Research on Frequency Synthesizers for Analogue Integrated Circuits Based on EDA Technology

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Abstract: The application scope of EDA technology is very wide, and the technology has been generally recognized in the process of promotion. In the context of the rapid development of integrated circuits, the application of EDA technology should be further strengthened to promote the continuous development of China's electronic information field. In this paper, the frequency synthesizer of analog integrated circuits based on EDA technology is studied, and its main performance indicators, applicable technology and reinforcement design are briefly analysed.

Keywords: EDA Technology; Analogue Integrated Circuits; Frequency Synthesizer

Preface

Frequency synthesizers have entered a new period of change in the context of the continuous development of science and technology, and have become an indispensable component in the field of integrated circuits. As the main carrier of signal transceiver, has a very important utilization value, based on the promotion of EDA technology, technical personnel also need to further strengthen the control of its performance, improve its efficiency and operational stability, for the development of China's integrated circuits to play a role in promoting.

1. Analog integrated circuit frequency synthesizer main performance indicators

1.1 Tuning range and centre frequency

Analog integrated circuit frequency synthesizer minimum frequency and maximum frequency change range is also known as the tuning range, the most commonly used in the electronics market, the tuning range of the phase-locked loop frequency synthesizer, the most important influencing factor is the voltage controlled oscillator output frequency range. For low to medium high frequency receivers as well as receivers with super outlier structures, the frequency fluctuation range does not correspond to the normally specified access platform regulations and differs by an intermediate frequency. For receivers with a zero-intermediate spectrum structure, the tuning range compares perfectly with the prescribed standards of international wireless communication protocols. In the actual design of the frequency synthesizer, technical

personnel will be under the communication protocol provisions of the standard, for its sufficient fluctuation space, the centre frequency as a measure, usually, the centre frequency high or low on the tuning range has a direct impact, specifically the higher the centre frequency, the greater the frequency synthesizer tuning range.

1.2 Frequency resolution

There are two main factors affecting the frequency resolution, one is the minimum frequency deviation under this provision of the communication protocol, and the other is the channel spacing. In the field of communication electronics and integrated circuits common frequency synthesizer is divided into integer frequency division and fractional frequency division two, for the integer frequency division frequency synthesizer, the frequency change of the clock can be used as a reference object, for the fractional frequency division frequency synthesizer, the accuracy of the modulator has a direct impact on its frequency resolution.

1.3 Phase noise

Oscillator is one of the core building blocks of the frequency synthesizer, in use the oscillator will be affected by internal and external noise of the device, mainly reflected in two aspects, one is the amplitude, the other is the phase. If the amplitude change is suppressed by an amplitude and phase modulation wave, the amplitude limiting characteristics of the oscillator will automatically recover the amplitude change, whereas under normal circumstances the oscillator is unlikely to automatically recover the instantaneous phase because of its limiting conditions. Based on the phase noise variation, it is possible to identify whether the frequency synthesiser signal is ideal or not. Single sideband phase noise centre frequency noise is relatively large, the average carrier decibel number is an important variable in the calculation of noise power per unit frequency band, if the frequency synthesizer signal is in an ideal state, deviating from the centre frequency far enough, the phase noise tends to be flat, if there is signal interference, the phase noise will fluctuate [1].

1.4 Timing jitter

Timing jitter is a measure of periodic variation over a time range. Periodic jitter represents the average of periodic fluctuations and typically reflects the dynamics of a frequency synthesiser over a short period of time, as judged by the average of the differences in successive cycle times. In addition to the period jitter, there is also a timing jitter called cumulative jitter or absolute jitter, compared to the period jitter, which reflects the long-term timing dynamics of the frequency synthesizer, mainly used to measure the phase-locked loop frequency synthesizer, for the measurement of free oscillation VCO jitter situation does not have too much reference value. Phase noise is a measure of frequency synthesizer fluctuations in the frequency domain, while timing jitter is a measure of frequency synthesizer stability in the time domain, and there is some correlation between the two.

1.5 Spurious

Spurious is a situation where the spectral component of the frequency synthesiser is not expected to occur when it is operating stably. Such periodic disturbances are very common and unavoidable, and are

mainly influenced by the non-ideal characteristics of the charge pump and the discriminator. In the actual spectrum, there is spurious at off-centre frequencies and multiple spurious at other locations.

1.6 Locking time

Lock time and conversion time in the frequency synthesizer performance index analysis belongs to the same meaning, the frequency synthesizer output frequency by a variety of interference factors, there will be a certain error, usually from a frequency to another frequency required to transfer the time consumed by the lock time expressed. When analysed in conjunction with its performance indicators, the shorter the lock time of a frequency synthesiser represents the better the result, as the system is in a waiting state between frequency transitions. Through the study, it was found that the open-loop loop was the key influencing factor for the locking time.

