

## Continued Innovation for the Healthcare Sector – combining Affordability with Performance, Quality and Size

### Application Note for Crystals and Oscillators used in Medical Devices

The Healthcare sector, comprising of platforms, products, and services as well as financial and logistic aspects, has undergone continuous changes and evolution for some years now.

It is one of the sectors which has a high growth rate even in economically difficult times, dominated more and more by AI (artificial intelligence) driven processes and products, while being extremely quality driven. A big challenge is to bring overall costs down to an affordable level without compromising quality. On the contrary - performance and quality are expected to rise.

If we only consider the medical and pharmaceutical devices for example, a huge evolutionary step has been made in the past 5-10 years, focusing on equipment performance, size and cost.

Crystals and oscillators are key components for timing, synchronization and frequency control in the medical sector. Accuracy and reliability along with the small size qualify these frequency components for various medical devices ranging from Medical Imaging and Pacemakers to small wearable health devices, like Hearing Aids, Fitness trackers and portable ECGs.

### Types of frequency products in medical use

- Quartz Crystals – most common frequency components used in medical devices due to an excellent price/performance ratio
- XO/PXO Oscillators – widely used due to a broad frequency range coverage and simple design
- TCXOs – temperature-compensated oscillators, used in devices that need a high precision and/or are exposed often to temperature changes, e.g. portable devices
- OCXOs – oven-controlled crystal oscillators, used in high-end imaging devices due to high precision
- MEMS oscillators – shock-resistant, high-performance oscillators – only used in equipment where power consumption is not critical

### Certifications and standards required in medical equipment

To ensure the safety of users, patients and third parties, medical devices must be designed and checked regularly for functional safety.

Simplified, the medical applications can be classified into:

- *Human safety relevant or high-risk devices*
- *Human safety neutral or low-risk devices*

While, for 'high-risk' devices, the manufacturer of the medical equipment must comply to

- ISO 13485 - international standard for quality for medical devices
- IEC 60601 - standard for safety and performance of medical electrical equipment
- FDA regulations – USA specific regulation for body implants
- Other special vibration and reliability normatives,

for 'low-risk' equipment, the compliances for both equipment and component manufacturer are less stringent.

Cybersecurity is also playing an increasingly important role for networked devices.

If a medical device is not life sustainable, is not used as human implant or in diagnosis and treatment of severe conditions, the electrical components do not need to fulfil specific certifications, however they need to ensure the functionality and reliability requested by the application.

## **Latest Generation Components meeting the demands of the medical sector**

Our high-precision crystals and oscillators can be found in a wide range of medical devices, for example diagnostic equipment such as MRI and CT for imaging tissue, organs and bones.

We supply components for patient monitoring devices such as mobile acoustic recorders, which can be used to automatically record and analyze breath and lung sounds.

The accuracy paired with the ultra-compact design of the Geyer crystals and oscillators makes them ideal for the integration into the smallest medical devices without compromising performance. Their low power consumption extends the life time of battery-powered devices.

Many medical applications use oscillators instead of crystals, as they add an additional level of reliability. This simplifies design as no additional analog design know-how is needed, whilst providing less sensitivity to noise, component variations and layout.

Medical equipment, although often used in controlled environments, can still be exposed to temperature fluctuations. In this case our TCXOs are the perfect match ensuring a tight frequency stability of 0,5 -1 ppm over the temperature range.

Low phase noise and stable frequency ensure a proper wireless connectivity and prevent signal loss or interference with other equipment.

***Summarizing, GEYER Quartz Technology offers the perfect fit for the medical sector:***

- Communication-bus independent components
- High accuracy and long-term stability
- Low aging and phase noise
- Low power consumption
- Operation over a wide temperature range

## The future belongs to trendy health devices - compact, portable, energy efficient

High quality crystals from GEYER Electronic play a decisive role in the reliable operation of the medical devices. As frequency generation components, they ensure a precise system clock and stabilize communication, which in turn increases the reliability and energy efficiency of the devices. This is particularly important for small, portable devices which rely on stable communication, long battery life time and environment-independent functionality.

