DLP (Digital Light Processing)

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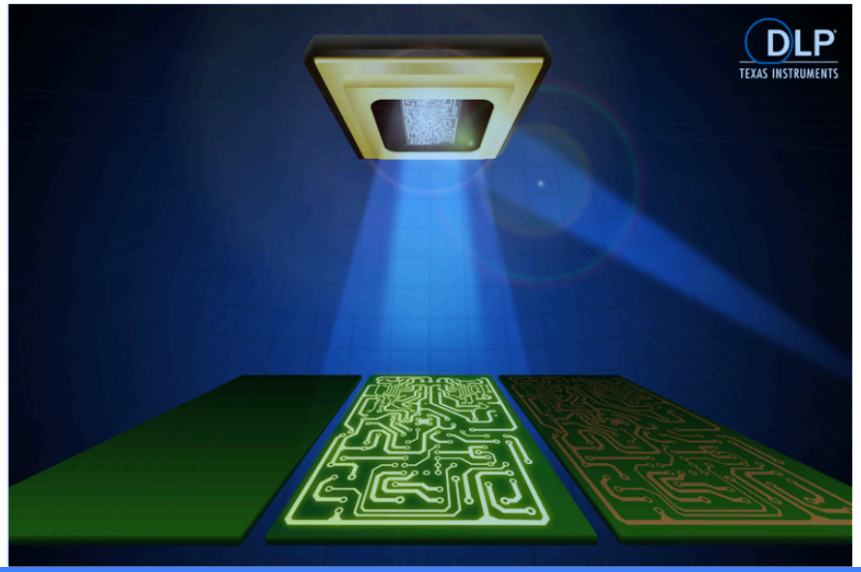


DLP technology

- By Texas Instruments
- Most mature **large-screen** technology for **projectors** but is fast becoming the most mature for **small-screen** projectors, too.
- Uses
  - Maskless Lithography
    - Mainly PCBs
  - Head up display (HUD)
  - Small-screen and big screen display
    - wearables
    - screenless TVs
  - 3D printing

DLP Size

- 2 million full HD pixels into an 11.9 millimeter diagonal area

DLP in Lithography

- Maskless lithography solutions
  - Used in PCB patterning, solder masks, laser marking.
- Programmable light steering DLP technology is used to directly expose patterns onto photoresist films without the need for contact masks.
- Advantages (in comparison to other PCB printing methods)
  - Reduces material cost,
  - improves production rates, and
  - allows for rapid changes of the pattern (even better for DP).
  - Higher reliability
  - No mask cost

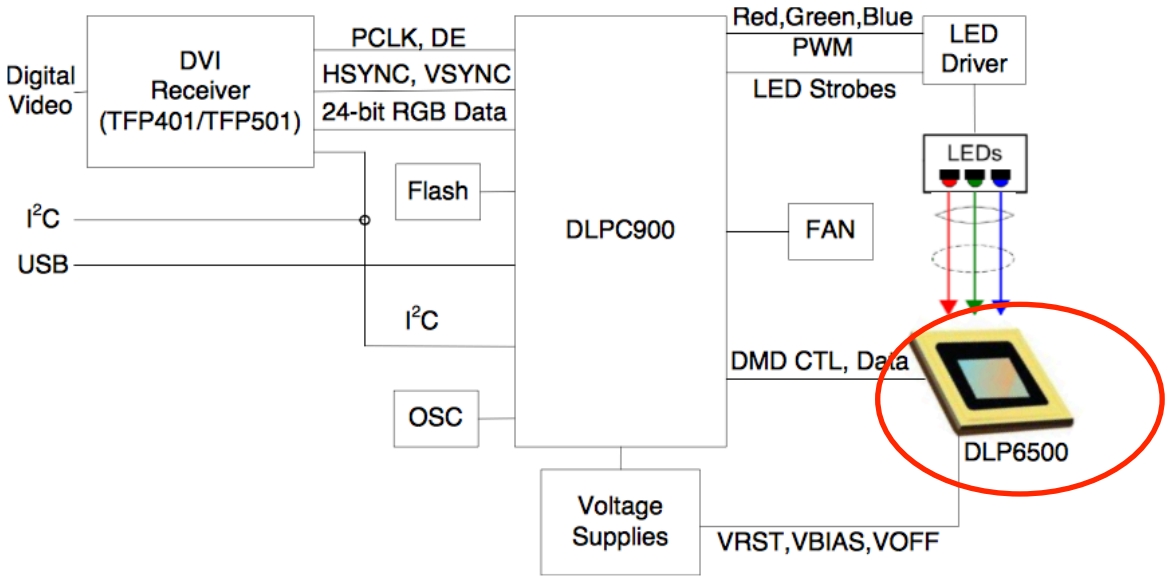
DLP in Lithography

- Highest resolution available:
  - Chipset for lithographic applications with a 4 million pixels (2560 x 1600).
  - For light wavelength 400-700nm
  - Pixel pitch: 7.6um
  - Can be de-magnified to print features ~1um [6]
  - Max Pattern Rate for binary bits: 9,527 Hertz

