Selective Erase Driving of PDP's with Three Wall Charge States

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Abstract

We reported the result of driving PDP's in selective erase scheme and three wall charge states. Compared to the selective write driving scheme, the selective erase scheme achieved flicker free half-ON state with much simpler driving waveforms than the selective write scheme. We believed that this improvement was possible since the cells entering the address period with enough wall charges to modulate easily with.

1. Introduction

AC PDP is well accepted as large screen wall-hanging TV thanks to strong non-linearity, wide viewing angle, high luminance, color capability, and so on. To drive this technology into HDTV regime, improvements in luminous efficiency as well as picture quality are required[1-3].

Regarding the picture quality, dynamic false contours in slowly varying images are considered as the most serious problem. To overcome, researchers reduced the amount of sub-field combination change among adjacent gray levels by dividing the MSB sub-field into two or four sub-fields. Since the number of sub-fields increases, less time is available for display discharge and therefore, luminance drops. Another most promising technique in reducing the dynamic false contours is the stretched-out coding [4]. However, this method requires too many sub-fields for practical use. In Table 1, one can see that 10 sub-fields were required to implement 11 discrete grey levels.

We have proposed the Quantized Memory Addressing (QMA) driving method which sets different amount of wall charges during the address period and obtain various luminance levels in a sub-field. General driving waveform for this method is shown in Fig. 1 where only widths of the pulses applied to data electrode modulated by the control signal. We have tested the driving method in the selective write scheme and reported the improvement in luminance[4,5] and dynamic false contour reduction[6]. However, we observed flickering cells randomly scattered in the test panel. These flickering cells appeared when we tried to achieve intermediate luminance levels. . We believed that the selective write data pulse width for intermediate luminance was not long enough to establish stable wall charge distribution in these flickering cells.

In this paper, we report initial results of selective erase QMA driving. The selective erase scheme was our second choice since it can cause excessively large background luminance.

Table 1 Implementation example of the stretched-out coding [4]

Grey level	Subfield									
	1	**2**	**4**	**8**	**16**	**24**	**32**	**40**	**56**	**72**
0	0	0	0	0	0	0	0	0	0	0
1	1	0	0	0	0	0	0	0	0	0
3	1	1	0	0	0	0	0	0	0	0
7	1	1	1	0	0	0	0	0	0	0
15	1	1	1	1	0	0	0	0	0	0
31	1	1	1	1	1	0	0	0	0	0
55	1	1	1	1	1	1	0	0	0	0
87	1	1	1	1	1	1	1	0	0	0
127	1	1	1	1	1	1	1	1	0	0
183	1	1	1	1	1	1	1	1	1	0
255	1	1	1	1	1	1	1	1	1	1

