

# Frequently Asked Questions (FAQ's)

Dear Friends,

This is Prof. Chao Li. I am the president of Central China Display Laboratories, Ltd. (CCDL). I am the only State-ranked Expert in China's LED Display Industry. As R&D of CCDL's 3D LED displays has made great progress, we have received a lot of questions. Now I am drafting the following replies for your reference.

Sincerely,

Chao Li

## Question

**So far how many kinds of stereoscopic displays had been developed?**

## Answer

Since more than 100 years, scientists researched and developed different kinds of stereoscopic displays or models. Those are but not limited as double-image 3D displays, holographic, true 3D, volumetric 3D displays etc. All holographic, true 3D, volumetric 3D displays etc. are of naked-eye (glasses free) displays. For double-image 3D displays, there are double-color mode, shutter mode, polarizing mode and naked-eye mode etc. Of double-image naked-eye displays, there are also different kinds. Of above so many different 3D or stereoscopic displays, so far only polarizing 3D displays had been widely applied practically.

## Question

**So far why only polarizing 3D displays have been widely applied?**

## Answer

**Double-color mode 3D display** will be normally using Red/Cyane colors correctly. Then the Red color for left eye and Cyane color for right eye. As either eye cannot see full colors, it is called information-shortened 3D display. Its advantage is that it uses normally a 2D display to play 3D pictures. So its cost is very low. Looking at its advantage and disadvantage, it cannot be widely used.

Shutter mode display looks that it could be much better than a polarizing display as it won't lose any color. But at any time that just one eye can see a picture, it will produce a lot of problems. This is described later. Its advantage is similar to a double-color 3D display. It is practically using a 2D display and added a frequency-doubler.

The function of this frequency-doubler is to let both left and right pictures be played sequentially. So the cost of the screen is also rather low. However, different from a double-color 3D display, the cost and trouble of shutter glasses cannot be omitted. So even if some places could use a shutter mode 3D display, besides its so many problems, there is the added trouble of the shutter glasses that will make the system function become low. Practically, a normal 3D movie is shaped in 4D instead of 3D. The 4D are of Horizontal, Vertical, Depth and Time. This means the fourth dimension is just Time dimension. That is to say that the 3D pictures will be played one frame by one frame according to time progress. A shutter mode 3D display brings out a big distortion at the fourth dimension.

Polarizing mode 3D display is using two different direction polarizing systems onto the 3D display system. This mode of 3D display has most advanced functions and the 3D result is the best of all kinds of 3D displays. Its main disadvantage is its cost is much higher than any other 3D displays. From below the further descriptions we can see its most significant advantages.

The basic principle of a naked-eye mode 3D display is trying to emit the light of left picture to just the left eye, and emit the light of right picture to the right eye, by using the fact that the distance of two eyes is about 65 mm (by CCDL testing for 100 staff, the distance is just 62.4 mm). A pair of glasses of any above three modes is practically a separator or a filter. As there is no such a thing in a naked-eye 3D display, it is difficult to avoid each eye sees both pictures. This is why a naked-eye 3D display must be of very narrow viewing angle and low resolution. So a naked-eye 3D display can be as an advertising display only. It cannot realize the playing for either 3D TV or stereoscopic movie. To enlarge the viewing angle, multi-view mode has been used. Mainly 8-view, and also in the R&D history for naked-eye 3D displays, 28-view and even 60-view and at maximum 128-view 3D had been tested. Multi-view naked-eye 3D display solved the viewing angle problem, but it not only let the cost of both display and the 3D picture making become high and also let the 3D result become low.

#### Question

**How about the practical features of LED 3D display?**

#### Answer

Normally, LED displays should be applied at various kinds of public places. At the very beginning, a double-color mode was applied. That is a very simple system but also the 3D result is very poor. Then shutter mode had been developed. The result of a shutter mode is much better than a double-color mode. But shutter mode has also a lot of problems. Then polarizing mode was developed. Naked-eye LED 3D display is still under development. Of naked-eye mode LED 3D displays, both viewing angle and resolution are much poorer than a polarizing system. So it will be for advertising purpose only. Why has polarizing system been developed? That is because the 3D result and also the relevant function are much better than any other 3D displays. This is also why so far of so many kinds of stereoscopic displays, only polarizing system has been widely used, and its most popular application is in cinemas that is polarizing projectors.

