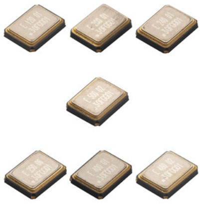
**Use case**
Eaton quartz crystal resonators for solar inverters



# Utilizing Eaton's quartz resonators in solar inverters

As the world moves away from an overreliance on fossil fuels, solar power installations are playing a crucial role in driving clean energy initiatives around the world. According to a new report by the Solar Energy Industries Association (SEIA), the second quarter of 2024 saw the installation of approximately 9.4 GWdc of solar capacity in the United States alone, representing a 29% increase from a year earlier.

Central to solar power systems are solar inverters, which play a crucial role in converting the direct current (DC) output of photovoltaic (PV) solar panels into alternating current (AC) that can be fed into a commercial electrical grid or used by off-grid electrical networks.

Solar inverters help to maintain grid stability with features like anti-islanding, voltage regulation, and frequency control. In commercial applications, frequency control in solar inverters is crucial for integrating solar energy into the power grid and ensuring the stability and reliability of both the grid and the solar installation. Because power grids operate at a specific frequency (50 Hz or 60 Hz), inverters must match this frequency to synchronize solar-generated electricity with the grid. Any considerable deviation in frequency can result in grid instability, which would affect the quality of power supply to consumers.

Due to their piezoelectric properties, materials such as quartz crystals can generate electrical charges under mechanical stress, allowing them to produce consistent oscillations in electronic circuits. This property is valuable in PV inverters, where precise timing and frequency control are necessary for effective energy conversion and synchronization with the grid.

Crystal resonators are designed to vibrate or resonate at a specific frequency, known as its resonant frequency. On the other hand, crystal oscillators use the resonant frequency of the resonator to generate an electrical signal with a precise and stable frequency. In essence, a crystal resonator serves as a high-precision frequency reference, and the oscillator utilizes this property to produce a stable electrical signal at that frequency.

Eaton's quartz crystal resonators, including both megahertz (MHz) and kilohertz (kHz) products, are designed to provide precise timing and frequency control in electronic applications. The E5X, E2X, E3X, and E9X are MHz quartz crystals, offering a wide frequency range of 8 MHz to 60 MHz. These products are suitable for high-temperature reflow processes and offer customizable options in terms of nominal frequency, load capacitance, frequency stability, and tolerance.

The E3K represents Eaton's kHz quartz crystals, offering a frequency of 32.768 kHz, an operating temperature range of -40 °C to +85 °C, and a frequency tolerance of ±20 ppm at +25 °C. These crystals are designed using plated electrodes encapsulated with a ceramic base, providing high frequency density, excellent shock and heat resistance, and long-term reliability.

Eaton's MHz and kHz quartz crystal products are well-suited for solar inverter applications, offering stability and precision in frequency generation, which is crucial for ensuring the solar inverter's output matches the grid frequency. They are also applicable to maximum power point tracking (MPPT), which ensures that PV panels operate at their optimal power point, enhancing harvest under varying sunlight conditions. Eaton's quartz crystals are designed to be compact for ease of integration into various inverter designs, including space-constrained models. They are offered in a broad range of sizes, operating frequencies and tolerances; are RoHS-compliant; and are designed to perform reliably in high-temperature applications, meeting lead-free soldering requirements.

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