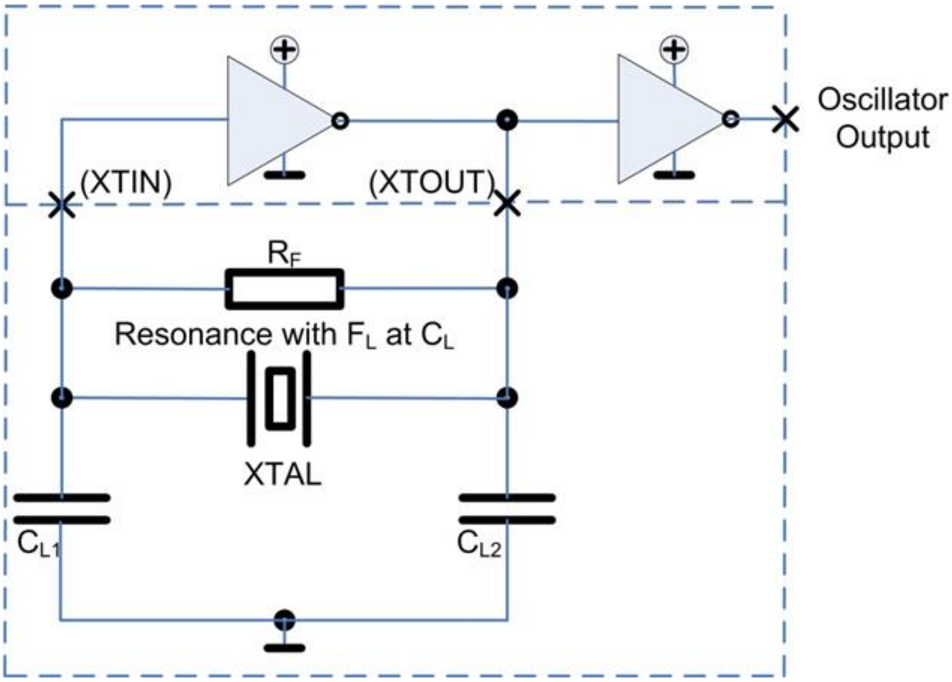
What's the difference between a crystal and an oscillator?

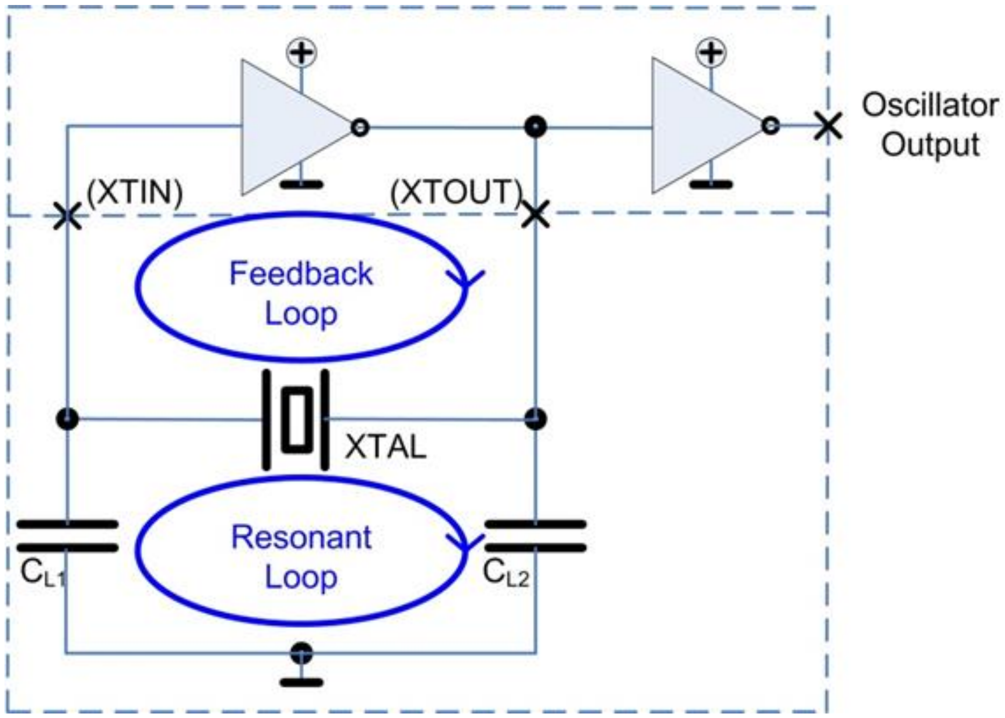
- Crystal:
  - Passive component
  - Needs external energy to oscillate
- Oscillator:
  - Active component
  - Requires supply voltage
  - Is able to provide subsequent circuits with signals



