DLPR410 Configuration PROM

1 Features

- Pre-Programmed Xilinx® PROM Configures the DLPC410ZYR
- Data Transfer up to 32 Mbps
- I/O Pins Compatible With 1.8 V to 3.3 V
- 1.8-V Core Supply Voltage
- –40°C to 85°C Operating Temperature Range

2 Applications

- Lithography
  - Direct Imaging
  - Flat Panel Display
  - Printed Circuit Board Manufacturing
- Industrial
  - 3D Printing
  - 3D Scanners for Machine Vision
  - Quality Control
- Displays
  - 3D Imaging
  - Intelligent and Adaptive Lighting
  - Augmented Reality and Information Overlay

3 Description

The DLPR410 device is a programmed PROM used for properly configuring the DLPC410, which supports reliable operation of the DLP7000FLP, DLP7000UVFLP, DLP9500FLN, and DLP9500UVFLN DMDs. The DLPR410 configuration enables the DLPC410 to operate at a pixel data rate up to 48 Gigabits per second (Gbps) with the option for random row addressing.

The DLPR410 device is part of a multiple component chipset in the DLP® Advanced Light Control portfolio. A dedicated chipset provides developers easier access to the DMD as well as high speed, independent micromirror control.

The DLPC410 configuration program is only available within the DLPR410. The DLPR410 requires that it be used in conjunction with the DLPC410, the DLP7000FLP, DLP7000UVFLP, DLP9500FLN, and DLP9500UVFLN DMDs, and the DLPA200 components for reliable function and operation of the chipset.

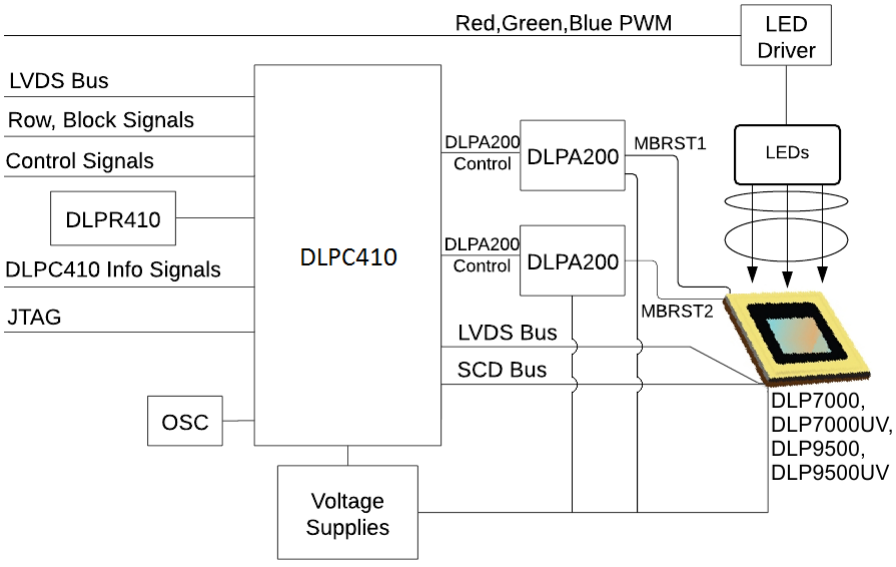
For complete electrical and mechanical specifications of the DLPR410, see the XCF16P product specification at www.xilinx.com.

Device Information(1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
DLPR410	DSBGA (48)	8.00 mm × 9.00 mm × 1.20 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.

Typical Application Diagram



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4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision C (April 2013) to Revision D — **Page**

- Updated *Features*, *Applications*, and *Description* ... 1
- Deleted DLPR4101 (enhanced functionality PROM part number) throughout document ... 1
- Added *ESD Rating* table, *Feature Description* section, *Device Functional Modes*, *Application and Implementation* section, *Power Supply Recommendations* section, *Layout* section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section ... 1
- Moved Block Diagram to new Typical Application section ... 1
- Deleted 1.8 V and 3.3 V operation values from V_{CCO}, V_{IL}, and V_{IH} - this implementation is 2.5 V ... 6
- Changed Device Marking Image ... 13
- Deleted DLP® Discovery™ 4100 Chipset Datasheet from *Related Documentation* ... 14
- Added Link to XCF16P data sheet at xilinx.com ... 14

Changes from Revision B (March 2013) to Revision C — **Page**

- Added Top View of Device ... 1
- Added DLPR4101 "Load 4" enhanced functionality to Features ... 1
- Added DLPR410 and DLPR4101 (enhanced functionality PROM part number) to DLPR410 throughout document ... 1
- Added a link to the data sheet ... 1
- Added the Version column to the *Ordering Information* table ... 4
- Updated DLPC and DLP7000 / DLP7000UV Embedded Example Block Diagram ... 11
- Updated DLPC and DLP9500 / DLP9500UV Embedded Example Block Diagram ... 12
- Added DLPR4101YVA as equivalent to TI part number 2510442-0006 ... 13
- Added Reference to DLPC410 data sheet ... 13
- Added DLPR410 to Figure 4 ... 13
- Added Top View of Device to device marking ... 13
- Added DLP7000UV Related Documentation ... 14
- Added DLP9500UV Related Documentation ... 14

