

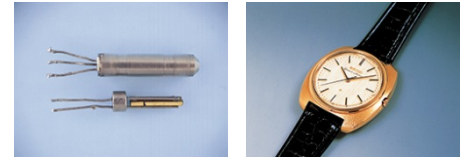
EPSON TIMING DEVICES

FACT SHEET: TIMING DEVICES



Founded in 1942, the Seiko Epson Corporation is a global technology leader dedicated to connecting people, things, and information with its original, efficient, compact, and precision technologies. Epson is well known for its market-leading printers and projectors. Total revenue was \$9.457B in FY16 (ending March 31, 2017).

Long before printers, Epson developed a Quartz crystal small enough to fit inside a watch and enabled the world's first Quartz watch. In 1969, the Seiko Astron revolutionized time keeping with lower cost, better accuracy, and better reliability than existing mechanical watches.



Today, Quartz is used for precision timing and to set frequency of virtually every electronic device including mobile phones, laptops, networking equipment, datacenters, and automotive. Through generations of innovation, Epson has miniaturized timing devices while reducing jitter and improving frequency and time accuracy.



#1 in Timing Devices

Epson is the world leader in Quartz timing devices. Since 2005, Epson has had #1 share in the timing device market. Timing device revenue was \$438M in 2016, which is a 14% share of a \$3B market. Timing devices is part of Epson's \$890M microdevices division, which also includes integrated circuits and MEMS sensors.



Best Technology

With autoclaves and photolithographic crystal processing technology, Epson achieves the best quality and process control. A full portfolio of resonators – kHz tuning forks, MHz AT and SC-cut crystals, HFF crystals, SAW resonators, and atomic gas cells – enables the most complete product portfolio in the timing industry from crystals to RTCs and oscillators of all types, including VCXOs, VCSOs, TCXOs, OCXOs, and AOs.



Complete Control of our Supply Chain

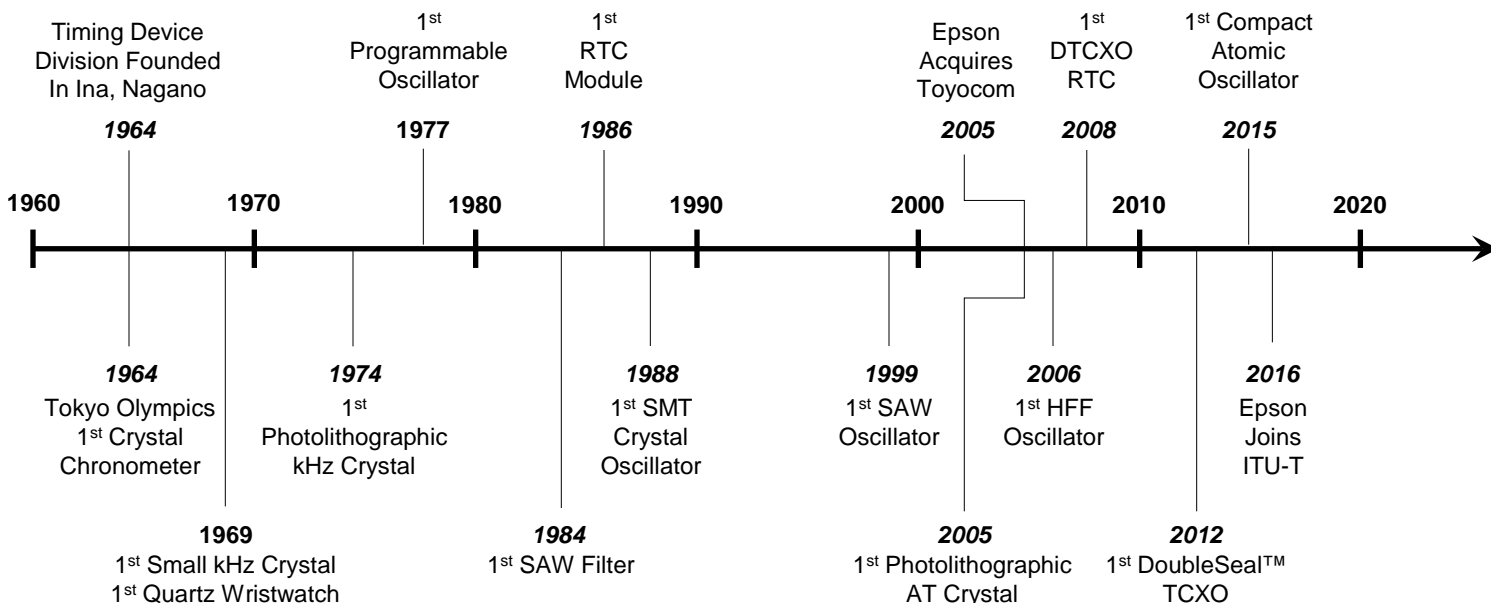
Epson is the most vertically integrated company in the Quartz timing industry. Epson is one of only seven timing device manufacturers to have their own autoclaves and the only company with their own IC fab. With every step of the production process under control, Epson has strict quality standards and is a truly dependable timing device supplier.