Jauch Quartz GmbH
info@jauch.com • www.jauch.com
THE PULSE OF PROGRESS

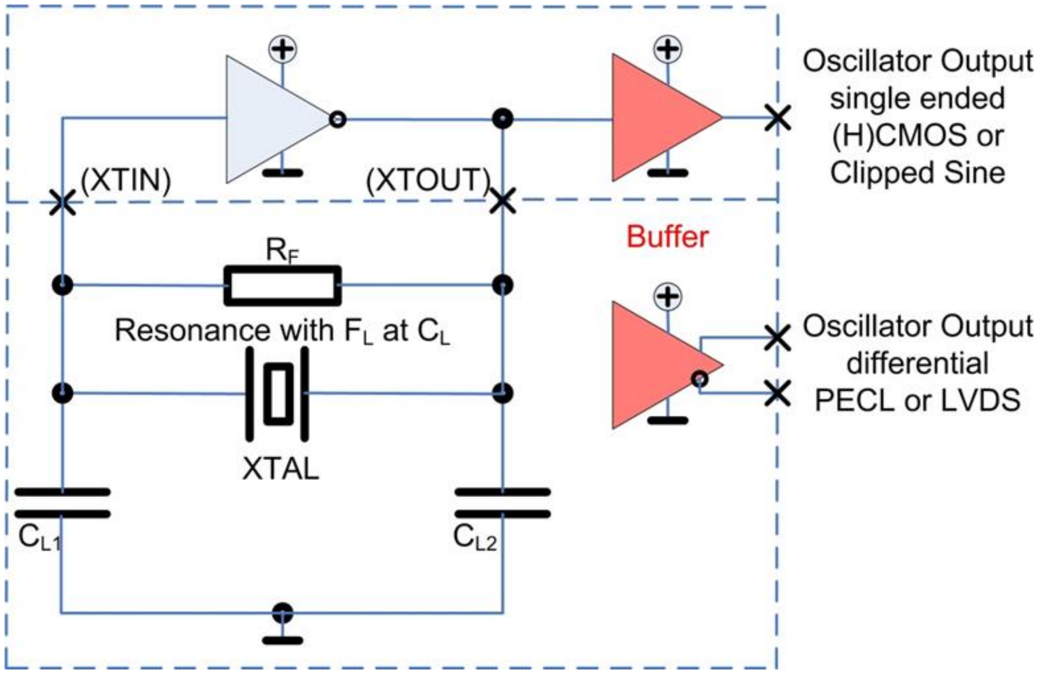
Oscillation circuit

- Resonant loop:
  - Crystal (XTAL) and load capacitors (CL1 & CL2)
  - Frequency is influenced by load capacitors
  - Series resistance of the crystal is responsible for the main energy loss
- Feedback loop:
  - Includes an amplifier that amplifies signals from XTIN to XTOUT with a certain gain
  - Amplifier is needed for compensation of resonant loop loss
  - In the case of a loss factor of 0.5, the amplification has to be min. 2 to compensate
  - Additional demand: proper phase shift of the fed back signal

