TI DLP® Products:
Enabling display innovations

July 2019
Agenda

Growth Factors

Display product portfolio

New Applications driving growth

Getting started
Agenda

Growth Factors

New Applications driving growth

Display product portfolio

Getting started
DLP technology display market growth factors

- Performance
  - Higher pixel density (left illustration)
  - Efficiency (10-25 lm/W; lm/cc)
DLP technology display market growth factors

- Performance
  - Higher pixel density
  - Efficiency

- Expansion into new product categories
  - Mini/mobile projector
  - New emerging applications
DLP technology display market growth factors

- Performance
  - Higher pixel density
  - Efficiency

- Expansion into new product categories
  - Mini/mobile projector
  - New emerging applications

- Technology Accessibility
  - Mature ecosystem
  - Easier to develop with TI.com
Fast time to market using ti.com/dlp

Evaluation

• DLP LightCrafter™ Display EVMs
  - WVGA to 4K
    > HDMI plug and play
    > PC software GUI
  - $99 DLP2000
  - 0.2 nHD
  - TI.com/DLP99
• Configuration using I²C
  - Brightness control
  - Image manipulation
  - More…
• E2E community

Development

Electronics

• Reference designs & tech docs
• System integrators

Optics

• MP¹ optical modules
• Custom design

¹MP : mass production
DLP technology display sub-system

- Application processor
- Display Controller (DLPCxxxx)
- PMIC (DLPxxxx)
- Flash
- Sub-LVDS
- DMD (DLPxxxx)
- Light Source
- System Power
-SPI
-I²C
-Video
-Data & video signals
-Power signals

Other components
DMD & LED cables

DLP components

Texas Instruments
DLP Products display portfolio

Resolution

nHD | WVGA | qHD | 720p / WXGA | 1080p | 4K

Brightness

>1500lm

In Production

.65 WXGA DLPC4422

.65 1080P DLPC4422

.66 4K DLPC4422x2

.47 1080P DLPC4422

.47 4K DLPC4422x2

.45 WXGA DLPC6401

.47 1080P DLPC3439x2

.47 4K DLPC6421x2

.3 720P DLPC3433/38

.33 1080P DLPC3437x2

.23 1080P DLPC3436

Available Now

.2 nHD DLPC2607

.2 WVGA DLPC3430/35

.23 qHD DLPC3432

.23 HD DLPC3434

.23 1080P DLPC3436

Texas Instruments
Agenda

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Getting started
**Smart Displays with DLP technology**

<table>
<thead>
<tr>
<th>Features</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free-form Images</td>
<td>Displays of any shape on virtually any surface</td>
</tr>
<tr>
<td>On-demand display</td>
<td>On when you want it, invisible when you don’t</td>
</tr>
<tr>
<td>Compelling Form Factors</td>
<td>High-resolution images from compact optical modules.</td>
</tr>
</tbody>
</table>

- Kitchen countertop, UST
- Night stand table top, free form projection map
- Kitchen, standard throw
- Tabletop, UST
Smart Displays with DLP technology

Compelling Form Factors

- 50cc engine - 20in to 40in image

High-resolution images from compact optical modules.

- Passive, “silent” fan-free
- 100lm thermal design example…
Natural Convection Flow Field and Temperatures
120 lumen LED thermal solution – no fan

LED, Aluminum Heat Sink, 120 Lumen, No Fan

TI Training & Videos -
“Creating a smart speaker projector with natural convection cooling”

<table>
<thead>
<tr>
<th></th>
<th>[°C]</th>
<th>5.99621</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient</td>
<td></td>
<td>40</td>
</tr>
<tr>
<td>Junction Temperature, Tj</td>
<td>77.6</td>
<td>88.5</td>
</tr>
<tr>
<td>Heat Sink Temperature, Tc</td>
<td>65.6</td>
<td>77.9</td>
</tr>
<tr>
<td>Criteria: Tj, max</td>
<td>120</td>
<td>150</td>
</tr>
<tr>
<td>Heat Sink Thermal Resistance</td>
<td>11.7</td>
<td>17.3</td>
</tr>
<tr>
<td>Max Air Velocity</td>
<td>0.278</td>
<td></td>
</tr>
<tr>
<td>DMD Temperature TP1</td>
<td>65.5</td>
<td></td>
</tr>
<tr>
<td>Active Array Temperature</td>
<td>69.9</td>
<td></td>
</tr>
<tr>
<td>Air Temperature at the Exhaust</td>
<td>75.5</td>
<td></td>
</tr>
<tr>
<td>Air Flow Rate at the Exhaust</td>
<td>0.00064</td>
<td></td>
</tr>
</tbody>
</table>

