

Overview 2022

HMI Frequency Technology



About HMI

HM International was created in 1996 by Marcel Hendrickx after more than 15 years experience in the crystal & oscillator field (former engineer at ECO nv).

Today HMI is the Leading Belgian manufacturer of precision crystals and oscillators with it's own global sales network through which it is able to provide worldwide technical support.

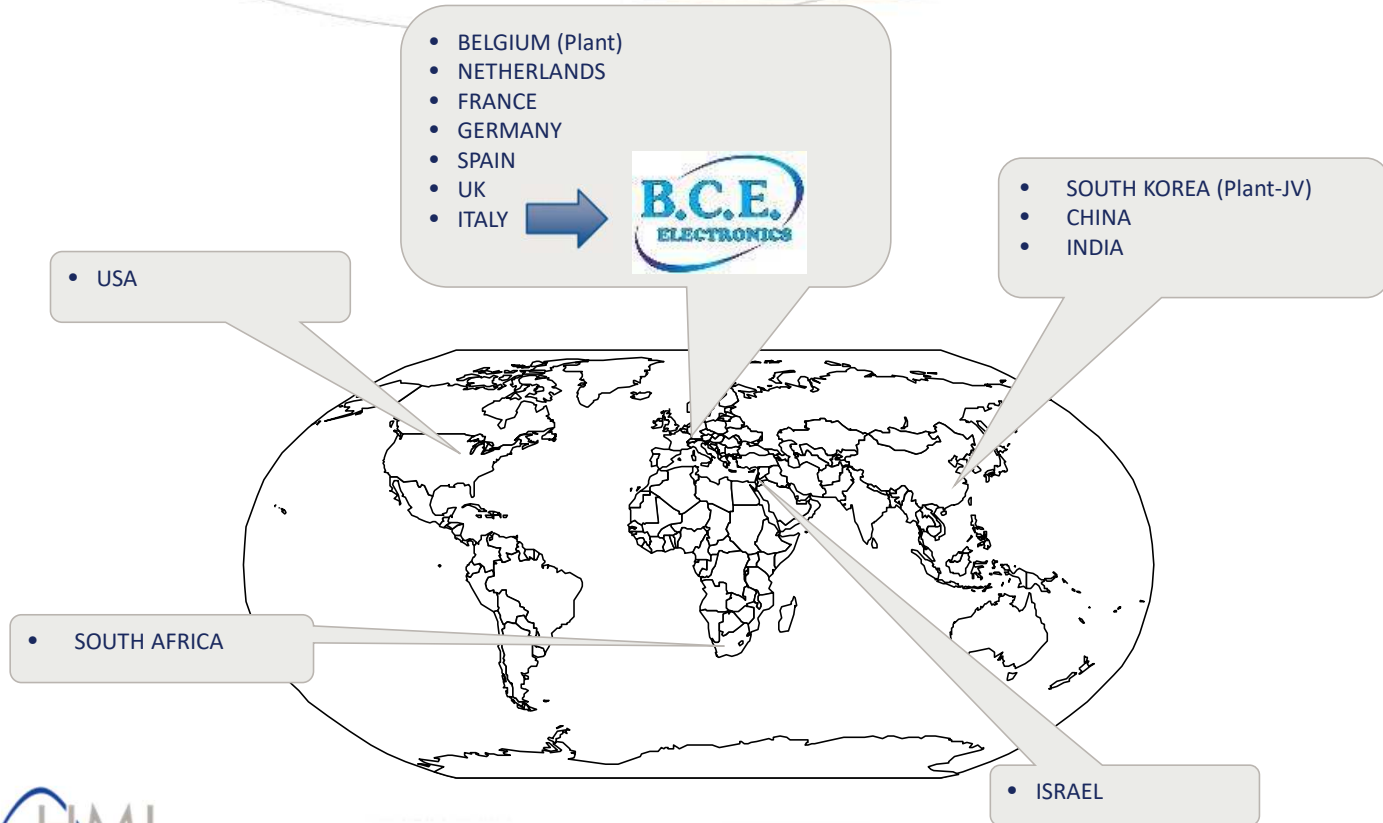
Our main goal is to work in close relationship with our customers to match our products to their applications. Even if this asks for the development of new products.



HISTORY

- **1996** Creation of HM International with own production in Belgium.
- **1997** Starting up production unit in South-Korea (JV).
- **1998** Building up a European and Middle East sales network.
- **2001** ECO integrated into HM International group.
- **2004** Expansion of sales network to Asia and South-Africa.
- **2007** Klove Electronics Netherlands integrated into HM International group.
- **2008** Move to new plant in Belgium.
- **2013** Expansion of sales network to North-America.
- **2014** Polaros Israel integrated into HM International group.
- **2015** Klove Electronics moved completely to Belgian plant.
- **2021** Klove Electronics took over all business activities of Quartslab UK.

Plants and representatives



Product Range

- SMD Crystals
- Thru-Hole Crystals
- kHz Crystals
- Crystal Oscillators (XO)
- MEMS Oscillators
- Voltage Controlled Crystal Oscillators (VCXO)
- Temperature Compensated Crystal Oscillators (TCXO)
- Voltage Controlled - Temperature Compensated Crystal Oscillators (VC-TCXO)
- Temperature Compensated - Voltage Controlled Crystal Oscillators (TC-VCXO)
- Oven Controlled Crystal Oscillators (OCXO)
- Ceramic resonators

Please check out our website at www.HMinternational.be for details.



