LLRF SYSTEM FOR THE KTF RFQ LINAC

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Abstract

The Radio-Frequency Quadrupole (RFQ) linac for the KOMAC [1] Test Facility (KTF) was built at Korea Atomic Energy Research Institute (KAERI). The low-level RF (LLRF) system for the KTF RFQ is to operate a klystron and to control RF fields in the RFQ cavity. It contains a preamplifier, interlock, and feedback loops. Overview of the RF system is presented. Design and construction of the LLRF are discussed.

1 INTRODUCTION

The RF system for the KTF RFQ [2-4] is made up of the LLRF system, the 1MW CW klystron system, the high voltage power supply system, and the transmitter system which includes a waveguide, RF vacuum window, and input RF couplers.

The KTF RFQ dissipates an average 417kW of RF power. RF power by the LLRF system is amplified by the 350MHz klystron. The amplified RF power travels to the RFQ through the transmitter system.

In this paper, we overview the RF system for the KTF RFQ linac and discuss the design and construction of the LLRF system.

2 OVERVIEW OF THE RF SYSTEM

The KTF RFQ dissipates an average 417kW of RF power, including beam loading and power dissipation by a cavity wall. RF power by the LLRF system is amplified by the 350MHz klystron which was made by THOMSON-CSF Ltd. Minimum average output power of the klystron is 1.0MW. Table 1 lists the klystron parameters.

Table 1. 350MHz klystron specifications.

Parameter	**Specification**
Average Output Power, min	1.0 MW
Drive Power, max	100 W
Efficiency, min	65 %
Duty Factor	1.0
Peak Cathod Current	21 A
Gain at Saturation	40.8dB

The amplified RF power travels to the RFQ through the transmitter system includes a WR2300 waveguide,

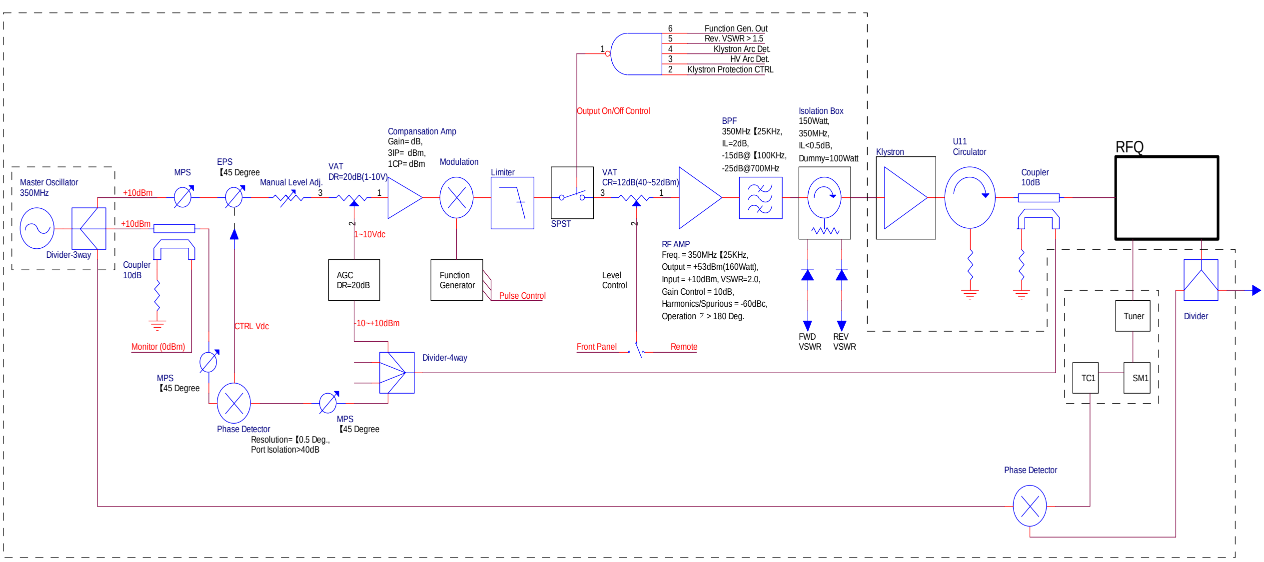

Figure 1. LLRF system for the KTF RFQ.

circulator, RF vacuum window, and input RF coupler [5]. 350MHz Y-junction circulator which was made by AFT is rated to operate into a full reflection standing wave during 1.0 MW RF power is being transmitted by the klystron. The RF vacuum window used was made by THOMSON-CSF Ltd. RF feeds are in the third section of the KTF RFQ. In order to supply the RF power in the RFQ, we studied two types of the input RF couplers which one is a coaxial-type and the other is an iris-type. A test input RF coupler were constructed in KAERI. S-parameter of the input RF coupler constructed is 0.008 at 350.0 MHz.

