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EXPERIMENTAL INVESTIGATIONS ON RADIATION CHARACTERISTICS OF IC CHIPS

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Abstract—The proposed work focuses on the experimental investigation of radiation characteristics of the discarded IC chips mounted on the dielectric substrate when fed trough one of the metal leg pins. Several sets of the experimental results are obtained using Vector Network Analyzer to obtain the return loss characteristics of the proposed structure. The return loss characteristics reveal that at some frequencies the ICs certainly show radiation mechanism. Feeding the same chip at different pin locations, changes the resonant frequency. The measured radiation pattern of the IC chip shows an omni-directional characteristic. This experimental study also reveals that the ICs can be easily interfered by the surrounding radiation prevalent in any wireless environment following the reciprocity principle of an antenna.

1. INTRODUCTION

Integrated circuits can be found in almost every modern electrical device such as computers, cars, television sets, CD players, cellular phones, etc. Depending on the specific function to perform they are available in various sizes and pin configurations as shown in Figure 1.

These integrated circuits are often a source of Electromagnetic Interference [1–3] when put in an electronic circuit. They can couple their energy to larger objects such as heat sinks, circuit board planes and cables to radiate significantly. This vary fact has been taken into consideration to determine its radiation characteristics and to exploit its possible use as an efficient radiator. The discarded or used IC chips are employed for this purpose which certainly reduces the production cost and manufacturing time of a radiator.

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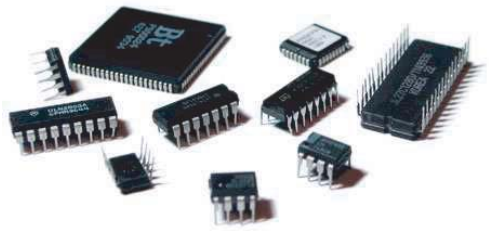


Figure 1. Various IC chips with different pin configurations illustration by electronetwork.org 2004, ©-free.

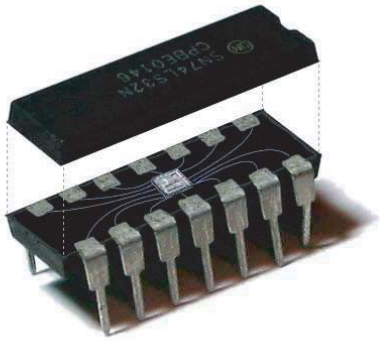


Figure 2. Integrated circuitry of IC die bonded by electrical wire to metal leg pins illustration by electronetwork.org 2004, ©-free.

Looking inside a finished chip one could see a tiny die which is hooked up by tiny wires to the metal pins, which are the external interface to the circuitry inside. The chip is packaged in a plastic holder or cover as shown in Figure 2.

When all the metal leg pins except the one to be used for feeding are broken, a small rectangular metallic portion of each metal pin below the plastic coating is still retained. Hence the radiating structure can be visualized as the small central rectangular portion bonded by electrical wire to the remaining planar portion of the metal leg pins. The plastic cover acts as the superstrate to the radiating structure. One of the metal leg pins of the IC which is to be used as the feed line is retained and pulled straight while rests of the pins are removed by simply breaking it. The SMA connector is then connected to the pin which is retained for the purpose of feeding. The chip is then mounted on a single sided copper clad FR4 substrate connected with a SMA connector. The inner conductor of the SMA connector is soldered with the IC pin and the outer conductor is connected with the ground plane

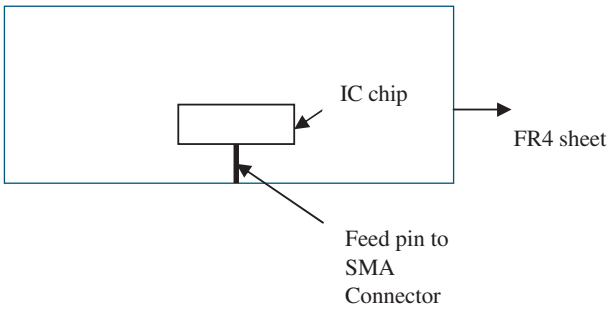


Figure 3. Schematic of the proposed structure as a radiator.

metallization of the FR4 substrate. The schematic of the proposed structure is shown in Figure 3.

