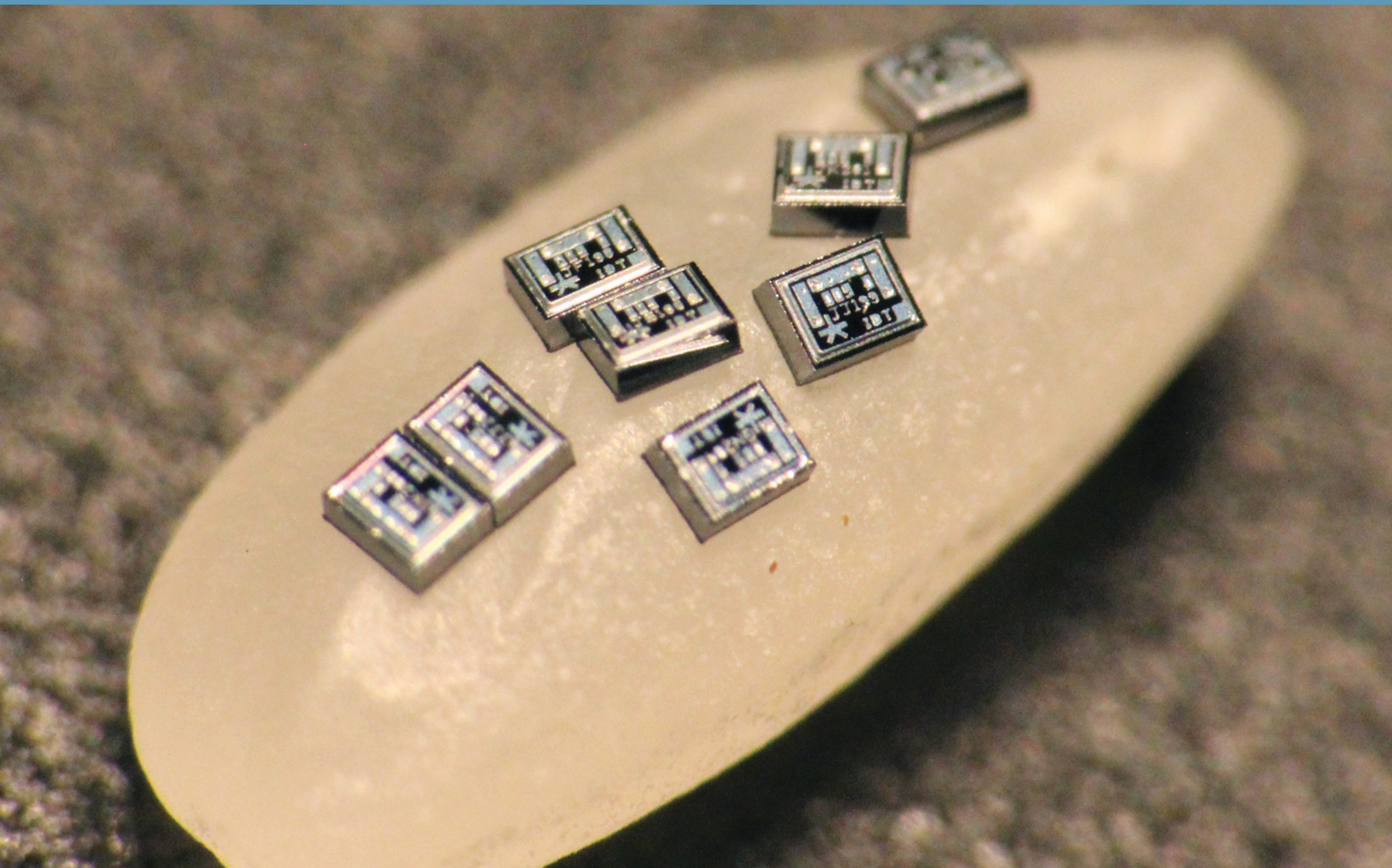
7-13 December 2011 | No. 2490 | ElectronicsWeekly.com

ElectronicsWeekly



Would you like rice with your MEMS?