#### Question

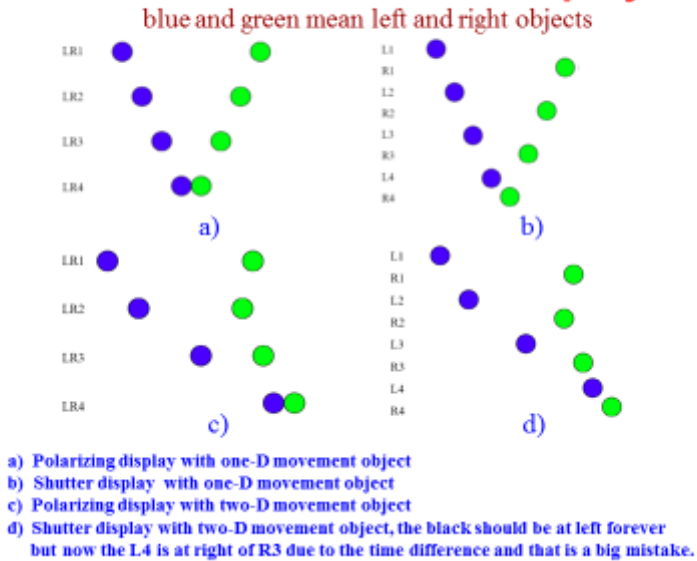
**What are the main problems of a shutter mode LED 3D display?**

#### Answer

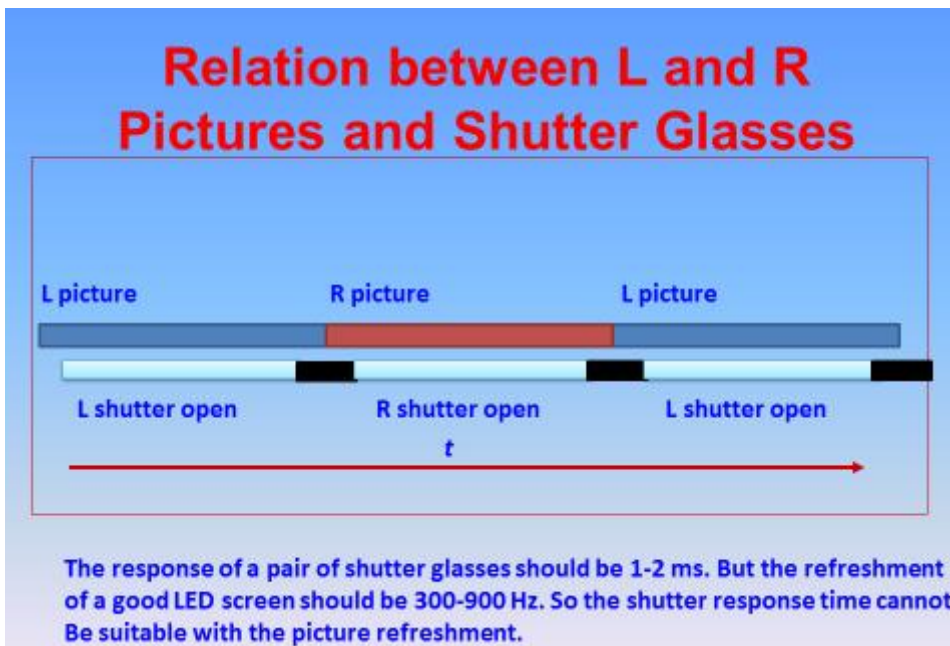
The following comparison chart shows the main problem of a shutter mode 3D LED display. From Fig. b, we can see at any time, just one eye can see the picture and the other eye can see nothing. The basic principle of a 3D picture is that human's central nervous system added two pictures received from both left and right eyes and shapes the 3D feeling at the third eye that is just our central nerve itself. As at any time a shutter mode one can see only one picture, so how to shape the third eye of 3D feeling? There must be memory in our brain and it should work very hard. What is the memory? That is the just epidemic cells of our brain. When one sees a 3D with shutter mode display, so many epidemic cells of our brain have to work hard to make temporary storage. But there is no such a job in polarizing mode system. This is why it must be feeling a strong fatigue when one seeing a shutter mode than a polarizing mode display as there is no such a hard work in our brain but a shutter mode must be. And also by Fig. d), the "3D resolution" of a shutter mode LED display has decreased. That is as L4 has been moved to

right of R3 and this distortion will never occur in a polarizing mode 3D display.

