

BY DIPL.-ING. DAPHNE POPESCU, PRODUCT AND SALES MANAGEMENT, AND
DIPL.-ING. HANNES EHRENBURG, HEAD OF DESIGN- AND TESTCENTRE, BOTH OF GEYER ELECTRONIC

Smart technology – finding the right balance for energy efficiency

Requirements and new areas of application for frequency-controlled components

ABSTRACT

Smart technology is a very broad term that extends from the private sphere to various branches of industry and global IoT-based networking platforms. Ultimately, it refers to technologies used for devices that collect, exchange and bundle data via intelligent networking, thereby offering technical and price advantages in both the private and industrial sectors. Thanks to artificial intelligence, the level of automation is increasing in many areas, providing decisive advantages in the medium and long term, but may initially entail additional certification costs.

The integration of renewable energy sources into today's energy system is technically interesting and challenging, requiring solutions and components that will contribute significantly to the energy transition in the foreseeable future.

Since the requirements for smart applications are equally demanding, we have summarised areas in this article where sensors, connectivity and data exchange via mobile communications, Wi-Fi, Bluetooth or various other, sometimes proprietary communication channels play a decisive role. The focus is on the resulting requirements for component manufacturers and how they can contribute to energy efficiency with key components.

Quartz crystals and oscillators, which are generally used for precise time measurement and clock generation, are becoming increasingly important in smart applications and battery-powered devices, as they help to optimise energy consumption and extend battery life.



“INTELLIGENT” APPLICATIONS

Below, we briefly explain a few important “SMART” applications and their common features, in which frequency-controlled products are playing an increasingly important role.

The future belongs to smart cities – intelligent cities

Sustainability, safety and a high quality of life are today's requirements for the future. In a smart city, modern technologies from the fields of energy, mobility, urban planning, administration and communication are networked in such a way that the quality of life for residents is improved. From parking guidance systems in multi-storey car parks to power supply, processes run more efficiently and sustainably.

Low power consumption and low tolerances, coupled with excellent performance in extreme weather and vibration conditions, make GEYER products the right choice for networking applications in smart cities.



Developments in the smart building sector

Modern, intelligent buildings usually use automated, energy-efficient, supply decentralised energy and can be precisely controlled in terms of their energy consumption. Existing buildings can also be converted into smart buildings as part of modernisation and renovation projects.

So-called heat maps are used wherever the density of a specific parameter needs to be measured – and measures need to be taken in real time wherever possible.

GEYER products are used in a wide range of intelligent concepts for the demand-based control of heating, cooling, ventilation and lighting solutions.

Smart grids and the smart metering concept

Smart grids enable real-time monitoring and control of grid facilities. Intelligent devices monitor energy generation, transport, storage and distribution, as well as consumption, which is used to create a grid profile and regulate the energy grid.

Terms such as 'Internet of Energy', integration of renewable energies, and 'grid to vehicle integration' are becoming increasingly important.

Global climate targets and programmes for the transition to renewable energies require smart grids in which electricity producers and consumers communicate digitally. This requires devices known as smart meters, to enable this communication.

A smart meter system consists of a digital meter and a communication unit known as an SMGW (smart meter gateway). This gateway, which is connected via LAN or mobile communications, can be used to transmit the measured electricity consumption to the relevant electricity network operators.

The concept is not limited to smart metering, but applies to all smart buildings and smart grid applications where any type of consumption needs to be monitored.

Although the introduction of smart metering systems began several years ago, it is expected to reach its peak in the coming years. Manufacturers of smart meter devices are currently focusing on a new generation of devices in new frequency ranges with a narrower channel spacing, e.g. the so-called SRD-860 frequency band (ZigBee, IEEE802.15.1, LPWlan, etc.). This is changing the technical requirements for quartz manufacturers and posing significant challenges in terms of accuracy and stability.

Smart Urban Mobility

Another area of application where energy efficiency and sustainability are important is intelligent mobility solutions, in which traffic volumes are continuously planned and monitored so that they can be diverted as necessary, thereby minimising traffic density and CO2 emissions.

There are many more examples of future-oriented concepts and technologies that require smart devices and controls. But what do all these areas have in common?

They all focus on:

- Automation
- Connectivity
- Energy efficiency
- Miniaturisation
- Sustainability
- Competitiveness

DEMANDING TECHNICAL REQUIREMENTS

For many applications in which smart technologies are used, there is a trend in new developments towards very precise and stable components. This also applies to quartz crystals and quartz oscillators.

The new “standard” for quartz crystals is a component with low frequency deviation at room temperature, low tolerance across the temperature range and the lowest possible ESR (equivalent series resistance). The former industrial temperature range of -40 to +85°C is becoming established as the normal temperature range in more and more applications.

