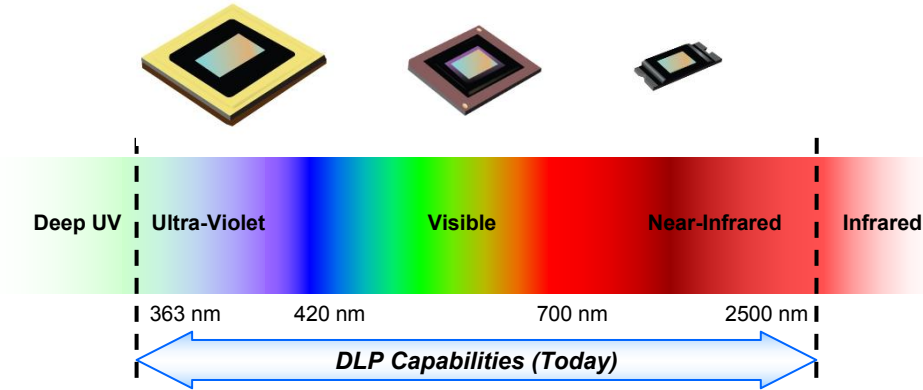


# TI DLP® Products

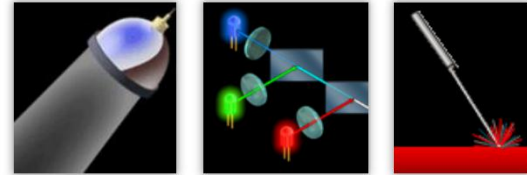
Enabling Innovations in Industrial Applications

**Mengao Zeng**  
July 11 2018

# DLP MEMS technology for industrial



Works with lamps, LEDs, and Lasers



**The DMD is a fast, efficient, and reliable spatial light modulator (SLM) offering:**

- 1) High Speed Switching – Switching of the full array at **up to 32 kHz**
- 2) Extended Wavelength – Supporting **UV to near-infrared (NIR)** and extended visual spectrum
- 3) Pixel Accurate Control – **Direct pixel mapping** combined with accurate timing and triggers

