

Integrating More Functions to TCXO Module Saves Power, Board Space

The voices to downsize devices of mobile phones are getting louder with the expansion in the number of devices integrated in multifunctional mobile phones.

Daishinku Corporation has been supplying temperature-compensated crystal oscillator (TCXO) to the market as reference oscillator for the radio frequency (RF) sections in mobile phones and the company's mainstream development trend for TCXO also target miniaturization.

Watching the movement of miniaturization for the past 10 years, significant miniaturization has advanced at around 1/7 in area and 1/14 in capacities. In terms of package size, as represented in four digits, from 7050 or 7.0 × 5.00mm the package size has gone down to 5032-size to 3225 and to 2520-size.

The development of 2016 size-is planned to advance miniaturization, but the implementation of miniaturization is fading slowly.

Development Over the Years

Daishinku has been developing and producing multifunctional TCXO module by building peripheral circuits into a single chip die in the TCXO as well as miniaturizing TCXO.

The first model was a 5032 size product specialized for Personal Digital Cellular (PDC) in Japan, which had two built-in TCXO frequency outputs and one nine-multiple frequency output for intermediate frequency (IF).

In 2004, Daishinku began supplying the 3225-size DSA322MA multifunctional TCXO module (Second Generation), which had built-in two TCXO frequency outputs and an analog temperature sensor targeted for Wideband Code Division Multiple Access (W-CDMA) and CDMA 2000 mobile system markets.

This time, Daishinku developed DSA322MB multifunction TCXO (Third Generation) as a succeeding model of DSA322MA. The DSA322MB is a 3225-size multifunctional TCXO module with three built-in frequency outputs and one built-in analog temperature sensor (See Fig 1).

The technical background for the development of DSA322MB multifunctional TCXO and its electrical performance is being introduced in this article.

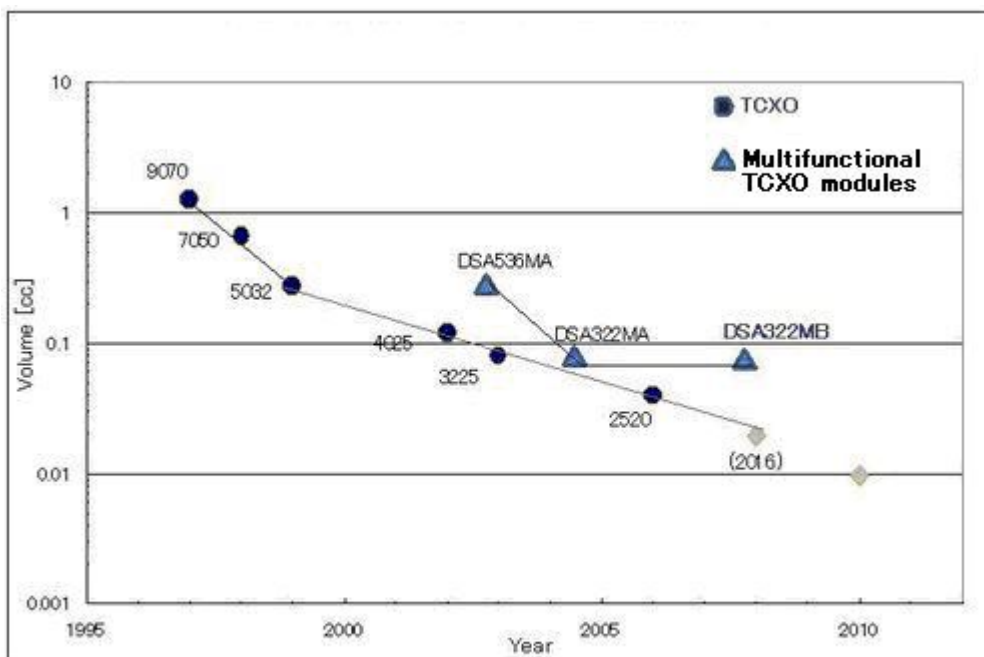


Fig.1 Trend in size reduction of TCXO and multifunctional TCXO modules

Multifunctional TCXO Module

Mobile phones have constantly evolved with the integration of more functions and the downsizing of digital equipment. Technologies for size reduction, modularization of functions and the integration of functional ICs underpin this development.

