Examinations into Irradiation Optics for Evaluations of Reflective LCD

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1. Introduction

It is the main current in these years to use reflective LCD for PDA and cellular phones. To obtain good visibility of reflective LCD, high reflectance and contrast ratio have to be ensured as well as wide color reproducibility 1). In evaluation of visibility of reflective LCD, different measurement values result depending on the method of irradiation, different from samples of nearly complete diffusion surface such as paper. There are many irradiating conditions in actual environments. Thus, studies are being made for evaluation of visibility of reflective LCD under various indoor environments 2). Further, in view of rapid spread of reflective LCD, standardization of measurement methods became important, so that JEITA (Japan Electronics and Information Technology Industries Association) specified four irradiation methods for evaluation of reflective LCD in the EIAJ-ED2523 Standard 3). However, measurement values resulting from these irradiation methods do not become same due to different conditions of irradiation. In this report, we take measurements of the reflectance and the contrast ratio of reflective LCD according to three irradiation methods out of four and examine features of data resulting from respective irradiation methods.

2. Irradiation optics and measured data

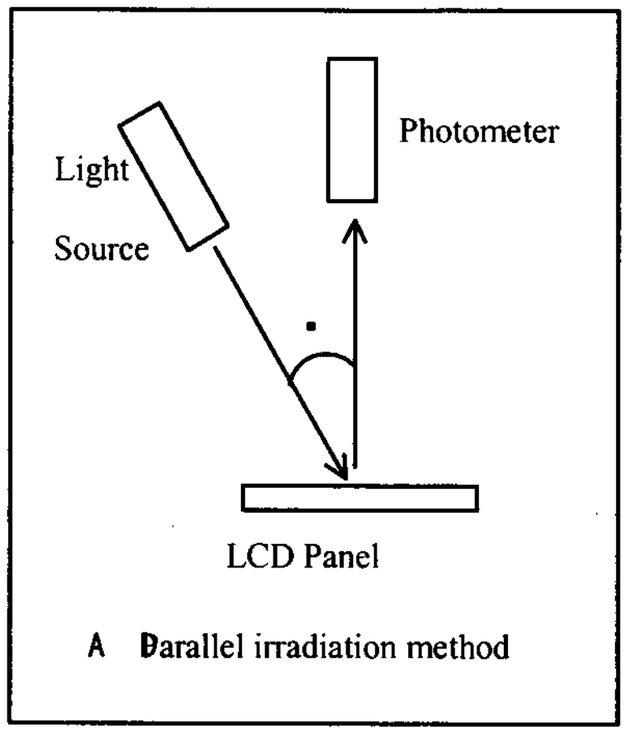
Fig. 1 shows the optics specified by EIAJ-ED2523. Except for the case of evaluation of viewing angle characteristics, measurements are taken in the normal direction or design viewing angle direction to the display surface of the LCD panels. This time, measurements were taken with three irradiation optics of A, B and D. As to samples, the measurements were taken with CLIE (SONY) and GENIO (TOSHIBA) used in Round Robin Test. Evaluations were made with the touch panel, light conductive plate and front light removed.

The method A is called "Parallel irradiation method" to take measurement with parallel light irradiated to a sample. Out of the four methods, this is the only one method to enable detail evaluation of the irradiating angle dependence and the viewing angle dependence in multi directions 4). The irradiating angle dependence of the reflectance and the contrast ratio were measured, using the method A, for which the measurement results are shown in Fig. 2. The EIAJ-ED2523 Standard recommends the irradiating angle of 30 .▪In 30 irradiation, both reflectance and contrast ratio are low. For stable measurement, care has to be taken of the optical axis accuracy, since fluctuation of the reflectance according to the change of the irradiating angle is large.