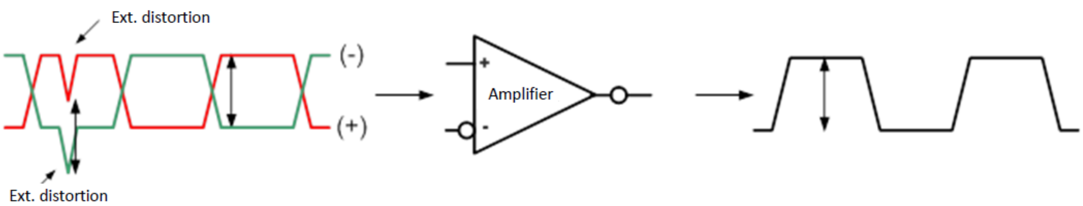


Oscillation Circuit – Output Buffer

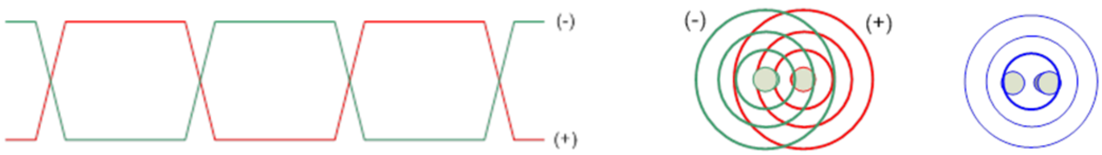
- Output buffer:
  - Isolation of the inner oscillation circuit from the external load of the external customer circuit
  - Different buffer types for the required signal types and circuit conditions
  - Single ended standard signal types: (H)CMOS, Clipped Sine
  - Differential standard signal types: PECL, LVDS



- Advantages of differential buffers at high frequencies:
  - High suppression of coupled in distortion signals

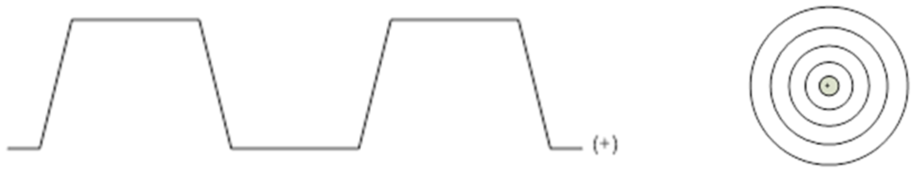


  - Lower undesired RF emissions produced by differential wiring



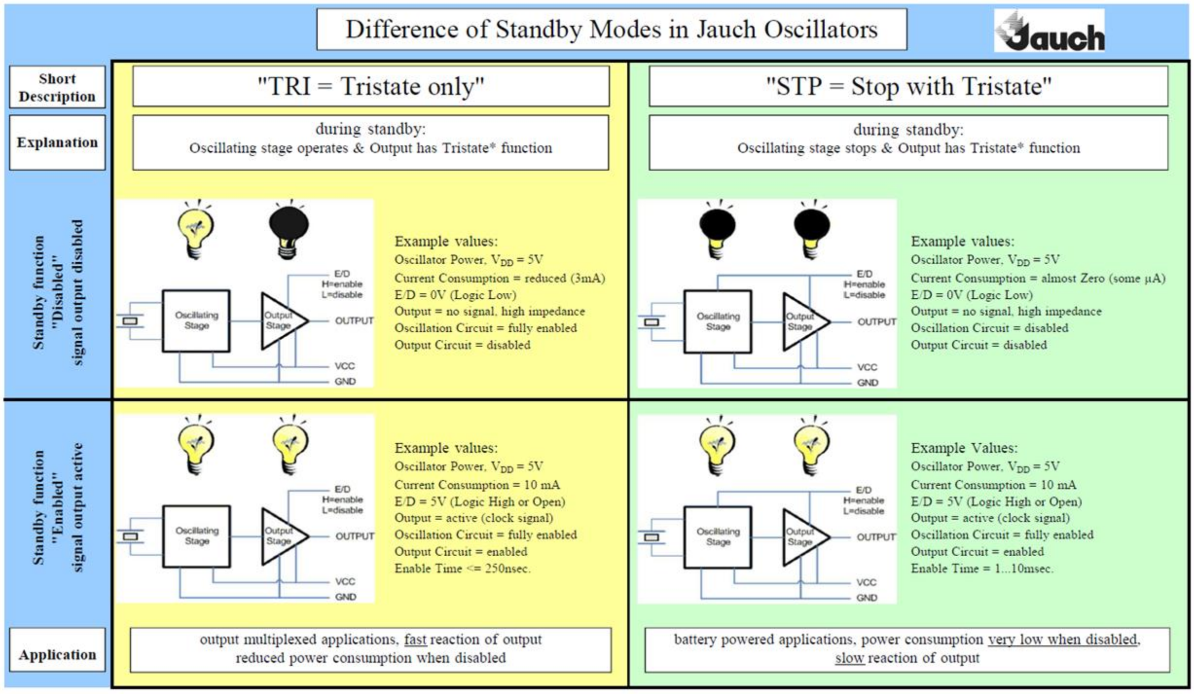
Jauch Quartz GmbH
info@jauch.com • www.jauch.com