AS SCALE BECOMES A DOMINANT CONSIDERATION WE EXAMINE THE POSSIBLE REPLACEMENTS FOR QUARTZ AS A FREQUENCY SOURCE PAGE 14

Lattice targets performance

COMPANY SEES FPGAS DELIVER 50% PERFORMANCE IMPROVEMENT IN WIRELESS DESIGNS PAGE 8

Interview: Government not helping

NOT ONE GOVERNMENT INITIATIVE HAS HELPED US IN THE PAST 12 MONTHS, SAYS MARKETING DIRECTOR OF LED FIRM MARL PAGE 16

Who's making time in areas where quartz can no longer measure up?

Steve Bush explores the alternatives that might replace quartz crystals where their physical properties just can't cope

For over 60 years there was only one practical frequency reference for electronics: quartz crystals. True, there were atomic clocks in 19in racks for really precise work, although bulk, expense and power consumption pushed them beyond the pale for most applications.

There was not even a need for an alternative, until folk started to cram multiple transceivers into tiny things like mobile phones and USB dongles.

Part of the success of quartz is that it is amazing stuff. Through its piezoelectric nature it does its own electromechanical conversion, and its inherent homogeneity and stiffness

Macbeth: Annoying that quartz is so good

mean it resonates predictably with high Q – and high Q means good stability and low jitter. And it is well understood, with closely-predictable temperature characteristics.

But you cannot change the laws of physics, and these dictate that there is a limit to how far crystals can be shrunk before they cease to work effectively, or cost too much. Which leaves room for tiny alternatives, which are less expensive because they use semiconductors. These alternatives appear to be falling into two camps: electromechanical resonators based on micro-machined silicon, and all-electronic oscillators.

All-electronic oscillators

All-electronic designs have no moving mechanical structures at all, removing their bulk, hermetic sealing, and the power needed to drive them.

They have been around since the invention of the triode valve, with frequency controlled by any pair of inductance, resistance and capacitance, with the option of swapping the resistance for a current source. Unfortunately, output frequency is also dependent on temperature, mechanical stress, and any number of other effects.

All-electronic frequency references rely on removing or compensating for unwanted effects, and UK start-up eoSemi claims it can do just that.

"The really annoying thing about quartz it that it is really good at what it does," eoSemi co-founder and CEO Ian Macbeth tells *Electronics Weekly*. Simple "silicon oscillators are terrible", he says. "If you just let them free-run you get 10,000-30,000ppm accuracy. That is your starting point. Most of the tier 1 semiconductor companies have tried, and failed, to deal with it." In contrast, 50ppm is available from even cheap crystals.

EoSemi is making accurate oscillators using standard CMOS. "We are applying temperature and stress compensation to deal with the accuracy problem," says eoSemi vice-president of sales and marketing Steve Cliffe.

Any other compensation? "There are some other things in there," is all he would say. "It's an analogue-heavy design on standard CMOS," adds Macbeth. "The 0.18µm process that we are using is only recently cheap enough to be usable to create something that can compete with quartz in the field."

And how well does it work?

"We have to be beating or in the same ball park of everything that quartz does," says Cliffe. "We are sampling in New Year, and have some partners lined up desperate to see the parts."

On size, he says that compared with even 2x1.25mm crystals, "our offering is significantly smaller", and points out that the silicon MEMS oscillators are likely to be larger because they generally co-package a resonator and a separate driver-divider chip.

Although the technology will go much higher, initially eoSemi is aiming for the 32.768kHz market, the frequency used in watches and real-time clocks that conveniently divides down to 1Hz.

The firm's technology will work down there natively, without needing a large resonator, or a small resonator plus a frequency divider.

