

Klystron Vacuum Linearization

Local application

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Vacuum gauges used in the klystron area (400 Mev) of the Linac provide nonlinear readings. The VACK local application is used to linearize these pressure readings. This note explains some of the details.

The implementation was strongly based upon an earlier VACG that was used in the 750 Kev area of the Linac. In that case, two channels were produced for each reading, so that the mantissa and range could be separately specified. In VACK, only one channel is produced that is linearly scalable to pressure, using engineering units of 10^{-9} Torr, or nanoTorr. This naturally imposes a limit on the usable range of vacuum readings. For the present, the vacuum gauges use 1 ma current, so the formula that relates pressure to the voltage read by the A/D is:

$$p = 10^{(v - 2.0)} \times 10^{-9} \text{ Torr}$$

From this formula, it is clear that 0 volts means 10^{-11} Torr; 2 volts means 10^{-9} Torr. For the use in Linac, it has been decided that a resolution of 10^{-10} Torr is adequate. This means we can scale the value of p so that 10^{-9} Torr is represented by 000A. As a result, the fullscale value will be 32768×10^{-10} , or 3276.8×10^{-9} Torr. The highest pressure that can be reported is therefore 3.2768×10^{-6} Torr. For readings specifying higher pressures, the value will be shown as this maximum usable value. This is the price of squeezing this pressure reading into a 16-bit value.

The VACK local application uses an internal Power10 function that uses an approximation by Hastings. This permits it to work in an IRM, where there is no built-in support for raising 10 to a power in the 68040 CPU chip, as opposed to the 68020-based nodes that include the 68881 floating point chip on the board. The time to do this calculation for 9 signals is 2–2.5 ms. The logic does the calculation only if the reading value changes, but it changes almost continuously.

These same vacuum gauge readings are currently supported by nonlinear scaling performed in an Acnet console. But this does not permit the signals to be used in the local Linac consoles, where only linear scaling is supported. The names of the signals known to Acnet are L:C0VAC, L:CVVAC, L:C1VAC, ..., L:C7VAC. The channels used for access on local consoles are L:C0VACM, L:CVVACM, L:C1VACM, ..., L:C7VACM. The only change is the additional character M appended. These channels furnish readings of cavity vacuum in the klystron (high energy) area of the Linac.