

# Application described Software Defined Radio Receiver system based on Six Port Technology

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**Abstract:** Here a new topology for six port structures is proposed which might be used in software defined Radio (SDR) receivers. This topology is supposed to scale back the losses and hardware that are offered by existing topologies. the design of the port structure is completed exploitation ADS and the performance is analyzed exploitation scattering parameters and VSWR values. The port structure in SDR receiver may be a direct conversion receiver that down-converts the received RF signal on to baseband signal instead of generating the IF signal as done in heterodyne receivers. The advantage being driving away the problem of image frequencies which occur in IF stage and disadvantage being the added hardware and losses introduced by the port structures. A few topologies for port structures available currently and this work proposes a new topology which may add an equivalent way because the existing port structure with reduced hardware and losses. The analysis of this design is completed exploitation Advanced design System (ADS) tool. This new design has lesser scattering parameter and VSWR values. Hence lower scattering parameter values facilitate in reducing the insertion and return losses within the SDR receivers. Also, this design has reduced dimensions and so ends up in lesser area and cost.

**Keywords:** SDR, port structures, microstrip, power dividers, hybrid couplers, insertion and return losses, scattering parameters, VSWR.

## 1. Introduction

The overview of software defined Radios started once J Mitola introduced "Software Radio Architecture" that might method the signals of wide range RF and multiple protocols might be eliminating the issues of the incompatible standards. An extensive work on the SDR's have been started and plenty of were attracted towards this design of technology that rendered the great degree of adaptivity. In 1995, Renata G Bosisio et al. simulated the SDR receivers. Introducing port structures in SDR's they are capable of eliminating the issues due to IF conversion in conventional receivers. In the

year of 2001, Bosisio introduced a design direct six-port receiver. Developing the six port structure supported substrate integrated wave guide technology. It re-designed with 5 port Structures for SDR receivers that verified to be better than the preceding receivers of that type .SDR receivers being outperforming with the performance of adaptivity had the tradeoffs over area and losses. The SDR structures occupied a lot of space and incurred more losses. The main aim is to challenge in developing SDR's is reducing the area and losses. Different technologists received reducing the losses and area way of proposing new topologies while implementing of power dividers and hybrid couplers that are the basic elements of the SDR receivers. The intended work is also to scale back the area and losses further for an SDR receiver.

## 2. Software Define Radio

An SDR is a combination of flexible hardware and therefore the software that decides on the functioning of hardware. without introducing new hardware, an SDR will modify its properties like the operational frequency range, modulation type, bandwidth, most radiated or conducted output power, and therefore the network protocols by dynamic the software programs that control the process resources. This is a flexibility of SDR provides an incredible opportunity for solving interoperability issues between many various existing standards, implementing new standards, and minimizing the amount of hardware necessary to perform the required communications across these types of different standards. SDR permits effective spectrum utilization by facilitating spectrum sharing. It also permits equipment to be reprogrammed to more efficient modulation types. Its capability to enhance programmed also enhances interoperability between different radio services. the standard radio systems were having the issues of Image frequency due to the Intermediate Frequency Conversions performed within the mixer units of receivers. These type of Image frequencies is demanded a

separate unit for Image Frequency Rejection thereby increasing the cost and as well as size of the receivers. And it can moved to direct conversion receivers those directly converted to RF signals and to baseband signals hereby eliminating image frequency problem SDR receivers perform this direct down conversion with the help of port structures. usually six or 5 port structures are used in SDR receivers.

### 3. Port Structures

Hence a port structures have one power divider and 3 or 2 hybrid couplers depending on the number of ports the structure has. In different words the port structure has 2 inputs (one from the receiver antenna and the different from the local oscillator) and 4 outputs (of n case of six port structure) and 3 outputs of n case of 5 port structure). Here a various types of power dividers and the hybrid couplers are available for use in the SDR receivers. These power dividers and hybrid couplers may be enforced using microstrips of FR4 or RT Duroid substrates. Simulation of the all elements designed using an microstrips have been done using ADS package. S-parameter analysis that is supported by ADS simulation permit us to analyse the losses due to these power dividers and hybrid couplers and thereby permit to modify the design of the method by changing the topology of the system so, on it reduce the losses.

