SPACE POWER SYMPOSIUM (C3)
Wireless Power Transmission Technologies, Experiments and Demonstrations (2)

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SIDELOBE REDUCTION FOR GEO TO EARTH WIRELESS POWER TRANSFER

Abstract

The power to be transmitted to earth by orbiting solar power satellites exceeds typical satellite communications by some 13 orders of magnitude. Interference with space-to-earth and terrestrial communications can be severe and cause desensitization. Modes of interference include grating lobes, sidelobes, harmonics, blackbody noise, offset errors, and phase noise. In this work various configurations of a transmitting antenna in geostationary earth orbit are studied with the intent to reduce both grating lobe and sidelobe power levels outside of the primary power beam. Circular arrays are seen to generate unacceptably large sidelobes. Dual arrays were studied with the intent to destructively interfere with sidelobes at the expense of a minor loss in the main power beam. Such dual arrays with a secondary one-half wavelength behind the primary are capable of reducing sidelobes, albeit only at specific angles. It is then discovered that an array having triangular arrangement of antenna elements at 0.8 wavelength spacing using a Dolph-Chebychev beam profile across the array, and with a -120 dB sidelobe target, is capable of reducing sidelobe intensity by more than 200 dB. This is sufficient to prevent desense and to avoid interference with radio astronomy. Imperfections caused by element failures on such an array were studied, showing an expected correlation between the fraction of dead elements (randomly located) and the increase in sidelobe level. Failure rates of 0.1 % raise maximum sidelobe levels to -97 dB, while a more typical 3 % increases sidelobes to -79 dB relative to the primary power beam. These results compare favorably with existing phased array design studies which are generally no better than -40 dB for peak sidelobe level. This appears to be a new discovery which could considerably ease the challenges of frequency and bandwidth allocation for space solar power. Such technology might also be applicable for peer-to-peer power sharing for terrestrial customers.