SMD Crystals

■ Package Size (in mm):

11,4 x 4,7x4,2 (49SM)



1,2 x 1,0 x 0,35 (X12)

■ Frequency:

3,579 MHz



200 MHz



Thru-Hole Crystals

- Package Size (in mm) :

19,4 x 8,95 x 19,8 (HC48/51U)



7,8 x 3,3 x 6,0 mm (UM5)

- Frequency:

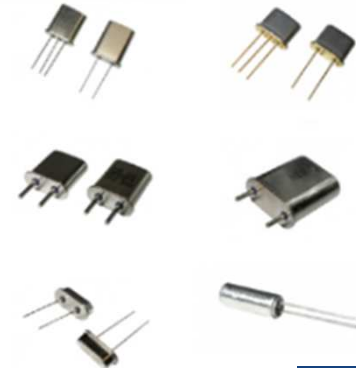
0,8 MHz



200 MHz

- Special frequencies or specs possible.

- 1 day delivery possible.



kHz Crystals

■ Package Size (in mm):

8,0 x 3,8 x 2,5 (SX99)



1,6 x 1,0 x 0,50 (X15)

■ Frequency

30 kHz



100 kHz



Crystal Oscillators (XO)

- Package Size (in mm):

20,7 x 13,1 x 7,48 (DL.)



2,0 x 1,6 x 0,70 (SX1)

- Frequency:

32,768 kHz



2100,0 MHz



- Output Logics: TTL/CMOS , LVPECL , LVDS , HCSL , CML , Low EMI , True Sine.

- NEW ➔ Short-term delivery XO's available (up to 1day delivery possible).

MEMS Oscillators

- Package Size (in mm):

2,0 x 1,6 x 0,75 (MX1C)



7,0 x 5,0 x 0,90 (MX7C)

- Frequency:

32,768 kHz



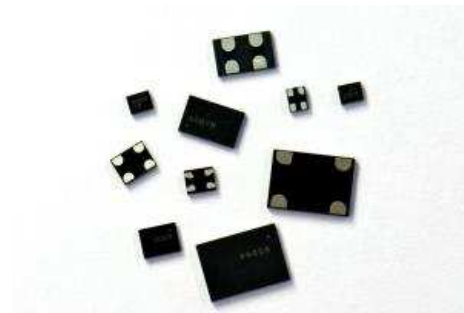
625,0 MHz

- Output Logics: CMOS , LVPECL , LVDS

- Silicon based MEMS oscillator

- Shock resistance up to 50000g

- Delivery within 48 hours



VCXOs

- Package Size (in mm):

20,7 x 13,1 x 5,08 (DL.V)



2,5 x 2,0 x 0,75 (SX2.V)

- Frequency:

1,0 MHz



2100,0 MHz

- Low jitter and Superior Phase Noise.

- Output Logics: TTL/CMOS , LVPECL , LVDS , HCSL , CML , True Sine.

- NEW → Short-term delivery VCXO's available (up to 1day delivery possible).



TCXOs

- Package Size (in mm):

20,7 x 13,1 x 7,48 (DLT)



1,6 x 1,2 x 0,6 (SXAST)

- Frequency:

32,768 kHz



2100,0 MHz

- Low jitter and Superior Phase Noise.

- Stability 0,5 ppm -40/+85, Stratum III compliant, Low current.

- Output Logics: CMOS , LVPECL , LVDS , HCSL , CML , Clipped Sine Wave.

- NEW ➔ Short delivery TCXO's available (up to 1day delivery possible).



VC-TCXOs

- Package Size (in mm):

20,7 x 13,1 x 7,48 (DL.VT)



1,6 x 1,2 x 0,6 (SXASVT)

- Frequency:

32,768 kHz



2100,0 MHz

- Low jitter and Superior Phase Noise.

- Stability 0,5 ppm -40/+85, Stratum III compliant, Low current.

- Output Logics: CMOS , LVPECL , LVDS , HCSL , CML , Clipped Sine Wave.

- NEW ➔ Short delivery VC-TCXO's available (up to 1day delivery possible).



TC-VCXOs

- Package Size (in mm):

5,0 x 3,2 x 1,4 mm

- Frequency:

15,0 MHz



1300,0 MHz

- Low jitter 300 fsec, typical

- Stability 2,5 ppm -40/+85

- Pulling +-40 ppm to +-300 ppm

- Output Logics: CMOS , LVPECL , LVDS , HCSL , CML.

- Short-term delivery .

OCXOs

- OCXO = Oven Controlled Crystal Oscillator
- Inside the OCXO , the crystal and the oscillator circuit are working in an oven controlled environment that guarantees a constant temperature.
- This constant temperature improves performance and frequency accuracy up to a few ppb (parts per billion).
- Please contact us for your specific OCXO requirement.



