A possible power supply scheme for MAPMT in Airwatch/Owl

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It is well known that the power required by the MAPMT of Airwatch/Owl using the popular technique of a voltage divider is not practical, in fact, assuming $\sim 10^4$ phototubes with a gain of 10^6 and an average background light resulting in $5\ 10^7$ photo electrons per second per tube, we have a total anode current of $5\ 10^7 * 10^6 * 1.6\ 10^{-19} = 8\ 10^{-6}$ Amps. If, as usual, we assume a 10 times bigger current in the voltage divider, we end up with 80 μA per tube. The total power per tube will be: $P_{tot} = 800\ V * 80\ \mu A = 64$ milliWatt and the total power for all MAPMT's will be $10^4 * 0.064 = 640$ W.
Obviously this is too much.
A possible way out of this problem comes from the fact that if we could use 13 different power supplies (1 for the cathode and 12 for the dynodes) the total power would drop almost to zero. Clearly 13 different power supplies are not practical, considering the reliability issue.
Refining our approach we may note that most current is drained by the last 3 dynodes, so we could try to reserve one power supply for the last dynode (70 V and 8μ A), a second one could be used to power dynode # 10 and # 11, it should give 210 V for dynode # 10, the 140 V for dynode # 11 could be obtained easily using a simple voltage divider, the current required by this dynode is $\sim 2\mu$A so 20 μA have to be wasted in the resistor chain.
To power dynodes #1..9 we need $< 0.3\ \mu$ A, so we may use a current of $\sim 3\ \mu$ A in the resistors.
To summarize, using this scheme, the power needed is:

$$70 * 8\mu A + 210 * 20\mu A + 800 * 3\mu A = 7.26mW$$

The total power for 10^4 tubes is now < 80W.
No more power is needed for physics events: the short pulse of current occurring when a shower is detected can be managed with a few bypass capacitor across the dynodes, as usual.
To increase the reliability we have to take care of possible breakdown in the tubes itself, for this reason the MAPMT's have to be grouped in "macrocells" independent from each other so that a failure would blind just a small percentage of our system [1]. It would be reasonable to have a very small power supply (0.5 W maximum rating) for each macrocell, with 3 output voltages and a voltage divider powering all MAPMT's in the macrocell. Eventually the number of power supplies might be doubled to increase the reliability using a simple diode oring. See the proposed schematics in the following page.

[1] O. Catalano, Airwatch from space, Progress Report

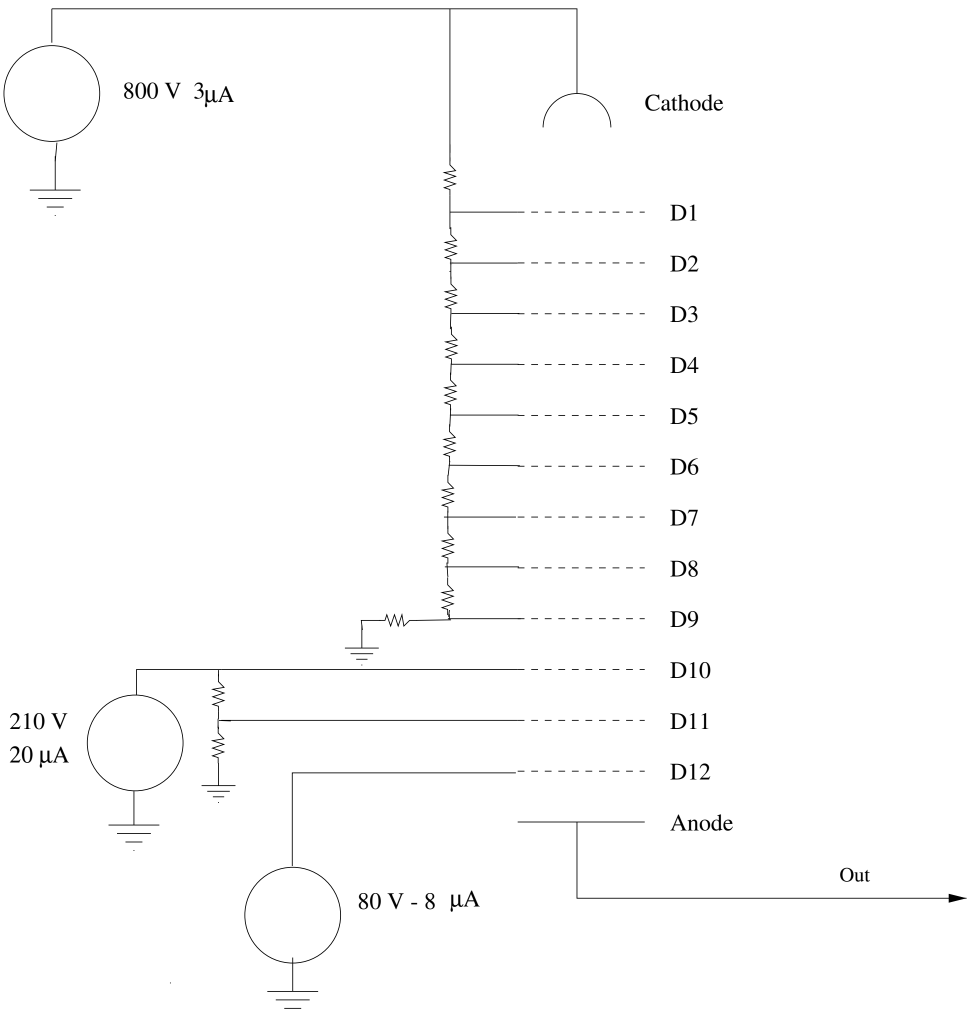

Figure 1: Schematics for a single PM