Changes from Revision A (September 2012) to Revision B **Page**

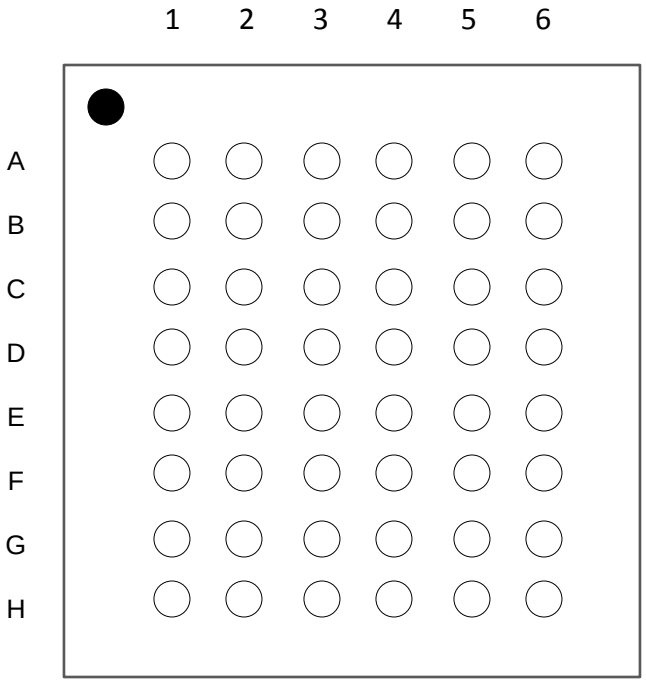
- Changed the top-side marking in the *Ordering Information* table 4

Changes from Original (August 2012) to Revision A **Page**

- Changed the device From: Product Preview To: Production 1

5 Pin Configuration and Functions

YVA Package
48-Pin DSBGA
Top View



Pin Functions

PIN		TYPE(1)	DESCRIPTION
NAME	NO.		
GND	A1	G	Ground
GND	A2	G	Ground
OE/$\overline{\text{RESET}}$	A3	I/O	Output Enable/$\overline{\text{RESET}}$ (Open-Drain I/O). When Low, this input holds the address counter reset and the DATA and CLKOUT outputs are placed in a high-impedance state. This is a bidirectional open-drain pin that is held Low while the PROM completes the internal power-on reset sequence. Polarity is not programmable. **Pin must be pulled High using an external 4.7-kΩ pull-up to V_{CCO}.**
DNC1	A4	—	Do Not Connect. Leave unconnected.
D6	A5	—	Do Not Connect. Leave unconnected.
D7	A6	—	Do Not Connect. Leave unconnected.
VCCINT1	B1	P	Positive 1.8-V supply voltage for internal logic.
VCCO1	B2	P	Positive 2.5-V supply voltage connected to the output voltage drivers and internal buffers.
CLK	B3	I	Do Not Connect. Leave unconnected.
($\overline{\text{CE}}$)	B4	I	Chip Enable Input. When ($\overline{\text{CE}}$) is High, the device is put into low-power standby mode, the address counter is reset, and the DATA and CLKOUT outputs are placed in a high impedance state.
D5	B5	—	Do Not Connect. Leave unconnected.
GND	B6	G	Ground
BUSY	C1	—	Do Not Connect. Leave unconnected.

(1) P = Power
G = Ground
I = Input
O = Output

Pin Functions (continued)

