DLP® Technology and Products

TEXAS INSTRUMENTS

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DLP® Technology and Products

Flexible and programmable optical solutions that enable a diverse range of display and advanced light control applications spanning industrial, automotive, enterprise and consumer market segments

What is DLP® technology?

While Texas Instruments is known worldwide for high-quality projection applications, including award-winning DLP Cinema®, the imaging choice for nearly 90 percent of the world's digital theatre screens, TI's DLP technology enables a diverse range of display and advanced light control applications. The Digital Micromirror Device (DMD), or DLP chip, is a high speed, efficient MEMS light steering device that can work with any type of light, including visible, infrared and ultraviolet. Using TI's proven semiconductor manufacturing capabilities, each DMD contains up to 8.8 million individually controlled micromirrors built on top of an associated CMOS memory. Since 1996, TI has produced more than 40 million DLP chipsets for customers around the world.

Why DLP technology?

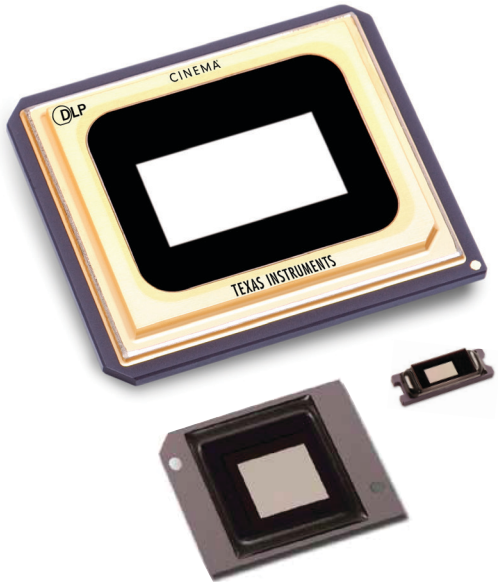
- Over 20,000 cycles/second
- Extremely high fill factor
- Polarization independent
- Quintillion cycles tested

Video and data display

Based on the same award-winning DLP display technology used in digital movie theatres, classrooms, and businesses worldwide, DLP® Pico™ chipsets enable developers to incorporate bright, efficient, high-definition projection into the smallest applications. To accelerate end product development, TI maintains the most extensive pico ecosystem of optical engine manufacturers in the industry. From cinemas to classrooms to cellphones, TI's DLP technology offers a way to satisfy virtually any application or form factor requirement and can display on freeform, curved surfaces.

Advanced light control

With a portfolio of chipsets optimized for speed, resolution, and wavelength, DLP advanced light control technology enables high-performance solutions that help customers solve difficult problems across the spectrum of ultraviolet, visible, and near-infrared light. Built upon an industry-leading position in digital cinema and consumer projection, the DLP advanced light control product portfolio is highly differentiated for digital lithography, machine vision, 3D printing, spectroscopy and several other emerging applications. With TI's powerful yet easy-to-use development tools, customers are now able to introduce innovative products to market faster and more easily.



TI DLP Cinema chip (top); TI advanced light control chip (left); and TI video and data display chip (right)

Automotive

TI's state-of-the-art semiconductor products help manufacturers and system suppliers deliver world-class features to the automotive market. This extensive automotive portfolio includes analog power management, interface and signal chain solutions, along with DLP displays, ADAS and infotainment processors, Hercules™ TMS570 microcontrollers and wireless connectivity solutions.

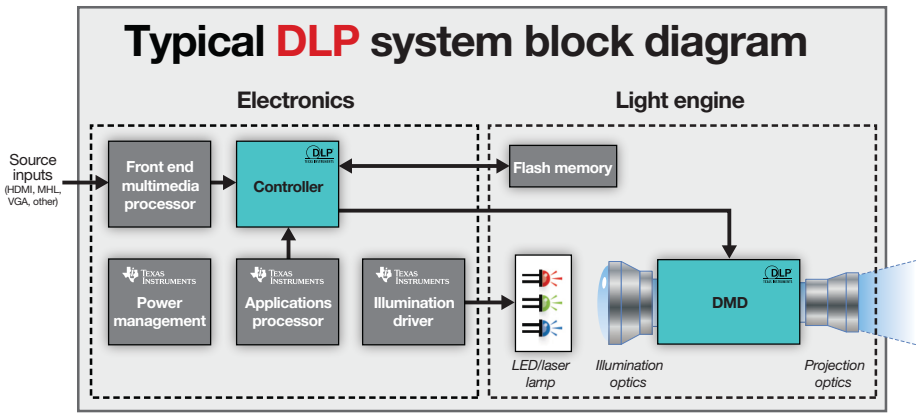
DLP chipsets for automotive are based on award-winning DLP Cinema technology and deliver robust solutions, bright and vivid image quality for head-up display and flexibility for adaptive headlight applications. From large-scale digital dashboards and center console touchscreens that seamlessly integrate with curved interiors, to smart headlamps that improve visibility during inclement weather, DLP technology can help automobile manufacturers differentiate their unique safety features and enhance the driver experience.