- In comparison to single wiring (single ended buffer)



Oscillation Circuit – Stop and TriState

- Standard → Stop (with TriState), low current consumption when disabled
- Optional → TriState (only), very short startup time

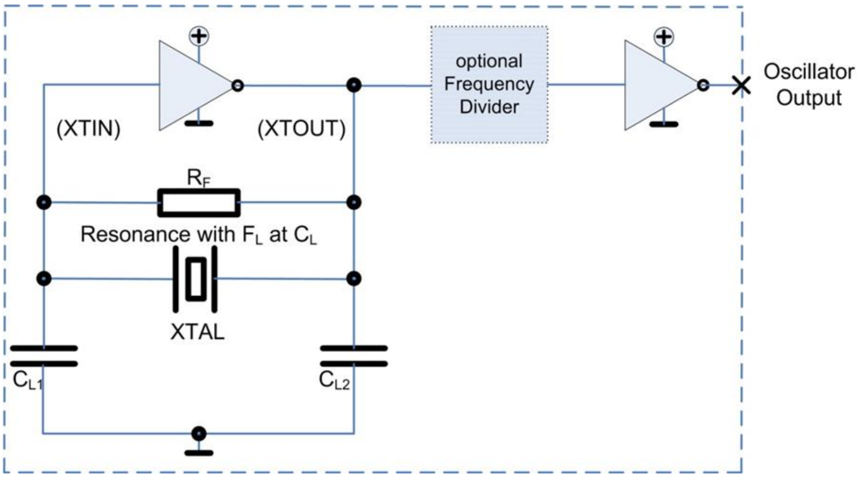


Short Description	"TRI = Tristate only"	"STP = Stop with Tristate"
Explanation	during standby: Oscillating stage operates & Output has Tristate* function	during standby: Oscillating stage stops & Output has Tristate* function
Standby function "Disabled" signal output disabled	Example values: Oscillator Power, V_{DD} = 5V Current Consumption = reduced (3mA) E/D = 0V (Logic Low) Output = no signal, high impedance Oscillation Circuit = fully enabled Output Circuit = disabled	Example values: Oscillator Power, V_{DD} = 5V Current Consumption = almost Zero (some µA) E/D = 0V (Logic Low) Output = no signal, high impedance Oscillation Circuit = disabled Output Circuit = disabled
Standby function "Enabled" signal output active	Example values: Oscillator Power, V_{DD} = 5V Current Consumption = 10 mA E/D = 5V (Logic High or Open) Output = active (clock signal) Oscillation Circuit = fully enabled Output Circuit = enabled Enable Time <= 250nsec.	Example Values: Oscillator Power, V_{DD} = 5V Current Consumption = 10 mA E/D = 5V (Logic High or Open) Output = active (clock signal) Oscillation Circuit = fully enabled Output Circuit = enabled Enable Time = 1...10msec.
Application	output multiplexed applications, fast reaction of output reduced power consumption when disabled	battery powered applications, power consumption very low when disabled, slow reaction of output