PIN		TYPE(1)	DESCRIPTION
NAME	NO.		
CLKOUT	C2	—	Configuration clock output. Each rising edge on the CLK input increments the internal address counter. **Pin must be pulled High and Low using an external 100-Ω pull-up to V_{CCO} and an external 100-Ω pull-down to Ground. Place resistors close to pin**.
DNC2	C3	—	Do Not Connect. Leave unconnected.
DNC3	C4	—	Do Not Connect. Leave unconnected.
D4	C5	—	Do Not Connect. Leave unconnected.
VCCO2	C6	P	Positive 2.5-V supply voltage connected to the output voltage drivers and internal buffers.
($\overline{CF}$)	D1	I	Configuration pin. **The ($\overline{CF}$) pin must be pulled High using an external 4.7-kΩ pull-up to V_{CCO}**. Selects serial mode configuration.
($\overline{CEO}$)	D2	—	Do Not Connect. Leave unconnected.
DNC10	D3	—	Do Not Connect. Leave unconnected.
DNC11	D4	—	Do Not Connect. Leave unconnected.
D3	D5	—	Do Not Connect. Leave unconnected.
VCCO4	D6	P	Positive 2.5-V supply voltage connected to the output voltage drivers and internal buffers.
VCCINT2	E1	P	Positive 1.8-V supply voltage for internal logic.
TMS	E2	I	JTAG Mode Select Input. TMS has an internal 50-kΩ resistive pull-up to V_{CCJ}.
DNC4	E3	—	Do Not Connect. Leave unconnected.
DNC5	E4	—	Do Not Connect. Leave unconnected.
D2	E5	—	Do Not Connect. Leave unconnected.
TDO	E6	O	JTAG Serial Data Output. TDO has an internal 50-kΩ resistive pull-up to V_{CCJ}.
GND	F1	G	Ground
DNC6	F2	—	Do Not Connect. Leave unconnected.
DNC7	F3	—	Do Not Connect. Leave unconnected.
DNC8	F4	—	Do Not Connect. Leave unconnected.
GND	F5	G	Ground
GND	F6	G	Ground
TDI	G1	I	JTAG Serial Data Input. TDI has an internal 50k-Ω resistive pull-up to V_{CCJ}.
DNC9	G2	—	Do Not Connect. Leave unconnected.
REV_SEL0	G3	I	Revision Select [1:0] Inputs. When the ($\overline{EN\_EXT\_SEL}$) is Low, the Revision Select pins are used to select the design revision to be enabled. The Revision Select [1:0] inputs have an internal 50-kΩ resistive pull-up to V_{CCO}. **The (REV_SEL0) pin must be pulled Low using an external 10-kΩ pull-down to Ground**. **The (REV_SEL1) pin must be connected to Ground**.
REV_SEL1	G4	I	
VCCO3	G5	P	Positive 2.5-V supply voltage connected to the output voltage drivers and internal buffers.
VCCINT3	G6	P	Positive 1.8-V supply voltage for internal logic.
GND	H1	G	Ground
VCCJ	H2	P	Positive 2.5-V JTAG I/O supply voltage connected to the TDO output voltage driver and TCK, TMS and TDI input buffers.
TCK	H3	I	JTAG Clock Input. This pin is the JTAG test clock. It sequences the TAP controller and all the JTAG test and programming electronics.
($\overline{EN\_EXT\_SEL}$)	H4	I	External Selection Input. ($\overline{EN\_EXT\_SEL}$) has an internal 50-kΩ resistive pull- up to V_{CCO}. **The ($\overline{EN\_EXT\_SEL}$) pin must be connected to Ground**.
D1	H5	—	Do Not Connect. Leave unconnected.
D0	H6	O	DATA output pin to provide data for configuring the DLPC410 in serial mode.

6 Specifications

6.1 Absolute Maximum Ratings

over operating free-air temperature (unless otherwise noted) (see (1) (2))

			MIN	MAX	UNIT
V_{CCINT}	Internal supply voltage	Relative to ground	–0.5	2.7	V
V_{CCO}	I/O supply voltage	Relative to ground	–0.5	4.0	V
V_{IN}	Input voltage with respect to ground	V_{CCO} < 2.5 V	–0.5	3.6	V
		V_{CCO} ≥ 2.5 V	–0.5	3.6	V
V_{TS}	Voltage applied to high-impedance output	V_{CCO} < 2.5 V	–0.5	3.6	V
		V_{CCO} ≥ 2.5 V	–0.5	3.6	V
T_J	Junction temperature			125	°C
T_{stg}	Storage temperature, ambient		–40	125	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) Maximum DC undershoot below GND must be limited to either 0.5 V or 10 mA. During transitions, the device pins can undershoot to –2 V or overshoot to 7 V, provided this overshoot or undershoot lasts less then 10 ns and with the forcing current being limited to 200 mA.

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$ (1)	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins (2) (3)	2000	V

(1) Electrostatic discharge (ESD) to measure device sensitivity and immunity to damage caused by assembly line electrostatic discharges in to the device.
(2) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(3) JEDEC Standard JESD22-A114A (C1 = 100 pF, R1 = 1500 Ω, R2 = 500 Ω).

6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

			MIN	NOM	MAX	UNIT
V_{CCINT}	Internal voltage supply		1.65	1.8	2.0	V
V_{CCO}	Supply voltage for output drivers	2.5-V operation	2.2	2.5	2.7	V
V_{IL}	Low-level input voltage	2.5-V operation	0	–	0.7	V
V_{IH}	High-level input voltage	2.5-V operation	1.7	–	3.6	V
V_O	Output voltage		0	–	V_{CCO}	V
t_{IN}	Input signal transition time (measured between 10% V_{CCO} and 90% V_{CCO})		–	–	500	ns
T_A	Operating ambient temperature		–40	–	85	°C

6.4 Thermal Information

Refer to the XCF16P product specifications at www.xilinx.com.

6.5 Electrical Characteristics

Refer to the XCF16P product specifications at www.xilinx.com.