Head-up display and center console touchscreen

How DLP technology works

During operation, the DMD controller loads each underlying memory cell with a “1” or a “0”. Next, a micromirror clocking pulse is applied, causing each micromirror to switch to a plus or minus 12° landed state. In a projection system, the +12° landed state corresponds to an “on” pixel, and the -12° landed state corresponds to an “off” pixel. Grayscale patterns are created by programming the on/off-duty cycle of each mirror. And simultaneously, multiple light sources are multiplexed to create full RGB color images. In advanced light control applications, the ±12° states offer two general purpose output ports with a pattern and its inverse.

The DMD works in concert with an optical module containing optics and illumination to create the heart of the projection engine. The controller is installed on the electronics board near the optical module to control the DMD and perform necessary data formatting and processing functions.



Typical DLP system block diagram

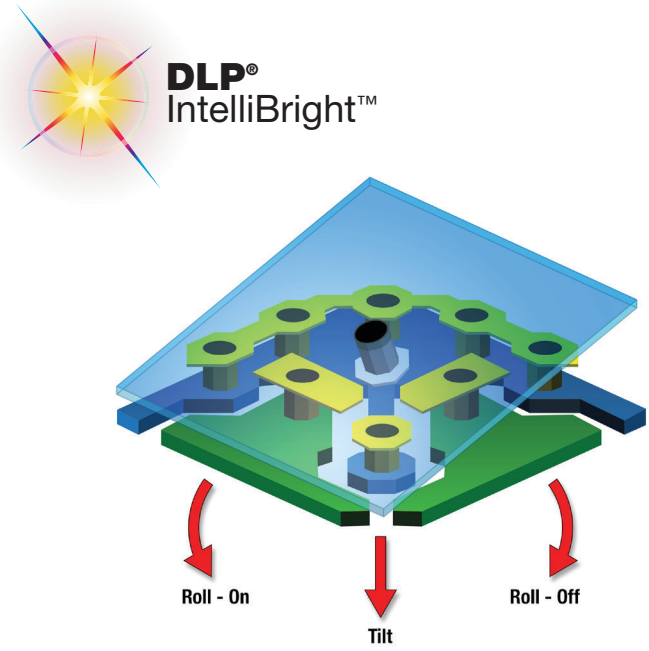
DLP chipsets consist of two primary components: the Digital Micromirror Device (DMD) and the DMD controller chip. Certain chipsets also include a power management chip.

TRP architecture explained

TI’s proprietary TRP architecture and adaptive DLP® IntelliBright™ suite of algorithms enable developers to increase brightness or consume less power. TI chipsets incorporating TRP architecture can incorporate twice the number of pixels and deliver 30 percent greater optical efficiency and up to 50 percent power savings on a frame-by-frame basis than previous TI architectures of comparable resolution.

TRP architecture benefits

- Twice the pixels
- 30 percent greater optical efficiency
- Up to 50 percent power savings



Each DLP TRP pixel is 1/20th the width of a human hair

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Capabilities

Video and data display capabilities

DLP video and data display products empower developers to incorporate bright, efficient, high-definition projection into the smallest applications. The DLP chip offers extremely flexible and programmable light management, enabling a wide range of display applications.

Embedded projection from tablet

- Great image quality – DLP video and data display chipsets are based on proven DLP Cinema technology and provide unique advantages, including outstanding readability, precise color, fast digital video performance, HD resolution, and the ability to work with any light source, including lamp, LED or laser.
- Any size – DLP chips are available in several resolutions and package sizes to enable developers to innovate a broad range of industrial, enterprise and consumer electronics applications. With optical modules as thin as 5.5 mm, the DLP ecosystem of optical engine manufacturers offers a wide range of turnkey optical modules to serve virtually any size requirement.
- Any shape – The unique micromirror structure of DLP chips enables projected display on virtually any surface shape, including curved and freeform surfaces.
- Robust touch – DLP technology can enable the transformation of virtually any surface into an interactive display and can incorporate wire-free physical knobs within a free-form rear-projection display.

