Display technology for automotive application

Jun Chen
Sr. manager for display technology
TPO Display Corporation

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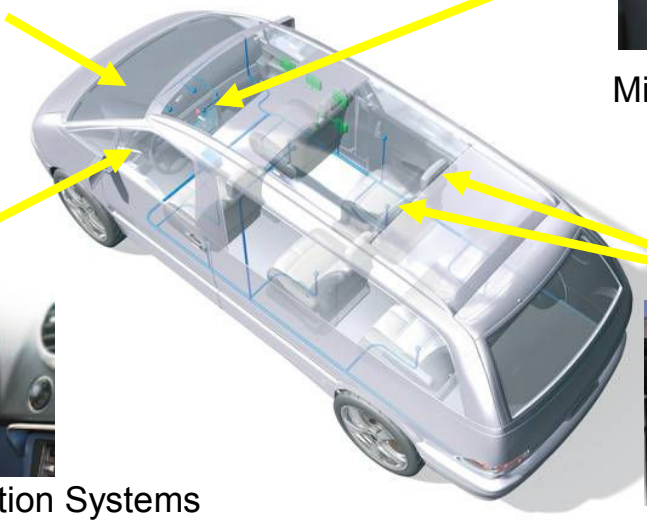
Content

- 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

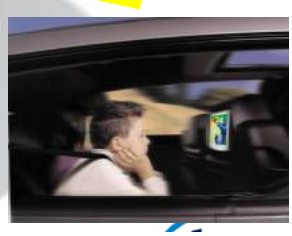
Displays in a car- key applications

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.

Audi A6 Cluster Display

Audi A8 Cluster Display

Display in a car – mid console

- Center information display in mid console
  - Audio/Video, climate control, telecom, GPS, camera
  - Passive, TFT, OLED
  - Transmissive, transflective,
  - Duel view.
- Cluster in the center.

VW Golf V Radio Display

Peugeot/Citroen/Fiat

Navigation display

Display in a car – Rear seat entertainment

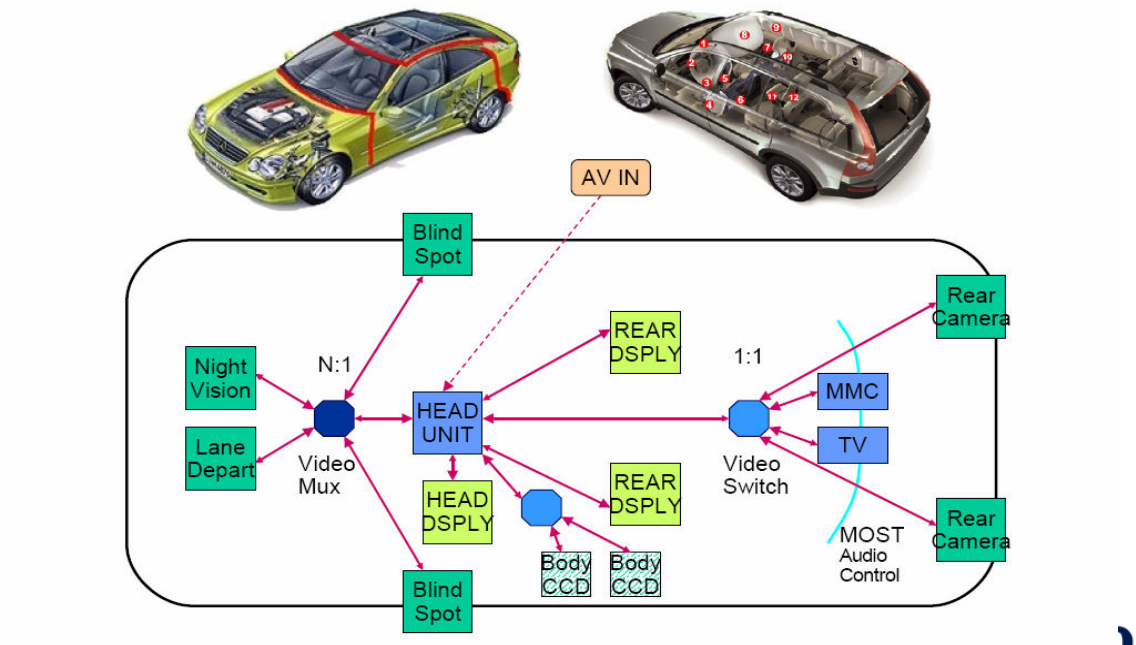
- Video entertainment display for rear seat.
  - DVD player
  - TFT.

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**

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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 :
    -40ºC → 90ºC, 95ºC, 105ºC
  - Functional temperature, readable:
    -40ºC, -30 ºC → 85ºC ~ 95ºC
  - Operational temperature, meet spec. (acceptable performance) :
    -40ºC, -30 ºC→ 70ºC ~ 85ºC

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

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.