In the development of TCXOs, Daishinku paid attention to the fact that the signal from the TCXO is buffered and supplied to more than one device on a circuit board of a mobile phone. A buffer amplifier is laid out on a substrate in order to ensure the isolation between the signals and convert them into a signal level needed by the receiver. In addition, some models use an analog temperature sensor IC for the gain temperature compensation of

the power amplifier or LCD.

Daishinku is developing the multifunctional TCXO module, integrating these functions into a single-chip TCXO module in order to provide more benefit to the mobile phone systems than the miniaturization of conventional TCXOs.

Built-in Functions

The following are the integrated functions of the multifunctional TCXO module.

Three outputs vs. two outputs of DSA322MA

The TCXO output is typically supplied to the phased lock loop (PLL) circuit of the RF/Logic circuit through a buffer amplifier. The DSA322MB has integrated three buffers in the single die and provided less board space and less power consumption compared to the circuit with the external buffers (See Fig.2)

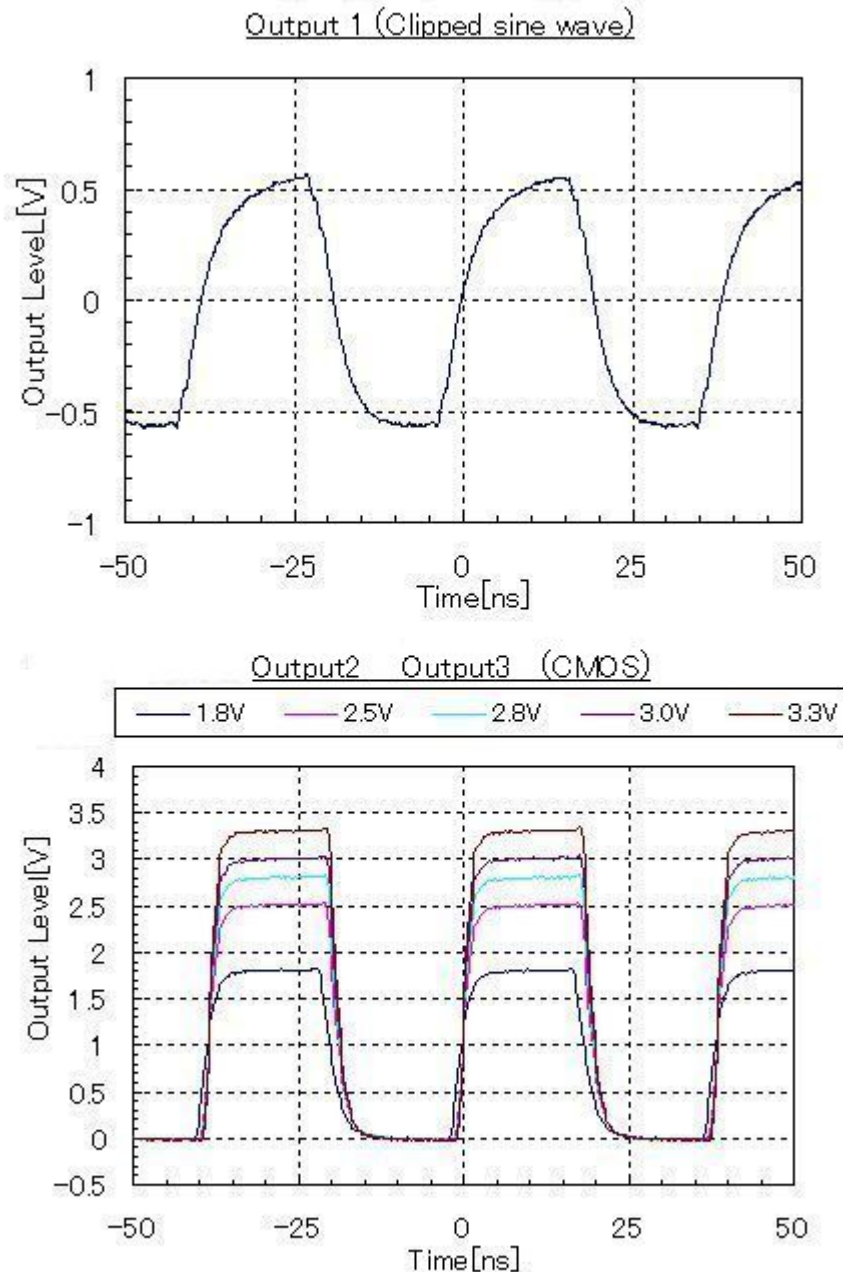


Fig. 2: An output waveform of the 26MHz DSA322MB

The first output has a clipped sine wave for PLL circuit in the RF sections and the output can be controlled with the enabled/disabled pin for power saving.

