Latest technology dominating day-by-day life – combining precision with design, taste and comfort

Application Note for Frequency Products used in Home Appliances

Home Appliances and Smart Home Applications are 2 terms that are often mixed up and although they can be interlinked, there is a clear difference between the two of them.

While Home Appliances are physical machines that perform different domestic tasks, Smart Home Applications are systems, software or Apps that automate and control home devices, connected via a communication protocol (Zigbee, Bluetooth, Wi-Fi, etc.) to a network.

Coffee machines, washing machines, dishwashers, refrigerators, etc. are examples of home appliances that perform an electrical or mechanical task, working as a standalone unit which is still manually operated although full of electronics.

More and more home appliances are now using smart applications, so they can be programmed and monitored remotely.

Crystals and oscillators are key components for timing, synchronization and frequency control in the consumer electronics and small appliances.

While for consumer electronics such as wearables, size is often the decisive factor, for household appliances robustness and high precision are the parameters more in focus.

In washing machines, the installed crystals must be **insensitive** and **shock-resistant**. Whilst an automatic coffee maker demands the **highest precision:** consumers expect the right drinking temperature and perfect foam consistency every time.

Latest Generation Components meeting the demands of Household Appliances

Independent of the operation, either locally or remotely controlled, the majority of home appliances products, (e.g. coffee machines) use frequency components both for the main clock function as well as very precise tuning fork crystals (32.768 kHz) for the RTC function.

Taking the example of coffee machines, manufacturers are looking to exchange designs based on older crystals with large footprints to newer market-driven models, that meet their requirements.

Our experience is that the right fit is the **2.0 x 1.6 mm GEYER, KX-5 product family.**

Combined with high-performance MCUs, the **GEYER crystal types KX-5 (2.0 x 1.6 mm) or KX-7 (3.2 x 2.5 mm)** provide a compact, reliable solution for coffee machines but also for other various household products and wearables. Commonly used frequencies in coffee machines are 16 MHz- 25 MHz.

Optimized for low-power real-time clocks, GEYER offers a wide range of 32.768 kHz tuning fork crystals, in either of our KX-327NHT (3.2x1.5 mm) or KX-327RT (2.0 x 1.2 mm) form factors. Variants ranging from 6 ~ 12.5 pF load capacitance, and with different ESRs are available depending on the customer preference.

***Summarizing, GEYER Quartz Technology offers** the perfect fit for coffee machines:*

- High accuracy and long-term stability
- Low aging and robustness
- Low power consumption
- Operation over a wide temperature range
- Communication-bus independent components – to allow integration into Smart Home Applications as well.

Due to the excellent price/performance ratio and the seamless interworking with the ICs from STM, Microchip, NXP, Renesas, as examples, the GEYER components have proven to be the right choice for **energy efficient** coffee makers, providing stable and reliable timing.

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.

Examples of Crystal Oscillator Design using the GEYER KX-5 (2.0 x 1.6 mm):

Taking the example of Coffee Machines using crystals at 16 MHz and 24 MHz respectively 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 crystal.

The simulation gives you first feedback regarding the type of crystal that you need and the oscillator design performance. Based on this you can order samples for your pre-series/series board and request validation of the HW design from us, including a Reference Design with the IC that you are using.

Simulation example for a coffee maker using a 16 MHz crystal:

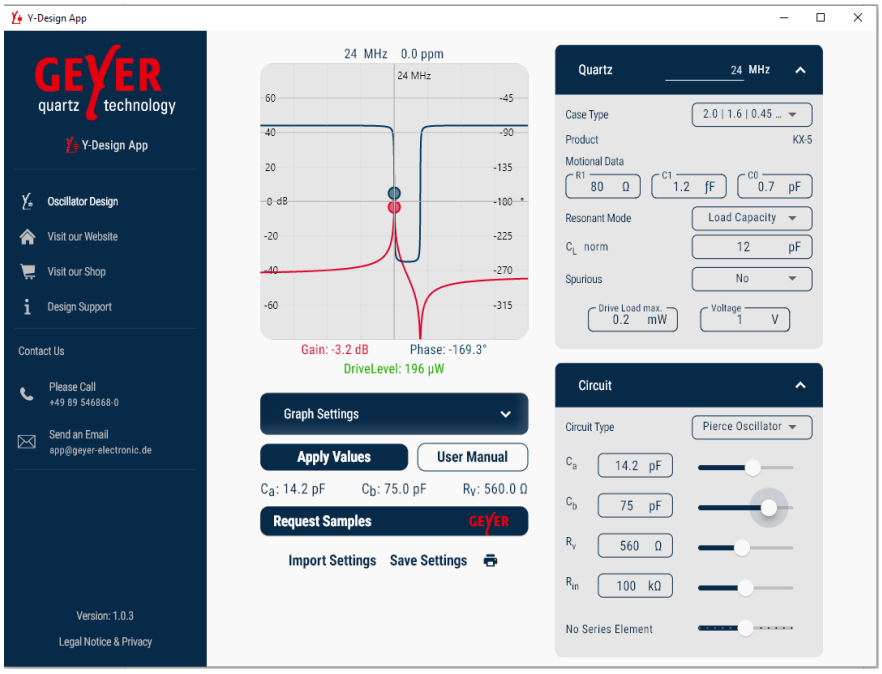
Part number	12.85549
Model	KX-5
Dimensions	2.0 | 1.6 | 0.45 mm
Frequency	16.0 MHz
Load Capacitance	8 pF
Tolerance at +25°C	± 30 ppm
Temperature Tolerance	± 50 ppm
ESR R1 max.	200 Ohm
Operating Temperature	-40°C to +85°C

C1: 1,2 fF C0: 3,5 pF maxR1: 100 Ohm typ.

Simulation example for a coffee machine using a 24 MHz crystal:

Part number	12.85525
Model	KX-5
Dimensions	2.0 | 1.6 | 0.45 mm
Frequency	24.0 MHz
Load Capacitance	12 pF
Tolerance at +25°C	± 30 ppm
Temperature Tolerance	± 100 ppm
ESR R1 max.	100
Ohm	

C1: 1,3 fF C0: 0,7 pF typ R1: 80 Ohm typ.



Further 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

Mechanical Reliability meeting Digital Innovation

Traditional appliances are shifting from standalone devices to monitored, connected systems.

Coffee machines range from basic to highly advanced models, the tendency being clearly on integration into a smart SMART Home ecosystem.

They are a perfect example for an intersection between mechanical robustness, digital innovation and modern design.

Either as simple or schedule-based brewing or/and geolocation, GEYER Electronic supports you with the best choice of frequency products for your coffee machine and further home appliances.

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