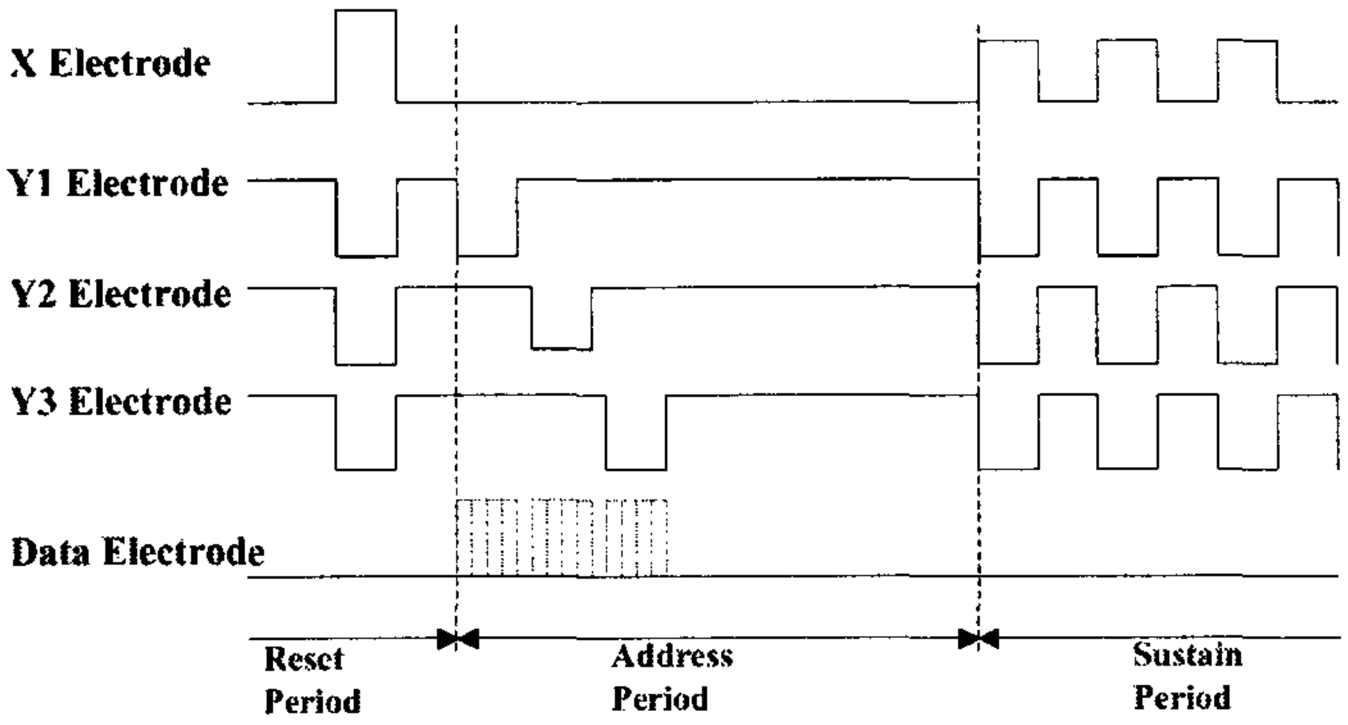

Fig. 1 Driving waveforms for new gray scale implementation method. Pulse width modulation on address pulses applied to the data electrodes.

2. Experiments and Results

Since we believed that the flickering in some cells occurred due to discharge cell characteristics variation such as physical dimension and/or gas composition, we decreased the number of wall charge states to three, "ON", "OFF", and "half-ON". To minimize the flickering, we adopted the selective erase driving scheme to overcome the cell characteristics variation. This scheme was attractive because the data pulse only needed to erase required amount of wall charges instead of generating them. In this way, we can overcome insufficient wall charge build up by the narrow "half-ON" data pulses in some flickering cells.

We used 6-inch three electrode surface discharge type test panel with phosphors. Driving waveforms were generated by computer interfaced arbitrary waveform generator from FT Lab. Inc. Fig. 2 shows our driving waveform which is consisted of total write (reset), selective erase (address), sustain and erase period. We used rectangular total write pulse of 200 volts on Y electrode and -100 volts on X electrode. There were two discharges during the reset period. One was discharge caused by the 300 volts total write pulse applied between X and Y electrodes. And the other was opposite direction discharge triggered by 180 volts pulse applied to the X electrodes. This discharge stabilized the wall charges.

During the address period data pulses of 20 to 80 volts were applied to the data electrode while X and Y electrode remained at ground level. We varied the data pulse widths from 0 to 3 usec to measure the luminance change during the sustain period as a function of data pulse widths. During the sustain period, opposite polarity pulses were applied between X and Y electrode to generate potential differences between 140 to 210 volts. After the sustain, 50 to 100 usec long ramp erase pulses were applied to all electrodes to eliminate wall charges. We found more effective erase was possible by applying the erase pulse on the data electrode.

