More Antennas for the Switched Oscillator

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Switched oscillators are appropriate sources for mesoband (medium band ratio) radiating systems. They use the switching technology appropriate to hyperband radiators such as impulse radiating antennas (IRAs), except that the switches close into a pulse impedance of a few ohms (say 4Ω) instead of the 100 or 200 Ω impedances of the antennas. The switch risetime is limited by the inductance of the arc, typically of the order of 1 nH for a 1 mm gap (for hundreds of KV in pressurized hydrogen or transformer oil). The L/R time constant for a 4Ω load is then 250 ps. This makes switched oscillators appropriate for hundreds of MHz. For higher frequencies one can, of course, increase the pulse impedance of the switched oscillator. However, this makes the pulse impedance closer to the antenna impedance, thereby decreasing the number of cycles (or Q) of the resonance, as well as decreasing the stored energy for a given charge voltage.

Our problem is the design of effective radiating antennas for such frequencies in a limited space. Let us try to fit our antennas into a volume described by *h* (height), *w* (width), and *d* (depth). We would like the antenna aperature (area *hw*) to be filled with a wave of approximately uniform phase over the aperture for maximum boresight gain. Some typical numbers might be of the order

$$f = 200 \text{ MHz},\ \lambda = 200 \text{ MHz},\ \lambda = 1.5 \text{ m},\ \lambda/2 = 0.75 \text{ m}$$
$$h = 1.5 \text{ m (height)},\ w = 3 \text{ m (width)},\ d = 1.5 \text{ m (depth)}$$
$$A = \text{hw} = 4.5\text{m}^2 \text{ (aperture area)}$$

For our example the aperture is 1 λ by 2 λ. While one might like more wavelengths across the aperture, this is a fundamental limitation.

One can modify reflector-IRA-like antennas. In this case the feed arms are needed as a conical transmission line to effectively get the long-wavelength fields to the reflector. However, the resistive terminations are not needed for this purpose; they absorb energy. Replacing the terminating resistors by extensions of the conducting feed arms all the way to (and connected to) the reflector may be beneficial, by giving larger currents reaching to and reflecting from the reflector.

There are also modifications which can be made to the reflector to increase efficiency. It has been shown that certain portions of the reflector can be removed (those portions with small fields or even reversed polarization) for increased efficiency. Other portions can be extended to better fill the rectangular aperture. Once can also replace portions of the reflector by a uniconducting surface (wires or conducting strips) to convert fields in undesirable directions to more reflected fields. While these conductors may introduce resonances, this may not be important for appropriate mesoband applications.

The above antenna has a fundamental limitation in that the TEM mode has about half the energy not intercepting the reflector. Consider a quite different kind of antenna. It is basically a sophisticated type of horn. It can be called a folded horn. Compared to the previous section, the intent here is to make all the energy go in the desired direction toward the target. Let us first consider the single-ended version for simplicity.

This has an H-plane sectoral waveguide of small height to expand the wave to width *w*. Then, using a parabolic-contoured bend (E plane) to make the phase uniform across *w*, the height is expanded to half of *h* to fill the available aperture.

Taking two of these back to back (joined at a differential switched oscillator), the full height *h* of the aperture is filled.