Advanced light control

TI's advanced light control technology and extensive ecosystem enables flexible optical sensing and illumination.

3D machine vision

- Structured light – DLP technology enables Programmable Structured Light. With this method, a series of patterns is projected upon a target object while a sensor detects the distortions of the patterns that result from a non-flat surface. Compared with Contact Coordinate Measurements (CCM) or scanning lasers, DLP systems can produce non-contact, highly accurate 3D data in real-time, facilitating 3D Machine Vision.
- Wavelength selection – With DLP technology, a dispersive optical element is used to spread light into spatially separated wavelengths on the surface of the DMD chip. The number of mirrors turned on / off in each DMD column is used to select and attenuate the corresponding wavelength. One common example of wavelength selection is a spectrometer that can can analyze liquids and solids in areas such as food, agriculture, pharmaceuticals and plastics.

Spectroscopy

- Digital exposure – Systems based on DLP technology project digital patterns from the DMD that selectively cure and harden a layer of photopolymer or resin in one shot. These systems have higher throughputs than point-by-point technologies while achieving micron-scale patterns. PCB Lithography and 3D Printers use this capability today.

PCB lithography

Light source agnostic

DLP technology can support a broad range of light sources, including LED, laser, UHP, and xenon, depending on the application need. DLP technology can also support a wide spectrum of wavelengths from ultraviolet (365 nm wavelength) to near infrared (2500 nm); in some cases, DLP chips are designed for a specific wavelength.

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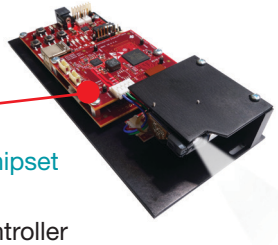
Development tools

TI offers many versatile and flexible platforms that help accelerate development time. At the heart of every evaluation module (EVM) is a DLP chipset, which includes a DMD and a controller.

The DLP LightCrafter™ Display 2010 EVM is an easy-to-use evaluation module for the 0.2" TRP WVGA display chipset. It includes an optical module (~25 lum), an HDMI interface (for input data) and the DLP LightCrafter Display GUI for configuration.



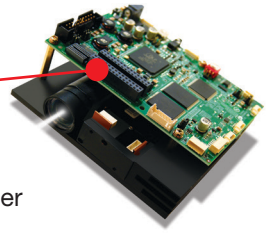
DLP LightCrafter Display 2010 EVM

0.2" TRP WVGA display chipset
- DLP2010 DMD
- DLPC3435 display controller
- DLPA2000 power management/LED driver

The DLP LightCrafter 4500 EVM provides a flexible light steering solution with high brightness and resolution for industrial, medical and scientific applications. The DLP LightCrafter 4500 features the 0.45" WXGA chipset and offers a compelling combination of resolution, brightness, and programmability in a small form factor.

Developers can easily create, store, and display high-speed pattern sequences through the EVM's USB-based application programming interface (API) and easy-to-use graphical user interface (GUI).

DLP LightCrafter 4500 EVM



0.45" WXGA chipset
- DLP4500 DMD
- DLPC350 digital controller

EVM catalog

Name	Device Included			Software	Features	Price ($ U.S.)
	DMD	Controller	Power IC			
Video and data display						
DLP LightCrafter Display 2010	DLP2010	DLPC3430/3435	DLPA2005	Yes	Standard HDMI input; USB-based GUI for real-time programming; plug and play	599
DLP LightCrafter Display 3010	DLP3010	DLPC3433/3438	DLPA2005	Yes	Standard HDMI input; USB-based GUI for real-time programming; plug and play	699
DLP LightCrafter Display 4710	DLP4710	2x DLPC3439	DLPA3005	Yes	Standard HDMI input; USB-based GUI for real-time programming; plug and play	1,099
Advanced light control						
DLP LightCrafter 3000	DLP3000	DLPC300	NO	Yes	RGB LED 20L light output; High speed patterns using DLP3000; WVGA resolution (608 x 684)	699
DLP LightCrafter 4500	DLP4500	DLPC350	NO	Yes	RGB LED 150L light output; 0-5A LED driver; High speed pattern display (912 x 1140)	1,299
DLP LightCrafter 6500	DLP6500FYE	DLPC900	NO	Yes	2 configurable I/O triggers; Supports data transfer up to 20 Gbps; USB 1:1, HDMI and I²C interfaces	1,999
DLP LightCrafter 9000	DLP9000	DLPC900	NO	Yes	2 configurable I/O triggers; Supports data transfer up to 40 Gbps; USB 1:1, HDMI and I²C interfaces	5,749
DLP NIRscan	DLP4500NIR	DLPC350	NO	Yes	Spectrometer optical engine; 1350-2450 nm range; >30,000:1 SNR (typical)	8,499
DLP NIRscan Nano	DLP2010NIR	DLPC150	DLPA2005	Yes	Spectrometer optical engine; 900-1700 nm range; >6,000:1 SNR (typical); USB interface; power by USB or battery	999
DLP Discovery 4100	DLP7000, DLP7000UV, DLP9500, DLP9500UV	DLPC410	DLPA200	No	Fast pattern rates for light exposure and image capture; Maximum flexibility to format and sequence light patterns	7,999 +