6.6 Supply Voltage Requirements for Power-On Reset and Power-Down

(see (1))

		MIN	MAX	UNIT
t_{VCC}	V_{CCINT} rise time from 0 V to nominal voltage (2)	0.2	50	ms
V_{CCPOR}	POR threshold for V_{CCINT} supply	0.5	–	V
t_{OER}	OE/$\overline{\text{RESET}}$ release delay following POR (3)	0.5	30	ms
V_{CCPD}	Power-down threshold for V_{CCINT} supply	–	0.5	V
t_{RST}	Time required to trigger a device reset when the V_{CCINT} supply drops below the maximum V_{CCPD} threshold	10	–	ms

(1) V_{CCINT}, V_{CCO}, and V_{CCJ} supplies can be applied in any order.
(2) At power up, the device requires the V_{CCINT} power supply to monotonically rise to the nominal operating voltage within the specified T_{VCC} rise time. If the power supply cannot meet this requirement, then the device might not perform power-on-reset properly. See Figure 6, in the Xilinx XCF16P (v2.18) Product Specification for more information.
(3) If the V_{CCINT} and V_{CCO} supplies do not reach their respective recommended operating conditions before the OE/$\overline{\text{RESET}}$ pin is released, then the configuration data from the PROM is not available at the recommended threshold levels. The configuration sequence must be delayed until both V_{CCINT} and V_{CCO} have reached their recommended operating conditions.

6.7 Timing Requirements

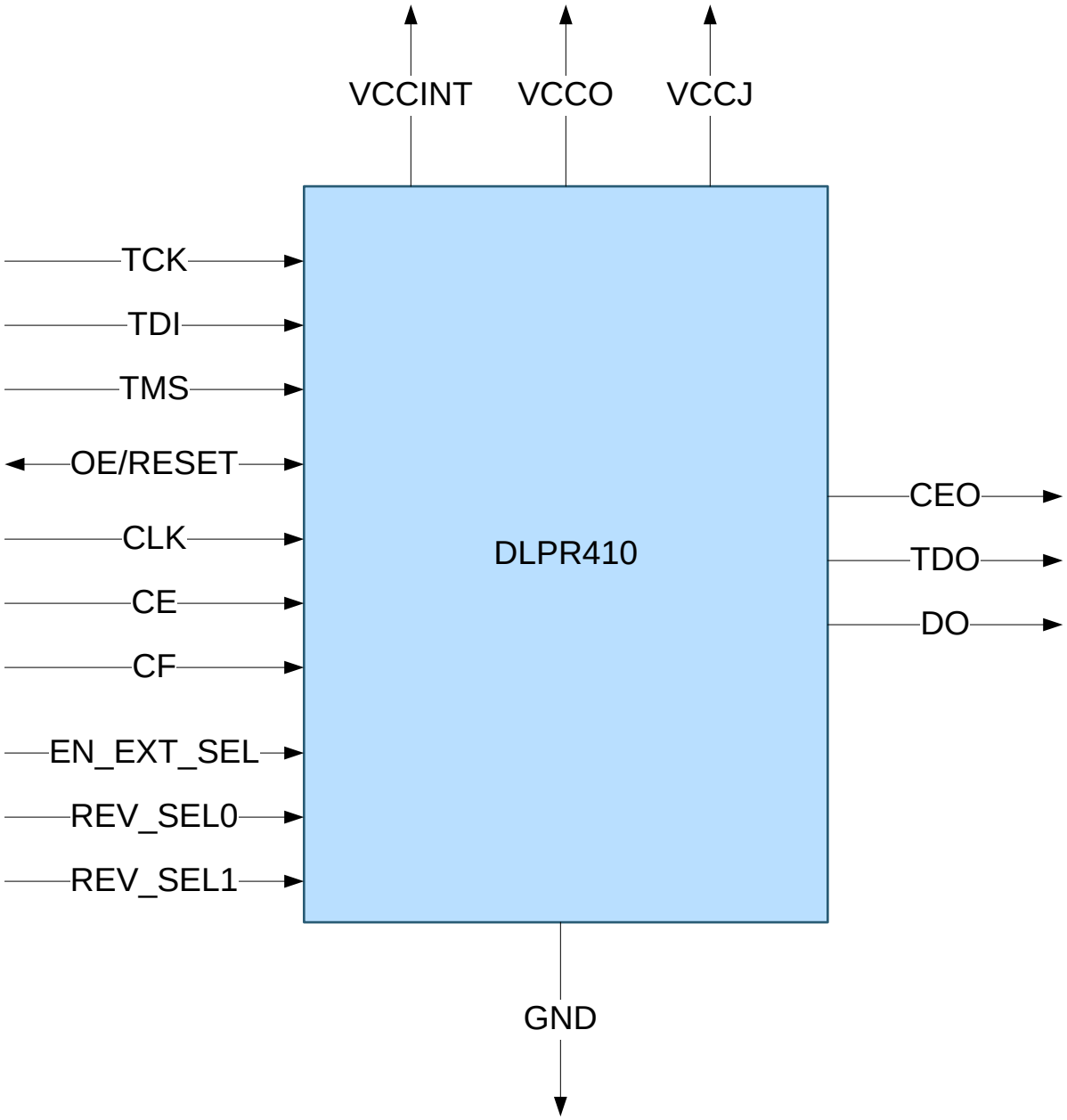
Refer to the XCF16P product specifications at www.xilinx.com.

