RMSP (Ramp biased Multiple Short Pulses) reset method for AC PDP

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Abstract
We have proposed a new reset discharge method for AC PDP, which is composed of fast Ramp biased Multiple Short Pulses (RMSP). By using this method, we achieved stable reset discharges with reduced reset time. At the same time, it resulted in lower background luminance as well as stable and higher address margin using the tail effect.

1. Introduction
There have been a lot of researches done on the reset methods in AC PDP. [3]-[6] The strong pulse reset method is characterized by the strong discharge in the whole panel followed by a self-erasing discharge. [3] Since the report of the ramp reset method, many PDP makers have adopted it because of many good features. [5] Deployment of weak positive resistance discharges using ramp pulse could provide the stability, wide address margin, and small background luminance at the same time. The ramp reset method needs relatively long time to perform the reset operations because of the slow ramp rate of 1~3V/μs, and it needs to be shortened to be able to provide longer display time or increased number of sub-fields to improve the moving picture quality. [6]

We are proposing a new reset discharge method for AC PDP, which is adopting Ramp biased Multiple Short Pulses (RMSP) and can provide stable wall voltage states, lower background luminance, and shorter reset time.

2. Analysis of Discharge in RMSP
The change in wall voltage during the discharges should be controllable for reducing the reset time. The stability of RMSP reset method can be explained using the VTC (Voltage Transfer Curve) [1] [2]. A VTC draws the relationship between the discharge space voltage (V_D) and the change in the wall voltage (ΔV_W).

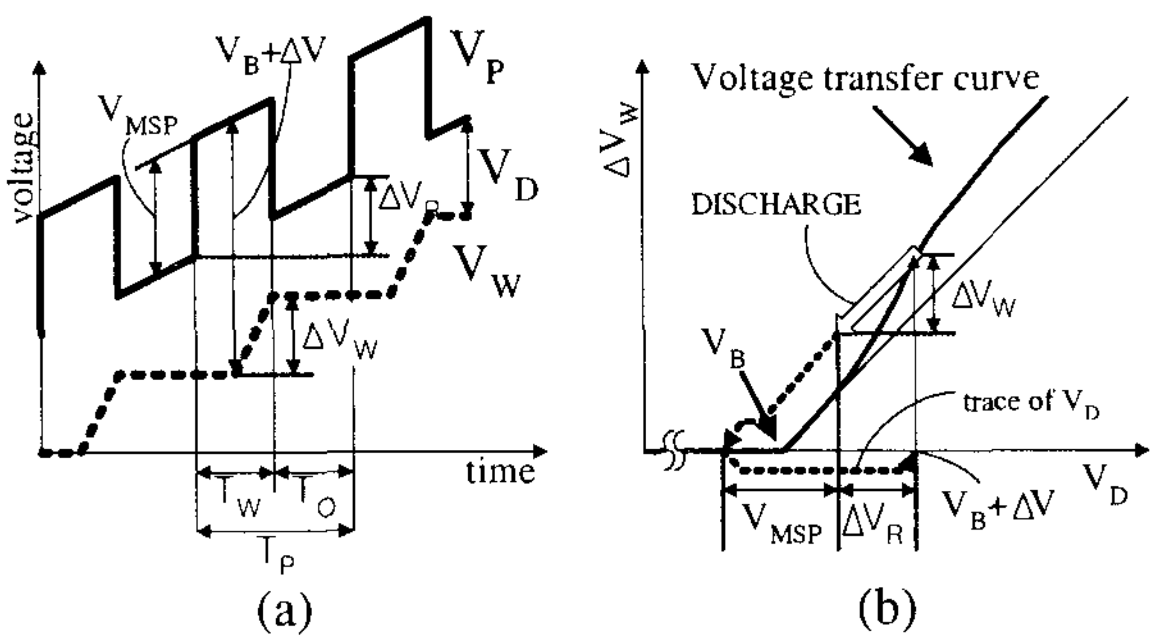

Fig.1 Detailed transition of wall voltage when MSP have the ramp bias voltage (a) Waveforms (b) VTC

Fig.1 shows the discharge sequences when the multiple short pulses (MSP) are placed on top of the ramp bias. As the voltage between the electrodes (V_P) is increased, the first discharge occurs when the condition of V_P-V_W (=V_D) ≥ V_B (: the breakdown voltage) is met. By limiting the period TW while this condition is met, a limited □V_W is created. The ramp bias increases by □VR in a period T_P (=T_W+T_O). If ΔV_W (1st pulse) = ΔV_R(per period), the second discharge will occur on the same position on the VTC and □V_W (2nd) = □V_W (1st).