Ceramic Resonators

- Ceramic resonators are build with other piëzo-electric materials than quartz (usually Barium Titanate).
- Ceramic resonators are a less expensive alternative for quartz devices, but are less accurate.
- Accuracy is mentioned in % and not in ppm (parts per million).
- Available in thru-hole versions (2 lead or 3 lead) or in surface-mounted versions.
The 3 lead (3 pad) versions have built-in capacitors
- Please contact us for your specific ceramic resonator requirement.



Market Evolutions

■ Smaller packages:

Recommended parts for new designs:

- SMD Crystals:
 - [X32](#) (3.2 x 2.5mm) = high runner
 - [X25](#) (2.5 x 2.0mm) = high runner
 - [X20](#) (2.0 x 1.6 mm)

- 32.768 kHz Crystals:
 - [X31](#) (3.2 x 1.5mm) = high runner
 - [X21](#) (2.0 x 1.2 mm) = high runner

- Oscillators:
 - [SX7](#) (7.0 x 5.0mm)
 - [SX5](#) (5.0 x 3.2mm)
 - [SX3](#) (3.2 x 2.5mm) = high runner
 - [SX2](#) (2.5 x 2.0mm)

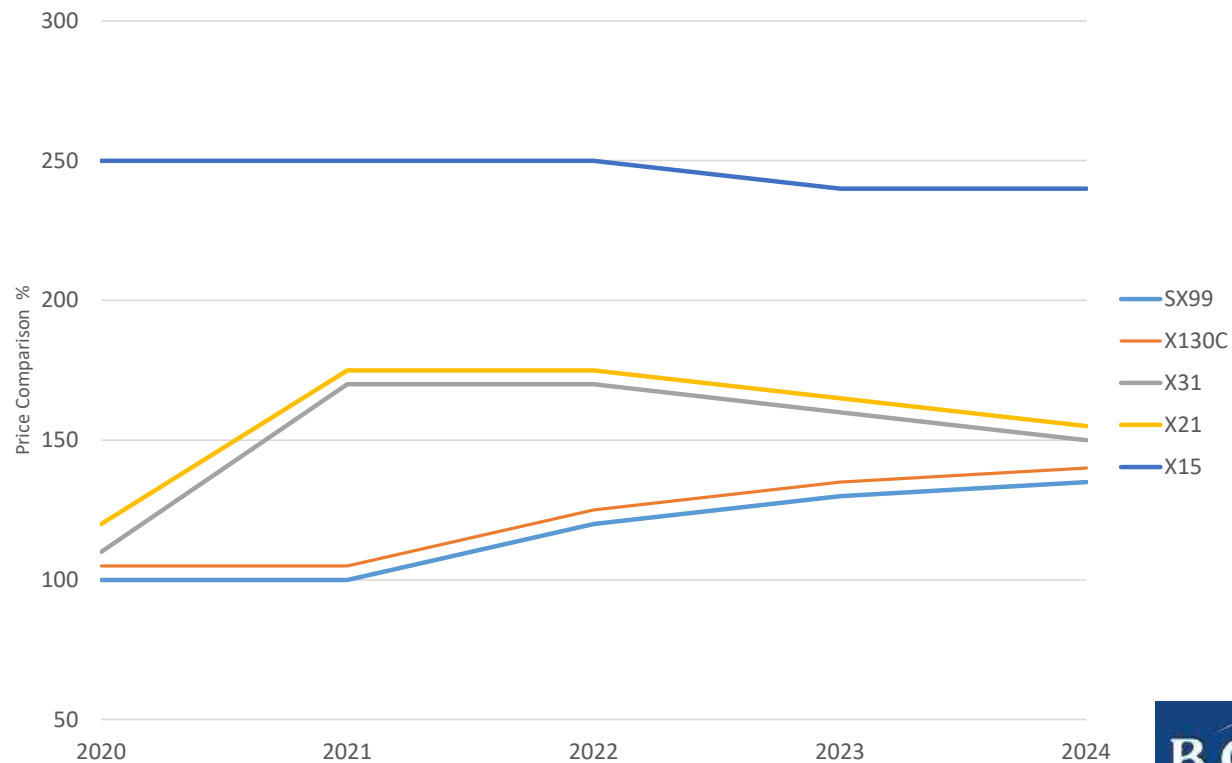
Market Evolutions

- Competitive pricing & shorter lead times
 - HMI can provide competitive prices and shorten lead times by focussing it's production on these mentioned parts.
 - We can offer buffer stock , based on customer forecast.
 - On-call deliveries
 - **Short-term delivery versions of XO, MEMS , Spread Spectrum Oscillator, VCXO, TCXO , VC-TCXO and TC-VCXO to reduce lead times even to 1 week !**