LED junction temperatures all below Tj max limits, Ambient temperature 40°C

DMD array temperature below 70 °C
# Pocket-able companion mobile projector

## What’s new with mobile projection:

### Higher Performance:
- New .23 platform expands resolution to 1080P:
  - .23qHD, .23 HD and .23 1080P

### Smaller sizes
- Illumination and optical engine efficiency advancements
- Less power, smaller heat sinks and thermal designs
- Battery enabled

### More cost effective
- New lower cost engine options with .2nHD

### Better Connectivity
- USB Type C (Power and video)
- WiFi, Airplay2, Casting

## Always with you:

**with family & friends**

**traveling**

**at work**
# Augmented Reality (AR) with DLP technology

<table>
<thead>
<tr>
<th>Features</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>High optical efficiency</td>
<td>Good fit for wearable displays that demand high brightness over a medium to large field of view.</td>
</tr>
<tr>
<td>Fast Pixel Switching</td>
<td>Support frame rates up to 240 Hz, depending on the input resolution, and enable low latency display systems. High switching speed reduces motion blur.</td>
</tr>
<tr>
<td>High Contrast</td>
<td>High contrast ratios enable a highly transparent display background even at high brightness levels.</td>
</tr>
<tr>
<td>DLP IntelliBright™</td>
<td>Save power with Content Adaptive Illumination Control (CAIC). Increase display vividness with Local Area Brightness Boost (LABB)</td>
</tr>
<tr>
<td>Small Size</td>
<td>Enables very compact optical engine designs that meet the space-constrained demands of wearable displays.</td>
</tr>
</tbody>
</table>
Augmented Reality (AR) Optical Design Trade-off

- **Field of View**
  - Angular extent of visible world
  - Over 120° human eye, horizontal

- **F/number**
  - Smaller F/number corresponds to “faster” optics- allows more light
  - Larger F/number reduces optics size and increases contrast

- **Pupil Size**
  - Pupil size range from 2 – 8 mm
  - 12 to 15 mm for minimal adjustment
  - 3-5X expansion by waveguide reduces entrance pupil size to 2-5mm

- **Panel Size**
  - 0.2” – 0.47 panel size
  - nHD – 1080P resolution
  - XPR enables higher pixel density

- **Note**:
  - Larger F/number reduces optics size and increases contrast.
Augmented Reality (AR) Optical Design Trade-off

The normal **pupil size** diameter in adults varies from 2-4 mm in bright light to 4-8 mm in the dark (Journal of vision, September 2012)

- Smaller F/number corresponds to “faster” optics- allows more light
- Larger F/number reduces optics size and increases contrast

- **Pupil size range from 2 – 8 mm**
- 12 to 15 mm for minimal adjustment
- 3-5X expansion by waveguide reduces entrance pupil size to 2- 5mm

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- nHD – 1080P resolution
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Augmented Reality (AR) Optical Design Trade-off

- Smaller F/number corresponds "faster" optics- allows more light
- Larger F/number reduces optic size and increases contrast

Pupil diameter = 2-8 mm

Inter-pupillary distance (IPD)
- Male: 52-78 mm
- Female: 52-76 mm
- 1988 army survey

An Eyebox of 15 mm diameter will not require adjustment for face sizes

- Pupil size range from 2 – 8 mm
- **12 to 15 mm for minimal adjustment**
- 3-5X expansion by waveguide reduces entrance pupil size to 2-5mm

An Eyebox of 15 mm diameter will not require adjustment for face sizes

- 0.2" – 0.47 par
- nHD – 1080P resolution
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Augmented Reality (AR) Optical Design Trade-off

