AMP INRUSH
MLA-2500B
Soft Start

As seen from the measurements previously made, the MLA-2500B has a very high transformer- and filament inrush current which should be reduced. It can be reduced by using a properly designed Step-Start. It's also a good idea to optimize the filament voltage to increase the lifetime expectancy of the tubes.

Test conditions:

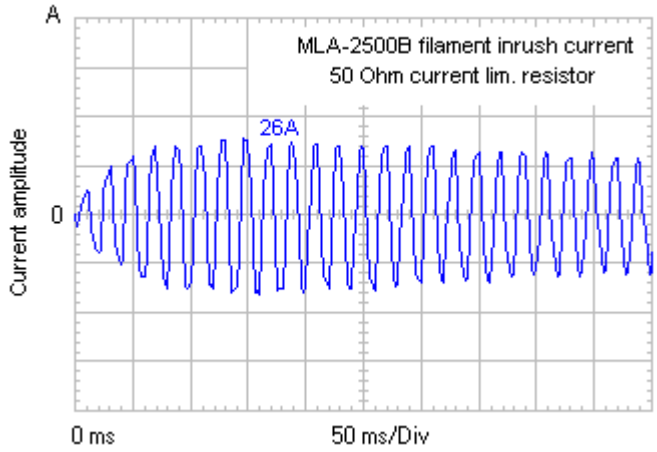
Line Voltage	Amplifier mode	Ambient temp
230VAC, 50Hz	Stand By - CW / Tune	21 degrees C.

Filament voltage optimization.

The measured filament voltage was 6.39V at 230V line. The specified filament voltage for the Eimac 8875 is 6.3V ±0.3V, but by lowering the filament voltage to the low side, the lifetime expectancy of the filament will be increased. Taking line voltage variations at my location into consideration, I decided to set it to 6.15V at 230V line voltage.
A 22 AWG teflon covered wire was installed in series with the filament winding going to ground, and cut to a length giving 6.15V filament voltage. Length about 0.70 meter and resistance 0.037 Ohm. The filament inrush current does not decrease with this resistance.
Note: The voltmeter used must be calibrated.

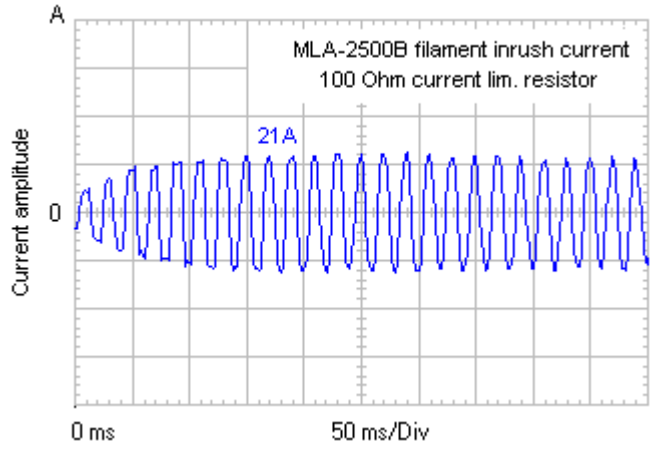
Filament inrush current reduction.

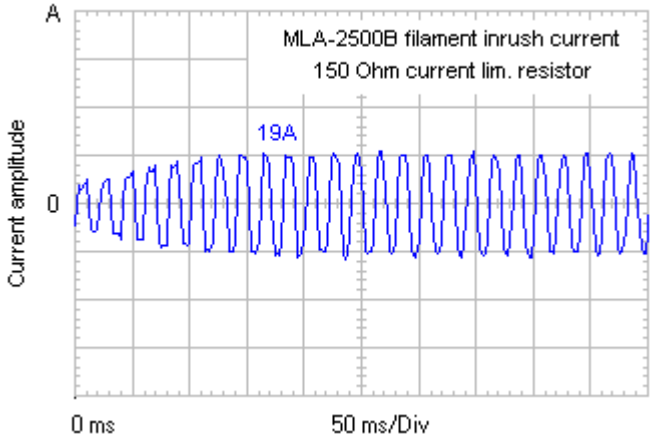
Here a step start is used, with a current limiting resistor in series with the transformer primary. After power on, the resistor is shorted out after a set time by a time-delay relay.
The goal was to decrease the filament inrush current to about two times the nominal filament current; i.e. about 12A RMS. The inrush current was measured using current limiting resistors of 50, 100 and 150 Ohms.



