Oscillator pdf notes

A popular op-amp relaxation oscillator. An electronic oscillator is an electronic circuit that produces a periodic electronic signal oscillating, often a sine wave or a square wave. [1] [2] [3] Oscillators convert direct current (DC) from a power supply into an alternative current signal (AC). They are widely used in many electronic devices ranging from the simplest clock generators to digital instruments (such as calculators) and complex computers and devices, etc.[3] Common examples of signals generated by oscillators include signals broadcast by radio and television transmitters, clock signals that regulate computers and quartz clocks. , and the sounds produced by electronic beepers and video games. [1] Oscillators are often characterized by the frequency of their output signal: a low-frequency oscillator (LFO) is an electronic oscillator that generates a frequency of less than about 20 Hz. This term is generally used in the field of audio synthesizers, to distinguish it from an audio frequency oscillator. An audio oscillator produces frequencies in the audio range, about 16 Hz to 20 kHz. [2] An RF oscillator produces signals in the radiofrequency range (RF) from about 100 kHz to 100 GHz.[2] In AC feeds, an oscillator that produces AC power from a DC supply is usually called an inverter. An electromechanical device that also converts DC power into AC is called a converter. There are two main types of electronic oscillator: the linear or harmonic oscillator and the non-linear or relaxation oscillator. [2] Crystal oscillators are ubiquitous in modern electronics and produce frequencies of 32 kHz to more than 150 MHz, with 32 kHz crystals common in timing and higher frequencies common in clock generation and RF applications. 1 MHz electronic oscillator circuit that uses the resonant properties of an internal quartz crystal to control frequency. Provides the clock signal for digital devices such as computers. Harmonic oscillator block diagram of a linear feedback oscillator; an A amplifier with its output fed in its input vf through a filter, β (je). The harmonic, or linear oscillator produces a sinusoid output. [2] [5] There are two types: feedback oscillator The most common form of linear oscillator is an electronic amplifier such as a transistor or operational amplifier connected in a feedback loop with its output brought back into its input by a selective electronic frequency filter to provide positive feedback. When the power supply to the amplifier is switched on for the sometimes, the electronic noise in the circuit provides a non-zero signal to start the oscillations. The noise circulates around the loop and is amplified and filtered until it converges very quickly towards a sine wave at a single frequency. Feedback oscillator circuits can be categorized according to the type of selective frequency filter they use in the feedback loop:[2][5] In a RC oscillator circuit, the filter is a network of resistances and and RC oscillators are mainly used to generate lower frequencies, for example in the audio range. The common types of RC oscillator circuits are the phase shift oscillator and the Wien Bridge oscillator. In an LC oscillator circuit, the filter is a set circuit (often called a tank circuit; the set circuit is a resonator) consisting of an inducer (L) and a capacitor (C) connected to each other. [2] [5] The charge flows back and forth between the capacitor plates through the inductor, so that the regulated circuit can store electrical energy oscillating at its resonance frequency. There are small losses in the tank circuit, but the amplifier compensates for these losses and provides power for the output signal. LC oscillators are often used at radio frequencies[2], when a tunable frequency source is required, such as in signal generators, tunable radio transmitters and local oscillators in radio receivers. The typical LC oscillator circuits are the Hartley, Colpitts[2] and Clapp circuits. Two common LC oscillator circuits, the Hartley oscillators and Colpitts In a crystal oscillator circuit, the filter is a piezoelectric crystal (usually a quartz crystal). [2] [5] The crystal vibrates mechanically like a resonator, and its vibration frequency determines the oscillation frequency. Crystals have a very high Q factor and also better temperature stability than set circuits, so crystal oscillators have much better frequency stability than LC or RC oscillators. Crystal oscillators are the most common type of linear oscillator, used to stabilize the frequency of most radio transmitters and to generate the clock signal in computers and quartz clocks. Crystal