A Study of Distortion of Waveform in AC PDP

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Abstract

In this paper, distortion of waveform in AC-PDP module has been studied. The propagation losses and interference due to coupling between the electrodes can be considered as the causes for waveform distortion. The distorted waveform has been obtained from the calculated propagation losses. The coupling between the electrodes has been measured using a proper experimental setup. This distorted waveform could account for underfiring problem in AC PDP module.

I. Introduction

Nowadays, flat panel display (FPD) increases with demand. FPD includes liquid crystal display (LCD), organic light emitting diodes (OLED), and plasma display panel (PDP). FPD has much more advantages in compact volume, high picture quality, and high resolution than CRT. Among the FPD, PDP is a promising candidate in large size panel application because it has advantages of brightness, presentation effect, function of good digital zoom, angle of vision, and excellent resolution [1]. However, PDP has some problems to be overcome. Among them, underfiring could be a serious problem for high picture quality.

In this paper, distortion of waveform, which could be a cause for underfiring problem, has been studied. To estimate the degree of the distortion of waveform, we should consider the propagation losses and interference. The propagation losses include dielectric loss, condution loss, and radiation loss. These losses are calculated. The distorted waveform has been obtained from the calculated propagation losses. The interference between scanned pulse and coupled pulse from the adjacent electrode can result in the distortion of waveform. The coupling voltage between the electrodes has been measured using our proper experimental setup.

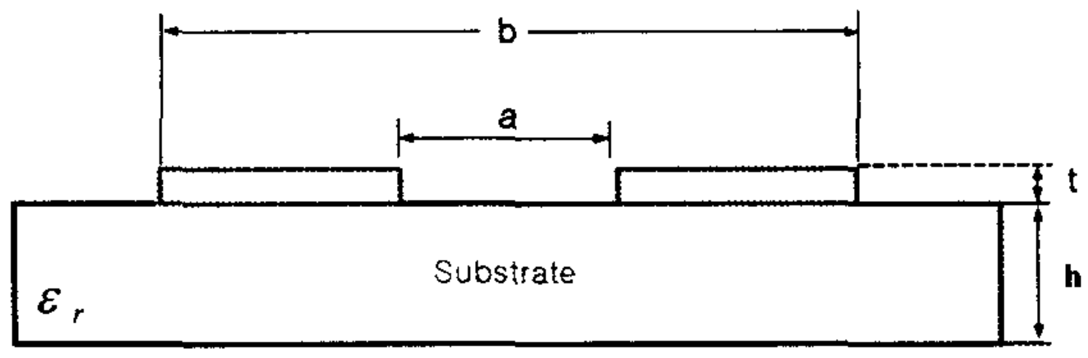

Fig. 1 Cross-section of electrode

II. Propagation Losses

Fig. 1 shows the cross section of electrode structure of PDP. As shown in Fig.1, the structure can be considered as a coplanar transmission line (CTL). Then, the conduction loss and dielectric loss of CTL can be calculated by equation (1) and (2), respectively [2]

$$\alpha_c = 17.34 \times \frac{R_s}{Z_0} \cdot \frac{P'}{\pi \cdot a}\left(1+\frac{b-a}{2\cdot a}\right) \times \frac{1.25}{\pi} \ln \frac{4\cdot\pi\cdot(b-a)}{2\cdot t} + 1$$

$$+ \frac{2.5\cdot t}{\pi\cdot(b-a)} \times \frac{1}{\left\{1+\frac{b-a}{a}+\frac{1.25\cdot t}{\pi\cdot a}\cdot\left[1+\ln\frac{2\cdot\pi\cdot(b-a)}{t}\right]\right\}^2} \, [dB/m] \qquad (1)$$

where

a = inner distance between two conductors (a=0.1mm)

b= distance between two conductors. (b=0.78mm)

t= thickness of conductor.(t=0.001mm)

h= height of dielectric.(h=0.03mm)

Z_0 = the characteristic impedance

ε_{eff} = the effective dielectric constant

ε_r = relative dielectric constant. (ε_r=15)

k = the complete elliptical integral of the first kind [3]

