Shielding Effectiveness of Mesh Screen Filter of Plasma Display Panel

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Abstract

A shielding effectiveness of mesh screen filter of plasma display panel (PDP) has been calculated in this paper. Since the screen filter is located near the radiation source, the near field wave impedance of the radiation source, i.e., the PDP electrodes, has been considered to calculate the shielding effectiveness. The near field shielding effectiveness of screen filter at 30~300 MHz has been estimated to be more than 65~80 dB. The measured shielding effectiveness of screen filter is 10~50 dB at 30~300 MHz [1]. The resulting discrepancy indicates that there are other EMI emission sources such as emission from PCB and cable besides the PDP electrodes.

1. Introduction

Flat panel display (FPD) has much more advantages in compact volume, high picture quality, and high resolution than CRT. Among FPD's, plasma display panel (PDP) is a promising candidate in large size panel application since it has advantages of brightness, angle of vision, and excellent resolution [2]. However, PDP system is causing electromagnetic interference (EMI) problem because it uses high voltage drive circuit and plasma that is formed by gas discharge to denote image. Thus, the electrode itself of display panel could be serious EMI source [3,4]. Since EMI emission from electronic equipments is restricted by some regulations, EMI emission of PDP modules ought to be shielded to meet regulations.

Mesh screen filter is widely utilized to shield electromagnetic wave to satisfy the EMI regulation. It is commonly made of copper mesh layer with a film substrate of polyethylene terephthalate (PET) for the conductive layer. There are some experimental reports for shielding effectiveness of mesh screen filters [1]. However, there is no theoretical result on shielding effectiveness of mesh screen filter.

In this paper, the shielding effectiveness of mesh screen filter has been calculated. Since the screen filter is located near the radiation source, the near field wave impedance of the radiation source, i.e., the PDP electrodes, has been determined using finite element method (FEM) to calculate the shielding effectiveness. Other EMI emission sources of PDP such as PCB and cable are investigated to account for the discrepancy between theory and experiment.

2. Wave impedance of the electrode

In order to calculate the shielding effectiveness of mesh filter, the near field wave impedance of emission source should be calculated since the shielding effectiveness is a strong function of the wave impedance of source. To calculate the wave impedance of one electrode line using FEM simulator, one electrode line of PDP is reconfigured as shown in Fig.1 [5]. Fig.2 shows the calculated wave impedance with the distance from the radiator. It shows that the wave impedance decreases with the distance and converges to 377 Ω as expected. As seen in Fig.2, the wave impedance of one electrode line with a gap has high wave impedance.