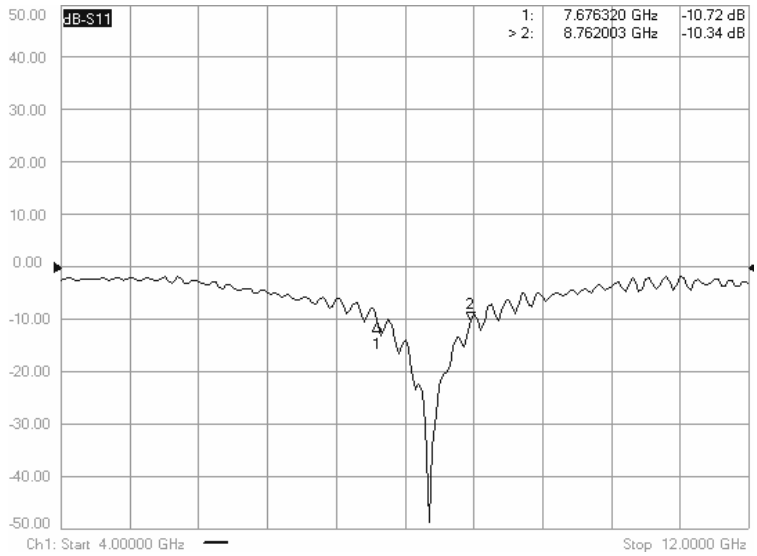
2. RESULTS AND DISCUSSION

The return loss characteristics of the proposed structure are obtained using a PNA series vector Network Analyzer. As the first proposed sample a 555 timer chip is fed at pin number 1 when all other pins are broken out. It is seen that the return loss less than −10 dB between 7.67 and 8.76 GHz. showing a minimum value of less than −40 dB at around 8.3 GHz as evident from Figure 4(a). Next the same IC 555 is fed at pin 7. It is seen that the now the return loss characteristics changes and the −10 dB return loss is depicted between the frequencies 3.69 to 4.45 GHz as shown in Figure 4(b).

The next sample picked up is an IC741 fed at pin 3. The return loss characteristic shows that the return loss is below −10 dB between frequencies 7.1 and 8.36 GHz as shown in Figure 5(a). The same IC when fed at pin 6 shows a −10 dB return loss characteristic between 7.45 and 8.83 GHz as shown in Figure 5(b).

The third sample picked up is an IC7400 chip fed at pin No. fed at pin 1. The return loss is less than −10 dB between 5.2 and 6.54 GHz as shown in Figure 6(a). When the same IC is fed at pin 4, the return loss is below −10 dB between 8.3 and 9.65 GHz as shown in Figure 6(b).

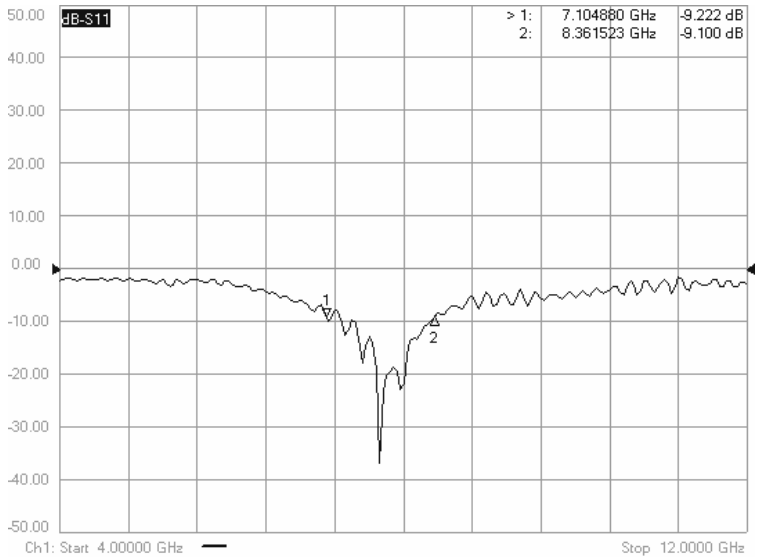
The above experimental investigations confirm an adequate matching at the input port. However, to confirm if the power delivered to the chip is radiated or lost in the substrate, the radiation characteristics are determined and patterns are plotted for few of the cases and are shown in Figure 7 and Figure 8. The radiation characteristics show a good omni-directional radiation pattern confirming the radiation from the chip.