If $\Delta V_W > \Delta V_R$, the second discharge point moves left and the discharge becomes weaker, which makes ΔV_W (2nd) < ΔV_W (1st). If $\Delta V_W < \Delta V_R$, the second discharge point moves right and ΔV_W (2nd) > ΔV_W (1st). [7] [9] [10] Thus, ΔV_W (2nd) become close to ΔV_R. As a result, the discharge point can be controlled through adjusting T_P (changes ΔV_R) and T_W (changes ΔV_W) according to the chosen slope of the ramp. Even when the slope of the ramp bias is increased compared with a normal ramp reset pulse, the discharge can be stably controlled as far as ΔV_W moves toward ΔV_R.

This concept of adding multiple short pulses on the fast ramp bias voltage can be used to have the reset pulse waveforms shown in Fig.2, the R period and F

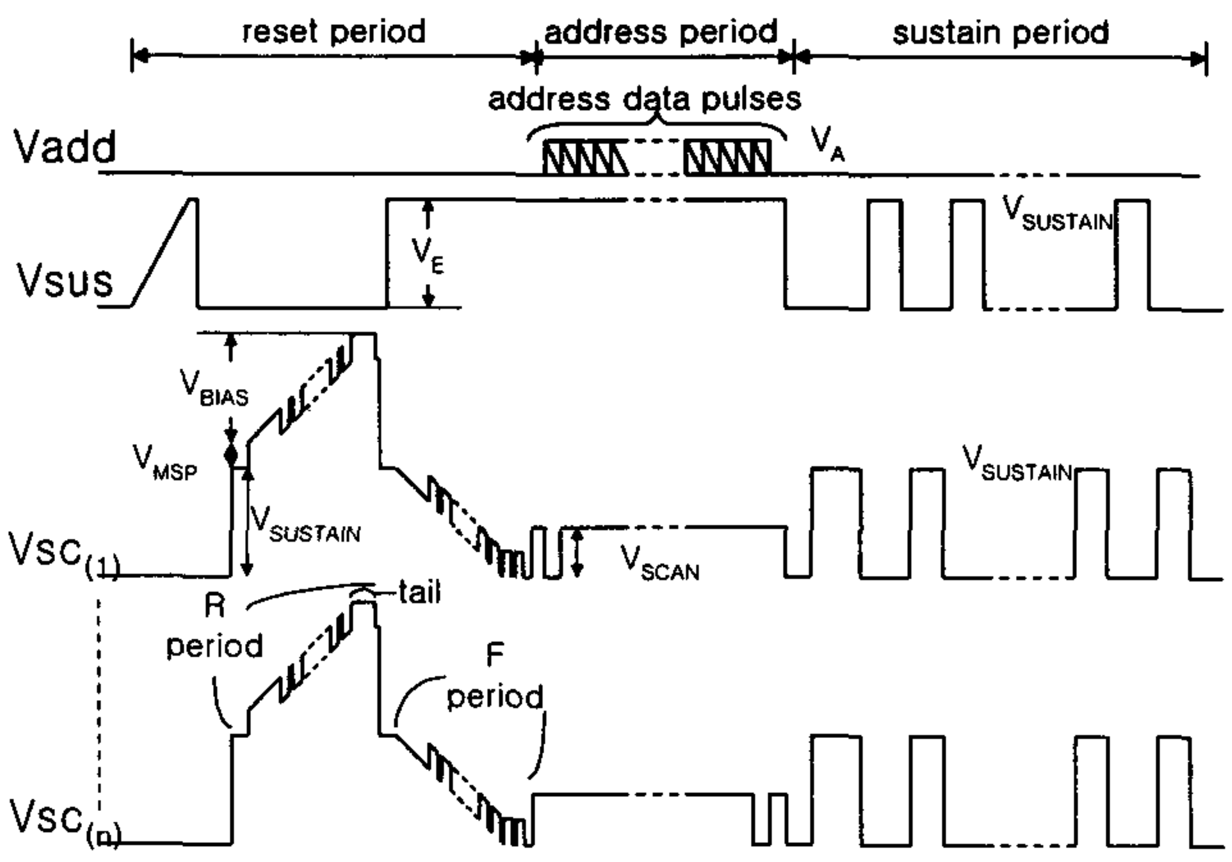

Fig.2 New Ramp biased Multiple Short Pulse (RMSP) reset method

period when the voltage of the scan electrode is higher than that of the sustain electrode and vice versa, respectively.