3 LLRF SYSTEM

The main goal of the LLRF system for the KTF RFQ is to operate the klystron system and to control RF fields in the RFQ cavity and field stability within ±1% peak to peak amplitude and 1.4^o peak to peak phase. A block diagram of the LLRF is shown in Fig. 1

The LLRF system consists of a master oscillator, phase shifter, limiter, amplifier, band pass filter, isolator, and phase detector. The frequency of the master oscillator fixes as 350.0 MHz. The maximum output power of the RF amplifier is 160 W. Table 2 shows the electrical specifications of the LLRF system.

Table 2. Electrical parameters of the LLRF system.

Description	Specification
Center Frequency	350 MHz
Stability	± 350Hz / 6 Month
Number of Output	3
Harmonics	< -60dBc
Spurious	< -60dBc
BW	± 25KHz
Final Output Power	52 dBm (160Watt)
Automatic Level Control	User Settable
Level Control Range	12dB @ output
Phase Control	≥ ± 45°
Phase Accuracy	1.4° Min.
VSWR	2.0 Max.
Modulation	OOK
Limiter	0 dBm
FWD/BWD Monitor	Controller
Alarm Protection	Controller
System Monitoring	Controller
Control and Monitoring	Controller
Output Port	N – Female
Operating Mode	≥ 180° (Class – AB)
Interface	D-Sub 15 Pin
Mechanical Dimension	19" Standard Rack
Isolation	> 20dB
Isolator Dummy	100 Watt
BPF	350MHz ± 25KHz

Conventional I/Q modulator and demodulator modules provide the basic LLRF control loop. A high VSWR detection circuit and arc detector provide protection to the power amplifier and RFQ cavity in the event of fault conditions. By implementing a LLRF control system that provides easy software/hardware interaction, other functions can be implemented besides simple real-time set-up by the accelerator operators. Software can also be used to perform RF system analysis.

A phase detector provides the input to the tuner DSP. The amplified tuner DSP output drives a step motor to provide the RFQ cavity tuning. The cavity field amplitude-only control is included as a means of conditioning the RFQ. In order to condition the KTF RFQ, it is necessary to operate in a controlled amplitude-modulated scenario, where higher RF pulse amplitude on top of a lower DC level is injected into the cavity. Because the RFQ drifts in frequency with the amount of RF power in it, this control must be able to for the RFQ control system has been described previously as well as some preliminary LLRF modelling for the RFQ.

Fig.2 shows a control circuit of the LLRF system. The control part consists of the Intel 8751microprocessor, decoder, alarm monitor, and pulse generator.

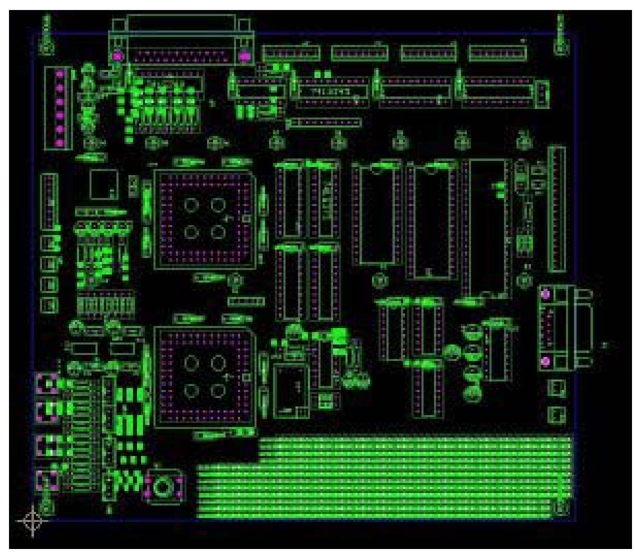

Figure 2. Control circuit of the LLRF system.

