Gyro-amplifiers for High Power Millimeter Wave Radar

B.G. Danly¹

Code 6843

US Naval Research Laboratory

4555 Overlook Ave., SW

Washington, DC 20375

A. *Introduction*

Over the past several years there has been a concerted effort within the US to develop millimeter wave gyro-amplifiers for high-power millimeter wave radar. Efforts have been carried out by a number of researchers at both Ka and W-bands. These efforts have culminated in the successful integration of a high-average-power W-band gyro-klystron into the NRL WARLOC radar. This talk will review gyro-amplifier research and development at both Ka and W-bands, as well as the completed integration into the NRL W-band radar.

High power millimeter wave instrumentation radars have a number of important applications ranging from defense missions to basic scientific studies [1-3]. At the Naval Research Laboratory, a new high power 94 GHz radar named WARLOC has been developed. This radar employs a high power gyro-klystron as the final power amplifier and was developed during 1996-2001. Examples from this radar will be used to discuss the application of gyro-amplifier technology to radar applications. Details on the gyro-klystron-based transmitter and associated components will be discussed in a companion paper at this conference[4].

B. *Gyro-amplifier based radar transmitters*

Gyro-amplifier have long held promise as powerful amplifiers for millimeter wave radar applications. Pioneering work in the Former Soviet Union on gyro-amplifiers led to radar application, including a large mega-watt power level Ka-band radar[2]. In the US and in other countries, work on both Ka-band and W-band gyro-amplifiers has been carried out over several decades. Recent work at NRL has focused on W-band gyro-klystrons, Ka-band gyro-klystrons, and now, more recently, Ka-band gyro-TWTs. The W-band (94 GHz) gyro-klystron amplifier for the NRL WARLOC radar was developed over a number of years in two stages, as a joint effort between NRL, Communications and Power Industries (CPI), Litton EDD, and the University of Maryland for the first prototype development[5,6], and by NRL and CPI for the more recent improvements to the gyro-klystron technology [7]. The second gyro-klystron, VGB-8194 SN2, is a five-cavity amplifier, producing 100 kW peak output power in the TE_{01} output mode at 10% duty factor with a 3-db bandwidth of 700 MHz and a saturated gain of 33 dB. Work on gyro-amplifiers at NRL has not been limited to W-band gyro-klystrons. The noise performance of gyro-amplifiers and operation of a 225 kW peak power Ka-band gyroklystron at NRL has been studied extensively[8,9]. Building on the work of Chu and others[10], continuing studies on both TE_{01} and TE_{11} -mode Ka-band gyro-TWT amplifiers are taking place at NRL for applications requiring wider bandwidths than that achievable from gyro-klystrons [11,12].

C. *Summary*

Substantial progress in the development of high average power gyro-amplifiers has been achieved and their use for millimeter wave radar is now being pursued by the Naval Research Laboratory.

¹ Email: danly@nrl.navy.mil , phone: 202-767-0032, FAX: 202-767-1280

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