3. Experimental Setup

Fig.3 shows the experimental system set up for the feasibility study of RMSP method. The test panel used in this experiment was 6 inch diagonal with 1.08mm. 1.08mm pixel pitch. 12 sub-fields constituted 1 TV frame and every sub-field has its own reset period. The scan period and sustain period were set to be 1.6μs and 5μs each. The experiment has been performed only when the stability of the reset period is satisfied.

The characteristics of the ramp reset method were examined with the rise and fall slope of 1.5V/μs. For the minimum address voltage of 40~45V, the required peak reset voltage was shown to be 370V~375V and the background luminance was shown to be 1.88~2.0cd/m^2.

Fig.4 shows an example of experimental pulse shapes of RMSP on the scan and the sustain electrodes. Fig.5 shows the enlarged view of the short pulses during R period and F period. It should be noted that the width of pulse (T_W) is defined as the high side of pulse during R period and low side during F period.

The experiments were focused on the region of low (≤ 40V) VMSP (the amplitude of the multiple short pulses: Fig.2) to keep the switching power loss as small as possible. To successfully inhibit the plasma discharge with T_W up to 2μs and the ramp slope 5V/μs, VMSP of 30V was found to be the appropriate value.

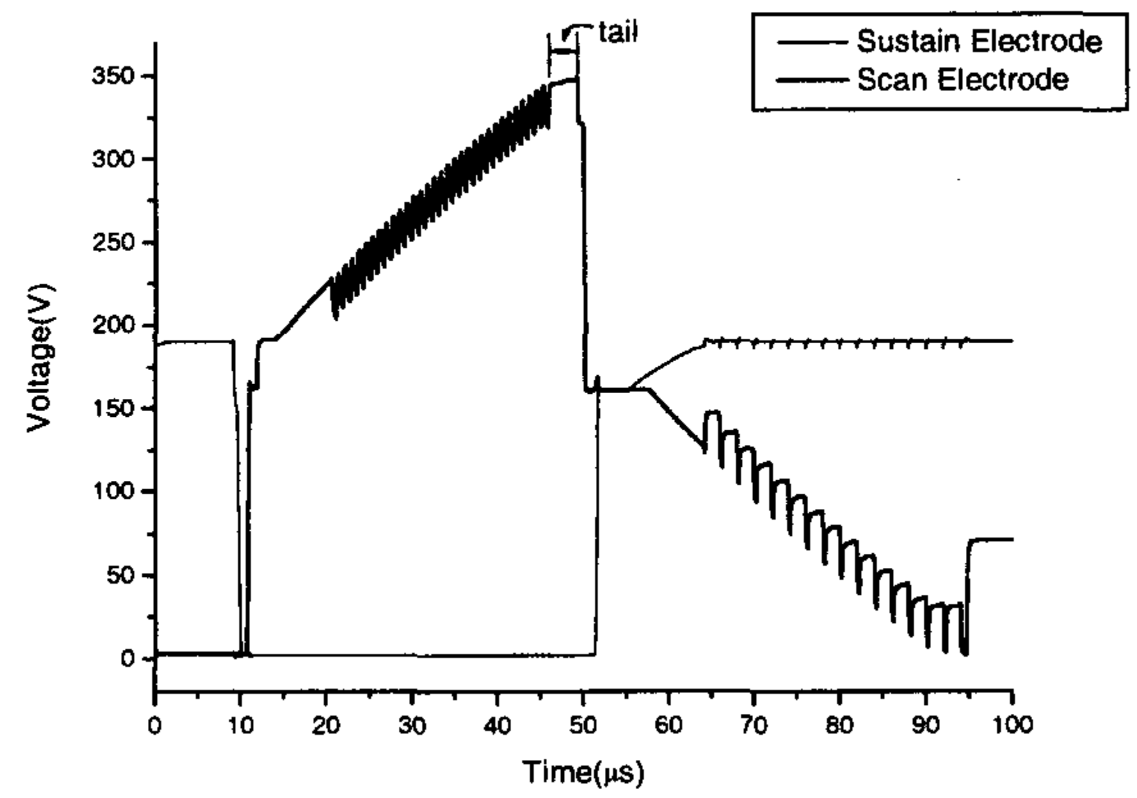

Fig.4 Experimental RMSP reset pulse waveforms applied in the test panel

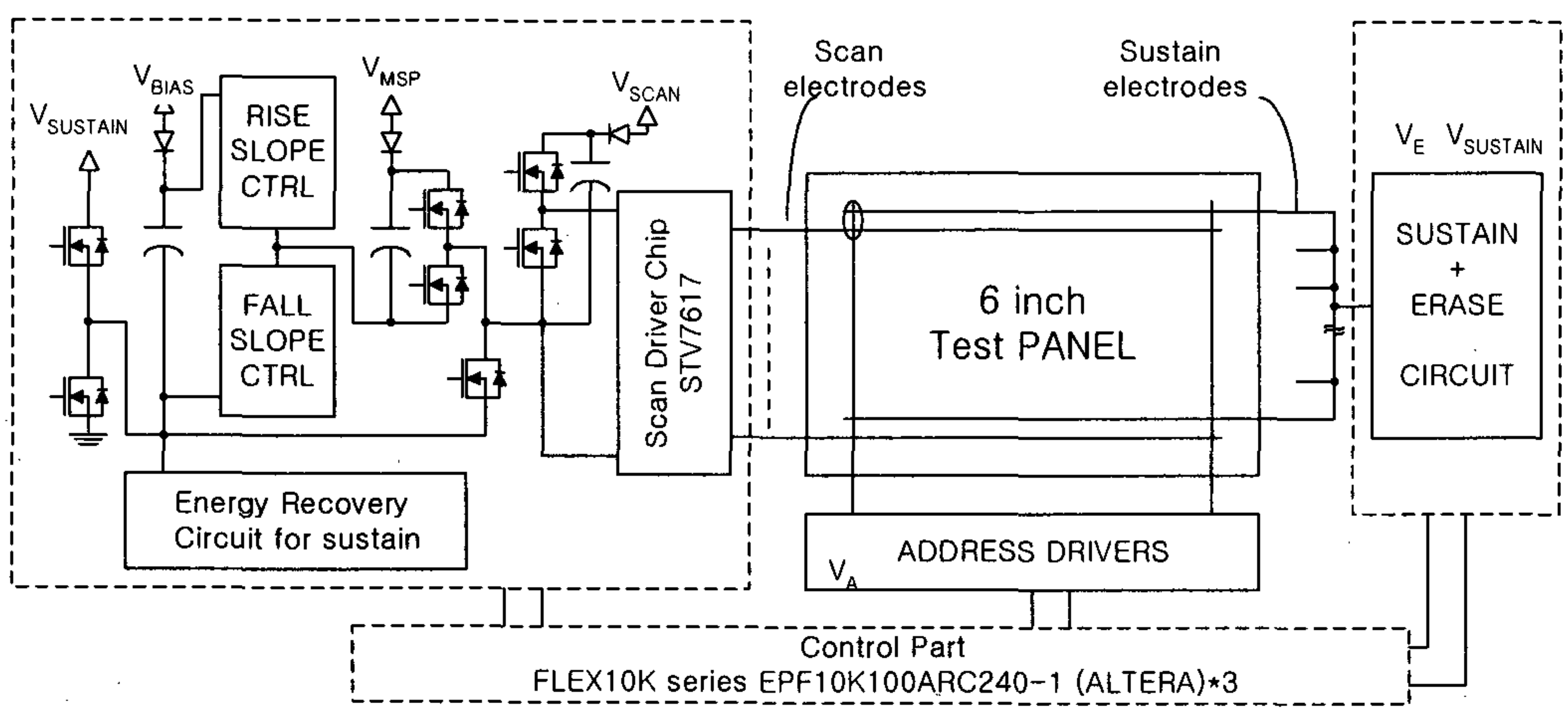

Fig.3 The structure of experimental system

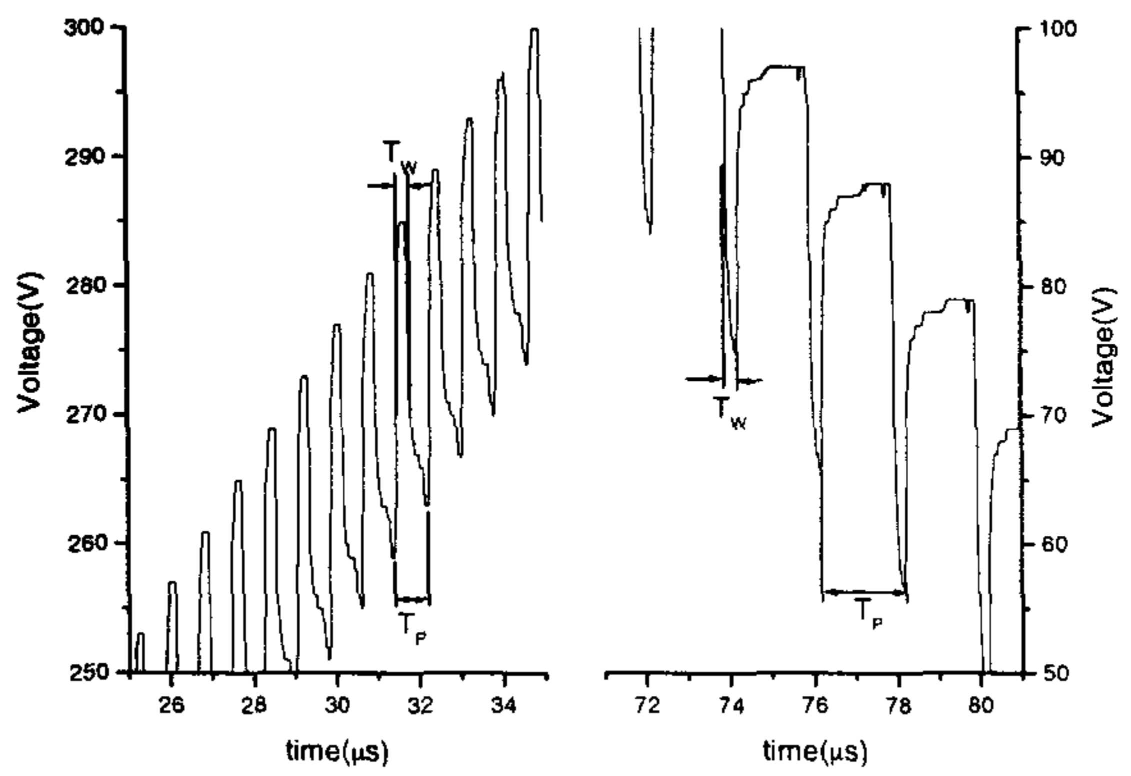

Fig.5 The enlarged view of the short pulse waveforms

4. Experimental Results

The tail effect in RMSP reset method is defined as an effect which can add controllability of wall voltage amounting □V. For F period, the address margin and the background luminance are improved by ending RMSP before many pulses are applied on terminal voltage and quickly go to the next stage. The tail effect was applied to F period by erasing the tail region after F period and preserving ΔV. [8]

For R period, the discharge was intentionally increased by adding a tail pulse. Table 1 shows the conditions for R period experiments to obtain the results shown in Fig.6. The condition of F period is fixed such as T_P=2μs, T_W=200ns. As a tail pulse was added, the background luminance increased but the minimum address voltage greatly decreased. For the same address margin, the background luminance is lower when the tail pulse is added than when the peak reset voltage is raised to adjust the address margin.

TABLE I
Conditions for Fig.7

Voltage Condition			
$V_{SUSTAIN}$	160V	V_{SCAN}	70V
V_{BIAS}	160V	V_{MSP}	30V
V_E	190V	V_A	0~80V
R Period	Ramp slope : 5V/us Peak voltage: 350V MSP: T_P: 800ns Duty ratio: 1: T_W=200ns, T_O=T_P-T_W: 25% 2: T_W=TO: 50% 3: T_W=T_P-T_O, T_O=200ns: 75%		
F period	Ramp slope: -5V/us MSP: T_P: 2us, T_W: 200ns, T_O=T_P-T_W		