oscillators often use the same circuits as LC oscillators, with the crystal replacing the set circuit; The Pierce oscillator circuit is also commonly used. Quartz crystals are generally limited to frequencies of 30 MHz or less. [2] Other types of resonators, dielectric resonators and surface acoustic wave devices (SAWs), are used to control higher frequency oscillators up to the microwave range. For example, SAW oscillators are used to generate the radio signal in cell phones. Negative resistance oscillator (left) Typical block diagram of a negative resistance oscillator. In some types, the negative resistance device is connected in parallel with the resonant circuit. (right) Negative-strength microwave oscillator consisting of a Gunn diode in a cavity resonator. The negative resistance of the diode excites the microwave oscillations in the cavity, which radiate the opening in a waveguide. In addition Feedback oscillators described above, which use active two-port amplifiers such as transistors and operational amplifiers, linear oscillators can also be constructed using one-port devices (two terminals) with negative resistance[2][5], such as magnetron tubes, tunnel diodes, IMPATT diodes and Gunn diodes. [2] [5]. Negative resistance oscillators are generally used at high frequency in the microwave range above, because at these frequencies the feedback oscillators malfunction due to excessive phase shift in the feedback path. In negative resistance oscillators, a resonant circuit, such as an LC circuit, crystal or cavity resonator, is connected through a device with negative differential resistance, and a DC bias voltage is applied to provide energy. A circuit resonating in itself is almost an oscillator; it can store energy in the form of electronic oscillations so excited, but because it has electrical resistance and other losses the oscillations are cushioned and decomposition to zero. The negative resistance of the active apparatus cancels the (positive) resistance to internal losses in the resonator, creating a resonator without damping, which generates spontaneous continuous oscillations at its resonance frequency. The negative resistance oscillator model is not limited to port devices such as diodes; feedback oscillator circuits with two-port amplification devices such as transistors and tubes also have negative resistance. [6] [7] [8] At high frequencies, three terminal devices such as transistors and FETs are also used in negative resistance oscillators. At high frequencies, these devices do not require a feedback loop, but some loads applied to one port may become unstable at the other port and show negative resistance due to internal feedback. The negative resistance port is connected to a set circuit or a resonant cavity, causing them to oscillate. [6] [7] [9] High-frequency oscillators in general are designed using negative resistance techniques. [6] [7] [8] Some of the many harmonic oscillator circuits are listed below: Active devices used in oscillators and approximate maximum frequencies[7] Empty Tube Peripheral Frequency Triode 1 transistor bipolar GHz (BJT) -20 GHz Bipolar Transistor Heterojunction (HBT) -50 GHz Metal-semiconductor field effect transistor (MESFET) -100 GHz Gunn diode, Fundamental mode '100 GHz Magnetron tube '100 GHz Transistor High Electronic Mobility (HEMT) '200 GHz Klystron tube '200 GHz Gunn diode , harmonic mode '200 GHz IMPATT diode '300 GHz Gyrotron tube '600 GHz Armstrong oscillator, a.k.a. Oscillator Meissner Clapp oscillator Colpitts oscillator Oscillator coupled Dynatron oscillator Oscillator Hartley Oscillator Opto-electronic Oscillator Pierce oscillator phase-shiftIng Oscillator Robinson oscillator Os Tri-tet Oscillateur Vack-oscillator Wien bridge oscillator Relaxation Main article: Relaxation oscillator A non-woody or relaxation oscillator produces a non-sinusoidal output, such as a square wave, scitooth or triangle. consists of an energy storage element (capacitor or, more rarely, an inductor) and a non-woody switching device (a latch, Schmitt trigger or negative resistance element) connected in a feedback loop. The switching device periodically charges and discharges the energy stored in the storage element, causing sudden changes in the output waveform. Square-wave relaxation oscillators are used to the clock signal for sequential logic circuits such as stopwatches and counters, although crystal oscillators are often preferred for their greater stability. Triangle or sawdust wave oscillators are used in time base circuits that generate horizontal deflection signals for cathode ray tubes in analog oscilloscopes and television sets. They