7 Detailed Description

7.1 Overview

The configuration bit stream stored in the DLPR410 supports reliable operation of the DLPC410 and the DLP7000FLP, DLP7000UVFLP, DLP9500FLN, and DLP9500UVFLN DMDs. The DLPC410 digital controller loads this configuration bit stream from the DLPR410.

7.2 Functional Block Diagram



7.3 Feature Description

7.3.1 Data Interface

7.3.1.1 Data Outputs

The DLPR410 is configured for serial mode operation, where D0 is the data output pin. D0 output pin provides a serial connection to the DLPC410, where the configuration is read out by the DLPC410.

7.3.1.2 Configuration Clock Input

The configuration CLK is connected to the DLPC410 in master mode, where the DLPC410 provides the clock pulses to read the configuration from the DLPR410.

7.3.1.3 Output Enable and Reset

When the OE/($\overline{\text{RESET}}$) input is held low, the address counter is reset and the Data and CLKOUT outputs are placed in high-impedance state. **OE/($\overline{\text{RESET}}$) must be pulled High using an external 4.7-kΩ pull-up to V_{CCO}.**

7.3.1.4 Chip Enable

The ($\overline{\text{CE}}$) input is asserted by the DLPC410 to enable the Data and CLKOUT outputs. When ($\overline{\text{CE}}$) is held high, the DLPR410 address counter is reset, and the Data and CLKOUT outputs are placed in high-impedance states.

7.3.1.5 Configuration Pulse

The DLPR410 is configured in serial mode when the Configuration Pulse ($\overline{\text{CF}}$) is held high and ($\overline{\text{CE}}$) and OE are enabled. New data is available a short time after each rising clock edge.

7.3.1.6 Revision Selection

REV_SEL_0, REV_SEL_1, and ($\overline{\text{EN\_EXT\_SEL}}$) signals are used for selecting which revision to be the default. Setting all three signals to GND will default to revision 0 for simple DLPR410 setup.

7.4 Device Functional Modes

To successfully program the DLPC410 upon power-up, the DLPR410 must be configured and connected to the DLPC410 as shown in Figure 1.