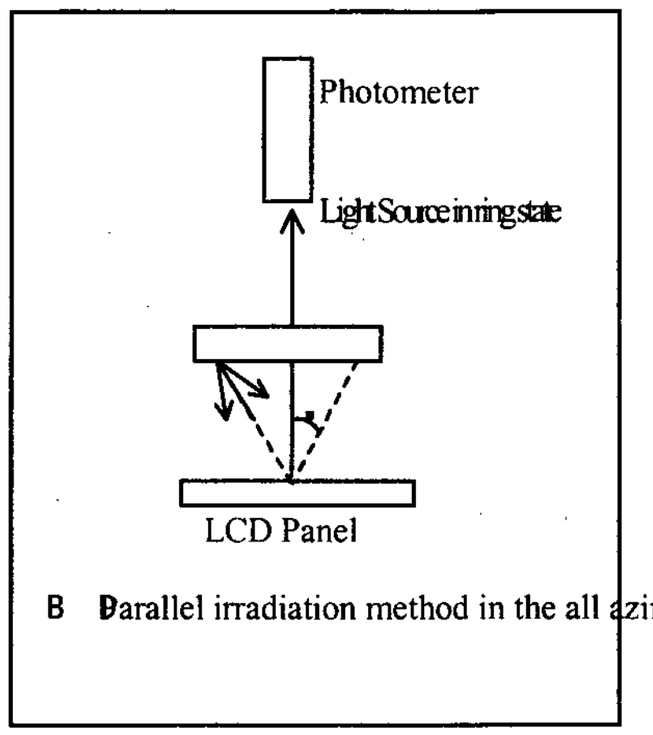
The maximum contrast value of CLIE was obtained at the irradiating angle of 27 .▪In the case of GENIO, it was 20 .▪At these angles where the maximum contrast values are obtained, it is known that comparatively stable measurements are available with little fluctuation of the reflectance

The method B is called "Parallel irradiation method in the all azimuth" to use a ring state light source.

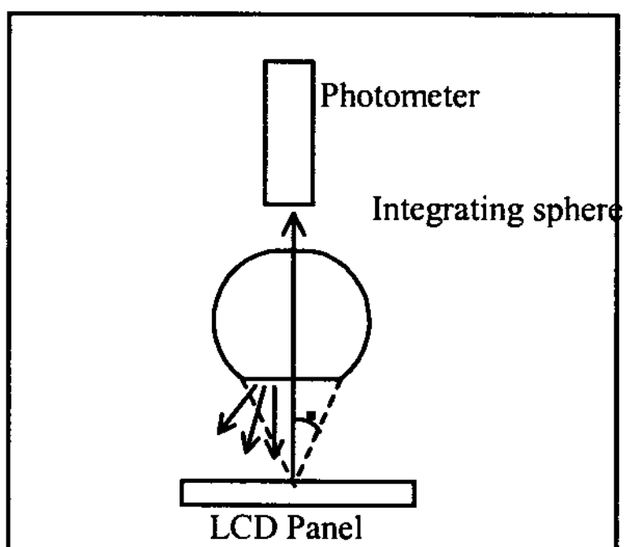
So to speak, the light source is with parallel light arranged in ring state. Reflection characteristics cannot be evaluated in the illuminating azimuth. But, when a sample is of high dependence on the illuminating azimuth, this method enables simple measurement of the reflectance without any careful attention required for the azimuth of setting of the sample. Fig. 3 shows the measured results.