Filament inrush current with 50 Ohm current limiting resistor.
Peak current is 26Amps (18A RMS). That is 3 times the normal value.

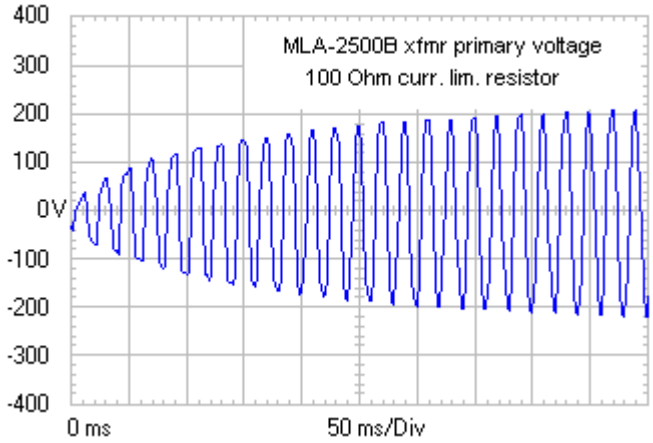
Filament inrush current with 100 Ohm current limiting resistor.
Peak current is 21Amps (15A RMS). That is 2.5 times the normal value.





Filament inrush current with 150 Ohm current limiting resistor.
Peak current is 19Amps (13A RMS). That is about 2 times the normal value.

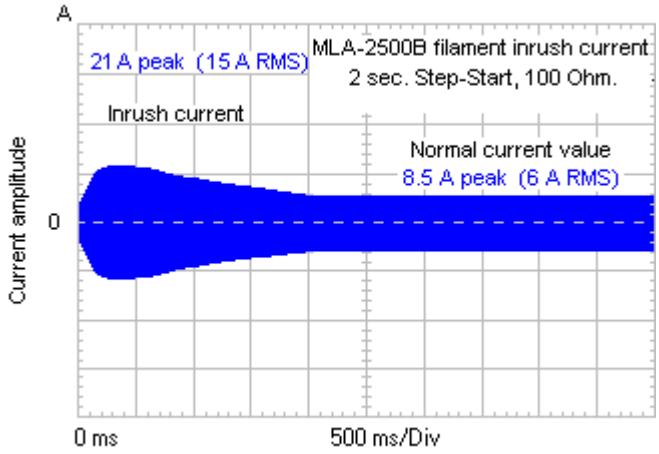
The initial increase in filament current amplitude (soft start) is due to the increasing voltage amplitude applied to transformer primary at turn on (see below), caused by the decaying voltage drop over the Step-Start current limiting resistor. The decaying current amplitude at the transformer primary is caused by the decaying charging current amplitude of the filter capacitors in the high voltage power supply.
In other words, the charging of the filter capacitors is causing an additional feature in reduction of the transformer- and the filament inrush current. If the amp is turned off and immediately on again, this is not the case as the filter capacitors are still charged. However, the filament inrush is OK, as the filaments has its normal operating temperature.