- Pupil size range from 2 – 8 mm
- 12 to 15 mm for minimal adjustment
- 3-5X expansion by waveguide reduces entrance pupil size to 2-5mm

Wave guide : 3-5X pupil expansion

Entrance pupil
3mm to 5mm

Exit pupil
15mm

- 0.2” – 0.47 panel size
- nHD – 1080P resolution
- XPR enables higher pixel density
Augmented Reality (AR) DLP FOV & Contrast Ratio

**0.23 Platform**
- Dia FOV: 30° to 70°
- FOFO contrast: 2000:1@F/2.4 & 50° FOV
- 3500:1@ F/3.4 & 30° FOV

**0.3 Platform**
- Dia FOV: 30° to 90°
- FOFO contrast: 2000:1@F/2.4 & 65° FOV
- 6500:1@ F/5 & 30° FOV
Augmented Reality (AR) 0.2 DMD Inline Illumination

**4-in-1 LED Light Tunnel**

- **9mm x 6.5mm x 28mm**
  - 1.64cc
  - **Target Light output**: Under 5-6 lumens at Pupil entrance
  - **System operates at F/2.5**

- **11mm x 6mm x 26mm**
  - 1.72cc
  - **Target Light output**: 10+ lumens at Pupil entrance
  - **System operates at F/1.7**
High-brightness LED projector with DLP technology

<table>
<thead>
<tr>
<th>Features</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED Light Source</td>
<td>Beautiful color performance</td>
</tr>
<tr>
<td>High Resolution</td>
<td>1080p or 4K UHD resolution</td>
</tr>
<tr>
<td>High-brightness</td>
<td>&gt;1,500lm, Display images in well-lit ambient settings</td>
</tr>
<tr>
<td>Competitive contrast</td>
<td>Captivating viewing experience</td>
</tr>
<tr>
<td>Telecentric optics</td>
<td>Enables a compact optical architecture</td>
</tr>
</tbody>
</table>
Projection in Indoor Lighting: Programmable, Informative Displays on Any Surface in Any Environment

**In Warehouse/Factories**

- Long Lasting, Instant On / Off

- DLP Technology Benefit: Long throw optics
- Variable image sizes with similar form-factors

**For Safety Lighting**

- DLP Technology Benefit: Small Form-factor
- Mount anywhere

- DLP Technology Benefit: Programmable display
- Configure to display variety of information
Agenda

- Growth Factors
- Display product portfolio
- New Applications driving growth
- Getting started
Strong ecosystem
Large number of companies committed to DLP technology

- Evaluation modules
- Optical engines
- System integration
- Optical design
- Hardware
- Software
DLP Products business model and ecosystem

- **Optical Module Mfr & ODMs**
  - Controller & PMIC
  - DMD
  - Chip maker
  - Design support
  - Integration support
  - Variety of sizes, resolutions, and brightness levels

- **System integrators**
  - System integrators

- **Brands**
  - Business facilitator
Extensive resources at TI.com/DLP

Getting started

Getting to know DLP Pico technology
Learn the basics of the technology.

Beginning development
Start development with evaluation tools, optical modules, and technical resources.

Advanced Development
Leverage support resources for advanced and custom designs.