## Comparison between polarizing mode and shutter mode 3D displays



Besides, there are other problems for a shutter mode 3D display. Let us see the following Figure. The response time of a good pair of shutter glasses could be 1ms and a normal shutter could be 2ms. However in an LED system, the refreshment could be up to hundreds hertz. As the switch time is too long compared with the picture period, this is very obvious that part content could be lost and a shutter mode 3D display cannot compare with a polarizing mode 3D display.



### Question

**Can CCDL LED 3D Stereoscopic Movie System be put into cinema chain application?**

### Answer

We believe that is absolutely possible. We attended twice SMPTE Exhibition in Hollywood, once for SID Exhibition in San Jose and twice for ISE Exhibition in Amsterdam. All attendees and visitors highly appraised our system. Many people believe that this system replacing any present projector system is just a matter of time. As its function is very brilliant and specifications are much higher than any projector

system. A very obvious advantage is that it solved some problems of damage to human's health from the present projector systems. In scientific progress history, any progress that concerns human's health must be considered as very great progress. However, the system has to pass SMPTE standard first and DCI standard further. We cannot guarantee when it can be put into practical cinema chain applications. The expected time should be 3-4 years.

**Question**

**How about the comparison between a projector and an LED 3D display?**

**Answer**

A projector could be also polarizing mode. The comparison between a projector and an LED polarizing 3D display is shown as follows.

No.	Name	Digital Projector	3D LED Display
1	Rays and Light	Both	Only light, no rays
2	Brightness	Low	Very high, can be used outdoor conditionally
3	Contrast	Low	Very high
4	Defocusing	Very Bad	No Defocusing
5	Misconvergence	Very Bad	No Misconvergence
6	Reflection by screen and Glare by lens	Bad	No Reflection No Glare
7	Refresh frequency	Low and cannot be controlled	High, can be controlled
8	Life	Short	Can be up to 100,000 hours
9	2D/3D Compatibility	Not apply	Compatible
10	3D TV program	No	100% compatible
11	Not comfortable physiological stimulating	Bad	No such a problem
12	Color attenuation	Bad	Almost no change
13	Projection room	Occupies a big space. There must be an individual projecting room at the back of a cinema.	Can set up more seats and very importantly gather all playing machines for all movie halls of one movie city into one control room to make centralizing control.
14	Efficiency	Low	Much higher
15	3D Vertigo Syndrome	Yes	Almost No
16	Separation rate of left and right	95% or less	99% or higher

3D LED Display vs Digital Projector

There are many advantages in a 3D LED Display over than a digital projector system. Here the main ones are described.

**1. RAYS AND LIGHT**

Table shows that a digital projector shines light onto a screen with beams of light and that affects the audience at the rear of the theater a lot. Unlike a digital projector, an LED 3D display has no beams or rays of light to distract viewers.



Strong rays from a projector affects back audience

**2. BRIGHTNESS**

Digital projectors are not as bright as 3D LED displays. When using a digital projector it is helpful to close shade windows, close doors and dim lights. Because a 3D LED display is much brighter, it is not necessary to control indoor lighting in order to attain a superior image.

A 3D LED display can be effective even in many outdoor settings conditionally. From the technical approval of the LED system, and from research, the screen brightness is about 30 times, or even higher, of a digital projector system. And furthermore see the below “*Not Comfortable Physiological Stimulating*”.

### 3. CONTRAST

A digital projector has much a lower contrast ratio than a 3D LED display. There are several reasons for this including variable projection screens, projector technology limitations and lighting conditions. Simply speaking, a projector system is of low brightness with white background. But an LED system is of high brightness with dark background. By practical testing, the contrast is will be around dozens times of a digital projector at a certain condition.

### 4. DEFOCUSING

Defocusing is a very obvious weakness of digital projectors. Even at the finest adjustment of focus, the focus is always imperfect. The focus imperfections of digital projectors increase with screen size and projection distance. In a 3D LED system there is absolutely no such a problem.