R_s = the surface resistivity

$$P' = \frac{k}{k'^{3/2}\cdot(1-k')}\left[\frac{K(k)}{K'(k)}\right] \qquad 0 \le k \le 0.707$$

$$\alpha_d = \frac{20\cdot\pi}{\ln 10}\cdot\frac{\varepsilon_r\cdot q}{\sqrt{\varepsilon_{eff}}}\cdot\frac{\tan\delta}{\lambda_0} \, [dB/m] \qquad (2)$$

where

q = the dielectric loss filling factor.

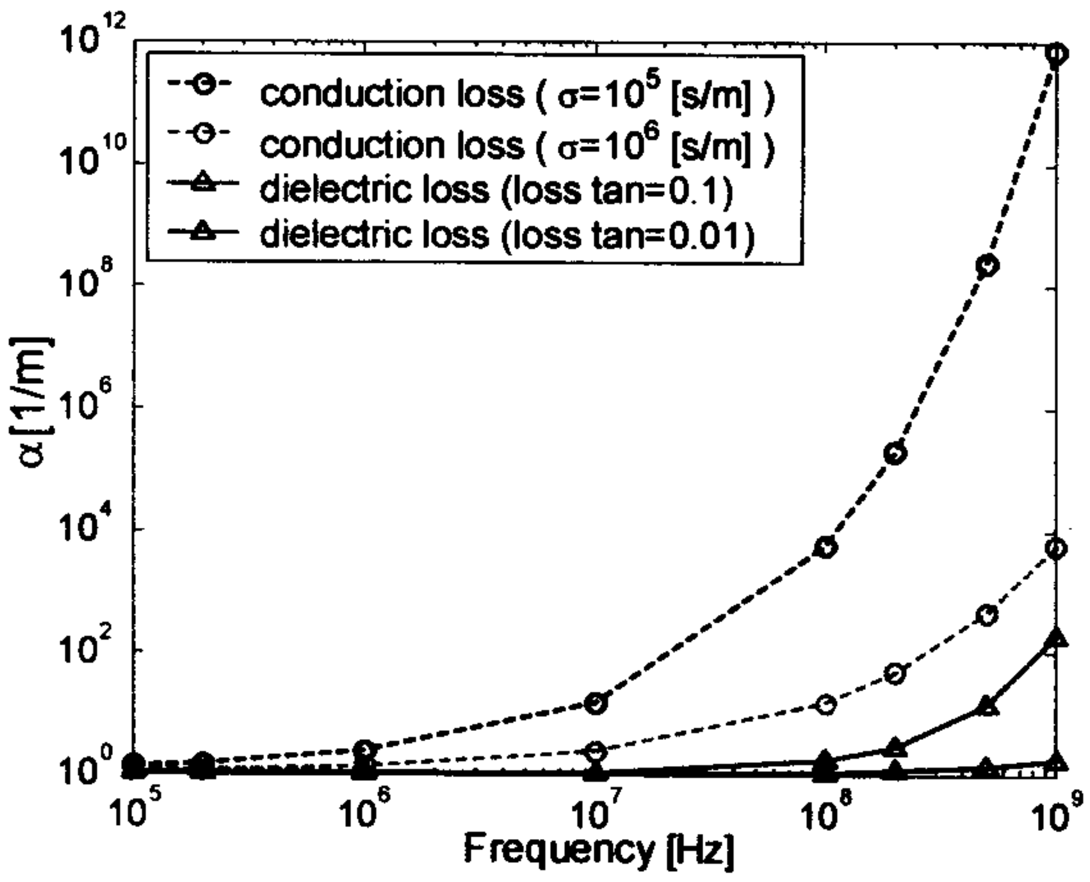

Fig.2 Propagation losses versus frequency

The radiation loss of CTL can also be calculated by the following equations [4]