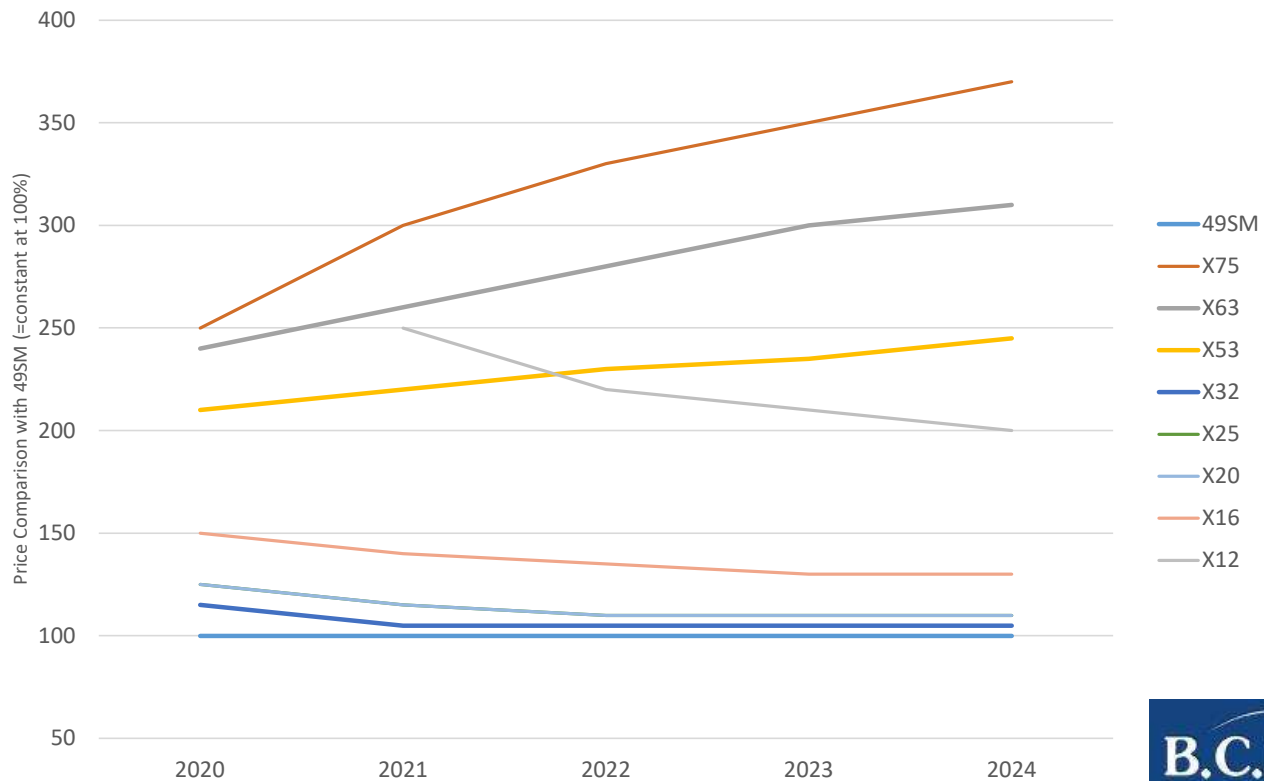
Market Evolutions

- More requirements for Accuracy , Stability , Jitter and Temperature
 - HMI can measure and test in house.
 - All Saunders Assoc. test systems for Quartz resonators, Oscillators, Ceramic resonators, Filters and MEMs.
 - We are able to provide free of charge samples with test reports.

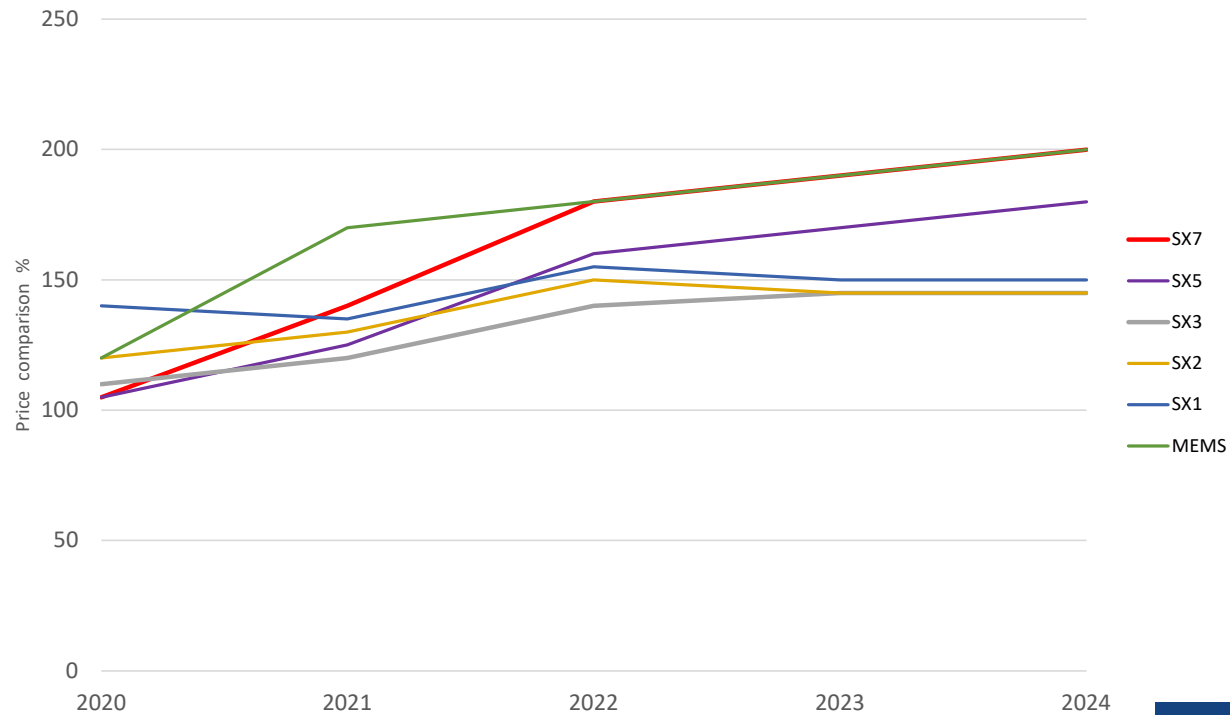
Price evolution 32,768 kHz Crystals



Price evolution Crystals



Price evolution Oscillators



New Products 2020

■ Short-term delivery XO's

- Up to 200MHz for CMOS versions
- Up to 1450MHz for LVPECL , HCSL and LVDS versions

