

7835 Power Amplifier Filament Controller

Due to the unreliability of the old filament control system, a PLC based upgrade with Touch Panel interface was installed during the 2012 Shutdown. This upgrade makes operation of the filament controller simpler than the old stepper relay logic system and provides better filament current regulation due to a newer, variable speed, motor. Also, the 7835 Power Amplifier Ion Pump Power supply has been placed next to the touch panel. This is an effective measurement of the vacuum in the tube, which rises as the current is turned on. To run the station, this current must be below 50 microamps to make up the Cavity Press Interlock on the Pulse Interlock Module.



The 7835 filament current is regulated by a motor driven inductrol (variable transformer) which ramps up and down to turn the filament current on from 0 to 7500 Amps (6800 is the typical value for the 7835 PA). It can take approximately a minute to ramp the tube up to full current, which helps tube life time by minimizing the stress of turn on for both the tube and the electrical connecting spring rings.

In order to turn the tube on, two conditions need to be met. All of interlocks (Except 480 VAC Cont Aux & 480 VAC Undervoltage) need to be made up and the Lower Limit switch being activated, which indicates that the inductrol is in its lowest voltage output position. The interlocks are listed on the left side of the touch screen. Note that the touch screen has a screen saver and needs to be touched once to wake up, which should not activate any buttons unless pressed repeatedly to wake the screen up, which could potentially cause unwanted commands to be issued. Before each interlock is both an Instantaneous and Latched status light (listed as I and L respectively). These are useful in diagnosing problems and should be looked at before applying a reset, which would clear the latched status if there was an intermittent that tripped the system off.

There are two ways to reset the system, using the Blue Reset Button on the screen, or the Blue Reset Button on the main HV control panel. Once all of the interlocks are made up, including the ON/OFF switch located to the left of the touch panel, the system is ready to get turn on. After the reset, the system will be in manual mode (this manual mode is switched to automatically when on the lower limit) and you will then hear the sound of the 480 VAC Cont Aux closing in, but the filament will not

start to ramp up. Pressing the AUTO button, located below the Auto Mode Current Set Point, places the system in regulation mode.

After a reset, and once in auto mode, the filament will start to ramp up to the set point. This is different than the old filament regulator, which was usually left in manual mode and raised to the final set point using the up and down commands. Before switching to Auto mode, please make sure that the current set point is a reasonable number (~6800 Amps) and should be set much lower when turning on tubes for the first time after the filament has tripped off. Also, note that the system If the filament trips off, this procedure of turning back on should only be done under the guidance of a system expert. The operating 7835 filament current can be adjusted by pressing the set point, and typing in a new value, or can be raised in 10 Amp increments by using the up and down arrows to the right of the set point. In filament automatic mode, the motor can run in one of two speeds; fast and slow. It runs fast when the present value for current is far from the set point, and switches to slow as it near the set point. This is done to minimize overshoot.

Once the filament current has risen above the Filament Ready Set Point (typically set at 6400 Amps), there will be a 5 minute timer that starts. The purpose of this time delay is to give the 7835 tube time to stability in both the voltage, current, and temperature. As the tube warms up, the impedance will increase, the current will start to drop, and the controller will slower ramp up the current to compensate. After 5 minutes, the Filament Ready light will turn on, which should make up the PA ready light on the main HV control panel.

The filament can also be raised in manual mode by pressing MANUAL and using the MANUAL UP and MANUAL DOWN button to the right of the MANUAL select button. While in manual, you can set the Manual Speed Select to either slow or fast by pressing (toggling) the button to the right. Below this button is an indicator telling you what speed the motor is current running in if it is presently moving. Also, there are a total of 3 pages that can easily be accessed by using the bottom right corner of the touch screen labels Interlocks, Regulation, and Data Log. Although all operating setting can be made from the Interlocks screen, the Regulation screen is useful for system experts and the Data Log screen can be used to observed voltage, current, and impedance of the tube over time. There is also a Setup (EXPERT ONLY!) button on the screen which can be used to change various parameters and is password protected to restrict use to system experts.

If there is a problem where the filament needs to get turned off, such as loss of CUB water cooling, the ON/OFF switch can be used to slowly ramp down the filament. Before ramping down the filament, the ideal procedure it zero the gradient using the Amplitude Control Module, Turning of the pulse using the Waveform Generator, and turning of the system high voltage. This new procedure is a lot easier and quicker than the old regulation system, which required placing the system in manual operation and holding down the raise/lower switch until the filament current drops to zero. Even when there is a CUB cooling loss, there is enough cooling left in the water cooling loop to keep the filament cool until the system ramps down, assuming that each system can be shutdown with minutes of the CUB outage before the temperature in the RF water system starts to rise. Since turning the tube off hard (without ramping down) it not good for the tube, this ON/OFF switch should always be used to turn the filament off, even under normal operating conditions. The filament breaker in the A3 rack, which shuts down the filament immediately, should not be used to turn off the 7835 filament since it can possibly damage a tube, but can be done if the controller fails to ramp down the current. Below is a list of the interlocks used for the filament controller.

120 VAC Control	Always on so long as the station has main power
120 VAC Switched	Is on when the control power switch is turn on
480 VAC CB AUX	Auxiliary contact on the A3 Filament breaker
Mod Test Normal	Rarely used unless there is a modulator dummy load set up
Cooling Complete	Indicates the cooling water for the entire station is okay
Motor CB Aux	Auxiliary contact on the circuit breaker in the inductrol cabinet
Motor Drive Contactor	Auxiliary contact on the contactor in the inductrol cabinet
Motor Drive Fault	Indicates a problem with the motor drive unit
Inductrol Temp	Over temperature Klixon in the inductrol
Inductrol Air Flow	Air Flow switch used on the motor blower which cools the inductrol
Rectifier Temp	String of Klixons located on the diodes
Hard Limits	Back up limits to the normal lower/upper limits. If hit, the motor has failed
Filament Open	PLC calculation that indicates the filament is open
Over Voltage	PLC indication that the voltage was > 7.5 Volts
PLC Over Current	PLC indication that the current was > 7500 Amps
External Overcurrent	Built in backup overcurrent located in rectifier cabinet
Soft Shutdown Switch	Switch located to the left of the touch screen labeled ON/OFF
Interlocks Complete	Indicates that all of the above interlocks are made up
480 VAC Cont Aux	Off until Interlocks Complete is on, reset is activated, and Contactor closes in
480 VAC Undervoltage	Off until 480 VAC Cont Aux is on & 3 phase power detected in the inductrol