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# Regulation Requirements for the Quadrupole Power Supplies
# LU – 162

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**Abstract**

The specification for the regulation of the quadrupole power supplies for the linac upgrade is given explicitly along with some motivation. It is pointed out that there is flexibility in many of the supply parameters which gives the the designer some freedom in the means to obtain the operationally important properties.

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The general tolerance specification on focusing strength for the upgrade project is $\pm 0.1\,\%$, where the range is meant as a limit, not as shorthand for some measure of variability like standard deviation. Using a power supply which makes an ideal half-sinusoid waveform, the peak of the pulse is flat to $\pm 0.1\,\%$ during an interval of $\pm 4.03 \times 10^{-2}$ of the half-width of the pulse. Therefore, for the 2 ms pulsewidth we have specified, there is a time window of $\pm 40.3\,\mu$s around the peak of the pulse during which the current is within tolerance. Of course, the pulse need not be perfectly sinusoidal and there may be errors in in both its amplitude and timing. Taking $\pm 15\,\mu$s ($>$ 13 turns) as the required regulation period results in a deviation during an ideal pulse of $\pm 0.014\,\%$, leaving nearly the full tolerance to accommodate errors. Except for the time during the beam pulse, we really care only in a very general way what the supply does, and we do not need to know what fraction of the error derives from timing, amplitude, *etc.* For example, it really doesn't matter if the pulse is exactly 2 ms at the base so long as it can be precisely triggered for the timing of the peak and does not deliver excessive average power.

Because this same power supply is used for the quads in the transition section and may also be set over a fairly broad range during $\Delta$t tuneup procedures, we should require that the specified percentage regulation be attainable down to 50 % setting and regulation should remain at least $\pm 0.2$ % at 20 % of full output.

In summary —

1. $\Delta I/I < \pm 0.1\,\%$ over $\Delta t = \pm 15\,\mu$s
2. Full percentage regulation down to 50 % full output
3. $\Delta I/I < \pm 0.2\,\%$ for 20 % full output

Note that this specification does not touch on the question of whether a supply will be expected to power one or two quads except implicitly. We prefer to have a single supply for each quad unless they turn out to take up too much space. If it is necessary to size the supply to run two quads it will be desirable to have full regulation down to about 25 % of full output.