ENGINEERED FOR PERFORMANCE

EPSON TIMING DEVICES
<http://www5.epsondevice.com/en/>

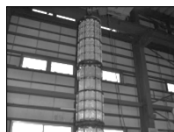
EPSON
EXCEED YOUR VISION

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Crystal Technology

Epson has the broadest range of Quartz crystal resonator technology in the industry. Photolithography enables smaller size, better performance, and better process control for kHz, AT, and HFF crystals. Epson SAWs cover high frequencies with the industry's best reliability. Epson also manufactures our own SC-cut crystals for OCXOs.



Autoclaves

To achieve the best possible quality, yield, performance, and assurance of supply, Epson produces synthetic Quartz with extremely high purity in its own autoclaves.



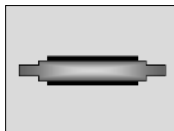
Photolithographic Crystal Processing

Epson pioneered cutting and shaping crystals by etching. Compared to using a mechanical saw, photolithography enables shape engineering and delivers better process control.



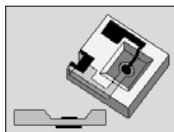
kHz – 32.768 kHz

Epson pioneered 32 kHz crystals for precise timekeeping applications. Epson kHz crystals are available in very small sizes and deliver low ESR for fast startup and low power.



MHz AT – 16-80 MHz

Epson ultra-miniature MHz crystals cover a frequency range of 16-80 MHz. Photolithographic processing delivers consistent performance and enables small size and high Q.



HFF (High-Frequency Fundamental) – 80-500 MHz

Using an inverted-mesa structure, Epson HFF crystals are fundamental and do not suffer from startup, mode-jumping, and activity dip problems common to 3rd overtone designs.



SAW (Surface Acoustic Wave) – 0.5-1 GHz

Epson introduced the world's first SAW oscillator in 1999. With zero field failures in 18 years, Epson SAW oscillators are the most reliable frequency control device ever made.

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Epson has the broadest range of crystal and oscillator products of any timing device supplier. Epson's portfolio includes RTCs for precise time keeping, programmable oscillators for fast-turn prototypes, crystal and SAW oscillators for clock generation, VCXOs and VCSOs for low-jitter tunable clocks, and TCXOs, OCXOs, and Atomic Oscillators for highly-stable synchronized systems. In each category, Epson is the technology leader.



SPXOs – 32.768 kHz & 1-700 MHz
Simple Packaged Crystal Oscillators

With a complete suite of technologies – kHz, AT, HFF, & PLL – Epson can provide low-jitter oscillators for frequencies up to 700 MHz with LVPECL, LVDS, HCSL, and LVCMOS outputs.



