SAW components

October 2005

Multifrequency in a single chip

The rapid spread of short-range devices (SRD) in automobiles calls for new ways of making the rising volume of radio data traffic more secure. Multifrequency resonators from EPCOS provide a simple and economical solution.

Radio-based systems such as keyless entry for locking and unlocking car doors and deactivating electronic immobilizers are becoming standard equipment in more and more automobiles. Wireless systems for tire pressure monitoring are also entering the market in growing numbers. All these radio systems have a very simple and low-cost design. They operate throughout Europe either in a band for industrial, scientific and medical applications (ISM) with a center frequency of 433.92 MHz or in a band allocated especially for SRD applications around 869 MHz. For smooth operation in the same frequency band, however, all these applications must harmonize, i.e. their mutual effects and interference must be kept to a minimum. There are several ways of reaching this goal:

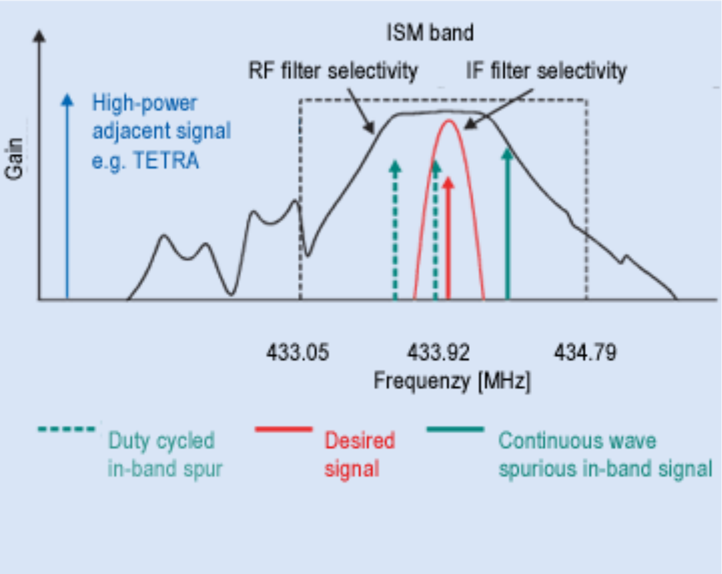
- a short duty cycle
- range limitation
- use of alternative, less crowded frequencies

Short duty cycle and range limitation

A short duty cycle reduces power consumption, prolonging the standby time of the SRD. The short range results from the low transmit power limited by reduced battery output, usually in conjunction with low antenna efficiency. Conventional monofrequency transmission techniques usually operate at a center frequency of 433.92 MHz in the ISM band. If this frequency happens to be occupied by other users, interference with the desired signal or that of other users results ➔ 1.

Applications & Cases

1 | Conventional ISM band structure

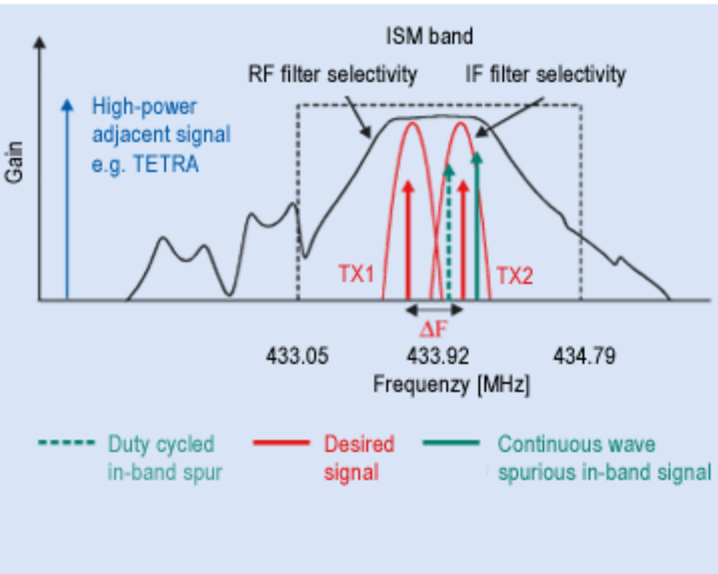


1 As transmission takes place on one frequency only, interference may occur if the number of users increases.

Sequential transmission on additional frequencies

The concept of the 2in1 filter now presented considerably improves transmission reliability with almost no increase in system costs. It transmits the information redundantly and sequentially on two or more frequencies. The receiver changes its receive frequency asynchronously in the same way. When the receiver detects a transmission, it remains on that frequency and evaluates the information. If there is interference on one transmission channel but not on the other, a valid transmission still takes place. The likelihood of interference then drops enormously, especially if the transmission frequencies used are above or below the busy ISM center frequency.