- SX2 (2.5 x 2.0mm) in CMOS , LVPECL , HCSL and LVDS
- SX3 (3.2 x 2.5mm) in CMOS , LVPECL , HCSL and LVDS
- SX5 (5.0 x 3.2mm) in CMOS , LVPECL , HCSL and LVDS
- SX7 (7.0 x 5.0mm) in CMOS , LVPECL , HCSL and LVDS

New Products 2020

■ Short-term delivery VCXO's

- Up to 245MHz for CMOS versions
- Up to 1450MHz for LVPECL , HCSL and LVDS versions

- SX3 (3.2 x 2.5mm) in CMOS , LVPECL , HCSL and LVDS
- SX5 (5.0 x 3.2mm) in CMOS , LVPECL , HCSL and LVDS
- SX7 (7.0 x 5.0mm) in CMOS , LVPECL , HCSL and LVDS

New Products 2021

- Short-term delivery TCXOs and VC-TCXOs

- Up to 245MHz for CMOS versions
 - Up to 1450MHz for LVPECL and LVDS versions
-
- SX3 (3.2 x 2.5mm) in CMOS, LVPECL and LVDS
 - SX7 (7,0 x 5,0 mm) in CMOS, LVPECL and LVDS

New Products 2021

- 32,768 kHz TCXO , very low current consumption

- 3,2x2,5 mm package
- 1,8V – 5,0V supply voltage
- Current consumption : 1,4 μ A @ 3,3V
- +-2,5 ppm -20° to +70° C

➤ [SX3KTF](#) (3.2 x 2.5mm)

New Products 2021

- Ultra Low Jitter oscillator , SXCJ series
 - 3,2x2,5mm , 5,0x3,2mm & 7,0x5,0mm package
 - 1,8V , 2,5V , 3,3V supply voltage
 - Frequency Range : 5,0 MHz – 50,0 MHz
 - **RMS Phase Jitter : 48 fsec typ.**

New Products 2021

■ New ceramic SMD crystal X12

- Package size : 1,2 x 1,0 x 0,35 mm
- Frequency Range : 36 – 80 MHz
- Available from Q3 2020 – Q1 2021

New Products 2021

- F-series XO : 4 output frequencies in one product

- 4 output frequencies in the freq, range from 15MHz to 2,1 GHz
- 7,0 x 5,0 mm package
- 1,8V , 2,5V , 3,3V supply voltage
- **RMS Phase Jitter : 150 fsec typ.**
- CMOS , LVPECL , LVDS , HSCL and CML
- Short delivery , 2 weeks max . !!
- Available Q1 2020

New Products 2021

- TCXO & VCTCXO up to 2100MHz , Ultra Low Jitter
 - 5,0 x 3,2 mm package
 - 1,8V , 2,5V , 3,3V supply voltage
 - **RMS Phase Jitter : 300 fsec typ.**
 - CMOS , LVPECL , LVDS , HSCL and CML
 - $\pm 2,5$ ppm -40° to $+85^{\circ}$ C
 - Short delivery , 2 weeks max . !!
 - Available Q1 2020

New Products 2021-2022

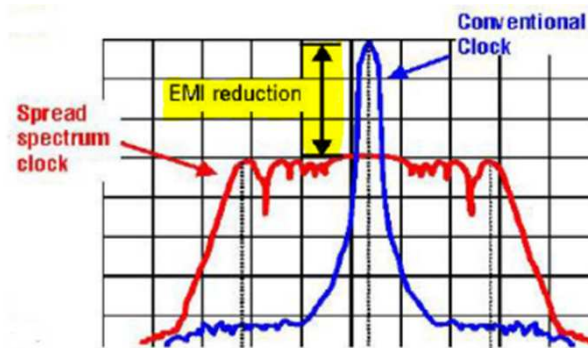
- TCVCXO up to 1300MHz , Ultra Low Jitter
 - VCXO with Temperature compensating !!
 - 5,0 x 3,2 mm package
 - +-2,5 ppm -40° to +85° C
 - Pulling +-40 ppm to +-300 ppm
 - 1,8V , 2,5V , 3,3V supply voltage
 - RMS Phase Jitter : 300 fsec typ.
 - CMOS , LVPECL , LVDS , HSCL and CML
 - Short delivery , 2 weeks max . !!
 - Available Q3 2020

New Products 2021-2022

- Oscillator & VCXO up to 2100MHz , Ultra Low Jitter
 - 5,0 x 3,2 mm , 7,0 x 5,0 mm package
 - 1,8V , 2,5V , 3,3V supply voltage
 - **RMS Phase Jitter : 150 fsec typ.**
 - CMOS , LVPECL , LVDS , HSCL and CML
 - Short delivery , 2 weeks max. !!