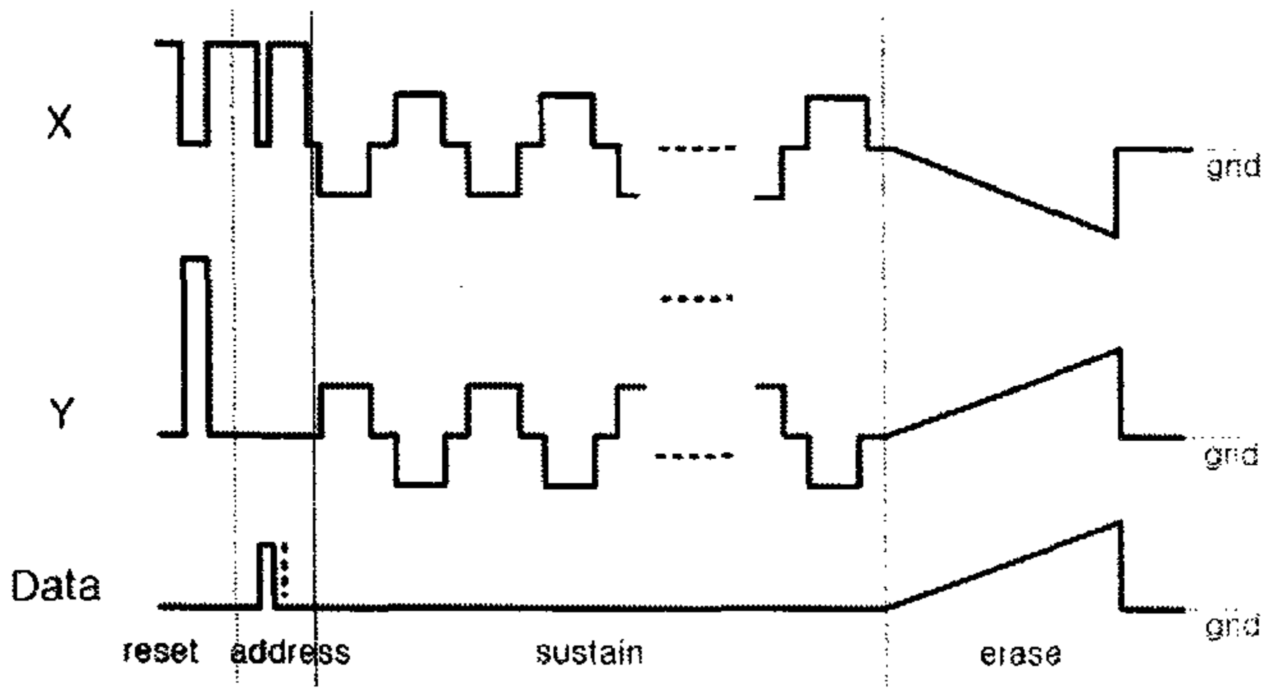

Fig. 2 Driving waveform for the selective erase scheme

We have measured emission from the panel with Hamamatsu C6386 photo sensor/amplifier during the address period. Typical results are plotted in Fig. 3. In the figure, we found larger photo emission for longer data pulses. Similar results were obtained with discharge current measurement by Tektronix CT-1 current probe. From these results, it is clear that the longer data pulses caused stronger erase discharge and wall charges were eliminated proportionally. To confirm, we measured the average luminance with photo-transistor array. Measurement results are shown in Fig. 4. As expected, we obtained maximum and minimum luminance when 0 and 2usec wide data pulse was applied, respectively at 70 volts data pulse amplitude. It is clear from the figure, that there was window of data pulse widths where the luminance drops linearly. And the size of the window was larger than that of the selective write scheme[5].