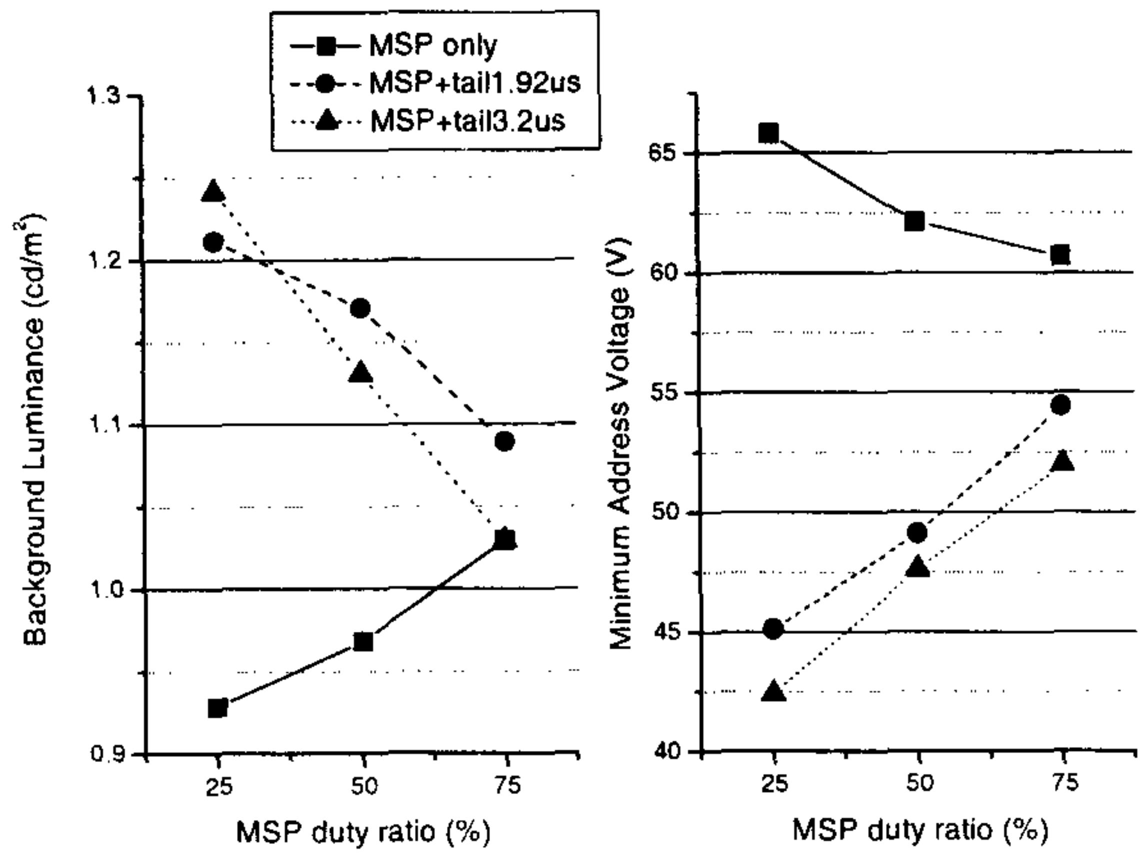

Fig.6 Background luminance and address margin of MSP + tail pulse in R period

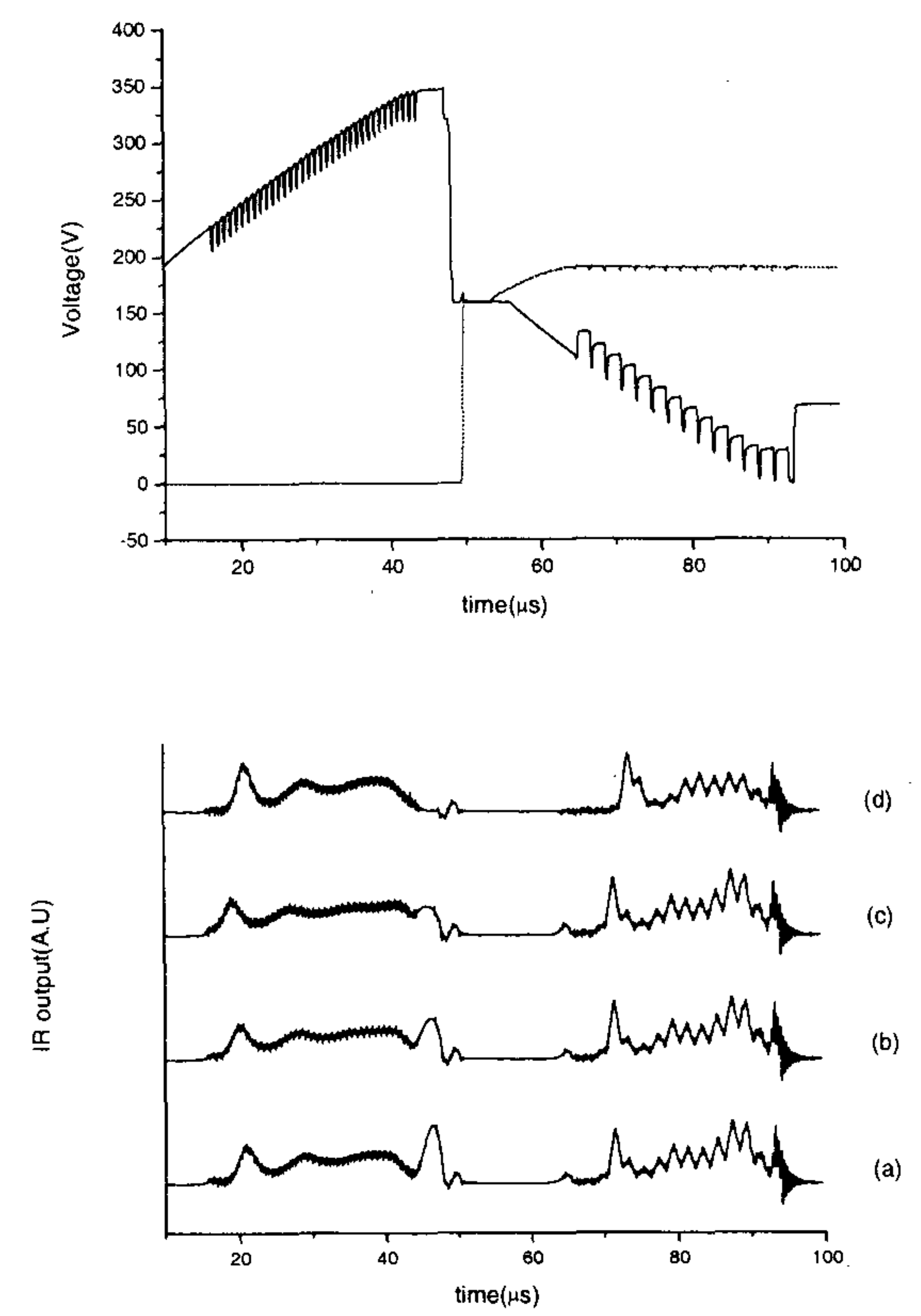

Fig.7 IR outputs in R period (period of MSP in R period: 800ns) (a) 25% duty+ (Tail 3.2μs) (b) 50% duty+ (Tail 3.2μs) (c) 75% duty+ (Tail 3.2μs) (d) 25% duty+ (Tail 0μs)

Fig.7 shows the IR (Infra Red light) output measurement during R period with the conditions given in Table 2. Fig.7 (A) shows the input voltage waveforms of the scan and sustain electrodes and (B) shows the IR output measurement. The discharge in the tail region intensifies as the duty ratio decreases, which also explains the results shown in Fig.6.

Table 2 shows the improved background luminance, address margin and reset time of RMPS after the optimization of the waveform. The background luminance is reduced to 66% of that of normal ramp reset pulse case and 215μs of the reset time can be saved per one sub-field.

TABLE II

Performance comparison between conventional normal ramp reset method and the new RMSP reset method

	Normal Ramp reset method	new RMSP reset method
Peak reset voltage	370V	350V
Rise rampBias slope	1.5V/μs	5V/μs
Fall ramp Bias slope	1.5V/μs	5V/μs
Background luminance	1.886cd/m^2	1.242cd/m^2
Address margin	44.9~80V	42.4~80V
Reset time	350μs	135μs
Condition: 60 frame/second, 12 reset periods (=12 sub field)/frame 6 inch test panel $V_{SUSTAIN}$=160V, V_{SCAN} =70V, V_E=190V Address margin: Tested with full white pattern		

5. Conclusion

The tail effect was proved to be effective in widening the address voltage margin. In R period, the tail effect contributed to the decrease of the minimum addressing voltage through the utilization of discharge at the tail pulse. On the other hand, the remained ΔV before the tail region was preserved to lower the minimum address voltage by removing the tail pulse in F period.

The optimized new RMSP reset scheme showed 52% improvement of dark room contrast ratio and 2.58ms time save in one TV field when compared with the results of the normal ramp reset scheme. It is expected that this new reset pulse style can be applied to many reset schemes giving more freedom that the simple ramp pulse.

6. References

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