TI Designs

TI Designs, TI's comprehensive reference design library, helps jump-start system design. Designs include schematics or block diagrams, BOMs, design files and test reports that support a broad range of applications. Examples of TI Designs pertaining to DLP technology include:

DLP Products TI Designs

Video and data display

Ultra Mobile, Ultra Low Power Display Reference Design Using DLP Technology

Portable, Low Power HD Projection Display using DLP Technology

Full HD 1080p Projection Display Reference Design using DLP Pico Technology

Portable, High Brightness HD Projection Display Reference Design using DLP Technology

Advanced light control

DLP Near-Infrared Spectrometer for Optical Analysis of Liquids & Solids Reference Design

DLP Ultra-mobile NIR Spectrometer for Portable Chemical Analysis with Bluetooth Connectivity

Portable Point Cloud Generation for 3D Scanning using DLP Technology Reference Design

High Res, Portable Light Steering Reference Design using DLP Technology

Accurate Point Cloud Generation for 3D Machine Vision Applications using DLP Technology

High Resolution 3D Scanner for Factory Automation using DLP Technology

Best-in-class Combination Stereolithography 3D Printer Development Using DLP Technology

High Speed DLP Sub-system for Industrial 3D Printing and Digital Lithography Reference Design

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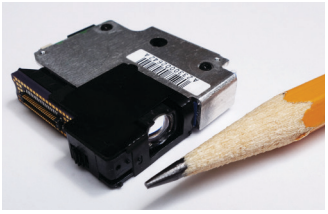
DLP technology ecosystem

The DLP ecosystem, consisting of the DLP Design Network and optical engine manufacturers, aids developers in accelerating product development and time to market.

- The DLP Design Network is a group of independent, well-established companies that provide hardware/software integration, optics design, system integration, prototyping, manufacturing services, and turnkey solutions to a worldwide customer base to accelerate product development and time to market with DLP technology. Visit ti.com/dlp-design-house for more information.
- DLP optical engine manufacturers are independent, well-established companies that provide turnkey optical modules to a worldwide customer base. These modules incorporate a Digital Micromirror Device (DMD), an LED-based illumination source, and the necessary optical elements that form the core of a projection system. TI customers can procure optical modules directly from these optical engine manufacturers to accelerate product development and time to market. Visit ti.com/dlp-modules for more information.

DLP® Design Network



Example optical module for video and data display applications

Market opportunities

TI's DLP technology is highly flexible and enables a diverse range of display and advanced light control applications for industrial, automotive, enterprise, medical and consumer market segments.

Industrial

- Control panels
- Human machine interface
- 3D machine vision
- Spectroscopy
- 3D printing
- PCB lithography
- Digital signage: interactive surface, storefront, retail
- Commercial gaming

Enterprise

- Government
- Education
- Cinema
- Large venue
- Mobile projection
- Laptops

Personal electronics

- Gaming: dual console, interactive
- Wearable display
- Mobile phones
- Tablets
- Camcorders
- 3D printing
- Smart home

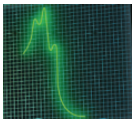
Automotive

- Head-up display
- Center console
- Smart headlights

Medical

- Spectroscopy
- 3D printing
- 3D machine vision

DLP video and data display technology enables a broad range of industrial and consumer electronics wearable display applications, including augmented reality and immersive full field of view



Affordable near-infrared spectrometer with more than 30,000:1 signal-to-noise ratio for <1 second measurements.