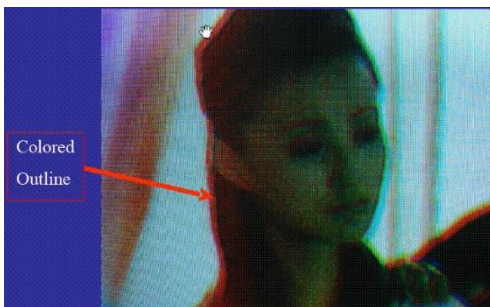
a) A projector system

b) An LED system

Practical viewing feeling for a projector system and an LED system

### 5. MISCONVERGENCE

Digital projectors have a problem with consistent convergence of RGB. Imperfect convergence is demonstrated in Fig 5.3. In a 3D LED system there is absolutely no such a problem.



Misconvergence effect

### 6. REFLECTION AND GLARE

A digital projector shines light onto a projection screen that can reflect light back into the eyes of the viewer. This reflection can be very distracting at different angles. The lens of projector will produce multiple reflections and that will bring glare. These do not happen with a 3D LED display.

## 7. REFRESHMENT RATE

Refreshment of a projector system should be 48, 50 Hz or 60 Hz and it is not adjustable. So sometimes it will flicker. In an LED system the refreshment can be preset as 300 Hz or even higher such as 900 Hz, and that can be set at any time conditionally if it is necessary. There is no flicker in an LED system.

## 8. LIFE

It is said that life of a good quality lamp of a digital projector can be at most 20,000 hours and the lamp is very expensive. Sometimes of a normal projector system the lamp could have to replace in just one month, at low rank cinemas. Life of an LED system can be up to 100,000 hours.

## 9. 2D/3D COMPATIBILITY

An LED system can play either 2D or 3D movies without any change for the systems.

## 10. 3D TV BROADCASTING

The LED 3D cinema can play without any loss. It is easy to switch to a local zone to play 3D TV to any audience. But a projector could not.

## 11. UNCOMFORTABLE PHYSIOLOGICAL STIMULATING

A person going to a movie theater experiences a "dark adaptation" when entering the theater and then a "bright adaptation" upon leaving. Medical research suggests that the latter of these adaptations may cause visual fatigue and possible long term damage. These adaptations can be eliminated by using 3D LED displays. This is very easy to understand. But on the other hand, for a digital system the screen brightness could be only  $48 \text{ cd/m}^2$  before polarizing and just  $20 \text{ cd/m}^2$  after polarizing. But by writer's experience, the brightness of that could be much lower. At least in China, the practical brightness in many, many cinemas is lower than  $20 \text{ cd/m}^2$ . For many dark scenes of a movie say, as an example many sceneries of movie, must be very low say, lower than  $1 \text{ cd/m}^2$ . When the peak brightness of the silver screen is lower than  $15 \text{ cd/m}^2$ , the low brightness of dark sceneries could be lower than  $0.5 \text{ cd/m}^2$  and that must be even lower after polarizing glasses to the eyes. As by the principle, when the brightness is as low as between  $0.01 \text{ cd/m}^2$  to  $1 \text{ cd/m}^2$ , the Pyramidal cells and Pillar cells of human's eyes will exchange very actively and that must be harmful for human's eyes.

## 12. DECOLORATION

An LED system is from digital to digital and it is a full digital procedure. The chromaticity of an LED won't vary during its life time. But during a projection system there is optical transmission procedure and color filters inside. Besides, the three primaries of color filters could bring different color attenuation under high temperature after a long time heating by the Xenon Lamp.