3rd Party Evaluation Modules
Keynote Photonics
FlexLight 4K-HLD EVM

Buy off-the-shelf optical engines

DLP3010 (3 720p) DMD

<table>
<thead>
<tr>
<th>#</th>
<th>Brightness (lm)</th>
<th>Size (mm)</th>
<th>Throw ratio</th>
<th>Offset</th>
<th>Company</th>
<th>Region</th>
<th>Purchase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&lt;300</td>
<td>81.5 x 57.0 x 14.7 without lens</td>
<td>1.2</td>
<td>100%</td>
<td>Anhua</td>
<td>China</td>
<td>Buy from supplier</td>
</tr>
<tr>
<td>2</td>
<td>&lt;300</td>
<td>59.0 x 66.0 x 13.2</td>
<td>1.47</td>
<td>100%</td>
<td>New</td>
<td>China</td>
<td>Buy from supplier</td>
</tr>
<tr>
<td>3</td>
<td>&lt;300</td>
<td>44.5 x 55.0 x 16.2</td>
<td>1.66</td>
<td>100%</td>
<td>Cheng</td>
<td>China</td>
<td>Buy from supplier</td>
</tr>
<tr>
<td>4</td>
<td>&lt;350</td>
<td>82.5 x 69 x 22</td>
<td>1.1</td>
<td>100%</td>
<td>Young Optics</td>
<td>Taiwan</td>
<td>Buy from supplier</td>
</tr>
<tr>
<td>5</td>
<td>&lt;150</td>
<td>88.81 x 67.65 x 21.24</td>
<td>1.42</td>
<td>100%</td>
<td>Digital Optics</td>
<td>Korea</td>
<td>Buy from supplier</td>
</tr>
<tr>
<td>6</td>
<td>&lt;320</td>
<td>111.06 x 77.49 x 37.01</td>
<td>1.39</td>
<td>100%</td>
<td>Digital Optics</td>
<td>Korea</td>
<td>Buy from supplier</td>
</tr>
</tbody>
</table>

Optical Module Search Tool

- Find your optical module quickly
- DLP Display, Light Control, Automotive
- >10 OMMs contributing

More...

- Reference Designs
- E2E community
- DLP design network
- Application notes
- White papers
DLP EVM & reference designs

Visit DLP Pico™ Tool Portal to find display sub-systems for any end equipment that requires a compact or portable display.

<table>
<thead>
<tr>
<th>Ultra-Mobile, Ultra-Low Power</th>
<th>Mobile Low Power</th>
<th>Compact High Resolution</th>
</tr>
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<tbody>
<tr>
<td>.2 nHD Chipset</td>
<td>.2 WVGA Chipset</td>
<td>.3 720p Chipset</td>
</tr>
<tr>
<td>TIDA-01473</td>
<td>TIDA-00325</td>
<td>TIDA-01571</td>
</tr>
<tr>
<td>.3 720p Chipset</td>
<td>.33 1080p Chipset</td>
<td>.45 WXGA Chipset</td>
</tr>
<tr>
<td>DLPDLR2000EVM</td>
<td>DLPDLR2010EVM</td>
<td>DLPDLR3010EVM-G2</td>
</tr>
<tr>
<td>DLPDLR3310EVM</td>
<td>DLPDLR3310EVM</td>
<td>DLPDLR4710EVM-G2</td>
</tr>
</tbody>
</table>

.TIDA-00782                    | TIDA-01226       |

Ultra-Mobile, Ultra-Low Power: .2 nHD Chipset TIDA-01473 DLPDLR2000EVM
Mobile Low Power: .2 WVGA Chipset TIDA-00325 DLPDLR2010EVM
Compact High Resolution: .3 720p Chipset TIDA-01571 DLPDLR3010EVM-G2

WVGA Chipset
720p Chipset
1080p Chipset
WXGA Chipset
1080p Chipset

TIDA-00782
TIDA-01226

Compact High Resolution
DLPDLR3310EVM
DLPDLR4710EVM-G2

Texas Instruments
Industry’s most affordable pico projection EVM

Designers need affordable, low power, and free-form display solutions

- DLP2000 DMD {US$19.99}
- DLPDLCR2000EVM {US$99}
- Virtually any low-cost processor
- Start now!
New! First high-brightness EVM on TI.com

- Recently launched on TI.com
- 0.66 4K UHD (DLP660TE) EVM with DLPC4422 Controller EVM
- 0.47 4K UHD (DLP470TE) EVM with DLPC4422 Controller EVM
- More high-brightness EVMs on the way!
Summary

DLP Products  
- Superb image quality  
- High illumination efficiency  
- Tiny form factors  
- Large free-form displays

DLP Products display market is poised for growth
- Technology advancements
- Broad portfolio of display products
- Growing DLP Display application space

Easy to get started
- All the tools you need at TI.com
- Strong mature ecosystem
- Start today with $99
Thank You
谢谢
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