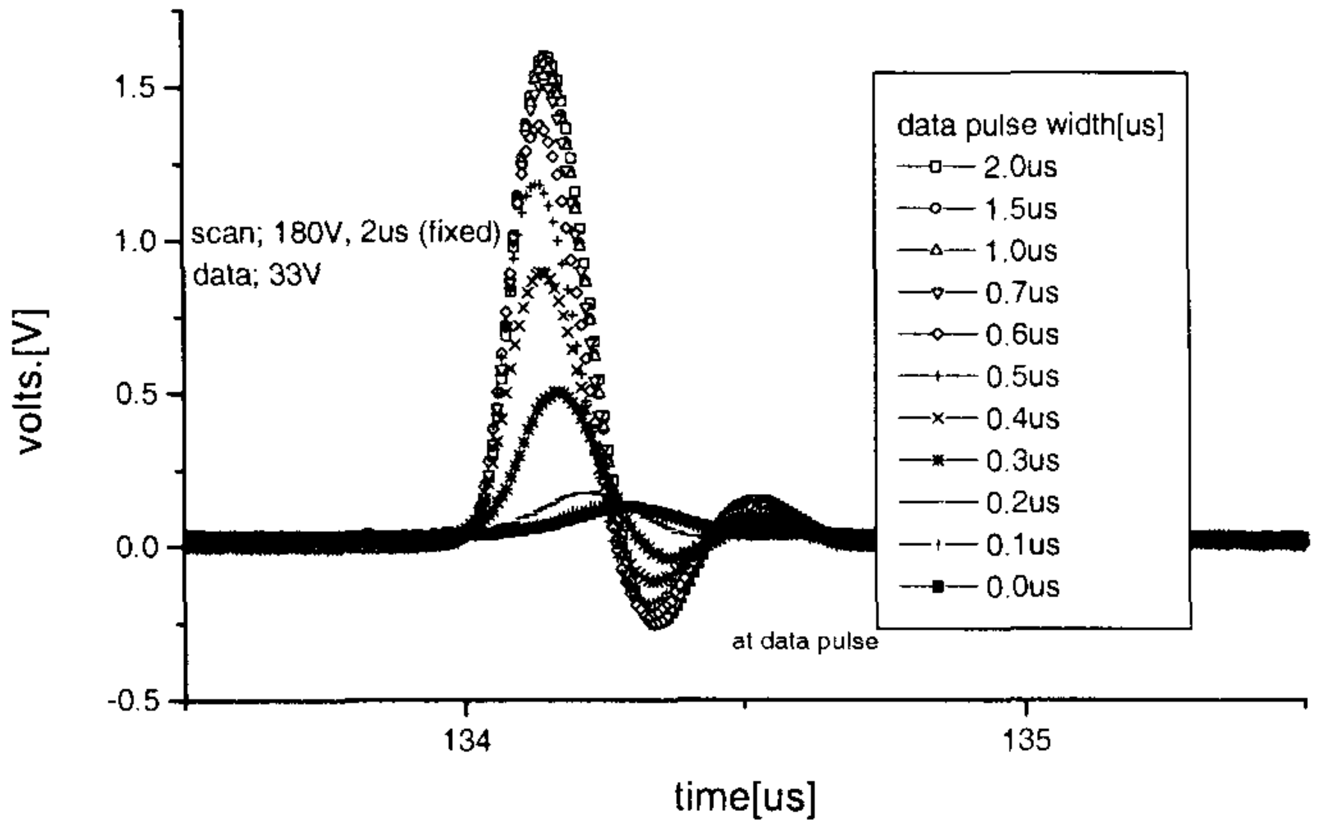

Fig. 3 Photo sensor/amplifier measurement results for various data pulse widths in the selective erase driving scheme.

