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”SYSID#4 - Parametric modal testing using slow but continuous variation of operating conditions. Illustration on a contact bench.”

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Several systems have vibration properties, modes and non-linear limit cycles, that are significantly affected by environmental properties such as temperature, pressure, rotation speed, ... The classical testing strategy is to select a number of fixed operating conditions, wait for the system to stabilize at each condition and extract the vibration characteristics once stabilized. A lot of test configurations may thus be required to finely characterize the influence of environmental parameters on the system dynamics. The novel point of view taken here is to consider that in a number of applications, one can generate a slow variation of the operating condition that is sufficiently below the frequencies of interest to allow continuous monitoring of vibration properties. The application chosen as illustration of the process is a test bench seeking to characterize contact stiffness properties in a brake subassembly focusing on piston/backplate and piston/chamber contacts. A first rough estimate of the relation between modal frequency and pressure changes is obtained by traditional modal tests. Then pressure and excitation frequency are linked together in a feedforward iterative testing process to track phase resonance, thus giving access to modal property (resonance frequency, damping and shape) evolution at all intermediate pressures. Demodulation is used to address leakage issues in the signal processing and is shown to give appropriate results for both the excitation fundamental and its harmonics. The notion of harmonic modulation is finally introduced: it is used to analyze the fluctuations of the response within a given cycle and thus provides an understanding of spatial variations of non-linearities. To allow detailed shape characterization, a 3D vibrometer scan is used and the optimization of the scanning procedure is discussed.

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