Improvement of Standard EM Fields Distribution in 4-port TEM Cell with Slit-structured Septum

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Abstract— This paper proposes a method of reducing the unwanted electromagnetic field component in the 4-port transverse electromagnetic cell with two internal septa, which is used for electromagnetic compatibility emission and immunity test. Adopting slit structure in the internal septa, 4-port transverse electromagnetic cell provide the improved standard EM field distribution inside the usable test volume.

1. INTRODUCTION

In recent years, as many kinds of electronic devices are present EM (electromagnetic) fields generated from these electronic devices may not only cause problems in the human body, but also affect the electronic devices to induce a malfunction and failure. Therefore, the EMC (electromagnetic compatibility) studies are actively ongoing so that radiation of undesired EM fields can be suppressed below a regulation value and a normal operation can be done in an EM field environment with a constant regulation value. Standard EM field generators such as transverse electromagnetic (TEM) cell and Gigahertz Transverse Electromagnetic (GTEM) cell are widely used in these EMC

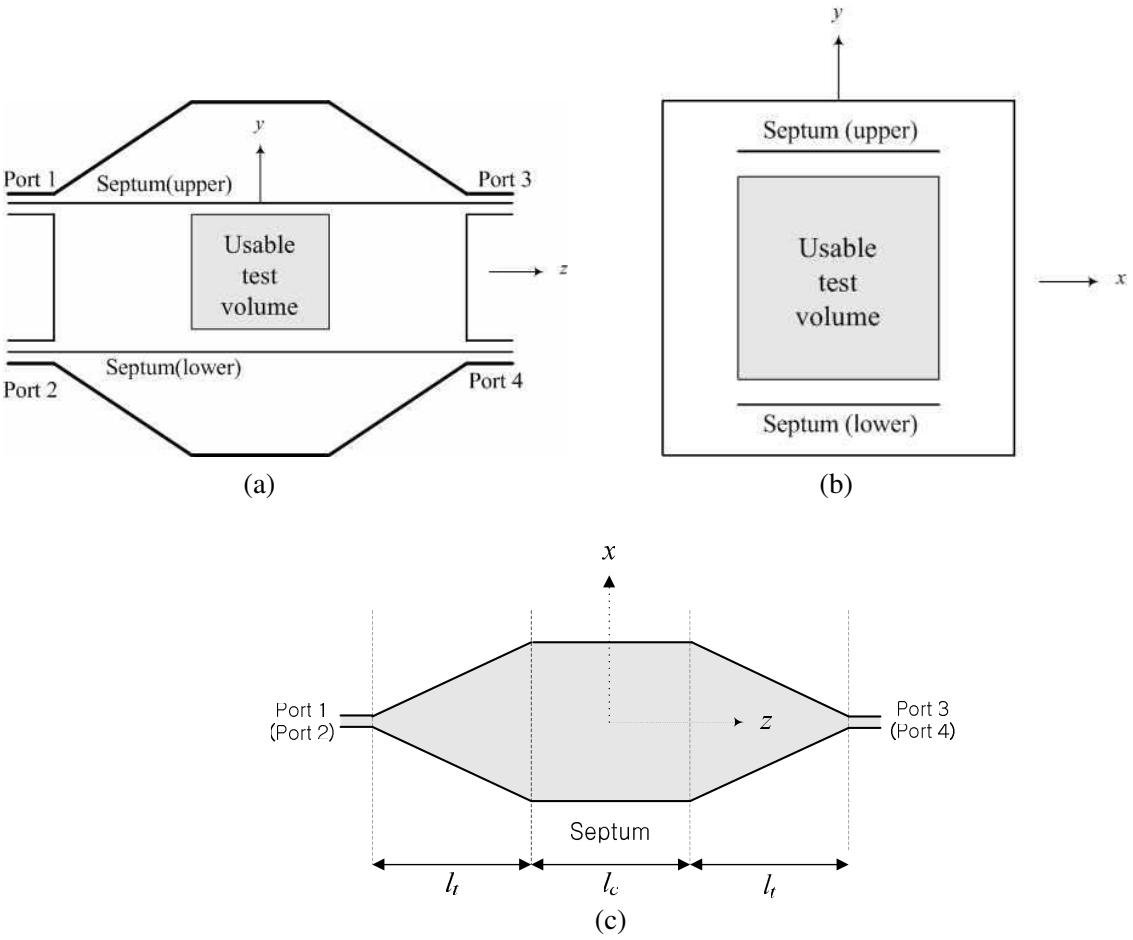

Figure 1: Geometry of 4-port TEM cell with two septa. (a) Side view, (b) cross-section view, (c) top view of septum.

field, but have a difficulty in reducing unwanted field components. That is, because the unwanted field components may occur highly in a direction corresponding to the traveling direction of the EM field, there is a problem when generating a near field mode as well as the TEM mode.

In this paper, we proposes a method of reducing the unwanted EM field component in the 4-port TEM cell with two internal septa, which is used for EMC test. Adopting slit structure in the internal septa, 4-port TEM cell provide the improved standard EM field distribution inside the usable test volume. The reduction of the field component propagating the unwanted direction is shown without changing of wanted field component through EM simulation.

2. PERFORMANCE AND SIMULATION RESULT

The geometry of 4-port TEM cell with two septa is shown in Fig. 1. The 4-port TEM cell generates the standard EM field wave between two parallel septa connected to four ports at each end. Outer wall consists of the perfect conductor with zero potential.

Figure 2 shows the top view of the proposed septum in the 4-port TEM cell with one and 3 slits respectively; in Fig. 2(a), the width (w_x) of the slit is changing and in Fig. 2(b) the $w_x = 300\,\text{mm}$ and $w_{z\_space} = 10\,\text{mm}$ in the septum with 3 slits.