are also used in controlled voltage oscillators (WNVs), inverters and switching power supplies, double-slope analogs to digital converters (ADCs), and in function generators to generate square and triangular waves for test equipment. In general, relaxation oscillators are used at lower frequencies and have lower frequency stability than linear oscillators. The ring oscillators are built from a ring of active delay steps. Generally, the ring has an odd number of inversion steps, so there is no single stable state for internal ring tensions. Instead, a single transition spreads endlessly around the ring. Some of the most common oscillator relaxation circuits are listed below: Pearson-Anson Multivibrator Oscillator Ring Oscillator Line Oscillator Delay-line Oscillateur Royer Voltage-controlled oscillator (VCO) Main article: Tension-controlled oscillator An oscillator can be designed so that the oscillation frequency can be changed over a certain range by an input voltage or current. These voltage-controlled oscillators are widely used in phased locked loops, in which the oscillator frequency can be locked at the frequency of another oscillator. These are ubiquitous in modern communication circuits, used in filters, modulators, demodulators, and forming the basis of frequency synthesizer circuits that are used to adjust radios and TVs. Radiofrequency VCRs are usually made by adding a varactor diode to the tuned circuit or a resonator in an oscillator circuit. Changing DC voltage through the varactor changes its ability, which changes the resonance frequency of the set circuit. Tension-controlled relaxation oscillators can be constructed by loading and unloading the energy storage capacitor with a voltage-controlled power source. The increase in input voltage increases the capacitor's charging speed, decreasing the time between switching events. History The first practical oscillators were based on electric arcs, which were used for lighting in the 19th century. The current through an arc light is unstable due to its negative resistance, and often breaks into spontaneous oscillations, causing the arc to make sing sounds, humming or howling[10] that had been noticed by Humphry Davy in 1821, Benjamin Silliman in 1822,[11] Auguste Arthur of the Shore in 1846,[12] and David Edward Hughes in 1878. Ernst Lecher in 1888 shows that the current through an electrical arc can be oscillatory. [14] [15] An oscillator was built by Elihu Thomson in 1892[17][18] placing a circuit set by LC in parallel with an electrical arc and included a magnetic eruption. Independently, the same year, George George FitzGerald realized that if damping resistance in a resonant circuit could be rendered null or void, the circuit would produce oscillations and, without success, attempted to construct a negative resistance oscillator with a dynamo, what would now be called a parametric oscillator. [19] [10] The bow oscillator was rediscovered and popularized by William Duddell in 1900. [20] Duddell, a student at London Technical College, was investigating the arcing effect. He attached an LC circuit (set circuit) to the electrodes of an arc lamp, and to the negative resistance of the excited arc oscillation in the set circuit. [10] Some of the energy was radiated as sound waves through the arc, producing a musical tone. Duddell demonstrated his oscillator to the London Institute of Electrical Engineers by sequentially linking different circuits set across the bow to play the national anthem God Save the Queen. Duddell's singing arc does not generate frequencies above the audio range. In 1902, Danish physicists Valdemar Poulsen and P. O. Pederson were able to increase the frequency produced in the radio range by operating the arc in a hydrogen atmosphere with a magnetic field, inventing the Poulsen arc radio transmitter, the first continuous wave radio transmitter, which was used in the 1920s. [22] [23] [24] A 120 MHz oscillator starting from 1938 using a parallel stem transmission line resonator (Lecher line). Transmission lines are widely used for UHF oscillators. The vacuum tube feedback oscillator was invented around 1912, when it was discovered that feedback (regeneration) in the newly invented audio vacuum tube could produce oscillations. At least six researchers made this discovery independently, although not all of them can be said to have a role to play in the invention of the oscillator. [25] In the summer of 1912, Edwin Armstrong observed oscillations in the circuits of radio audions[27] and used positive comments in his invention of the regenerative receiver. [28] Austrian Alexander Meissner independently