The software control of the LLRF system can be performed with either LabVIEW or EPICS. Fig.3 shows block diagram of RF feedback loops will be used in the KTF LLRF control system.

4 PRESENT STATUS

We are constructing the RF system and its power system. A low duty test of the RFQ is planned in early next year.

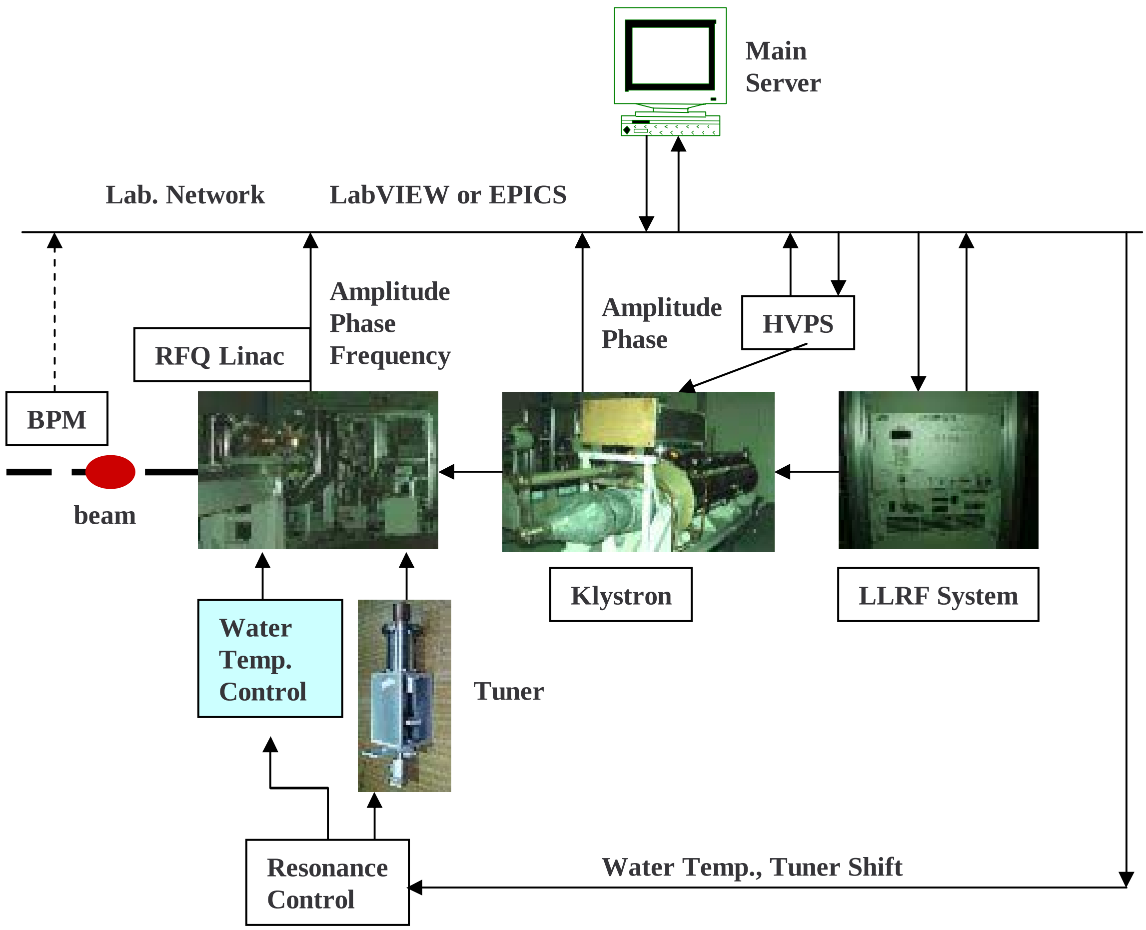

Figure 3. RF feedback loop.

ACKNOWLEDGMENT

We are grateful to Dr. J.Y. Hwang, M.W. Chun, I.H. Yu, J.S. Yang and Dr. H.S. Kang at PAL, H.J. Kim at Radionix Co. Ltd., C. K. Cho at KBS. This work has been supported by the Korean Ministry of Science and Technology (MOST).

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