Transactions of the Korean Nuclear Society Spring Meeting
Jeju, Korea, May 7-8, 2015

Development of the RF system for the KOMAC MEBT

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1. Introduction

The 100 MeV proton accelerator is constructed in the KOMAC, KOMAC has been provided with the proton beam for the many industrial applications. In the 100 MeV proton linear accelerator (Linac) for KOMAC, the RF source will power two-accelerator cavities (an RFQ, a DTL1) operated at a frequency of 350 MHz [1]. The low level RF (LLRF) system for 100 MeV proton linear accelerator provides field control including an RFQ and a DTL at 350 MHz. In our system, an accelerating electric field stability of ± 1% in amplitude and ± 1° in phase is required for the RF system [2, 3]. Eleven radio-frequency (RF) systems are required for the 100 MeV accelerator, which are one RF system for the radio-frequency quadrupole (RFQ) cavity, one RF system for the 20 MeV drift tube linear accelerator (DTL) tanks, two RF systems for the medium-energy beam transmission (MEBT) tanks, and seven RF systems for the 100 MeV DTL tanks [4]. Now a total of 9 RF systems are being operated. To improve the beam quality, the additional RF system for MEBT (Medium Energy Beam Transport) is needed. An addition of a MEBT RF system will reduce loss of beam quantity caused by gab between 20 MeV DTL tank and 100 MeV DTL tank.

2. RF System Design

RF system consists of FPGA controlling RF power amplitude and phase, SSA amplifying RF power for MEBT tank and low-level RF (LLRF) analog chassis performing a clock and RF distribution, an up/down conversion, RF signal processing, and an interlock for the high power RF system protection.

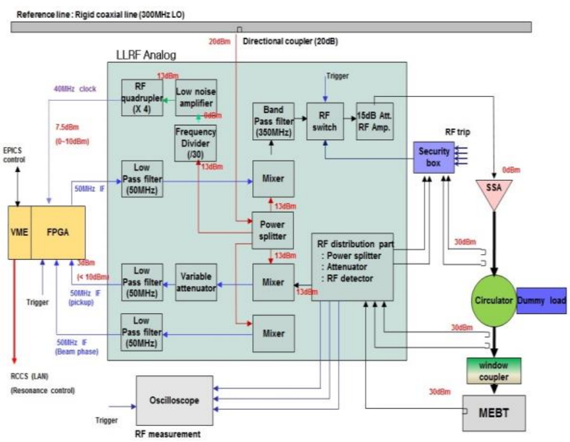

Figure 1: The overall system of RF system for MEBT

Figure 1 shows the overall system of RF system for MEBT. FPGA, VME, LLRF analog box, RF interlock box, Oscilloscope, 4 kW SSA are included in high frequency control rack for MEBT. High power RF from high frequency control rack goes into MEBT, running through the cable and waveguide. Three main parts of high frequency control rack are FPGA controlling the size and the phase of the high frequency signal, the SSA amplifying signal and sending into the tank, and LLRF analog box, which plays the role of a bridge between FPGA and SSA. FPGA operates at 50 MHZ, but the high frequency running into the tank is 350 MHZ. The LLRF analog box converts the frequency by the 300 Mhz of reference signal and providing the tank with appropriate power.

3. Installation and Test


Figure 2: MEBT RF control rack


Figure 3: The circulator for MEBT test

RF control racks, helix cables and circulator were installed in the klystron gallery. Each RF control rack for MEBT includes FPGA, VME, LLRF analog box, RF interlock box, Oscilloscope and 4 kW SSA. After installation is complete, Transmission losses between tunnel and gallery were measured by Sending a signal generator signal from the tunnel to the gallery. Attenuation of the signals passing through helix cables and waveguides were about 2.0 ~ 2.2dB. Next, we calibrate LLRF analog box. Calibration results are shown in Figure 4.

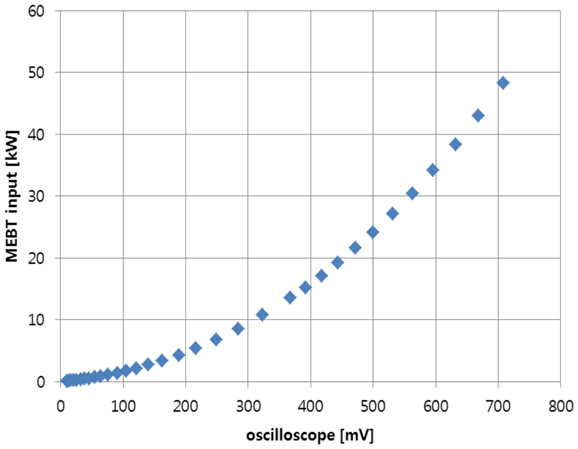

Figure 4: LLRF analog box calibration

Next, 4 kW SSA for the MEBT RF system were tested. First, the output was measured by powermeter as the input in the SSA increased slightly. In this test, the maximum output was 4 kW as seen in the Figure10. Then the operating status was checked for an hour on condition of both 1 ms, 50 Hz, output of 1 kW and 100 us, 1 Hz, output of 4 kW. The test results are Figure 5.

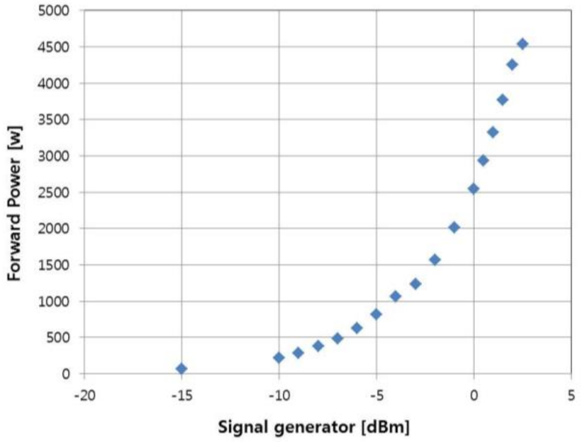

Figure 5: 4kW solid state amplifier test

4. Conclusions

The transmission lines from the RF control rack to the MEBT tank were installed. RF system for MEBT is being installed. LLRF analog and SSA have been tested. The condition of the test is 350 MHz, 9% pulse duty (1.5 ms, 60 Hz), 4 kW(peak power). Perfecting an RF system of MEBT will reduce loss of beam quantity caused by gab between 20 MeV DTL tank and 100 MeV DTL tank.

This work was supported by the Ministry of Science, ICT & Future Planning of the Korean Government.

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