Closed Loop Testing of Microphonics Algorithms Using a Cavity Emulator

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Introduction

An analog crystal filter based cavity emulator is modified with reverse biased varactor diodes to provide a tuning range of around 100 Hz. The piezo drive voltage of the resonance controller is used to detune the cavity through the bias voltage. A signal conditioning and summing circuit allows the introduction of microphonics disturbance from a signal source or using real microphonics data from cavity testing





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Cavity Emulator Design

The emulator has two detuning inputs for microphonics caused by mechanical vibrations and Lorentz force detuning resulting from deformations in the cavity caused by the high-power RF drive. An additional input is included to allow for corrective piezo electric drive signals for tuning. A summing circuit to generate a bias voltage is used to change the resonant frequency



5 120 100

80

nter 325.000000 MH

5 BW 10 Hz

Bias Voltage

ΔMKR1: -160.

5weep Time: 286.30 ms (401 r

<8 Smpl/Pt

VBW 100 H

Open Loop Testing



A 40 Hz 0-5 V input was applied to the microphonics input. The cavity detuning is displayed with tuner feedback off.

Closed Loop Testing





A signal generator provides a sinusoidal disturbance \mathbf{V} 0-1 the microphonics to input input. The output of the piezo tuner Ch A is connected to the piezo input. Piezo is enabled and feedback is enabled

Max 0.008 66.15

Detuning waveform FB OFF



Tuner Control Settings

Summary

The emulator was tested to characterize the frequency detuning response under different bias conditions. A full test stand was

$V_{BIAS} = V_{Micro} + 6.25 V_{LFD} - V_{Piezo}$

Table 1: Simulator Inputs

Input	Range(V)	Scaling
Microphonics	0 - 5	1
LFD	0 - 5	6.25
Piezo	0 - 30	-1



Test Setup

V_Piezo





constructed to exercise the LLRF controller and the resonance controller with the cavity emulator in the loop. Open loop and closed loop operation showed that the resonance tuning method with varactor diodes can be used to study microphonics effects and compensation schemes.



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