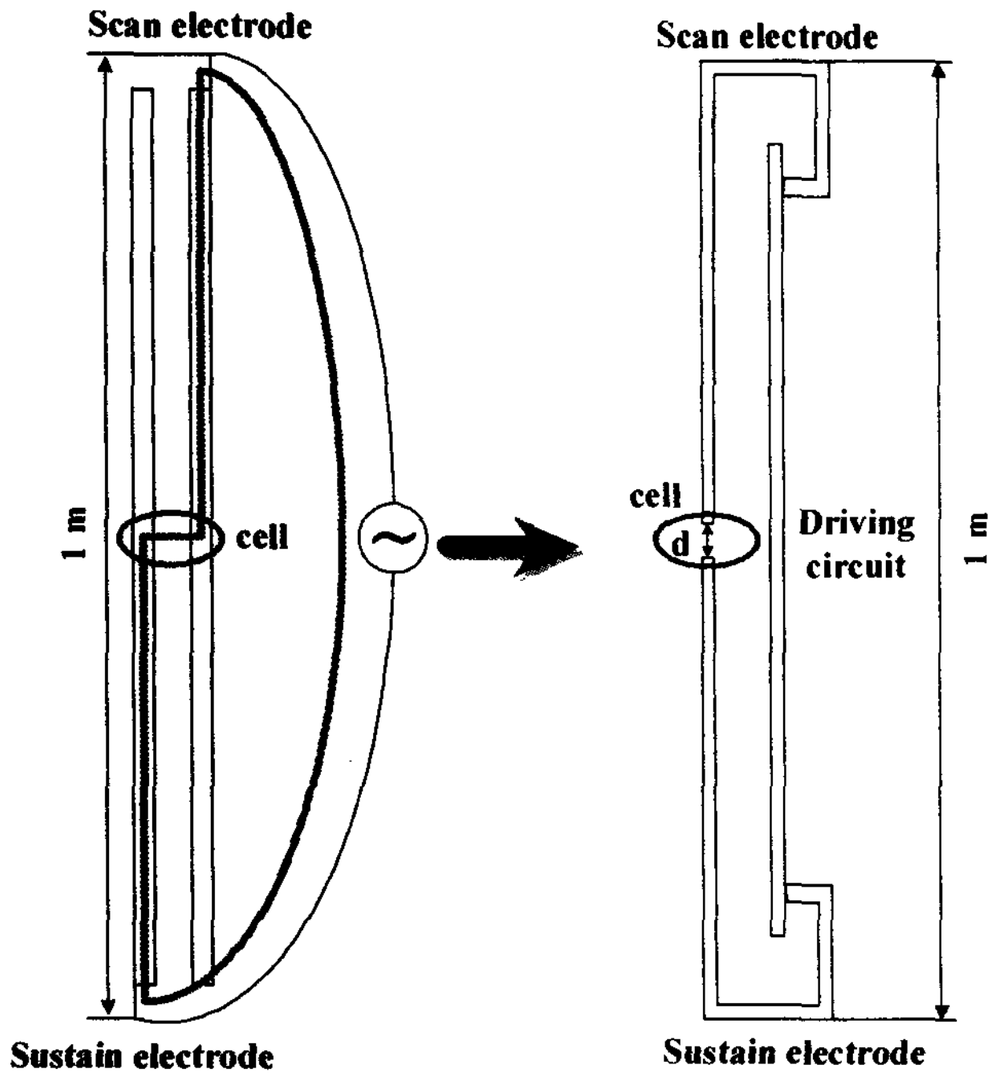

Fig.1 Reconfigured electrode

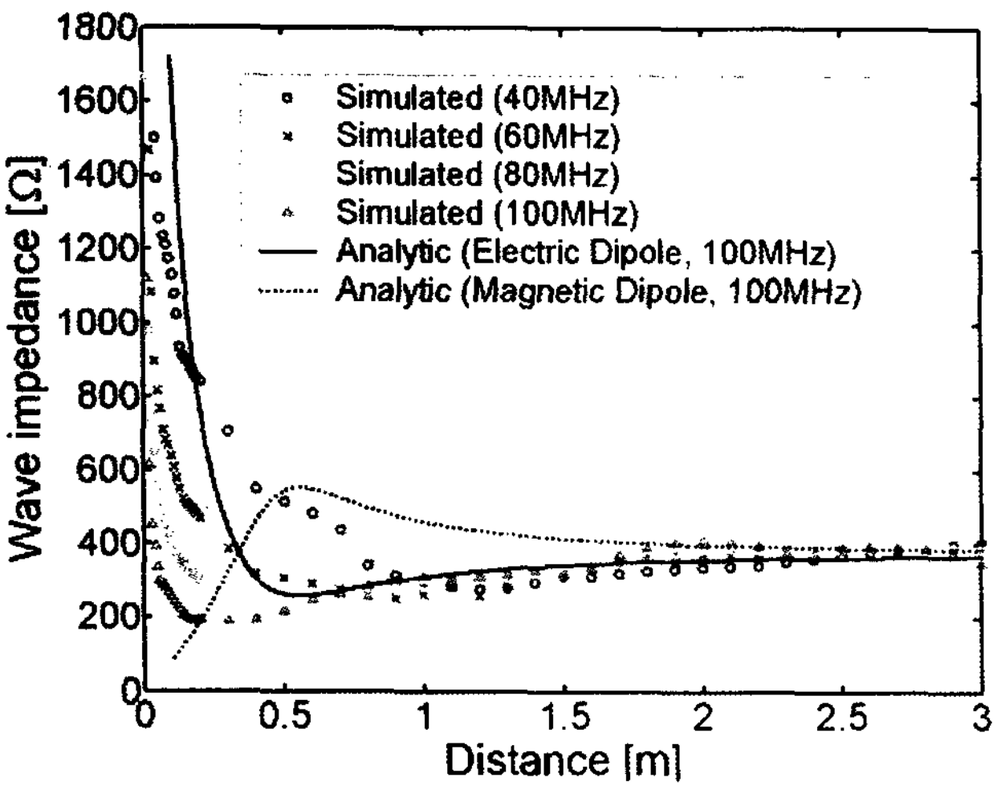

Fig.2 Wave impedances of the reconfigured electrode with distance from source

3. Shielding effectiveness of mesh screen filter

The shielding effectiveness of mesh screen filter has been calculated using FEM simulator. It is assumed that the incidence wave upon mesh screen is transverse electromagnetic (TEM) wave, i.e., its wave impedance is 377 Ω. The mesh has a line width of 10 μm and pitch of 300 μm. To calculate the shielding effectiveness of screen filter, TEM wave is incident on mesh screen filter which

