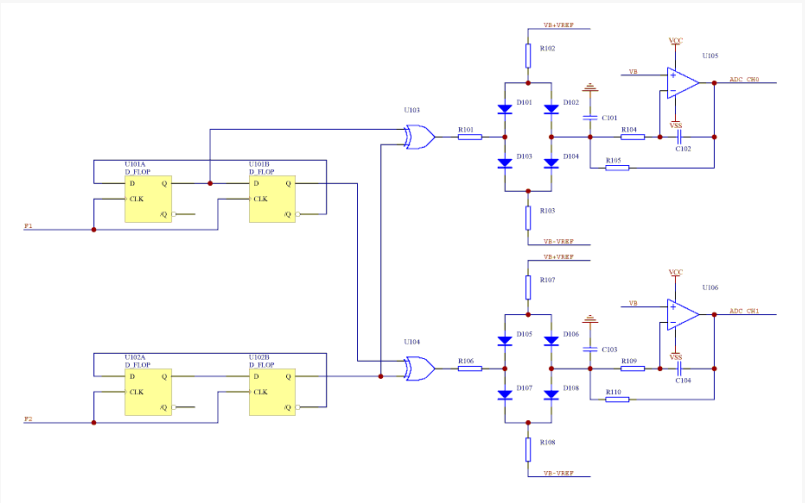
Linear - Comparators: A Linear Phase Comparator Digital Phase-locked Loop Circuit

This article describes the classification, selection principles and applications of comparators.



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SHENZHEN, GUANGDONG, CHINA, December 7, 2022 /EINPresswire.com/ -- A comparator is an electronic component that outputs different voltage results at the output by comparing the magnitude of the current or voltage at the two inputs. With the rapid development of semiconductor technology, electronic devices based on digital circuits are gradually being integrated into all aspects of people's lives. Analogue-to-digital converters (ADCs) are widely used as a bridge between analogue and digital signals. Among all ADCs, the successive approximation analog-to-digital converter (SAR ADC) has the lowest power consumption, moderate speed and accuracy. With the development of portable electronics, SARADCs are receiving more and more attention. As the core unit of SAR ADC, the comparator has high requirements on accuracy, speed and power consumption. For a SAR ADC with 1.8V supply voltage, 50 MS/s speed and 12-bit accuracy, the minimum resolution of the comparator is required to reach 0.5LSB (least significant bit), i.e. 220μV, and the speed should be above 600 MHz.

Comparator Classification

Over-zero voltage comparator: a typical amplitude comparison circuit with the circuit diagram and transmission characteristic curve shown in the figure.

Voltage comparator: A voltage comparator is obtained by changing one of the inputs of the over-zero comparator from ground to a fixed voltage value.

Window comparator: The circuit consists of two amplitude comparators and some diodes and resistors. A high level signal with a potential level above a specified value VH is equivalent to a positive saturation output of the comparator circuit. A low level signal with a potential level below a specified value VL is equivalent to a negative saturation output of the comparator circuit. The comparator has two thresholds and the transmission characteristics curve is windowed, so it is called a window comparator.

Hysteresis comparator: A resistive voltage divider branch is led from the output to the in-phase input. When the input voltage VI increases gradually from zero and VI is less than VT, the comparator output is a positive saturation voltage and VT is called the upper threshold (trigger) level. When the input voltage VI>VT', the comparator output is a negative saturation voltage, VT' is called the lower threshold (trigger) level.

Principles of Comparator Selection

The principle of operation of a comparator is straightforward. It has a positive pin and a negative pin. When the voltage on the positive pin is high, the output of the comparator "asserts" (or drives) a signal. With an open collector output, the output pin of the comparator is the collector of a transistor or the drain of a FET. With a push-pull output, the comparator has a "totem pole" output, i.e. a complementary NPN/PNP stage, like in an operational amplifier. The open collector output is used when the load and the comparator each use a different power supply. Another function of the open collector output is to minimise the quiescent current when the output is switched off. In the totem pole stage, no base current flows in the N-type output transistor, while some base current always flows in one of the two output transistors.

However, open collector outputs also have some disadvantages. For example, they require external pull-up resistors. These resistors must perform the pull-up task during the high resistance cycle so that the comparator can switch faster when the output is below off and the pull-up resistor makes the output high. Therefore, an open collector output is not suitable when you need a symmetrical waveform, as in a clock recovery circuit. If your circuit does not require level switching, you should choose a push-pull output, such as with the ALD2321APC, which provides 24mA of output drive capability with 90μA quiescent current.

The high speed comparator may also have a latch output so that the output can be held in a known state to meet the set and hold time requirements of the digital input behind it. Once the digital section has read the output of the comparator, the latch pin can be released to allow the output to track the input.

Applications of Comparator

The four comparators form a current detection circuit which can be used to indicate the four states of the input current, with resistors "Shunt" used to convert the input current into a voltage signal, R1 and R2 used to set the gain of the operational amplifier and provide the reference

voltage required for the comparator. R4 to R7 can be used to set the detection thresholds for the different digital output states.

Over-zero comparator
An over-zero comparator is used to detect whether an input value is zero. The principle is to use a comparator to compare two input voltages. The two input voltages are the reference voltage Vr and the voltage to be measured Vu. Generally Vr is connected from the forward input and Vu from the reverse input. Depending on the result of the comparison of the input voltages the forward or reverse saturation voltage is output. When the reference voltage is known the measurement result of the voltage to be measured can be derived, when the reference voltage is zero that is the over-zero comparator.

An over-zero comparator constructed with a comparator is subject to a certain measurement error. When the product of the voltage difference between the two inputs and the open-loop amplification is less than the output threshold, the detector will give a zero value. For example, with an open-loop amplification of 106 and an output threshold of 6v the detector outputs zero if the voltage difference between the two input stages is less than 6 microvolts. This can also be considered as the uncertainty of the measurement.

Relaxation oscillators

Comparators can be used to construct relaxation oscillators, where both positive and negative feedback is applied. The positive feedback is a Schmitt trigger, which forms a multi-harmonic oscillator. The RC circuit adds negative feedback to it, causing the circuit to start oscillating spontaneously, turning the whole circuit from a latch into a relaxation oscillator.

Level conversion using open-drain comparators such as the LM393, TLV3011 and MAX9028 can construct level converters for changing signal voltages. Selecting the appropriate pull-up voltage allows flexible selection of the voltage value to be converted. For example, a ±5 V signal can be converted to a 3 V signal using the MAX972 comparator.
Analogue to digital converters

A comparator is used to compare an input signal to see if it is higher than a given value and can therefore convert an input analogue signal into a binary digital signal. Almost all digital-to-analogue converters, including ΔΣ modulation, contain comparators for quantizing the input analogue signal.

More specific information can be found here.

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