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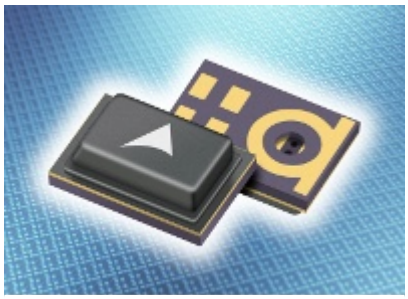
The Customer Magazine



MEMS microphones for improved sound quality October 2010

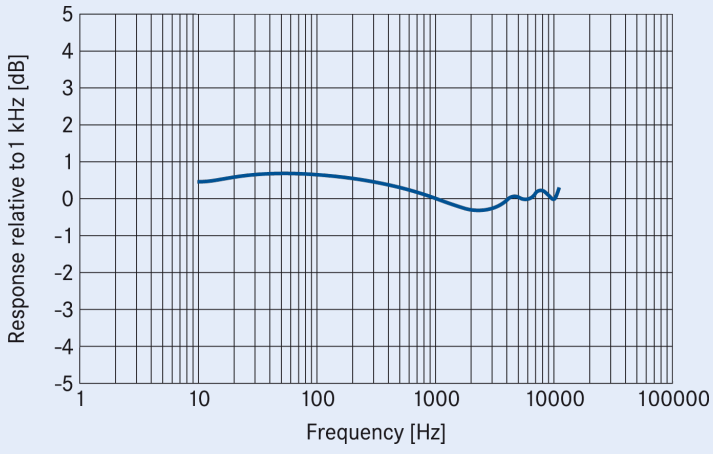
Big impact in a small package

An increasing number of portable devices such as mobile phones, headsets, cameras, or MP3 players are featuring advanced noise cancellation techniques to eliminate background noise and improve the sound quality for users. The prerequisite for the implementation of such cutting-edge features is the use of multiple microphones that are not only immune to RFI and EMI, but are also extremely tiny. MEMS microphones from EPCOS represent an ideal solution for these requirements. As the smallest microphones commercially available on the market, they offer superior acoustic performance combined with excellent EMI shielding.

Excellent performance with a tiny footprint

Based on the design capability for cutting-edge MEMS and ASIC technology, deep application know-how and a strong patent portfolio, the first products to be introduced were the EPCOS T4000 and T4010 series. Now the portfolio has been extended to include the T4030 series of digital output microphones. The new series combines the small size with a sensitivity of -26 dB FS (full scale) and a signal-to-noise ratio of 60 dBA. Even at a sound level of 100 dB, the distortion factor is under 1 percent. Its frequency response is characterized by high bandwidth and low amplitude fluctuations (Figure 1). The T4030 is largely insensitive to electromagnetic interference thanks to a digital PDM (pulse density modulation) output. The suppression of the power supply noise is -82 dB FS. Two channels can also be transmitted via one signal line, making stereo or multiple microphone applications much simpler to implement than in analog technology. The supply voltage range is between 1.64 and 2.86 V. The power consumption is 650 µA and is reduced to less than 10 µA in standby operation.

FIGURE 1: FREQUENCY RESPONSE CURVE



The frequency response of the T4030 MEMS microphone from EPCOS is characterized by its high bandwidth and low amplitude ripple.

Compact solutions

Because of the T4030's excellent performance and extremely small size, it is predestined for noise cancellation applications in portable devices where space considerations are top priority. A good example is the stylish Jabra STONE Bluetooth headset developed by GN Netcom, the Danish manufacturer of headset solutions for mobile phones, contact centers and offices (Figure 2). The Jabra STONE is an extremely compact headset that is designed to provide users with a perfect balance between noise elimination and the delivery of a natural sounding voice. This is made possible by the use of dual microphones to capture sound while intelligently filtering background noise only. For this purpose, microphones of the T4000 series were selected for their small size and high performance.

GN Netcom considers the Jabra STONE its most revolutionary product and believes it will change the way consumers think about Bluetooth headsets. "The unique shape combined with noise cancellation technology so advanced that a boom arm isn't needed make it an all new concept," explains Anne R. Rasmussen, Vice President, Mobile Division at GN Netcom.

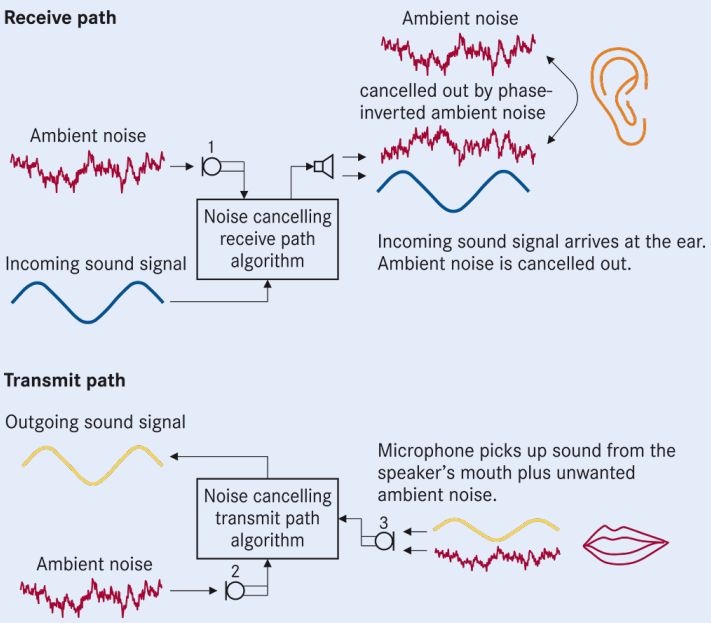
FIGURE 2: JABRA STONE BLUETOOTH HEADSET FROM GN NETCOM

Thanks to noise cancellation technology only the voice of the speaker is transmitted without the need for a boom arm.

