL to use a mounted crystal blank instead of a crystal sealed in a holder. The use of a crystal blank only allows NEL to offer a reduced height, as short as 0.200" without glass stand-offs.



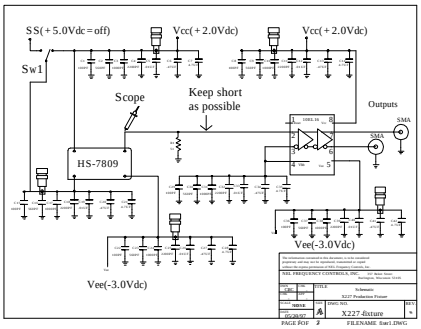
The gold-plated base and lead are great for solder or conductive epoxy mounting. The unit is backfilled with 92 percent helium, sealed and vacuum checked for minute leaks of three time ten to the minus eighth torr. This type

of sealing assures good aging and thermal conduction.

The output waveform characteristics, demodulate characteristics, and the DC characteristics are tested on each unit for compliance to specification.

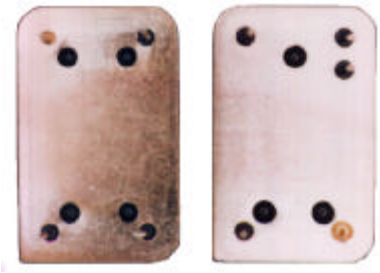
DC Supply

The unit is tested at NEL using a split supply of Vcc equal to plus two volts dc and Vee equal to minus three volts dc and terminating the output with a dc 50Ù load. NEL also tests the product using a 82Ù resistor from Vcc to the output and 130Ù resistor from the output to Vee.



This oscillator comes in two case styles. The first style has the case tied to Vee (pin seven) and a single output on pin eight. This unit is recommended to be operated on plus five volts dc because of case to ground shorting. The second style has complementary outputs and the case is tied to Vcc (pin fourteen). This case is designed with a minus five volts dc supply, because it will keep the case at ground potential. Keeping the case at ground potential is important to keep the noise from radiating onto the circuit.

The unit draws approximately 60 mA of current nominally. The maximum current during operation is 75 mA of dc current. This series will operate at three point three volts or five volts dc and a tolerance better than ±10 percent.



Reliability

All of NEL's products go through strict reliability testing before they are released for sale. These units have been placed in an oven at one 125 °C for two-thousand hours and not one has failed to operate.

NEL constructs this unit in a class 500 clean room. The clean environment keeps the oscillators aging low with a very high reliability. Strict anti-static procedures are in place to prevent damage that may shorten the life of the product.

All units are tested 100 percent at room temperature and AQL testing is provided over temperature on each lot produced. NEL does not use chlorofluorocarbons or other environmentally harmful chemicals. Scrap materials are recycled whenever it is possible.

NEL is ISO 9001 certified, showing their commitment to total quality and customer satisfaction.

Conclusion

The performance of computers today are forcing the clock frequencies higher, and increasing the number of gates. This equates to electro-magnetic interference. The HS-7800 oscillator allow for reduction of these emissions without costly enclosure designs or multilayer ground plane PC-board construction.

Since the average frequency is calibrated these units will keep time within twelve minutes in a year. That is within one minute a month.

Contact NEL with your exact system requirements. NEL can provide this unit in a wide range of deviations and output frequencies.

References:

Lexmark International, Inc.
Patent 5,631,920

Dow Jones News Service
Acticle "Hedy Stuff"

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