BEAM PULSING OPTIONS

COMPARISON OF VARIOUS BEAM PULSING METHODS

In most guns, the electron 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 0-1.

The grid (G-1) provides the first control over the beam and usually can be used to shut off the beam. In an electron gun, if the grid voltage is sufficiently negative with respect to the cathode, it will suppress the emission of the electrons, first from the edge of the cathode and at higher (more negative) voltages from the entire cathode surface. The minimum voltage required to completely shut off the flow of electrons to the target is called the grid cut off. The grid voltage is controlled manually by a potentiometer 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 electrons 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 0-1 (listed in order of speed).

Not all guns are designed to be pulsed. For example, a few electron guns have a positive grid in order to extract more electrons, and so these guns do not usually have grid cut off, unless a dual grid supply is ordered. In some high-current electron guns, the optical design, the position of the cathode, does not allow for cut-off by the grid, and so a different option, called blanking, must be used to interrupt the beam instead of pulsing.

In general, ECC (emission current control) can not be used with pulsing. During grid pulsing, the average emission current is close to zero, and the ECC feedback will raise cathode temperature to try to compensate for the lack of emission current while the gun is pulsed off. This could result in reduced cathode lifetime.

The simplest method of turning the beam off and on is just to cycle the grid voltage by hand with the keypad and up/down arrows on the front of the power supply. Clearly, this would be slow and not reproducible.

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. For most guns, the dual supplies are (1) the normal, variable control grid supply which is adjusted to allow the electron flow and (2) a fixed grid supply which is set at the cut-off grid voltage at the factory. For guns that usually have a positive grid, the dual supplies are (1) a variable positive grid supply which allows the electron flow, and (2) a variable negative grid supply which is adjusted to cut-off.

For the capacitive or fast pulsing option, many guns can be equipped with a capacitor-containing device (either a separate pulse junction box or cylinder, or a cable with a box) that receives a 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.

Beam blanking is a different type of pulsing that does not rely on grid cut-off and is used in some high current guns. Blanking deflects the electron beam to one side of the gun tube to interrupt the flow of electrons to the target without actually turning off the beam. Unlike other types of pulsing, beam blanking can be used with ECC, because blanking does not affect emission from the cathode. Blanking is usually controlled by a TTL signal input. However, capacitive fast pulsing as described above is also possible using a pulse junction box attached to the blanker input on the gun; the pulsed voltage from the external pulse generator can cancel the blanker voltage to pulse the beam on.

Table 0-1 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.

BEAM PULSING OPTIONS cont.

Table 0-1 Summary of Beam Pulsing Methods for Various Electron 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 manually control grid settings
		Drawbacks: Slow and irregular 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 5 kHz, (optional, higher with computer)
		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
Beam Blanking Option	Blanker assembly in gun (not grid cutoff) Blanker power supply with a TTL signal input, OR Pulse junction box and additional external pulse generator	TTL switched: Pulse lengths ~ 1 μsec to DC, Rep rate to 5 kHz, Capacitive: Pulse lengths ~ 20 nsec to 100 μsec, 50 Ω impedance, 1 W standard
		Controlled by any TTL generator (computer or stand alone) OR by a external pulse generator with variable voltage (to 600 V)
		Optional, blanker assembly built into gun and supply built into main Power Supply, requested at time of order Optional, removable pulse junction box
		Drawbacks: Shunts beam to the side, does not suppress emission. Available on only a few gun models
Capacitive Pulsing Option **(also called Fast Beam Pulsing)**	Pulse junction box connected to grid, or pulse junction cylinder, or grid pulsing cable (depends on gun model) Additional external pulse generator	Rise /fall ~ 10 nsec
		Pulse lengths ~ 20 nsec to 100 μsec (box or cylinder) ~ 100 nsec to 1 msec (cable)
		50 Ω impedance, 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 Guns with positive grid require dual grid supplies