HMI can also provide

- Standard Low EMI Spread Spectrum Clock Oscillators
 - Reduces peak radiation energy on your PCB without EMI filters or metal shielding.
 - Can reduce EMI up to 15dB compared to conventional clock oscillators.



HMI can also provide

- On demand HMI is still able to produce parts that are obsolete for many manufacturers:
 - Larger packages SMD Crystals
 - X75 (7.0 x 5.0 mm)
 - X63 (6.0 x 3.5 mm)

HMI can also provide

- On demand HMI is still able to produce parts that are obsolete for many manufacturers:
 - 2-pad versions SMD Crystals
 - X632 (6.0 x 3.5 mm)
 - X532 (5.0 x 3.2 mm)

HMI can also provide

- On demand HMI is still able to produce parts that are obsolete for many manufacturers:
 - Following Thru-hole Crystals, even in special frequencies and/or special specifications in **very short lead times (up to 1 day)**.
 - 48U (19.4 x 8.95 x 19.8 mm) 
 - 49U (11.0 x 4.7 x 13.5 mm) 
 - 50U (11.0 x 4.7 x 13.5 mm) 
 - 51U (19.4 x 8.95 x 19.8 mm) 
 - UM1 (7.8 x 3.3 x 8.0 mm) 
 - UM5 (7.8 x 3.3 x 6.0 mm) 

HMI can also provide

- On demand HMI is still able to produce parts that are obsolete for many manufacturers:
 - DIL 14 oscillators (20.7 x 13.1 mm):
 - XO in CMOS, LVPECL, LVDS and True Sine
 - VCXO in CMOS and True Sine
 - TCXO in CMOS and Clipped Sine
 - VC-TCXO in CMOS and Clipped Sine



HMI can also provide

- On demand HMI is still able to produce parts that are obsolete for many manufacturers:
 - DIL 8 oscillators (12.7 x 12.7mm):
 - XO in CMOS
 - VCXO in CMOS



How to make a good Crystal enquiry

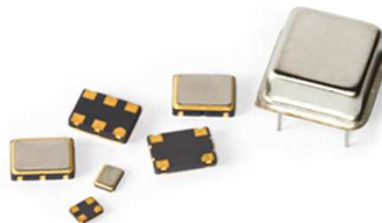
- Crystals – Needed parameters:
 - Package size: in ...x... mm (or our package type numbers).
 - Frequency: in MHz or kHz.
 - Circuit condition: Series or Parallel.
 - For Parallel Please mention Load Capacitance in ... pF.
 - Frequency Tolerance in ppm.
 - Frequency Stability in ppm over ...°C to ...°C.



How to make a good Oscillator enquiry

■ XO – Needed parameters:

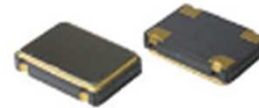
- Package size: in ...x... mm (or our package type numbers).
- Frequency: in MHz or kHz.
- Output Logic: [HCMOS](#), [LVPECL](#), [LVDS](#), [HCSL](#), [True Sine](#).
- Supply Voltage: in V
- Overall Frequency Stability: +/- ppm over ...°C to ...°C.



How to make a good Spread Spectrum Clock Oscillator enquiry

■ Spread Spectrum Clock Oscillator – Needed parameters:

- Package size: in ...x... mm (or our package type numbers).
- Frequency: in MHz.
- Output Logic = HCMOS.
- Supply Voltage: 2.5V or 3.3V.
- Overall Frequency Stability: +/- ppm over ...°C to ...°C.
- Center or Down Spread: in %.



How to make a good VCXO enquiry

■ VCXO – Needed parameters:

- Package size: in ...x... mm (or our package type numbers).
- Frequency: in MHz or kHz.
- Output Logic: HCMOS, LVPECL, LVDS, HCSL, True Sine.
- Supply Voltage: in V.
- Overall Frequency Stability: +/- ppm over ...°C to ...°C.
- Tuning Range: +/- ppm Min



How to make a good TCXO enquiry

■ TCXO – Needed parameters:

- Package size: in ...x... mm (or our package type numbers).
- Frequency: in MHz or kHz.
- Output Logic: HCMOS, LVPECL, LVDS, HCSL , CML , [Clipped sine](#).
- Supply Voltage: in V.
- Frequency Stability in ppm over ...°C to ...°C.



How to make a good VC-TCXO enquiry

■ VC-TCXO – Needed parameters:

- Package size: in ...x... mm (or our package type numbers).
- Frequency: in MHz or kHz.
- Output Logic : HCMOS, LVPECL, LVDS, HCSL , CML , Clipped sine.
- Supply Voltage: in V.
- Frequency Stability in ppm over ...°C to ...°C.
- Tuning Range: +/- ppm Min.



Glossary of terms



■ Frequency:

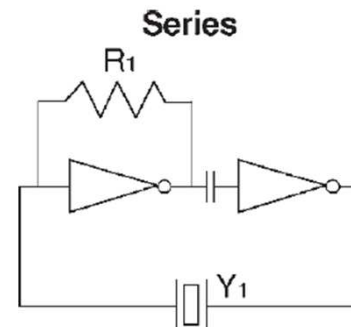
This is the center frequency of the crystal device in kiloHertz or MegaHertz. This can be in fundamental mode or in overtone mode.

