4.3 EMISSION CURRENT CONTROL (ECC)

This power supply offers the option of feedback stabilized Emission Current Control (ECC). Under normal circumstances, when a constant voltage source drives the ion source heating, emission current varies over time. The emission current changes are due to variations in the ion source heater's resistance as its temperature varies and physical changes such as evaporation and contamination. To provide a stable and constant emission current, the ECC option can be used. The ECC circuit maintains a constant emission current by using feedback control to adjust the source voltage.

With the alkali metal ion source, it takes time to stabilize emission due to the heat capacity of the solid cartridge. The electronic feedback circuitry responds over a shorter time frame than it takes the cartridge to reach a stable temperature. During this period, oscillations will be seen in both source current and emission current. By making only small adjustments with the ECC control and waiting for these oscillations to subside, a stable ion emission can be achieved.

Note that while the emission current is held constant, the beam current may still vary. Many factors can cause the ratio of beam current to emission current to vary such as, but not limited to: Grid and Focus values, chamber pressure, Ion Gun and target contamination, and outgassing.

Although protection against excessive source current is built into the ECC circuitry, it is best to employ the ECC mode **after** the approximate operating parameters have been determined in Source mode. For example, as the grid voltage is increased toward beam cutoff, the ECC feedback will call for more source current in order to maintain the chosen emission current value. This increased source current will increase the evaporation rate of material in the ion cartridge, thus reducing the cartridge's lifetime.

Do not switch from ECC Mode to Source Mode while the Ion Gun is running.

When operating in ECC mode, the number of turns of the **SOURCE/ECC** potentiometer determines the desired emission current level. Ten turns of the potentiometer will yield the maximum emission current. For example with an ECC range of 0 to 500 µA, 10 turns will yield the full 500 µA, while 5 turns will yield a half the range or 250 µA, etc. The emission current is read on the Emission Current meter, but the ECC range may be set to be less than the full meter range.

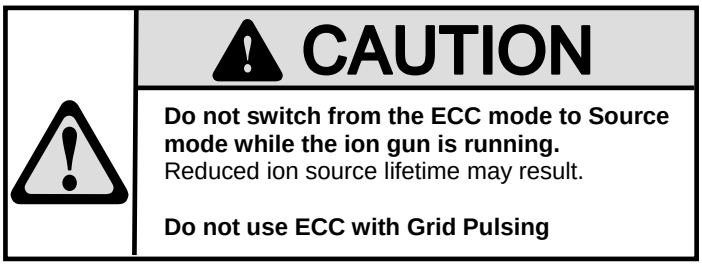
When operating in Source mode, the number of turns of the **SOURCE/ECC** potentiometer determines the source voltage; 10 turns of the potentiometer will yield the maximum source voltage. Such a high source current will result in short ion source lifetime. If the **SOURCE/ECC** potentiometer is set to 10 turns while operating in ECC mode and the power supply is switched to Source mode, then source current will be switched to its maximum level, reducing ion source lifetime.

For systems with the Grid Pulsing option, do not operate the Ion Gun in ECC mode if using the Grid Pulsing. Reduced ion cartridge lifetime may result. The ECC circuitry is designed to be a DC feedback system. During grid pulsing, the average emission current is close to zero and the ECC feedback will raise ion source heater temperature to try to compensate for the lack of emission current while the gun is pulsed off.

The Zener limit, which controls the maximum source current, and the gain, which determines the maximum emission current, have been preset at the factory for the Source/ECC board. If, under normal operating conditions, the desired ion emission current range cannot be achieved while the ECC circuit is in use, please call the Engineering Department at Kimball Physics at (603) 878-1616. Note that the Zener limit is meant to protect the ion source from high, life shortening, current. Achieving the full emission current range under all operating conditions will not be possible.

CAUTION: The Zener limit is calibrated for a particular gun and a particular ion source. When the ion source is replaced by the user or the gun is rebuilt, the Zener limit may need to be recalibrated. Call Kimball Physics at (603) 878-1616.

4.3 EMISSION CURRENT CONTROL cont.



OPERATING PROCEDURE FOR ECC MODE

1. Set-up:
   a. To assure low ion source heater temperatures, initial emission current adjustment should be done with little or no grid bias. Once operating in the ECC mode, the beam may be optimized by slowly adjusting the grid bias while maintaining source current. Excessive source current will reduce ion source lifetime.
   b. With the **SOURCE** pushbutton on, turn the **SOURCE/ECC** potentiometer to zero, fully counterclockwise.
   c. Switch the **ECC/SOURCE** toggle switch to **ECC**.

2. Adjusting Emission Current Control:
   a. Slowly turn the **SOURCE/ECC** potentiometer clockwise one turn and wait.
   b. In approximately 30 seconds the Source voltage and Source current will start to rise.
   c. Turn the **SOURCE/ECC** potentiometer until the desired Emission current is achieved. It may take time to stabilize emission. Make only small changes, and wait for any oscillations to stop before adjusting again. Monitor emission on the **EMISSION CURRENT** meter.
   d. The Emission current called for is proportional to the number of turns of the **SOURCE/ECC** potentiometer. (For example, with a 0 to 500 µA ECC range, 10 turns will yield the maximum of 500 µA, while 5 turns will yield half the ECC range or 250 µA, etc.) The ECC range varies with the gun model.

3. **For Remote Programming**: The ECC option can also be controlled by a 0 V to +10 V programming signal (such as might be provided by a D/A supply) into the back of the Power Supply. +10 V will yield the full-scale emission current value, shown in the table below.
   (For example, with a 0 to 500 µA ECC range, +10 V will yield 500 µA, while +5 V will yield half the ECC range or 250 µA, etc.)

4. **For Pulsing:** Do not use ECC mode; use normal Source mode.

5. Turning off the ECC option:
   a. Turn the **SOURCE/ECC** potentiometer fully counterclockwise. Failure to do so could severely damage the ion source and greatly shorten the ion source's lifetime.
   b. Switch the **ECC/SOURCE** toggle switch to the **SOURCE** position.

This completes the ECC Instructions.