Electronic Displays Explained

*Hitachi Europe Ltd.*
<table>
<thead>
<tr>
<th>LCD</th>
<th>CRT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contrast/colour change with angle</td>
<td>Consistent image irrespective of viewing angle</td>
</tr>
<tr>
<td>Poor black images</td>
<td>Good black (quality monitor, adjusted)</td>
</tr>
<tr>
<td>Motion-blur</td>
<td>Usually portray motion well</td>
</tr>
<tr>
<td>Peak brightness limited; photos look &quot;flat&quot;</td>
<td>Very high (small area) peak brightness possible; gives &quot;sparkle&quot; and &quot;life&quot; to movies/video/photos</td>
</tr>
<tr>
<td>Missing pixels</td>
<td>Not pixel-based, no problem</td>
</tr>
<tr>
<td>Fixed inherent resolution</td>
<td>Support multiple resolutions equally well</td>
</tr>
<tr>
<td>Maturing technology; cost falling</td>
<td>Mature technology; cheap</td>
</tr>
<tr>
<td>Native interface is digital (eg. DVI)</td>
<td>Naturally suited to analogue interface</td>
</tr>
</tbody>
</table>
LCD Structure (1)

Backlight

Polarising filters

Glass panels

Liquid crystal molecules

Display Excellence
LCD Structure (2)

- **TN (Twisted Nematic)**
  - Pixel electrode
  - Liquid Crystal
  - Common electrode
  - Polarizer
  - Back Light

- **IPS (In Plane Switching)**
  - Pixel electrode
  - Liquid Crystal
  - Common electrode
  - Polarizer
## LCD Advantages

<table>
<thead>
<tr>
<th>LCD</th>
<th>CRT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compact</td>
<td>Bulky</td>
</tr>
<tr>
<td>Lightweight</td>
<td>Heavy</td>
</tr>
<tr>
<td>Low power</td>
<td>High power (c.150W)</td>
</tr>
<tr>
<td>Perfectly sharp</td>
<td>Limited sharpness; tend to blur more at high brightness, and with age</td>
</tr>
<tr>
<td>Perfect image geometry</td>
<td>Tend to suffer from geometric distortions, which may be picture (brightness) dependent, and worsen with age</td>
</tr>
<tr>
<td>Consistent tonal scale</td>
<td>Strong bright areas can cause other regions of the picture to dim</td>
</tr>
<tr>
<td>Excellent text contrast</td>
<td>Poor text contrast (bandwidth limited)</td>
</tr>
<tr>
<td>No flicker</td>
<td>Inherently flicker (although peoples sensitivity varies)</td>
</tr>
</tbody>
</table>
Colour Reproduction

Better Display Quality

Transmittance vs Color saturation

- Notebooks PC
- Monitors
- TVs
- Mobile Phones
- Automotive

Display Excellence
The Normal TFT LCD Reality
IPS TECHNOLOGY ADVANTAGE (1)

- Upper 30deg.
- Front
- Lower 30deg.

Normal TFT vs IPS: Display Excellence
Half Contrast Angle

Definition: Viewing angle ranges into half of Contrast Ratio (CR) (°)
Measuring Condition: Right and left (H), Upper and lower (V)
(127G/64G:Gray Scale)

![Graphs showing contrast ratio versus viewing angle for IPS and Normal TFT displays.]

IPS

Normal TFT

Display Excellence
Brightness is set at 500cd/㎡
LCD Black Level - Vertical

Brightness is set at 500 cd/㎡

Viewing angle (deg)

Black Level (cd/m²)

-50 -40 -30 -20 -10 0 10 20 30 40 50

0.0 0.5 1.0 1.5 2.0 2.5 3.0

Normal TFT

IPS

Display Excellence
IPS Display Improvements


Next Generation
Target

Further superiority

Transmittance (a.u.)

100 ➔ 130 ➔ 155 ➔ 180

Contrast

350 ➔ 630 ➔ 900 ➔ 1400

New LCD material / New driving method
Improved moving picture (10→8ms)

New Optical design / New alignment

Display Excellence
LCD Performance

- IPS
- Normal TFT

Transmittance (Brightness or Low Power)

Color Saturation

Motion Picture (IPS-Pro+ Super Impulse)

Response Time (All gray scale)

All Direction Black Level

Front Direction Black Level

Color shift & Color Tracking

Half Contrast Ratio

Display Excellence

Best point is 10
The switch from CRT to LCD

Display Excellence