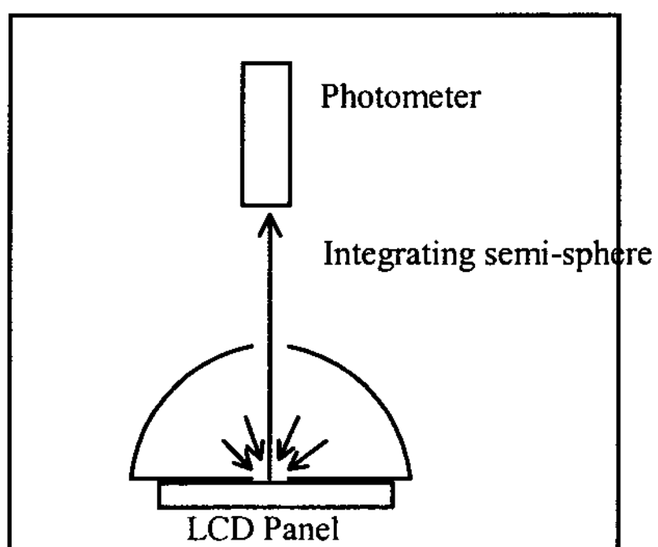
A Parallel irradiation method



B Parallel irradiation method in the all azimuth



C Diffusion irradiation method in a partial dire



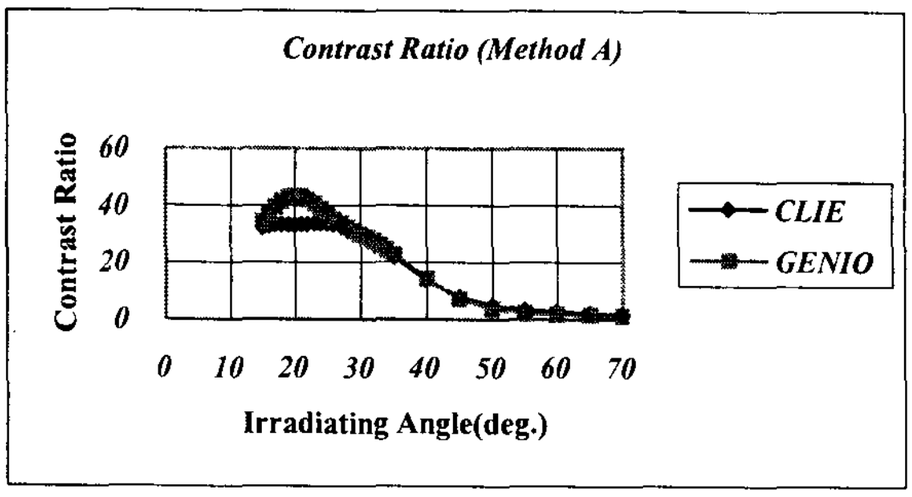
D Diffusion irradiation method in the all direction.

Figure 1. Irradiation optics for evaluation of reflective LCDs

The general profile proved close to that obtained according to the method A. Difference in measurement values arises from the illuminating azimuth dependence of the sample, dependence in black display in particular. As described above, the light source of the method B is considered to be that of the method A in ring state. Accordingly, the cumulative averaged data of the irradiating angle dependence in the azimuth direction measured according to the method A became nearly same as the data measured according to the method B in the same tilt angle. Care has to be taken of the irradiating angle accuracy (distance and inclination between the sample surface and the light source), since dependence on the illuminating tilt angle is high, same as the case of the method A. The EIAJ-ED2523 Standard recommends the irradiating angle of 20 ."Same as the case of the method A, measurements at the irradiating angle to enable obtainment of the maximum contrast value bring about higher stability of measurements.

The method D is called "Diffusion irradiation method in the all direction" to take measurements with light of uniform quantity irradiated to the sample in multi directions. To create uniform diffusion illuminant, an integration sphere or integration semi-sphere is used. The reflectance is considered close to those measured under environments such as clouded sky and environment with wall face on the background not exposed to direct sunlight. Out of four methods, only this method enables evaluations of values measured under such environments. In the case of this method, the reflectance varies, since the irradiating angle range varies with the distance between the sample surface and the diffusion irradiation light emitting unit. As the distance is wider, the irradiation optics becomes close to that of the method C. Fig. 4 shows reflectance values measured with the variable distances.

The reflectance to be measured according to the method D is measured as an average value of reflectance of irradiated light at all angles.



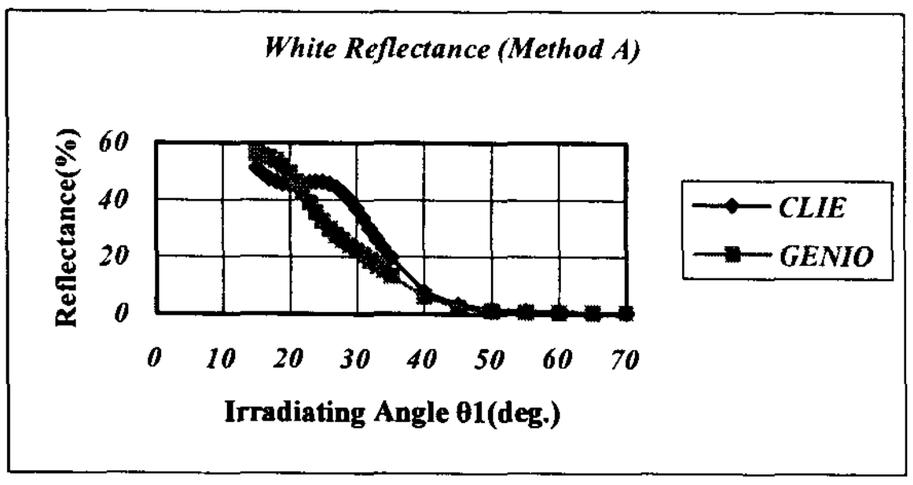
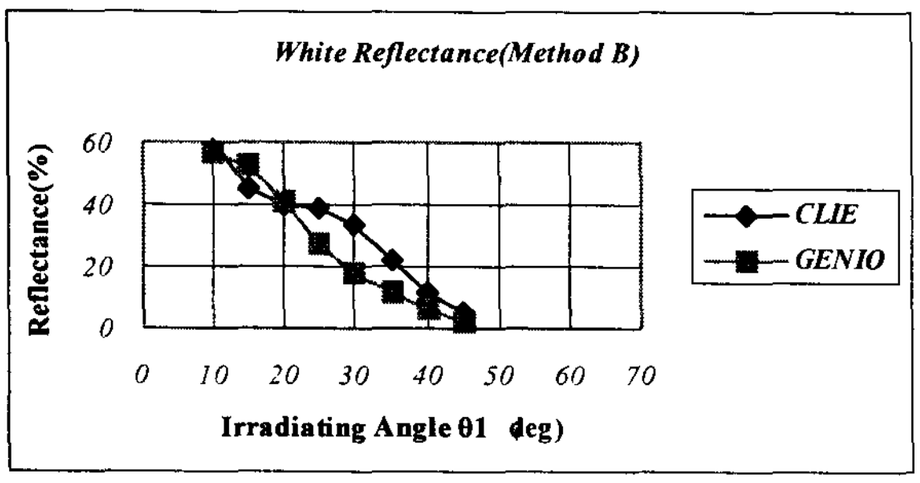


