A 6-18 GHz 20W SPDT SWITCH USING SHUNT DISCRETE PIN DIODES

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ABSTRACT

A broadband high power SPDT switch using shunt discrete PIN diodes is presented. By using shunt SPDT switch configuration, high power performance can be obtained. A novel structure, in which matching sections are added outside of shunt PIN diodes, provides broadband characteristics. The insertion loss of fabricated MIC switch is less than 2.0dB at 6 to 18GHz, and is less than 1.5dB at 7 to 17GHz. The power handling capability is over 20W CW at 12GHz.

I. INTRODUCTION

There is an increasing demand for high power, low insertion loss broadband PIN diode switches for both radar and communication applications. There are mainly two types of broadband PIN diode switch. One is series-shunt configuration[1][2]. This configuration has the advantage of broadband performance. Generally they are fabricated in MMIC process in order to avoid the influence of bonding wires used in connecting discrete chip components. The other is shunt configuration using quarter wavelength transmission lines[3][4]. Merits of this configuration are low insertion loss and possibility of use of discrete components. By using shunt discrete PIN diodes, high power handling capability can be achieved. On the other hand, this switch configuration limits its frequency range because of quarter wavelength transmission lines on isolated arm.

In order to overcome the limit of the bandwidth of conventional shunt switch, a novel shunt PIN diode switch configuration is proposed. The proposed switch consists of a conventional shunt switch and a pair of matching sections attached to the outside of both shunt PIN diodes. The performance of the fabricated shunt PIN diode switch using proposed configuration will be described.