In addition, more and more frequencies are becoming established, such as 38.4 MHz, 39 MHz, 40 MHz and 48 MHz, which are mainly determined by the newly approved frequency ranges and ICs, as well as new communication buses.

If we consider the smart meter sector, for example, all smart meters, regardless of type, require:

- Precise time synchronisation for accurate data analysis and reliable data transmission within the network
- A wide temperature range for use in different environments
- Low power consumption for long battery life

For some time now, another trend has been emerging that is gradually becoming a reality.

More and more manufacturers of smart devices are relying on TCXOs (temperature compensated crystal oscillators) in order to utilise the excellent frequency accuracy and low power consumption of these oscillators for demanding designs. TCXOs help to better avoid or control mutual interference caused by the ever-increasing number of devices in larger networks.



Low phase noise and low jitter are two further parameters that are increasingly being taken into consideration when it comes to designs with XOs or TCXOs.

OUR PRODUCTS AND SOLUTIONS FOR THIS PURPOSE

As a long-standing manufacturer of quartz crystals and oscillators, celebrating 60 years of consistency in 2024, GEYER always keep up with the latest developments.

GEYER Quartz Technology offers the right quartz crystals for the requirements of IoT-based, intelligent applications:

- BUS-independent components
- Quartz crystals with low tolerances of only ± 10 -15 ppm over the entire temperature range
- An operating and storage temperature suitable for industrial use
- Ageing of ± 10 ppm over 20 years
- Total tolerance of ± 25 ppm after 20 years
- Tuning fork crystals for the RTC function

In addition to the tried-and-tested 3.2 x 2.5 mm size, the new designs mainly feature quartz crystals in a 2.0 x 1.6 mm housing. GEYER manufactures key components for the most common frequencies in the smart technology industry in this size. In the oscillator sector, we have specialised heavily in recent years in TCXOs with small dimensions of only 2.5 x 2.0 mm or 2.0 x 1.6 mm.

High frequency stability across the temperature range, low power consumption and low jitter or phase noise are the component features that, in addition to the size, meet the requirements of energy-efficient applications.

To illustrate the technical evolution of TCXOs, the following table shows the main features of different component sizes:

Dimensions mm	Power consumption – typ.	Phase Noise	Frequency stability	GEYER model
5.0 x 3.2	2.5 mA	-130 dBc/Hz@1kHz	2.5 ppm@-40 – 85°C	KXO-83
3.2 x 2.5	1-2 mA	-125 dBc/Hz@1kHz	1.5 ppm@-40 – 85°C	KXO-84
2.5 x 2.0	1mA	-125 dBc/Hz@1kHz	0.5- 1.5ppm @-40 – 85°C	KXO-86
2.0 x 1.6	1mA	-145 dBc/Hz@1kHz	0.5- 1.5ppm @-40 – 85°C	KXO-81
1.6 x 1.2	1mA	-145 dBc/Hz@1kHz	0.5- 1.5ppm @-40 – 85°C	KXO-88

Regardless of the application-specific products we provide as a manufacturer, we strive to support our customers in bringing their end products to market on time.

Every new development and introduction of new supporting components, e.g. controllers, quartz crystals, etc., entails new tests and often also the need for new certifications. These are time-consuming and expensive and sometimes slow down the introduction of new generations of devices to the market.

In addition, both equipment manufacturers and component manufacturers are striving to increasingly automate and optimise processes, and are increasingly taking advantage of the possibilities offered by artificial intelligence. Quality control in production and predictive maintenance are already examples of such processes and require less and less human intervention.

What can be seen as an advantage in the medium and long term initially proves to be a further delaying factor, because AI-supported processes must first undergo certification or regulation. In some cases, this is a complex and lengthy process.

Even if we can only influence some changes in the industry to a limited extent at the moment, we can still support our customers with component certifications using targeted reference designs, our development app for simulating quartz oscillator designs and our R&D department.

All the necessary technical information can be found on the GEYER homepage and in the GEYER web shop.

Conclusion

The industry is in the midst of a revolution: technological advances, natural disasters and global political changes are sending shock waves through everyday life. While many branches of industry are experiencing difficult times, others are becoming increasingly important overnight.

The fact is that there is no way around the energy transition and that we must use all mechanisms at our disposal to think, produce and live in a more energy-efficient manner.

As a component manufacturer, it is therefore very important to be well aware of the degrees of freedom and possible limitations of technologies and applications – these determine the requirements and the selection of the appropriate components.

In recent years, we at GEYER Electronic GmbH have seen a significant boost in the development and manufacture of quartz crystals and quartz oscillators for frequency-controlled electronic components that can reduce the energy consumption of end products, despite increasing technical demands – tolerances, availability, jitter, etc.

Contact:
GEYER Electronic GmbH
info@geyer-electronic.de