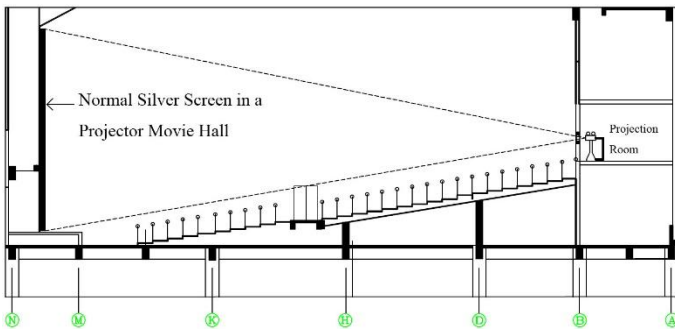
Original Picture



Color attenuated picture in a projector system

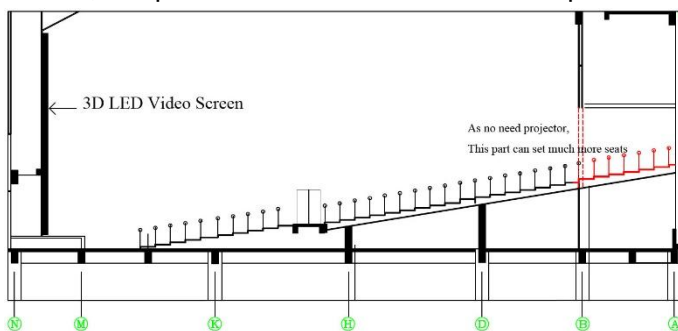
For all of the above, a digital projection system has critical weaknesses compared to 3D LED displays. Brightness and contrast are much higher in 3D LED displays. The superior clarity of a 3D LED display is demonstrated in the Fig. The quality of 3D LED technology has surpassed digital projection. By the testing results, people's practical significant feeling of a 2k projector movie will be no better than the same movie to be played with a 1k LED system.

### 13. CINEMA PROJECTION ROOM STRUCTURE



There is a special and individual projection room for each movie hall

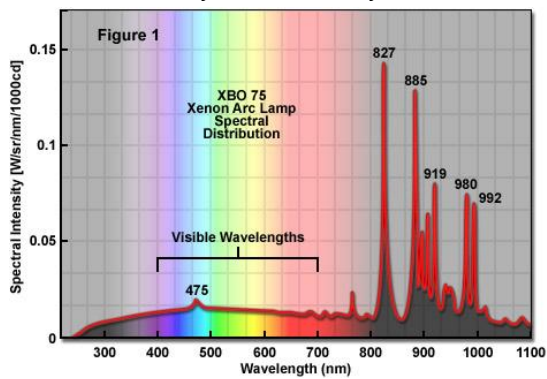
In a movie theater or a movie city, there could be many movie halls. For example, there could be up to 50 movie halls in one Movie City. For every hall there should be at least one projection room and that must be special and individual. For an LED system, the status should be quite different. There is no need special and individual projection room for each movie hall. So the rear part for the projection can be moved to set up much more seats. And for all the movie halls in one movie city all the display players such as movie servers or computers can be gathered into one room to make centralizing control. To supervise the movie, it is very easy to arrange a normal video camera to do that. Such a way will be suitable for modern management. And that is more useful in a society, such as in America, of that computer technology is very advanced and the labor cost is expensive. In a movie city or a movie theater, it is possible that one mainframe computer controls all movie halls.



Much more seats can be set and playing equipment for all movie halls can be in one room to make centralizing control.

**14. Efficiency** An LED screen is of high efficiency display. The following descriptions can make things clearly.

The consumption of a LED system is about 3 times as high as a comparable projector system. But its brightness is about 15 times greater. This is because as known to all, the Xenon Lamp is a very, very low efficiency lighting device - a lot of the Xenon Lamp energy is outside the visible wavelength. Therefore, much of the power that is used for Xenon Lamp display just ends up as heat – not light. On the other hand, an LED is a highly efficient device. Its whole energy is within the visible wavelength. And add with factors, the efficiency of an LED system is about 4-5 times as high as a projector system.



Spectrum of a modern xenon lamp. A big part is outside of the visible wavelength and this is one of the main disadvantages on Xenon Lamp technology.

Certainly by the policy of Energy Star Program, any movie player should be analyzed with its energy efficiency. In lighting systems, just a couple percentage points higher of energy efficiency should be very visible. How about 4-5 times high? Certainly it should be of selective preference. And how about the real consumption that is about 3 times high? The low consumption of a projector system is to take the harm to human's eyes as cost, and such a harm has been removed in an LED system. And by calculation, the cost of consumption of a 220 sq. meter LED screen for every two hours is about one ticket only. Certainly that is very valuable, as it concerns human's health.

