Hyperband Inverter for HPEM Antennas with Differential Feeds

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High power electromagnetic (HPEM) systems are used in a variety of applications ranging from radar to intentional electromagnetic interference. There are many definitions of HPEM, but typically they have peak source voltages of several tens of kilovolts and peak power levels of tens of megawatts to gigawatts. HPEM systems tend to be categorized based on their bandwidth (D. V. Giri and F. M. Tesche, *IEEE Trans. on Electromag. Compat.*, **46**:322 – 328 (2004)). This study is concerned with the class of sub-hyperband and hyperband systems, sometimes colloquially referred to as ultra wideband systems, that have fractional bandwidths on the order of 25% - 200%.

Hyperband HPEM systems have a number of challenges to overcome specifically associated with the high voltages and large bandwidths. One such challenges is that conventional strategies for making elements like baluns and inverters do not always work in the demanding hyperband HPEM regimes. An example would be the design of hyperband HPEM inverters for use with differential antenna feeds. A variety of hyperband antennas can benefit from a differential feeding system. Since many hyperband antennas are based on TEM horn feeds, a differential input addresses issues of symmetry and floating grounds that can cause difficulties. Specifically in array application, the floating ground between neighboring modules of an array can cause significant difficulties for the pulsed power system.

Conventional microwave inverters are generally based on inductive coupling. While this works at low power levels, the range of magnetic materials available for HPEM applications is limited. As power levels and repetition rates increase, typical ferrite materials used for magnetic isolation saturate and cease to perform. In this paper, we will present design, analysis, and experimental results for a capacitively coupled hyperband HPEM inverter. The system is based on the design principles of hyperband baluns, and essentially includes a pair of back-to-back baluns we refer to as an unbalun, since it takes a coaxial input and inverts into a coaxial output. The system is built in a low-performance circuit element implementation and a high performance transmission line implementation. We demonstrate the inverter in the feeding network for an HPEM TEM horn antenna and a differentially fed impulse radiating antenna.