Resonator defects identification technique with using a vector network analyzer

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SAW resonators are widely used as sensitive elements of sensors where the resonance frequency f_r is an informative parameter. Resonance frequency f_r defines by the maximum amplitude of the probing signal response.

In case of defects in resonator structure the parasitic modes are excites which impact on the measurement accuracy. In this paper a resonator defects identification technique with using a vector network analyzer is proposed.

The $|S_{11}|$ parameters (white curve) of defective resonator and probing frequency dependence of damping oscillation amplitude at certain delay time (red curve) are presented in Fig. 1. As shown from Fig. 1 resonator defect at $|S_{11}|$ is not detected. However at red curve we see two peaks which shifted about 40-50 kHz from each other.

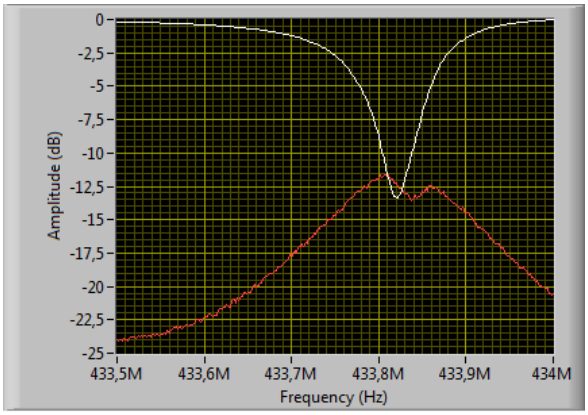

Fig. 1:

These two peaks on the response characteristic can leads to an ambiguity of reading results.

The experimental dependence can be explained by presence of the two resonance modes described by parallel resonant circuits in the equivalent schematic of a defective resonator. The resonant frequencies of modes and unload Q-factors are approximately equal. The coupling of main resonance circuit with a transmission line is close to critical and parasitic resonance coupling is a few times weaker. The stronger is the resonator coupling with a transmission line the more is reduced the loaded Q-factor and , as a result, increasing the rate of reflected amplitude decay in time. Consequently the rapid decline of amplitude in time domain at the start of damping oscillation is because of stronger mode, but also strongly coupled. Later the response due to 2nd mode, less coupled, is observed (Fig.2).

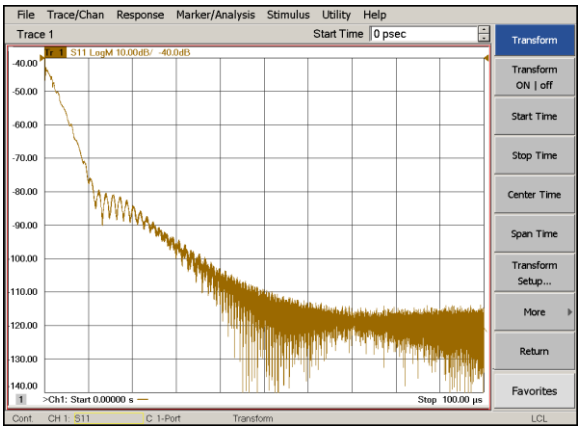

Fig.2:

The network analyzer measurement data of the time dependence of the damping oscillation power were extracted by “Time Domain” mode depicted in Fig. 2. Proposed technique used on JSC “Avangard” during functional control of SAW resonators.