$$\alpha_{cps} = \pi^5 \cdot \frac{(3-\sqrt{8})}{2} \cdot \sqrt{\frac{\varepsilon_{eff}}{\varepsilon_r}} \cdot \left(1-\frac{\varepsilon_{eff}}{\varepsilon_r}\right)^2 \times \frac{(s+2w)^2 \cdot \varepsilon_r^{3/2} \cdot f^3}{c^3 \cdot K' \cdot K} \ [1/m] \quad (3)$$

where
s= inner distance between two conductors (s=a)
w= width of conductor ($w = \frac{b-a}{2}$)
ε_{eff} = the effective dielectric constant
ε_q = the quasi-static effective permittivity
b = independent of the dimension
f_{te} = the surface wave TE_1 mode cut-off frequency.

The parameter a is related to the CTL geometry as [5]

$$\log(a) = u \cdot \log(s/w) + v$$
$$u = 0.54 - 0.64q + 0.015q^2$$
$$v = 0.43 - 0.86q + 0.54q^2$$
$$q = \log(s/d) \cdot$$

Fig. 2 shows that propagation losses of electrode structure are calculated with various values of conductivity and loss tangent. The radiation loss of electrode is also calculated. The attenuation constant of radiation loss is ~10^{-20}. So, it can be neglected. Fig.3 shows the systematic procedure to obtain distorted waveform due to propagation losses. First, we transformed the original waveform in time domain into the waveform spectrum in frequency domain using a Fourier transform since the attenuation constants are strong functions of frequency as seen in Fig.2. Then, the propagation losses, which are calculated as a function of frequency in Fig.2, are applied for each frequency component of waveform. Note that the propagation length is assumed to be 1 m and the conductivity and loss tangent are set to be 10^6 S/m and 0.01, respectively.