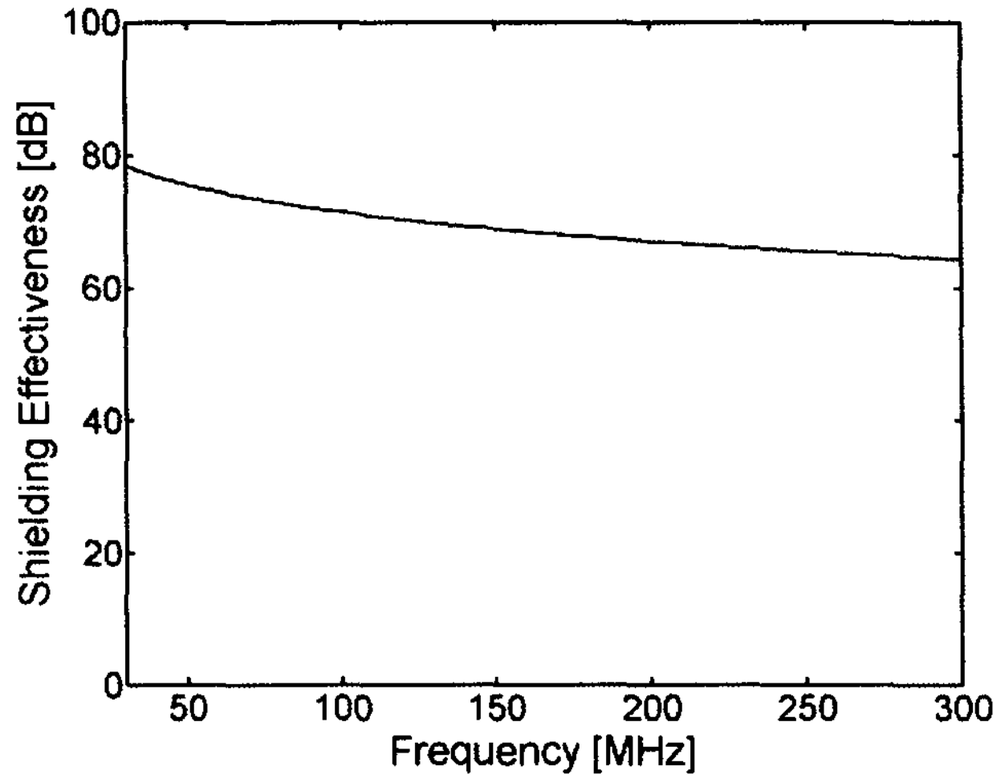

Fig.3 Shielding effectiveness of mesh screen filter (line width of 10μm, pitch of 300μm)

is placed on the center of parallel plate waveguide. The shielding effectiveness is found from S-parameters calculated by FEM simulator.

$$SE = 20\log_{10}\frac{1}{|S_{21}|} \qquad (1)$$

Fig.3 shows that the calculated shielding effectiveness at 30~300 MHz is 65~80 dB. It is well known that high impedance wave is easier to shield than plane wave whose wave impedance is 377 Ω [6]. Therefore, the actual shielding effectiveness of mesh screen filter is expected to be more than 65~80 dB. However, the measured shielding effectiveness of screen filter is 10~50 dB at 30~300 MHz [1]. The resulting discrepancy between theory and experiment indicates that there exist other EMI emission sources of PDP such as emission from PCB and cable besides the PDP electrodes.

4. Other EMI emission sources

As discussed before, there are other EMI sources to account for the discrepancy between theory and experiment for shielding effectiveness. EMI emissions from PCB and the cable are considered as other EMI sources in this paper. First, the emission level from PCB