# DLP Industrial innovations



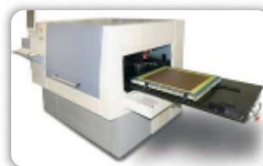
Factory Automation



PCB/PCA AOI



Vein Viewer



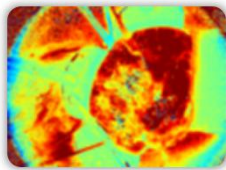
PCB Lithography



FPD Lithography



3D Biometric



Hyperspectral Image



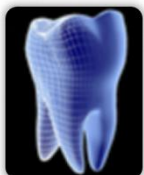
Optical inspection



Optical Networking



3D Printing



Dental Scan



Quality Inspection



3D Fingerprint



Marking & Coding



Stage Lighting

# DLP Industrial fast growing markets

## Lithography



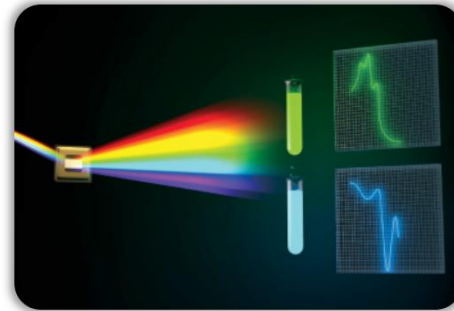
## 3D Printing



## 3D Machine Vision

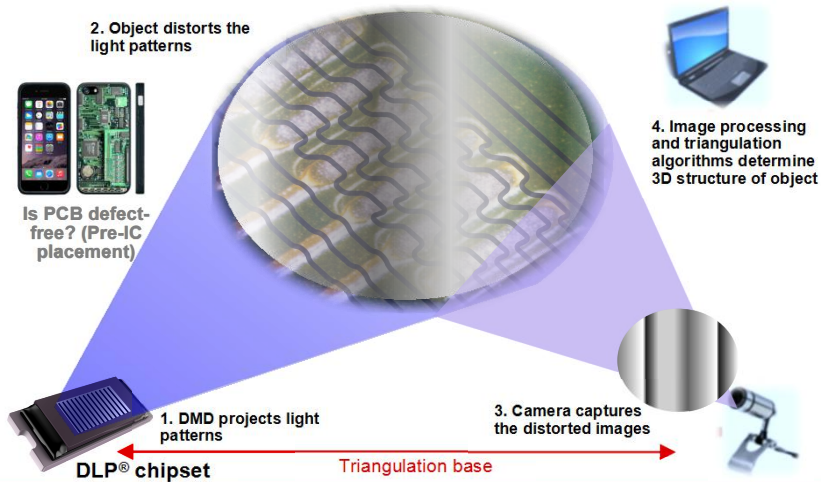


## Spectral Sensing



# 3D Machine Vision with DLP technology

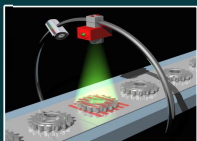
## 3D Sensing: Look in-3D



## End Equipment Examples



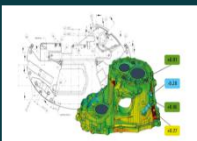
3D Biometric



Factory Automation



Dental/Medical Scanners



Industrial/Metrology

## Why choose DLP technology?

DLP Feature	Design Benefit
Optical MEMS device	Generating reliable and precise structured light patterns with superior image quality
<b>High speed</b> pattern rates up to 32 kHz with ~2 μs optical switching	Real-time light processing and/or display for instant information
External triggers	Enables easy synchronization to external cameras and sensors
High bit-depth	Higher accuracy and resolution
<b>Extended wavelength</b> support 363-2500 nm	Enabling applications that require UV, visible, or NIR light sources or light detection
Small form factor	Portable, lower cost solutions when combined with TI's embedded processors
Strong DLP ecosystem	Quicker time-to-market with lower investment

# DLP 3D Machine Vision market opportunities

## Inline Automated Optical Inspection

### Use Cases

- PCB Solder Paste & assembly Inspection
- Advanced IC Packaging
- Machined Parts Inspection



## Medical 3D Scanner

### Use Cases

- Implant Surgery
- Mouth Rehabilitation
- Bridge and Crowns
- Hearing Aid
- Live Cell Imaging

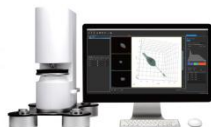


image © Tomocube



image © Carestream

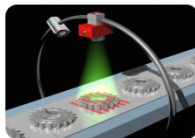
## Industrial/Metrology Scanner

### Use Cases

- Quality Control
- Factory Automation
- Tool Inspection
- In-Process Inspection
- Reverse Engineering



image © Zividlabs



## Prosumer 3D Scanner

### Use Cases

- 3D Modeling
- Scan-to-Print
- 3D Animation
- E-commerce



image © Shining3D

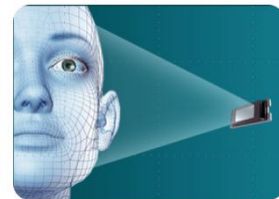


image © eSun

## 3D Camera

### Use Cases

- Facial Recognition
- Mixed Reality
- AR/VR
- Gaming
- Drone & Robots



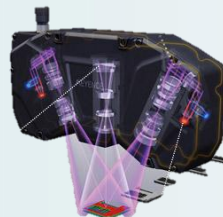
# 3D Machine Vision | inline and offline



image © Keyence



image © Shining3D



Hand Held

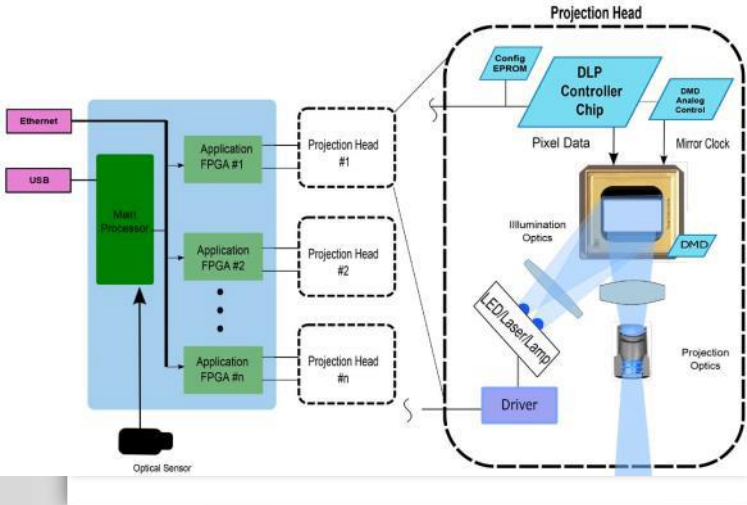
Enabling  
to

Factory Floor

# Digital Lithography with DLP technology

Enabling high-speed and high-throughput solutions

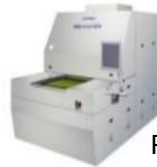
## System Block Diagram



## Why choose DLP technology?

DLP Feature	Design Benefit
<b>High speed</b> digital pattern rates >32 kHz Pixel rate > 61 Gpps	Improve throughput and eliminate the need for masks or print plates
Micromirror size 7.6, 10.8, and 13.6 $\mu\text{m}$	Achieve micron-level features for high accuracy and demanding applications
<b>Extended wavelength</b> support 363-2500nm	Cure a variety of photosensitive materials