Glossary of terms

■ Circuit condition of a crystal: Series or parallel

➤ Series:

This is the case when there **are NO** reactive components in the crystal unit loop on the PCB.

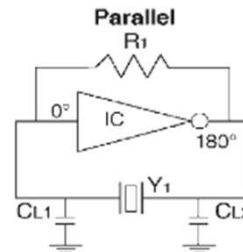


Glossary of terms

■ Circuit condition of a crystal: Series or parallel

➤ Parallel:

This is the case when there **are** reactive components (mostly capacitors) in the crystal unit loop on the PCB. To work properly in this circuit the crystal unit must have a specific load capacitance (in pF).



Glossary of terms



■ Frequency tolerance:

This indicates the maximum frequency deviation from the center frequency at room temperature of 25°C (+/- 3°C).

e.g. : a 30MHz crystal with 20ppm (parts per million) must be between 29.999.400 Hz and 30.000.600 Hz.

Glossary of terms



■ Frequency stability:

A frequency stability is always linked with a temperature range. It is the maximum allowable frequency deviation over this temperature range.

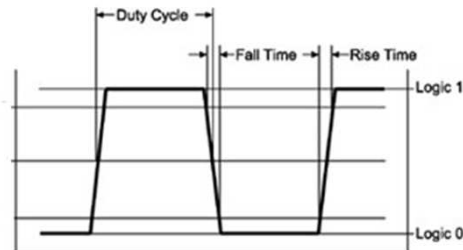
e.g. : a 27MHz crystal with a Freq stability of 30 ppm from -20°C to +70°C must stay between 26.999.190 Hz and 27.000.810 on every temp between -20°C and +70°C.

Glossary of terms

■ Output Logic of an XO:

HCMOS (High-speed Complementary Metal–Oxide–Semiconductor):

- It generates a typical square wave which is TTL (transistor-transistor logic) compatible.
- Benefits: low power consumption, low cost solution for Freq up to 200 MHz .

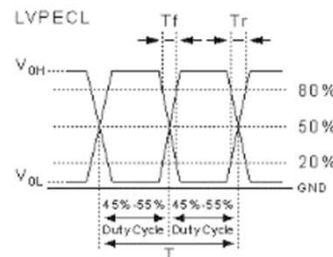


Glossary of terms

■ Output Logic of an XO:

LVPECL (Low Voltage Positive Emitter Coupled Logic):

- It generates a pair of complementary signals (square wave). So redundancy can be delivered for High speed circuits.
- Benefits: Best jitter specs, suited for high speed technologies up to 10Gbps, but less power efficient.

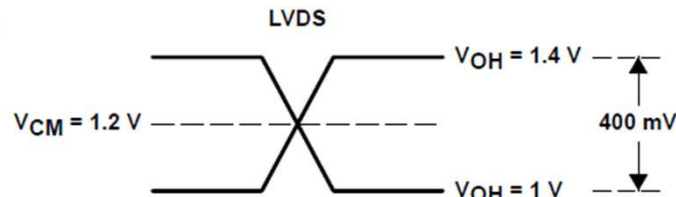


Glossary of terms

■ Output Logic of an XO:

LVDS (Low Voltage Differential Signaling):

- It generates a pair of complementary signals (square wave). So redundancy can be delivered for High speed circuits up to 3.125Gbps.
- Benefits: lower power consumption than LVPECL due to small voltage swings around operating voltage of 1.2V (regardless power supply).

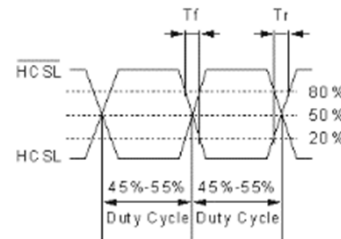


Glossary of terms

■ Output Logic of an XO:

HCSL (High speed Current Steering Logic):

- It generates a pair of complementary signals (square wave) that is typically used in PCI express applications and Intel chipsets.
- Benefits: Quickest switching times, power consumption between LVDS and LVPECL.

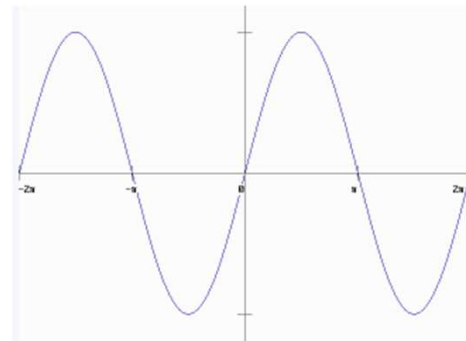


Glossary of terms

■ Output Logic of an XO:

True Sine :

- It generates only the pure output of the XO: a true sine wave with it's fundamental frequency.
- Benefits: low [phase noise](#)
- Disadvantage : Expensive

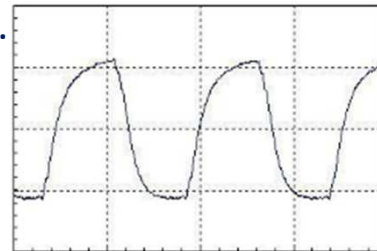


Glossary of terms

■ Output Logic of an XO:

Clipped Sine :

- It generates a single sine wave that is “clipped off” at it’s maximum.
- Benefits: lower power consumption which improves thermal characteristics. Perfect for TXCO’s.
- Cheapest solution for TCXO’s



Glossary of terms



■ Supply voltage:

This is the voltage the XO device needs to work properly.

