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Model based fast protection system for High Power RF tube amplifiers used at European XFEL accelerator

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The driving engine of the superconducting accelerator of the European X-ray Free-Electron Laser (XFEL) are 27 Radio Frequency (RF) stations. Each of an underground RF station consists from multi-beam horizontal klystron which can provide up to 10MW of power at 1.3GHz. Klystrons are sensitive devices with limited lifetime and high mean time between failures. In the real operation the lifetime of the tube can be thoroughly reduced by failures. To minimize the influence of service conditions to the klystrons lifetime the special fast protection system named as Klystron Lifetime Management System (KLM) has been developed. The main task of this system is to detect all events which can destroy the tube as quickly as possible and switch off driving signal. Detection of events is based on comparison of model of high power RF amplifier with real signals. All algorithms are implemented in Field Programmable Gate Array (FPGA). For the XFEL implementation of KLM is based on the standard Low Level RF (LLRF) Micro TCA technology (MTCA.4 or xTCA).

This article focus on the klystron model estimation for protection system and implementation of KLM in FPGA on MTCA.4 architecture.

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