

LE Linac Solid State Amplifier Upgrade

Trevor Butler

7/14/2014

Introduction

During the 2014 Shutdown, I will be upgrading the LE Linac Driver systems with new solid state RF amplifiers, which will replace the present 4 Watt & 400 Watt solid state amplifiers and the 7651 Amplifiers. The new amplifiers are designed to have enough gain (68 dB) to amplify signals directly from the LLRF system, applying to the next stage 4616 RF tube amplifier. They will have 6 kW (68 dBm) of peak envelope power with 1 dB compression point of 5kW (67 dBm). I have listed below the changes that will be made and signals required in operating the new solid state amplifiers. This should help when debugging any problems this system may have in the future.

Summary of Changes

- The following power systems will be disconnected since they will no longer be required. Some will be physically removed and other systems will just have the power disconnected.
 - 4W SS Amplifier & Power Supply
 - 400W SS Amplifier & Power Supply
 - 7651 Blower Fan (A11A1B1) – Physically Removed
 - 7651 Filament Power Supply (A11A1A1) – Physically Removed
 - 7651 Screen Power Supply (A11A1A2) – Power Disconnected
 - 7651 Bias Power Supply (A11A1A3) – Power Disconnected
 - 7651 Intra-pulse Bias Controller (A11A1A4) – Power Disconnected
 - 7651 Anode Power Supply (A11A1A6) – Power Disconnected
- The following interlocks will be made up either with jumpers or interlock from SS Amplifier
 - Air Cooling On (Screen/Cabinet Air Cooling + Jumper A)
 - 7651 Filament On (6 kW Tomco RF Amplifier Jumper B)
 - 7651 Bias PS On (6 kW Tomco RF Amplifier Jumper C)
 - 7651 Screen PS On (6 kW Tomco RF Amplifier Jumper D)
 - 7651 Anode PS On (6 kW Tomco RF Amplifier DC Power Ready)
- A solid state amplifier box will be installed when the present filament power supply is located which will contain the need interface between our present 120 VAC interlocks and the 5 Volt interlocks inputs and outputs of the new Solid State RF Amplifier.
 - Shutdown (Input to the SS RF Amp) - Used to shut down the amplifier high voltage is applied to the 4616
 - DC Power (Output of the SS RF Amp) – Used to prevent high voltage from being applied to the 4616 until the SS amplifier has valid DC power rails

- Tomco Solid State RF Power Amplifier (BT6K-Delta) Inputs and Outputs
 - RF IN (N-type)
 - Comes from the LLRF system
 - Calibrated to have 0 dBm of power at the input, which requires proper padding of signal and setting of L:VxARF (“x” is the station number)
 - RF OUT (7/16 DIN)
 - Signal first goes Werlatone Isolator (I10002-28) to absorb any reflected power from the 4616. This will add in tuning the 4616 since the SS RF Amplifier will not trip off during tune-up, even if there is full reflection of the waveform.
 - Then the signal goes to a Werlatone Directional Coupler (C9864), which will be used to create readback in ACNET (L:SSDAxF & L:SSDAxR) for both forward and reverse power
 - GATE (BNC)
 - 5 Volt pulse used to gate the RF Output of the SS RF Amplifier
 - The LLRF pulse is already gated with the Mixer output of the A5 Modulator Control NIM Crate (A5A6)
 - The SS RF Amplifier Gate input is connected to the Linac RF System Driver Modulator Pulse Controller (0230.00-EC-60666) using the old Output to the 7651 Grid Pulser
 - Vfwd (BNC) – Secondary readback before the isolator of the forward power (L:TMCxF)
 - Vref (BNC) – Secondary readback before the isolator of the reflected power (L:TMCxR)
 - INTERFACE (DB-25) – Connects to interface box for control and status of driver HV
 - MAINS IN (IEC) – Connects to power strip
 - GROUND (M6 Bolt) – Connected to the ground of the Driver
 - ADDRESS – Set to 0 for the Buncher, which will allow for operation without interface box. Set to 1 for other RF systems to require interface connection for operations, which will light the selected indicator on the SS RF Amplifier.

Conclusion

The new solid state amplifier will enable more stable operation in the future. This new system will be less prone to failure and provide stable RF power to the 4616, which will in turn, enables longer lifetime of operation by adjusting the power level out of the SS RF Amplifier. This level can either be adjusted using the gain control knob, or preferably, done using the LLRF parameter L:VxARF in ACNET to provide enough power to limit the screen voltage on the 4616 tube. After installation, it may be desired to study the relationship between tube gain at different screen voltages to optimize lifetime and performance. Since there were only minor changes to the wiring of the driver, the drawing for A11A1 (0230-EE-60091) has been manually modified to reflect the changes, which will be kept in the Linac reference book. The manual for the new solid state amplifier, as well as the drawings will also be available, but only has a hard copy due to copyright protection, which will be available upon request.