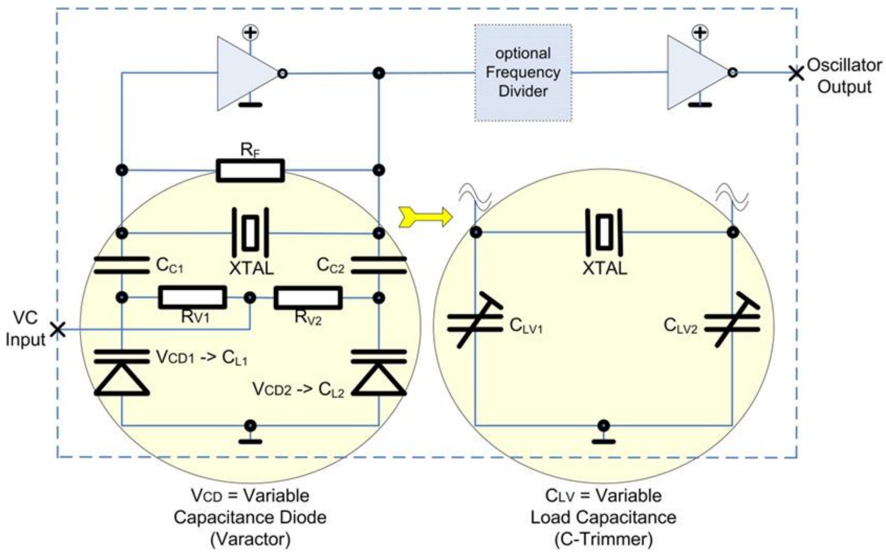
Jauch Quartz GmbH
info@jauch.com • www.jauch.com

Oscillator – Features Overview

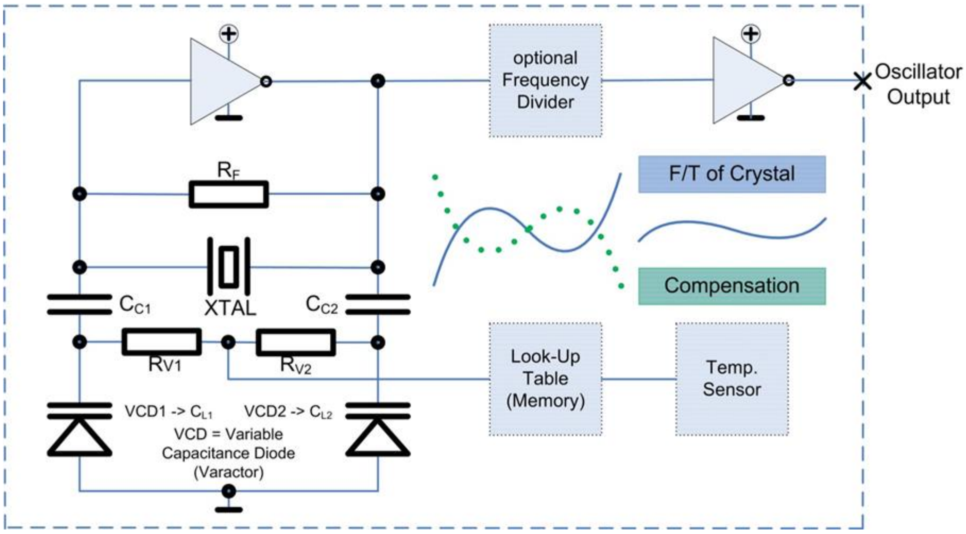
- XO (Crystal Oscillator):
  - Fixed frequency oscillator (e.g. JOxx, VX3)
  - Crystal (XTAL) and Load capacitors (CL1 and CL2)
  - Resonant frequency is controlled by crystal with fixed load capacitors
  - Crystal blanks depending on the frequency at fundamental or overtone
  - Low frequencies by divider /2; /4; /8; /16; /32; /64 of the fundamental frequency