Figure 2. Measured results according to Method A



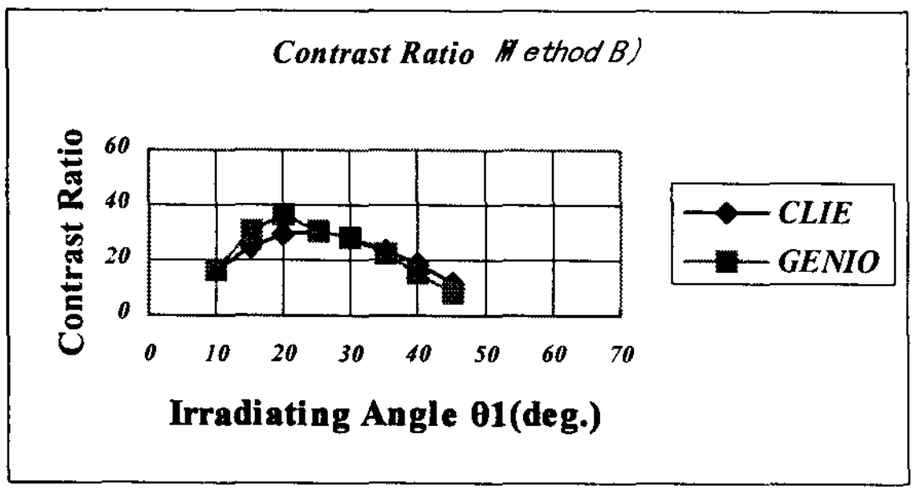
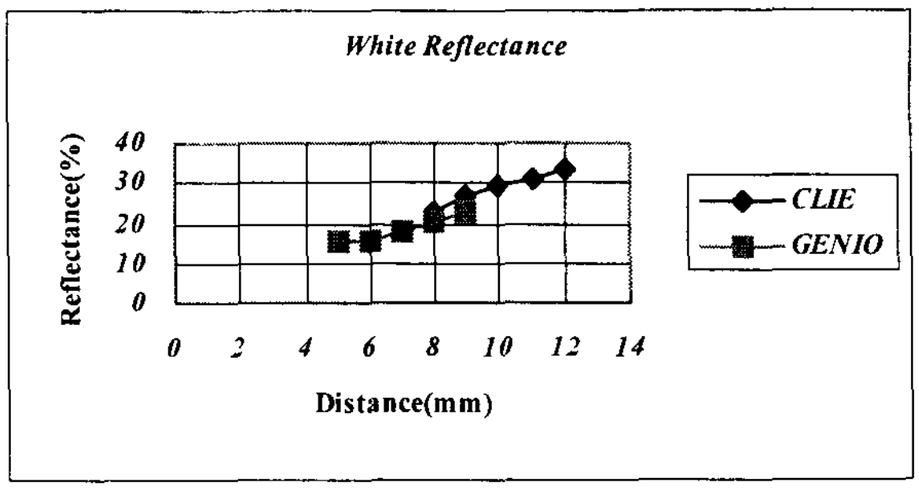