Typical values are: 1.8V, 2.5V, 3.0V, 3.3V, 5.0V.

Glossary of terms



■ Overall Frequency Stability :

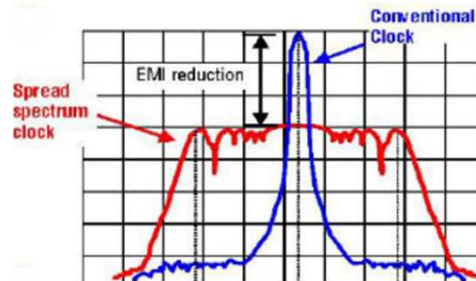
In a XO-device the overall Frequency Stability indicates the sum of frequency tolerance, frequency stability and aging in ppm. Because frequency stability is included , a temperature range has to be specified.

Glossary of terms

■ Center or Down Spread:

Center spread :

- The energy of the nominal frequency is spread 50% down and 50% up of this frequency.
- Benefits: LOW EMI, extremes of spread spectrum are closer to nominal Freq than Down Spread.
- e.g. in a 1% center spread 100MHz oscillator, the controlled modulation process starts from 99.5MHz to 100.5MHz.

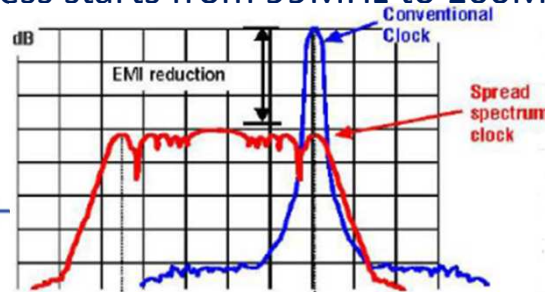


Glossary of terms

■ Center or Down Spread:

Down spread :

- The energy of the nominal frequency is spread completely at the down side of this frequency.
- Benefits: LOW EMI, but no influence for over-clocking sensitive devices.
- e.g. in a 1% down spread 100MHz oscillator, the controlled modulation process starts from 99MHz to 100MHz.



Glossary of terms

■ Tuning range:

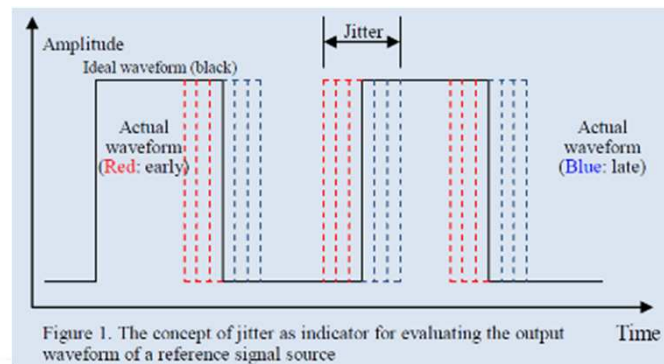
Is the (minimal) deviation in frequency that a voltage controlled oscillator device must be able to reach by manipulating the control voltage of the device.

e.g. if a tuning range of $\pm 100\text{ppm}$ is requested for a 200MHz VCXO, the output nominal frequency must be able to be shifted from 199.98MHz to 200.02MHz.

Glossary of terms

■ Jitter:

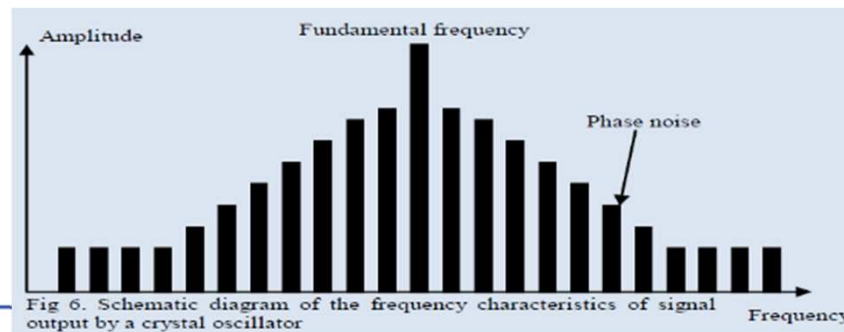
Is used to indicate the deviations from the ideal period (and frequency) of the oscillator. If Jitter could be 0 the actual output signal would be the mathematical “ideal” output signal.



Glossary of terms

■ Phase Noise:

These are the output frequencies the XO generates above the noise floor in the vicinity of the fundamental frequency. They are measured at certain offset frequencies around the fundamental frequency over a period of 1Hz.



Glossary of terms



■ Aging :

The change in frequency experienced by every crystal unit over time.

Typically this is +/- 5ppm over first year maximum for metal-package crystals and +/-2ppm over first year maximum for small ceramic package crystal units.

Thank you !



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