The second and the third output have CMOS logic output and these can be used for the CPU/DSP in the base band sections and any other logic circuits in the systems.

The output level of those two CMOS outputs are independently controlled with applying required supply voltage to the output buffers and the logic level can be selected anywhere from +1.4 to +3.3 V.

For example, output2 can be assigned to the clock for Bluetooth with +1.8V, and output3 can be assigned to the clock for DSP with +2.8V.

Temperature sensor output (Analog output)

The DSA322MB has a temperature sensor output for compensating temperature of power amplifier and LCD on RF. The output can be used for compensating temperature of the output level of power amplifier and contrast of LCD.

Therefore, the conventional external temperature sensing circuit (temperature sensing ICs or thermistors) are no longer needed with the temperature sensor output from the DSA322MB and this provides a big advantage in terms of saving the board space and reduce the bill-of-material (BOM) cost. (See Fig. 3)

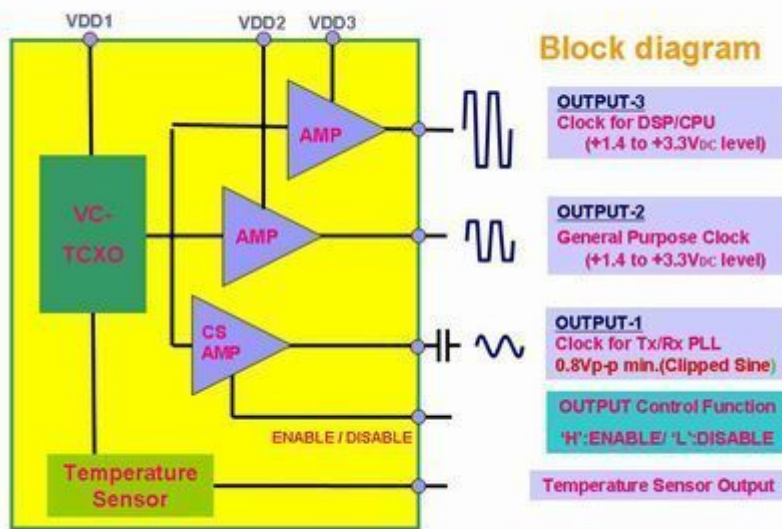


Fig. 3: Block diagram

TCXO Module Features

The DSA322MB has these functions integrated into a newly developed single chip IC with the 10 terminals leaded chip carrier (LCC) package achieving a maximum module size of 3.2 × 2.5 × 1.0mm (3225) (See Fig. 4)

The module adopts a single-packaged structure, in which an IC chip and a piece of crystal are placed in the same cavity.

Meanwhile, the product’s height is also lowered (See Fig. 5). To mount the IC, a special flip chip mounting technology developed for devices with single-packaged structure was applied. The company employed lead-free connections and materials for this module.

The sample electrical performances are shown on Table 1 with 19.2 MHz/26MHz as the prepared standard frequencies.