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Chipset catalog - video and data display

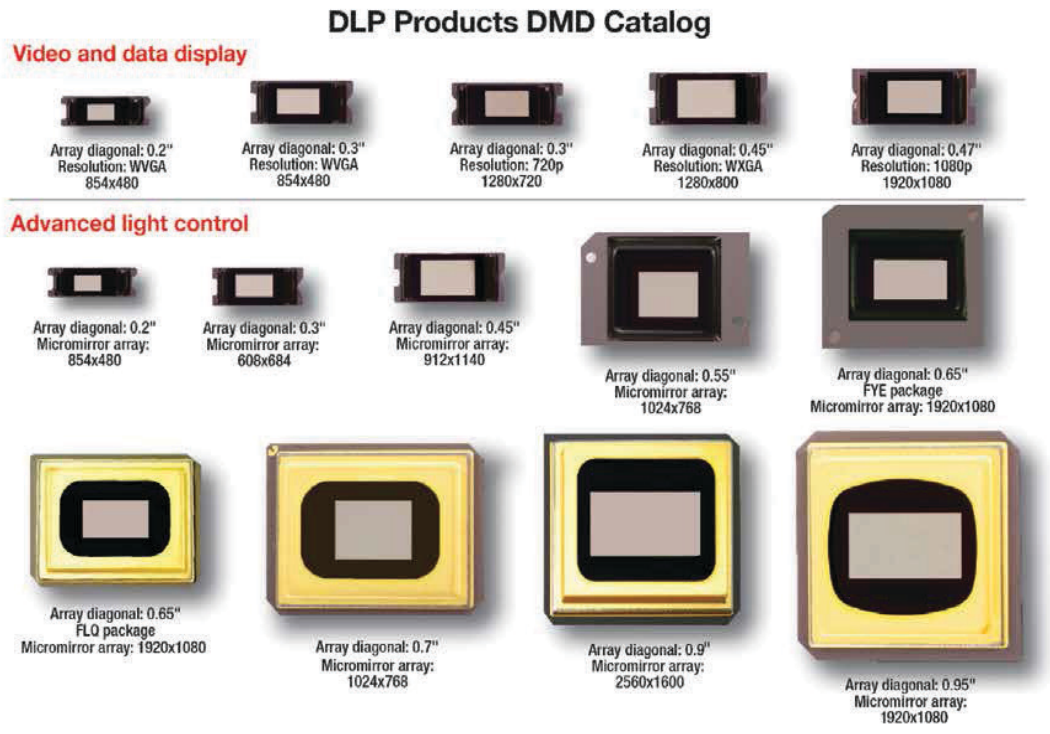
DMD Number	Resolution	Array Diagonal	Controller	PMIC-LED Driver	Max Pattern Rate	Optimized Wavelengths	Pixel Pitch	Pixel Orientation	Pixel Architecture	Features	EVM	DMD Package Dimensions (lxwxh)	DMD Pin/ Pkg	DMD 1ku Price ($ U.S.)	Controller 1ku Price ($ U.S.)	PMIC 1ku Price ($ U.S.)
DLP2010	854 x 480	0.20"	DLPC3430/ 3435	DLPA2000/05	RGB 120 Hz	420-700 nm (visible)	5.4 µm	Orthogonal	TRP	Plug and play DLP IntelliBright	LightCrafter Display 2010	15.9 x 5.3 x 3.18 mm	40/FQJ	80.07	17.82	6.33
DLP3000	854 x 480	0.30"	DLPC2607	PAD1000	RGB 120 Hz	420-700 nm (visible)	7.6 µm	Diamond	VSP	Parallel interface	DLPC2607 DISPLAY EVM*	17.62 x 5.92 x 3.1 mm	50/FQB	85	11.63	Call
DLP3010	1280 X 720	0.30"	DLPC3433/38	DLPA3000	RGB 120 Hz	420-700 nm (visible)	5.4 µm	Orthogonal	TRP	Plug and play DLP IntelliBright	LightCrafter Display 3010	18.2 x 7 x 3.78 mm	57/FQK	103.88	22.08	6.33
DLP4501	1280 x 800	0.45"	DLPC6401	None	RGB 120 Hz	420-700 nm (visible)	7.6 µm	Diamond	VSP	LVDS and Parallel interface	DLPC6401 DISPLAY EVM*	20.7 x 9.1 x 4.2 mm	80/FQE, FQD	128	25.33	—
DLP4710	1920 x 1080	0.47"	DLPC3439	DLPA3005	RGB 120 Hz	420-700 nm (visible)	5.4 µm	Orthogonal	TRP	DLP IntelliBright	LightCrafter Display 4710	24.5 x 11 x 3.78 mm	100/ FQL	179	20.49	8.23