The combination of crystals from GEYER Electronic with modern microcontrollers and SoCs ensures that the devices function at the highest technical level.

While, for the larger medical devices, the equipment manufacturer uses crystals and oscillators with form-factor 3.2 x 2.5, 2.5 x 2.0 or 2.0 x 1.6 mm respectively, for portable devices they are looking for smaller components.

Combined with high-performance ICs/SoCs, the **GEYER KX-2 (1.0 x 0.8 mm)** and **KX-3 (1.2 x 1.0 mm)** crystals provide a compact, reliable solution for portable, power saving fitness trackers and medical devices. Small oscillators such as KXO-V94, KXO-V95 or TCXOs are also an excellent choice and alternative for health devices.

## Create the design of your choice using the GEYER Y-Design App

Before ordering the samples to test the crystal oscillators for your applications, you can make use of the GEYER simulation App. This allows you to check the accuracy of your parameters in advance and save valuable design time.

### Our GEYER Y-Design App offers you:

- A modern and user-friendly menu navigation - programmed for iOS, Android and Windows
- A graphical and numerical representation of the parameter input/output
- The selection of desired component packages
- The import of design specific templates
- A direct sample inquiry and a link to our Online Shop

With just a few clicks you can create new designs, and check or optimize existing circuits.

### A typical design using the App requires following input parameters.

$f_L$	Nominal frequency of Quartz crystal
$R_1$	ESR of Quartz crystal (usually specified as upper limit)
$C_0$	Static capacitance of Quartz crystal (usually specified as upper limit)
$C_1$	Dynamic (motional) capacitance of Quartz crystal (rarely specified)
$C_L$	Nominal load capacitance of Quartz crystal
$L_1$	Dynamic inductance of Quartz crystal (rarely specified)

These values are specified in the datasheet of the component. Exact values can be found by analyzing a batch of Quartz crystals with a network analyzer.

## Example of a Crystal Oscillator Design using the GEYER KX-2:

Taking the example of a Hearing Aid operating at 48 MHz, you can simulate and optimize the characteristics of a Pierce Crystal oscillator by inputting the corresponding values. You can visualize and vary the amplitude and phase characteristic of the feedback circuit, consisting of the Quartz crystal and surrounding components, for reliable oscillation without exceeding the maximal drive level of the Quartz crystal.

Part number	12.62000
Model	KX-2
Dimensions	1.0   0.8   0.3 mm
Frequency	48.0 MHz
Load Capacitance	6 pF
Tolerance at +25°C	± 10 ppm
Temperature Tolerance	± 15 ppm
ESR R1 max.	60 Ohm
Operating Temperature	-30°C to +85°C

C1: 0,9 fF      C0: 0,5 pF max      L1: 12 mH      R1: 28,7 Ohm



## Example of a Crystal Oscillator Design using the GEYER KX-3:

Another crystal that is often used in hearing devices, medical/fitness trackers or special sensors, is the 32 MHz in KX-3 package.

Choosing a crystal with the parameters as below, one obtains a performant design by using the optimization algorithm of the Simulation-App.

Part number	12.61024
Model	KX-3
Dimensions	1.2   1.0   0.3 mm
Frequency	32.0 MHz
Load Capacitance	4 pF
Tolerance at +25°C	± 10 ppm
Temperature Tolerance	± 15 ppm
ESR R1 max.	100 Ohm
Operating Temperature	-40°C to +85°C

C1: 0,8 fF    C0: 3.0 pF maxL1: 30,5 mH    R1: 63 Ohm



### Instructions regarding the App and design rules

can be found on our homepage or in our Short Tutorial on Crystals and Oscillators

<https://www.geyer-electronic.de/en/design-test-center/design-support/#white-papers>

## The future of medical devices and fitness wearables is Smarter and Preventative

The evolution of the medical sector is driven by multiple factors such as aging population and disease growth on one side while preventive care and health awareness is getting more into the daily focus. With technology evolving fast, the expectation of price decrease and also the life-time of medical wearables for example is quite high. Designs have to be simple, robust, trendy.

GEYER Electronic supports you with the best choice of frequency products for your design.

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