### 15. 3D Vertigo Syndrome

The 3D Vertigo Syndrome is much lower than a projector system.

### 16. Separation rate of left and right

The separation of both left and right pictures in an LED system can be up to 99% and even higher. The system separation of a projector system is named by 95% but practically 92-93% only. That is a very big difference. The very lower separation makes the so said "Ghost" in a projector is obvious.

#### Question

#### How about CCDL Polarizing LED 3D display?

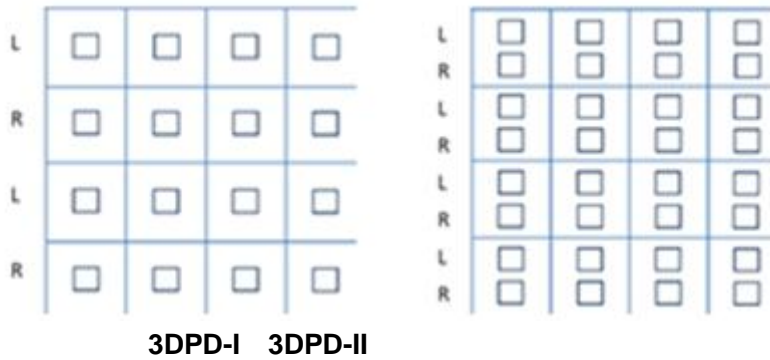
#### Answer

Generally speaking, CCDL Polarizing LED 3D Displays has so many advantages. That is as it has been under a very hard and longtime R&D. As its very brilliant functions, it must be developed and put into different applications very widely.

CCDL polarizing LED 3D displays has two main series. That is 3DPD-I and 3DPD-II.

From the following comparison chart, we can see the main difference between the two series.





3DPD-I is professional rank. Its vertical resolution has been cut by half. Its main advantage is that it can be easily changed between 2D and 3D modes. It can accept inputs of Side-by-Side (SbS), Top-and-Bottom (TaB). It will be widely used in education display systems and so on. For those systems the Double-Channel High Definition (DCHD) will be rarely used. But if a DCHD input must be used, one converter equipment should be added. 3DPD-I series has a very significant advantage. The change between 2D and 3D should be just 2-3 seconds as it needs just clicks.

3DPD-II series is movie rank. Of that each line has been divided into two sub-lines. Of that one sub-line is for left picture and one sub-line is for right picture. This is why it is called Double-Channel High Definition. Despite it is of SD, HD or UHD applications, there will be no any loss for resolution. Compared with 3DPD-I series, the cost of 3DPD-II series is higher. And when switch between 2D and 3D pictures, it needs re-setting so it needs 1-2 minutes. It accepts directly for all three 3D input formats those are SbS, TaB and DCHD.

The following table showed two examples:

How about the function comparison and the difference between DPD-I and what DPD-II? The following is for samples. .

	2D viewing distance	3D viewing distance	2D/3D switch	Input
P4 3DPD-I	4 m	8 m	In 2 seconds, just clicks	SbS/TaB. If DCHD is necessary, it needs separate equipment
P6 3DPD-II	6 m	6 m	Needs re-set, needs 2-5 minutes	SbS/TaB/DCHD

SbS: Side-by-Side, TaB: Top-and-Bottom, DCHD: Double-Channel High Definition

The specification of the samples in the exhibition in Guangzhou Exhibition Center from 24-27 Feb. Booth number:11.2 A07.

1. Type: 3DPD-I, P4, Size: 6.4 x 3.84 = 24.576 m<sup>2</sup>, Pixels: 1600 x 960 = 1,536,000, Brightness: not less than 600 cd/m<sup>2</sup>, Input: 2D, 3D (SbS, TaB).
2. Type: 3DPD-II, P6, Size: 5.76 x 3.456 = 19.90656 m<sup>2</sup>, Pixels: 960 x 576 = 552,960, Brightness: not less than 600 cd/m<sup>2</sup>, Input: 2D, 3D (SbS, TaB, DCHD).

Simply speaking, of the same size, 3DPD-I is cheaper. For education applications, the DCHD could be rarely used. For opera house, the DCHD could be used. When a singer or a dancer is playing, double

cameras could be used.