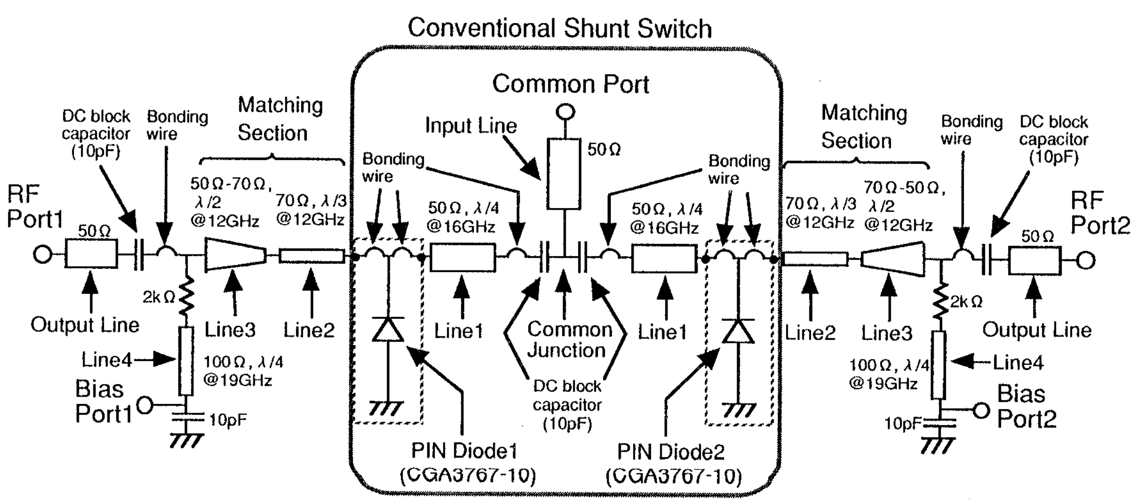

Fig.1 Schematic diagram of the proposed SPDT switch

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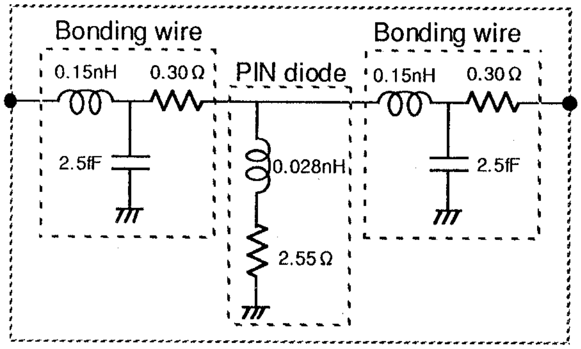
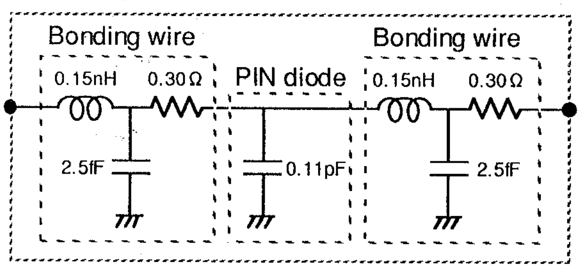


(a) Forward bias (Forward current : IF=20mA)



(b) Reverse bias (Reverse voltage : VR=-15V)

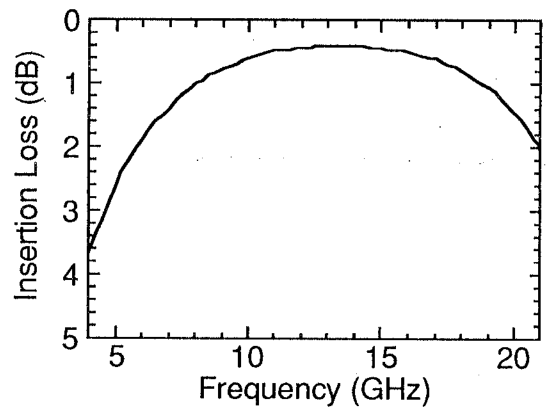
Fig.2 Equivalent circuit models of the shunt PIN diode

II. CIRCUIT CONFIGURATION AND DESIGN

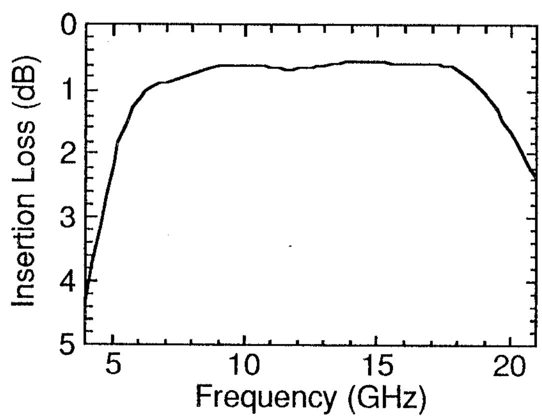
Fig.1 shows a schematic diagram of the proposed SPDT switch. The matching section consists of the Line2 and Line3, where the Line2 is a high impedance line, and the Line3 is a tapered line. The shunt discrete PIN diode is CGA3767-10 (Alpha industries). Because the influence of bonding wires can not be ignored, model parameters of the shunt PIN diode must be extracted including bonding wires. Fig.2 shows equivalent circuit models of the shunt PIN diode with bonding wires, which are enclosed with dotted lines in Fig.1. Model parameters are extracted from measured S-parameters.

Fig.3(a) shows the simulated small signal characteristic of conventional shunt switch section shown in Fig.1. The insertion loss of less than 1.5dB is achieved over the frequency range 7 to 20GHz. At lower frequency range, the isolated arm works as a shunt inductor connected to the common junction, whereas at higher frequency range, it works as a shunt capacitor. This effect of the isolated arm limits the broadband characteristic of the conventional shunt switch.

In order to compensate the inductive component at lower frequency range and the capacitive component at higher frequency range, the matching section is introduced. Fig.3(b) shows the simulated result of the proposed switch that is the shunt switch with matching sections. The frequency range, in which the insertion loss of less than 1.5dB is obtained, is 5.5 to 20GHz. By using proposed switch configuration, broadband characteristic can be obtained compared with conventional shunt switch.