## End Equipment Examples



PCB LDI Lithography



FPD (Flat Panel Display) Lithography

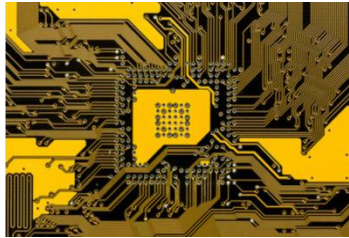


# Digital Lithography market opportunities

## PCB Patterning

### Use Cases

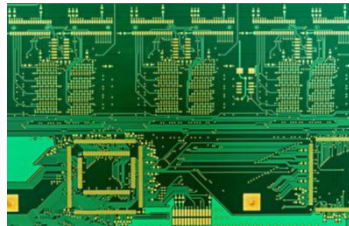
- PCB trace imaging
- Flexible roll to roll
- Advanced IC Packaging



## PCB Solder Mask

### Use Cases

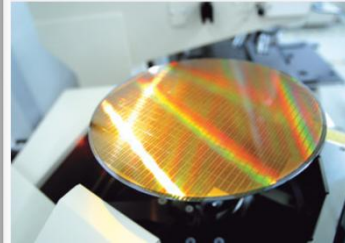
- PCB solder Mask
- Flexible cables
- Automotive harnesses



## Semiconductor 3D Packaging

### Use Cases

- Back end of Line
- Redistribution layers
- Through Silicon Via
- 3D packaging
- Copper Pillar



## FPD Patterning

### Use Cases

- LCD
- OLED
- Quantum Dot



# Industrial Lithography | Direct Imaging



image © YSPhototech



image © ORC



image © Advantools



image © Adtec



image © Chimeball



image © Orbotech



image © DNK



Manual exposure type



Automatic single-sided exposure type



Automatic double-sided exposure type

image © Hans Laser

BGAs

Enabling  
to

Flat Panels

# DLP Products: Lithography/3D scanning examples

## Industrial

**High power UV and 405 nm support** for digital lithography, and 3D scanning

Family of flexible DMDs optimized for next generation industrial factories



## Digital Lithography

Light Source	UV LED
Resolution	45/30 um L/S
Speed	240 panels per hour
Other Features	Patterning and solder mask all-in-one

## Solder Paste Inspection

Light Source	RGB LED
Resolution	10/15 um x 0.4 um
Scan Area	660 x 610 mm 200 cm <sup>2</sup> /sec
Other Features	Measures; Height, Area, Volume, and Offset in a single scan



Image © CBT

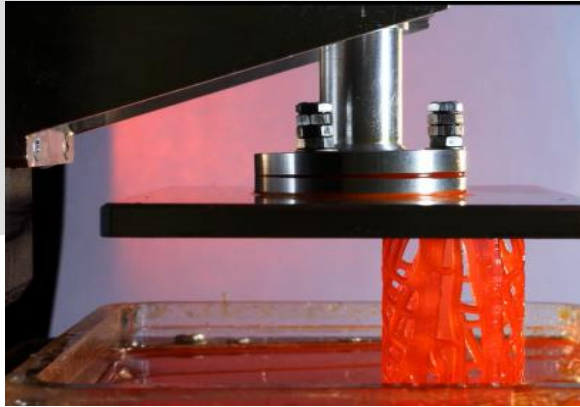


Image © TRI

# 3D Printing with DLP technology

## SLA - Photo polymerization

- **Photopolymer resins** are cured one layer at a time to build 3D objects
- DLP technology can be used with **ultra-violet** light to **cure a single layer in one shot** to provide faster print speeds



