Angle of Arrival Detection using Retrodirective RADAR

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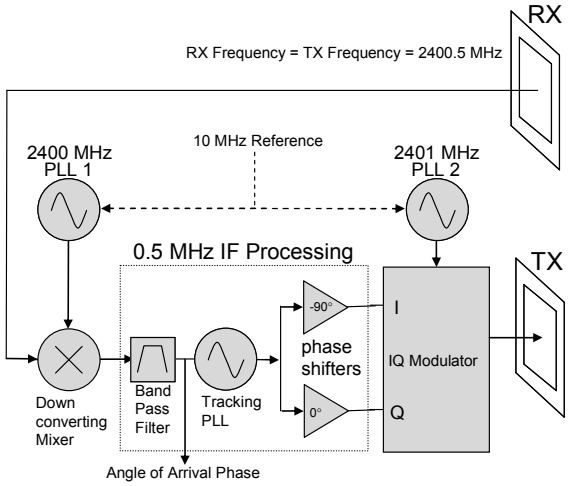
***Abstract*— In this paper, experimental results are shown for angle of arrival extraction using an analogue Retrodirective RADAR using PLL to an accuracy of 2.5°. Angle of arrival results from the Retrodirective RADAR were extracted from the low frequency IF phase of the PLL based phase conjugator. The target position can then be determined virtually instantaneously. Therefore the system does not require any complicated DSP post processing, so is able to operate with low power and relatively simple circuitry. This system is ideally suited to real time acquisition of fast moving projectiles.**

I. INTRODUCTION

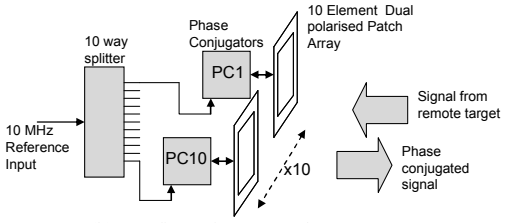
In certain applications, retrodirective RADAR systems can offer considerable advantage over its conventional RADAR counterparts. In a conventional RADAR, a directional antenna is scanned, usually by mechanical or closed loop electronic means, and a pulsed or modulated CW signal is transmitted, with the return (echo) signal providing the range information. Direction information is obtained from the position of the scanning antenna, at the time the pulse was received. These RADAR systems have been in use for a considerable period of time and are still likely to be the vehicle of choice for most applications where a large volume containing multiple targets has to be mapped. There are some applications, however, where this type of RADAR has extreme limitations. Consider the case of a fast moving projectile launched at very close range (tens of metres) from the RADAR. A conventional RADAR could have difficulty in acquiring and tracking such an object, since its scanning speed is slow in comparison to the speed of the object. The likely scenario is that the object may be detected for only one scan, or may be missed altogether. If immediate trajectory information was required, then the conventional RADAR system would offer little, or no, opportunity for obtaining such results. Futhermore in the case of a target located in the near field of a RADAR it is advantageous to get an immediate location information without recourse to inverse scattering techniques.

Retrodirective RADAR prototype systems employing DSP have been recently reported [1] which have the potential for tracking fast moving objects such as ballistic projectiles. The system in [1] demonstrated that small fast moving targets could be detected in terms of speed and azimuth information, although required the increased power consumption and complexity of the DSP processing circuitry. Previous attempts at such a RADAR system using analogue circuits [2] showed, with the hardware deployed, that these systems were unpredictable and difficult to setup repeatably. Despite this, analogue systems have the advantage of circuit simplicity, low power consumption and real time speed of response. In this paper we present far field results for a novel analogue Retrodirective RADAR which is robust and offers a reliable, fast and relatively simple low cost/mass/power consumption solution compared to DSP.

II. RETRODIRECTIVE RADAR ARCHITECHTURE



(a) One Cell of the Retrodirective RADAR system



(b) Configuration as 10 element array

Fig. 1 Retrodirective RADAR system showing IQ modulator phase conjugator and antennas

The basic building block of the Retrodirective RADAR presented here is the IQ modulator phase conjugator architecture shown in Fig. 1(a). The configuration of this as a