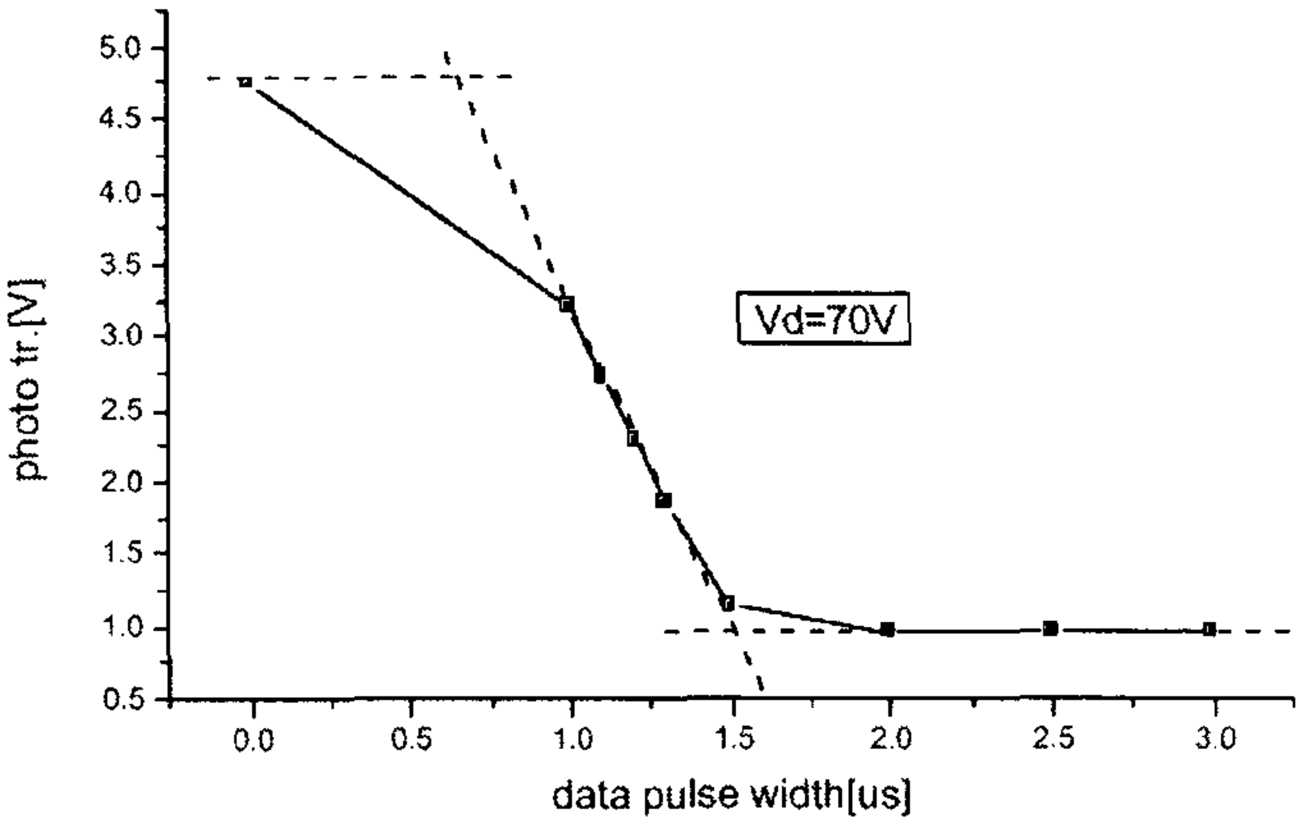

Fig. 4 Luminance versus data pulse width in selective erase driving scheme.

The smooth luminance change indicates that this scheme is better in controlling luminance of the half-on state. Furthermore, we found the panel was free of flickering in all the luminance levels when we applied 150 sustain pulses.