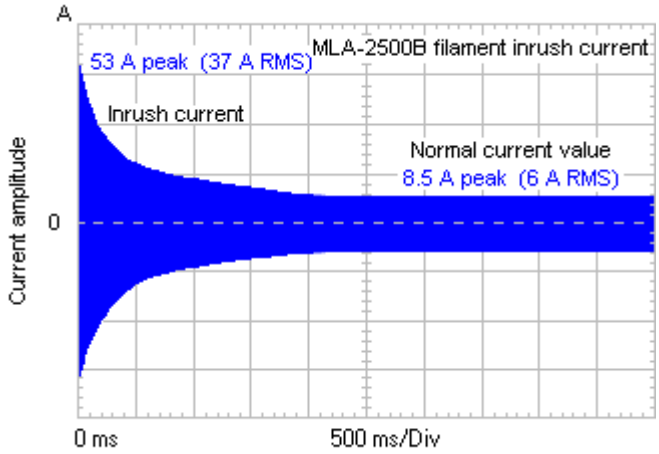
Transformer primary voltage.
The transformer applied primary voltage, using a 100 Ohm current limiting resistor.

After evaluating the above measurements, I decided to use a 100 Ohm current limiting resistor and 2 seconds step-start duration.

Filament inrush current envelope with 100 Ohm current limiting resistor.
A graphical representation of the filament inrush



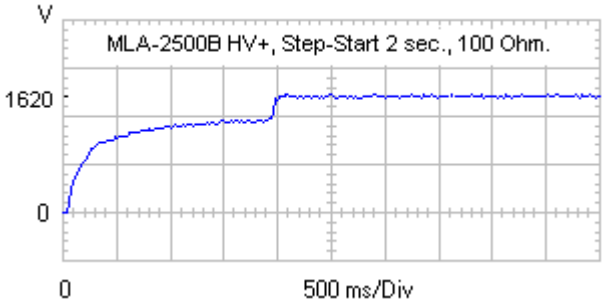
current. As seen, the filament inrush current is decreased from 37A RMS to 15A RMS. The Step-Start used has a 2 seconds duration.



For comparison:
Filament inrush current envelope with no Step-Start.

Absolute minimum Step-Start durations using current limiting resistor,
50 Ohm : 0.8sec
100 Ohm : 1.0sec
150 Ohm : 1.6sec

With these or shorter step-start durations, there will be an increase in the filament current amplitude when the time-delay relay closes and short out the current limiting resistor as the filaments has still not reach the normal operating temperature / resistance. Recommendation: Double these figures!

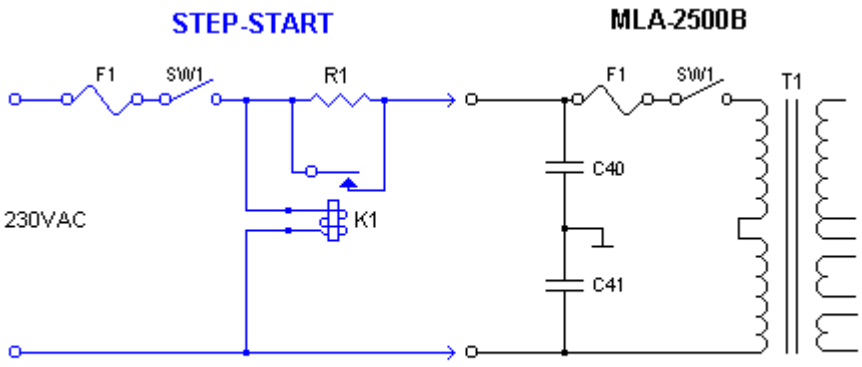


High Voltage Supply.
With Step-Start, the filter capacitors have a longer charging time. After 2 seconds, the time-delay relay short out the current limiting resistor, which causing full power to be applied to the the filter capacitors.

MLA-2500B transformer inrush current.

With a Step-Start using 100 Ohm current limiting resistor, there are no noticeable transformer initial inrush current measured at the transformer primary.

Shown below is a basic Step Start circuit. The MLA-2500B is a very compact amp with little space for additional circuits, so an external step start is preferable.



R1 : Current limiting resistor
K1 : Time-Delay relay

As current limiting resistor R1, I used a 100Watt aluminum housed power resistor.
For a more advanced step start, go to my softstart page.

Some of the measurements shown, should be taken with some caution, as this amp has other type of filter capacitors in the high voltage supply than delivered from the factory.

Acknowledgement.
My thanks to Hans Kise, LA1TCA for his help in this project.

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