Figure 3. Measured results according to Method B



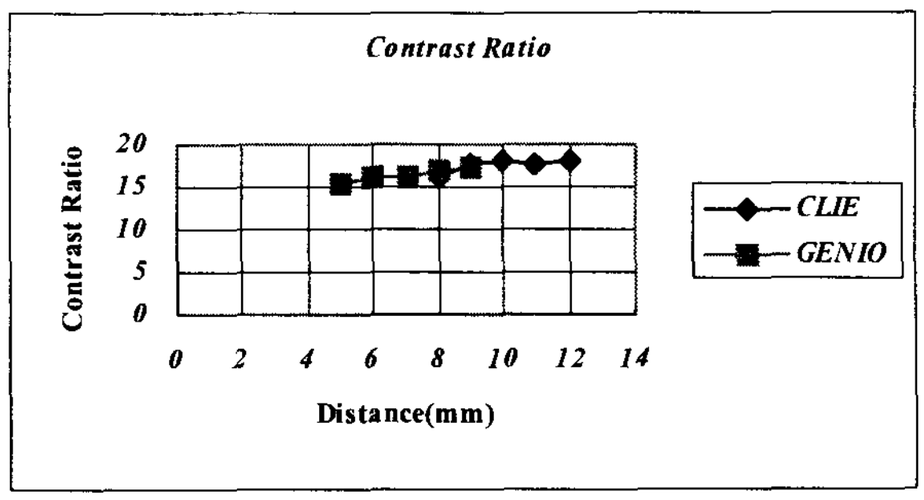


Figure 4. Measured results according to Method D

Accordingly, as is shown from the results of measurements according to the method A, the reflectance is affected by irradiation at a wide angle of low reflectance to be a value lower than those measured according to other methods. The wider the distance, the higher reflectance is obtained with decrease of irradiating light in the wide angle where reflectance is low. In measurements of this time, irradiation was made at distances of 5mm or 8mm considering its sample shape.

3. Conclusion

Parallel irradiation method (method A) enables detail evaluations of irradiating angle dependence and viewing angle characteristics of the sample. The EIAJ-ED2523 Standard specifies the standard irradiation at 30 . But, actual measurement of LCD panels revealed that 30 is not the irradiation angle to provide the maximum contrast ratio to be practically used and the reflectance at this angle is low. Table 1 shows the comparison of values measured at 30 irradiation and the maximum contrast angle. In actual measurement, it is advisable to take measurements at an angle to provide the maximum contrast ratio. As a result of measurement at such an angle, fluctuation of measurement values due to angle error can be minimized. Parallel irradiation method in the all azimuth (method B) enables simple measurements of the reflectance without any careful attention required for the azimuth of setting of the sample. In measurements

of this time, values nearly same as data with values measured according to method A. averaged in the azimuth direction were obtained. The method B assumes the standard irradiating angle of 20 .▪As to the method B, too, it is advisable to take measurements at an angle to provide the maximum contrast ratio, same as the case of the method A. Fluctuation of measurement values due to angle error can be minimized through measurements at such an angle.

Diffusion irradiation method in the all direction (method D) brings about reflectance lower than those measured according to other methods, since values measured are averaged including data of irradiation at wide angle of low reflectance (Table 1).

This point has to be taken into considerations since the reflectance measured according to this method is considered close to those measured under environments such as clouded sky and environment with wall face located on the background not exposed to direct sunlight. Further, in measurements of this time, the value is assumed to be nearly same values measured according to method C due to the distance between sample surface and irradiating unit.

CLE	Method A		Method B	Method D
	Irrad. 27	Irrad. 30	Irrad. 20	Dist 8mm
White Reflectance	47%	37%	40%	23%
Contrast Ratio	34	30	29	16

GEND	Method A		Method B	Method D
	Irrad. 20	Irrad. 30	Irrad. 20	Dist 8mm
White Reflectance	50%	23%	41%	15%
Contrast Ratio	43	30	36	15

Table 1. Comparison of values measured according to three methods

4. REFERENCES

[1]S.Kubota, "Lightness and Contrast Requirements for Legibility of Reflective Luquid Crystal Displays" ITE,Vol.50,No.8,pp.1091-1095(1996)

[2]S.Kubota, "Lightness and Contrast of Reflective LCDs in Real Environments" ITE,Vol.54,No.5,pp.733-736(2000)

[3]EIAJ ED-2523, ﾀMeasuring methods for matrix reflective LCD modules ﾁ,JEITA(2001)

[4]T. Ishinabe, T. Kishimoto, T. Miyashita and T. Uchida, " Measurement System and evaluation method of reflective LCDs" (IDW '00), pp.49-52 (2000).