P-SPXOs – 1-800 MHz
Programmable SPXOs

To enable rapid prototyping, Epson introduced the world's first programmable oscillator in 1977. The latest devices offer low jitter, high stability, and cover frequencies up to 800 MHz.



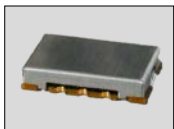
SPSOs – 50-700 MHz
Simple Packaged SAW Oscillators

Epson introduced the world's first SAW oscillator in 1999. With zero field failures to date in high-volume production, Epson SAW oscillators are the most reliable frequency control device ever made.



VCXOs – 1-800 MHz
Voltage-Controlled Crystal Oscillators

Enabled by HFF crystal technology, Epson's VCXOs achieve the industry's best phase noise and best vibration resistance and are recommended by every base station reference design.



VCSOs – 0.3-3 GHz
Voltage-Controlled SAW Oscillators

Epson VCSOs provide extremely low jitter (11 fs rms) at high frequencies (0.3-3 GHz) for coherent optical modules and other challenging applications.



RTCs – 32.768 kHz, 1 pps
Real-Time Clocks

Epson RTCs provide precise timekeeping and very low power. An integrated crystal saves board space and enables better accuracy and lower power. DTCXO technology enables high accuracy over a wide temperature range.



TCXOs – 10-200 MHz
Temperature-Compensated XOs

Epson TCXOs & VC-TCXOs are used in GPS, cellular phones, network synchronization (Stratum 3 & IEEE-1588), WiFi, and many wireless standards. Epson's advanced design delivers the industry's best wander and aging. DoubleSeal™ technology delivers the industry's best airflow resistance.



OCXOs – 10-50 MHz
Oven-Controlled XOs

Epson OCXOs are used in base stations and network synchronization. Epson's highly integrated design delivers superior airflow, transient, and thermal performance.



AOs – 10 MHz, 1 pps
Atomic Oscillators

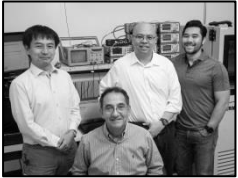
Epson Rubidium and Cæsium oscillators are used in network and broadcast synchronization. Epson's AO6860LAN uses D1 Cs CPT technology to achieve the industry's best stability ($< 5 \times 10^{-11}/\text{mo.}$) in a 73 cm³ package.

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Vertical Integration

Epson is the most vertically integrated company in the timing device industry. Epson is one of only seven timing device manufacturers that have their own autoclaves and the only company with their own IC fab. Epson designs our own ICs and Epson robots are used to automate module assembly and test.

Epson has 9 factories for timing device production. For assurance of supply, every product is made in at least 2 locations.



R&D



Synthetic Quartz



Crystal & IC Fabrication



Module Assembly & Final Test

R&D, manufacturing planning, and pilot production are at timing device headquarters in Minowa (Ina), Japan in Nagano prefecture.



Ina, Japan

Epson produces synthetic Quartz using autoclaves in 3 locations:

- Hachinohe (Aomori), Japan,
- Miyazaki, Japan, and
- Longview, Washington, USA.



Hachinohe, Japan



Miyazaki, Japan



Longview, WA, USA

IC fabrication is in Sakata, Japan.

Crystal fabrication is in:

- Ina & Miyazaki, Japan,
- Kuala Lumpur, Malaysia, and
- Chachensao, Thailand.



Sakata, Japan



Ina, Japan



Miyazaki, Japan

Final assembly is in:

- Suzhou, China,
- Kuala Lumpur, Malaysia,
- Chachensao, Thailand,
- Ina, Japan, and
- Miyazaki, Japan.



Suzhou, China



Kuala Lumpur, Malaysia



Chachensao, Thailand

Quality

All Epson factories are fully certified to ISO and automotive quality standards. Epson employs strict change control procedures, exercises careful control over suppliers and sub-contractors, and uses statistical quality control to achieve quality targets.