(a) Conventional configuration



(b) Proposed configuration

Fig.3 Simulated small signal characteristics of the switch without bias circuits and DC blocking capacitors

III. EXPERIMENTAL RESULTS

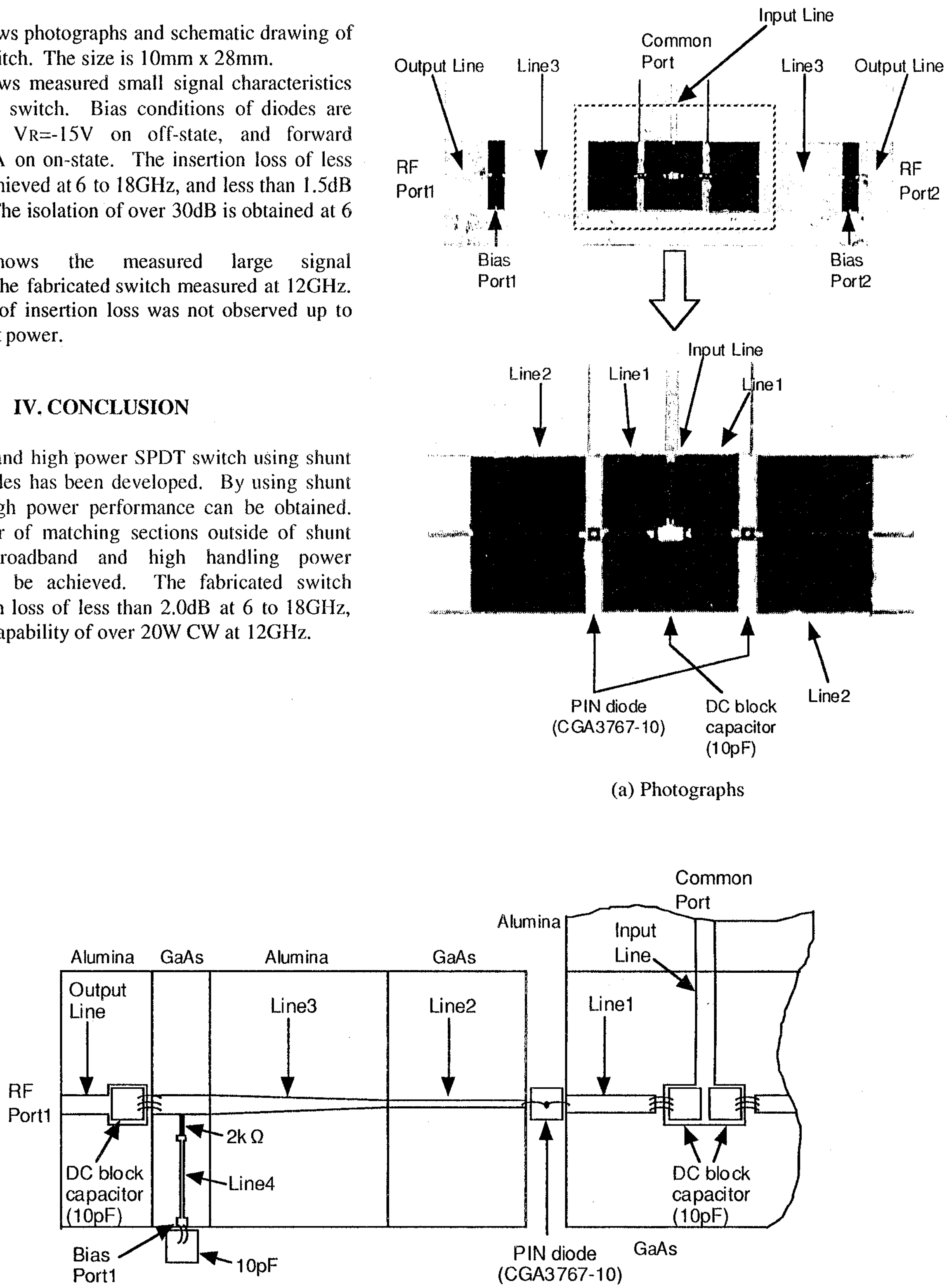
Fig.4 shows photographs and schematic drawing of the fabricated switch. The size is 10mm x 28mm.