discovered positive feedback and invented oscillators in March 1913. [27] Irving Langmuir at General Electric observed the returns in 1913. Fritz Lowenstein may have preceded the others with a crude oscillator in late 1911. [31] In Britain, H. J. Round patented amplification and oscillation circuits in 1913. In August 1912, Lee De Forest, the inventor of the audion, had also observed oscillations in his amplifiers, but he did not understand the importance and tried to eliminate it[32][33] until he read Armstrong's patents in 1914, which he quickly challenged. Armstrong and De Forest fought a long legal battle over the rights to the oscillator circuit [35][36] has been called the most complicated patent dispute in radio history. [37] De Forest finally won in the Supreme Court in 1934 for technical reasons, but most sources consider Armstrong's claim to be the strongest The first and most widely used relaxation oscillator circuit, the astable multivibrator, was invented in 1917 by French engineers Henri Abraham and Eugene Bloch. [38] [39] They called their dual-vacuum circuit coupled with a multivibrant, because the square wave signal it produced was rich in harmonics[39][40] compared to the sinusoid signal of other vacuum tube oscillators. Vacuum tube feedback oscillators became the basis of radio transmission in 1920. However, the triode vacuum tube oscillator performed poorly above 300 MHz due to interelecrode capacity. [citation needed] To reach higher frequencies, new transit time vacuum tubes (speed modulation) were developed, in which electrons traveled in clusters through the tube. The first of these was the Barkhausen-Kurz oscillator (1920), the first tube to produce energy in the UHF range. The most important and widely used were the klystron (R. and S. Varian, 1937) and the cavity magnetron (J. Randall and H. Boot, 1940). The mathematical conditions for feedback oscillations, now called the Barkhausen criterion, were derived by Heinrich Georg Barkhausen in 1921. The first analysis of a non-woody electronic oscillator model, the Van der Pol oscillator, was carried out by Balthasar van der Pol in 1927. [41] It showed that the stability of oscillations (limit cycles) in the actual oscillators was due to the non-leliarity of the amplification device. It is the origin of the term relaxation oscillation and was the first to distinguish between linear oscillators and relaxation oscillators. Further advances in mathematical analysis of oscillation were made by Hendrik Wade Bode and Harry Nyquist[42] in the 1930s. In 1969, Kurokawa obtained necessary and sufficient conditions for oscillation in negative resistance circuits, [43] which form the basis of the modern microwave oscillator design. [9] See also Oscillator locked injection Digitally controlled Oscillator Extended Interaction Oscillator Variable-Frequency Drive References - a b Snelgrove, Martin (2011). Oscillator. McGraw-Hill Encyclopedia of Science and Technology, 10th Ed., Science Access online service. Mr. McGraw Hill. Archived of the original on July 19, 2013. Recovered on March 1, 2012. A b c d e f h i j k l m m n Chattopadhyay, D. (2006). Electronics (fundamentals and applications). New Age International. 224-225. ISBN 978-81-224-1780-7. A b Horowitz, Paul; Hill, Winfield (2015). The art of electronics. Usa. 425. ISBN 978-0-521-80926-9. Inverter frequently asked questions. www.powerstream.com. Recovered 2020-11-13. A b c de e f g h Garg, Rakesh Kumar; Ashish Dixit; Pavan Yadav (2008). basic. Media firewall. 280. ISBN 978-8131803028. A b c Kung, Fabian Wai Lee (2009). Lesson 9: Oscillator Design (PDF). RF/Microwave circuit design. Professor Kung's website, Multimedia University. Archived with the original (PDF) on July 16, 2015. Retrieved October 17, 2012., Sec. 3 Negative Resistance Oscillators, pp. 9-10, 14 - a b c d ràisonen, V.; Arto Lehto (2003). Radio engineering for wireless communication and sensor applications. USA: Artech House. 180-182. ISBN 978-1580535427. A b Ellinger, Frank (2008). Radio Frequency Integrated Circuits and Technologies, 2nd Ed. USA: Springer. 391-394. ISBN 978-3540693246. A b Meuse, Stephen A. (2003). Non-woody microwave circuits and RF, 2nd House Ed. Artech. 542-544. ISBN 978-1580534840. A b c d Hong, Sungook (2001). Wireless: From Marconi's black box to the Audion. MIT Press. ISBN 978-0262082983., pp. 161-165 - Silliman, Benjamin (1859). First principles of physics: Or natural philosophy, designed for the use of schools and colleges. H.C. Peck and T. Bliss. 629. Davy Silliman Hissing. Casperson, L. W (1991). The phone buzzing like an acoustic maser. Optical and quantum electronics. 