

Improving CubeSat Transmitter EIRP to Enable Space Network Communication Capabilities

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The trend in increasing complexity and scope of CubeSat missions has driven a need for transmitters that enable greater link distances, higher data-rates, and more sophisticated modulation schemes. The Space Network and Deep Space Network provide the communication infrastructure necessary to satisfy this trend, however CubeSats currently lack the capabilities to utilize this infrastructure. This work focuses on the transmit power and transmit antenna gain to achieve sufficiently high effective isotropic radiated power (EIRP) in order to enable CubeSat inclusion in space communication networks.

Considering the power-limited environment of a CubeSat, work has been done to design a highly-efficient S-band solid-state power amplifier (SSPA) with 2 stages using 3.2-W LDMOS devices at 2.3 GHz. Measured results show an SSPA power-added efficiency (PAE) of 67%, with 35 dB gain at average power for a 5 dB peak-to-average ratio (PAR) CDMA signal with a bandwidth of 6 MHz. Under NASA receiver compatibility testing, the SSPA demonstrates sufficient linearity under high-efficiency operation without the use of linearization techniques.

Additionally, a compact feed for a high-gain S-band antenna considering CubeSat volume limitations is designed. A backfire monofilar helix feed for a deployable 40-cm parabolic reflector features a small radiation blockage, low cost, easy integration, and left-handed circular polarization. The feed is designed to be collapsible with the reflector. The antenna reflector and feed system achieve a simulated gain of 16 dBi.

These two technologies have never before been used in CubeSats, and are together expected to improve EIRP to 57 dBm, from 33 dBm for traditionally designed CubeSats transmitters. This enables closing the link to communication satellites in geostationary orbit with enough margin to increase data rate from 1 kbps to 303 kbps. The presented design is expected to demonstrate unprecedented communication capabilities for CubeSats and is paving the way for the next generation in satellite communication systems.