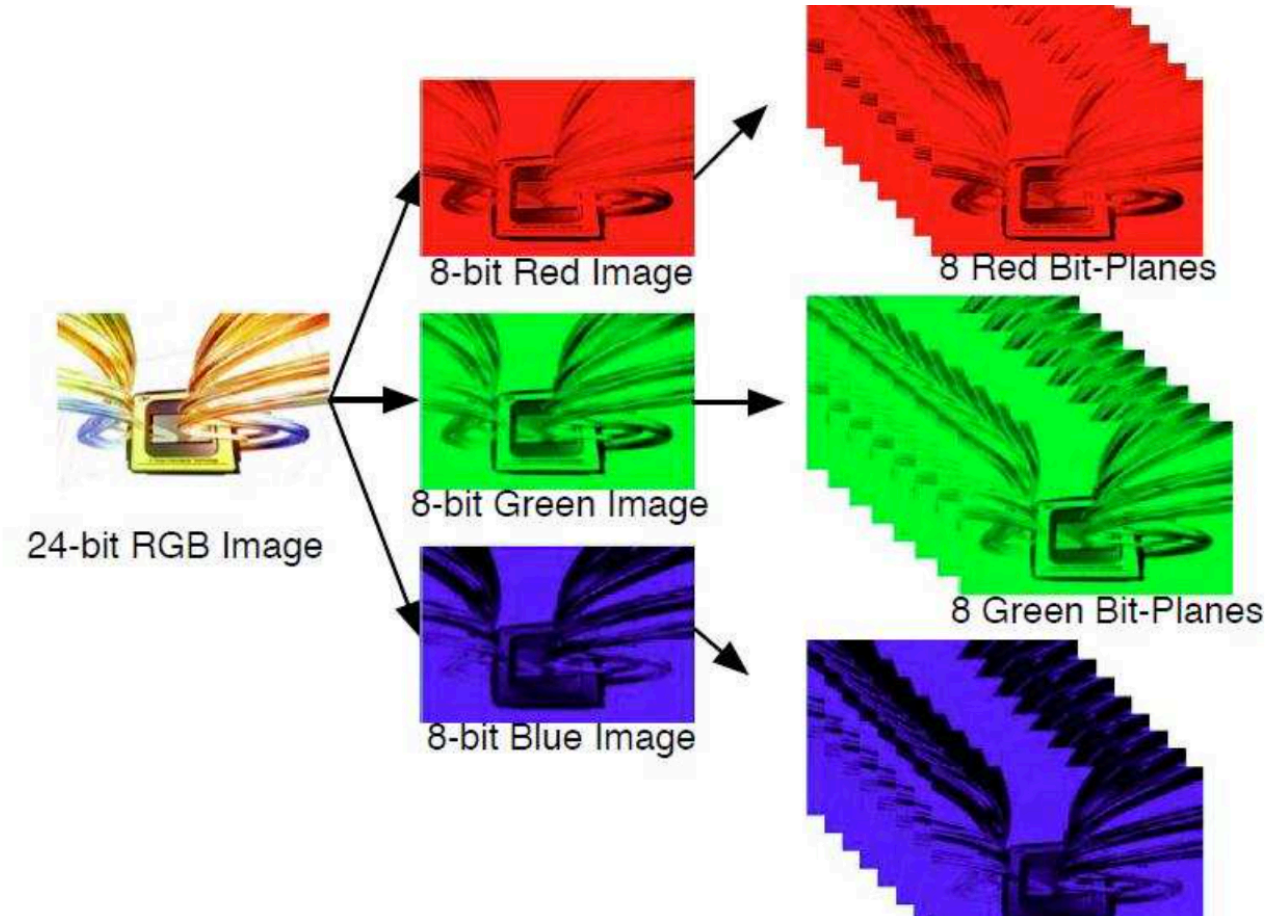
How does DLP work?