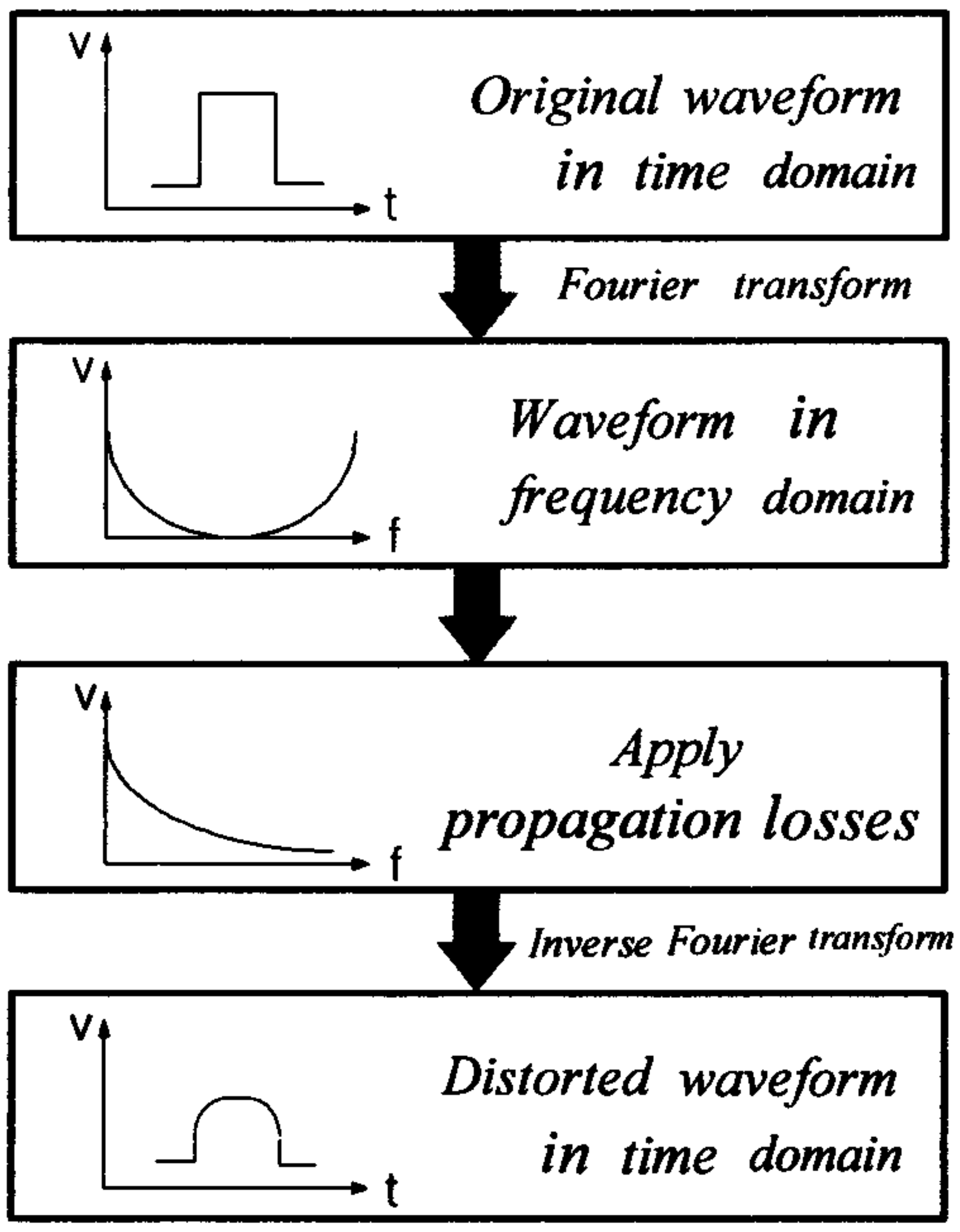

Fig.3 Procedure for obtaining distorted waveform due to propagation losses

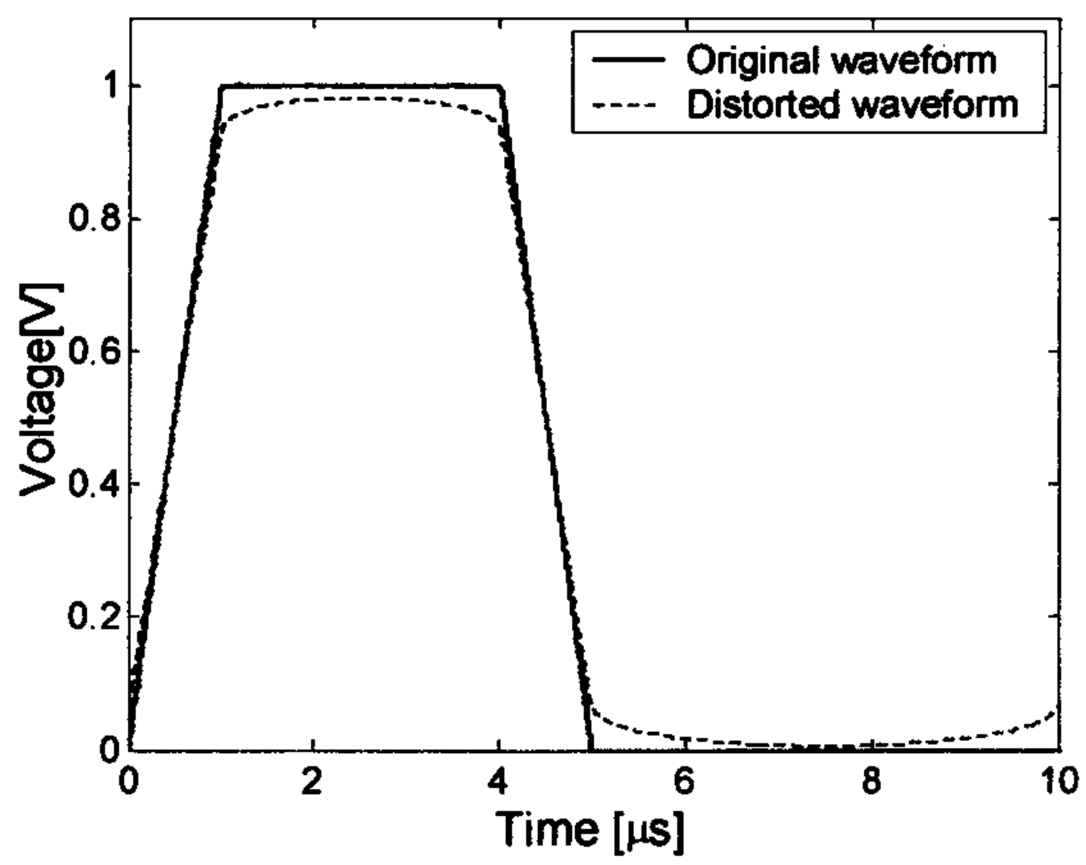

Fig.4 Distorted waveform of electrode due to propagation losses

After calculating the propagation losses for each frequency component, we obtain the distorted waveform as shown in Fig.4 using an inverse Fourier transform. It seems that the propagation losses do not influence the distortion of waveform significantly.