## SLS - Powder Bed Fusion

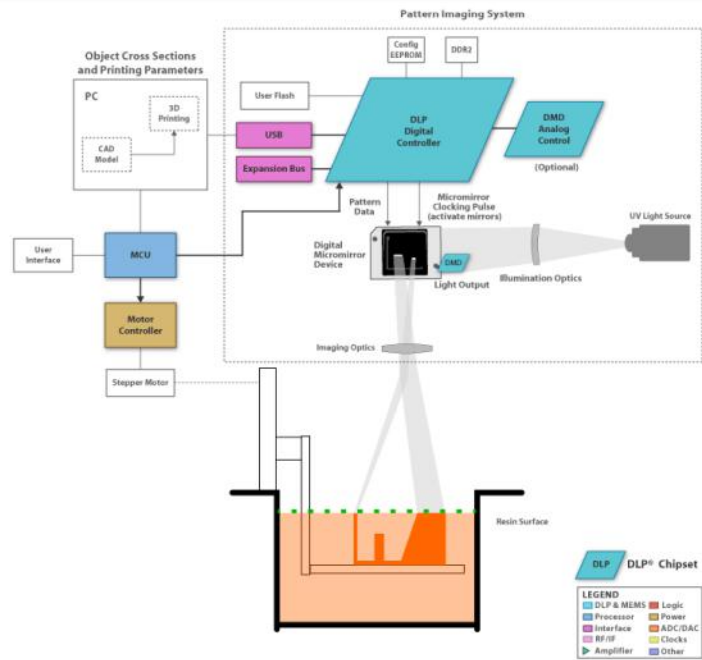
- **Powder particles** are sintered layer by layer to build 3D objects
- DLP technology can be used with **near-infrared** light to **spatially sinter** a layer of powder with **varying optical power**



# 3D Printing with DLP technology

Best-in-class combination of resolution and speed

## How it Works



## Why choose DLP technology?

DLP Feature	Design Benefit
Micromirror array exposes an entire layer in one shot	Faster build speed than point-by-point technologies and constant build time independent of layer complexity
Easily program high-resolution patterns	Enables sub-50 $\mu$ m resolution on the image plane and easily adjust layer thickness
<b>Extended wavelength</b> support 363-2500nm	Compatible with a wide range of polymers and resins
Reliable MEMS technology	No expensive parts (e.g. ink jets) to replace - translates to lower cost of ownership

## End Equipment Examples



Desktop  
3D Printers



Industrial  
Direct Manufacturing

# Industrial Printing | 3D printers SLA (Stereo lithography)



image © EnvisionTec



image © Carbon



image © Prodways



image © 3D Systems



image © Carbon



image © 3D Systems

Desktop

Build Sizes Enabling  
to

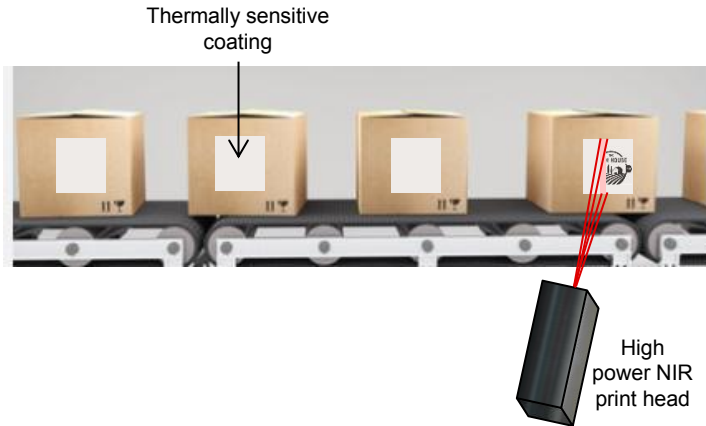
Factory Floor

# Thermochromic Printing with DLP technology

Digital inline printing for late stage product customization

## How it Works

The print head delivers a dynamic 2D near-infrared light pattern to thermally activate a substrate or coating on a moving production line.



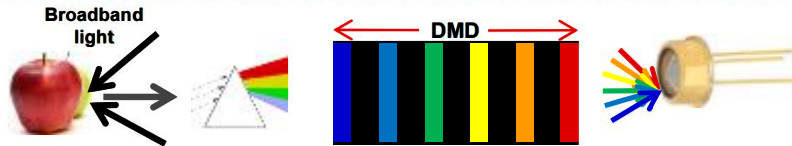
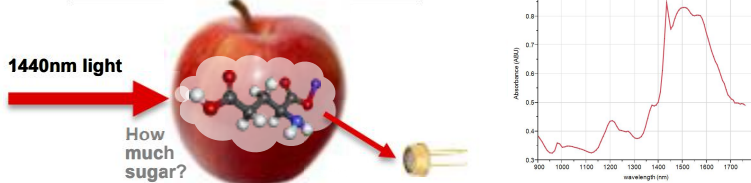
## Why choose DLP technology?