2. EDA technology based analogue integrated circuit frequency synthesiser applicability techniques

2.1 Direct digital frequency synthesis technology

From the digital signal, combined with EDA technology to form a synthesis signal frequency converter, based on this, to improve the rate of the frequency converter, to achieve the conversion between the frequency accuracy of the unity. The direct digital frequency synthesis technology uses a high performance monolithic circuit solution with self-designed programmable devices and has a high integration capability due to its faster speed. The technology has coherence in phase conversion, high efficiency in frequency conversion speed, high resolution and better results in phase noise control, and is highly competitive in the frequency synthesiser market for a long time or less.

2.2 Indirect phase-locked frequency synthesis technology

Phase-locked loop is the key to the process of indirectly locking the signal, the technology is mainly based on the form of feedback circuit, its functionality is mainly reflected in the synchronization loop with the external clock, usually, the phase-locked loop is applied to the closed-loop tracking circuit, in the field of device input and output frequency monitoring has considerable superiority, with the ability to actively monitor the input and output frequency can be automatically tracked. In the normal operation of the frequency synthesizer, the indirect phase-locked frequency synthesis technology can lock the voltage phase of the input and output signals, which has a greater advantage in cost and size than the above-mentioned direct digital frequency synthesis technology, which is simple to design and lays the foundation for the miniaturisation of the frequency synthesizer.

2.3 MCM micro-packaging technology

MCM micro-packaging technology takes the form of a number of bare chips packaged on the same high-density line substrate, allowing interconnection between chip components. The development of this technology has been recognized by the domestic microelectronics industry, effectively changing the defects of the traditional package density. the further development of MCM technology has further reduced the size of the frequency synthesizer, effectively enhancing the package performance, while also strengthening the stability of the system operation [2].

3. EDA technology-based analog integrated circuit frequency synthesizer reinforcement design

3.1 SET reinforcement

SET effect refers to the formation of circuit function mutations due to high-energy particle bombardment of the circuit, ionisation collisions in the device will generate additional charge, in order to further maintain the stability of the frequency synthesizer, to take the corresponding process technology for its reinforcement. The design reinforcement consists of two levels, system reinforcement and circuit level reinforcement, system reinforcement is mainly based on changing the system structure or parameters, circuit reinforcement is mainly based on changing the circuit structure or parameters, both forms of reinforcement are designed to improve the radiation resistance of the circuit.

3.2 Charge pump reinforcement design

Charge pump reinforcement design has been the focus and difficulty of research in the process of frequency synthesizer reinforcement for many years, the use of voltage type charge pump instead of current type charge pump is currently a more respected way of reinforcement design, can reduce the sensitivity of SET, but also improve the charge discharge and compensation rate, by reducing the sensitive nodes in the charge pump can further reduce the charge pump output efficiency, in order to facilitate the VCO voltage control. Although this research has been on the upside, the scheme has many shortcomings; the lack of a limit on the discharge current can cause power resource losses, and disturbances on the power supply can be coupled to the low-pass filter when the switch is in the closed state, which can affect the clock jitter performance of the frequency synthesiser [3].

3.3 Voltage-controlled oscillator reinforcement design

The VOC is the highest frequency module in the operation of the frequency synthesizer circuit, and for the whole frequency synthesis system, the performance of the VOC will have a direct impact on its overall performance. Triple-mode redundancy techniques are often used during VOC hardening to determine the correctness of the signal by selecting more than two identical values from the three circuit outputs. If the circuit is subjected to SET interference during reinforcement, the majority result needs to be obtained to rule out the signal interference phenomenon. The use of this technique in VCO reinforcement design can effectively reduce the sensitivity of the VCO and SET, thereby improving the operational stability of the frequency synthesiser and at the same time achieving a reduction in circuit power consumption.

3.4 Frequency discriminator and frequency divider reinforcement circuit design

If a high-energy particle attack occurs during the stable operation of the frequency synthesizer, the phase discriminator and frequency divider logic states may be flipped, and in this case an incorrect signal may be transmitted. The use of triple-mode redundancy technology to strengthen the frequency discriminator and frequency divider can be effective, and after strengthening the system, no abnormal changes occurred in operation, and the technology can effectively suppress the SET effect.

Conclusion

IC frequency synthesizer as a carrier of signal transceiver occupies a key position in the current electronic information technology field, and has become an important support for the development of China's digital economy and information consumption. With the high development of electronic information technology, frequency synthesizer miniaturization has become the inevitable trend of future development, based on EDA technology of analog integrated circuits to further enhance the level of research and development, and fundamentally promote the development of China's electronic field.

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