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

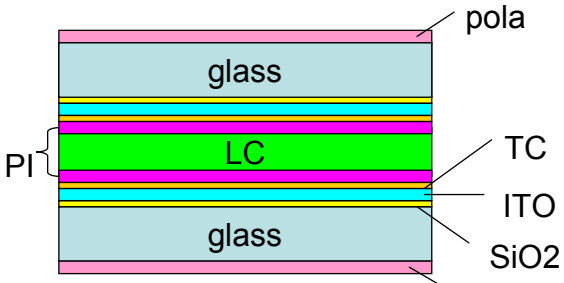
- Hidden display:
  - High CR and very wide viewing angle.
  - Adding smoke glass in front of the display with <50% transmission.
- Touch panel,

  Glass to glass type -> glass to film type -> capacitor type.
- Curve display.
- Shaped display.
- Duel view

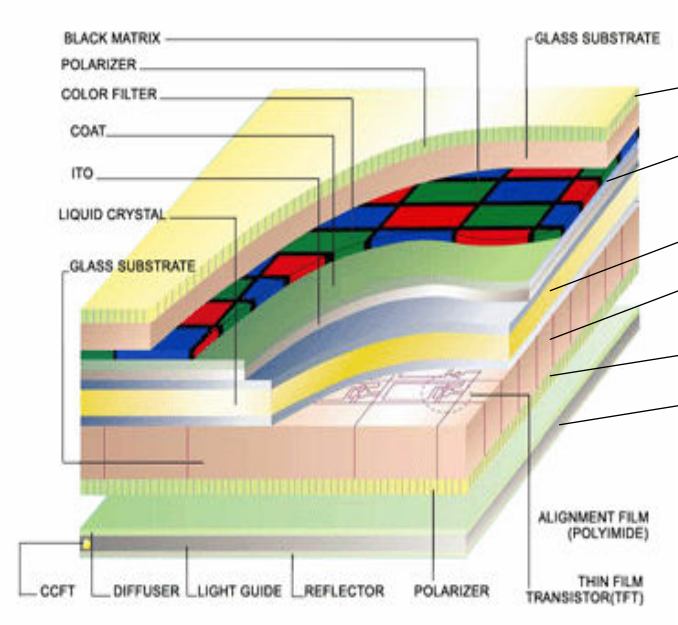
Display for auto-PLCD

- 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.

Twist angle of LC layer	90	120	180	240
Type of display	TN	HTN	STN	STN



Display for auto-TFT



Polarizer

CF (Color Filter)

LC

Array

Cell - Panel

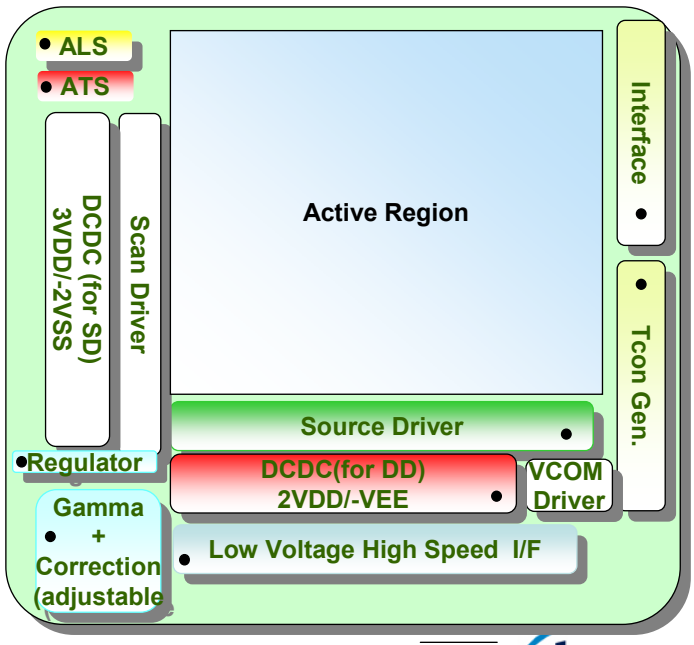
Polarizer

Back Light + PCB

Module

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.

Jaguar XJ

Mercedes-Benz F 700

Display for auto-Shaped display

LG.Philips

10.1“ Free Form (LTPS)

TMD

Free Form LCM-LTPS Epson

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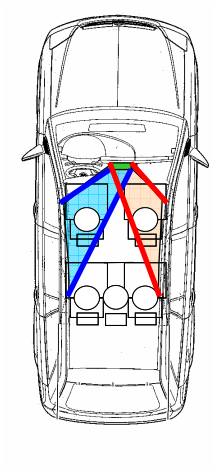
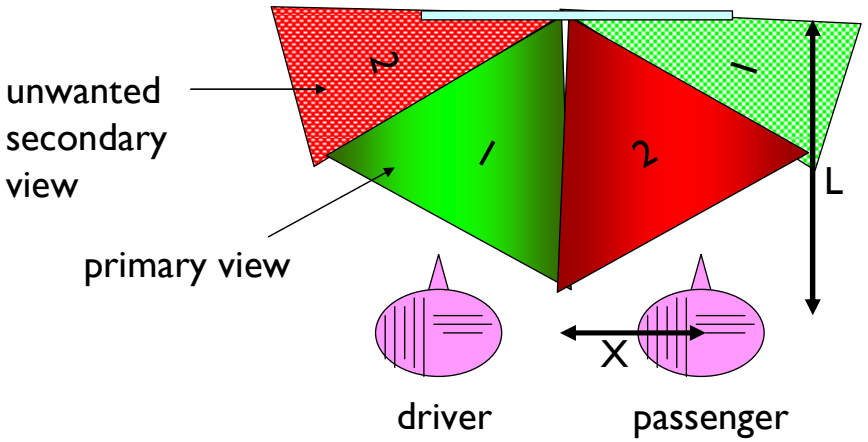
Display for auto-Duel view display





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