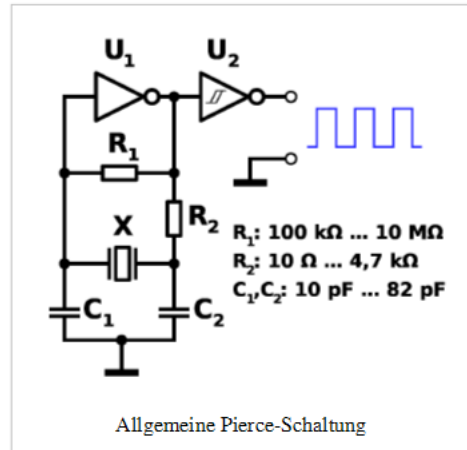


Pierce-Schaltung

Die **Pierce-Schaltung**, auch Pierce-Oszillator genannt, ist eine Oszillatorschaltung die nach ihrem Erfinder George W. Pierce benannt ist. Es ist eine abgewandelte Form der Colpitts-Schaltung, die mit einem Minimalaufwand an diskreten Bauelementen und deshalb sehr kostengünstig aufgebaut werden kann. Deshalb ist sie in der Digitaltechnik eine oft verwendete Form des Quarzoszillators. Sie kann mit einem Schwingquarz, oder alternativ dazu, auch mit einem kostengünstigen Keramikresonator aufgebaut werden.

Funktion

Der Widerstand R_1 stellt den linearen Betrieb des ersten Inverters U_1 (z.B. den Baustein 74AC04) sicher und kann in manchen Anwendungen auch weggelassen werden, da der ohmsche Anteil des Schwingquarzes X bereits ausreicht. R_2 begrenzt den Spitzenstrom und kann, wenn der Ausgangswiderstand des Schmitt-Triggers hoch genug ist, auch durch eine direkte Verbindung (0 Ohm) ersetzt werden. Im Rückkopplungsszweig befindet sich der Schwingquarz X . Die beiden Kondensatoren C_1 , C_2 (sog. Ziehkondensatoren (s.u.)) dienen zur Phasenverschiebung, um die Phasenbedingung von 180° sicher erfüllen zu können. Sie stellen mit dem Schwingquarz ein π -Filter dar. Aufgrund der kleinen Kapazitätswerte reichen auch hier in manchen Aufbauten bereits parasitäre Kapazitäten im Bereich der Leiterplatte aus. Der Schwingquarz arbeitet unterhalb der Resonanzfrequenz als eine Induktivität mit sehr großer Kreisgüte.



Der Schmitt-Trigger U_2 dient als Verstärkerstufe und liefert an seinem Ausgang ein für Digitalschaltungen nötigen rechteckförmige Spannungsverlauf, in der Skizze in der Farbe blau angedeutet.

Ziehkondensator

Da der Quarz als Bauteil mit induktivem Charakter arbeitet, muss auf der Schwingfrequenz die restliche Beschaltung kapazitiven Charakter aufweisen. Deshalb kann ein sogenannter *Ziehkondensator* mit einer Größe von wenigen Pikofarad seriell oder parallel zum Schwingquarz die Resonanzfrequenz der Gesamtschaltung wieder auf den Nominalwert *ziehen*.

Lastkapazität

Die Kapazität, welche der Schwingquarz an seinen Anschlüssen von der restlichen Schaltung „sieht“, wird als Lastkapazität C_L bezeichnet. Sie wird vom Hersteller des Schwingquarzes im jeweiligen Datenblatt aufgeführt. Bei handelsüblichen Quarzen liegt sie im Bereich um 20 pF und wird bei Parallelresonanz durch die Reihenschaltung der Kondensatoren bestimmt. Neben den diskreten Bauelementen C_1 und C_2 , deren Werte beim Entwurf einer Schaltung leicht wählbar sind, treten dabei noch andere Kapazitäten in Erscheinung, die man eher als gegeben hinnehmen muss: die Eingangs- bzw. Ausgangskapazitäten C_i und C_o der Inverterstufe (Schmitt-Trigger) sowie die Streukapazität C_s , welche primär durch den Aufbau der Leiterplatte und durch das Gehäuse des Schwingquarzes bestimmt wird. Die Streukapazität liegt bei typischen Aufbauten im Bereich von 3 pF bis 9 pF.

Die Lastkapazität C_L ist gegeben als:

$$C_L = \frac{(C_1 + C_i) \cdot (C_2 + C_o)}{(C_1 + C_i + C_2 + C_o)} + C_s$$

Eine Vergrößerung der Lastkapazität reduziert geringfügig die Frequenz des Oszillators.

Weblinks

- Pierce-gate oscillator crystal load calculation ^[1] (PDF; 27 kB), Applikationsschrift aus der Fachzeitschrift *RF Design*, Juli 2004 (engl.)
- HCMOS Crystal Oscillators ^[2] (PDF; 46 kB), Fairchild Semiconductor, Application Note 340 (engl.)

Einzelnachweise

[1] <http://www.crystekcrystals.com/crystal/appnotes/PierceGateLoadCap.pdf>

[2] <http://www.fairchildsemi.com/an/AN/AN-340.pdf>

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