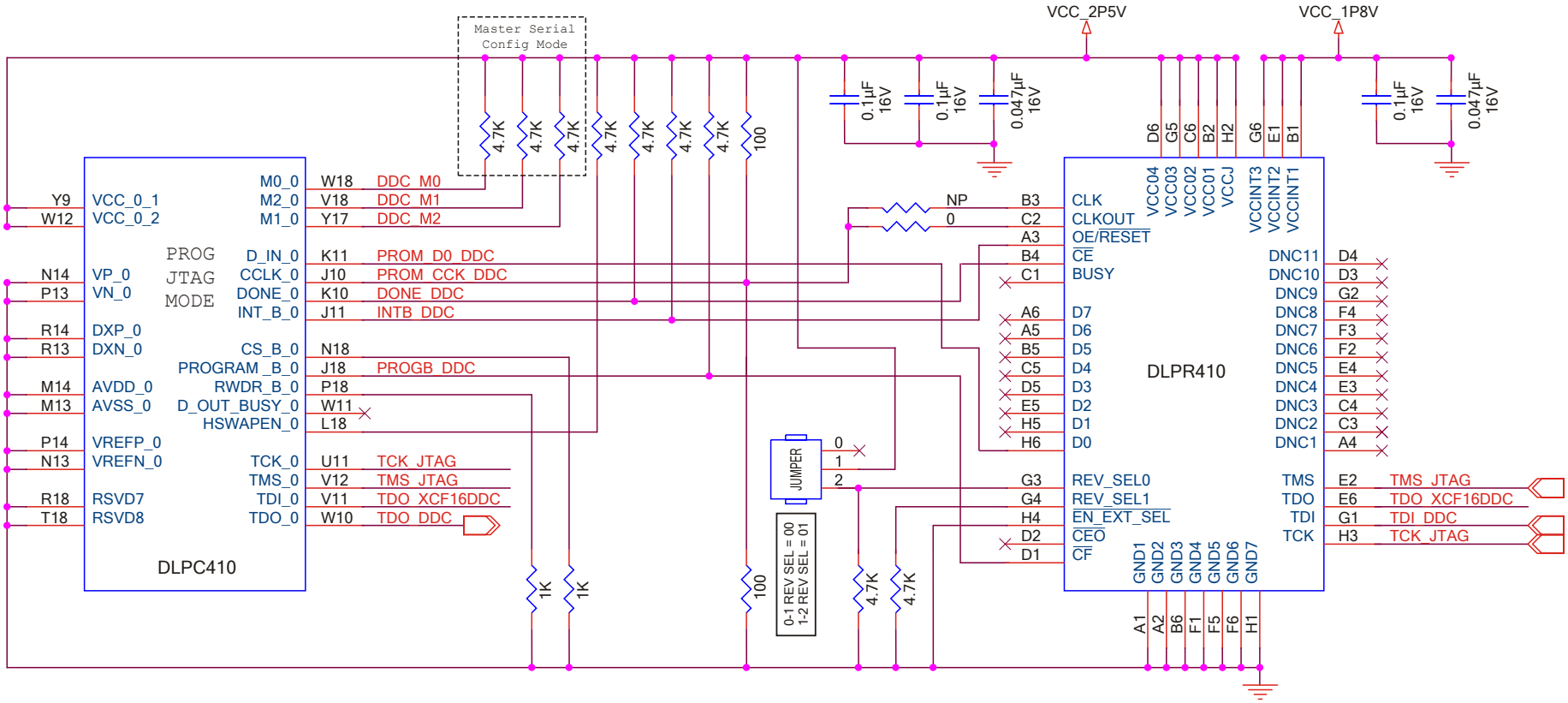


Figure 1. DLPC410 and DLPR410 Connection Schematic

8 Application and Implementation

NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

8.1 Application Information

The DLPR410 configuration PROM comes pre-programmed with configuration code for the DLPC410. Upon power-up, the DLPC410 and the DLPR410 handshake with each other to enable configuration information to be sent from the DLPR410 to the DLPC410, such that the DLPC410 can configure itself for proper operation within the application. Without the DLPR410 properly connected to the DLPC410 in the application system, the DLPC410 would not be able to boot itself and the system would remain inoperable.

8.2 Typical Application

A typical embedded system application using the DLPC410 controller programmed by the DLPR410 is shown in Figure 2 and in Figure 3. For complete details of this typical application refer to the DLPC910 data sheet listed in *Related Documentation*.

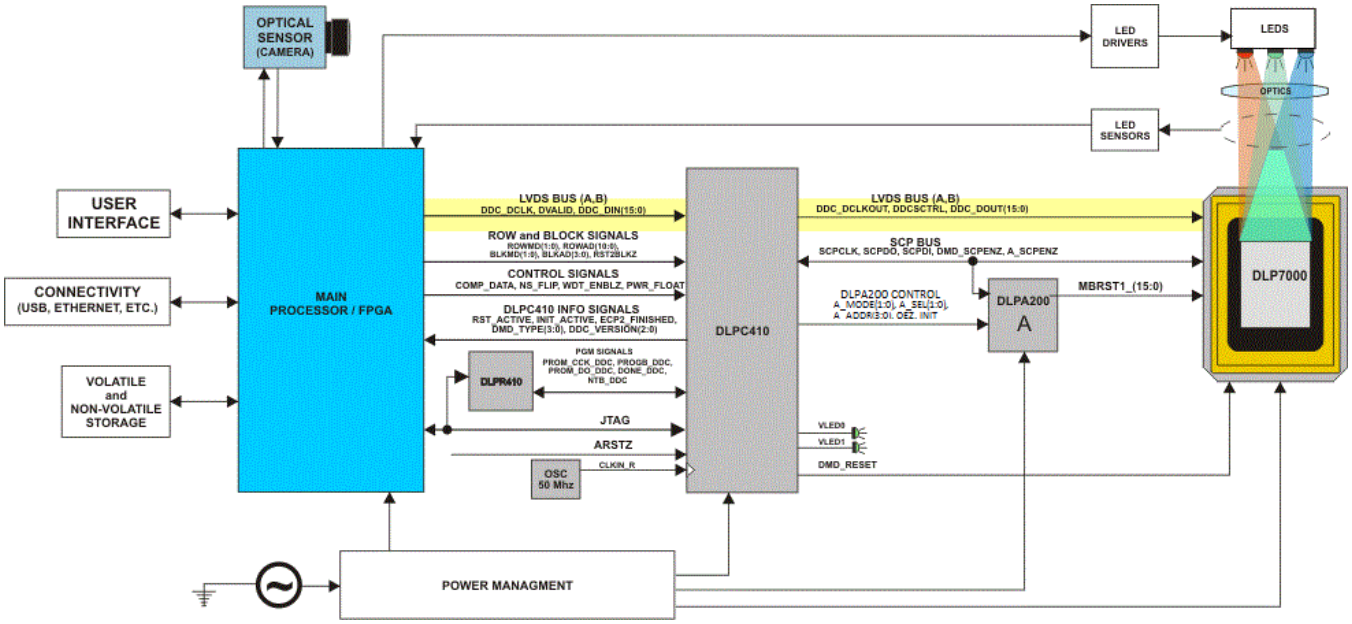


Figure 2. DLPC410 and DLP7000 / DLP7000UV Embedded Example Block Diagram

Typical Application (continued)