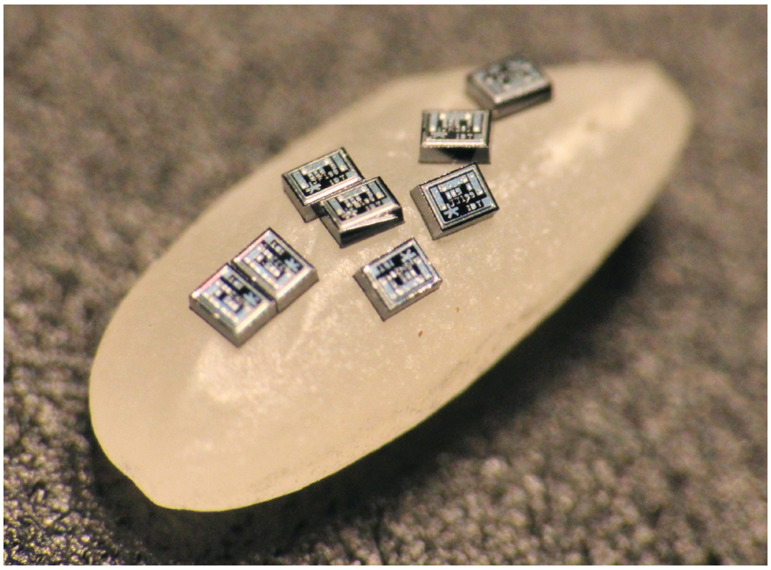
"We are targeting timekeeping in the mobile space, like cameras even in their power-down mode. MEMS cannot do this because they are too power-hungry. We are going to be orders of magnitude lower power than other silicon oscillator companies," claims Macbeth, who in 2010 told *Electronics Weekly* that 8µA would be a likely figure – not as low as a quartz oscillator of the same frequency.

Silicon MEMS oscillators

In some ways, silicon MEMS oscillators have similarities to quartz. Chip-grade silicon is a flawlessly homogeneous and, providing it can be shaped accurately enough, will produce precise frequency references.

However, silicon is not piezoelectric, nor as cheap as quartz, so the only way silicon resonators can economically compete with quartz is if the devices can be made in their thousands using micromachining on a chip production line. And this is what several companies, including SiTime and Discera, have been doing.

The latest firm to enter the fray is



To see the world in a grain of rice ...

IDT, revealing its resonator only last week (*pictured*).

At 0.5x0.45mm, “it is the world’s smallest wafer-level-packaged resonator”, says Harmeet Bhugra, managing director of IDT’s MEMS division. That size includes the cap that retains “sub-atmospheric pressure” around the moving parts. “We can get GHz without a hard vacuum,” says Bhugra.

What the size does not include is the driver-divider chip that has to be packaged alongside the resonator to make a final product. IDT’s resonant structure is a micro-machined block of monocrystaline silicon, tethered at each end, with a thin layer of piezo-electric material deposited on top as an electro-mechanical interface. Other companies drive with electrostatic force. “SiTime and Discera use capacitive MEMS,” points out Bhugra.

There are only a few performance figures available for the technology, which has been dubbed pMEMS. “pMEMS can go very high in frequency, from kilohertz to gigahertz native,” claims Bhugra. He says that jitter is low – low enough to result in sub-ps jitter (in 12kHz to 20MHz bandwidth) in a finished packaged product.

Something that he is keen to talk about is frequency stability over time. The firm has released test figures showing ±2ppm stability over 14 months at 25°C and 3,500 hours at 125°C so far. And more recent tests over three to four months suggest the actual figure is even better as errors in the test gear contributed to the figure above, says Bhugra.

Quartz

While firms have been developing all-electronic and MEMS silicon frequency sources, quartz has not been standing still, and it still offers some inherent advantages, claims Neil Floodgate, sales director of crystal company IQD.

“Technically, quartz offers a better phase noise and jitter specification and is able to achieve much tighter tolerances, down to ±0.5ppm,” he says. “Quartz also has a much smoother perturbation which gives it a much more repeatable change in frequency when the operating temperature changes.”

He adds that frequencies up to 800MHz are now available, and that the production process lends itself to quick turn-around on custom frequencies.

“We can adjust the specification to the precise needs of the engineer where, with silicon, there is very little flexibility,” says Floodgate.

He adds: “Over the past few years the price of quartz-based products has reduced, which now means there is very little price differential between quartz and silicon-based timing devices.” ■

more online

Products: Maxim high-frequency crystal oscillators provide low-jitter performance
www.electronicsweekly.com

IDT claims first piezoelectric MEMs
www.eetimes.com

Design: ‘Transition away from quartz oscillators has begun’ - IDT
www.electronicsweekly.com

ElectronicsWeekly.com