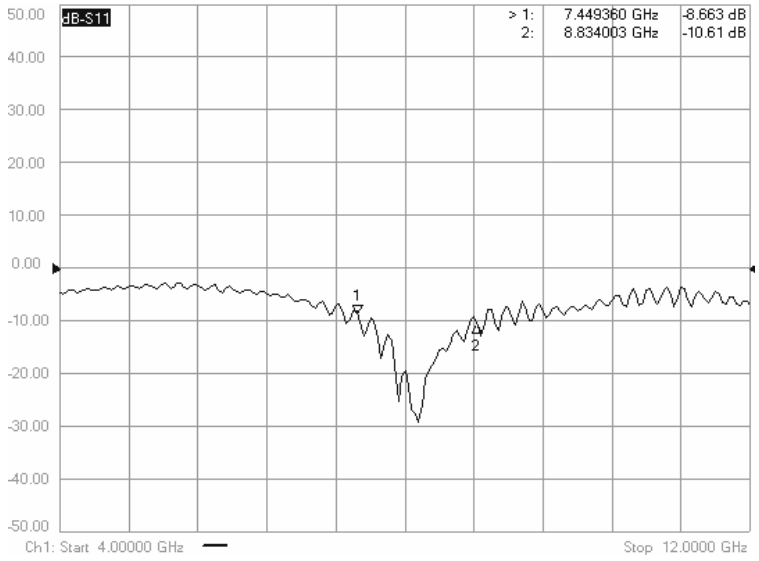
(a)

(b)

Figure 4. Return loss characteristics of IC 555 fed at pin 1 and 7.

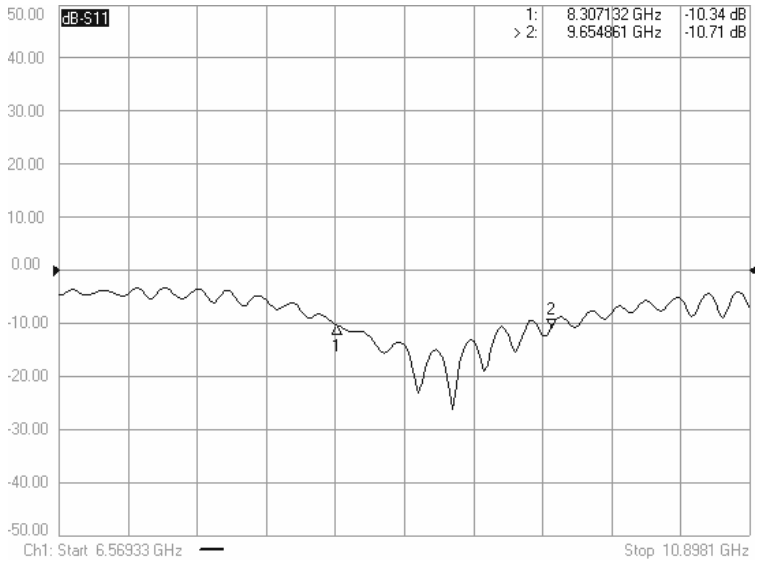


(a)

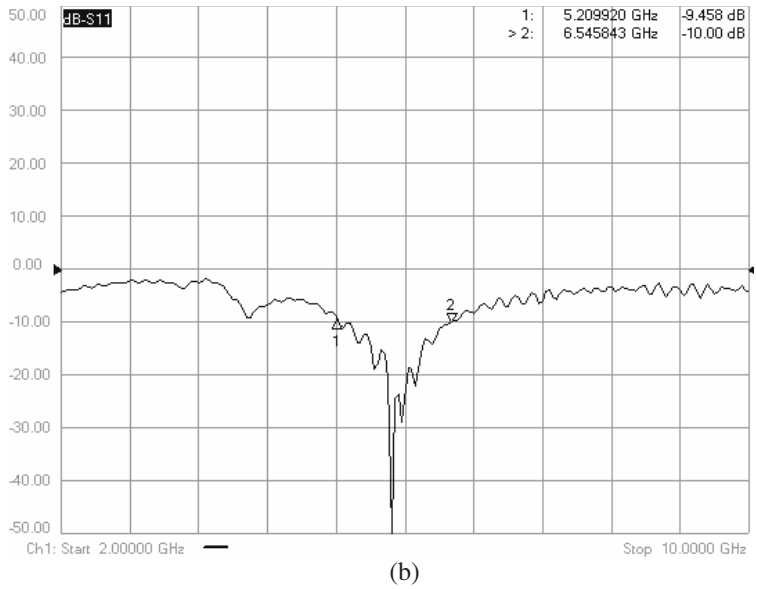


(b)

Figure 5. Return loss characteristics of IC 741 fed at pin 3 and 6.