#### 3.1.Components of port structures

Hybrid couplers, Power Dividers and phase shifters are the major elements of port structures.

##### Microstrips

Microstrips are transmission lines which can be used purpose of transmission microwave frequencies. These microstrips have a conducting strip has separated from an ground area by a dielectric substrate. using these microstrips we can kind microwave elements like power splitters and couplers. Microstrip devices are build then an FR4 substrate that's less expensive. The signal transmitted by a microstrip travels each different substrate and the air needs an effective dielectric constant to be specified. that will lie between the dielectric constants which provide the substrate and air. Here dielectric constant for FR4 substrate is four.6

##### Hybrid couplers

Coupler is a microwave component it allows a part of the signal at one of its port to be out there at another port. If the coupling is completed in only one direction it's called directional coupling. A directional coupler has four ports.

- Port 1 – Input port
- Port 2 – Transmitted Port
- Port 3 – Coupled Port
- Port 4 – Isolated port

A part of power of signal provided at port 1 is given to the coupled port depending on the coupling factor of the coupler. Remaining power from the input is sent to the transmitted port. Port 4 is usually terminated with matched

load. Couplers are four port devices which are loosely coupled i.e., only a portion of the input signal is coupled to the coupled port. If the coupling factor is 3dB then the directional coupler is called hybrid coupler. If coupling factor is beyond 3db, the power at the coupled port will be more than that available at the transmitted port. Then we may need to interchange the name of the ports.

### Power Dividers

Power dividers split the input signal power into two parts either equally or unequally depending on the dimensions of the components used. Simple T-junctions can be used as power dividers.

### Phase shifters

Phase shifters with required phase values can be selected so as to generate different phase components of incident waveforms.

### 4.Proposed portStructureTopology

A new topology for the port structure in SDR receiver is proposed in this paper. This topology has two power dividers, two hybrid couplers and two phase shifters. Fig 1. shows such a six port structure.

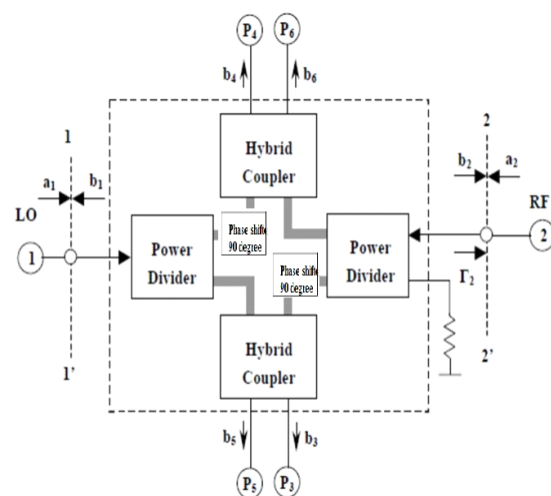


Fig.1. Proposed six port structures

Here RF input is provided to one of the first power divider, that splits the signal. Similarly, the LO input is provided at the second power divider which splits the LO signal. One output of each power divider is given to a 90-degree phase shifter. currently we have four different signals.

- Half Power LO
- Half Power LO with 90-degree phase shift
- Half Power RF
- Half Power RF with 90-degree phase shift

These are input to hybrid couplers which generate four different combinations of power at the outputs.

- Half Power LO + Half Power RF
- Half Power LO + Half Power RF and 90-degree phase shift
- Half Power LO with 90-degree phase shift + Half Power LO
- Half Power LO with 90-degree phase shift + Half Power RF with 90-degree phase shift

Topology takes two different inputs and generates four outputs, it forms a six port structure that can be used as direct conversion receivers. The design of this system is done using ADS tool as on the fig. 2.

