

Ka-Band Quasi-Optical Array Amplifiers on AlN

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Background

Studies of repeatability as well as effects of biasing were performed on two experimental Ka-band quasi-optical arrays. The two arrays, referred to as array A and B, are of identical RF design. A single 0.9λ unit cell contains a 38-mW 19-dB Alpha AA028P3-00 MMIC amplifier connected by 50- Ω CPW transmission lines to two orthogonally-polarized slot antennas. The array has 36 unit cells arranged in a 6-by-6 triangular lattice chosen to suppress sidelobes. The theoretical output power of each array is 1.4 W. The 170-W/mK thermal conductivity of the 254- μm -thick AlN substrate holds the array temperature below the maximum 125°C limit.

Measurement Setup

Three different modes of operation were studied: far-field gain measurements using standard horns, near-field gain measurements using hard horns, and far-field reflection-mode gain measurements. Far-field gain measurements are performed by placing two orthogonally-polarized horn antennas 60λ away from the array and its polarizers. Similarly, near-field small-signal gain measurements are performed by placing two orthogonally-polarized hard-horn antennas 10λ away. The hard-horn antennas provide a uniform field distribution with amplitude and phase variations of only ± 1 dB and 80° over 98% of the horn aperture[1]. Reflection-mode measurements are performed by placing two orthogonally-polarized antennas on one side of the array while backing the other with a mirror. In reflection mode, for small angles of separation between the transmitting and receiving horn, polarizers cannot be used, resulting in a gain decrease.

Results

The maximum gain and frequency; gain bandwidth; on-off ratio; and gain contributed by the amplifiers are shown in the adjacent table. Gain is measured with respect to a through calibration. The 4-dB gain variation between the arrays is due to the differing bias-line constructions resulting in gain variation across the arrays. Far-field standard horn measurements show gain as high as 6.5 dB at 31 GHz over a 500 MHz bandwidth.

Operation Mode	Array	Freq (GHz)	Gain (dB)	BW (GHz)	On-Off (dB)	G_{amp} (dB)
Standard-Horn	A	31.02	2.1	0.34	34	10
	B	31.40	6.5	0.50	38	14
Hard-Horn	A	30.32	2.0	0.22	25	10
	B	31.30	4.7	0.70	35	12
Reflection-Mode	A	30.01	-3.5	–	29	14
	B	31.20	0.0	–	32	16

References

- [1] Maha A. Ali, Sean Ortiz, Toni Ivanov, and Amir Mortazawi, “Analysis and measurement of hard horn feeds for the excitation of quasi-optical amplifiers,” *IEEE Trans. Microwave Theory Tech.*, vol. 46, no. 10, pp. 1469–1473, Oct. 1998.