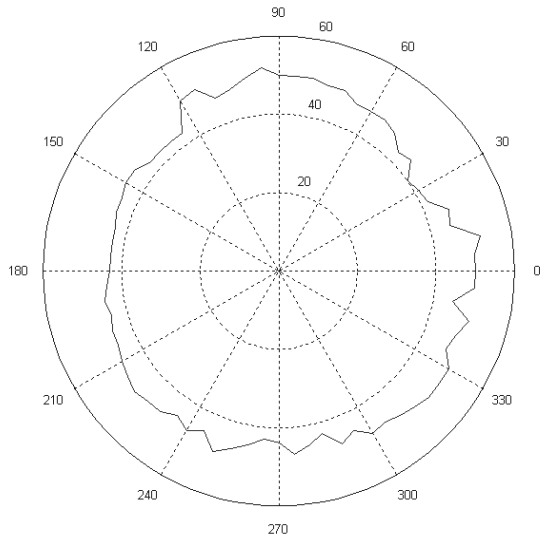


(a)

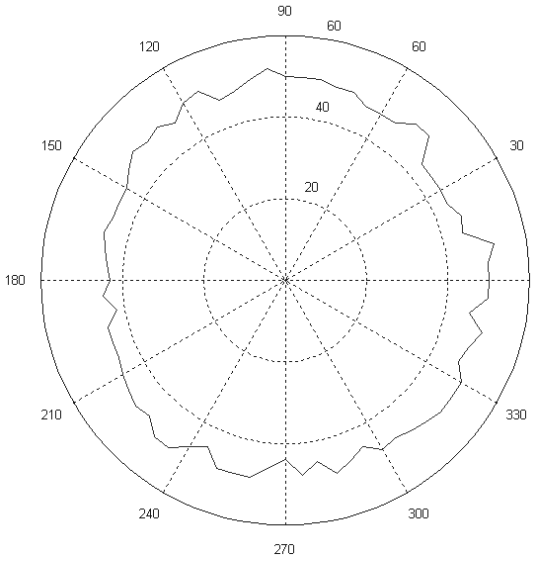


(b)

Figure 6. Return loss characteristics of IC 7400 fed at pin 1 and 4.

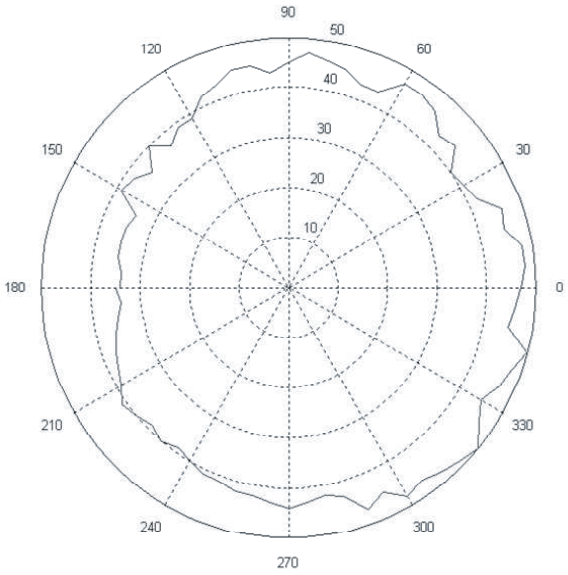


(a)

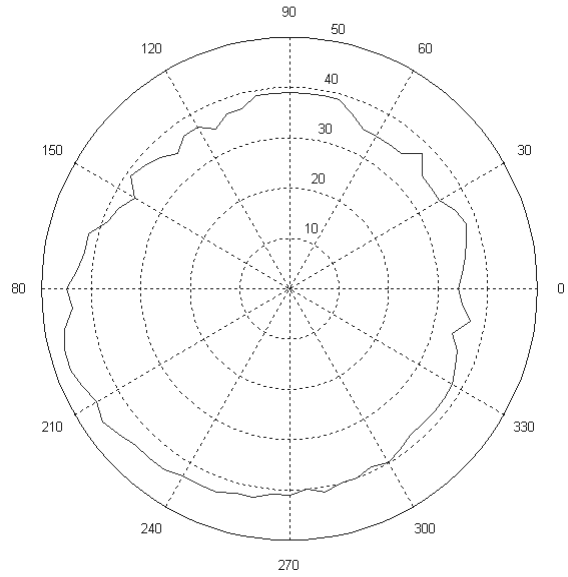


(b)

Figure 7. *E*-plane and *H*-plane radiation pattern of IC 555 fed at pin 1.



(a)



(b)

Figure 8. *E*-plane and *H*-plane Radiation pattern of IC 7400 fed at pin 1.

3. CONCLUSION

The experimental investigations on radiation characteristics of ICs reveal that the ICs can radiate to interfere with the field of other sources as well as be interfered by the radiation from the other sources. The return loss and radiation characteristics confirm its application as an antenna. It may also be accepted as a cheap and viable option to be used as an antenna for various applications depending upon the frequency of operation by feeding it at different pin locations.

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