DLP Feature	Design Benefit
High resolution micromirror array exposes a 2D image in one shot	Faster print speed than point-by-point technologies for complex images. Larger print areas without trading off throughput.
Dynamically program complex patterns and images	Select custom graphics in real-time on the production line.
High power NIR wavelength support	Compatible with thermally sensitive coatings, including food-safe options. Can thermally react substrates through transparent covers.
Digital controller with high bit depth	Print high resolution grayscale images.
Reliable MEMS technology	Stable and clear prints over time and temperature. Fewer parts to replace or maintain for lower cost of ownership

# DLP Spectral Sensing market opportunities

## How it works?

### Sugar Molecule in an apple



1. Spread the wavelengths across the DMD columns
2. Sequentially select one wavelength (one column) at a time
3. One photodetector measures absorption of each wavelength

## Food Analysis

- Identification of food allergens – ex., Gluten in Food
- Food contamination - ex., Melamine in Milk
- Food consumption analysis – ex., Protein/Carb Content



## Pharmaceutical

- Counterfeit drug detection – ex., Botox
- In-pharmacy ingredient testing – ex., Custom Drugs
- In-line quality control – ex., Drug Manufacturing



## Agriculture / Petrochemical

- Soil Analysis – ex., Nitrogen level detection
- Crop Analysis – ex., Wheat Protein levels
- Oil contamination – ex., Kerosene levels in Gasoline



**Competitive Advantage - Portable, low cost, flexibility**

TI Information – Selective Disclosure



# New Pico Products for 3D Scanning and 3D Printing

# New TI DLPC347x Controllers



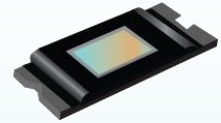
DLP2010 DMD



DLP2010NIR DMD



DLP3010 DMD



DLP4710 DMD



**DLPC3470**  
controller

Smallest size



**DLPC3470**  
controller

Invisible light



**DLPC3478**  
controller

Optimized size/resolution



**DLPC3479**  
controller

Highest resolution

Precision light control and high image quality for portable applications

# Bringing 3D printers and scanners to consumers

Capture

Imagine

Create



Micron-level accuracy captures fine detail and enables smooth, high-quality printed objects at speeds **5X faster** than existing 3D printing technologies

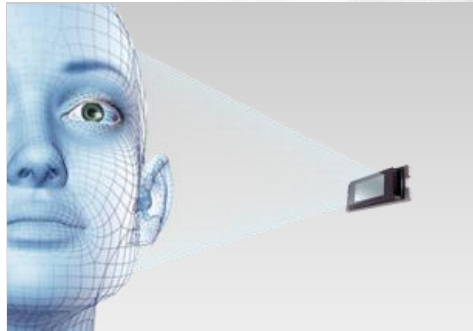
# Precision pattern control in smaller form factors



Home  
hobbyist,  
artist,  
inventor



Dental and  
medical  
applications



Facial  
recognition  
/ access  
control



Small form  
factor  
industrial  
applications

Enables a variety of portable 3D scanners and desktop 3D printers

# DLP Design Network & TI Designs

## Advanced Light Control - Optics & electronics

DLP optical module and electronics manufacturers are independent 3rd party companies with expertise in designing and manufacturing systems utilizing TI DLP Products. These off-the-shelf optical modules and electronics are specifically designed for industrial applications and may include a digital micromirror device (DMD), an illumination source, optics, and associated mechanics and electronics. Customers can accelerate product development and reduce time to market by procuring these production-ready solutions directly from this list of manufacturers.

Note: most of the 3rd party companies also provide design services and support other DLP chips beyond the ones listed above. For more details, please check out their company profile pages.