#### Question

**Can a Polarizing LED 3D display to be made high density?**

#### Answer

Yes. We can make the screen higher density. However, as we calculate the price by pixel numbers, so if one is applying much smaller pitch, the cost will become very high. The cost of a polarizing 3D screen is higher than a normal 2D screen. On the other hand, a projector of small size could be much cheaper. But an LED screen could be quite different. When the screen is made in a small pitch at the same resolution, the whole cost could become higher. And also, as the practical feeling of screen resolution of CCDL 3D polarizing screen is higher than the feeling of a same pitch normal 2D screen, at most cases no need to make so small pitch screens.

#### Question

**How should we make decision for 3DPD-I and 3DPD-II Series of polarizing LED 3D screens?**

#### Answer

The above has described clearly the main features of the two series of screens. When you make choice between the two series, firstly think about the application purpose. If you must use DCHD; if in your applications you could need fast switch between 2D and 3D; if your budget is enough and so on. Generally speaking, we recommend the application for cinemas and opera house and other high rank applications to select 3DPD-II. We will recommend the applications for 3D education and other professional rank applications to select 3DPD-I series. In fact in a 3D education classroom, there are many cases it should play 2D video lessons.

#### Question

**How about the warranty of CCDL 3D screens?**

#### Answer

Normally the guarantee is one year. As at present stage the screen reliability is much higher than the past time. At the beginning the possible problems that our clients could meet is always software 3D settings or so. So our software engineers are always checking for our clients around in Europe, Asia and Americas. Once any tile of the screen failed, the buyer can change it and reinstall a spare one as easy as a normal 2D screen. And then send back the failed one, when we fix it we will send it back. For very important events, the guarantee from CCDL engineer at site is possible upon conditions and agreement.

#### Question

**Can CCDL polarizing 3D systems use other companies' control cards?**

#### Answer

The R&D of CCDL 3D systems has got support from LINSN. CCDL 3D systems can use control cards made by LINSN only.

#### Question

**If we hope to become a distributor of CCDL, how ab out our earning?**

#### Answer

We always suggest our distributor to mark up for 30-40%. That could be different among different areas. But there should be no terrible competitor as it is patented technology.

### Question

**Why the cost of a polarizing 3D screen is much higher than a normal 2D screen?**

### Answer

Generally speaking, one cannot compare a 2D screen with a 3D screen as the functions are quite different. 2D screen is much cheaper as China's 2D LED screen production has been up to 80% of the whole world and very terrible and non-reasonable competition started. There are more than 3000 companies in China are producing 2D screens. For 3D LED displays all over the world only CCDL is producing. And during the past 25 years, CCDL paid everything for R&D. When Prof. Chao Li published the news for success for our system in 2012, the facts let him understood that in China there were other no less than 15 universities were developing it but none of them could be successful. Frankly speaking, the whole R&D work is very, very hard.

### Question

**Why CCDL developed all three categories of 3D LED displays?**

### Answer

Shutter mode 3D LED screen could be much cheaper as it is really a 2D screen added a scanning frequency doubler. And also all functions of a shutter mode 3D LED is very poorer than polarizing. For that there is detailed explanation in my PPT. And also that is why when 1997 we set up the world's first shutter mode LED 3D screen, and when I went to LA, it was accepted by neither Disneyland nor Hollywood. Since 1997, Prof. Chao Li led his team to start the R&D for both naked-eye and polarizing LED 3D systems.

### Question

**Is it worth that we buy a 3D LED display for demo?**

### Answer

If you are in a very advanced country, that must be very worth to buy a sample screen. If the economy in your country is not so good, you can buy it when you really got a project.

