4.7 ION BEAM PULSING OPTIONS

COMPARISON OF VARIOUS ION BEAM PULSING METHODS

In most alkali metal ion guns, the ion beam may be turned off and on while the gun is running. The way this is accomplished depends on the particular gun design; often several methods are available for a gun. The beam pulsing options currently available for this gun model are described in detail following the summary
Table 4.7-1

The grid (G-1) provides the first control over the beam and usually can be used to shut off the beam. In an alkali metal ion gun, if the grid voltage is sufficiently positive with respect to the ion source, it will suppress the emission of the positive ions from the ion source cartridge. The minimum voltage required to completely shut off the flow of ions to the target is called the grid cut off. The grid voltage is controlled manually by a potentiometer knob on the power supply; thus, in most guns, the beam can be turned off while the gun is running by setting the grid to the cut off voltage.

Pulsing is stopping and starting the flow of ions in a fast cycle. This pulsing is usually accomplished by rapidly switching the grid voltage to its cut off potential to stop the beam. The grid voltage can be controlled by several different methods, which are summarized in Table 4.7.1 (listed in order of speed).

The simplest method of turning the beam off and on is just to cycle the grid voltage by hand with the control potentiometer or encoder wheel on the front of the power supply. Clearly, this would be slow and not reproducible.

A more systematic method of controlling the grid is by an input signal into the remote connector on the rear panel of the power supply. Remote control is a standard feature on all power supplies, so this method does not require any system options. However, it may not provide sufficiently fast pulsing.

With the dual grid pulsing option, there are two grid power supplies built into the main power supply. A pulsing TTL (transistor-transistor-logic) signal switches rapidly between the two supplies, pulsing the beam on and off. The dual supplies are (1) the normal, variable control grid supply which is adjusted to allow the ion flow and (2) a fixed grid supply which is set at the cut-off grid voltage at the factory.

For the capacitive or fast pulsing option, many guns can be equipped with a capacitor-containing device (either a separate pulse junction box or a cable with a box) that receives signal from an external pulse generator. The grid power supply and pulse generator outputs are superimposed to produce the voltage at the grid aperture. The general pattern of the beam pulsing is a square wave with a variable width (time off and time on) and a variable repetition rate. Capacitive pulsing can provide the fastest rise/ fall time and shortest pulse length of the various methods. However, the capacitor does not permit long pulses or DC operation. If there is a separate grid lead on the gun, this capacitive pulsing option can be added to most existing gun systems without modification.

Table 4.7-1 following is intended to provide a general comparison of different pulsing methods. Specifications may vary for some gun models, and custom designs are available for particular pulsing requirements. The pulse height is from no beam at grid cut-off to full beam current with no grid, all other parameters unchanged. The pulse length is defined as the time the beam is on, measured as the width at 50% of full beam and may include some ringing. The rise/ fall time is measured between 10% and 90% of full beam. Shortening the rise/fall will typically increase ringing. Pulsing performance may also depend on the performance of the user-supplied pulse generator.

NOTE: Not all ion guns are designed to be pulsed. For example, these types of pulsing do not work with gas electron-impact ionization guns.

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Table 4.7-1 Summary of Beam Pulsing Methods for Various Ion Guns

PULSING TYPE	CONTROL METHOD	FEATURES & DRAWBACKS
Manual	Manual control with grid dial potentiometer on front of power supply	Pulse lengths ~ 1 min to DC, Rise /fall ~ 10 sec
		Available on all guns that cut off with grid
		Operator needs to control grid potentiometers
		Drawbacks: Slow and irregular Not available on guns with positive grid or no cutoff
Remote Control	Remote control with computer input into grid power supply terminals	Pulse lengths ~ 100 msec to DC, Rise /fall ~ 20 msec
		Available on all guns that cut off with grid
		0 to 10 V control signal required (e.g. D/A converter or DAQ board with analog input)
		Drawbacks: May not be sufficiently fast Not available on guns with positive grid or no cutoff
Dual Grid Power Supply Option	Dual grid power supplies with a TTL signal input	Pulse lengths ~ 2 μsec to DC, Rise /fall ~ 500 nsec
		Repetition rates to 1 kHz
		Controlled by any TTL generator (computer or stand alone)
		Optional, built into main Power Supply requested at time of order, or separate pulsing supply
		Drawback: May not be sufficiently fast
Capacitive Fast Pulsing Option	Pulse junction box connected to grid, or grid pulsing cable (depends on gun model) and an external pulse generator	Rise /fall ~ 10 nsec
		Pulse lengths ~ 20 nsec to 100 μsec (box)
		50 Ωimpedance, 1 W standard (higher power available)
		Controlled by a external pulse generator with voltage at least equal to grid cut off value
		Removable pulse junction box or special cable
		Optional, can sometimes be added to existing system
		Drawbacks: Long pulses not achievable Requires pulse generator with desired rise /fall and sufficient voltage Not available on guns with no cutoff