A Power Conversion Method Based on Decentralized PID Controllers to Overcome the Power Deficiencies of a RF Thermal Emission Tube

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Thermal emission tubes are expensive electron devices regularly used in numerous applications such as Radio Frequency (RF) amplifiers, medical instruments, etc. In this work, an efficient RF power conversion method of a thermal emission tube which is employed as an RF amplifier within a 250kW shortwave transmitter in the Sri Lanka Broadcasting Corporation (SLBC), Trincomalee is discussed. The tube works as a class C amplifier within the frequency range of 6MHz-21MHz. It occasionally malfunctions due to its poor control capabilities. More often, the tube does not operate at its optimal or highest efficient point. As a consequence, a large amount of input electrical power is dissipated as heat within the tube itself. It is harmful for the internal structure of the tube. In this work, it is proposed to replace the existing fine-tuning controller with a closed loop control system. The proposed control scheme based on decentralized multiple PID controllers and H-infinity optimality criterion was tested for fine-tuning of the amplifier's final RF stage. The PID control gains were found using an algorithm based on Linear Matrix Inequality ensuring the stability of the closed loop system. The proposed controller should tune two fine-tuning elements, inductor, and capacitor until the phase difference between input and output RF of the emission tube (PHI2) becomes close to 180 degrees, and RF power (PWR) to the antenna or load reaches the expected value set by the operator. Test Results are obtained for several operating frequencies which drive the RF amplifier with half RF power, 125kW. Hence, the reference set point for controlled variable PWR is set to 3.125V. The reference value for controlled variable PHI2 is set to 5V. The behavior of the output variables, PHI2, and, PWR are compared for both existing and proposed controllers. The results validated the desired control capabilities of the proposed controller.

Keywords: PID controller, Power converter, RF, Thermal emission tubes