Piezo control for XFEL.

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Abstract

The superconducting cavities operated at high Q need to be precisely tuned to the RF frequency. Tuned cavities achieve maximum field strength and require a minimum level of RF power to reach the operating gradient level. The TESLA cavity control systems are tuned using slow (1 Hz) and fast control loops. No closed feedback loop is closed in parallel with the power amplifier. The open control loop is defined to provide limited control over 0.5 of the output current. The output current is limited to 1.5 A. A closed feedback loop is included with the power amplifier. The closed feedback loop improves the Q factor by increasing the current feedback, which reduces the flow of electromagnetic energy out of the cavity. This cavity cooling techniques, even in idle states. Therefore it requires cooling to be done. The tests have shown the temperature rise of the power amplifier radiates to 75 °C deg. up to 15 pulses of full voltage range at 70 V output.

The achieved performance fully covers specifications.

Piezo driver design

As a power amplifier, the Apex PEM integrated circuit was chosen. The design of the power driver is classical with preamplifier providing required voltage gain and driving the power device. The power driver is designed to be operated in bipolar mode operating conditions (in case one piezo is broken one can use the other). The system can be interchanged, increasing the reliability of the system. The power driver design is used in a closed feedback loop with the power amplifier. The open control loop is defined to provide limited control over 0.5 of the output current. The output current is limited to 1.5 A. A closed feedback loop is included with the power amplifier. The closed feedback loop improves the Q factor by increasing the current feedback, which reduces the flow of electromagnetic energy out of the cavity. This cavity cooling techniques, even in idle states. Therefore it requires cooling to be done. The tests have shown the temperature rise of the power amplifier radiates to 75 °C deg. up to 15 pulses of full voltage range at 70 V output.

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Piezo driver requirements

Each cavity at XFEL superconducting modules is equipped with two piezos. One piezo is used as the actuator to change the cavity length, while the second one, a dummy piezo, is used to reduce the cavity length. The dummy piezo can be interchanged, increasing the reliability of the system. This design is used in a closed feedback loop with the power amplifier. The power driver design is used in a closed feedback loop with the power amplifier. The power driver is designed to be operated in bipolar mode operating conditions (in case one piezo is broken one can use the other). The system can be interchanged, increasing the reliability of the system. The power driver design is used in a closed feedback loop with the power amplifier. The open control loop is defined to provide limited control over 0.5 of the output current. The output current is limited to 1.5 A. A closed feedback loop is included with the power amplifier. The closed feedback loop improves the Q factor by increasing the current feedback, which reduces the flow of electromagnetic energy out of the cavity. This cavity cooling techniques, even in idle states. Therefore it requires cooling to be done. The tests have shown the temperature rise of the power amplifier radiates to 75 °C deg. up to 15 pulses of full voltage range at 70 V output.

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Introduction

The high electric and magnetic field present in the necessary cavity during the pulse determines the cavity and defines the cavity wall. That corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nominal conditions due to changed cavity geometry. This corresponds to cavity detuning from nom