*Third Party EVM

Chipset catalog - advanced light control

DMD Number	*Micromirror Array	Array Diagonal	Controller	Micromirror Driver	Max Pattern Rate	Max Pixel Data Rate	Optimized Wavelengths	Pixel Pitch	Pixel Orientation	EVM	DMD Package Dimensions (lxwxh)	DMD 100u Price ($ U.S.)	Controller 100u Price ($U.S.)	Micromirror Driver 100u Price ($U.S.)
DLP2010NIR	854 x 480	0.2"	DLPC150	DLPA2000 / DLPA2005	1,500 Hz (binary)	1.2 Gbps	700-2500 mm	5.4 µm	Orthogonal	NIRscan Nano	15.9 x 5.3 x 4 mm	110 (1ku price)	20 (1ku price)	5.12 / 7.60 (1ku price)
DLP3000	608 x 684	0.30"	DLPC300	—	4,000 Hz (binary)	1.7 Gbps	420-700 nm	7.6 µm	Diamond	LightCrafter	16.6 x 7 x 3.54 mm	95	16	—
DLP4500	912 x 1140	0.45"	DLPC350	—	4,225 Hz (binary)	4.4 Gbps	420-700 nm	7.6 µm	Diamond	LightCrafter 4500	20.7 x 9.1 x 3.33 mm	143	56	—
DLP4500NIR	912 x 1140	0.45"	DLPC350	—	4,225 Hz (binary)	4.4 Gbps	700 - 2500 nm	7.6 µm	Diamond	NIRscan	20.7 x 9.1 x 3.33 mm	315	56	—
DLP5500	1024 x 768	0.55"	DLPC200	DLPA200	5,000 Hz (binary)	3.9 Gbps	420-700 nm	10.8 µm	Orthogonal	—	32.2 x 22.3 x 3.66 mm	403	140	12.36
DLP6500FYE	1920 x 1080	0.65"	DLPC900	—	9,500 Hz (binary)	19.7 Gbps	420-700 nm	7.6 µm	Orthogonal	LightCrafter 6500	40.6 × 31.8 × 6 mm	588	160	—
DLP6500FLQ	1920 x 1080	0.65"	DLPC900	—	9,500 Hz (binary)	19.7 Gbps	400-700 nm	7.6 µm	Orthogonal	LightCrafter 6500	32 x 41 mm	1,137	160	—
DLP7000	1024 x 768	0.7"	DLPC410	DLPA200	32,552 Hz (binary)	25.2 Gbps	420-700 nm	13.6 µm	Orthogonal	Discovery 4100	40.64 x 31.75 x 6.01 mm	787	193	12.36
DLP7000UV	1024 x 768	0.7"	DLPC410	DLPA200	32,552 Hz (binary)	25.2 Gbps	363-420 um	13.6 µm	Orthogonal	Discovery 4100	40.64 x 31.75 x 6.01 mm	3,763	193	12.36
DLP9000	2560 x 1600	0.9"	DLPC900 (qty 2)	—	9,500 Hz (binary)	39 Gbps	400-700 nm	7.6 µm	Orthogonal	LightCrafter 9000	42.2 x 42.2 x 7 mm	2,783	160	—
DLP9000X	2560 x 1600	0.9"	DLPC910	—	14,989 Hz (binary)	61.1 Gbps	400-700 nm	7.6 µm	Orthogonal	—	42.2 x 42.2 x 7 mm	4,449	295	—
DLP9500	1920 x 1080	0.95"	DLPC410	DLPA200 (qty 2)	23,148 Hz (binary)	48 Gbps	400-700 nm	10.8 µm	Orthogonal	Discovery 4100	42.2 x 42.2 x 7 mm	2,446	193	12.36
DLP9500UV	1920 x 1080	0.95"	DLPC410	DLPA200 (qty 2)	23,148 Hz (binary)	48 Gbps	363-420 nm	10.8 µm	Ortogonal	Discovery 4100	42.2 x 42.2 x 7 mm	6,999	193	12.36

*Addressable pixels Note: Multiple package types exist for DMDs. Visit ti.com/dlp to see all packages.



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In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI’s goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

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