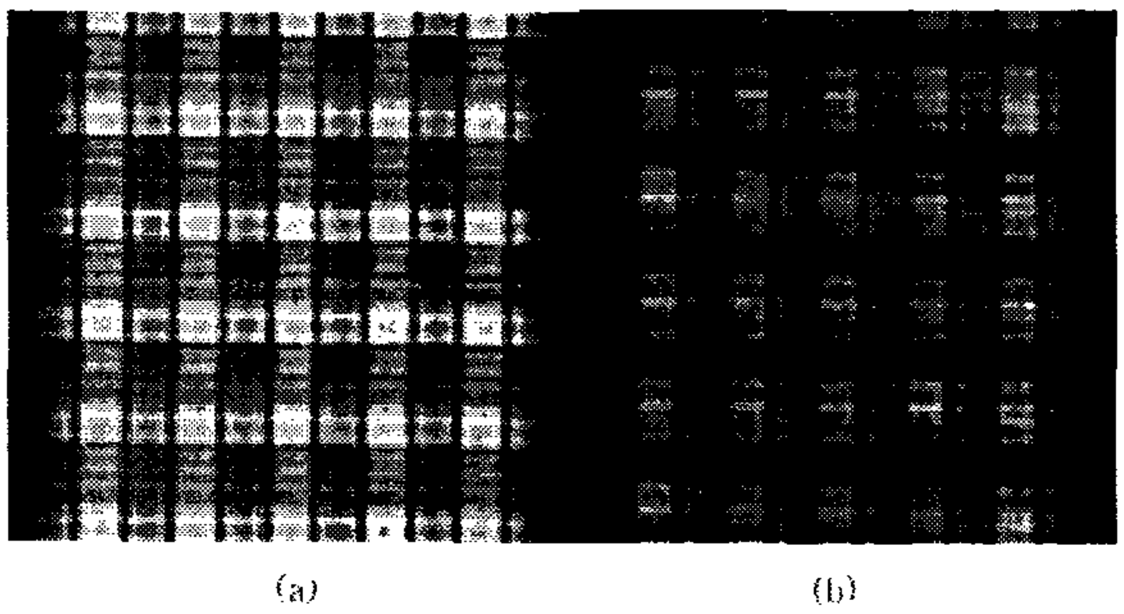

Fig. 5 Picture of the test panel at (a) fully-on and (b) half-on state with the same number of sustain pulses applied.

We believed that the total write pulse over-drove the panel and turn on all the cells regardless of minor cell property variations. However, we found that the background luminance was higher than that of the selective write driving scheme. From Fig. 4, the minimum luminance measured was about 1 volt photo-transistor output. In the selective driving scheme, it was usually around 0.5 volt due to ambient light. Furthermore, we found trade-off relationship between background luminance and half-on state stability. In other words, when we lowered the total write pulse amplitude to control the background luminance, it was difficult to maintain stable half-on state and vice versa. Therefore, we need to perform further optimization in waveform design. We obtained best results with conditions shown in Table 2. However, we think that further waveform engineering is necessary. Fig. 5 showed panel pictures in the "ON" and "half-ON" state, respectively.

Table 2 Driving conditions for selective erase scheme

	X	Y	Data
$V_{total\ write}$	-100 V	200 V	-100 V
$Width_{total\ write}$	5 usec		
$V_{address}$	180 -> 0V	0	0 -> 33V
$Width_{address}$		2 usec	0.5usec (half-ON)
$V_{sustain}$	75 or -75V	-75 or 75 V	0
$T_{sustain}$	20 usec		
$V_{erase\ peak}$	-100V	100V	100V
$Width_{erase}$	50usec	50usec	50usec

Grey scale can be implemented with the three wall charge states QMA driving. Different from conventional ADS driving technique, the grey scale is expressed as equation below:

$$grayscale = \sum_{i=2}^{8} 2^{i-1} SFQ(i)$$

where i represents sub-field index and SFQ(i) is the sub-field quality of i^{th} sub-field, which is 1 for fully-on state, 0.5 for half-on state and 0 for off state.

The advantage of this grey scale implementation was reported earlier[7]. Briefly speaking, this method ensures completely stretched-out coding for 255 grey levels with only 7 sub-fields as shown in Fig. 6. This is significant improvement in realizing the stretched out coding for high picture quality PDP's without dynamic false contours.