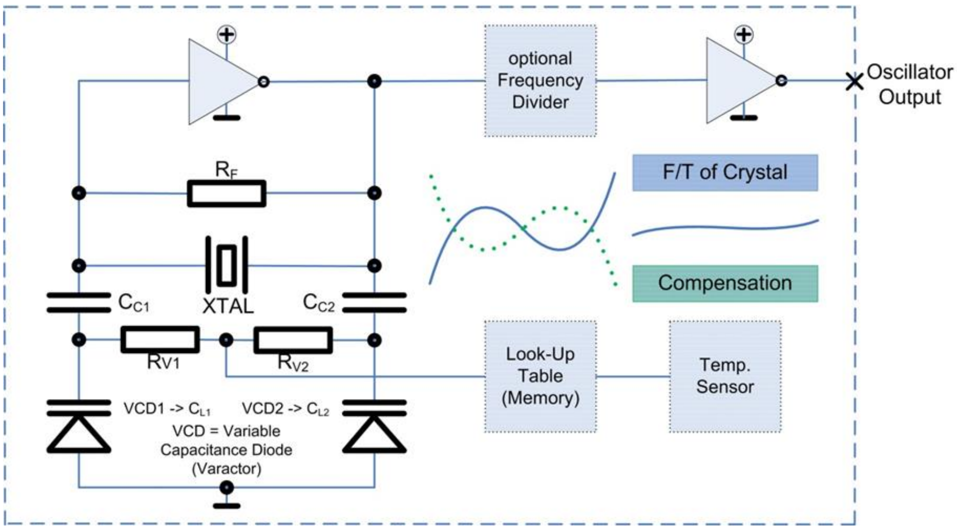
- VCXO (Voltage Controlled Crystal Oscillator):
  - Oscillator with variable frequency (e.g. JVxx)
  - Frequency variation is voltage controlled
  - Crystal (XTAL) and variable load capacitors / capacitance diodes (CL1 and CL2)
  - Resonant frequency is controlled by crystal and variable capacitors
  - Fundamental crystal blanks only (frequency at 3rd overtone not pullable => unusable)
  - Low frequencies by divider /2; /4; /8; /16; /32; /64 of the fundamental frequency



- TCXO "light" (Temperature Compensated Crystal Oscillator):
  - Temperature compensated Oscillator (JOxxH), better stability than JOxx
  - Crystal and variable load capacitors / capacitance diodes (varactors)
  - Resonant frequency is controlled by crystal and fixed load capacitors
  - Compensation with stored compensation values, according to current temperature
  - Compensation table determined and stored by calibration in production process
  - Fundamental crystal blanks only (frequency at 3rd overtone not pullable => unusable)