III. Coupling between Electrodes

Since an interference due to coupling between the electrodes can be another cause for waveform distortion, coupling voltage between the electrodes is measured using a proper experimental setup.

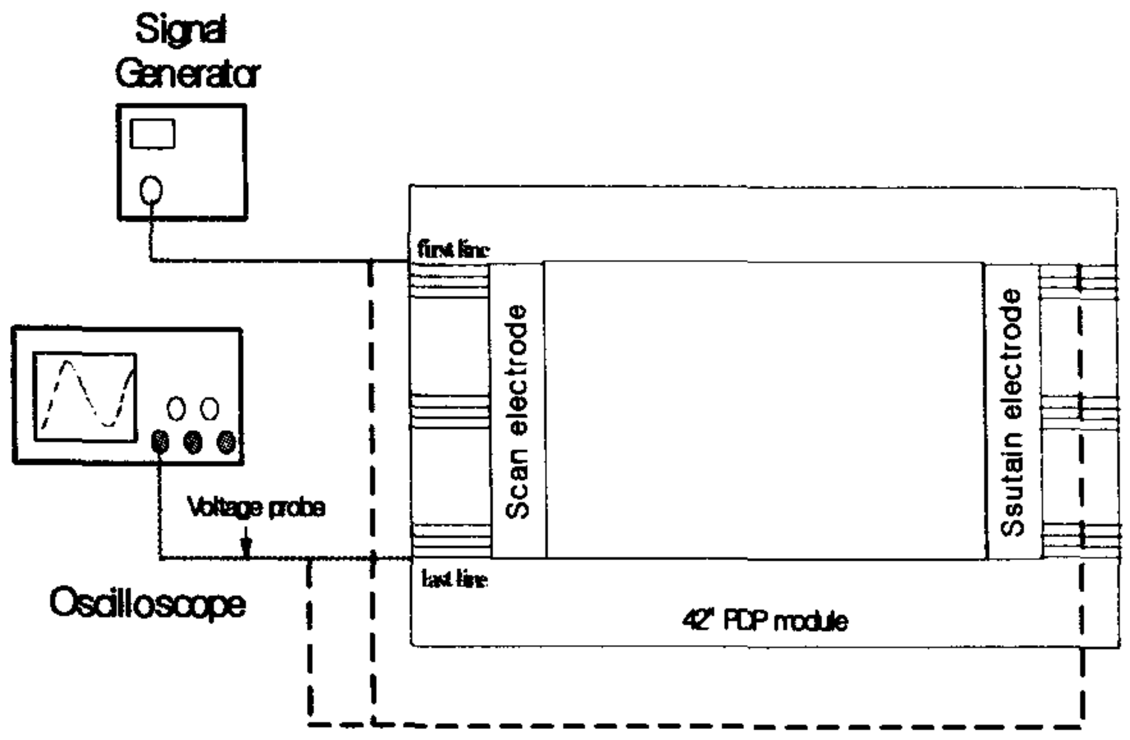

Fig.5 Experimental setup for measuring a coupling between the electrodes (without plasma)