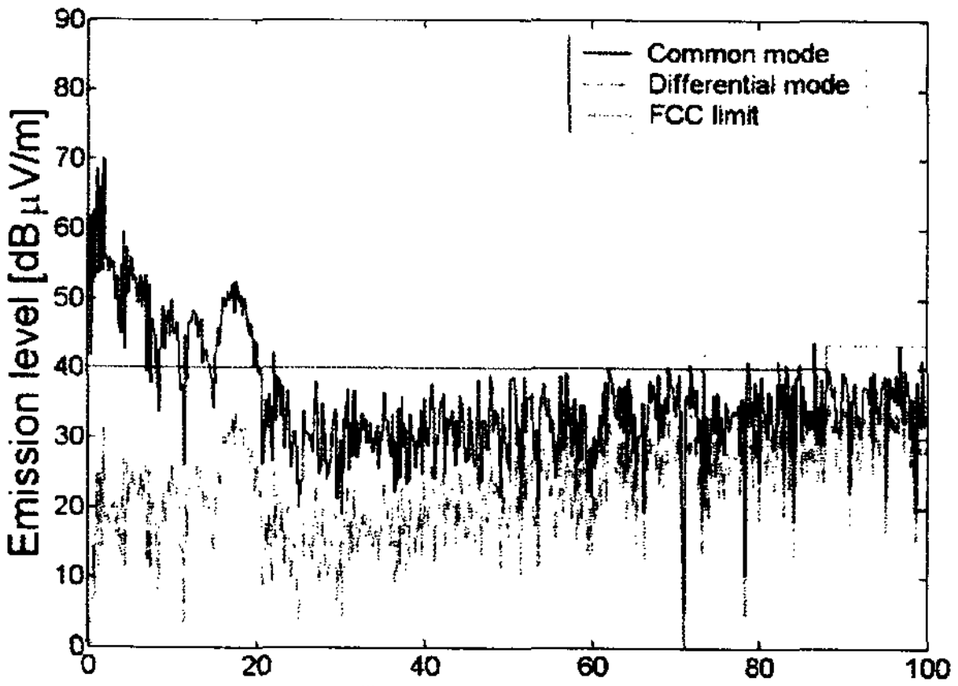

Fig.4 Estimated EMI emission level from PCB
(L=s=0.3m, d=3m)

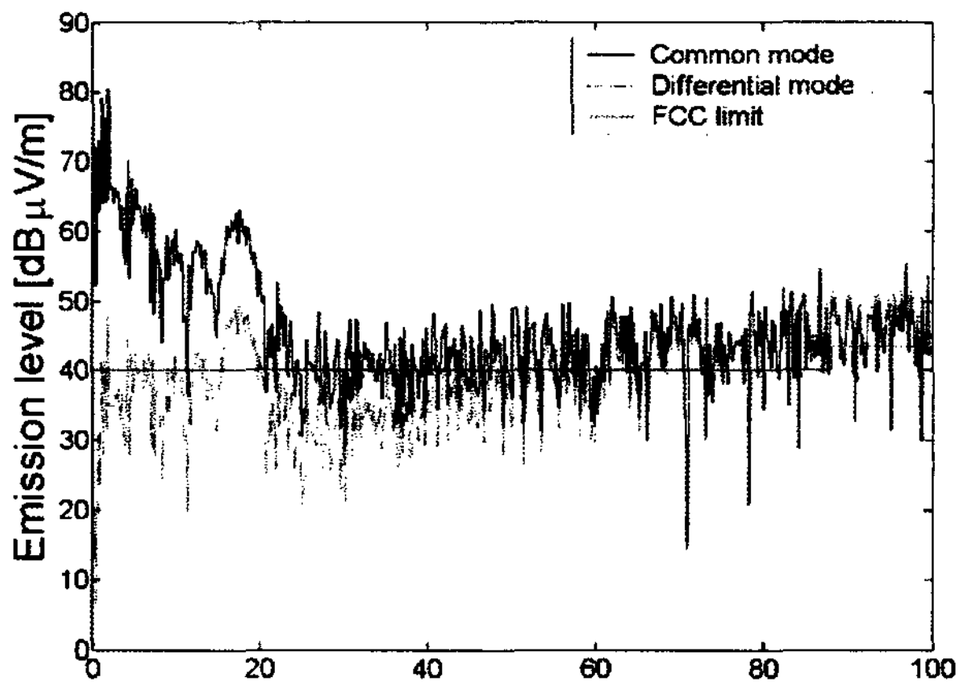

Fig.5 Estimated EMI emission level from Cable
(L=1m, s=0.6m d=3m)

could be calculated by the following equations [6]

$$\left|E_{c,\max}\right| = 1.257\times10^{-6}\frac{\left|I_c\right| fL}{d}\ [V/m] \quad (2)$$

$$\left|E_{d,\max}\right| = 2.632\times10^{-14}\frac{\left|I_d\right| f^2 Ls}{d}\ [V/m] \quad (3)$$

where L and s are the same values of 0.3 m which correspond to the size of driving circuit PCB of 42″ AC PDP module. The current spectrum of I_C and I_D has been obtained from Fourier Transform of the measured current. Then, the estimated emission level at the distance of 3 m is shown in Fig.4. In this figure, the FCC limit is plotted to be compared.

Second, the emission level of from cable can be calculated by the equation (2) and (3) [6]. Note that L and s are 1 m and 0.6 m, respectively, which correspond to the length of cable of 42″ AC-PDP module. The current spectrum of I_C and I_D has been obtained from Fourier Transform of the measured current. Then, the estimated emission level at the distance of 3 m is shown in Fig.5.

5. Conclusion

In this paper, the shielding effectiveness of mesh screen filter has been calculated using FEM simulator. The near field shielding effectiveness of screen filter at 30~300 MHz has been estimated to be more than 65~80 dB while the measured shielding effectiveness of screen filter is 10~50 dB at 30~300 MHz [1]. The discrepancy between theory and experiment indicates that there exist other EMI emission sources of PDP such as emission from PCB and cable besides the PDP electrodes. Finally, the EMI emission levels of PCB and cable are estimated.

6. References

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