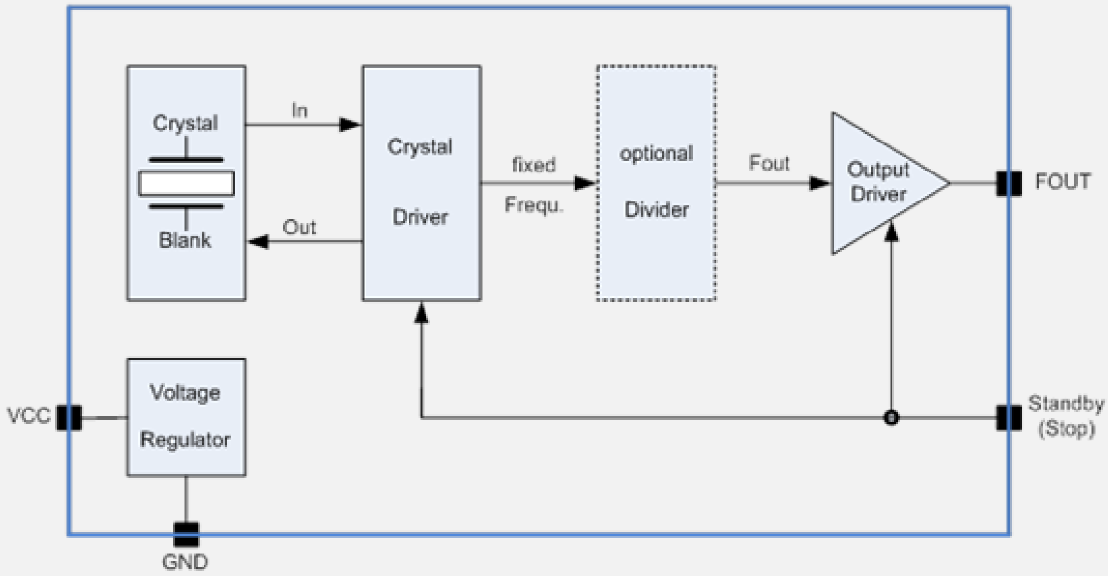


- TCXO (Temperature Compensated Crystal Oscillator):
  - Temperature Stabilized Oscillator with high stability (JTxx, JTxxC)
  - Variant with variable frequency optionally available as JTxxV (-> VCTCXO)
  - Crystal and variable load capacitors / capacitance diodes (varactors)
  - Resonant frequency is controlled by crystal and variable load capacitors
  - Compensation with saved compensation values, fitting to current temperature
  - Compensation table determined and stored by calibration in production process
  - Fundamental crystal blanks only (frequency at 3rd overtone not pullable => unusable)

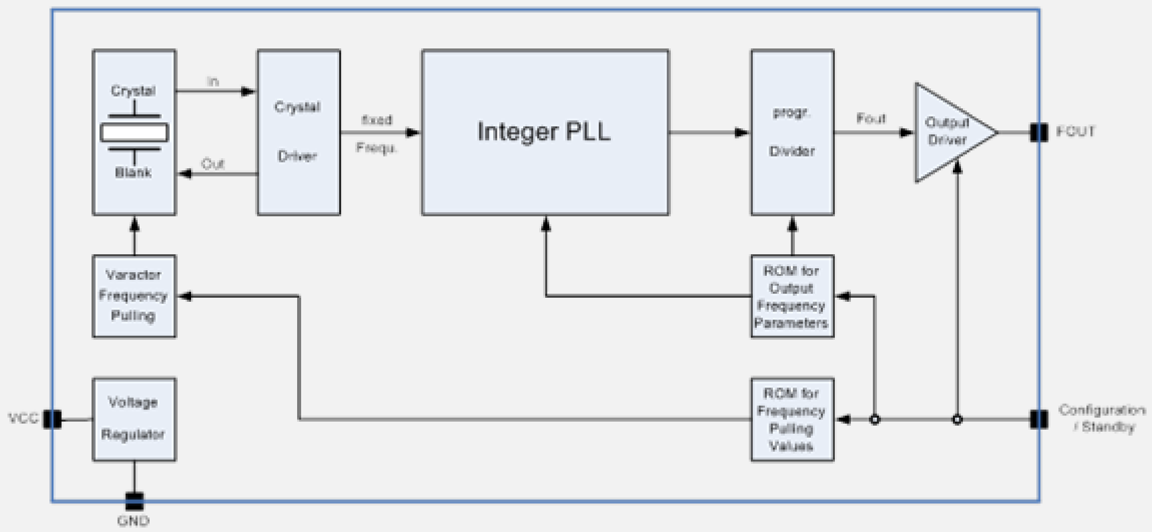


MEMS vs. Crystal Oscillator – Block Diagram Comparison

Crystal oscillator (blank determines frequency)