- Based on digital micro-mirror devices (DMDs),
  - one mirror for each pixel
- DMD controller enables programmable pattern rates
- Each tilt-and-roll pixel (TRP) deflects the light from red, green, and blue light sources (usually LEDs) onto its assigned area of the screen with intensity controlled by the duty cycle of on/off illumination of the pixel.

Simplified Diagram



Dealing with RGB data



Dealing with RGB data (cont'd)

- DLPC900 controller takes as input 16-, 20-, 24-, or 30-bit RGB data at up to 120-Hz frame rate
- 24bit RGB input: each color has 2.78ms time slot
- Each color has 8 bits➔ pulse width modulation
  - Mirror can either be on or off
    - The bit weight controls the amount of time the mirror is on

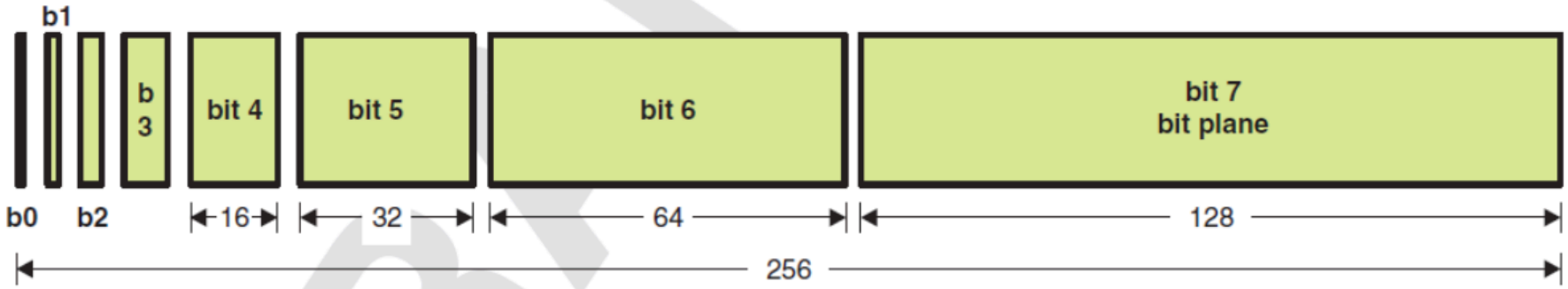


Figure 15. Bit Partition in a Frame for an 8-Bit Color

References

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3. http://www.ti.com/lit/ml/dlpt025c/dlpt025c.pdf
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DLP Chipsets for Lithography

DLP chipsets for lithography

DMD Number	Micromirror Array	Array Diagonal	Controller	Micromirror Driver	Max Pattern Rate	Optimized Wavelengths	Pixel Pitch	Pixel Orientation	EVM	DMD Package Dimensions (lxwxh)	DMD 100u Price ($U.S.)	Controller 100u Price ($U.S.)
DLP6500FYE	1920 x 1080	0.65"	DLPC900	—	9,500 Hz (binary)	420-700 nm	7.6 µm	Orthogonal	DLP LightCrafter 6500	32 x 32 mm	588	160
DLP6500FLQ	1920 x 1080	0.65"	DLPC900	—	9,500 Hz (binary)	400-700 nm	7.6 µm	Orthogonal	DLP LightCrafter 6500	32 x 41 mm	1,137	160
DLP7000	1024 x 768	0.7"	DLPC410	DLPA200	32,552 Hz (binary)	420-700 nm	13.6 µm	Orthogonal	Discovery 4100	40.64 x 31.75 x 6.01 mm	787	193
DLP7000UV	1024 x 768	0.7"	DLPC410	DLPA200	32,552 Hz (binary)	363-420 nm	13.6 µm	Orthogonal	—	40.64 x 31.75 x 6.01 mm	Coming soon	193
DLP9000	2560 x 1600	0.9"	DLPC900	—	9,500 Hz (binary)	400-700 nm	7.6 µm	Orthogonal	DLP LightCrafter 9000	42.2 x 42.2 x 7 mm	2,783	160
DLP9500	1920 x 1080	0.95"	DLPC410	DLPA200	23,148 Hz (binary)	400-700 nm	10.8 µm	Orthogonal	Discovery 4100	42.16 x 42.16 x 7.03 mm	2,446	193
DLP9500UV	1920 x 1080	0.95"	DLPC410	DLPA200	23,148 Hz (binary)	363-420 nm	10.8 µm	Orthogonal	—	42.16 x 42.16 x 7.03 mm	6,999	193

Typical projection system optics [6]