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Microwave Memos

Memo 5

Mark N Phaser

I. Introduction.

As the consideration of the design at a possible high-power microwave (HPM) weapon (phaser) continue to evolve [1-13] there is some convergence toward certain design concepts and associated parameters. Associated with past and potential future improvements in sources and antennas one might envision some progression of potential phaser designs we might refer to as Mark N [11]. If more than one version is built for a particular N, say Roman letters can follow the number to distinguish them.

For reference purposes [11], phaser stands for pulsed high-amplitude sinusoidal electromagnetic radiation. This is reasonably descriptive of such a microwave weapon system, in particular of the environment it would produce.

As discussed in [2,10,12,13] an HPM-weapon design is fundamentally associated with the target vulnerabilities and accurate determination of the same. At least for interaction via unintentional EM paths present evidence points toward an optimum HPM waveform as an approximate sinusoid with a frequency around 1 GHz with a width of 100 cycles or so, recognizing that these are only rough estimates.

Consistent with the above, there are the parameters of power P_s (averaged over one cycle) and reflector area, these being exhibited in [4,6,9,11,13]. Considering the power delivered from the source to the assumed low-loss antenna, let us define the general class of the phaser as Mark N where

$$P_s \gtrapprox 10^N \text{ in GW}$$

Of Course, here P_s means useful power, as in the power in the $H_{1,0}$ mode of a standard rectangular waveguide (or a set of such waveguides with a controlled phase relationship among all the waves).

II. N = 0 or $P_s \gtrapprox 1$ GW.

The phaser Mark 0 corresponds roughly to "off-the-shelf" sources which have already exceeded 1 GW at $f \simeq 1$ GHz. In principle, this can be used with a variety of reflector areas A, but early examples might start with standard reflectors of roughly 5 m diameter or 20 m^2 area. Such reflectors could even be made mobile, say by mounting them on a trailer with perhaps the ability of folding the reflector in half to minimize height in road transport.

While a lot of recent discussion concerns such a phaser, one should note the potential upgrade to larger powers. The associated waveguide (WR975 for 1 GHz), bidirectional couplers (H wall), vacuum flanges, horn exit dimensions, etc, can be designed for later use at higher powers.

III. N = 1 or $P_s \gtrsim$ 10 GW.

Current technology points to 10 GW single sources being possible. Magnetrons have already produced useful power of a few GW and may reach this level. Klystron-like devices may potentially have such useful powers. Both can be reasonably efficient. As such, a Mark 1 phaser is a reasonable basis for the near term [13].

IV. N = 2 or $P_s \gtrsim$ 100 GW (.1 TW).

Thinking somewhat bigger one can posit a Mark 2 phaser with parameters as discussed in [11]. Here, the source might be an ensemble of about 10 sources each of 10 GW. Of course, these need to be phase-locked as in [7]. At such a high power, the reflector area needs to be rather large (say 100 m^2) with lots of attention to avoiding breakdown, such as with lots of high-dielectric-strength gas.

An appropriate platform for such a large antenna, if the phaser is to be mobile, might be a ship.

V. Example Phasers.

Summarizing, let us take the three power levels as a basis for a set of example phasers with progressing antenna aperture areas and target ranges. Here, we assume an antenna power efficiency of 100%. A more realistic value of, say, 70%, will not decrease the fields very much. The common example frequency is 1 GHz.

N	Source Power P_s	Antenna Aperture Area A	Target Range r	Electric Field at Target E
0	1 GW	20 m^2	3 km	4.2 kV/m
1	10 GW	40 m^2	10 km	5.6 kV/m
2	100 GW	100 m^2	30 km	9.3 kV/m

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