Fig.5 shows an experimental setup for measuring a coupling voltage between the electrodes. In this experiment, 42" PDP module was employed which has 480 XY electrodes. It is also noted that the experiment was performed without plasma because of the difficulty in applying our test waveform at the scan electrodes with plasma. An original waveform whose peak to peak voltage is 2[v] with a frequency of 1MHz transmits the first line of scan electrode using signal generator (HM 8030-5) as shown in Fig.5. The coupled voltage at the last line was measured using a voltage probe (Tektronix P6139A) with a bandwidth of 500MHz. If there is no coupling between the electrodes, no voltage would be measured at the last line. However, some coupling voltage was measured as shown in Fig.6. The reasons for the measured coupling voltage are being investigated in detail. This coupled voltage would make interference with the direct scanned waveform, resulting in a distortion of waveform.

IV. Conclusion

Distortion of waveform, which could be a cause for underfiring problem, has been studied. The propagation losses of electrode, which can be considered as a coplanar transmission line, have been calculated as a function frequency. The distorted waveform has been obtained from the calculated propagation losses. The result shows that the propagation losses do not influence the distortion of waveform significantly.

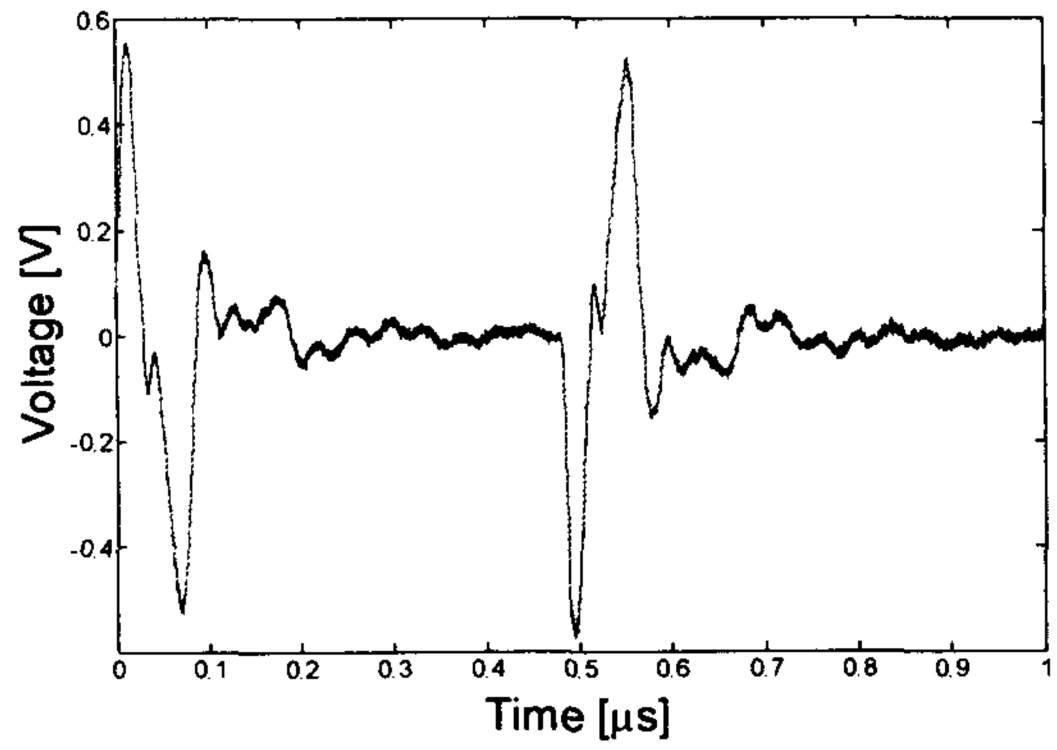

Fig.6 Measured coupling voltage at the last line of 42" PDP

Some coupling voltage between the electrodes, which could be another cause for distortion of waveform, has been measured using 42" PDP module. The reasons for the measured coupling voltage are being investigated in detail.

References

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