Display technology for automotive application

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- Displays in a car.
- Special requirements for automotive
- Different display technologies for automotive.
  - Passive LCDs
  - TFT LCDs
  - LTPS and SOP
  - Reconfigurable cluster
  - Shaped display
  - Dual view display
Displays in a car- key applications

- Head-up display
- Mid console display
- Driver Information Systems
- Rear Seat Entertainment
Display in a car - Instrument cluster

- Driver information system in instrument cluster
  - Driver information, GPS, camera
  - Passive, TFT, OLED
  - Transmissive, transflective, mostly use negative display mode.
  - Shaped display, display with hole.
Display in a car – mid console

- Center information display in mid console
  - Audio/Video, climate control, telecom, GPS, camera
  - Passive, TFT, OLED
  - Transmissive, transflective,
  - Dual view.
- Cluster in the center.
Display in a car – Rear seat entertainment

- Video entertainment display for rear seat.
  - DVD player
  - TFT.

Volvo XC90 RSE Display

GM (GMT201) RSE Display
2012 requirements and mind set

Apix system-Automotive Pixel Link
APIX – Automotive Pixel Link

**Market Requirements / Feature Set:**

- Link Distance: 2-pair STP cable / 15 m max.
- Automotive EMI / Cost-efficient / Small Package
- Direct Interfacing to Displays & Cameras
- 1 Gbit/s video bandwidth
- 18 Mbit bi-directional sideband
- Temp. Range: -40...+105°C (125°C)
- AEC-Q100
Special requirements for automotive
- Lifetime and durability

- Life time:
  - 15000 ~ 20000 hrs operation.
  - 10 years or 100,000 hrs environmental exposure.

- Humidity:
  - Just no water condensation allowed.
  - AHTO: 60°C/90%RH 504 Hrs, 65°C/93%RH 504 Hrs

- High reliability requirement:
  - CE 240 hrs -> Auto 504 hrs, even 1000 hrs.

- Life time of back light:
  - End of life definition: <50% of normal brightness, some customer even asked for < 80%.
Special requirements for automotive
- Summer and winter

- Temperature range:
  - Storage temperature:
    -40°C → 90°C, 95°C, 105°C
  - Functional temperature, readable:
    -40°C, -30 °C → 85°C ~ 95°C
  - Operational temperature, meet spec. (acceptable performance):
    -40°C, -30 °C → 70°C ~ 85°C

- Module is heated up by itself.
  - Backlight (major).
  - Electronics(minor).
  - Normally the temp of panel and optical foil will be 10~20°C higher than ambient temp.
  - Power derating needed at high temp(>~70°C).
Special requirements for automotive
- Day and night

- Daylight performance and sunlight readability:
  - High brightness, > 400 ~ 600 cd/m2 for TFT module.
  - Alternative solution: transflective (TF) display, brightness 350 cd/m2
  - Anti-glare and Anti-reflectance surface coating.
  - Sunglass visibility.

- High FoS performance required at night:
  - NB display mode is preferred.
  - Black background is really black at all viewing angles:
    high CR (>1000:1) and good view angle (VA and IPS needed).
  - Very sensitive for defects of display:
    Non-uniformity, cross-talk, cosmetic defects, etc.
  - Backlight dimming is required, dimming ratio, > 200:1
  - Light control film used to eliminate windshield reflection.


![tpo logo]
Special requirements for automotive
- Environment

- Vibration:
  Vibration and shock test needed, even at diff temp.

- EMC:
  EMC, ESD, and EMI.

- Display surface:
  Anti-Scratch, hardness >=3H.
  Chemical resistance.

- Anti-dust.

- Environment friendly:
  - RoHS.
  - Design for recycling.
Special requirements for automotive
- Quality

- Product rejection ratio < 100 PPM, target 0 PPM.
- TS16949 needed.
- ACE Q100/200 is more and more required for electronics components.
Special requirements for automotive
- Wow for interior

- Hidden display:
  - High CR and very wide viewing angle.
  - Adding smoke glass in front of the display with <50% transmission.
- Touch panel,
  - Glass to glass type -> glass to film type -> capacitor type.
- Curve display.
- Shaped display.
- Duel view
Display for auto-PLCD

- Passive LCDs are widely used for auto:
  - TN, FSTN, DSTN, ASTN, dye-STN, VA type.
  - Cheap solutions.
  - Market share decreasing comparing with TFT, but estimated still lasting for a long time.

<table>
<thead>
<tr>
<th>Twist angle of LC layer</th>
<th>90</th>
<th>120</th>
<th>180</th>
<th>240</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of display</td>
<td>TN</td>
<td>HTN</td>
<td>STN</td>
<td>STN</td>
</tr>
</tbody>
</table>

- TN, HTN, STN, and DSTN are types of display with different twist angles of LC layer.
- Glass, ITO, SiO2, and pola are materials used in the display structure.
Display for auto-TFT
Display for auto-LTPS

- **SOP** (system on panel): Single chip solution for 12.3” 1280X480.
- Higher aperture ratio.
- Higher reliability due to less output terminals.
- On panel light and temp sensor.
- Integration touch panel.
Display for auto-Reconfigurable cluster

- Reconfigurable cluster (one display cluster)
  - 12.3", 1280X480
  - High brightness, >1000 cd/m2
  - Fast response time, ~ 7ms.
  - Cross models platform.

Mercedes-Benz F 700

Jaguar XJ
Display for auto-Shaped display
Display for auto-Duel view display

- view 1: navigation info
- view 2: e.g. DVD video