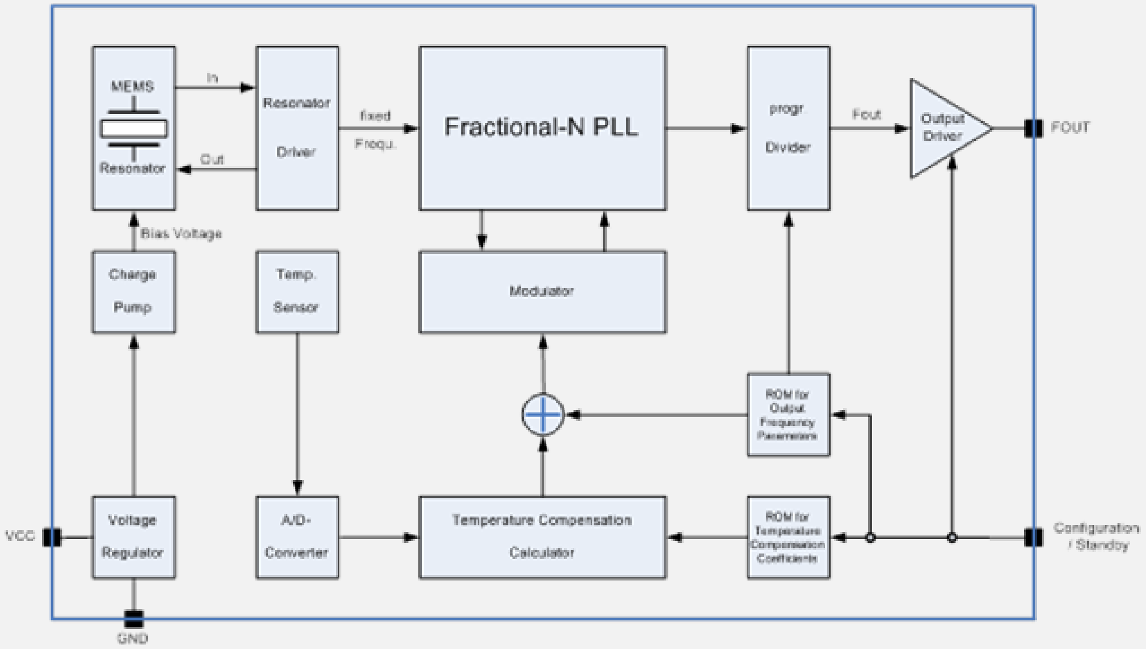
Crystal programmable oscillator



THE PULSE OF PROGRESS

MEMS oscillator

- ASIC contains
    - Temperature sensor
    - Fractional N PLL
    - Configurable algorithm for temperature compensation
    - Memory for compensation coefficients



Jauch Quartz GmbH
info@jauch.com • www.jauch.com

Oscillators – Features Overview

- Programmed Oscillator:
  - Oscillator with programmed output frequency
  - Could be crystal based or MEMS based

- Programmed Crystal Oscillator (XO):
  - Blank part contains crystal with fixed frequency and programmable IC
  - Customer frequency by division (/ R) und multiplication (x M) of fixed frequency
  - Low output frequency by divider /2; /4; /8; /16; /32; /64 derived from VCO
  - Unsolvable ratios of target frequency and blank frequency possible (not programmable)

- Programmed MEMS Oscillator:
  - The blank part contains MEMS with fixed frequency and programmable ASIC
  - ASIC contains temperature sensor and mathematic algorithm to compensate the temperature dependency and frequency tolerance of the MEMS resonator
  - In addition, the ASIC contains the registers that contain the customer-specific settings like frequency, edge control or enable/disable function