Development of a Broadband Matching Network for Electro- Absorption Modulators

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Abstract - **In this paper, a novel broadband impedance matching network for Electro-Absorption Modulators (EAM) is proposed. With this matching network, RF reflection can be great suppressed in a wide frequency range up to 43GHz, along with a extended 3 dB bandwidth to 39.5GHz.**

I. INTRODUCTION

The electro-absorption modulators (EAM) are attractive to long-reach broadband communications, and can offer a cost effective solution due to its compact size as well as low operation voltage. With reverse bias, the EAMs exhibit a high impedance operation. By the reason of degraded signal injection efficiency and strong reflection, the high impedance characteristic of the EAMs can limit the high-speed performance [1]. In terms of the EAM module packaging assembly, a dedicated impedance matching network is required to have an improved broadband performance. Generally, a simple parallel resistor is employed to meet a 50Ohm matching [2]. However, results show that such scheme can not cover the entire useable bandwidth.

In this paper, the small signal equivalent circuit model was built for an EAM chip, and a novel broadband equalizing network was developed that consists of four lumped elements. With this network, the RF reflection could be suppressed efficiently, and transmission bandwidth compensation could be achieved at the same time.

II. CIRCUIT MODEL FOR EAM CHIPS

In order to examine the RF characteristics of EAMs, a small signal based equivalent circuit is built with the matching networks. As shown in figure 1, the EAM consists of two sections. The first part includes the parasitical elements shown as C1, L4 and R5, which are the capacitance of the bond pad, inductance of the ridge structure, and the resistance of the device, respectively. C2, C3, R6, and R7 build the optoelectronic coupling in the absorption layer and intrinsic layers.

In Fig.2, the circuit elements are finely tuned to meet the measured S_{11}. The extracted circuit values are shown in table I. As a generally parallel resistor method, R4 are adjusted to meet the optimized performance. The broadband equalizing network proposed in this paper includes R1, R2, R3 and L1. The insertion in Fig.1 also shows an ALN based RF submount to validate the proposed scheme.
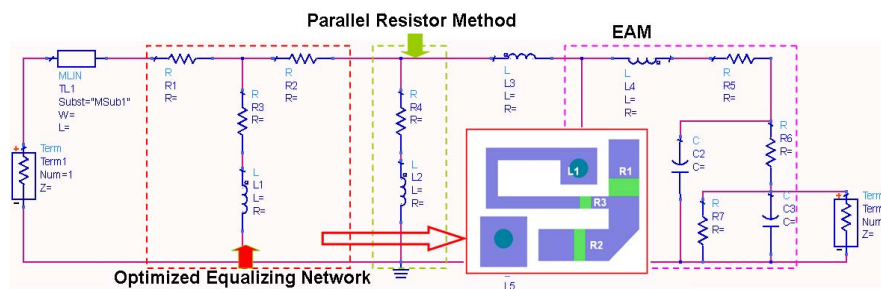

Fig. 1. Equivalent circuit for the EAM assembly includeing the EAM chip and matching networks; Insertion shows an ALN based RF submount design for the proposed broadband equalizer.
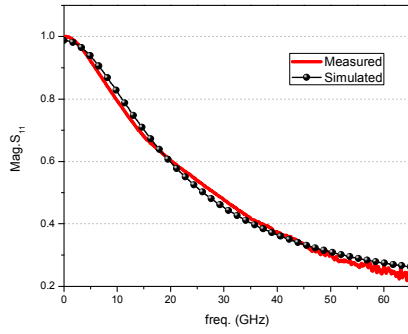
Fig. 2. Measured and simulated S_{11} of an EAM chip.

TABLE I

CIRCUIT ELEMENT VALUES FOR EAM CHIP

PARAMETERS	L4	C1	C2	C3	R5	R6	R7
UNIT	nH	fF	pF	pF	Ω	Ω	kΩ
VALUES	0.2	17	0.1	0.04	3	32	5.7

## III. BROADBAND IMPEDANCE MATCHING NETWORK

Figure 3 show the simulation results of these two impedance matching methods. With ordinary parallel 50Ohm matching network, a strong notch in Z_{in} curve may cause strong impedance mismatching. This mismatching will increase RF reflection dramatically beyond 10GHz, and the useful bandwidth is then limited at 13GHz.

By using the proposed matching network, as symbol-line shown in Fig.3, it is evident that S_{11} and Z_{in} can be improved in a relative wide frequency range. Based on the simulation results, element values for R1, R2, R3 and L1 in optimized matching network are 20Ohm, 15Ohm, 35Ohm and 0.5nH respectively. Fig.3b shows an approximately 50 Ohm Z_{in} throughout the useful bandwidth, and the S_{11} is as low as -10dB up to 43GHz.

With our matching scheme, the S_{21} of EAM chips can be compensated at certain extent. In Fig.3c, compared with a 3dB bandwidth of 36.5GHz using parallel matching, the proposed broadband matching network can extend the total transmission bandwidth to 39.5GHz.
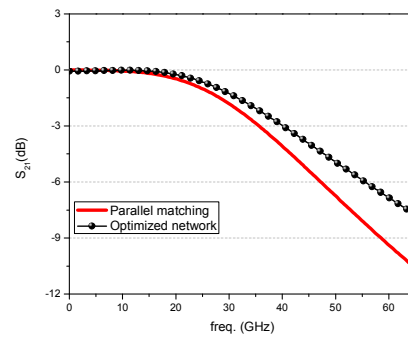
III. CONCLUSION

In this paper, a broadband matching network was developed for EAMs. Compared with the ordinary matching scheme, the proposed network can great suppress the RF reflection, and the transmission bandwidth can be extended to approximately 40GHz.
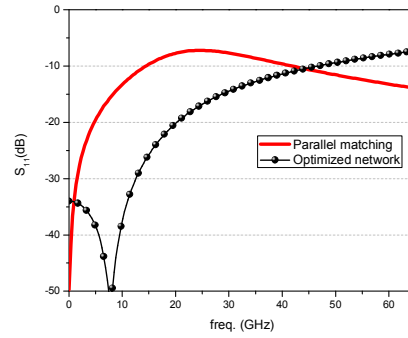
(a)
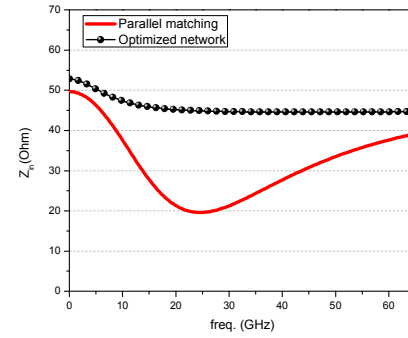
(b)

(c)

Fig. 3. Comparison between the parallel matching scheme and proposed matching network: (a) S_{11}, (b) Z_{in}, and(c) S_{21}.

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