2 | ISM band with two frequencies



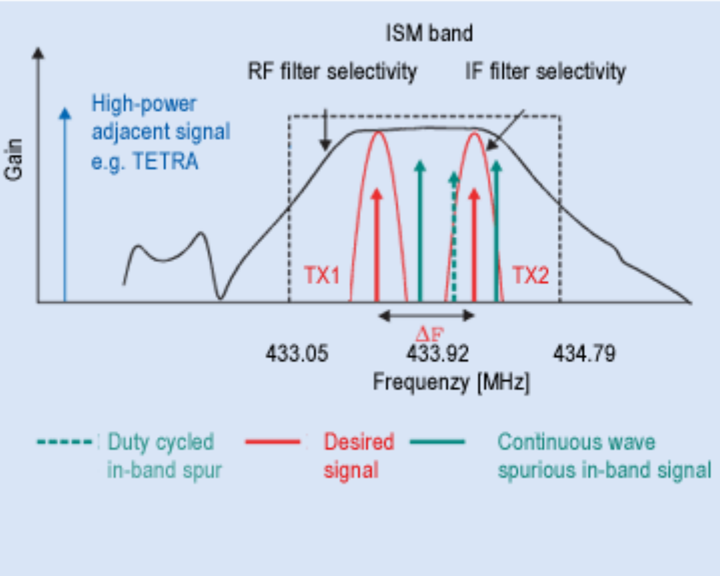
2 Selection is impaired by the short distance between TX1 and TX2.

Applications & Cases

Selection between TX1 and TX2 is performed by the IF filter → 2 and improves as IF filter bandwidth becomes narrower or TX1 and TX2 farther apart. The IF filter bandwidth is limited downward, because significantly greater frequency accuracy would otherwise be required from the transmitter and receive oscillator. However, a great distance between TX1 and TX2 requires a front-end filter with a wide passband to handle the frequency difference ΔF between TX1 and TX2.

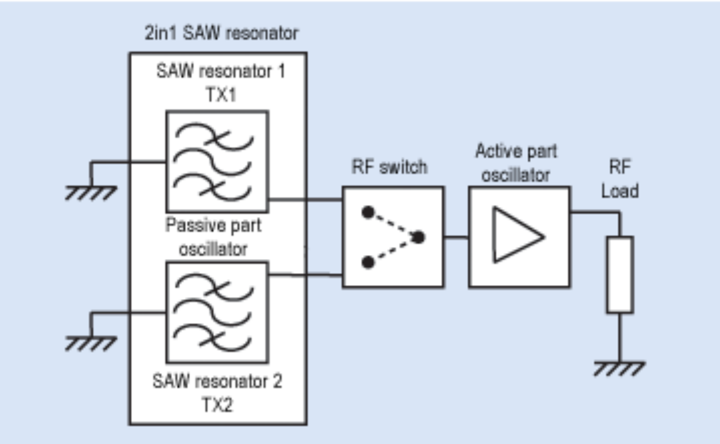
As a result of the very high traffic density of the ISM band, narrowband SAW input filters on a quartz substrate have gained acceptance for this application in Europe. They offer very good near-end selectivity, including the TETRA (terrestrial trunked radio) band from 410 to 430 MHz, and very good far-end selectivity. These filters offer an effective bandwidth of about 320 kHz over the full temperature range required in automobiles. In order to keep taking advantage of quartz filters for multifrequency systems, EPCOS significantly extended the effective bandwidth of filters B3780 and B3781 of the R770 series to 550 kHz without increasing passband ripple. The bandwidths of the passband may be even greater, but at the expense of increased passband ripple → 3.

3 | ISM band with increased ΔF



3 This solution provides good selectivity and thus high transmission reliability.

4 | Schematic diagram of multifrequency resonator



4 Thanks to the 2in1 solution from EPCOS, two resonators can be housed in a single package to save space and cut costs.

Generation of various transmit frequencies

To improve the signal-to-noise ratio with the principle described above, the frequencies of the transmit and receive oscillators must be suitably keyed. Switchable PLL synthesizers are used for this purpose. A MODULO-1-PLL enables the frequency to be keyed within a coarser grid, while a fractional N-PLL permits almost infinitely variable adjustment of the oscillator frequency. A very costeffective solution for the transmitter can be obtained if a SAW resonator is used whose resonant frequency can be keyed. In this two-in-one SAW resonator, two autonomous resonant structures are used on the same chip ➔ 4. Both structures are produced simultaneously in the same process. As a result, the frequency difference ΔF is specified very precisely. As both resonators have a similar temperature response, ΔF does not vary with temperature. The center frequency of both resonators can be set as desired within a wide range in the design process without being tied to a specific grid.

A switchable SAW oscillator is identical in structure with the familiar Colpitts SAW oscillator, except that the 2in-1 SAW resonator is embedded into the circuit by means of a sequential diode switch. By controlling the diodes, the oscillator can switch between TX1 and TX2 at high speed over a range of several kilohertz.