Bi-phase Modulator for L-band Applications

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Abstract -- **New compact design and developmental details of TTL control, compact Bi-phase modulator using hybrid & SPDT for L-band applications are outlined. It can meet fast switching of the order of nanoseconds in phase, which can easily be fulfilled by this design. Design discussed in this paper is compact (15x25 mm) and 50 ohm matched that opens broader usage of this circuit.**

Keywords: Bi-phase Modulation, ICAO, STANAG

I. INTRODUCTION

BI-PHASE modulator designs are available with additional matching circuits using FET, double-balanced mixers etc. Such designs use FETs or *p-i-n* diodes as switches. They are controlled at the modulation rate to give 0 degrees and 180 degrees phase conditions. Both devices exhibit complex impedance in two states. So, matching elements are used to resonate out these parasitics. It is difficult to achieve resonance in one state without affecting resonance in other state. Therefore, design can only approach 0 and 180 degree phase. Additional elements are needed to achieve amplitude balance, resulting in increased size and insertion loss.

Double-balanced mixers with superior carrier rejection (LO-to-RF isolation) are required for Bi-phase modulator applications. It is observed that modulation sidebands are close to the carrier. So, unwanted carrier leakage will introduce bi-phase output spectrum. High-frequency bi-phase modulated signals have normally been generated using a low-frequency torrid type mixer having LO-to-RF isolation of 40 - 50 dB as a narrow band modulator.

The design discussed in Paper gives broad band, 50 Ohm matched, TTL Control Bi-phase Modulator using SPDT Switch & Hybrid. In this design Hittite Make (HMC435MS8G) absorptive SPDT switch with excellent isolation has been used along with Macom Make Hybrid (HH128PIN).

II. DESIGN APPROACH

Figure 1 shows design approach of bi-phase modulator. In this new design 50 ohm matched absorptive SPDT and hybrid has been used. Pulse Signal Applies at Pin 1 & Switch is controlled through TTL (Dual Inverted TTL). When O/P is at Pin 2 of SPDT then Pin 5 of Hybrid gives in-phase output & As soon as the switch gives Output with Port 3, the Output appears at Pin 5 of Hybrid is out-of-phase.

Simulation of Insertion loss, Return loss, isolation etc has been done using ADS/App CAD. This developed design is being used in development of Pulsed Transmitter for Secondary Surveillance Radar (IFF) and same design can be used in any system using BPSK Modulation.

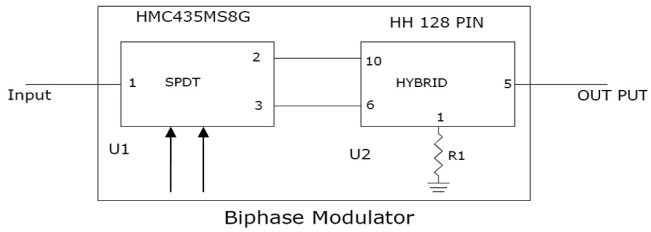

Fig: 1 Approach of bi-phase modulator design.

Hybrid and SPDT's are common parts used in various designs. SPDT can be designed using FET/ *p-i-n* diode and is also available in discrete IC form.

III. DESIGN OUTPUT

Figure 2 shows integrated bi-phase modulator in IFF transmitter. In this any substrate for PCB can be used as components used are 50 Ohm matched. We have used rogers substrate for our application. The design is compact and can be further modified with different available components which can generate very compact design for different frequency bands from UHF to X band.

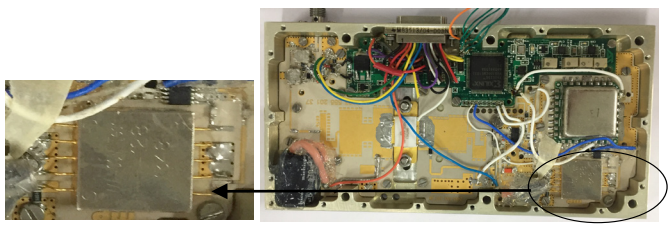

Figure 2. Developed bi-phase modulator design.

IV. RESULTS & DISCUSSION

The measured results show phase-accuracy of ±3-4° and gain-accuracy ± 0.2 dB at data rate of 8 Mbps. The current consumption is around 12 mA@5 volt. The switching speed is of the order of 30 nsec. This speed mainly depends on switching speed of SPDT and likewise isolation is also primarily governed

by SPDT used in design. One can achieve results up to 60 dB or better isolation as well.

Pulse characteristic requirement of IFF Transmitters like frequency stability [1, 3] are met by the manufactured design. Its compact-size, matched, accurate, low-current features makes it suitable for Mode-S IFF interrogator transmitters.

REFERENCES

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Amit Tiwari, FIETE obtained Bachelor in Engineering in Electronics and Communication & Master of Technology in Microwave Engineering from ITBHU. He has 20 years of R & D experience. He served MITS & Institute of Engineering, Jiwaji University Gwalior as an assistant professor.

Currently working as Manager, in Development & Engineering-Microwave Components of Bharat Electronics Limited, Ghaziabad. Designed & developed C-Band Airborne RF Transceivers, IFF Tx-Rx Unit & IFF Transmitters. Received various excellence awards for his innovative efforts. He has 3 IPR's in his name and 3 Patents are under evaluation. His exemplary 'Make in India' work was awarded with IETE Sh. Devi Singh Tyagi memorial award 2018-19.