Advanced noise cancellation

Noise cancellation will increasingly become a standard requirement for mid- to high-end mobile devices. Two noise cancellation functions may be integrated (Figure 3) in the receive path and in the transmit path. In the receive path (blue), microphone 1, which is located close to the loudspeaker, picks up ambient noise, which is added as a phase-inverted signal to the incoming sound. The phase-inverted noise signal cancels out with the ambient noise. As a consequence, the user can understand more clearly his or her partner, even in noisy surroundings.

FIGURE 3: NOISE CANCELLATION IN THE RECEIVE AND TRANSMIT PATHS



Noise cancellation can be implemented in both the receive path and the transmit path.

In the transmit path (yellow), microphone 2, which is facing away from the mouth, picks up ambient noise, while microphone 3, which is facing the mouth, picks up both ambient noise and the speaker's voice. Again the noise is canceled out by adding the phase-inverted noise signal. This time, the speaker's partner will be less bothered by the ambient noise.

Even more powerful and thus complex noise cancellation systems can be designed by using even more than 3 microphones. Size is becoming an increasingly important factor as more microphones are integrated in tiny mobile devices. Figure 4 shows two tiny T4000 microphones squeezed onto the PCB. At the same time, users expect the acoustic quality to increase, which in turn raises the requirements for the electric and acoustic properties of the microphone. In the future microphones will have to offer a signal-to-noise ratio (SNR) 62 dB and above as compared to today's common levels of 55 to 59 dB. The EPCOS T4020 MEMS microphone today features an outstanding SNR of 62 dB, and products with even higher SNR levels are in development.

FIGURE 4: PCB OF THE JABRA STONE WITH TWO MEMS MICROPHONES

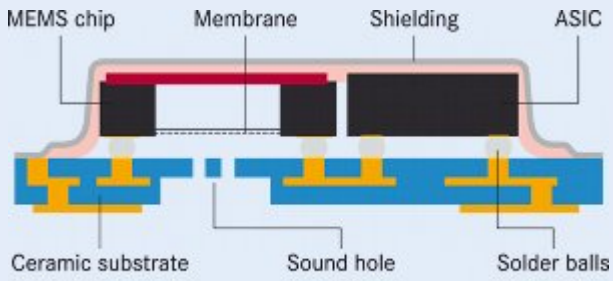
The openings of the two T4000 series microphones face in different directions in order to differentiate between the speaker's voice and ambient noise.

State-of-the-art packaging

EMI and RFI immunity has always been an important issue for SAW filters, which operate in the GHz range and are typically one of the first components in the signal path after the RF signal has been picked up at the antenna. For this reason excellent shielding is mandatory in order to preserve the very weak signal. This requirement led to the CSSP® technology (chip-sized SAW package) that provides excellent shielding in a very small package and has already proved itself in billions of mobile phones.

The MEMS microphones are based on the same packaging technology (CSMP™ or chip-sized MEMS package), which has been adapted specifically for MEMS (Figure 5). It thus benefits from matured EPCOS production processes as well as more than 15 years experience in the development of MEMS microphones. The MEMS microphones are RoHS-compatible and suitable for lead-free SMD reflow solder processes.

FIGURE 5: ROBUST PACKAGING FOR MEMS MICROPHONES



The T4030 MEMS microphone from EPCOS are manufactured in CSMP technology (chip-sized MEMS package), which was originally developed for SAW components and ensures excellent EMI shielding.

Thorough testing

TDK-EPC also uses the proven technology of SAW production for the final electro-acoustic measurement. The challenge of testing both acoustic and electric properties was solved by the design of a special test head; and customers benefit from a very thorough test program that measures all essential acoustic and electric properties against the specification of every microphone that leaves the factory, including:

- Sensitivity at 1 kHz and narrowband noise
- Wideband frequency response
- Wideband noise
- Power supply feedthrough
- Harmonic distortions
- Power consumption

The 100 percent testing gives users a high level of security that the MEMS microphones will exhibit strong performance in the application.

Thanks to their compact dimensions and outstanding electrical properties, the MEMS microphones are also predestined for applications with high requirements on audio quality. This also includes high-quality video and VoIP (voice over IP) systems, telephone conference installations, and beam-forming systems. Mass production of the T4000 series has already begun; engineering samples of the T4020 and T4030 series are now available.

TABLE: KEY TECHNICAL DATA

	T4000	T4012	T4020	T4030 (digital)
Signal/noise ratio at 94 dB SPL	57.5 dB(A)	57.5 dB(A)	62 dB(A)	60 dB(A)
Sensitivity at 94 dB SPL	-42 dBV	-42 dBV	-42 dBV	-26 dB FS
Power supply feed-through [Square wave 217 Hz 100 mV pp]				-82 dB FS
Power supply rejection ratio [Square wave 217 Hz 100 mV pp]	48 dB	48 dB	70 dB	
Current consumption	80 µA	80 µA	350 µA	650 µA
Total harmonic distortion at 100 dB SPL	< 0.5 %	< 0.5 %	< 1 %	< 1 %
Supply voltage	1.5 to 3.3 V	1.5 to 3.3 V	1.6 to 3.6 V	1.64 to 2.86 V
Size		2.05 x 2.05 x 1.03 mm³	3.05 x 2.15 x 1.1 mm³	3.25 x 2.25 x 1.1 mm³