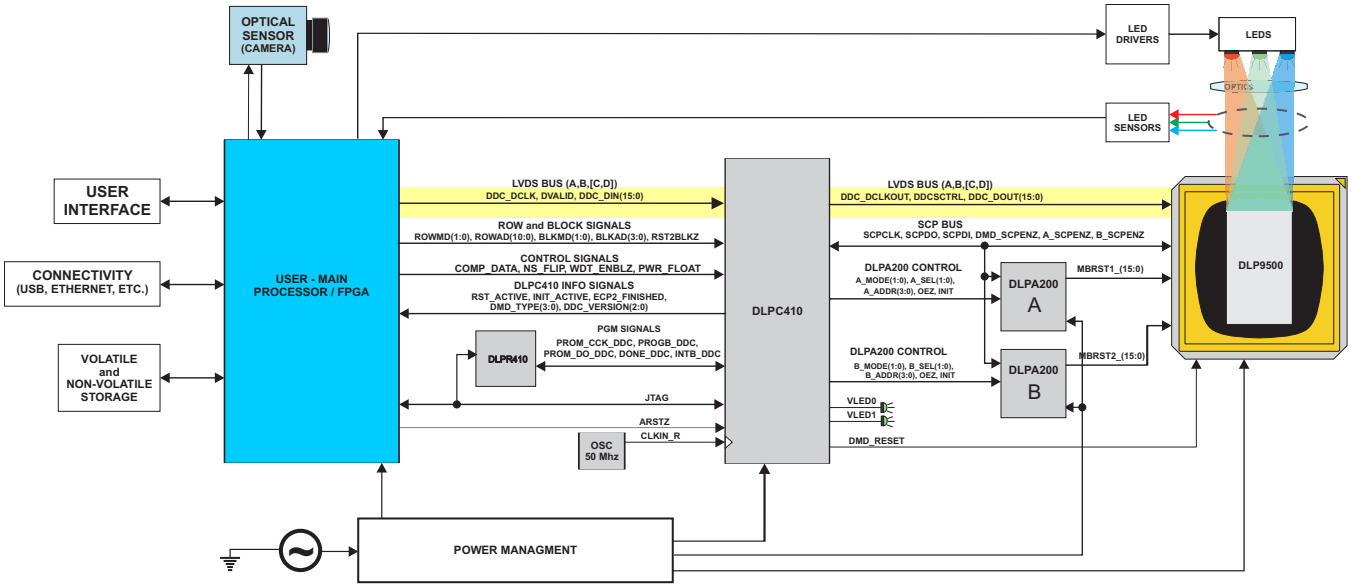


Figure 3. DLPC410 and DLP9500 / DLP9500UV Embedded Example Block Diagram

8.2.1 Design Requirements

The DLPR410 is part of a multi-chipset solution, and it is required to be coupled with the DLPC410 for reliable operation of the DLP7000FLP, DLP7000UVFLP, DLP9500FLN, and DLP9500UVFLN DMD. For more information, refer to the DLPC410 datasheet listed in *Related Documentation*.

9 Power Supply Recommendations

The DLPR410 uses two power supply rails as shown in Table 1.

Table 1. DLPR410 Power Supply Rails

SUPPLY	POWER PINS	COMMENTS
1.8 V	V_{CCINT1}, V_{CCINT2}, and V_{CCINT3}	All V_{CCINT} pins must be connected with a 0.1-µF decoupling capacitor to GND.
2.5 V	V_{CCO1},V_{CCO2},V_{CCO3}, V_{CCO4}, and V_{CCJ}	All V_{CCO} and V_{CCJ} pins must be connected with a 0.1-µF decoupling capacitor to GND.

10 Layout

10.1 Layout Guidelines

The DLPR410 is part of a multi-chipset solution, and it is required to be coupled with the DLPC410 for reliable operation of the DLP7000FLP, DLP7000UVFLP, DLP9500FLN, and DLP9500UVFLN DMD. Refer to the DLPC410 datasheet listed in *Related Documentation* for a layout example for this multi-chipset solution.

11 Device and Documentation Support

11.1 Device Support

11.1.1 Device Nomenclature

Table 2. Part Number Description

TI PART NUMBER	DESCRIPTION	REFERENCE NUMBER
DLPR410YVA	DLPR410 Configuration PROM	2510442-0005

11.1.2 Device Markings

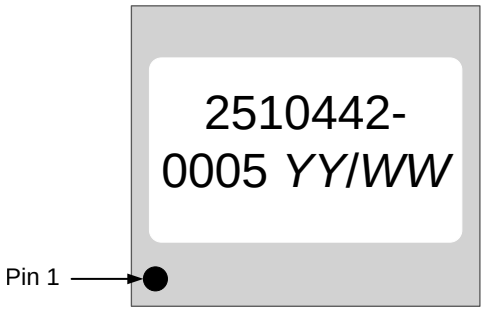


Figure 4. DLPR410 Device Markings

Where 0005 is the version number and *YY/WW* is the year/week the part was programmed.

11.2 Documentation Support

11.2.1 Related Documentation

For related documentation, see the following:

Table 3. Related Documentation

DOCUMENT	TI LITERATURE NUMBER
DLP7000 0.7 XGA Type-A DMD data sheet	DLPS026
DLP7000UV 0.7 XGA UV Type-A DMD data sheet	DLPS061
DLP9500 0.95 1080p Type-A DMD data sheet	DLPS025
DLP9500UV 0.95 1080p UV Type-A DMD data sheet	DLPS033
DLPA200 DMD Micromirror Driver data sheet	DLPS015
DLPC410 DMD Controller data sheet	DLPS024
XCF16P data sheet	available at www.xilinx.com

11.3 Community Resources

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

TI E2E™ Online Community ***TI's Engineer-to-Engineer (E2E) Community.*** Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support ***TI's Design Support*** Quickly find helpful E2E forums along with design support tools and contact information for technical support.