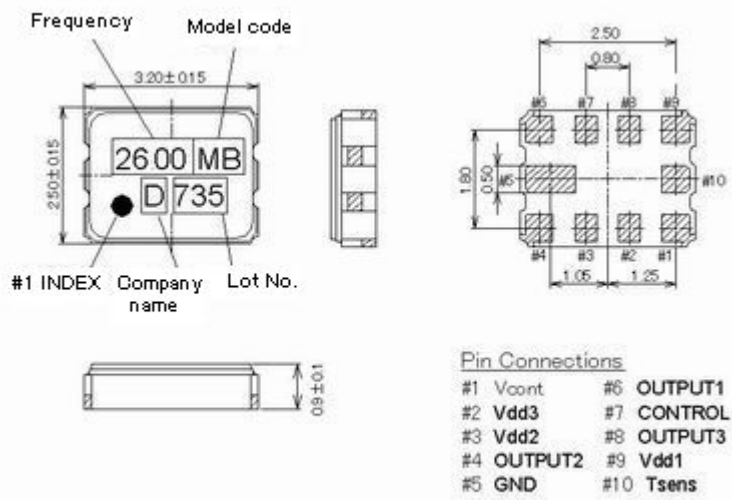


Fig. 4: External view of the DSA322MB

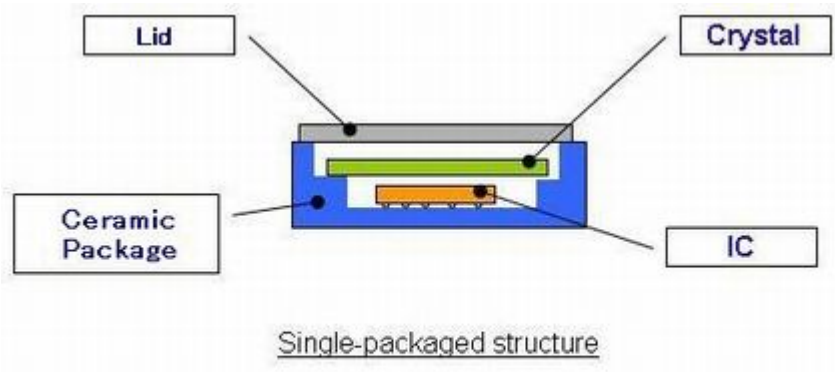


Fig. 5: Image of DSA322MB's internal structure

Table 1 : Electrical performance of a multifunctional TCXO module

Model name	DSA322MB
Standard frequency	19.2MHz/ 26MHz
Output frequency range	9.6MHz to 40MHz
Power supply voltage	+2.8V (operable voltage +2.4V to +3.3V)
Consumption current	+2.4mA typ.(F=26MHz/ Output1-DISABLE: Vdd2,Vdd3=+1.8V) +3.0mA typ.(F=26MHz/ Output1-ENABLE: Vdd2,Vdd3=+1.8V)
TCXO Output 1	0.8Vp-p min. Load: 10kΩ//10pF
TCXO Output 2	C-MOS Level (Load: 15pF workable in the range of Vdd2= +1.4V to +3.3V)
TCXO Output 3	C-MOS Level (Load: 15pF/operable voltage range Vdd3=+1.4V to +3.3V) ^o
Frequency initial tolerance	±1.5×10 ⁻⁶ (After 2 reflows)
Frequency stability vs. Temperature	±2.0×10 ⁻⁶ / -30deg.C to +85deg.C
Frequency stability vs. Supply voltage	±0.2×10 ⁻⁶ /(+2.8V±0.2V)
Frequency stability vs. Load variation	±0.2×10 ⁻⁶ /(10kΩ//10pF) ±10%
Frequency control sensitivity (VC-TCXO)	±7.6×10 ⁻⁶ to ±12×10 ⁻⁶ (Vcont=+1.4V±1V)
Aging characteristics	±1.0×10 ⁻⁶ / year
Start-up time	2.0msec max.
Temperature sensor output	+1.474Vtyp.(Ta=+30deg.C) -8.20mV/deg.C typ.

Advantages of the TCXO Module**Mounting Area**

Using Daisinku's TCXO module, the mounting area of devices can be reduced dramatically as temperature sensor and buffer amplifiers are integrated. The new TCXO module allows a 46 percent reduction in mounting area compared with a 2520-size (2.5 ×2.0mm) TCXO, where all the functions including the module's temperature sensor are configured on an external circuit while 41 percent of the mounting area was reduced compared with a case in which only the buffer amplifier function is used.

Current consumption

As this module features integrated functions in a single IC, the current consumption can be reduced because the leak current is lower relative to a case with multiple ICs and discrete devices. The utilization of the output control as well as other functions of the built-in buffer amplifier also contributed to cutting down the current level. The reduction in current consumption, however, depends on each configuration.

The Road Ahead

Mobile phone manufactures are working on scaling down the sizes of cell phones and on reducing power consumption, according to their unique individual perspectives.

The ability to reduce the number has become apparent by using DSA322MB TCXO module. In terms of the reduction in consumption current, however, quite a few factors depend on the customer's system design. For this reason, Daishinku provides a carefully developed customer support system to meet the requirements of each individual mobile phone manufacturer to fully optimize the use of its multifunctional TCXO.

Daishinku continues to analyze market trends and conduct activities in order to offer products designed from the customer's standpoint in a timely manner.