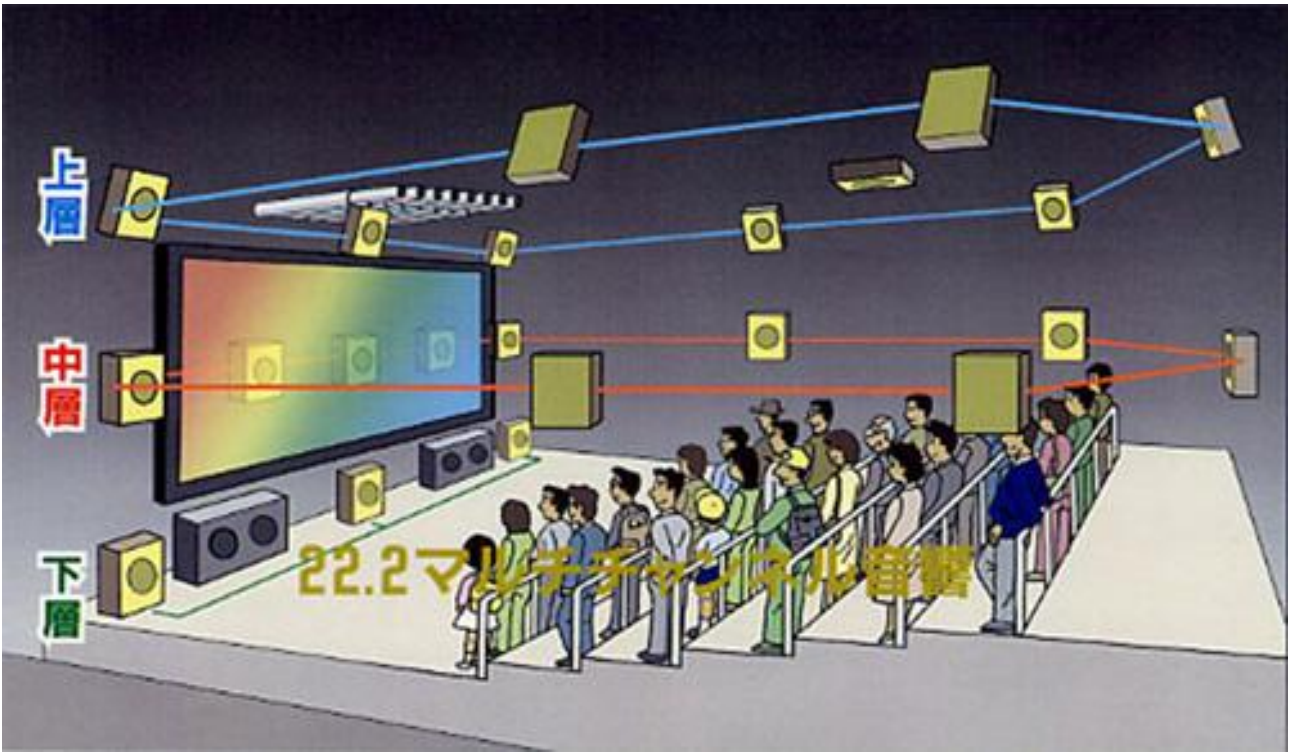
### Question

**Is there any disadvantage of LED 3D screen compared with a projector system?**

### Answer

So far, some experts talked about its possible disadvantages, one saying is that the brightness of an LED screen is too high. When some young couples watching a movie they could hugged together. Under a high brightness condition, they won't continue. For this our opinion is that we have to compare with human's health and other factors. If human's health is most important, we should forget about if the young people can hug or not.

And some said that the speakers could be a problem as it cannot be put at the rear of the screen. For this it could be a real disadvantage. However, our opinion is also that we have to compare the only disadvantage item with all its 16 advantage items. And we have to indicate that of all 5.1, 7.1, 9.1 and 11.1 audio systems, there is no restrict limitation that we must install the speakers at the back of the screen. The only restrict that some speakers should be installed at the back of the screen is 22.2 audio system that is submitted by NHK of Japan as shown in the following Fig.



Schematic diagram of 22.2 audio system

For this, our opinion is that the resolution of the projector is just half of an LED screen. And for the speaker problem we can divide the relevant speakers into two parts. Of that we can put one part up the screen and one part lower the screen. This arrangement makes the result of speakers' effects become very low.

Sincerely,

Chao Li [President of Central China Display Laboratories, Ltd.](#)

China National Expert with Outstanding Achievements

Distinguished Professor of Wuhan University of Science and Technology

Member of:

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3D Imaging Technology Professional Committee of China Society of Image & Graphics (Senior Advisor)

Society of Motion Picture and Television Engineers (SMPTE)

Institute of Electrical and Electronics Engineers (IEEE)

Society for Information Display (SID)

3D Technology Professional Committee of China Institute of Electronics

Technical Group of China Optics & Optoelectronics Manufacturers Association LED Division

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