11.4 Trademarks

E2E is a trademark of Texas Instruments.
DLP is a registered trademark of Texas Instruments.
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11.5 Electrostatic Discharge Caution

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

11.6 Glossary

SLYZ022 — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

12 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this datasheet, refer to the left-hand navigation.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
DLPR410YVA	ACTIVE	DSBGA	YVA	48	3	Pb-Free (RoHS)	Call TI	Level-3-260C-168 HR			Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

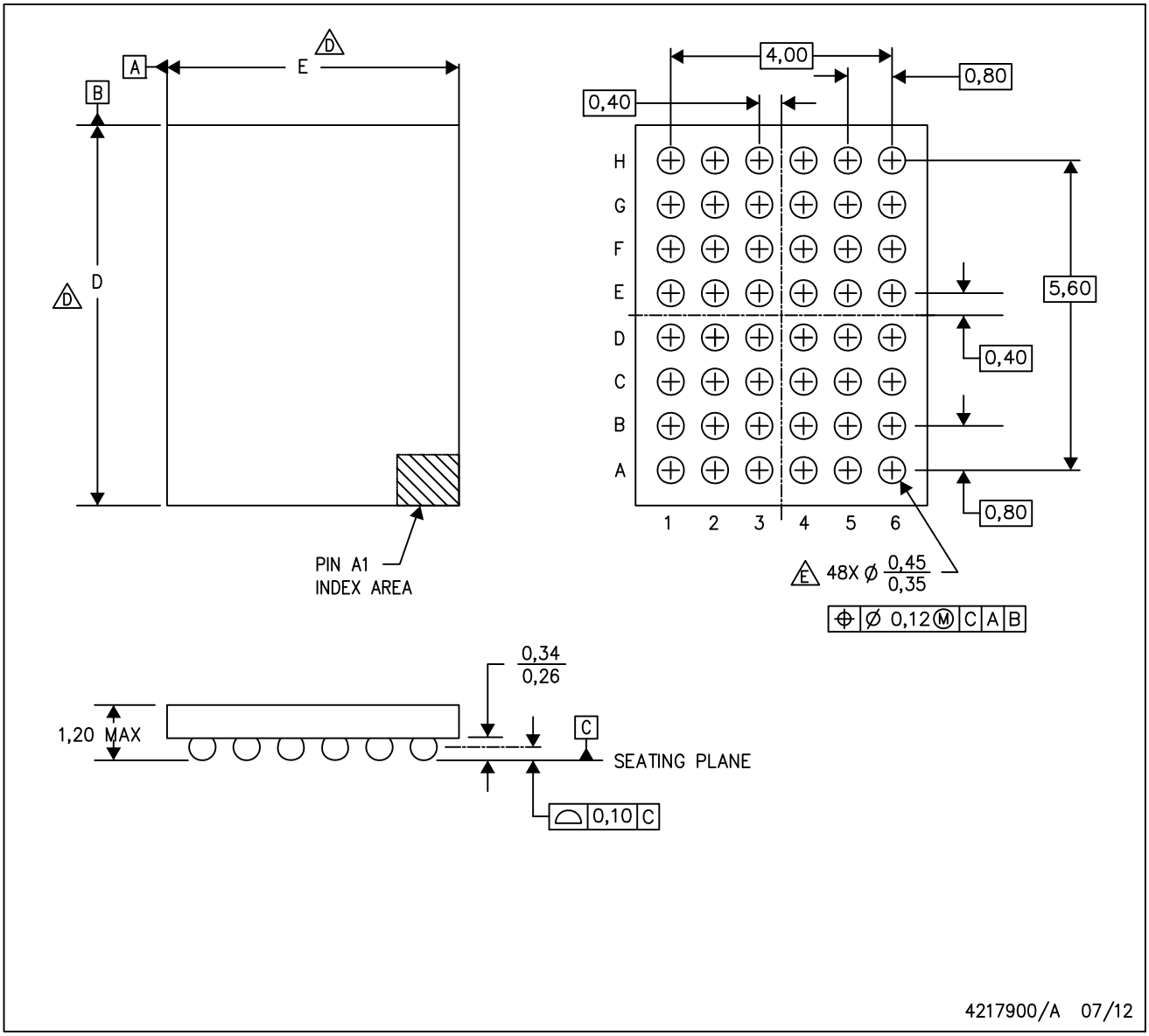
(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

YVA (R–XBGA–N48) DIE–SIZE BALL GRID ARRAY



NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. NanoFree™ package configuration.
D. The package size (Dimension D and E) of a particular device is specified in the device Product Data Sheet version of this drawing, in case it cannot be found in the product data sheet please contact a local TI representative.
E. Reference Product Data Sheet for array population.
6 x 8 matrix pattern is shown for illustration only.
F. This package contains Pb–free balls.

NanoFree is a trademark of Texas Instruments.

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