23 (8): 995–1010. doi:10.1007/BF00611436. S2CID 119956732. Anders, André (2009). Cathode arches: from fractal spots to energy condensation. Springer Science and Business Media. 31-32. ISBN 978-0387791081. Cady, W. G.; Arnold, H.D. (1907). On the electric arc between metal electrodes. American Journal of Science. 24 (143): 406. Recovered April 12, 2017. Notes. The electric exam. 62 (1578): 812. February 21, 1908. Recovered April 12, 2017. Morse 1925, 23 - US 500630, Thomson, Elihu, Method of and Means for Producing Alternating Currents, published on July 18, 1892, published on July 4, 1893 - G. Fitzgerald, On the Driving of Electromagnetic Vibrations by Electromagnetic and Electrostatic Engines, read at the January 22, 1892 meeting of the Physical Society of London in Larmor, Joseph, ed. (1902). The scientific writings of the late George Francis Fitzgerald. London: Longmans, Green and Co. pp. 277-281. Morse 1925, pp. 80-81 - GB 190021629, Duddell, William du Bois, Improvements in and connected with Means for the Conversion of Electrical Energy, Derived from a Source of Direct Current, into Varying or Alternating Currents, published on November 29, 1900, published on November 23, 1901 - Morse, 1925, p. 31 - GB 190315599, Poulsen, Valdemar, Improvements relating to the Production of Alternating Electric Currents, published on 14 July 1904 - US 789449, Poulsen, Valdemar, Method of Producing Alternating Currents with a High Number of Vibrations, published on 9 May 1905 - Hempstead, Colin; William E. Worthington (2005). Encyclopedia of 20th century technology. 2. Taylor and Francis. 648. ISBN 978-1579584641. Hong 2001, p. 156 - a b c Fleming, John Ambrose (1919). The thermal valve and its developments in radio telegraphy and telephony. London: The Wireless Press. 148-155. Hong, Sungook (2003). A History of the Regeneration Circuit: From Invention to Patent Litigation (PDF). Ieee. Recovered on August 29, 2012. Cite journal requires 'journal' (help), pp. Armstrong, Edwin H. (September 1915). Some recent developments in the Audion receiver (PDF). Proc. Ire. 3 (9): 215–247. 215–247. S2CID 2116636. Recovered on August 29, 2012. a b Hong 2003, p. 13 - Hong 2003, p. 5 - Hong 2003, pp. 6-7 - a b Hijiya, James A. (1992). Lee De Forest and the fatherhood of radio. Lehigh University Press. 89-90. ISBN 978-0934223232. Hong 2003, p. 14 - a b c Nahin, Paul J. (2001). The Science of Radio: With Matlab and Electronics Workbench Demonstration, 2nd ed. Springer. 280. ISBN 978-0387951508. Hong 2001, pp. 181-189 - Hong 2003, p. 2 - Abraham, H.; E. Bloch (1919). Measurement of the period of high-frequency oscillations. Reviews. 168: 1105. A b Glazebrook, Richard (1922). A Dictionary of Applied Physics, Vol. 2: Electricity. London: Macmillan and Co. Ltd. 633-634. A b Calvert, James B. (2002). The Eccles-Jordan and multivibrators circuit. Dr. J.B. Calvert's website, Univ. Denver. Recovered may 15, 2013. Van der Pol, Balthazar (1927). On relaxation-oscillations. The London, Edinburgh and Dublin Philosophical Magazine. 2 (7): 978–992. doi:10.1080/14786442608564127. Nyquist, H. (January 1932). Regeneration Theory (PDF). Bell System Tech. J. 11 (1): 126-147. doi:10.1002/j.1538-7305.1932.tb02344.x. Recovered on December 5, 2012. Alcatel-Lucent - Kurokawa, K. (July 1969). Some basic features of negative broadband resistance oscillator circuits (PDF). Bell System Tech. J. 48 (6): 1937-1955. doi:10.1002/j.1538-7305.1969.tb01158.x. Recovered on December 8, 2012. Eq. 10 is a necessary condition for oscillation; Eq. 12 is a sufficient condition, Morse, A. H. (1925), Radio: Beam and Broadcast: Its story and patents, London: Ernest Benn. History of radio in 1925. Oscillator claims in 1912; Case of De Forest and Armstrong cf. 45. Hummer/telephone oscillator by A. S. Hibbard in 1890 (carbon microphone has power gain); Larsen used the same principle in the production of an alternative current from a direct current source; accidental development of the vacuum tube oscillator; all at 86. Von Arco and Meissner first recognize the application to the transmitter; Tower for the first transmitter; patented triode transmitter at p. 87. Read also Ulrich Rohde, Ajay Poddar, and Georg Bock, The Design of Modern Microwave Oscillators for Wireless Applications: Theory and Optimization, (543 pages) John Wiley and Sons, 2005, ISBN 0-471-72342-8. E. Rubiola, Phase Noise and Frequency Stability in Oscillators Cambridge University Press, 2008. ISBN 978-0-521-88677-2. External links Wikimedia Commons has media related to electronic oscillators. Howstuffworks: oscillator. Oddities oscillator. A tutorial on the generation of precision frequencies. Excerpt from