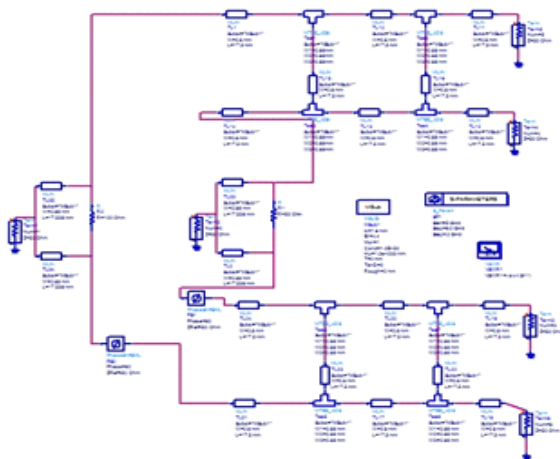


Fig.2. ADS design of six port structure

### 5. Analysis and Results

The analysis of the design is done with the s-parameter analysis option available in the ADS tool.

Design is made for a 5.8 GHz system. The results are as follows. The results are as follows.

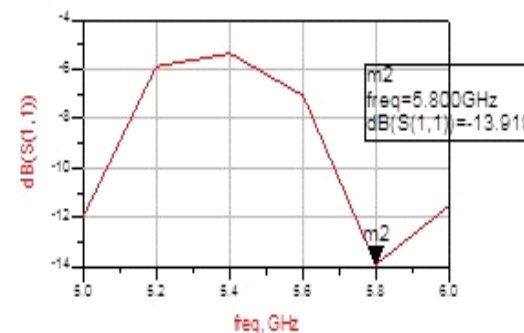
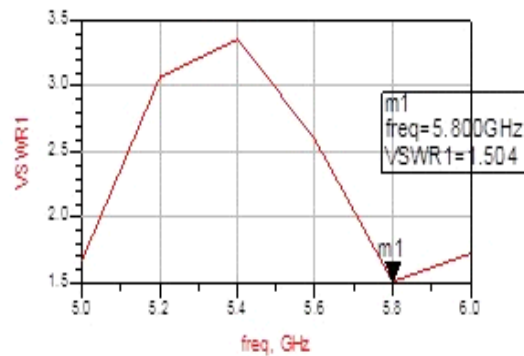
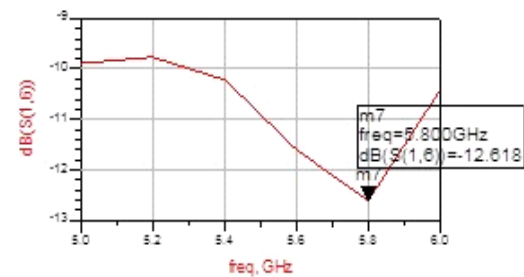
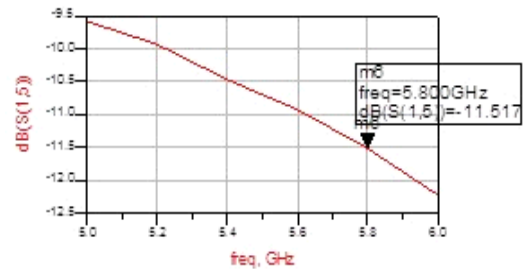


Fig3. s-parameter analysis

These values allow to calculate the return losses and mismatch losses incurred in the system.

## 6. Summary and Conclusion

The tabulation of s-parameters is done on table.1.

Fig: Table1

s-parameters	Proposed 6 port design in dB
s11	-13.919
s12	-16.125
s13	-6.896
s14	-6.228
s15	-11.517
s16	-12.618
VSWR	1.502(no unit)

This new topology provides a VSWR worth of one.504 that is lesser than those came previous designs which means that the standing waves area unit reduced that is because of reduced reflections. The reflection loss is calculated to be -13.9dB that is lesser than those obtained. The microstrips have the property of radiation which results in radiation losses. Has reduced range of microstrips (28 microstrips) during this design then the radiation losses also are reduced. As proposed the new topology proves to possess lesser losses and hardware when compared to styles planned earlier. so the a brand new topology for 6 port structures is designed using ADS tool and also the s-parameter analysis is done and verified that the proposed topology has lesser losses and area compared to the other designs.

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