LED Display Based on TMS320F28xx

Chris Fan
Product Manager
VPIC
Agenda

- LED Display System
  - LED Display Applications
  - LED Display System Diagram
- Display Controller Diagram
- Typical LED Module Diagram
  - Disadvantages
- LED Display Alternative Solution
- Complete LED Module Solution
  - TMS320F2801 LED Module
  - LED Driver and Dot-Correction
  - LED Module Implementation
- Auto Dot-Correction System
- DSP Solution Advantages
- Q&A
LED Display Applications

- The LED display applications in sports, entertainment and advertising are growing up and moving to high definition video equipment.
Outdoor advertising LED display system will including display hardware and control software.
LED Module Diagram

- The LED Driver provide constant current output for LEDs
- The current on constant current output is controlled by external resistor
Disadvantages

- Required PC to be a media server in order to provide video source
- Required high bandwidth data transfer and video buffer from DVI to Row Controller
- Difficult implement FPGA process for image processing
- Difficult implement LED dot correction auto calibration function in FPGA
LED Display Alternative Solution

- DaVinci™ Based DSP solution for display controller
- TMS320F2801 Based DSP solution for LED module
Complete LED Module Solution

- Performance
  - 100-MIPs (F2801)
  - Single-cycle 32x32 MAC
  - Fast interrupt response
- Flexibility
  - On-chip 16KB Flash for
  - Embedded emulation
  - Enhanced Peripherals
- No assembly required
  - C Optimized
  - 100 pin LQFP / u*BGA
TMS320F2801 LED Module

- Internal flash memory store calibrated LED dot correction data
- High speed DSP processing to achieve 16-bit color space conversion
- With integrated ADC and PWM easy to implement DC-DC buck converter and increasing supply power efficiency
LED Driver and Dot-Correction

- LED Driver function and control timing
LED Module Implementation

- Example of R,G,B 8X8 (12bit/16bit) LED Module
- Input configuration and Input / Output buffer management

[Diagram showing Row Controller and SCI with data rates and buffer management]
LED Module Implementation

- Use SCI input FIFO hardware to improve DSP interrupt efficiency
LED Module Implementation

- LED driver output configuration for F2801 require 1 SPI port and 1 PWM port

---

**TLC5941 INPUT SHIFT REGISTER DATA LENGTH**

<table>
<thead>
<tr>
<th>Gray-scale PWM Mode</th>
<th>Dot Correction Data Input Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>192-bit (12-bit x 16)</td>
<td>96-bit (6-bit x 16)</td>
</tr>
</tbody>
</table>

---

**SERIAL DATA TRANSFER RATE CONSIDERATION:**

- \( f_{SCLK} \times \frac{1}{16} \times \text{propagation} \)
- \( f_{SCLK} \times \frac{1}{8} \times \text{propagation} \times \times \)

- \( f_{SCLK} \) is maximum frequency needed for usage
- \( f_{SCLK} \times \frac{1}{16} \) minimum frequency needed for AMC and AMC
- Propagation: update rate of whole system
- \( \times \) number of the TLC5941 device
LED Module Implementation

- Use SPI output FIFO hardware to improve DSP interrupt efficiency
DC-DC Power Supply for VLED

Multiple channel DC-DC buck converter/s

Vin1 → EPWM1A → Buck #1 → Vout1

Vin2 → EPWM2A → Buck #2 → Vout2

Vin3 → EPWM3A → Buck #3 → Vout3

Vin4 → EPWM4A → Buck #4 → Vout4

How Many Channels?

| 2801 | 3 | Indep. Freq (+ eCAP) |
| (5)  | 6 | Freq pairs (+ eCAP)  |
Maximize Power Supply Efficiency

- Increasing power efficiency for each supply voltage for R,G,B LED voltage
- Increasing power efficiency for temperature change
Auto Dot-Correction System

- Auto calibration system for LED dot-correction
DSP Solution Advantages

- Highly system integration
- Simplify system design
- Low system cost for LED display controller
- Flexible LED module design
- Easy mass production and quality control
- Feature high quality and high resolution LED display system (HD Video)
Thanks!