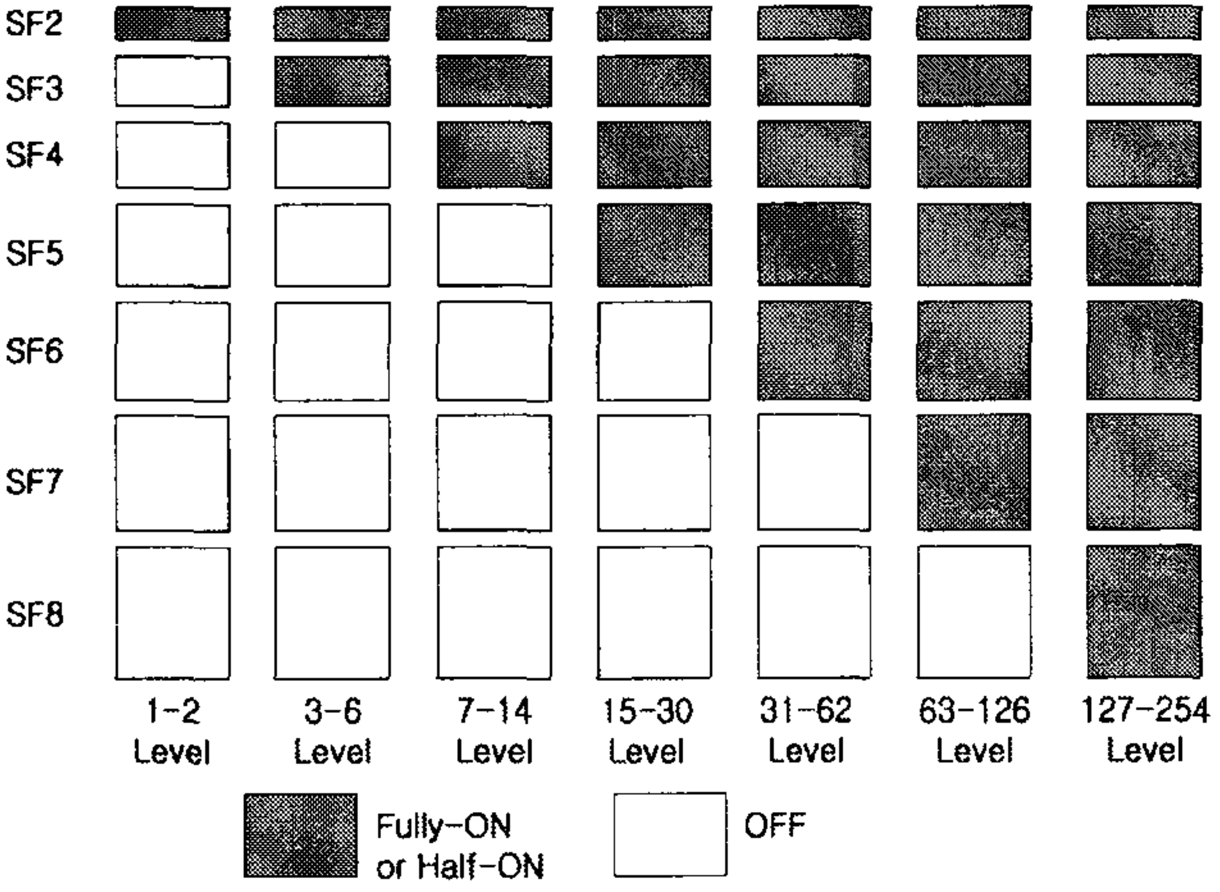

Fig. 6 Sub-field combination change from level 1 to level 254 obtained by this work.

3. Discussion

Obtaining the flicker free half-on state with selective erase driving is a key step toward successful implementation of QMA driving method. For selective write scheme which we tried first required sophisticated reset discharge control driving waveform to overcome the cell characteristics fluctuation. In general, the panel stability has been enhanced at the half-on state when we applied selective erase scheme with relatively simple driving waveforms.

We found minor color change in some cells during the sustain period when we expressed the "half-ON" state. Even though these color variation was much less noticeable than flickering cells, it is obvious indicator of non-uniform discharges. Furthermore, there is a trade off between background luminance and "half-ON" state stability. Up to this point, we were only partially successful in obtaining optimized driving waveform which can turn off a cell completed while providing stable half-on state.

From our experience, we suspect the voltage margin for the selective erase can be narrower than conventional driving schemes. But careful optimization is worth while since the QMA driving can solve high resolution driving problem as well as picture quality problem, simultaneously.

4. Conclusion and further works

We have tested selective erase driving scheme for quantized memory addressing (QMA) driving scheme. We were successful in obtaining stable half-ON state without flickering discharge cells. To obtain operating margin of practical use, further study on driving waveform is required.

5. Acknowledgement

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5. References

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