Figure 3 and Fig. 4 are the graphs illustrating an intended and intended electric field intensity of 4-port TEM cell with proposed slit-structured septum, respectively. Referring to Fig. 3, there is shown an electric field E_y intensity in a y-axis direction depending on the magnitude of frequency. In this case, since E_y in the y-axis is an intended electric field, it is preferred that a component of the E_y remains unchanged if possible irrespective of the presence or absent of the slits. Referring to Fig. 4, there is shown an electric field E_z intensity in a z-axis direction depending on the magnitude of frequency. In this case, since E_z in the z-axis is an unintended electric field, it is preferred that a component of E_z is needed to remove if any slit is present. As shown from Fig. 4, when a case of noslit where none of slits is formed is compared with a case of 1 slit ($w_x = 400\,\text{mm}$) where one slit with a length of 400 mm is formed, the component of E_z of these cases exhibits a difference of about 4.1 dBV/m with as a base of 0.15 GHz. Further, it can be observed that a case where

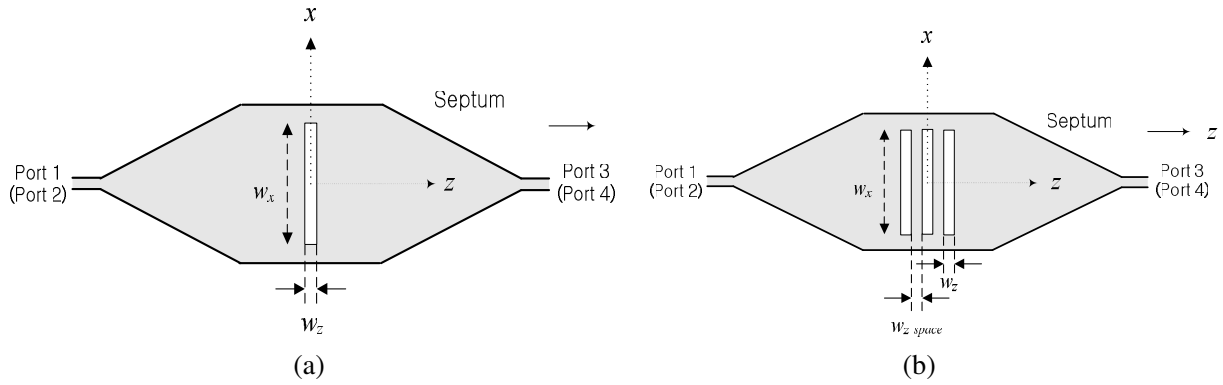

Figure 2: Top view of the proposed slit-structured septum. (a) 1 slit. (b) 3 slit.

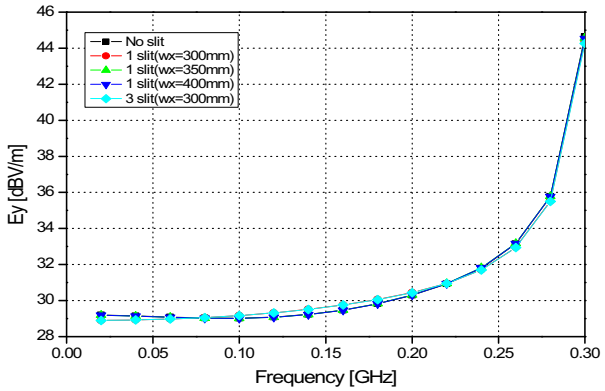

Figure 3: E_y intensity according to frequency.

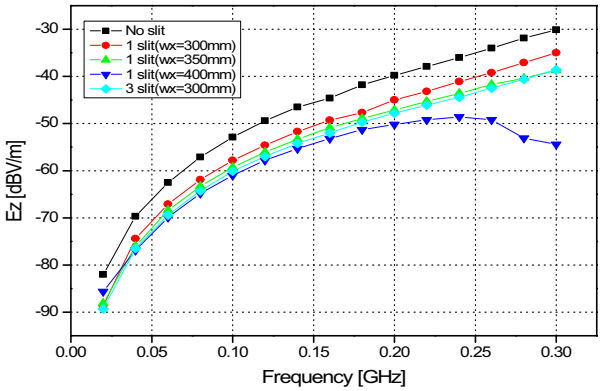

Figure 4: E_z intensity according to frequency.

even any one of the slits is formed is lower than a case where of noslit in the component of E_z. In addition, it can be also known that when the slits are the same in their lengths, the more the number of the slits is, the more the components of the unintended electric fields are removed.

As such, the amount of reduction in the electric field when the magnitude of frequency is changed differently is listed in a Table 1 as below.

Table 1: Reduction amount of E_z according to frequency.

Structure of slit		Frequency					
		100 MHz		150 MHz		200 MHz	
		E_z (dBV/m)	Reduction amount (dB)	E_z (dBV/m)	Reduction amount (dB)	E_z (dBV/m)	Reduction amount (dB)
No slit		−56.4	-	−48.9	-	−43.3	-
1 slit	$w_x = 300$	−58.2	1.8	−50.8	1.9	−45.4	2.1
	$w_x = 350$	−59.3	2.9	−52.2	3.3	−47.1	3.8
	$w_x = 400$	−61.0	4.6	−54.2	5.3	−50.2	6.9
3 slit	$w_x = 300$	−60.1	3.7	−53.0	4.1	−47.8	4.5

3. CONCLUSION

In this paper, a method of reducing the unwanted EM field component in the 4-port TEM cell was proposed. As described above, it is possible to reduce the component traveling in an unnecessary direction that occur in a TEM cell having two septa used as a standard EM wave field generator, which is one of the drawbacks of the TEM cell. Therefore, by applying the proposed slit structure, there is an effect on the improvement of Standard EM Fields distribution in the 4-port TEM cell.

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