Company	City, country	Optical modules for DLP chips	Electronics modules for DLP controllers	Focus applications
Digital Light Innovations	Austin, Texas, USA	DLP5500	DLPC200 DLPC410 DLPC900	• 3D printing • Machine vision
In-Vision Digital Imaging Optics GmbH	Guntramsdorf, Austria	DLP6500FLQ DLP6500FYE DLP9000 DLP9500 DLP9500UV	DLPC410 DLPC900	• 3D printing • Machine vision
VIALUX GmbH	Chemnitz, Germany	DLP6500FLQ DLP6500FYE DLP7000 DLP7000UV	DLPC410 DLPC900 DLPC910	• Digital lithography • 3D printing • Machine vision
VISITECH AS	Lier, Norway	DLP9000 DLP9500 DLP9500UV	DLPC410 DLPC900 DLPC910	• Digital lithography • 3D printing • Machine vision
Wintech Digital Systems Technology Corp.	Beijing, China	DLP4500 DLP6500FLQ DLP6500FYE	DLPC350 DLPC410 DLPC900	• 3D printing • Machine vision
Young Green Energy Co.	Hsinchu, Taiwan	DLP2010NIR	DLPC150	• Spectroscopy

Note: most of the Optical Module Manufacturers also provide design services and support other DLP chips beyond the ones listed above. For more details, please check out on their company profile pages.

**24** Independent 3<sup>rd</sup> Party Providers

**59** Unique Design Solutions with

- Electronics
- Software
- Optics
- Full System Integration

Refer to **TI Designs** to speed up your DLP design time. Reference designs include schematics, layouts, and BOM.

- 3D Point Cloud Generation
- NIR Spectroscopy
- Stereolithographic 3D Printing
- High Res, Portable Light Steering

DLP Design Network is at

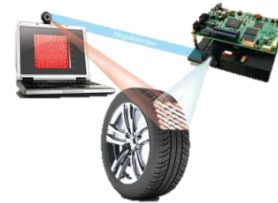
[www.ti.com/dlpdesign](http://www.ti.com/dlpdesign)

# DLP Industrial Getting started: easy as 1, 2, 3

- Explore the DLP 3D Machine Vision system block diagram
- Watch the 3D Modules from

- **Create** distributor or eStore
- Download the free TI Get Design: connected electronics,

- optics, and software
- Find a design services or module provider from the DLP

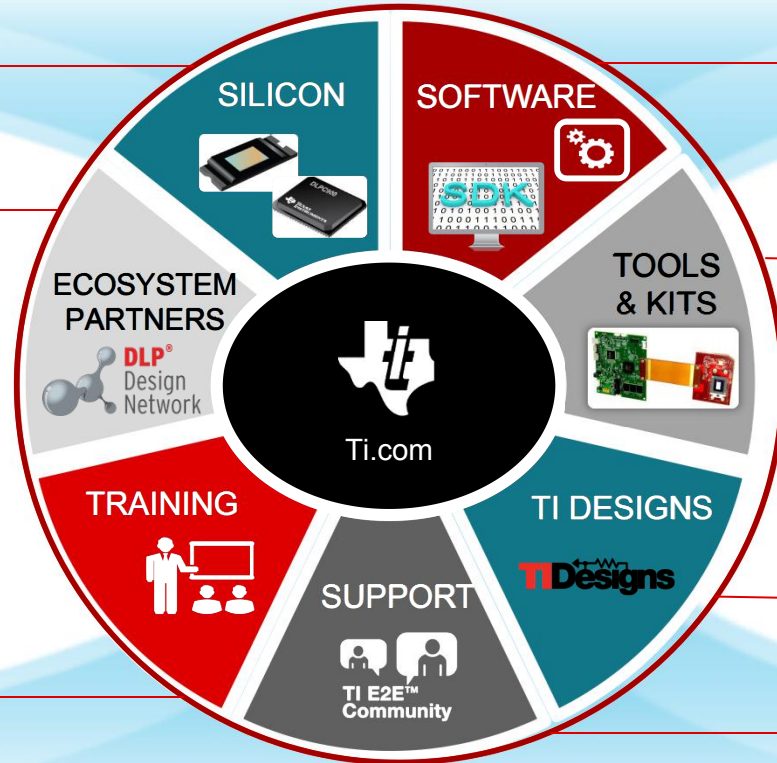


**TI** Designs



# Global Segment expertise and support, anytime and anywhere

- SILICON**  
Pick the chip that fits your system needs
- ECOSYSTEM**
- **20+** Independent 3rd Party Providers with DLP experience
  - **50+** Design Solutions:
    - Optics, Electronics
    - Software, Full System Integration
- View solutions & services from these companies
- TRAINING**  
View ALC training



- SOFTWARE**  
High speed visible SW  
UV SW  
NIR SW
- TOOLS & KITS**  
High speed visible EVMs  
UV EVMs  
NIR EVMs
- TI DESIGNS**  
Use DLP ALC reference designs
- SUPPORT**  
Search for ALC answers

## How Can We Help?

**Thank You!**