Fig.5 shows measured small signal characteristics of the fabricated switch. Bias conditions of diodes are reverse voltage: V_R=-15V on off-state, and forward current: I_F=20mA on on-state. The insertion loss of less than 2.0dB is achieved at 6 to 18GHz, and less than 1.5dB at 7 to 17GHz. The isolation of over 30dB is obtained at 6 to 18GHz.

Fig.6 shows the measured large signal characteristic of the fabricated switch measured at 12GHz. The degradation of insertion loss was not observed up to 43dBm CW input power.

IV. CONCLUSION

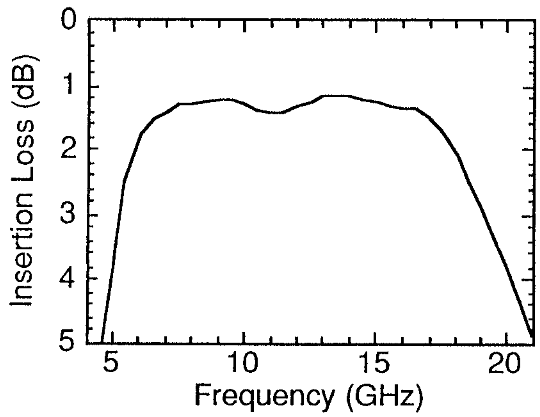
A broadband high power SPDT switch using shunt discrete PIN diodes has been developed. By using shunt configuration, high power performance can be obtained. By adding a pair of matching sections outside of shunt diodes, both broadband and high handling power performance can be achieved. The fabricated switch provides insertion loss of less than 2.0dB at 6 to 18GHz, power handling capability of over 20W CW at 12GHz.



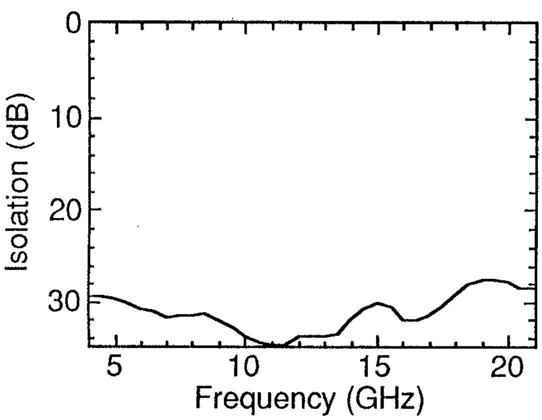
(a) Photographs

(b) Schematic drawing

Fig.4 Photographs and schematic drawing of the fabricated switch



(a) Insertion loss



(b) Isolation

Fig.5 Measured small signal characteristics of the fabricated switch

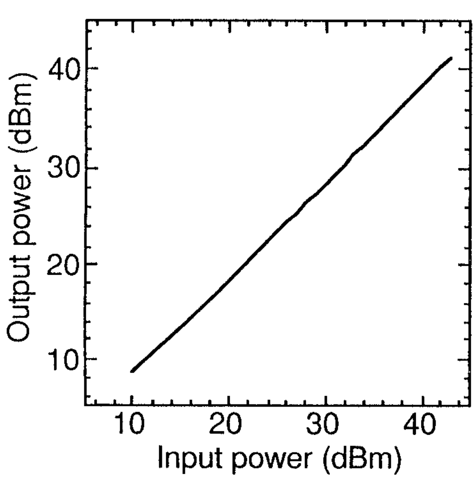


Fig.6 Measured large signal characteristic of the fabricated switch

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